INSTRUCTION MANUAL

MAGNETIC FLOWMETERS
10D1476C & P
1/25 through 4 Inches

K-MAG® MAGNETIC FLOWMETER

PN24453

ABB

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HART

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

NOTICE

The instructions given herein cover generally the description, installation, operation and maintenance of subject equipment. Fischer & Porter reserves the right to make engineering refinements that may not be reflected in this bulletin. Should any questions arise which may not be answered specifically by these instructions, the questions should be directed to Fischer & Porter for further detailed information and technical assistance. The material in this manual is for informational purposes and is subject to change without notice. Fischer & Porter Company assumes no responsibility for any errors that may appear in this manual.

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BAILEY FISCHER & PORTER

SUPPLEMENT TO MAGNETIC FLOWMETER INSTRUCTION BULLETINS 10D1475E,P & S and 10D1476C & P

THIS INFORMATION SUPPLEMENTS INFORMATION CONTAINED IN MAGNETIC FLOWMETER INSTRUCTION BULLETINS 10D1475E,P & S (PN24456) AND 10D1476C & P (PN24453)

1.0 Circuit Description of 10D1475G AND 10D1476G Primaries

Models 10D1475G and 10D1476G wafer flowmeter primaries each have two flux producing coils wired in series and a pair of diametrically opposed electrodes mounted at 90 degrees to the coil flux plane. Meter coils are driven with approximately ±10 volts of pulsed DC. A precision current sensing network is mounted in series with the coils. The current sense network produces what Bailey-Fischer & Porter refers to as a "Reference Voltage", which is typically ±70 millivolts. The reference voltage is directly proportional to the strength of the magnetic field in the measuring tube and must be measured by the signal converter since reference voltage variation also produces a proportional change in electrode signal voltage, assuming a constant flowing velocity.

Flowmeters of the pulsed DC type operate on the principle that unwanted electrode signals occur while the magnetic flux is changing. Accordingly, the signal converters have been designed to sample the electrode voltage only during that portion of the excitation cycle when the magnetic flux is constant. This occurs during the last 25% or 50% of each half cycle, depending on the type of signal converter. Pulsed DC operation of a magmeter system eliminates those variables capable of causing drift of the meter zero point.

The type of signal converter used in the flowmeter system determines the location and configuration of the circuitry used to produce the reference voltage. Further information regarding signal converter operations may be found in their respective instruction bulletins.

2.0 Systems Using The CD-1 Signal Converter

All primaries designed for use with the CD-1 analog signal converter are constructed with a 686B762 connection board beneath the converter module. This connection board serves to interconnect the primary wiring to the converter and also serves to direct converter input/output lines to the customer connection area. A number of configuration jumpers provide selection of certain terminal functions as shown in Table 1.

When used with the CD-1, the current sensing network of the 686B762 is active and produces the converter's reference voltage. The reference network consists of a 0.9 ohm kelvin resistor and a precision adjustable resistive divider network. Adjustment of the divider network changes the magnitude of the reference voltage, thereby forcing the flowmeter system to produce a fixed output for a given size and flow rate (constant meter factor per size).

If the signal converter is integrally mounted, the 686B762 assembly has provisions to bring the 4-20 mA current output, the scaled pulse output, power connections, and zero return inputs to the customer wiring compartment.

If the CD-1 converter is remotely mounted, then a J1 adaptor plug is installed in the ribbon cable connector. Also, the converter power plug is installed in P3. These plugs re-direct coil drive, electrode, and reference voltage signals into the meter's wiring compartment.

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TABLE 1. 686B762 BOARD JUMPER FUNCTIONS

JUMPER NUMBER	POSITION	FUNCTION
J1	1-2	ZERO RETURN
J1	3-4	10 KHZ SIGNAL
J1	5-6	REVERSE PULSE SIGNAL
J1	7-8	10 KHZ GROUND, ZERO RETURN
J1	9-10	REVERSE PULSE COMMON
J1	2-4, 8-10	REMOTE CONVERTER
P4	1-2	INTEGRAL CONVERTER
P4	2-3	REMOTE CONVERTER
P5, P6	1-2	M2 MODE
P5, P6	2-3	CD-1, XM1000 MODE

3.0 Systems With M2 Signal Converters

When the flowmeter system is fitted with an integrally mounted M2 microprocessor-based converter, a **686B776** circuit board assembly is installed underneath the converter module. This assembly incorporates the following functional blocks:

