

# ***INSTRUCTION MANUAL***

**MAGNETIC FLOWMETERS**  
**10D1476 Design Level S**  
**1/25 - 4 in.**

**K-MAG<sup>®</sup> MAGNETIC FLOWMETER**



PN25009A

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**WARNING** notices as used in this manual apply to hazards or unsafe practices which could result in personal injury or death.

**CAUTION** notices apply to hazards or unsafe practices which could result in property damage.

**NOTES** highlight procedures and contain information which assist the operator in understanding the information contained in this manual.

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#### **WARNING**

##### **INSTRUCTION MANUALS**

Do not install, maintain or operate this equipment without reading, understanding and following the proper ABB Inc. instructions and manuals, otherwise injury or damage may result.

##### **POSSIBLE PROCESS UPSETS**

Operation & maintenance must be performed only by qualified personnel and only after securing equipment controlled by this product. Adjusting or removing this product while it is in the system may upset the process being controlled. Some process upsets may cause injury or damage.

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## SAFETY SUMMARY

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### GENERAL WARNINGS

#### POSSIBLE PROCESS UPSETS

Maintenance must be performed only by qualified personnel and only after securing equipment controlled by this product. Adjusting or removing this product while it is in the system may upset the process being controlled. Some process upsets may cause injury or damage.

#### RETURN OF EQUIPMENT

All Flowmeters and/or Signal Converters being returned to ABB Inc. for repair must be free of any hazardous materials (acids, alkalis, solvents, etc.). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact ABB Inc. for authorization prior to returning equipment.

#### INSTRUCTION MANUALS

Do not install, maintain or operate this equipment without reading, understanding and following the proper ABB Inc. instructions and manuals, otherwise injury or damage may result.

#### ELECTRICAL SHOCK HAZARD

Equipment powered by AC line voltage presents a potential electric shock hazard to the user. Make certain that the system power is disconnected from the operating branch circuit before attempting electrical interconnections or service.

### SPECIFIC WARNINGS

#### ELECTRICAL SHOCK HAZARD

Equipment powered by AC line voltage presents a potential electric shock hazard to the user. Make certain that the system power is disconnected from the operating branch circuit before attempting electrical interconnections or service. (Pg. 2-18)

All Flowmeters and/or Signal Converters being returned to ABB Inc. for repair must be free of any hazardous materials (acids, alkalis, solvents, etc.). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact ABB Inc. for authorization prior to returning equipment. (Pg. 6-1.)

Equipment powered by an ac line voltage presents a potential electric shock hazard. Servicing of the Magnetic Flowmeter or Signal Converter should only be attempted by a qualified electronics technician. (Pg. 6-2)

Equipment that operates from ac line voltage constitutes a potential electric shock hazard to the user. Make certain that the system power is disconnected before making the following ohmmeter checks. (Pg. 6-3)

### SPECIFIC CAUTIONS

Do not use a dc ohmmeter for this measurement as polarization effects will produce completely erroneous data. (Pg. 4-3)

## **GÉNÉRAUX AVERTISSEMENTS**

**PROBLÈMES POTENTIELS.** La maintenance doit être réalisée par du personnel qualifié et seulement après avoir sécurisé les équipements contrôlés par ce produit. L'ajustement ou le démontage de ce produit lorsqu'il est lié au système peut entraîner des dysfonctionnements dans le procédé qu'il contrôle. Ces dysfonctionnements peuvent entraîner des blessures ou des dommages.

**RETOUR D'ÉQUIPEMENT.** Tout débitmètre et(ou) convertisseur retourné à ABB Inc. pour réparation doit être exempt de toute trace de produit dangereux (acide, base, solvant, ... ). Un certificat de sécurité matériel doit être joint pour tous les liquides utilisés dans le procédé. Contacter ABB Inc. pour autorisation avant renvoi du matériel.

**MANUEL DE MISE EN ROUTE.** Ne pas installer, maintenir ou utiliser cet équipement sans avoir lu, compris et suivi les instructions et manuels de ABB Inc., dans le cas contraire il y a risque d'entraîner blessures ou dommages.

### **RISQUE DE CHOC ÉLECTRIQUE**

Les équipements alimentés en courant alternatif constituent un risque de choc électrique potentiel pour l'utilisateur. Assurez-vous que les câbles d'alimentation amont sont déconnectés avant de procéder à des branchements, des essais ou tests.

## **SPÉCIFIQUES AVERTISSEMENTS**

Tout débitmètre et(ou) convertisseur retourné à ABB pour réparation doit être exempt de toute trace de produit dangereux (acide, base, solvant, ... ). Un certificat de sécurité matériel doit être joint pour tous les liquides utilisés dans le procédé. Contacter ABB pour autorisation avant renvoi du matériel. (Pg. 2-18)

### **RISQUE DE CHOC ÉLECTRIQUE**

Les équipements alimentés en courant alternatif constituent un risque de choc électrique potentiel pour l'utilisateur. Assurez-vous que les câbles d'alimentation amont sont déconnectés avant de procéder à des branchements, des essais ou tests. (Pg. 6-1)

### **RISQUE DE CHOC ÉLECTRIQUE**

Les équipements alimentés en courant alternatif constituent un risque de choc électrique potentiel. La maintenance sur des équipements électromagnétiques ou des convertisseurs doit être effectuée par des techniciens qualifiés. (Pg. 6-2)

### **RISQUE DE CHOC ÉLECTRIQUE**

Les équipements alimentés en courant alternatif constituent un risque de choc électrique potentiel. Assurez-vous que la puissance est déconnectée avant de procéder aux mesures de résistance suivantes. (Pg. 6-3)

## **SPÉCIFIQUES ATTENTIONS**

N'utilisez pas un ohmmètre de C.C pour cette mesure car les effets de polarisation produiront des données complètement incorrectes. (Pg. 4-3)

## **READ FIRST**

---

### **WARNING**

#### **INSTRUCTION MANUALS**

Do not install, maintain, or operate this equipment without reading, understanding and following the proper instructions and manuals, otherwise injury or damage may result.

#### **RETURN OF EQUIPMENT**

All Flowmeters and/or Signal Converters being returned to the factory for repair must be free of any hazardous materials (acids, alkalis, solvents, etc). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact the factory for authorization prior to returning equipment.

Read these instructions before starting installation;  
save these instructions for future reference.

### **Contacting the Factory...**

Should assistance be required with any of the company's products, contact the following:

**Telephone:**

**24-Hour Call Center  
1-800-HELP-365**

**E-Mail:**

**[ins.techsupport@us.abb.com](mailto:ins.techsupport@us.abb.com)**

The NEMA 4X rating applies to the meter body and electronics enclosure only. The following accessories (if supplied) may not meet NEMA 4X unless specifically ordered as NEMA 4X:

- meter flanges
- meter installation hardware: studs, nuts, bolts
- enclosure mounting hardware for pipe or wall mounting
- conduit hardware

This product is painted with a high performance epoxy paint. The corrosion protection provided by this finish is only effective if the finish is unbroken. It is the users' responsibility to "touch-up" any damage that has occurred to the finish during shipping or installation of the product. Special attention must be given to: meter flange bolting, pipe mounting of electronics, conduit entries and covers that are removed to facilitate installation or repair. For continued corrosion protection throughout the product life, it is the users' responsibility to maintain the product finish. Incidental scratches and other finish damage must be repaired and promptly re-painted with approved touch-up paint. Provide the model number and size of your product to the nearest ABB Inc. representative to obtain the correct touch-up paint.



## 1.0 INTRODUCTION

### 1.1 General

The Series 10D1476 K-MAG<sup>®</sup> magnetic flowmeter, shown in Figure 1-1, is an electromagnetic liquid flow rate detector. The meter uses the characteristics of a conductive liquid to generate an induced signal voltage, directly proportional to flow rate, as the liquid passes internal electrodes. The resultant voltage is applied to a solid state electronics package that conditions it to an output signal compatible with conventional receiving equipment.

The standard meter design provides a compact, very low power, obstructionless primary metering element that bolts between flanges in a process pipeline. Pressure losses in this type of meter are reduced to levels occurring in equivalent lengths of equal diameter pipeline, thus reducing or conserving pressure source requirements as compared to other metering methods. The compact size of the meter results in a light-weight unit that requires no additional support other than that used normally on pipe runs.

The Series 10D1476 K-MAG complies with 3-A Sanitary Standards For Flowmeters For Milk and Milk Products, Number 28-01\*. As an option, for 3-A Sanitary applications, the K-MAG can be supplied with TRI-CLAMP<sup>®</sup> sanitary adaptors for connection to the customer's sanitary tubing system. In addition, for USDA Meat and Poultry Equipment applications, the K-MAG is provided with USDA accepted epoxy paint on all exterior surfaces, gaskets certified to FDA/USDA sanitary requirements and TRI-CLAMP sanitary adaptors assembled to the meter with all stainless steel hardware.

\* 3-A Sanitary Standards are formulated by the International Association of Milk, Food and Environmental Sanitarians, the United States Public Health Service, Food and Drug Administration and the Dairy Industry Committee. The 3-A Sanitary Standards Symbol Administrative Council verifies compliance to these standards and authorizes the use of the 3-A Symbol.

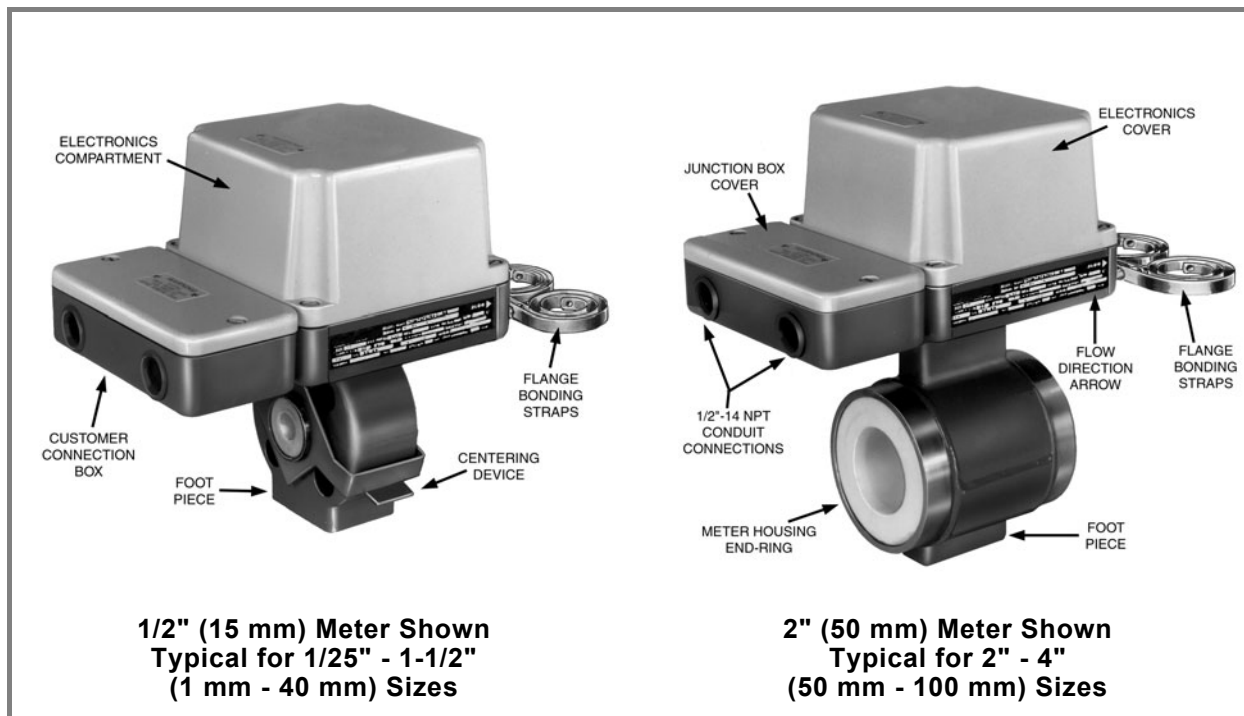
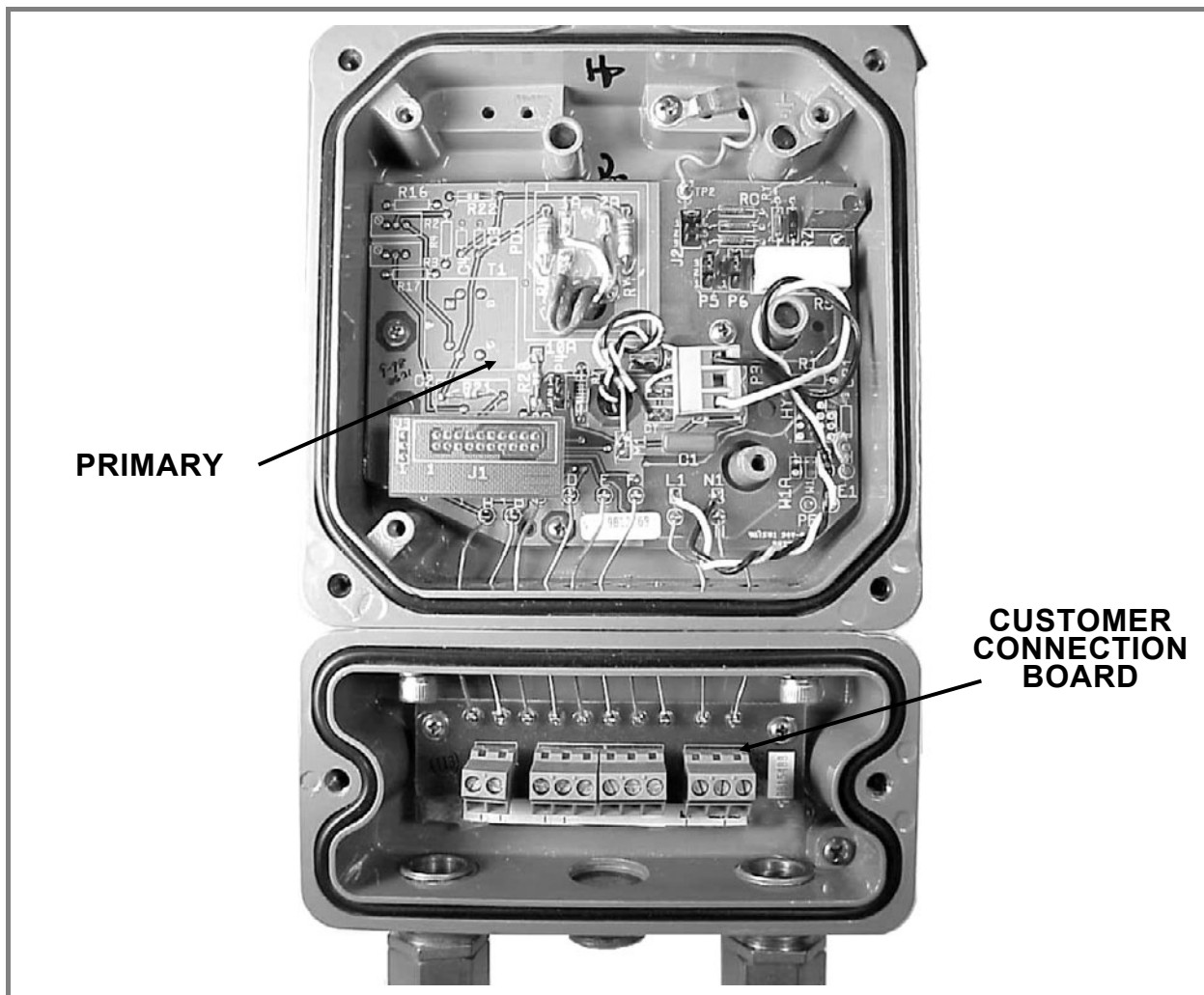


FIGURE 1-1. TYPICAL FLOWMETERS

This flowmeter can be used to meter either clean or dirty liquids. The meter may be used without regard to the heterogeneous consistency of the measured liquid and is as independent of the tendency to plug or foul as the pipeline in which it is mounted. By design, only the ceramic spool meter body and electrodes are wetted parts, and will accommodate most acids, bases, water and aqueous solutions.

Viscosity and density of the metered liquid have no effect on the measurement accuracy of the meter and, therefore, signal compensation is not required. Metering limitations are confined to a minimum threshold of electrical conductivity inherent to the liquid being metered. The degree of liquid conductivity has no effect upon the metering accuracy (as long as it is greater than the minimum level). The liquid temperature and pressure are limited to the meter material specification limits. Refer to Section 1.3.

The meter body is a sealed section that bolts between the customer's pipe line flanges. The measuring electrodes that contact the process liquid have their ends flush with the inside of the meter tube. For accurate results, the meter bore diameter must be centered in the pipeline. For the larger size meters, spacer sleeves are slipped over the flange mounting bolts. The smaller size meters use a unique centering device to center the meter. The centering device is shown in Figure 1-1.



**FIGURE 1-2. ELECTRONICS COMPARTMENT**

With the exception of the primary board, the associated electronics package is called the signal converter and is remotely mounted. Figure 1-2 shows the electronics compartment for the remote signal converter. The remote mounted signal converter improves performance if 1) the vibration specification is exceeded and/or 2) the process liquid temperature vs. ambient temperature exceeds the value specified for that of an integral converter.

The signal converter also contains a magnet driver unit that is used to power the meter's magnet coils. The steady state magnetic field principle, referred to as the MAG-X design concept, provides optimum zero point stability at an optimized frequency which is a submultiple of the power line frequency.

For additional information, refer to Section 4.0.