- A precision Kelvin current sensing network in series with the coils
- An encapsulated AC coupled buffer preamplifier for each measuring electrode
- An EEPROM for retention of primary span and zero correction factors
- Input/output lines for 4-20 mA current, scaled pulse or data link, contact inputs/outputs (by jumper configuration - Refer to Table 2 and Figure 1)

TABLE 2. 686B776 JUMPER FUNCTIONS

OPTIONAL COMBINATIONS	INPUT/OUTPUT	J1 TERMINALS TO BE CONNECTED
Zero Return / External Totalizer Reset	Input	7-8, 4-6 & 3-5
Alarm / Opto-coupled Scaled Pulse	Output	2-4, 1-3 & 8-10
Forward / Reverse Flow Indication	Output	2-4, 1-3 & 7-9

The resistive divider network which produces a converter reference voltage is similar to the one described previously (see CD-1), but in the case of the M2 converter, the reference voltage is maintained at $\pm$70 mV by the signal converter. This results in approximately 200 mA of constant coil current. The EEPROM is programmed with the mathematical corrections necessary to obtain "constant meter factor per size".

Systems fitted with remotely mounted M2 converters utilize the **686B762** connection board with a remote J1 adaptor. Through use of jumpers P5 and P6, the current sensing network is disconnected from the coils. No reference voltage is produced within this primary type, but rather at the current sense network in inside the remote converter housing (see M2 converter IB). The circuit path to the coils is completed by placing the power connector into P3. Thus, for remote systems using M2 converters, a simplified cabling scheme between primary and secondary consists of a circuit common, a safety ground, two electrode leads, and two coil leads.

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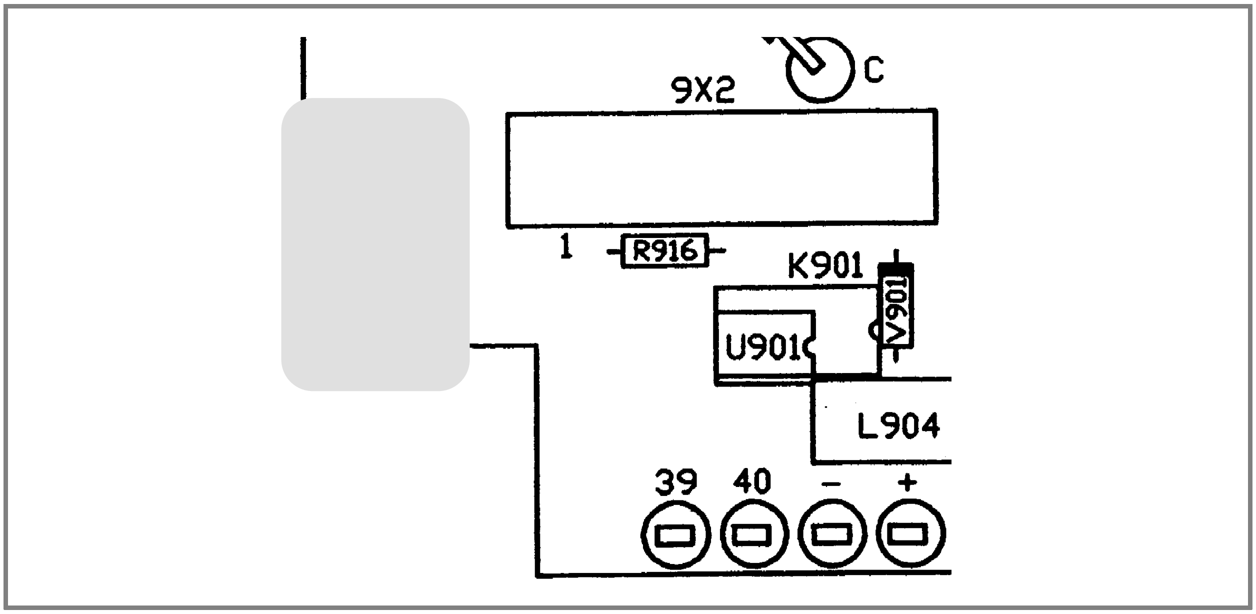

FIGURE 1. JUMPER LOCATIONS FOR 686B776 BOARD

4.0 Coil Resistance Data

Coil winding parameters for size 1-1/2" (1.5") meters differ from those tabulated in the Design Level E Instruction Bulletin. The coil resistance measured between the M1 and MR terminals of the connection board should be 32 ohms, +/-20%.

5.0 Replacement of Primary Printed Circuit Assemblies

The following printed circuit assemblies are **NOT field replaceable**:

- 686B776, used with integral M2
- 686B762*, only the version used with CD-1

The following printed circuit assemblies **may be replaced** without any need for adjustment:

- 686B810, customer connection board
- 686B762, version used with remote mounted M2

* if a constant current source (i.e. Transmation) is available, consult Bailey-Fischer & Porter for detailed replacement instructions.

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6.0 Model Numbers

6.1 10D1475G Model Number

10D1475 G N __ _ _ 2 _ _ _ _ _ _ _ _ _ _ _ _

Design Levell	**G**
Liner Material	
Tefzel (ETFE)	**N**
Meter Size - mm (in.)	
3 (1/10)	**01**
4 (5/32)	**02**
6 (1/4)	**04**
10 (3/8	**06**
15 (1/2)	**07**
25 (1)	**09**
40 (1-1/2)	**11**
50 (2)	**12**
80 (3)	**14**
100 (4)	**15**
Flange Std. / Pressure Rating	
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**
Not Required	**X**
Electrode Material	
Hastelloy-C	**D**
Tantalum	**F**
Zirconium	**L**
Platinum	**M**
Electrode Type	
Flush	**2**
Flange Material	
Flangeless Design w/ Self-Adhesive Tag	**8**
Flangeless Design w/ Riveted SST Tag	**9**
Safety Classification	
w/o FM Approval, Integral or Remote Converter (General Purpose)	**A**
FM Approved; Primary Flowmeter and remote mounted Signal Converter: Nonincendive for Cl I, Div 2, Gp A, B, C & D: Electrodes Intrinsically Safe for Cl I, Div 1, Gp A, B, C & D:Outdoor Hazardous Locations, NEMA 4X. Integ. Signal Converter enclosure additionally approved: Dust-Ignitionproof Cl II, Div 1, Gp E, F & G: Suitable for Cl III, Div 1; Accidental Submergence, 30 ft H_2O/48 hr (9 m H_2O/48 hr)	**K**

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10D1475G Model Number (cont.)

10D1475 G N __ _ _ 2 _ _ _ _ _ _ _ _ _ _ _ _

Power Requirements	
Integral Signal Converter, 220/230/240 VAC, 50/60 Hz	**A**
110/115/120 VAC, 50/60 Hz	**C**
48 VAC, 50/60 Hz	**E**
24 VAC, 50/60 hZ	**F**
48 VDC	**G**
24 VDC	**H**
Remote Converter w/ Separate Model Number	**Y**

Enclosure Classification	
IEC 529 IP65, NEMA 4X	**1**
Accidental Submergence, IEC 529 IP67, 30 ft H_2O/48 hr (9 m H_2O/48 hr)	**5**

Fluid Temperature Range	
Integral Converter to 65^{o}C (149^{o}F)	**1**
Remote Converter to 121^{o}C (250^{o}F)	**2**

Output Current	
No Output Signal Required	**A**
0-20 mA DC	**B**
4-20 mA DC	**C**

Output Options	
No Scaled Output Required	**1**
Active Scaled Pulse Forward & Zero Return	**2**
Active Scaled Pulse Forward & Reverse	**4**
Data Link, RS232C	**5**
Data Link, RS485	**6**
Active Scaled Pulse Forward & 10kHz Unscaled Pulse	**7**
Bailey FSK	**9**

Communication Mode	
Not Applicable	**1**
ASCII	**2**
HART Protocol	**4**

Coil Drive Frequency	
7 1/2 Hz (60 Hz Line Frequency)	**1**
15 Hz (60 Hz Line Frequency)	**2**
15 Hz (DC Power in vicinity of 60 Hz line)	**3**
6 1/4 Hz (50 Hz line frequency)	**4**
12 1/2 Hz (50 Hz line frequency)	**5**
6 1/4 Hz (DC Power in vicinity of 50 Hz line)	**6**
12 1/2 Hz (DC Power in vicinity of 50 Hz line)	**7**
7 1/2 Hz (DC Power in vicinity of 60 Hz line)	**8**
Other Frequency (presently not available)	**9**