## **1.2 Model Number Breakdown**

Refer to the equipment's data sheet or the data tag on the equipment for the model number of the instrument furnished. The details of a specific number are as follows:

## Model 10D1476S

10D1476		S	H	—	—	M	2	9	—	Y	—	3	A	1	1	—	2
<b>Engineering Reference</b>																	
<b>Design Level</b> with 50XM Electronics		S															
<b>Liner Material</b> Ceramic Spool		H															
<b>Meter Size</b> [Inches (mm)]																	
1/25 (1)		36															
1/12 (2)		37															
1/10 (3)		01															
5/32 (4)		02															
1/4 (6)		04															
3/8 (10)		06															
1/2 (15)		07															
1 (25)		09															
1-1/2 (40)		11															
2 (50)		12															
3 (80)		14															
4 (100)		15															
<b>Flange Standard/Pressure Rating</b>																	
ANSI Class 150		P															
ANSI Class 300		Q															
BS10 Table D		S															
BS10 Table E		T															
BS10 Table F		U															
DIN PN16		D															
DIN PN40		F															
U.S.D.A. Sanitary Tri-Clamp Fittings		1															
<b>Electrode Material</b> Platinum		M															
<b>Electrode Type</b> Flush		2															
<b>Flange Material</b> Flangeless Design		9															
<b>Safety Classification</b> w/o FM Approval (General Purpose)		A															
FM Approved - Primary Flowmeter & Remote-mounted Signal Converter: Nonincendive for Class I, Div 2, Gp A, B, C & D; Electrodes Intrinsically Safe for Class I, Div 1, Gp A, B, C & D; Outdoor Hazardous Locations, NEMA 4X.		K															
U.S.D.A. Approved Meat & Poultry Equipment (Also certified for F.D.A. & 3A Sanitary Applications)		N															

## Model 10D1476S (Cont.)

10D1476	S	H		M	2	9		Y		3	A	1	1		2
<b>Power Requirements</b>															
Remote Converter								Y							
<b>Enclosure Classification</b>															
IEC 529 IP 65, NEMA 4X									1						
Accidental Submergence, IEC 529 IP 67															
30 ft. H <sub>2</sub> O/48 hr. (9 m H <sub>2</sub> O/48 hr.)									5						
<b>Fluid Temperature Range</b>															
up to 356°F (180°C)										3					
<b>Output Current</b>															
No output signal required											A				
<b>Output Options</b>															
No Scaled Output Required												1			
<b>Communications Mode Over Data Link</b>															
Not Applicable													1		
<b>Coil Drive Frequency</b>															
7-1/2 Hz (60 Hz)														1	
15 Hz (60 Hz)														2	
DC 15 Hz (@60 Hz Line Frequency)														3	
<b>Additional Options</b>															
None															2

### 1.3 Specifications

**Power Requirements**

See Section 1.2 Model Number Breakdown

Power Consumption

Refer to signal converter instruction manual for power input requirements; typically, 30VA.

**Flowmeter Characteristics**

Meter Size/Flow Capacity

See Table 1-1

Span

Factory set at specified range between extremes listed in Table 1-1; can be field adjusted.

Rangeability

100:1

Minimum Liquid Conductivity

5  $\mu$ S/cm

System Accuracy

	<b>Flowrate</b>	<b>Accuracy</b>
<b>Frequency Output</b>	< 2% Cal Factor	$\pm$ 0.02% Cal Factor
	$\geq$ 2% Cal Factor	$\pm$ 0.5% of rate

RFI Protection

Class 2-abc-0.1% (10 V/m-20 to 1000 MHz) Per SAMA Standard PMC 33.1-1978. Standard with converters; not available with remote converter.

**Environmental Limits**

Enclosure Classification with or without Signal Converter

IEC 529 IP65; NEMA 4X

Accidental Submergence

IE 529 IP67, 30 feet H<sub>2</sub>O/48 h (9 m H<sub>2</sub>O/48 h)

Environmental Temperature Limits at Flowmeter.

-40 to 150° F  
(-40 to 65° C)**Process Limits**

Temperature Limits, Process Liquid

May not exceed 356° F (180° C)

Thermal Shock

positive temp change, 212°F (100°C)  
negative temp change, 158°F (70°C)

# NOTE

The temperature gradient between the liquid and the ceramic spool should not exceed 212°F (100°C) when increasing the temperature or 158°F (70°C) when cooling, to prevent cracking. For example, if the ceramic is at a temperature of 20°C, liquids at 120°C can be handled. If the liquid temperature is 180°C, the ceramic spool should be stabilized for approximately 5 minutes at 120°C before allowing it to increase to 180°C. A similar consideration should be made when cooling. This is especially important when following SIP\* (Steam-in-place) procedures.

\* SIP procedures per pharmaceutical industry.

## Pressure Rating

Meter size	Temperature		
	38° C (100° F)	130° C (266° F)	180° C (356° F)
1 - 80 mm (1/25 - 3 in)	5.11 MPa (740 psi)	4.62 MPa (699 psi)	4.43 MPa (643 psi)
100 mm (4 in)	2.00 MPa (285 psi)	1.66 MPa (240 psi)	1.45 MPa (210 psi)

Vacuum Limit

full vacuum at 180°C (356°F)

Meter Calibration Factor

specified on primary data tag (equal to max flow capacity in engineering units). This factor is equivalent to a flow velocity of 33.33 ft/s in the metering tube.

## Physical Characteristics

Outline Dimensions, magnetic flowmeter with or without signal converter

Standard

with Sanitary Fittings

1-40 mm (1/25 - 1-1/2")

See Figure 2-1

See Figure 2-3

50 - 100 mm (2 - 4")

See Figure 2-2

See Figure 2-4

Remote Mounted Signal Converter

See signal converter instruction manual

Conduit Connections

(2) 1/2" NPT internally threaded entrances in primary junction box

Meter Weight

See signal converter instruction manual

Signal Converter Vibration Limit

5 to 14 Hz, 0.20";  
14 to 200 Hz, 1.5 g

## Materials of Construction

Meter Body (Spool)	Ceramic, 99.5% Alumina
Electrode Assemblies (wetted)	Platinum
Meter Housing	carbon steel, all welded construction, epoxy finish
Housing End Rings	304 sst
Electronics Housing	die cast aluminum, epoxy finish, 316 sst attachment screws, 1/2 NPT conduit connections, gas-keted covers
Installation Kit	includes 2 gaskets, mounting studs and nuts, flange adaptor device(s) as required.

Exception: Sanitary TRI-CLAMP Fittings  
 Meter is preassembled; all mounting hardware (studs and nuts) and flanges are stainless steel. Gaskets are TEFLON-FEP (Virgin). Gasket manufacturer must provide certificate of compliance as proof of U.S.D.A. approval and compliance with 3A Sanitary Standards, Class-I material.

**TABLE 1-1. CAL FACTOR and CAPACITY**

**NOTE**

The CAL FACTORS given below can only be used with Model 10D1476 Design Levels B,C, M, N, P & S. For Meters manufactured under design level A, refer to the meter data tag for the appropriate factor.

			Flow Ranges 0 to value tabulated					
Meter Size		CAL FACTOR*	Minimum 10D1476B & C		Minimum 10D1476M, N & P		Maximum	
mm	inch	gpm	gpm	lpm	gpm	lpm	gpm	lpm
1	1/25	0.1610	0.014	0.06	0.009	0.03	0.18	0.60
2	1/12	0.5368	0.048	0.20	0.027	0.10	0.54	2.00
3	1/10	1.073	0.096	0.40	0.054	0.20	1.20	4.00
4	5/32	2.147	0.192	0.80	0.108	0.40	2.40	8.00
6	1/4	5.367	0.480	2.00	0.270	1.00	6.00	20.0
10	3/8	12.08	1.08	4.50	0.605	2.25	13.5	45.0
15	1/2	26.84	2.40	10.0	1.35	5.0	30.0	100.
25	1	53.67	4.80	20.0	2.70	10.0	60.0	200.
40	1 1/2	161.0	14.4	60.0	8.10	30.0	180.	600.
				m <sup>3</sup> /H		m <sup>3</sup> /H		m <sup>3</sup> /H
50	2	268.4	24.0	6.0	13.5	3.0	300.	60.
80	3	805.1	72.0	18.0	40.5	9.0	900.	180.
100	4	1073.0	96.0	24.0	53.7	12.0	1200	240.

\* Flow Velocity (ft/s) = (Operating GPM x 33.33)/CAL Factor



## 2.0 INSTALLATION

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### 2.1 Inspection

All Model 10D1476 K-MAG magnetic flowmeters are shipped in heavy duty containers. The packaging used for K-MAG protection is certified for air shipment by the Container Testing Laboratory. An itemized list of all items included in the shipment is attached to the shipping container.

The equipment will generally consist of a magnetic flowmeter and appropriate mounting hardware kit, and a remote mounted signal converter with a 30 foot (9 m) long interconnection cable. (signal cable lengths up to 100 feet (30 m) can be supplied, when specified.)

The mounting hardware kit for the standard K-MAG includes:

- 1) 4 or 8 threaded studs and nuts
- 2) 2 gaskets
- 3) appropriate flange adaptor components, if specified.

**NOTE**

The centering device (see Figure 2-7) or adaptor sleeves (see Figure 2-8) required for the particular meter installation are supplied by  
with all U.S. orders.

When a sanitary K-MAG USDA listed as Accepted Meat and Poultry Equipment is specified, it is provided with USDA accepted epoxy paint on all exterior surfaces, gaskets certified to FDA/USDA sanitary requirements and the TRI-CLAMP sanitary adaptors assembled to the meter with all stainless steel (studs and nuts) hardware as shown in Figures 2-3 and 2-4.

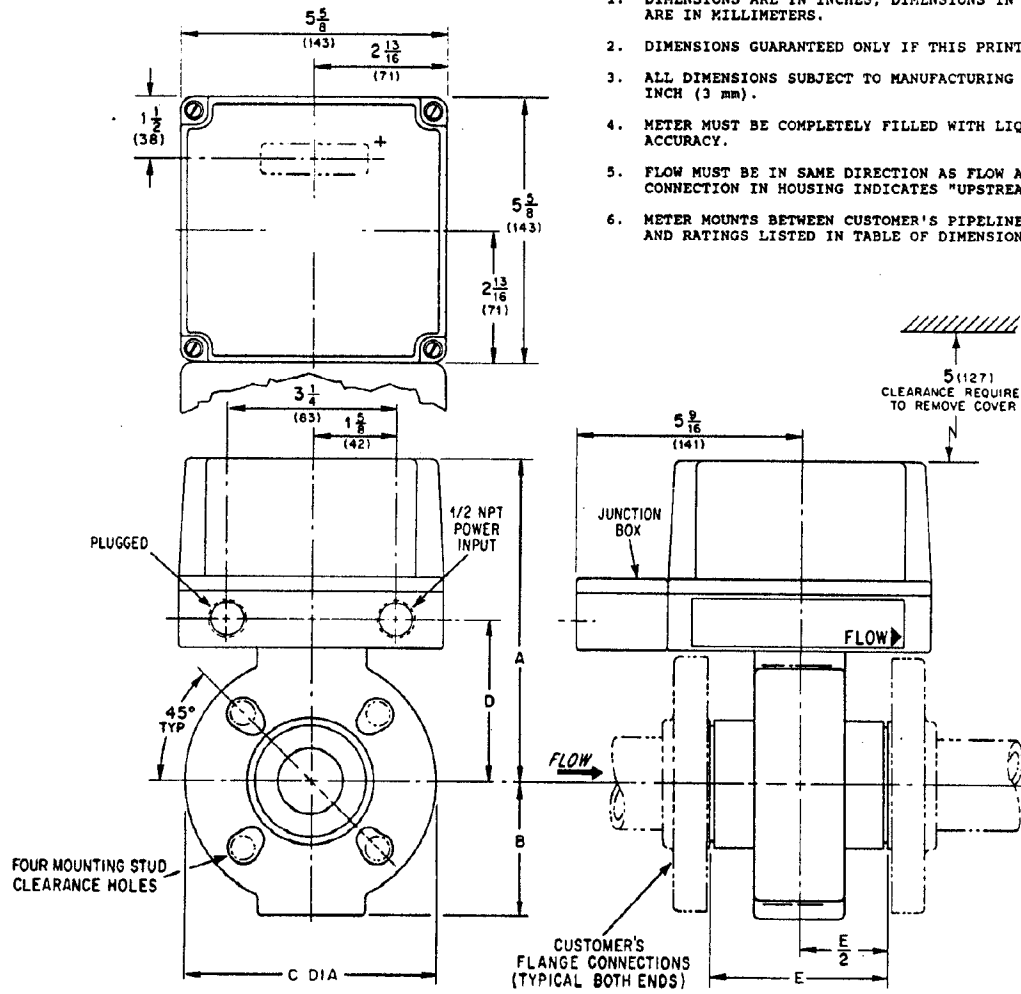
Inspect all items included in the shipment immediately for indications of damage which may have occurred during shipment. All damage claims should be reported to the shipping agent involved before attempting to install or operate the equipment.

The proper use of the items included in the mounting hardware kit and the proper employment of them during installation is necessary to maintain a valid instrument warranty. (An installation and warranty tag is furnished with the mounting hardware kit that provides the basic information essential for proper meter installation.)

Following inspection of the shipment contents, it is suggested that all items be carefully replaced in the shipping container for transit to the installation site. The use of normal care in the handling and installation of this equipment will contribute substantially toward satisfactory performance.

## NOTES:

1. DIMENSIONS ARE IN INCHES, DIMENSIONS IN PARENTHESES ( ) ARE IN MILLIMETERS.
2. DIMENSIONS GUARANTEED ONLY IF THIS PRINT IS CERTIFIED.
3. ALL DIMENSIONS SUBJECT TO MANUFACTURING TOLERANCE OF  $\pm 1/8$  INCH (3 mm).
4. METER MUST BE COMPLETELY FILLED WITH LIQUID TO ENSURE ACCURACY.
5. FLOW MUST BE IN SAME DIRECTION AS FLOW ARROW. 1/2 NPT CONNECTION IN HOUSING INDICATES "UPSTREAM" END OF METER.
6. METER MOUNTS BETWEEN CUSTOMER'S PIPELINE FLANGES. TYPES AND RATINGS LISTED IN TABLE OF DIMENSIONS.



METER SIZE		FLANGE SIZE		CUSTOMER FLANGE TYPE AND RATING	A*		B		C DIA		D		E	
INCH	mm	INCH	mm		INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm
1/25	1	1/2	15	ANSI CLASS 150 ANSI CLASS 300 BS 10 TBL D, E, F DIN PN 10, 16, 25 & 40	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	2-11/16	68
1/12	2	1/2	15		6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	2-11/16	68
1/10	3	1/2	15		6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	2-11/16	68
5/32	4	1/2	15		6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	2-11/16	68
1/4	6	1/2	15		6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	2-11/16	68
3/8	10	1/2	15		6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	2-11/16	68
1/2	15	1/2	15		6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	2-11/16	68
1	25	1	25		6-11/16	173	2-19/32	66	4-7/8	124	3-1/8	79	3-9/16	90
1-1/2	40	1-1/2	40		7-1/2	191	3-9/32	83	6-1/8	156	3-13/16	97	4-1/16	103

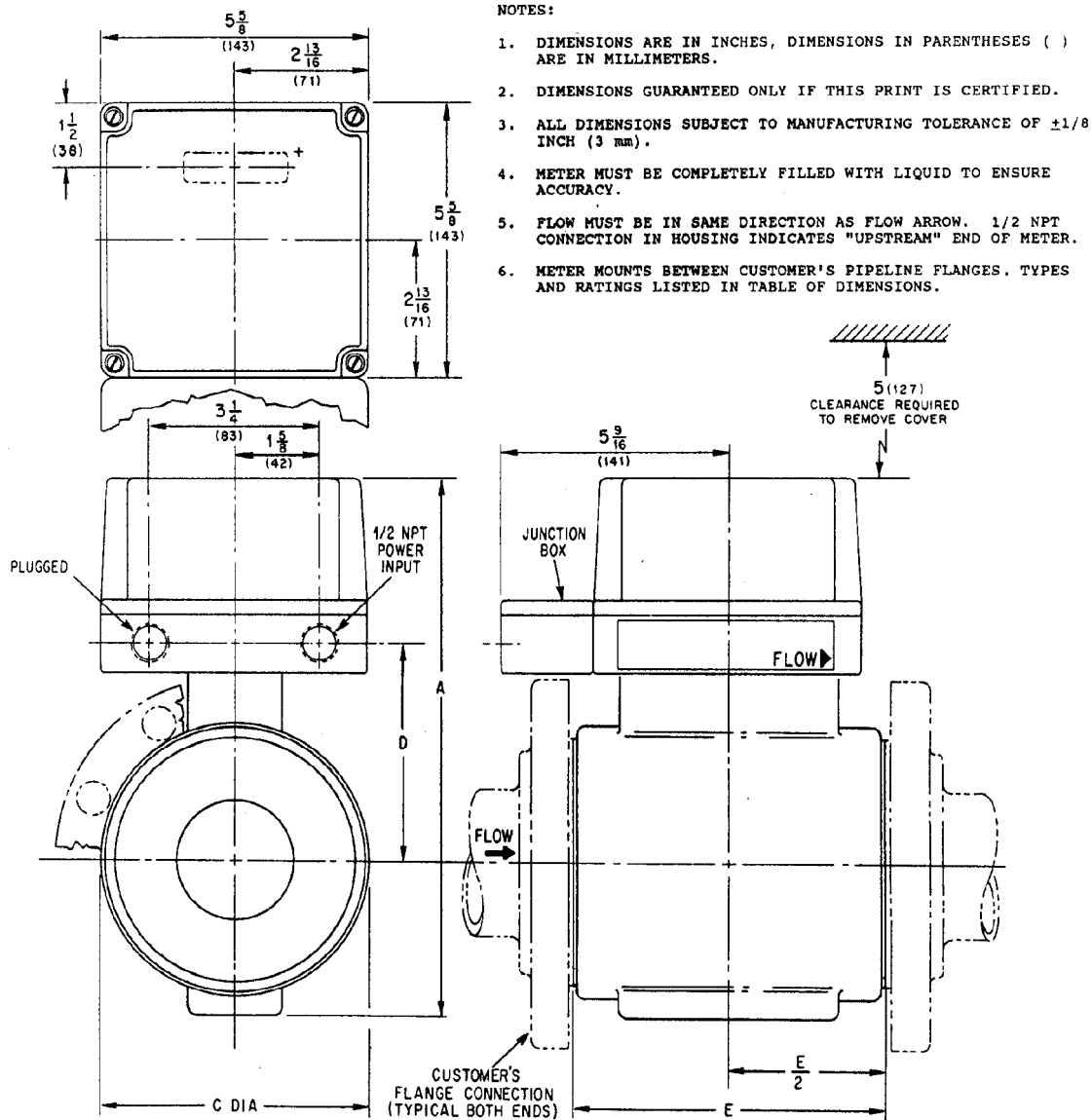
\*Add 1/4" (6 mm) to dimension "A" when housing cover with window is supplied.