Additional Options	
Empty Pipe Detector	**1**
None	**2**
HART Protocol & Empty Pipe Detector	**3**
HART Protocol	**4**

Mounting Hardware Kit	
Standard Kit: Steel Nuts & Bolts, Centering Device, Klinger Sil C-4401 Gaskets	**C**
Optional Kit: Steel Nuts & Bolts, Centering Device, Teflon Gaskets	**E**
Std. Kit Not Required	**X**

Converter	
Required	**1**
Not Required	**2**

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6.2 10D1476G Model Number

10D1476 G H __ _ M 2 _ _ _ _ _ _ _ _ _ _ _ _ _ _

Design Level	**G**
Liner Material	
Ceramic Spool	**H**
Meter Size - in. (mm)	
1 (1/25)	**36**
2 (1/12)	**37**
3 (1/10)	**01**
4 (5/32)	**02**
6 (1/4)	**04**
10 (3/8	**06**
15 (1/2)	**07**
25 (1)	**09**
40 (1-1/2)	**11**
50 (2)	**12**
80 (3)	**14**
100 (4)	**15**
Flange Std./Press. Rating	
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**
Not Required	**X**
USDA Sanitary Tri-Clamp Fittings	**1**
Electrode Material	
Platinum	**M**
Electrode Type	
Flush	**2**
Flange Material	
Flangeless Design w/ Self-Adhesive Tag	**8**
Flangeless Design w/ Riveted SST Tag	**9**
Safety Classification	
w/o FM Approval, Integral or Remote Converter (General Purpose)	**A**
FM Approved; Primary Flowmeter and remote mounted Signal Converter: Nonincendive for Cl I, Div 2, Gp A, B, C & D: Electrodes Intrinsically Safe for Cl I, Div 1, Gp A, B, C & D:Outdoor Hazardous Locations, NEMA 4X. Integ. Signal Converter enclosure additionally approved: Dust-Ignitionproof Cl II, Div 1, Gp E, F & G: Suitable for Cl III, Div 1; Accidental Submergence, 30 ft H_2O/48 hr (9 m H_2O/48 hr)	**K**
USDA Approved Meat & Poultry Equipment	**N**

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10D1476 G H __ _ M 2 _ _ _ _ _ _ _ _ _ _ _ _

Power Requirements	
Integral Signal Converter, 220/230/240 VAC, 50/60 Hz	A
110/115/120 VAC, 50/60 Hz	C
48 VAC, 50/60 Hz	E
24 VAC, 50/60 hZ	F
48 VDC	G
24 VDC	H
Remote Converter w/ Separate Model Number	Y
Enclosure Classification	
IEC 529 IP65, NEMA 4X	1
Accidental Submergence, IEC 529 IP67, 30 ft H_2O/48 hr (9 m H_2O/48 hr)	5
Brewery Design (NEMA 4X)	8
Fluid Temperature Range	
Integral Converter to $65^{o}C$ ($149^{o}F$)	1
Remote Converter to $180^{o}C$ ($356^{o}F$)	3
Output Current	
No Output Signal Required	A
0-20 mA DC	B
4-20 mA DC	C
Output Options	
No Scaled Output Required	1
Active Scaled Pulse Forward & Zero Return	2
Active Scaled Pulse Forward & Reverse	4
Data Link, RS232C	5
Data Link, RS485	6
Active Scaled Pulse Forward & 10kHz Unscaled Pulse	7
Bailey FSK	9
Communication Mode	
Not Applicable	1
ASCII	2
HART Protocol	4
Coil Drive Frequency	
7 1/2 Hz (60 Hz Line Frequency)	1
15 Hz (60 Hz Line Frequency)	2
15 Hz (DC Power in vicinity of 60 Hz line)	3
6 1/4 Hz (50 Hz line frequency)	4
12 1/2 Hz (50 Hz line frequency)	5
6 1/4 Hz (DC Power in vicinity of 50 Hz line)	6
12 1/2 Hz (DC Power in vicinity of 50 Hz line)	7
7 1/2 Hz (DC Power in vicinity of 60 Hz line)	8
Other Frequency (presently not available)	9
Additional Options	
Empty Pipe Detector	1
None	2
HART Protocol & Empty Pipe Detector	3
HART Protocol	4
Mounting Hardware Kit	
Standard Kit: Steel Nuts & Bolts, Centering Device, Klinger Sil C-4401 Gaskets	C
Optional Kit: Steel Nuts & Bolts, Centering Device, Gylon Style 3500 (Fawn) Gaskets	D
Std. Kit Not Required	X
Converter	
Required	1
Not Required	2

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Table List

READ FIRST

This revision of Instruction Bulletin 10D1476 replaces Pub. No. 24345. The purpose of this revision is to update the grounding information in Section 2.4 and the parts lists in Section 7.0.

WARNING

All Flowmeters and/or Signal Converters being returned to Fischer & Porter 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 F&P for authorization prior to returning equipment.

NEMA 4X, Corrosion Resistant Finish

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 Fischer & Porter representative to obtain the correct touch-up paint.

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

1.0 INTRODUCTION

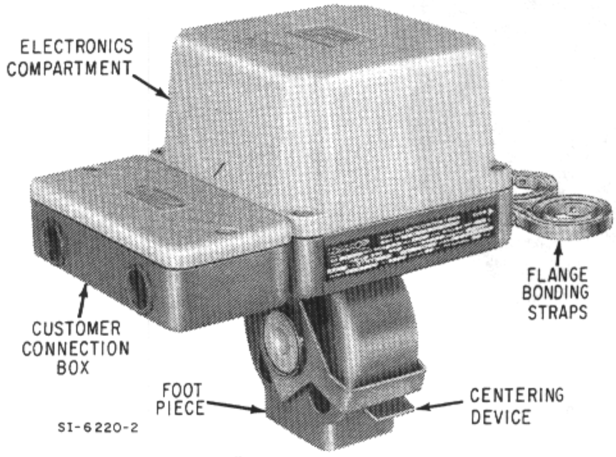
1.1 General

The Fischer & Porter Series 10D1476 K-MAG® 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.

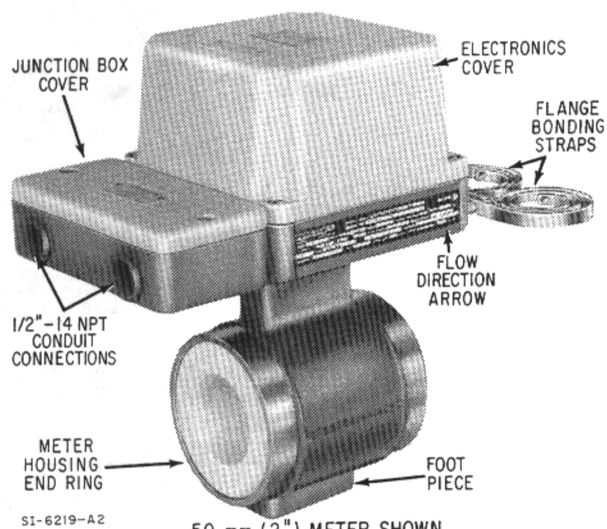
The standard meter design provides a compact, very low power, obstructionless primary metering element that bolts between flanges in a process pipeline. Pressure losses in this type of meter are reduced to levels occurring in equivalent lengths of equal diameter pipeline, thus reducing or conserving 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® 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.



15 mm (1/2") METER SHOWN
TYPICAL FOR 1 mm (1/25") THRU 40 mm (1-1/2") SIZES



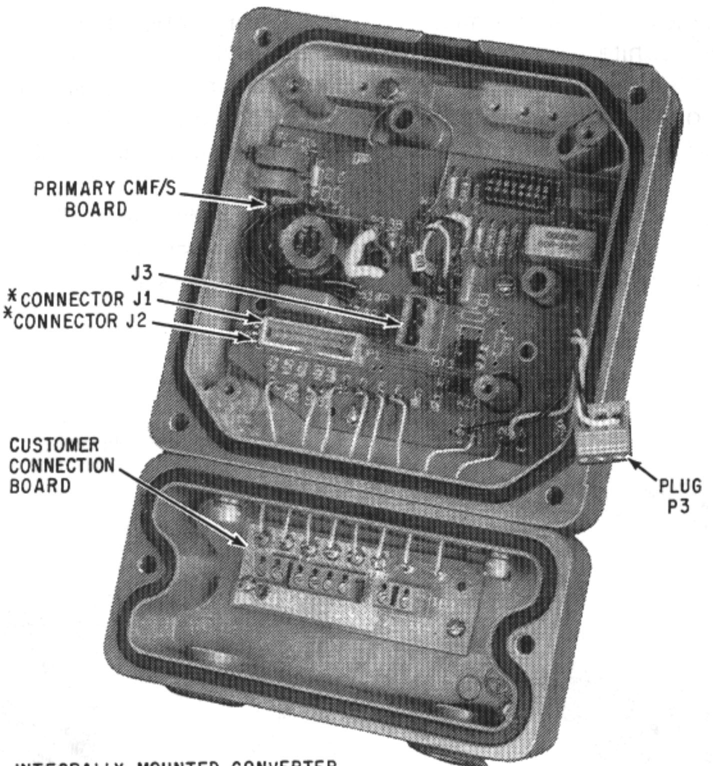
50 mm (2") METER SHOWN
TYPICAL FOR 50 mm THRU 100 mm (4") SIZES