REF.: OD-10D-4031  
OD-10D-4062, R1

B1-2577 [Modif.]

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FIGURE 2-1. OUTLINE DIMENSIONS, SIZES 1/25" THROUGH 1-1/2"



METER & FLANGE SIZES		CUSTOMER FLANGE TYPE AND RATING	A*		B		C DIA		D		E	
INCH	mm		INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm
2	50	ANSI CLASS 150 ANSI CLASS 300 BS 10 TBL D, E, F DIN PN 16 & 40	8	203	2-7/16	62	3-7/8	98	4-5/16	110	4-9/16	116
3	80		8-11/16	221	3-3/16	81	5-1/8	130	4-31/32	126	6-5/32	156
4	100	ANSI 150 BS 10 TBL D & E DIN PN 16	9-3/8	238	3-11/16	94	6-3/8	162	5-11/16	144	7-1/2	190

\* Add 1/4" (6 mm) to dimension "A" when Housing Cover with window is supplied.

REF.: OD-10D-4032, R1  
OD-10D-4068, R0

BI-2578 [Modif.]

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FIGURE 2-2. OUTLINE DIMENSIONS, SIZES 2" THROUGH 4"

## 2.2 Location

The flowmeter is suitable for either indoor or outdoor installation. When selecting the installation site, consideration should be given to the ambient and process temperature limits, as stated in Specifications Section 1.3. The standard meter is rated NEMA 4X, (dust tight and watertight) and will thus stand rain and hose down. If flooding is a problem, the optional "Accidental Submergence" flowmeter is suited for applications where occasional submergence to 30 ft H<sub>2</sub>O/48 h (9 m H<sub>2</sub>O/48 h) may occur.

Stray electromagnetic and electrostatic fields, low power radio transmissions, etc. will have no effect upon the operating characteristics of the K-MAG magnetic flowmeter system. It is recommended, however, that the meter not be installed within the immediate proximity of heavy induction equipment such as pumps, motors, etc.

Outline dimensions of the flowmeter are given in Figures 2-1 through 2-4.

The installation site must be provided with a source of 12 or 24 V dc or 120 V ac, 50/60 Hz (220/240 V ac, 50/60 Hz optional) single phase line power. Power requirements for the particular magnetic flowmetering system are given on the instrument data tag. The power source must have an external disconnect and suitable fuse (or circuit breaker) as shown on the applicable interconnection diagram. System interconnection diagrams are provided in the Instruction Manual supplied with the particular signal converter.

## 2.3 Mounting

### 2.3.1 Meter Orientation

The Model 10D1476 K-MAG magnetic flowmeter may be installed in horizontal, vertical or sloping pipe runs. However, precautions must be taken to assure that the meter is filled at all times during measurement. A vertical installation, with the pipe line carrying liquid upwards, assures a filled hydraulic line under low flow rate conditions and also minimizes wear on the metering tube by abrasive grit. Horizontal installations should be made with the meter in the lower section of a pipeline to assure a filled meter condition.

The electronic housing of the meter should be top oriented for horizontal or sloping installations. This aligns the meter electrodes in a lateral plane, a position that eliminates the possibility of entrained air acting as an electrode insulator. Electrodes must not be on "top" when the meter is horizontally mounted.

The magnetic flowmeter must be oriented in accordance with the direction of process flow, as indicated by the FLOW arrow on the meter data tag. Elbows should be located a minimum of three pipe diameters upstream from the meter. Control valves should be located on the downstream side of the meter. Control valves upstream of the meter can create turbulence that result in air pockets and may effect the meter's accuracy or cause its output to be noisy. If for some reason the control valve cannot be located downstream from the meter, a minimum of ten pipe diameters upstream are required between the meter and the control valve. The requirements for control valves also applies to pumps. Pipe diameters are measured from the centerline of the meter to the nearest edge of the device, as shown in Figure 2-5. For higher accuracy requirements, use twice the recommended number of pipe diameters.

When the process liquid contains abrasive grit, avoid disturbance of the flow profile upstream of the meter so that the liquid passes smoothly through the meter; elbows and turns can distort the flow pattern causing uneven wear of the ceramic spool.

### 2.3.2 Meter Handling

The ceramic body of the flowmeter must be protected at all times, as it can be damaged by sharp objects or cracked by sharp impact blows. If required, temporary supports may be used during meter installation. Do not pass any rope or wire sling through the meter bore. Meter weights are listed in Table 1-2.

### 2.3.3 Pipe Connections

The Model 10D1476 magnetic flowmeter has a wafer type body designed for mounting between adjacent pipe flanges. Most commonly used ANSI, BS and DIN type flanges can be accommodated.

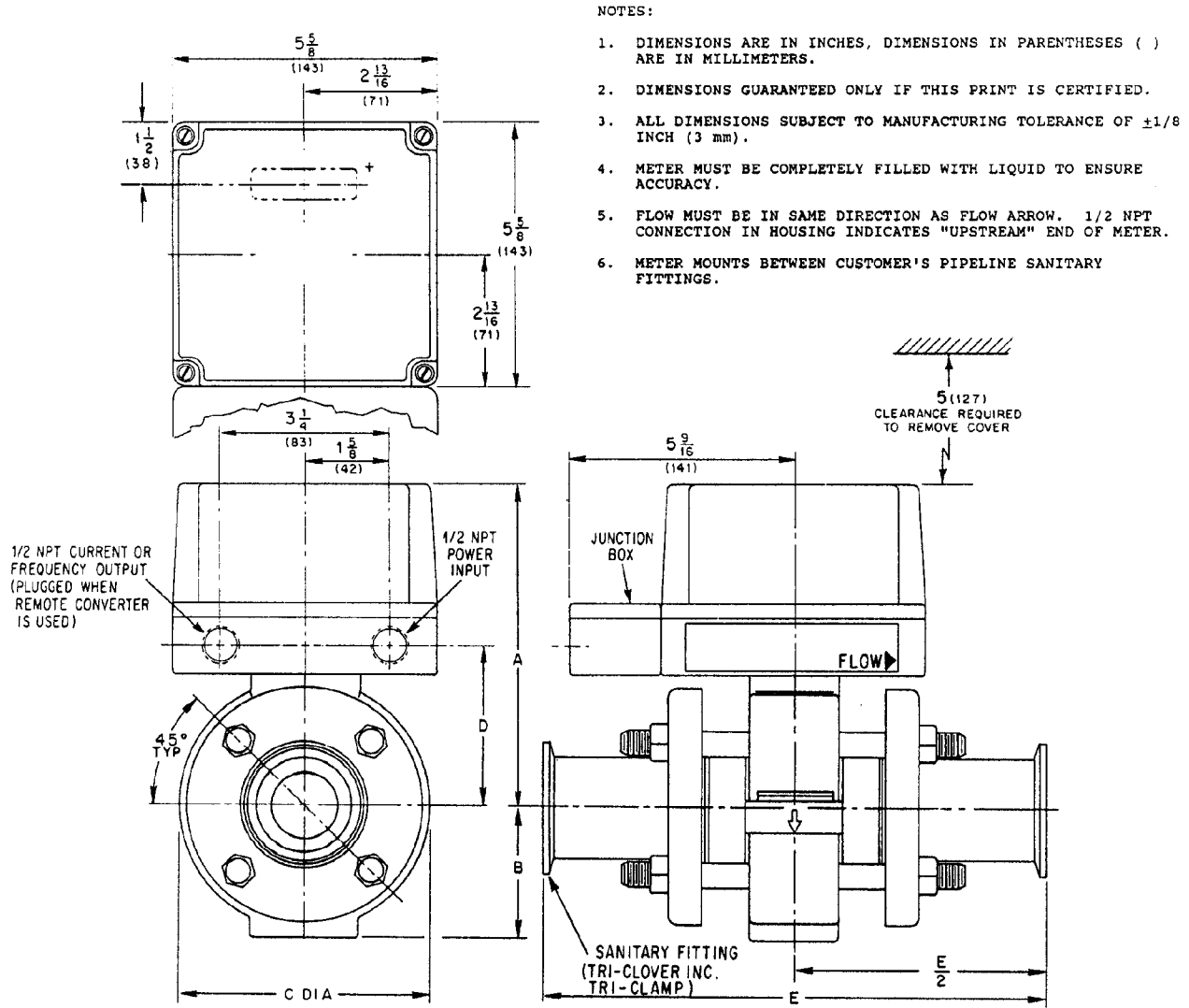
Mounting hardware (studs, nuts, gaskets and the flange adaptor device(s) for the particular flange type and rating specified) is included with the meter, if required. (See Model Number Breakdown in Section 1.2.)

The K-MAG magnetic flowmeter is supplied in one of two basic body designs, depending upon meter size. For example, 1 - 40 mm (1/25 - 1-1/2 inch) size meters have clearance holes provided in the meter body for through-bolt mounting, while 50 - 100 mm ( 2 - 4 inch) size meter bodies mount in a cradle formed by the mounting studs and sleeves used for that particular 4-bolt or 8-bolt flange pattern. Typical mounting arrangements are illustrated in Figures 2-6 and 2-7. Figure 2-8 illustrates the use of sanitary end fittings (flanged adaptor with ferrule). Line schedule 80 or lighter pipe is recommended for system piping.

When the magnetic flowmeter is to be mounted in an electrically non-conductive pipeline such as totally plastic pipe, or a metal pipeline with an insulating liner, the user must obtain a pair of meter grounding rings (discussed in Section 2.4 Grounding Procedure) to facilitate grounding of the process. Good grounding is effected by bonding to the process liquid, both upstream (inlet end) and downstream (outlet end) of the meter, thereby preventing any stray electrical currents that may be carried by the pipeline, or by the process, from passing through the magnetic flowmeter. Improper grounding often results in unsatisfactory meter performance, therefore particular attention should be paid to the meter grounding procedure.

The flange gaskets supplied with the installation kit are the proper size for the particular meter. These gaskets fit inside the meter housing end rings, against the upstream and downstream spool faces, as shown in Figures 2-6 and 2-7. When the meter is installed, the gaskets must be placed within the housing end rings so that they will be between the spool face and the adjacent pipe flange. When sanitary couplings are specified, the flanged adaptors with the ferrule for Tri-Clamp coupling are preassembled to the meter body (see Figure 2-8). Raised face type pipe flanges are recommended for meters with sanitary couplings.

The threaded mounting studs and nuts supplied in the meter installation kit should be well lubricated before use. When the meter has been installed in the pipeline, tighten the nuts in even increments around the flange surface as described in Figure 2-6. It is recommended that an open end wrench with an handle no greater than 8 inches be used for tightening the nuts; i.e., torque should be limited to that which will produce a positive seal without damage to the face of the meter spool. Refer to Table 2-1 for recommended bolt torque.



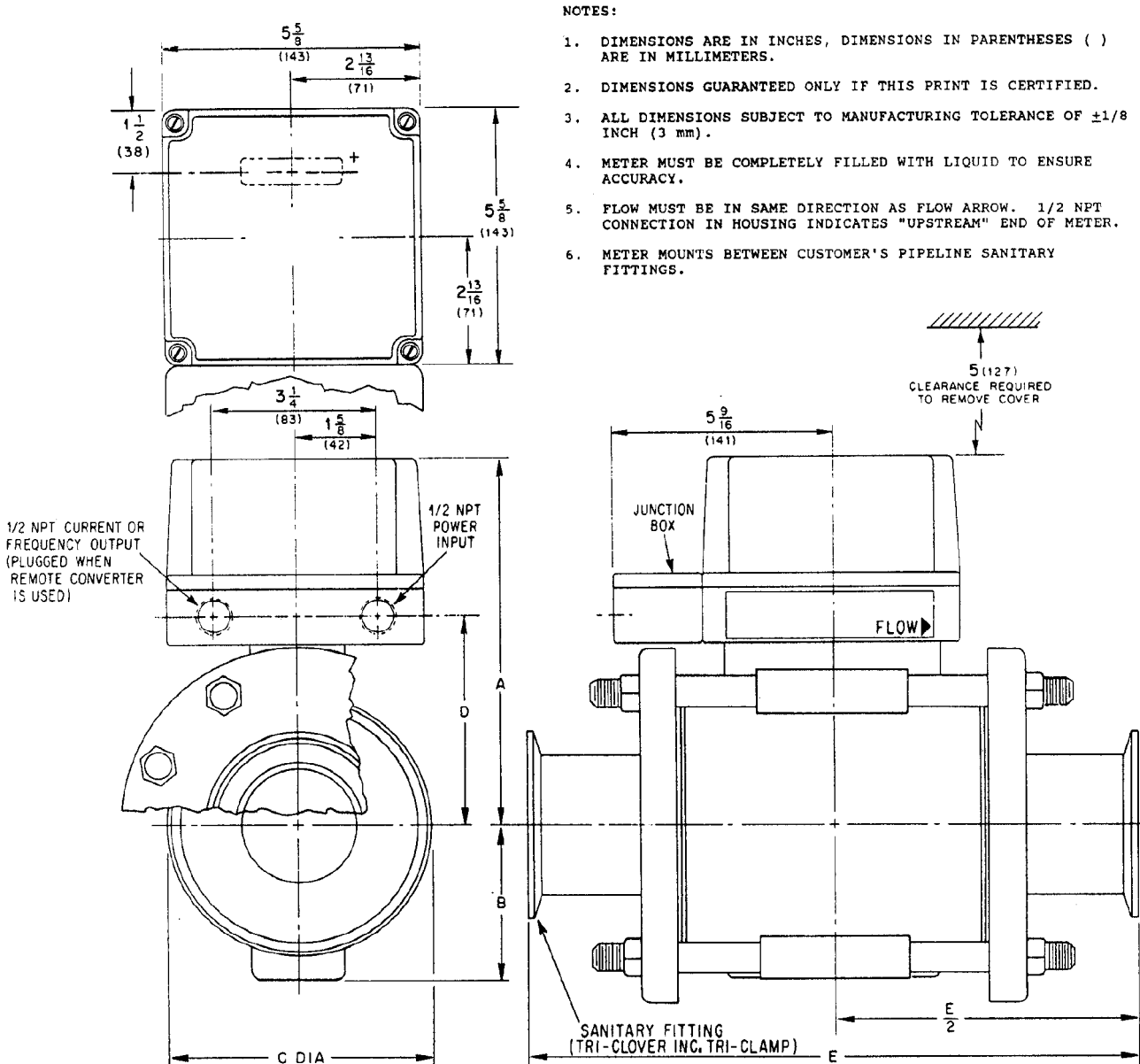
METER SIZE		SANITARY TRI-CLAMP FLANGE SIZE		A*		B		C DIA		D		E	
INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm
1/25	3	1/2	15	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	7-1/2	191
1/12	3	1/2	15	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	7-1/2	191
1/10	3	1/2	15	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	7-1/2	191
5/32	4	1/2	15	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	7-1/2	191
1/4	6	1/2	15	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	7-1/2	191
3/8	10	3/4	19	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	7-1/2	191
1/2	15	3/4	19	6-1/4	159	2-1/32	52	3-3/4	95	2-9/16	65	7-1/2	191
1	25	1	25	6-13/16	173	2-19/32	66	4-7/8	124	3-1/8	79	8-5/8	219
1-1/2	40	1-1/2	40	7-1/2	191	3-9/32	83	6-1/8	156	3-13/16	97	9-3/8	238

\* Add 1/4" (6 mm) to Dimension "A" when Housing Cover with window is supplied.  
Ref: 00-100-4067 R1

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FIGURE 2-3 OUTLINE DIMENSIONS, WITH SANITARY FITTINGS, SIZES 1/25" THROUGH 1-1/2"



METER SIZE & SANITARY TRI-CLAMP FLANGE SIZE		A*		B		C DIA		D		E	
INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm
2	50	8	203	2-7/16	62	3-7/8	98	4-5/16	110	11	279
3	80	8-11/16	221	3-3/16	81	5-1/8	130	4-31/32	126	13	330
4	100	9-3/8	238	3-11/16	94	6-3/8	162	5-11/16	144	14-5/16	364

\* Add 1/4" (6 mm) to dimension "A" when housing cover with window is supplied.