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.



INTEGRALLY MOUNTED CONVERTER
* J1 MATES WITH P1 FROM CONVERTER CABLE.
P3 MATES WITH J3 ON OUTPUT BOARD.
REMOTE MOUNTED CONVERTER
* J1/J2 MATES WITH P1/P2 ON ADAPTOR BOARD.
P3 MATES WITH J3 ON PRIMARY BOARD.

SI-7000

FIGURE 1-2. ELECTRONICS COMPARTMENT WITHOUT SIGNAL CONVERTER

With the exception of the primary board, the associated electronics package is called the Signal Converter and may be either integrally or remotely mounted. Figure 1-2 shows the electronic housing without the integral Signal Converter. A view of an integrally mounted Signal Converter is shown in Figure 1-3. The Flowmeter without the electronic package is used with a remote Signal Converter. A remote mounted Signal Converter is recommended if 1) the vibration specification is exceeded and/or 2) the process liquid temperature exceeds the value given for that ambient temperature listed in the specifications.

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.

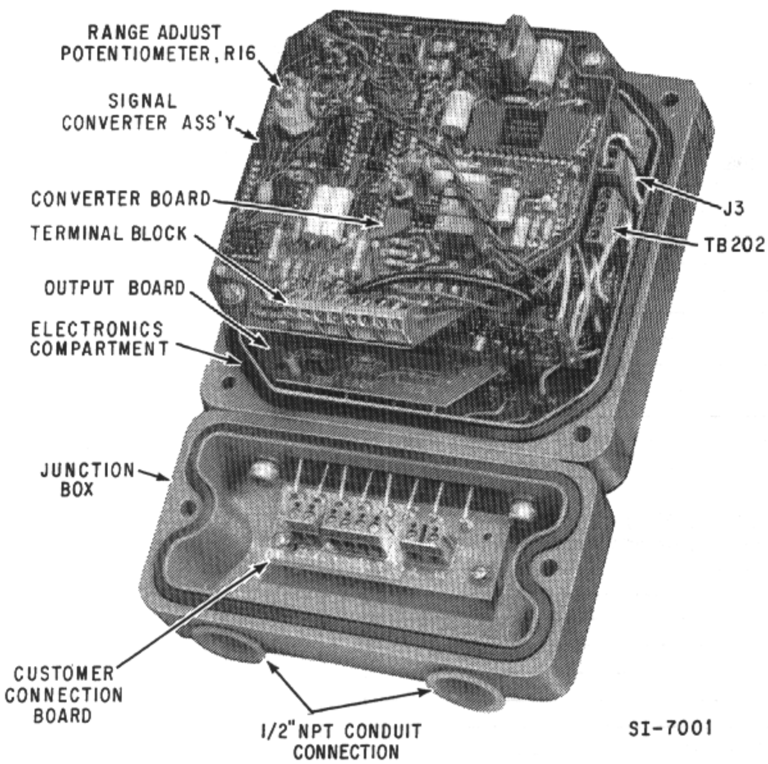


FIGURE 1-3. ELECTRONICS COMPARTMENT WITH SIGNAL CONVERTER

1.2 Model Number Breakdown

Refer to the F&P 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:

1.2.1 Model 10D1476C

10D 1476 C H _ _ M 2 9 _ _ _ _ _ _

Engineering File Reference – 10D
Obstructionless Magnetic Flowmeter

Design Designation — 1476
K-MAG Design
(non-flanged insert)
MAG-X Driver Circuit

Design Level — C
Letter assigned by the factory;
Constant meter factor/size and
Analog Signal Converter

Liner Material

Ceramic Spool	H

Meter Size, mm (inches)