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FIGURE 2-4 OUTLINE DIMENSIONS, WITH SANITARY FITTINGS, SIZES 2" THROUGH 4"

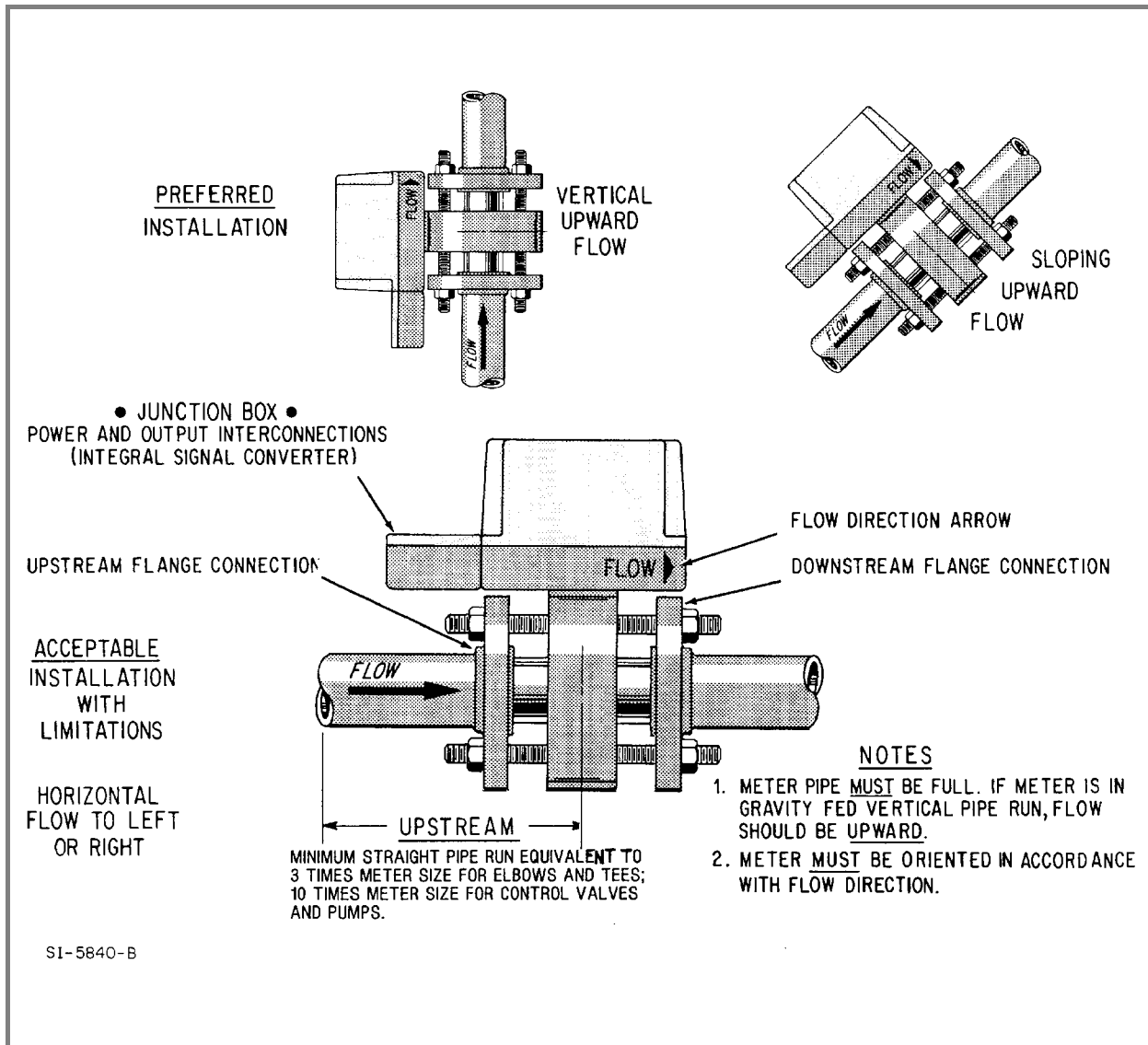
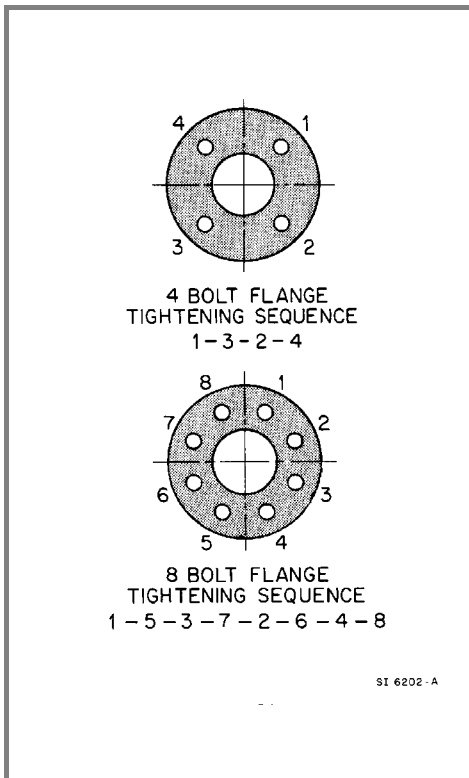


FIGURE 2-5. RECOMMENDED PIPING DIAGRAM





**FIGURE 2-6. FLANGE BOLT TIGHTENING SEQUENCE**

**TABLE 2-1. RECOMMENDED BOLT TORQUE**

Meter Size mm (inch)	ANSI CL 150 DIN PN 16 BS TABLE D & F	ANSI CL 300	DIN PN 40 BS TABLE F
1 - 25 ( $\frac{1}{25}$ - 1)	10 ft lb 15 N • m	15 ft lb 20 N • m	15 ft lb 20 N • m
40 ( $1\frac{1}{2}$ )	15 ft lb 20 N • m	25 ft lb 35 N • m	40 ft lb 54 N • m
50 (2)	25 ft lb 35 N • m	15 ft lb 20 N • m	30 ft lb 40 N • m
80 (3)	40 ft lb 55 N • m	30 ft lb 40 N • m	30 ft lb 40 N • m
100 (4)	30 ft lb 40 N • m	-----	-----

**Recommended Procedure:**

- 1st Pass - 50% of Torque Value
- 2nd Pass - 80% of Torque Value
- 3rd Pass - 100% of Torque Value

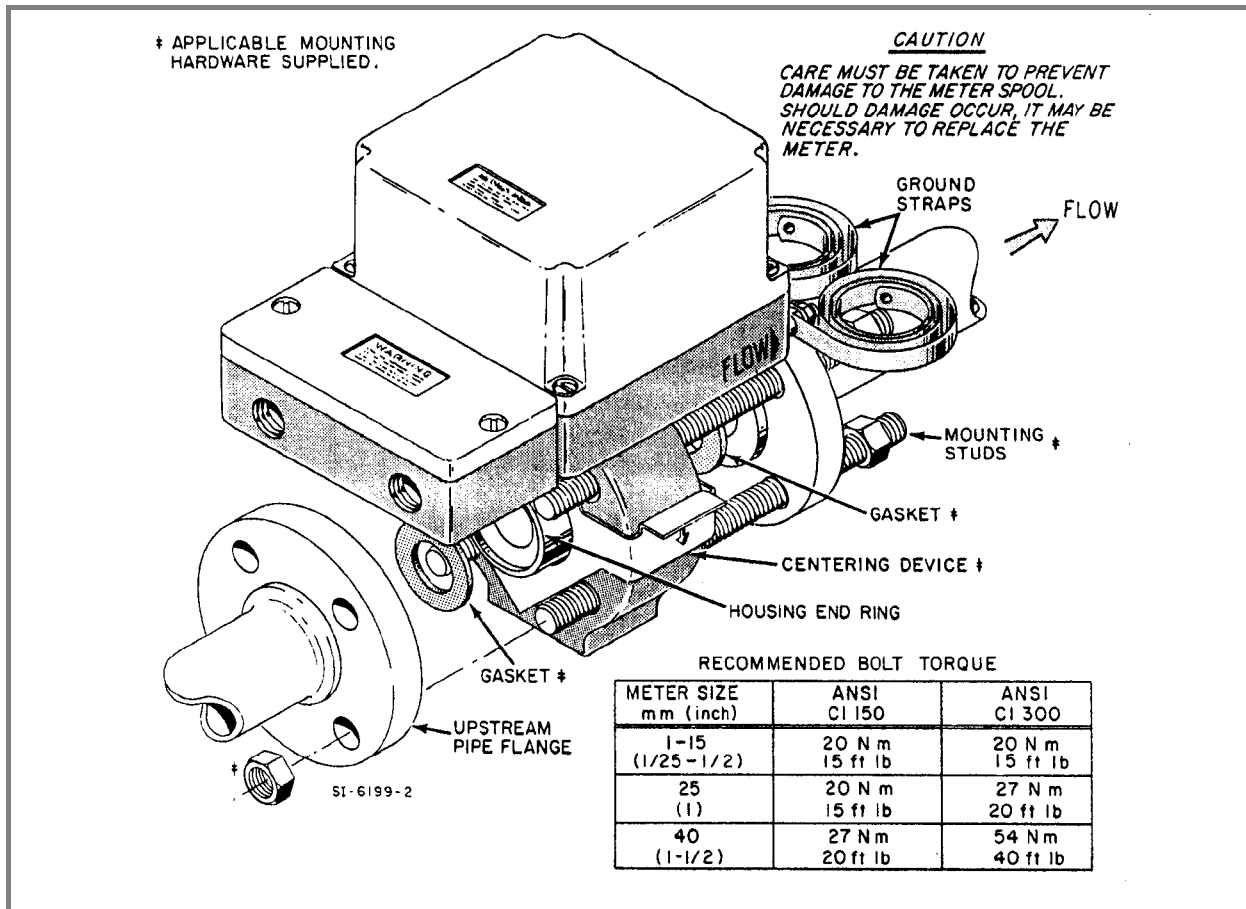
**NOTE**

The recommended bolt torque limits are based on the use of gaskets supplied by the manufacturer. If other than these gaskets are used, the bolt torques must be adjusted accordingly to prevent cracking the spool.

Should it become necessary to replace an existing magnetic flowmeter (that has a longer lay length) with a Model 10D1476 K-MAG, a flanged spool piece is available from the factory for ANSI Class 150 flanges in  $\frac{1}{25}$  - 4 inch sizes. The length of the spool is selected so that the lay length of the K-MAG plus the spool piece will be the same as that of the meter it is replacing. Existing piping does not have to be altered. Specify the model number and size of the meter being replaced to facilitate pipe spool selection.

**NOTE**

All 1 - 15 mm ( $\frac{1}{25}$  -  $\frac{1}{2}$  inch) size magnetic flowmeters are sized to mate with 15 mm ( $\frac{1}{2}$  inch) pipe flanges.



**FIGURE 2-7. MOUNTING DIAGRAM FOR 1- 40 mm (1/25 - 1-1/2") SIZES**

### 2.3.4 Basic Mounting Procedure, Standard Coupling

Select the following procedure applicable for the size meter supplied.

#### 2.3.4.1 1 - 40 mm (1/25 - 1-1/2 inch) Meter Sizes

Refer to Figures 2-1 and 2-6 to supplement the following procedure.

1. Install flange adaptor on meter as shown in Figure 2-7. Align the flange adaptor device (supplied with meter) so that the mounting stud clearance holes in the meter body are not obstructed.
2. Place one of the gaskets inside the housing end ring next to the inlet end of the ceramic spool; so that the gasket will be between the pipe flange and the meter body.
3. Insert meter in pipeline in accordance with the flow direction arrow. Next while supporting the meter, insert one, or more, of the mounting studs through the clearance holes in the upstream pipe flange, so that these studs enter the holes in the meter body. This will help support the meter.
4. Insert the other (downstream) gasket between the meter outlet and the downstream pipe flange, with the gasket inside the meter's downstream end ring. The mounting studs can then be guided through the clearance holes in the downstream pipe flange. Similarly, insert the remaining mounting studs through the clearance holes provided.

5. Thread nuts on both ends of the four mounting studs, finger-tight.
6. To center the magnetic flowmeter with the longitudinal axis of the pipeline, press down firmly on the centering device. This will force-spread the mounting studs, thereby centering the meter body. Maintain pressure on centering device and tighten nuts of the mounting studs until nuts are sufficiently tight to prevent movement of meter relative to the flanges.
7. Tighten the stud nuts in even increments to prescribed torque as shown in Figure 2-6, using prescribed tightening sequence (1-3-2-4) to maintain even pressure distribution around the respective flanges. Bolt torque should be limited to that which is sufficient to produce a positive seal for the application as given in Table 2-1.

#### **2.3.4.2 50 - 100 mm (2 - 4 inch) Meter Sizes**

Refer to Figures 2-2 and 2-8 to supplement the following procedure.

1. Insert both of the two lower mounting studs (see Figure 2-8, Detail "I" 4-Bolt Flange, or Detail "II" 8-Bolt Flange, as applicable) through the clearance holes in the pipe flange, so that approximately half the stud length extends past the flange face. (Start with either the upstream or downstream flange, as convenient.)
2. Slip an adaptor sleeve\* on both of the mounting studs. The two mounting studs can now be guided through the clearance holes in the downstream (typical) flange.
3. Place a gasket inside the meter end ring at both the inlet and outlet ends of the meter, so that the gasket will be between the ceramic spool and the adjacent pipe flange.
4. Place the K-MAG magnetic flowmeter between the two pipe flanges, with the meter body foot piece (opposite the neck) being seated between the two adaptor sleeves. The meter must be oriented in accordance with the flow direction arrow.

Note that in pipelines with 8-bolt flange patterns (Figure 2-8 - Detail "II"), the adaptor sleeves required (Type II) have a "flat" machined surface with color strip. This flat surface must face the flat part of the meter body foot (and neck) to permit the meter to be seated properly.

5. Install the two upper mounting studs and adaptor sleeves as shown in Figure 2-8. Note that when the sleeves are properly located, only four adaptor sleeves are needed for positioning the meter. In systems with an 8-bolt flange pattern, insert the four remaining mounting studs through the clearance holes in the upstream and downstream flanges.
6. Thread nuts on both ends of the 4 (or 8) mounting studs, finger-tight.
7. As the meter body is positioned properly by the adaptor sleeves, it is only necessary to tighten the stud nuts to complete the mounting procedure. Tighten the nuts in an alternate pattern as shown in Figure 2-6 (e.g., 1-3-2-4 or 1-5-3-7-2-6-4-8) using proper torque and tightening sequence to produce an even pressure distribution around the flange faces. Bolt torque should be limited to that sufficient to produce a positive seal for the application, as shown in Table 2-1.

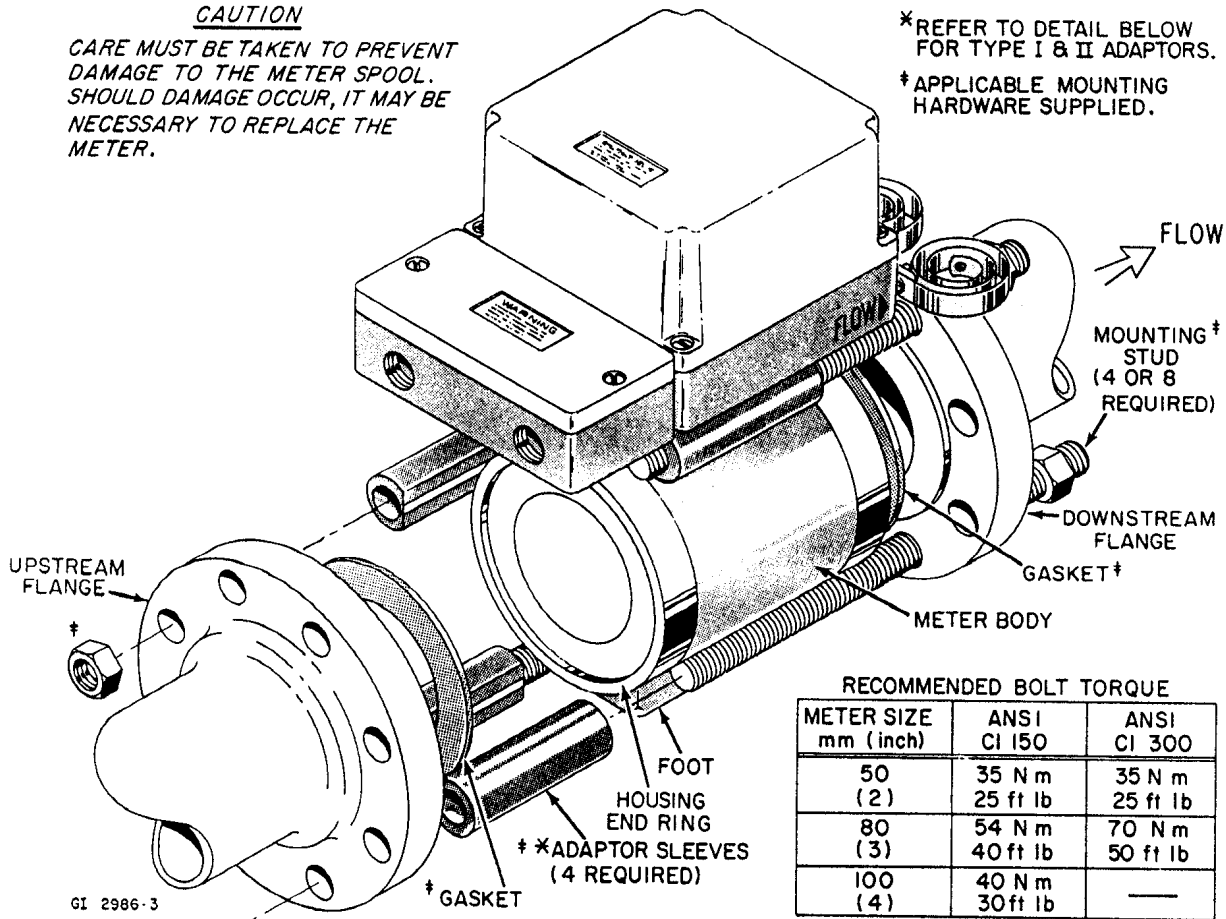
\*Exception: Adaptor sleeves not required for type BS 10 - Table D or E flanges in 50 - 100 mm sizes, or for DIN PN 10/16 in 100 mm size.

**CAUTION**

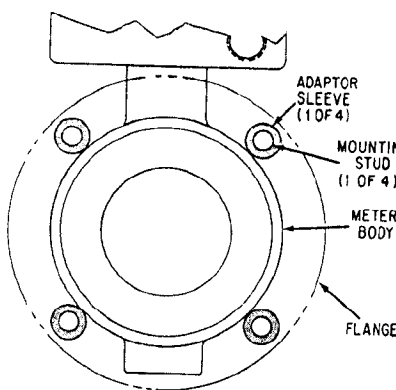
CARE MUST BE TAKEN TO PREVENT DAMAGE TO THE METER SPOOL. SHOULD DAMAGE OCCUR, IT MAY BE NECESSARY TO REPLACE THE METER.

\*REFER TO DETAIL BELOW FOR TYPE I & II ADAPTORS.

†APPLICABLE MOUNTING HARDWARE SUPPLIED.


**RECOMMENDED BOLT TORQUE**

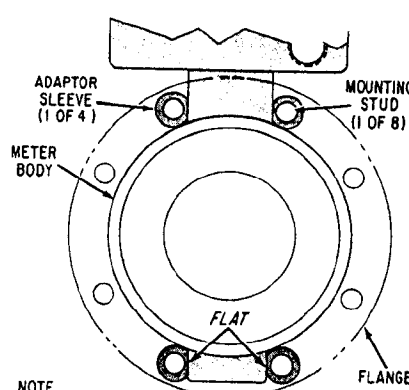
METER SIZE mm (inch)	ANSI CI 150	ANSI CI 300
50 (2)	35 N m 25 ft lb	35 N m 25 ft lb
80 (3)	54 N m 40 ft lb	70 N m 50 ft lb
100 (4)	40 N m 30 ft lb	—



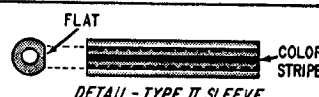
4-BOLT FLANGE PATTERN  
(ADAPTOR SLEEVE, TYPE I)



DETAIL - TYPE I SLEEVE



8-BOLT FLANGE PATTERN  
(ADAPTOR SLEEVE, TYPE II)



DETAIL - TYPE II SLEEVE

**TYPE I ADAPTOR SLEEVES**

METER SIZE	FLANGE RATING	COLOR CODE	†P/N
2-INCH (50 mm)	ANSI CLASS 150	BLUE	U01
3-INCH (80 mm)	ANSI CLASS 150	BLUE	U02
2-INCH (50 mm)	BS 10" F" & DIN 10-40	GREEN	U03

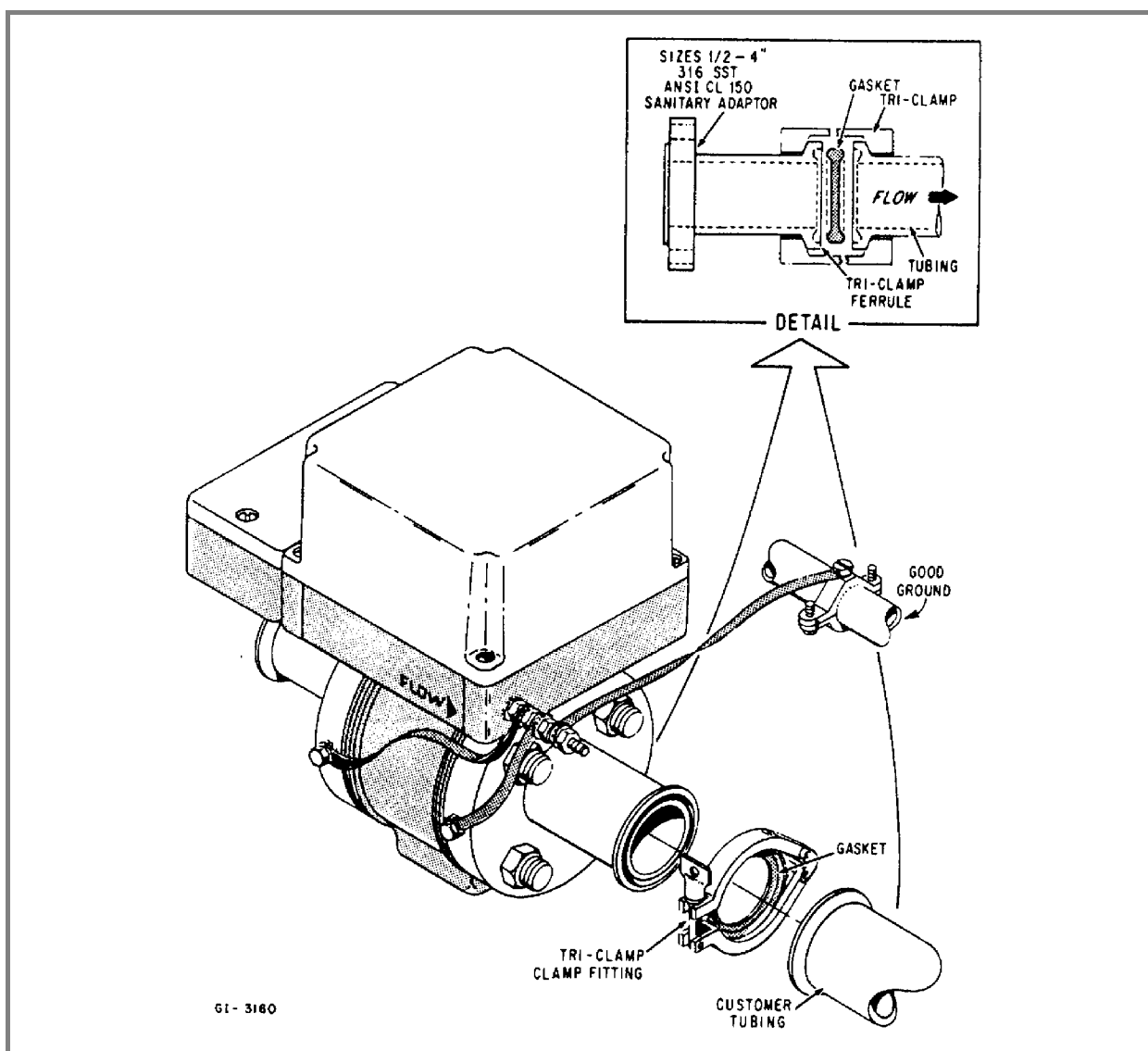
**TYPE II ADAPTOR SLEEVES**

METER SIZE	FLANGE RATING	COLOR CODE	†P/N
2-INCH (50 mm)	ANSI CLASS 300	YELLOW	U04
3-INCH (80 mm)	DIN 10-40	YELLOW	U05
4-INCH (100 mm)	ANSI 150 & BS 10" F"	YELLOW	U06
3-INCH (80 mm)	ANSI 300 & BS 10" F"	RED	U07
4-INCH (100 mm)	ANSI 300	RED	U08
4-INCH (100 mm)	DIN 25-40	WHITE	U09

†PART No. 430E013 (ADD UO FROM TABLE TO COMPLETE PART No.)

NOTE: ADAPTOR SLEEVES ARE NOT REQUIRED FOR BS 10 TABLES D & E, 2, 3" AND 4" SIZES; OR FOR DIN 100 PN 10/16

**FIGURE 2-8. MOUNTING DIAGRAM FOR 50 - 100 mm (2 - 4") SIZES**



**FIGURE 2-9. MOUNTING DIAGRAM, SANITARY FITTINGS**

### 2.3.5 Mounting Procedure, Sanitary Coupling

The magnetic flowmeter must be oriented as shown by the flow direction arrow on the meter data tag. The meter, when installed, will generally be supported by the adjacent pipeline sections. These upstream and downstream pipe sections must be fabricated of rigid piping. Further, meter inlet and outlet piping must conform with recommended piping practices and be properly supported by use of anchors, guides, hangers or other mechanical support systems. Pipe supports should be placed adjacent to the meter inlet and outlet to eliminate excessive stress on the Tri-Clamp couplings. Refer to Figure 2-9 to supplement this discussion.

Install the meter with its pipe axis (centerline) in line with the center line of the piping system. It will be necessary to support the flowmeter temporarily until the inlet and outlet connections have been secured. All piping and hardware (except gaskets) must be stainless steel to comply with sanitary requirements.

## 2.4 Grounding Procedure

### 2.4.1 General

Satisfactory operation of the magnetic flowmeter system requires that careful attention be paid to proper grounding techniques. Meter grounding requirements are really a combination of standard grounding methods and a bonding of the meter body to the process liquid. The most important of these is the process bonding, which is nothing more than insuring that the meter ground is in contact with the process liquid at both ends of the meter body. Basically, the bonding procedure places an electrical short circuit across the meter, thereby routing any stray current around the meter rather than through it.

There are two basic types of piping systems:

- One of these is an electrically conducting pipeline in which the process liquid comes in contact with the conductive pipe. This piping requires only that the K-MAG bonding wires be attached to the adjacent pipe flanges.
- In the other case, the pipeline may be made of an electrically non-conductive material or is lined with a non-conductive material. These nonconductive pipelines require the use of metal grounding rings to bond the process to ground.

A good ground is one that is in contact with the earth over a large conductive area. An excellent example of this is an iron cold water pipe that is buried in the earth for a considerable distance in its distribution system. The water pipe laterals form a large conductive area of contact, that in turn provides a low resistance connection to earth. Some systems in use today use plastic pipe and do not provide a good ground system.

Select the applicable grounding procedure from Paragraph 2.4.2 or 2.4.3. Proper grounding of the magnetic flowmeter is required for optimum system performance.

#### NOTE

Regardless of which grounding system is used, the grounding procedures given in this section must be followed.

### 2.4.2 Conductive Pipeline

If the magnetic flowmeter is included as part of a conductive pipeline that is not electrically insulated from the liquid to be metered, the following grounding procedure should be followed. Refer to Figure 2-10 to supplement the text. Note that the grounding method shown in Figure 2-10 is applicable also for meters supplied with sanitary fittings.

1. Drill and tap a blind hole on the peripheral surface of each of the two adjacent pipeline flanges (see Figure 2-10 - INSET). These tapped holes should be placed so that they are within easy reach of the bonding straps (2 supplied) attached to the ground lug on the meter housing.
2. Obtain a bright metal surface around the edges of both tapped holes with a file or burnishing tool.
3. Clamp the lug on the end of each bonding strap to the adjacent pipe flange, using a pair of 1/4" hex head bolts and external tooth lockwashers (supplied by user).
4. The user must supply a sufficient length of grounding wire for connecting the meter grounding post (ring lug supplied) to a good electrical ground. (Number 12 AWG, or heavier, copper wire may be used for this grounding wire.)

### 2.4.3 Non-Conductive or Insulated Pipeline

For the magnetic flowmeter mounted in a non-conductive or liquid insulated pipeline (such as totally plastic pipe, ceramic lined iron pipe, or cast pipe with internal bitumastic coating), perform the grounding procedure outlined below. Refer to Figures 2-11 and 2-12 to supplement this discussion.

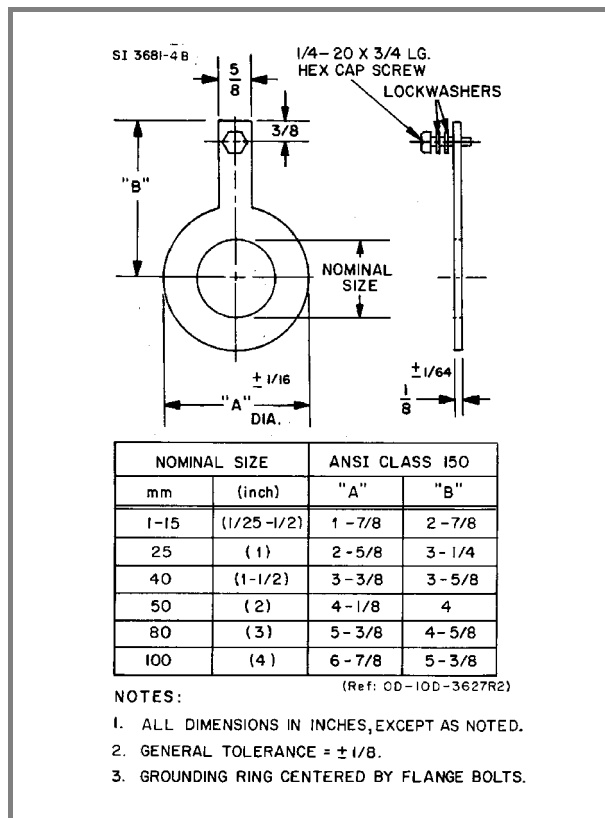
1. Grounding rings are mounted between the meter, and the upstream and downstream pipe flanges. These metal grounding rings are available in various corrosion resistant materials and should be selected to be compatible with the process liquid. When installed, these rings are centered by the flange bolts and therefore must be selected according to the flange rating. If grounding rings were not specified when the meter was ordered, refer to Section 7.0 Tables 7-2 and 7-3 for ordering information. Refer to Figure 2-10 for the outline dimensions of the grounding rings.

2. When installing the meter in the pipeline, place a grounding ring at both the inlet and outlet connections of the magnetic flowmeter. Provide gasketing between the face of the meter (see Figure 2-12) and the grounding ring and between the grounding ring and the adjacent pipe flange; i.e., four gaskets required. (Note that the gasket at the meter face must fit inside the end ring.) Position the grounding rings in the pipeline so that the meter grounding straps (2) attached to the meter ground post will easily reach the ground strap connection bolt on the respective grounding ring.

3. The user must supply two bonding wires which will connect the flanges adjacent to the meter to the meter grounding rings. These should be made with ring lugs and #12 AWG, or heavier, copper wire. They should be secured, along with the free end of each stainless steel bonding strap from the meter, to the upstream and downstream grounding rings, using 1/4" hex head bolts and external tooth lockwashers (supplied with the grounding rings when the rings are supplied by the manufacturer).

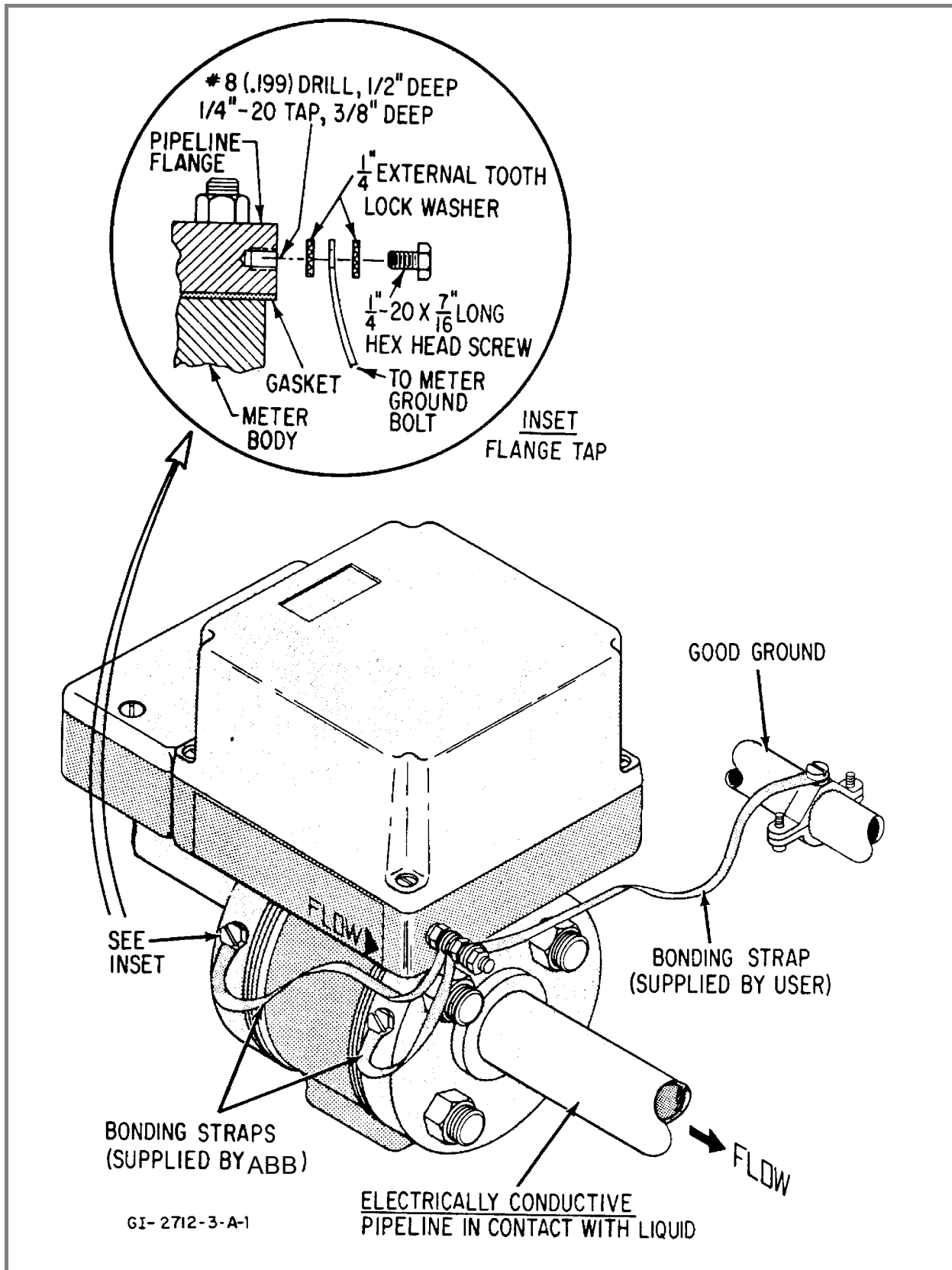
4. The flanges adjacent to the meter must be drilled and tapped for 1/4" threads. A bright metal surface around the area of the tapped hole must be obtained using a file or emery cloth. The bonding wires from the grounding rings are to be attached to the flanges with 1/4" bolts and external tooth lockwashers.

5. The user must supply a sufficient length of wire for connecting the meter grounding post (ring lug supplied) to a good electrical ground. (Number 12 AWG, or heavier, copper wire may be used for this grounding wire.)



**FIGURE 2-10. OUTLINE DIMENSIONS, GROUNDING RINGS\***

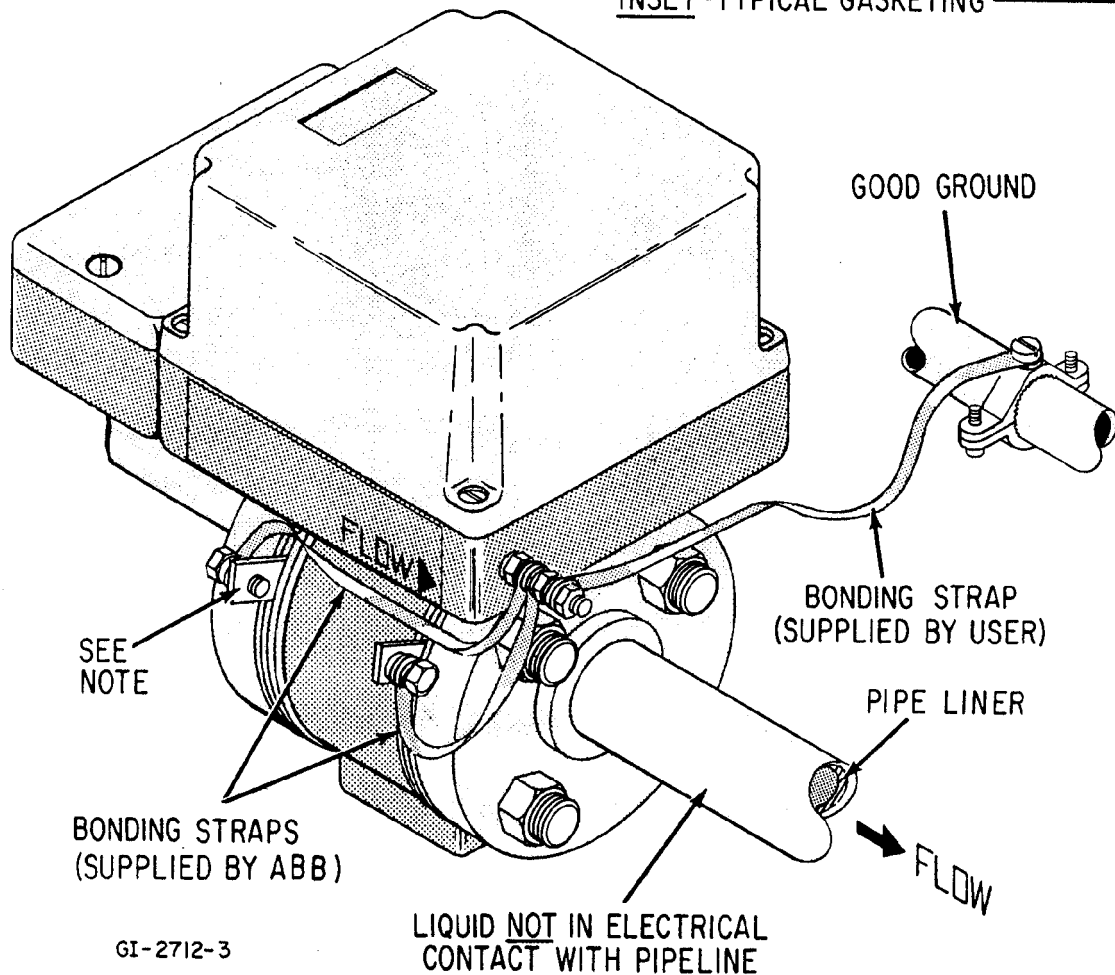
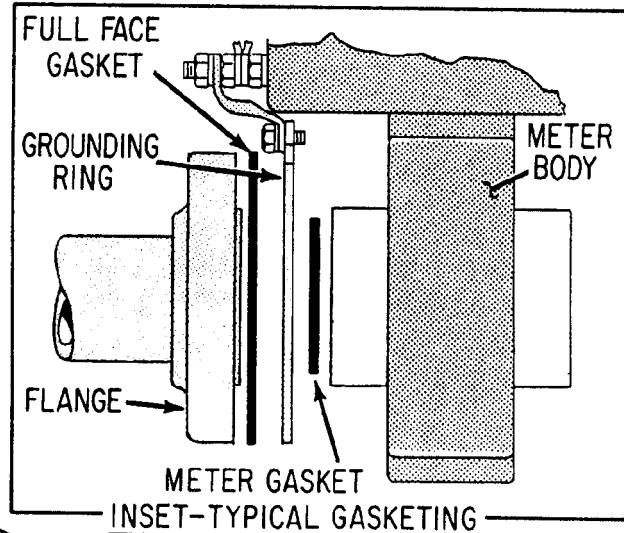
\* For applications other than ANSI CLASS150, contact the manufacturer.

**FIGURE 2-11. GROUNDING PROCEDURE, NON-INSULATED PIPE**



**NOTE:**

METAL RING IN CONTACT WITH LIQUID (SUPPLIED BY USER). A QUANTITY OF 4 GASKETS ARE NEEDED FOR PROPER INSTALLATION OF THE 2 GROUNDING RINGS REQUIRED (SEE INSET). WHEN THE GROUNDING RINGS ARE PURCHASED FROM ABB, GASKETS ARE SUPPLIED.



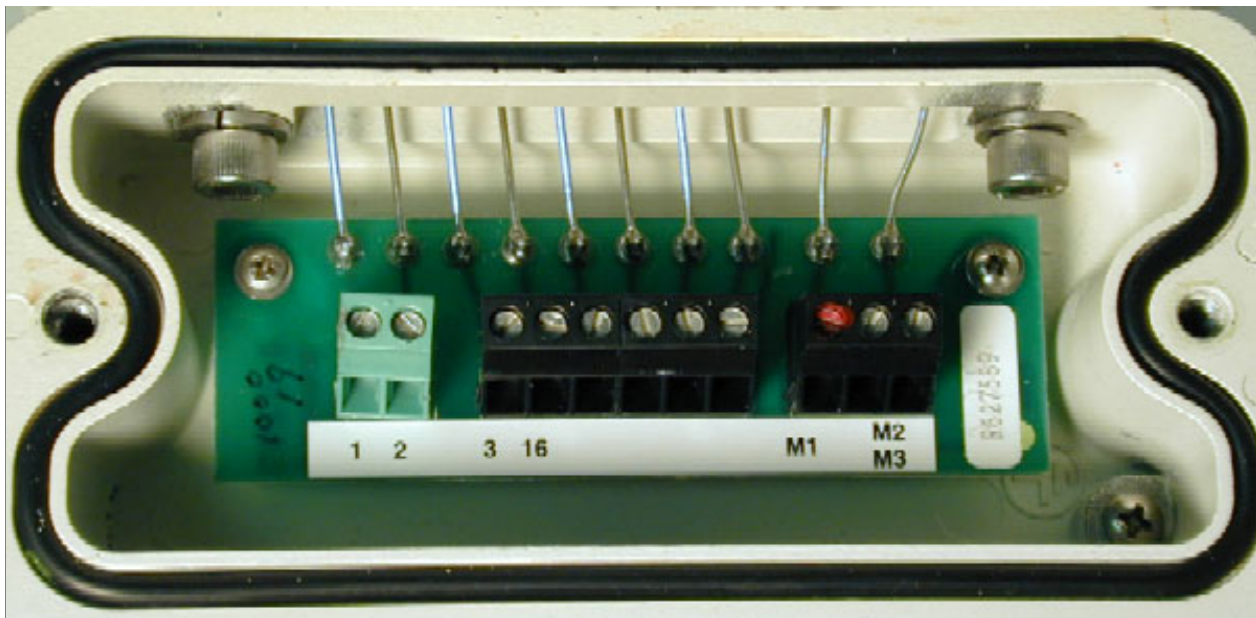
**FIGURE 2-12. GROUNDING PROCEDURE, INSULATED PIPE**

## 2.5 Electrical Interconnection

The Series 10D1476S K-MAG magnetic flowmeter is furnished with a remotely mounted signal converter. Interconnection wiring is done in the customer connection box shown in Figure 2-13. For additional information and wiring details, refer to interconnection diagrams provided in the instruction manual supplied with the signal converter.

### WARNING

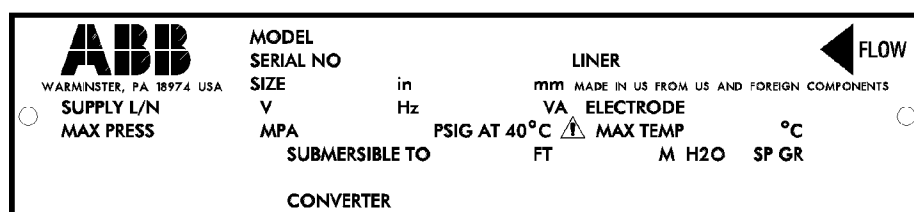
Equipment powered by ac line voltage constitutes a potential electric shock hazard to the user. Make certain that the system power input leads are disconnected from the operating branch circuit before attempting electrical interconnections.



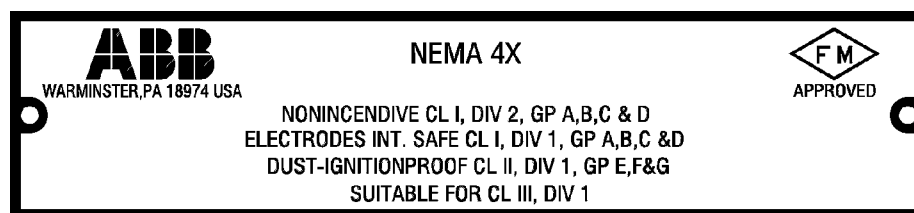
**FIGURE 2-13. 10D1476S REMOTE CUSTOMER CONNECTION BOX**

When making wiring interconnections between the flowmeter and the remote signal converter, the grounding procedures given in Section 2.4 must be followed.

Initiate process flow through the pipeline. Flow measurement and concurrent output signal transmission will commence with flow through the meter. Information concerning operation of the Signal Converter is provided in the Instruction Bulletin supplied with the Converter.



### FIGURE 3-1. TYPICAL INSTRUMENT TAG



### FIGURE 3-2. ADDITIONAL TAG FOR FM APPROVED METER

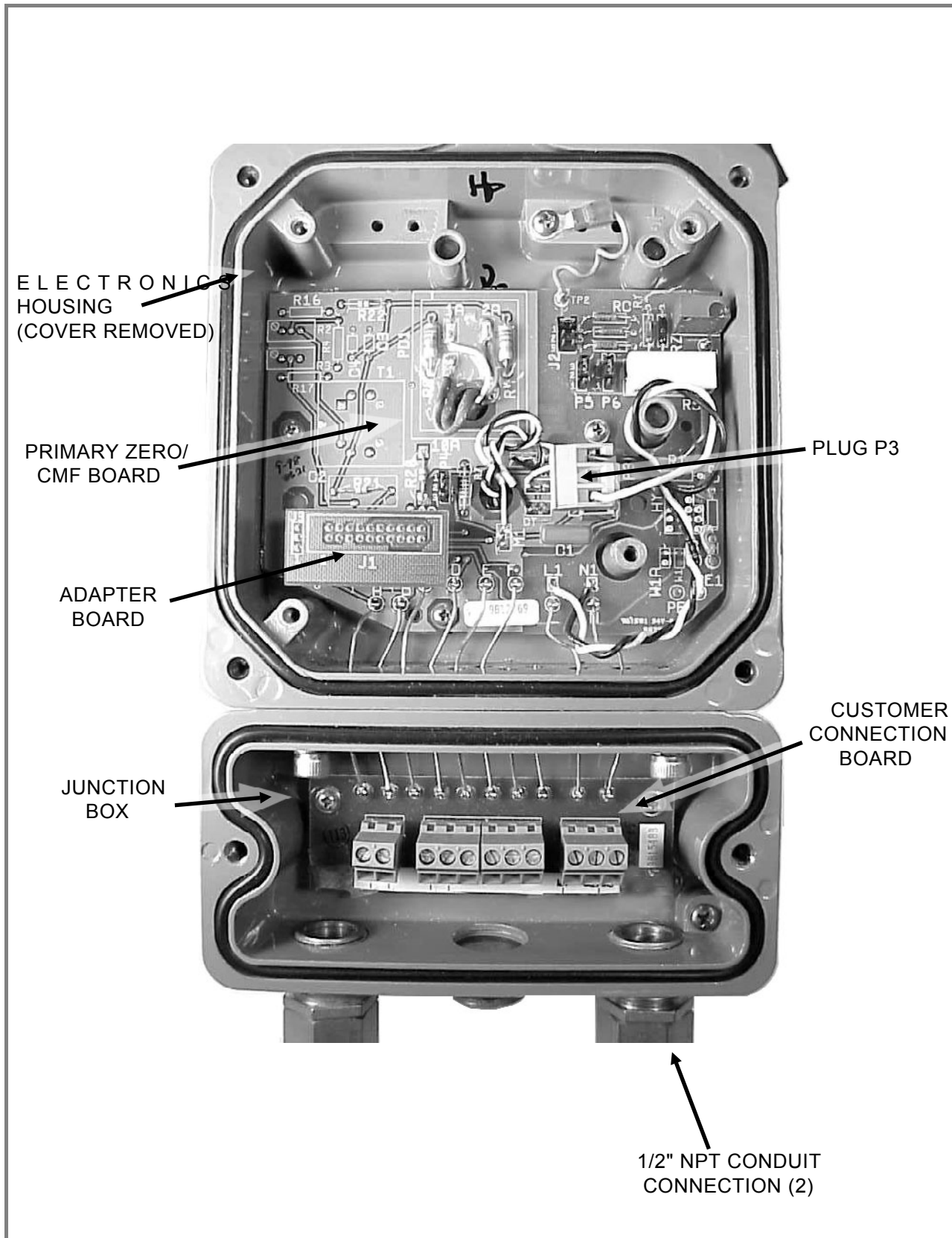


FIGURE 3-3. PRIMARY MOUNTED PC ASSEMBLIES

## 4.0 FUNCTIONAL DESCRIPTION

The Magnetic Flowmeter body houses two signal electrodes and the flux producing magnet coils, as shown schematically in Figure 4-1. All primary intraconnection wiring is terminated at a printed circuit assembly located in the base of the meter housing (see Figure 3-2).

The primary provides two output signals to the associated Signal Converter:

- an electrode signal that contains the flow rate information
- the reference signal which is proportional to the magnet excitation current (theoretically, this reference signal is proportional to the flux density in the metering section).

The reference voltage is derived across a precision "constant meter factor" resistance network that is connected in series with the magnet coils. Changes in magnet drive voltage, which cause a variation of flow signal, will simultaneously cause a proportional variation of the reference voltage. The circuitry will provide an exact ratio and thereby provide immunity to power supply variation. The magnet coil drive circuitry is contained in the Signal Converter.

### 4.1 Basic Operating Principle

#### 4.1.1 Signal Voltage Generation

The operating principle of the Model 10D1476 Magnetic Flowmeter is based upon Faraday's Law of Induction which states that the voltage induced across any conductor as it moves at right angles through a magnetic field will be proportional to the velocity of that conductor. This principle finds common application in direct and alternating current generators. Essentially, the Magnetic Flowmeter constitutes a modified form of a generator.

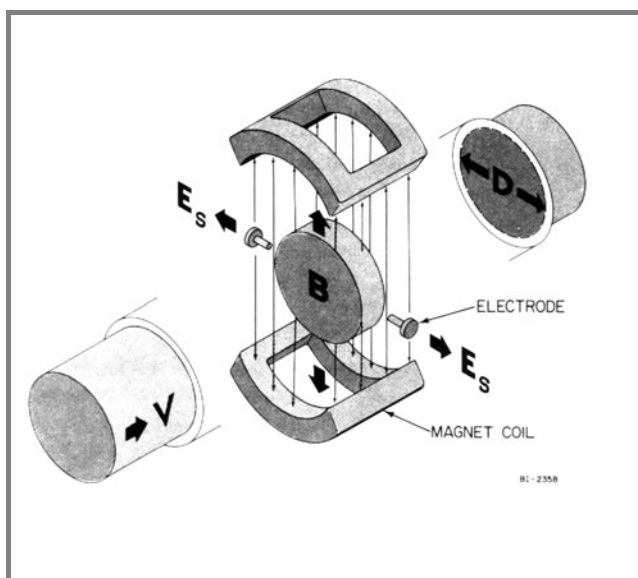


FIGURE 4-1. BASIC OPERATING PRINCIPLE

Figure 4-1 graphically illustrates the basic operating principle. Consider magnetic field, "B", being generated in a plane which is perpendicular to the axis of the meter pipe. Further, consider a disc of the metered liquid as a conductor; the transverse length, "D", is equal to the meter pipe diameter. Since the velocity, "V", of the liquid disc is directed along the axis of the meter pipe, a voltage, " $E_s$ ", will be induced within this liquid which is mutually perpendicular to the direction of the liquid velocity and the flux linkages of the magnetic field; i.e., in the axial direction of the meter electrodes. This electrode voltage is the summation of all incremental voltages developed within each liquid particle that passes under the influence of the magnetic field.

This may be expressed mathematically as:

(Equation #1)

$$E_s = \frac{1}{\alpha} BDV$$

where,

$E_s$  = induced electrode voltage  
 $B$  = magnetic field strength  
 $D$  = meter pipe diameter  
 $V$  = liquid velocity  
 $\alpha$  = dimensionless constant

Thus, the metered liquid constitutes a continuous series of conductive liquid discs moving through a magnetic field. The more rapid the rate of liquid flow, the greater the instantaneous value of signal voltage as monitored at the meter electrodes.

#### 4.1.2 Magnet Coil Drive Circuits

In most conventional Magnetic Flowmeters the integral magnet coils are driven directly by the customer's 50/60 Hz power service. Notably, however, the design of the Series 10D1476 Magnetic Flowmeter uses magnet drive circuits which are alternately energized bi-directionally at a low frequency rate as commanded by the associated Converter/Driver assembly.

#### 4.1.3 Volumetric Flow Rate Measurement

The Magnetic Flowmeter is a volumetric flow rate measuring instrument. This can be shown by substituting the physical equivalent of liquid velocity into equation #1, preceding, as follows:

(Equation #2)

$$V = \frac{Q}{A} = \frac{4Q}{\pi D^2}$$

Substituting for  $V$  in equation #1

$$E_s = \frac{1}{\alpha} BD \frac{4Q}{\pi D^2}$$

and solving for  $Q$ :

$$\therefore Q = \frac{\pi \alpha D^2}{4} \cdot \frac{E_s}{B}$$

Since  $B = \beta E_r$   
 and since  $\alpha$ ,  $D$  and  $\beta$  are constant:

(Equation #3)

$$Q = \gamma \frac{E_s}{E_r}$$

where:

Q = volumetric flow rate  
A = cross-sectional area  
D = pipe section diameter  
 $E_s$  = induced signal voltage  
 $E_r$  = reference voltage  
B = magnetic flux density  
 $\alpha$  = dimensionless constant  
 $\beta$  &  $\gamma$  = dimensional constant  
V = liquid velocity

Therefore, volumetric flow rate is directly proportional to the induced signal voltage as measured by the Magnetic Flowmeter.

## 4.2 Operating Characteristics

### 4.2.1 Liquid Variables

#### 4.2.1.1 Liquid Conductivity

The K-MAG Magnetic Flowmeter requires a liquid conductivity of 5  $\mu\text{S}/\text{cm}$  or higher for operation. This minimum liquid conductivity requirement is not affected by the length of the signal interconnection cable when remote mounting of the Signal Converter is required, as long as the supplied interconnection cable (with driven shields) is utilized. The nominal maximum transmission distance is 30 meters (100 feet); longer distance can be accommodated - contact the factory for details.

The conductivity of a given liquid, may be determined experimentally under a filled meter condition, as follows:

1) Remove the Converter housing cover. Disconnect the electrode signal interconnection leads from terminals "1" and "2" of the Signal Converter. (These leads should be identified so that they will be properly reconnected.)

2) Measure the resistance between signal leads "1" and "2" with an ac ohmmeter.

#### CAUTION

**Do not use a dc ohmmeter for this measurement as polarization effects will produce completely erroneous data.**

The conductivity of the process liquid (in  $\mu\text{S}/\text{cm}$ ) may be determined from the ac electrode resistance measurement (in megohms) by substitution of values in the following equation.

$$\sigma = \frac{1}{(R_{ac} - 0.072) \times \text{Electrode Dia. in cm}}$$

where:

0.072 is the electrode barrier resistance in M ; i.e.,  $36 \text{ k} \times 2/10^6$

The electrode diameter is 0.15 cm (0.060") for all meter sizes except 1/25" (0.020") and 1/12" (0.040").

For example, assuming the measured ac electrode resistance (full pipe and zero flow) is 190,000 ohms and electrode diameter is 0.15 cm, then

$$\sigma = \frac{1}{(0.192 - 0.072) \times 0.15} = 55.55 \mu\text{S/cm}$$

This is above the threshold for specified measurement accuracy for the particular liquid, meter size and Signal Converter combination. Liquid conductivities at the operating temperature may also be determined from standard reference works for many pure liquids. Field Engineers are equipped to determine the conductivities of special liquids at the user's site as an engineering service.

#### **4.2.1.2 Liquid Temperature**

Having established the minimum liquid conductivity requirements for a given application, any liquid which exhibits equal or higher conductivity may be metered without concern for any system compensating adjustments. However, due regard for the effect of the liquid conductivity versus temperature should be considered.

Most liquids exhibit a positive temperature coefficient of conductivity, it is possible for certain marginal liquids to become sufficiently non-conductive at lower temperatures so as to hamper accurate metering. However, the same liquid at higher or normal environmental temperatures may be metered with optimum results. The possibility of an adverse temperature conductivity characteristic should be investigated before attempting to meter such a liquid. Liquid or ambient temperatures are also limited by the meter materials specification.

Other normal effects of temperature, such as influence upon liquid viscosity and density, the size of the metering area, and the flux density of the magnetic field, have negligible or no effect upon metering accuracy.

#### **4.2.1.3 Other Liquid Variables**

Other liquid variables such as viscosity, density and liquid pressure have no direct influence on metering accuracy. Liquid density has no effect on volumetric flow rate since only the area of the meter pipe and liquid velocity are required to determine the rate of flow. Viscosity and metering pressure are restricted to physical limitations alone as given in Specifications Section 1.3.

#### **4.2.2 Metering Characteristics**

The metering pipe must be completely filled at all times for accurate results. See Installation Section 2.0 for piping information. The Magnetic Flowmeter will measure the total amount of material passing in the liquid stream. The meter will not, for instance, differentiate between the amount of liquid and the amount of entrained gases - or - in the case of a slurry, it will not differentiate the amount of liquid from solids. If the liquid to mixant ratio is of importance to process control, then separate measurements of the concentration of the desired medium must be made and appropriate correction factors must be applied to the Magnetic Flowmeter output.

In applications involving variable quantities of uniformly dispersed, non-conductive mixing agents, it must be determined that the higher concentrations of mixant will not drive the average conductivity of the liquid mixture below the minimum conductivity level for the given installation.



## 5.0 Circuit Description

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### 5.1 Primary Signals

The Magnetic Flowmeter body houses two signal electrodes and the flux producing magnet coils, as shown schematically in Figures 5-1. All primary intraconnection wiring is terminated at the CMF/ZERO pc board located in the base of the meter housing.

The primary provides two output signals to the associated Signal Converter; one, an electrode signal that contains the flow rate information, and two, the reference signal which is proportional to the magnet excitation current. Theoretically, this reference signal is proportional to the flux density in the metering section. The reference voltage is derived across a precision "constant meter factor" resistance network that is connected in series with the magnet coils. Changes in magnet drive voltage, which cause a variation of flow signal, will simultaneously cause a proportional variation of the reference voltage. The circuitry will provide an exact ratio and thereby provide immunity to power supply variation. The magnet coil drive circuitry is contained in the Signal Converter.

The (gated) magnet driver operates at a frequency that permits magnetic flux in the primary to reach a steady state level during the last 50% of each half period of magnet excitation. By using sampling techniques, the flow (differential mode) signal is measured only during the intervals that magnetic flux is constant ( $d\phi / dt = 0$ ).

Therefore, zero instability due to changing flux is eliminated by use of the MAG-X design concept (sampling technique), providing a meter totally free of zero drift. A thorough discussion of Signal Converter operation is provided in the instruction manual supplied with the particular Signal Converter.

### 5.2 Constant Meter Factor (CMF) PC Assembly (686B623)

A circuit schematic of the primary CMF board is shown in Figure 5-3. The CMF Assembly provides several functions. These include:

1. Establishing interconnections between the Flowmeter internal wiring and the Converter.
2. Permitting adjustment of meter calibration factors to a fixed value for each nominal size primary.
3. Permitting adjustment of primary zero.
4. Establishing proper wiring connections for remotely mounted Converters.



### 5.3 Jumper Selections

For remote converters, zero return and functions associated with the 50XM1000 signal converter are established by the **686B623U01 Primary Board** assembly, shown in Figure 5-2.

Settings are determined by movable jumpers at terminals A2 and B1 located on the lower left corner of the **686B623U01** assembly. The diagram and table that follow the figure correlate the zero return and other functions with the jumper settings.

A circuit schematic of the primary CMF board is shown in Figure 5-3. The meter calibration factor is established by a voltage division off the R5 current sensing resistor, first by a coarse network consisting of R6 through R12, and then by a fine adjustment via potentiometer R14. These values may only be re-established by noting the open positions of shunt S1 and measuring (out of circuit) the values of R14 (each end to wiper) and R15.

System zero is established with the aid of transformer T1, through whose primary winding the magnet coil current flows. The center tap connection of the respective secondary windings of T1 are connected in series with each electrode signal.

One secondary winding removes the voltage impulse from electrode signal 2 which occurs as a result of coil voltage reversal (see waveform). This signal is factory adjusted to a minimum, using an oscilloscope connected to the input amplifying system of the Converter. The adjustment is very sensitive and thus extreme care must be exercised when setting potentiometer R3.

Electrode circuit 1 receives a signal from the other secondary winding, and is integrated via capacitor C2 and potentiometer R2 so as to produce a square wave. This adjustment removes residual offset not corrected by the previous adjustment.

The magnet coils are driven (see Figure 5-1) via the connection of J3 to P3, while the 686B630 Adaptor Board routes the reference and electrode signals to the proper positions of J1, J2, and their corresponding RFI filters (see INSET, Figure 5-3).

Refer to the instruction manual provided with the Signal Converter for interconnection wiring.

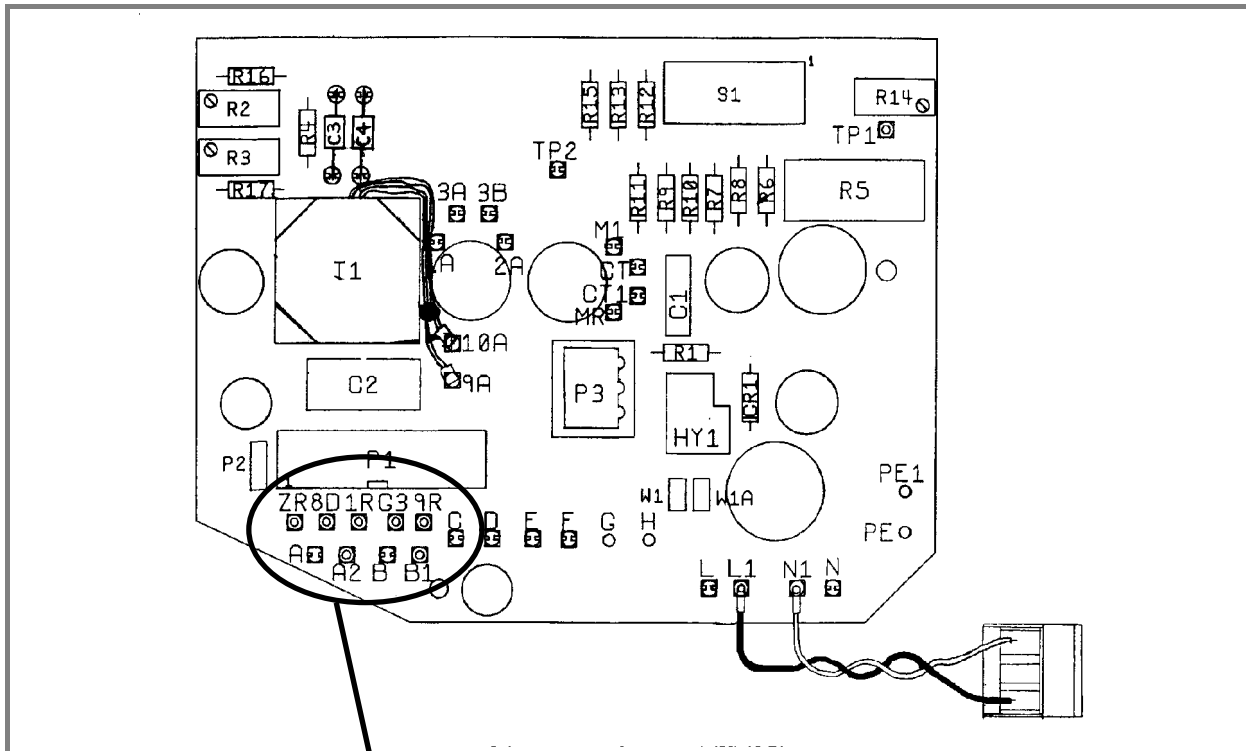
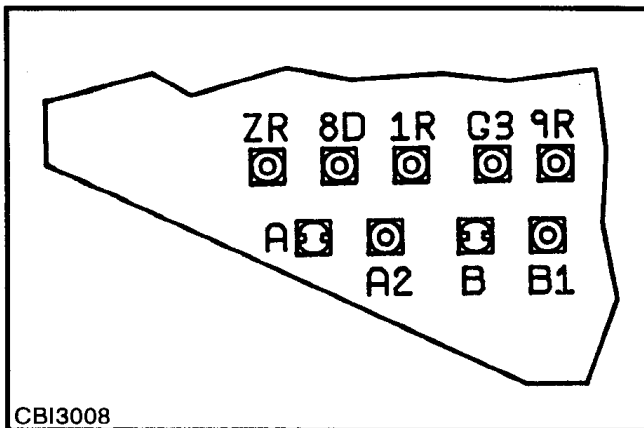


FIGURE 5-2. 686B623U01 CMF/ZERO PCB ASSEMBLY



CBI3008

Jumpers		
Functions	A2	B1
Zero return	ZR	G3
10 kHz	8D	G3
Pulse reverse	1R	9R

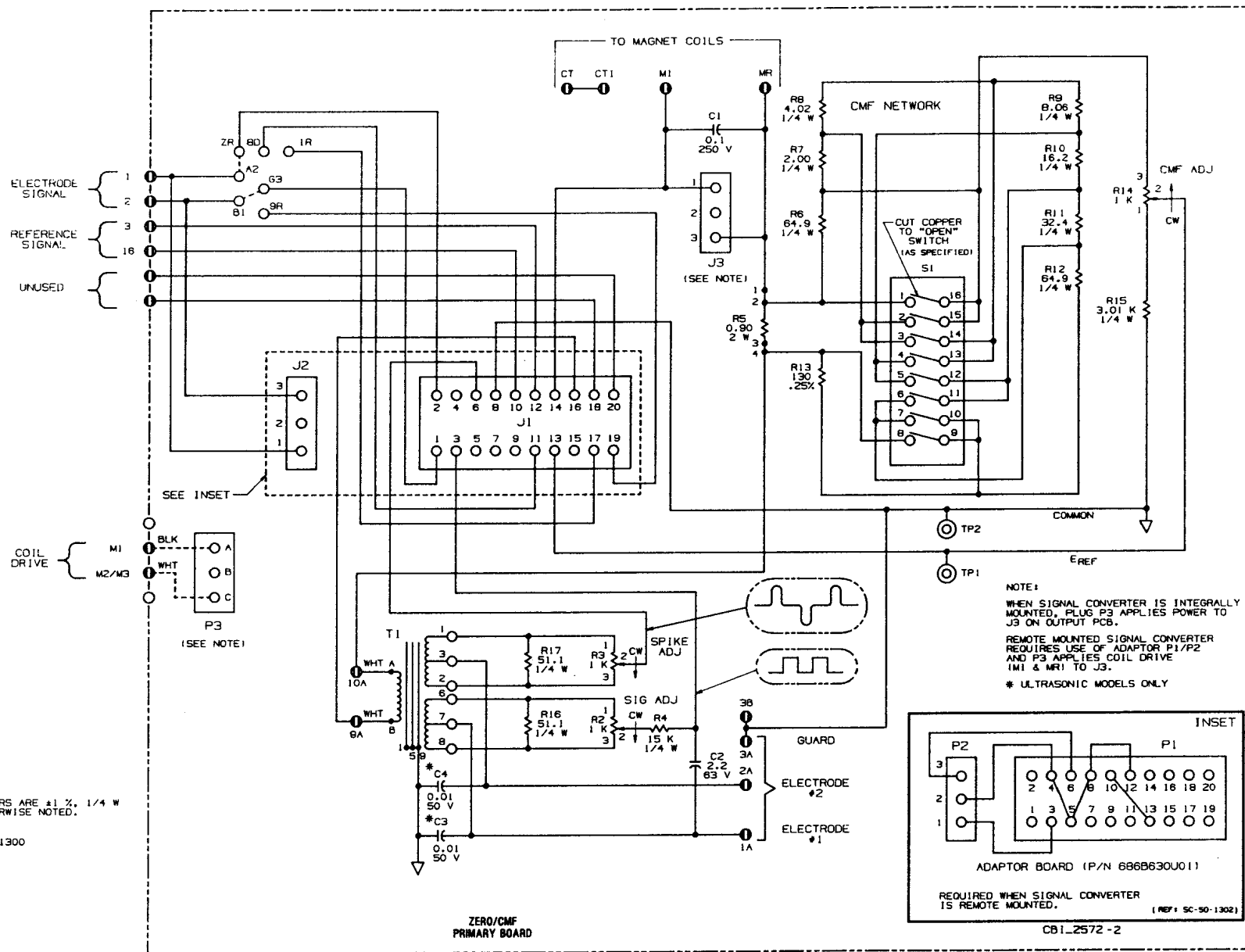


FIGURE 5-3. SCHEMATIC for CMF BOARD

## 6.0 MAINTENANCE

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### 6.1 General

Except for an occasional performance verification check, there is no required routine maintenance for the Model 10D1476. The Flowmeter body is of all welded construction. In the event a malfunction occurs in the Flowmeter body, the meter body must be replaced. If supplied, the integrally mounted Signal Converter assembly is removable.

The manufacturer offers a Repair/Exchange Program to facilitate replacement of a defective Meter or Converter. If the equipment is beyond the warranty limit, under this program a fixed price will be charged to the account of the Buyer for replacement of defective equipment with appropriate credit issued when the repairable unit is received by the manufacturer (charges prepaid). The equipment available under this program is as follows:

- the complete Flowmeter with integrally mounted Signal Converter and installation hardware
- the Flowmeter and primary board, without the Signal Converter
- the Signal Converter assembly

#### **WARNING**

**All Flowmeters and/or Signal Converters being returned to the manufacturer for repair must be free of any hazardous materials (acids, alkalis, solvents, etc.). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact the manufacturer for authorization prior to returning equipment.**

#### **NOTE**

Operation and maintenance procedures for the Signal Converter are provided in the Instruction Bulletin supplied with the Signal Converter.

When communicating with the manufacturer in regard to replacement of a complete Flowmeter (with integral Converter assembly), the Flowmeter body, or the Signal Converter, it is important to refer to the complete instrument serial number to assure that the correct replacement will be supplied. The necessary information is provided on the manufacturing specification sheet supplied with the Flowmeter, and on the Flowmeter data tag.

## 6.2 System Troubleshooting

If the Magnetic Flowmeter does not appear to be operating properly, the following procedure can be used as a guide to isolate the malfunctioning device to either the primary meter or the Signal Converter. A standard multimeter and an oscilloscope are suitable for making the test measurements.

To supplement the following discussion refer to:

Section 5.0 Circuit Description  
Primary Signals  
Primary CMF Board

Figure 5-1 Primary Wiring

Figure 5-2 686B623U01 CMF/Zero Pcb Assembly

Figure 5-3 Schematic Diagram for Primary CMF Board

Signal Converter Assembly ... refer to applicable Instruction Manual

### **WARNING**

**Equipment powered by an ac line voltage presents a potential electric shock hazard. Servicing of the Magnetic Flowmeter or Signal Converter should only be attempted by a qualified electronics technician.**

If improper meter operation is suspected, proceed as outlined below.

1. Remove access covers from customer junction box and electronics compartment of primary. Remove access cover from remote Signal Converter housing, if applicable. Inspect for evidence of condensate in junction box. If condensate is present, de-energize system power source. Conduit seals must be used at cable entrances to prevent entry of condensate. Allow interior of junction box to dry completely before restoring system power.

2. The Signal Converter options available for use with the Magnetic Flowmeter include:

- remote mounted Analog Signal Converter
- remote mounted Microprocessor-Based Converter

Because signal wiring and operating procedures are dependent upon the type of Converter and the mounting option selected, the user should refer to the instruction bulletin supplied with the associated Signal Converter for system troubleshooting procedures. A static performance test for the primary mounted components is discussed in Section 6.3, following.

3. Possible causes of erroneous flow rate indication are:

- incorrect grounding
- excessive noise due to a heavy slurry process or a non-homogeneous process
- loose or intermittent wiring
- non-full or empty meter pipe
- excess air entrained in process liquid

## 6.3 Static Test

If improper operation of the Magnetic Flowmeter is suspected, the following resistance measurements can be made to establish whether an electrical malfunction has occurred. A standard multimeter is suitable for making the resistance checks. These measurements can be made at the Primary Board located in the Flowmeter electronics base.

### **WARNING**

**Equipment that operates from ac line voltage constitutes a potential electric shock hazard to the user. Make certain that the system power is disconnected before making the following ohmmeter checks.**

### 6.3.1 Magnet Coil Check

There are two magnet coils in the meter that are connected in a series arrangement. The respective coil leads are brought up to lugs "M1 and CT1" and "CT and MR" on the CMF board in the meter electronics base. (Note that terminals CT and CT1 are internally connected via printed circuit path.) Figure 5-1 shows the actual connection method.

Before making resistance measurements, verify that the system power service has been de-energized. Remove the electronics housing cover to obtain access to the CMF board.

Since the 10D1476 is a remote-mounted Signal Converter, proceed to step 1).

- 1) Set the ohmmeter to its lowest range; e.g., R x 1.
- 2) Connect the Ohmmeter test leads to terminal lugs M1 and CT1 on the CMF board. The value displayed should correspond to 1/2 of the value ( $\pm 20\%$ ) indicated in Table 6-1.
- 3) Connect the Ohmmeter test leads to terminal lugs CT and MR. The value displayed should correspond to that obtained in Step 2 and as indicated in Table 6-1 within  $\pm 20\%$ .

If proper coil resistance is measured, it can be assumed that the magnet coils are functional. If the measurement indicates that either or both coils are "open" (infinite resistance), the Magnetic Flowmeter must be replaced.

- 4) Carefully unsolder the four coil wires from the terminal lugs on the CMF pc board. Identify each wire to enable its proper reconnection.



5) Set the Ohmmeter to its highest range (R x 10,000) and measure from wire lead M1 or MR to the meter body (case ground). The resistance reading should be infinite. If this measurement is less than 100 K ohms, the meter is defective and must be replaced.

When all measurements appear normal, the coil wires can be reconnected and the meter can be returned to service. As applicable, re-install the integrally mounted Signal Converter and/or replace meter housing cover.

**TABLE 6-1. PRIMARY COIL RESISTANCE**

Meter Size		Coil Resistance
mm	inch	Ohms (nominal)
1	1/25	18
2	1/12	18
3	1/10	18
4	5/32	18
6	1/4	18
10	3/8	18
15	1/2	18
25	1	41
40	1 1/2	60
50	2	16
80	3	19
100	4	21

### 6.3.2 Electrode Check

The electrode check is essentially a resistance measurement that can be made to establish that a short (or high resistance leakage path) does not exist between one, or both, electrodes and ground.

Before proceeding, verify that system power has been de-energized. To perform this test, the meter must be removed from the pipeline and the meter liner "wiped" dry. When the meter liner has been thoroughly dried, proceed as follows:

- 1) Remove field wiring connected to electrode leads "1" and "2". Proceed to step 2). Electrode wiring is shown in Figure 5-1.
- 2) Place Ohmmeter on highest available range (for example, R x 10,000).
- 3) Connect the Ohmmeter "minus" lead to the meter ground stud and the "plus" lead to electrode line 1. This reading should be infinite. If any resistance can be measured, the meter is defective and must be replaced.
- 4) Check the other electrode by connecting the Ohmmeter "plus" lead to line 2. This reading must also be infinite. If any resistance can be measured, the meter is defective and must be replaced.
- 5) If measurement of both electrodes indicate an infinite resistance reading, the meter may then be returned to on-stream operation after wiring has been restored. Re-install the housing cover and place meter in operation.

### 6.3.3 Flowmeter Board

The Flowmeter board is located in the base of the electronics housing as shown in Figure 6-1. This pc board includes the constant meter factor/size network. The constant meter factor/size network is used to standardize the particular flowmeter; i.e., provide a meter CAL FACTOR that will be the same for all meters of the same size.

The constant meter factor/size network is factory set by precise calibration prior to shipment. Further, this calibration procedure (used to establish the exact setting for the particular constant meter factor/size network) also compensates for variations resulting from manufacturing tolerances. The value of constant meter factor/size network on each Flowmeter board is unique and may be applicable only for the particular flowmeter for which it was supplied.

Replacement of the Flowmeter board in the field is not recommended. Should board replacement become necessary, the following steps must be followed:

1. De-energize the Signal Converter power source (this will remove power from the primary).
2. Before removing the board, it will be necessary to unsolder the 8 leads from the RFI capacitors (see Figure 5-1), plus the 3 leads from the meter electrodes, and the four wires from the magnet coils. Use care to identify all leads to ensure proper reconnection.
3. When primary connections to the board have been disconnected, remove the 3 # 4-40 board mounting screws. The board can now be removed from the meter base.

The following procedure is required to maintain the accuracy of the meter Cal Factor.

4. Potentiometer R14 and resistor R15 must be carefully removed from the old circuit assembly (note the orientation of potentiometer R14). If they are in usable condition, place them into the new assembly (observe R14 orientation). If they cannot be used, then measure and record the resistance of the following components to an accuracy of 0.1%:

R15, R14 pin 1-2, R14 pin 3-2 ("2" is the wiper)

Calculate the following:

$$K = (R15 + R14 \text{ pin } 1-2) / (R15 + R14 \text{ pin } 1-2 + R14 \text{ pin } 3-2)$$

5. Remove R14 and R15 from the replacement assembly. Measure R15 and adjust R14 to obtain the same "K" as calculated in step 4. Place R14 and R15 back into the circuit board, noting the proper orientation of R14.
6. Note which positions of shunt S1 were opened in the old CMF board. Open the identical shunt positions of S1 in the replacement board.
7. Replace the CMF board in the meter base and restore intraconnection wiring.
8. A zero flow, full pipe condition in the primary must now be established and the system powered. An oscilloscope must be connected to TP5 (TP1 com.) of a CD-1 Converter or TP103 (TP101 com.) of the XM Converter. CD-1 Converters must be set to a 1 ft/sec range and placed into self-test (elevated). R3 of the CMF assembly must be adjusted for a peak to peak waveform value of less than 2 volts (CD-1) or 0.2 volts (XM).

9. After R3 has been adjusted, R2 is to be set so that the Converter output is zero. For CD-1 Converters, the Converter must be elevated on a 1 ft/sec span and R2 then set to obtain 74.3% output (+/- 0.2%). For microprocessor-based 50XM1000 Converters, the Converter must be placed in the bidirectional mode, low flow cutoff set to zero, and R2 set so that indication on the rate display toggles between forward and reverse.

10. Following completion of steps 4 through 9, the system may now be returned to normal operation.

## 7.0 PARTS LIST

**TABLE 7-1. ANSI CLASS 150 GROUNDING RINGS**

Meter Size		ABB Part Number*	Part Number Suffix (Material)			
mm	inch		316 sst	Hast. "C"	Hast. "B"	Alloy 20
1 - 15	1/25 - 1/2	800D508	U01	U09	U34	U27
25	1	800D508	U02	U10	U18	U24
40	1 1/2	800D508	U03	U11	U35	U28
50	2	800D508	U04	U12	U20	---
50	2	800D575	---	---	---	U07
80	3	800D508	U05	U13	U36	---
80	3	800D575	---	---	---	U08
100	4	800D508	U06	U14	U37	---
100	4	800D575	---	---	---	U09

\* To complete the part number, add suffix from table; e.g., 800D508U02 for ordering one set (2) of 25 mm (1 in.) 316 sst grounding rings.

**TABLE 7-2. GASKETS FOR ANSI CLASS 150 GROUNDING RINGS (2 required)**

KLINGER SIL C-4401-----Part Number 333J089U\_\_\*

GYLON Style 3500-----Part Number 333J090U\_\_\*

Flange Rating ANSI CL150	Meter Size					
	1 - 15 mm	25 mm	40 mm	50 mm	80 mm	100mm
	1/25 - 1/2 inch	1 inch	1 1/2 inch	2 inch	3 inch	4 inch
Suffix	U01	U10	U15	U19	U22	U29

\* To complete the part number, add suffix from table; e.g., 333J089U10 for 25mm (1 inch) meter with KLINGER SIL gaskets. For applications other than ANSI CLASS150 Flanges contact the factory.

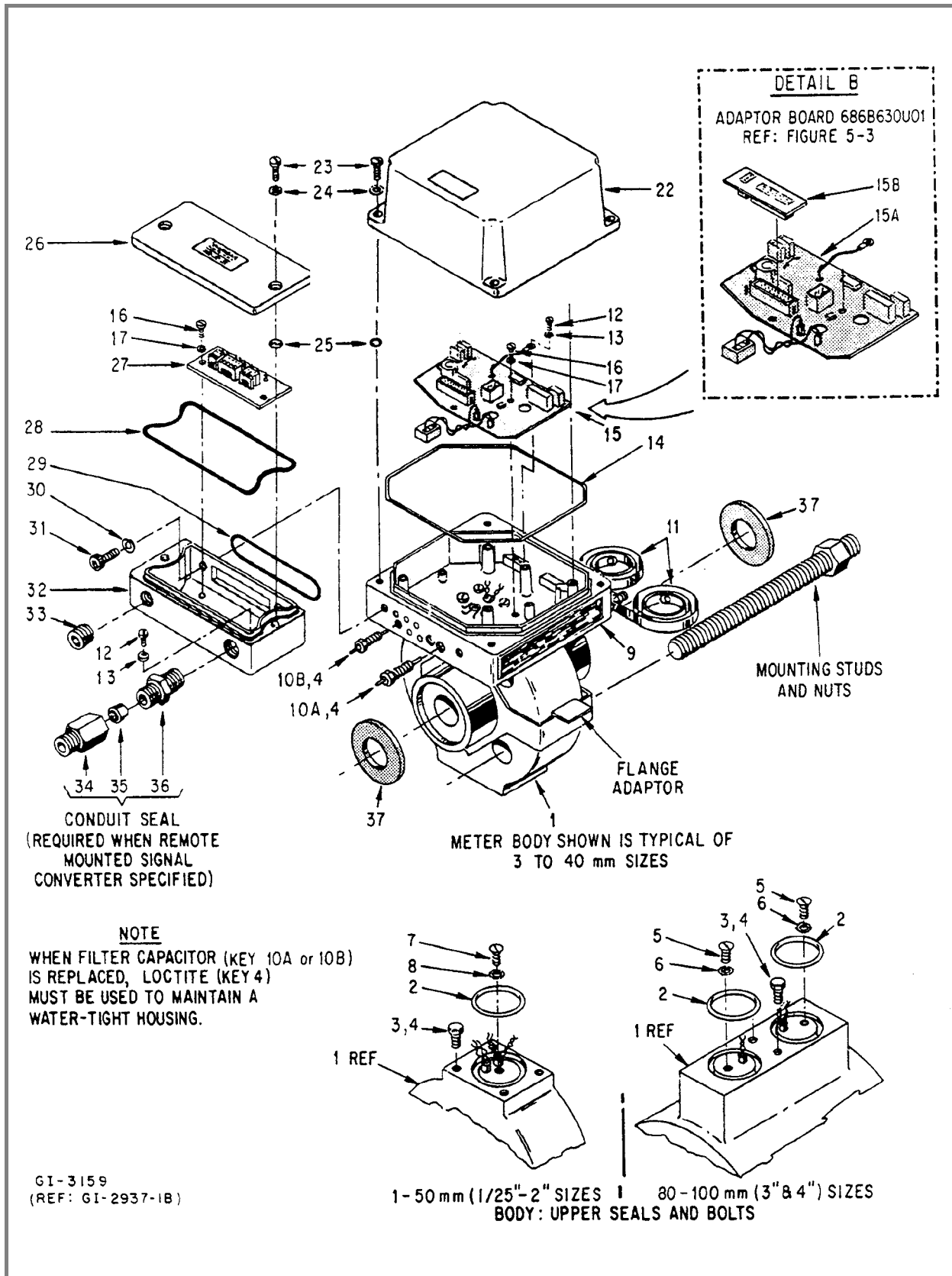
**TABLE 7-3. GASKETS FOR METER BODY (2 required)**

KLINGER SIL C-4401-----Part Number 333J089U\_\_\*

GYLON Style 3500-----Part Number 333J090U\_\_\*

	Meter Size					
	1 - 15 mm	25 mm	40 mm	50 mm	80 mm	100mm
	1/25 - 1/2 inch	1 inch	1 1/2 inch	2 inch	3 inch	4 inch
Suffix	U04	U05	U06	U07	U08	U09

\* To complete the part number, add suffix from table; e.g., 333J089U05 for 25mm (1 inch) meter with KLINGER SIL gaskets.



**FIGURE 7-1. EXPLODED VIEW, BASIC FLOWMETER PARTS**

**TABLE 7-4. BASIC METER PARTS (REF: FIGURE 7-1)**

KEY	QTY	DESCRIPTION	SIZE, mm	PART NUMBER
1	1	METER BODY:SEE NOTE 1		N/A
2	1	O-RING:Converter Base Seal	3 - 25	101A927U01
	1		40 - 50	101A937U01
	2		80	101A922U01
	2		100	101A927U01
3	2/4	BOLT, Self Sealing		091B022U01
4	-	LOCTITE, Type 271		145A016U02
5	2	SCREW, Flat Hd: 1/4-20 x 1/2'		032B008T10
6	2	WASHER, Csk: M6		85G027KU05
7	1	SCREW, Flat Nd: #8-32 x 1/4"	3 - 25	002K004T10
		#10-32 x 5/16"	40 - 50	002L005T10
8	1	LOCKWASHER, Csk, Ext.Tooth #8	3 - 25	085M008V11
		#10	40 - 50	085M010V11
9	1	BASE,Converter	3 - 25	610B249U03
			40 - 50	610B249U04
			80	610B249U05
			100	610B249U06
10A	2	FILTER CAPACITOR ASSY (RFI), 100 pF, 120 VAC		C160C102U01
10B	6	FILTER CAPACITOR ASSY (RFU), 1000 pF, 500 VDC		160C055U01
11	2	GROUND STRAP		355A422U01
12	2	SCREW, Pan Hd: #6-32 x 1/4"		006H004T10
13	2	LOCKWASHER, Ext. Tooth: #6		085H006V11
14	1	SEAL RING, Cover		101A834U01
15A	1	PRIMARY BOARD, Converter Base (CMF)		686B623U01
15B	1	ADAPTOR BOARD (for remote converter)		686B630U01
16	5	SCREW, Pan Hd: #4-40 x 1/4'		006H004T10
17	5	LOCKWASHER, Ext. Tooth: #4		085H004V11
22	1	COVER, Converter Base: w/o Window with Window		379D358U01 D612A083U01
23	6	SCREW, Pen Hd: #10-32 x 3/4"		006L012T10
24	6	LOCKWASHER, Ext Tooth: #10		085D010T10
25	6	O-RING, Screw Retainer		333C596U01
26	1	COVER, Customer Connection Box		C379D371U01
27	1	PC BOARD, Customer Connection Box		C686B624U01
28	1	SEAL RING, Customer Connection Box		101A825U01
29	1	O-RING, Connection Box to Converter		101A001U08
30	2	LOCKWASHER, Ext Tooth: 1/6"		085H416T10
31	2	SCREW, Hex Soc Hd: 1/4-20 x 7/8"		038B014T10
32	1	CUSTOMER CONNECTION BOX:		C323D416U02
33	1	PIPE PLUG: 1/2" NPT SEE NOTE 2		112A352U22
34	1	FITTING, PipeSEE NOTE2		364D297U01
35	1	GROMMETSEE NOTE 2		368D145R90
36	1	FITTING,PipeSEE NOTE 2		364D257U01
37	2	GASKET,See TABLE 7-3		

**NOTES:**

1. Meter body (Key 1) is a welded assembly and is not a repairable item. The manufacturer maintains a repair/exchange program so that the entire meter or the Signal Converter alone, can be replaced with a minimum of down time; contact your local factory field office for details. To order specify either a new or repair/exchange meter or Signal Converter, as required. ALL correspondence should reference the complete instrument model number and serial number.
2. Parts are supplied with signal cable, when specified.
3. Mounting hardware and gaskets (supplied by the manufacturer) are selected according to meter size.
4. The Primary CMF Board is not interchangeable, see procedure 6.3.3 in MAINTENANCE section. It is suggested that the user return the Magnetic Flowmeter to the factory for repair and calibration, or consult a factory service representative for assistance.

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