1 (1/25)#	36
2 (1/12)#	37
3 (1/10)	01
4 (5/32)	02
6 (1/4)	04
10 (3/8)	06
15 (1/2)	07
25 (1)	09
40 (1-1/2)	11
50 (2)	12
80 (3)	14
100 (4)	15

Flange Standard/Pressure Rating
(Meter clamps between customer's pipeline flanges)

ANSI Class 150	P
ANSI Class 300*	Q
BS10 Table D	S
BS10 Table E	T
BS10 Table F*	U
DIN PN 16	D
DIN PN 40*	F
U.S.D.A. Sanitary TRI-CLAMP Fittings+	1

Electrode Material

Platinum	M

Electrode Type

Flush	2

Flange Material

Flangeless Design	9

1.2.1 Model 10D1476C (continued)

10D 1476 C H _ _ M 2 9 _ _ _ _ _ _

Certifications (See NOTE))

Without FM Approval (General Purpose)
Integral or Remote Converter — A

FM Approved
Primary Flowmeter and remote mounted Signal Converter:
Nonincendive for Cl I , Div 2, Gp,A,B,C & D;
Electrodes Intrinsically Safe for Cl I, Div 1, Gp A,B,C & D;
Outdoor Hazardous Locations, NEMA 4X.
Integral Signal Converter enclosure additionally approved:
Dust-Ignition proof Cl II, Div 1, Gp E,F & G;
Suitable for Cl III, Div 1
Accidental Submergence, 30 ft H_2O/48 h (9 m H_2O/48 h) — K

U.S.D.A. Approved Meat & Poultry Equipment — N
(Also certified for F.D.A. & 3A sanitary applications)

Power Requirement

Signal Converter Integral Mounted		Signal Converter Remote Mounted	
220 V ac, 50 Hz	A	220 V ac, 50 Hz	R
220 V ac, 60 Hz	B	220 V ac, 60 Hz	S
120 V ac, 50 Hz	C	240 V ac, 50 Hz	T
120 V ac, 60 Hz	D	240 V ac, 60 Hz	U
240 V ac, 50 Hz	K	120 V ac, 50 Hz	V
240 V ac, 60 Hz	L	120 V ac, 60 Hz	W
12 V dc#	1	12 V dc#	6
24 V dc#	H	24 V dc#	7

Remote Converter with separate Model Number — Y

Enclosure Classification

IEC 529 IP 65, NEMA 4X — 1
Accidental submergence, IEC 529 IP 67
30 ft H_2O/48 h (9 m H_2O/48 h) — 5

Fluid Temperature Range

Integral Converter To 80°C (175°F) — 1
Remote Converter To 180°C (356°F) — 3
NOTE: See Process Limits under 1.3 Specifications for
allowable combinations of liquid and ambient temperature at primary.

Output Signal

No Output Signal Required — A
0-20 mA dc — B
4-20 mA dc — C
0-1 kHz pulse (not available when Scaler option is specified) — G
4-20 mA dc with direct reading Indicator (3-1/2 digit LCD) — K

Scaler

No scaled output required — A
Isolated Scaled Freqency Output
50 ms pulse, 10 Hz max, Opto coupled — B
Isolated Scaled Frequency Output
50 μs pulse, 10 kHz max, Opto coupled — C

* Not available in 100 mm (4") size
+ No grounding or mounting hardware supplied. Requires Product Manager approval.
# Requires Product Manager approval.

NOTE: Certification options "K" and "N" are not mutually exclusive; i.e.,
an FM approved meter can be supplied for sanitary applicatons.

1.2 Model Number (continued)

1.2.2 Model 10D1476P

10D 1476 P H _ _ M 2 9 _ _ _ _ _ _ _ _ _

Engineering File Reference – 10D
Obstructionless Magnetic Flowmeter

Design Designation — 1476
K-MAG Design
(non-flanged insert)
MAG-X Driver Circuit

Design Level — P
Letter assigned by the factory;
Constant meter factor/size and
Microprocessor-Based Signal Converter

Liner Material
Ceramic Spool — H

METER SIZE, mm (inches)

1 (1/25)#	36
2 (1/12)#	37
3 (1/10)	01
4 (5/32)	02
6 (1/4)	04
10 (3/8)	06
15 (1/2)	07
25 (1)	09
40 (1-1/2)	11
50 (2)	12
80 (3)	14
100 (4)	15

Flange Standard/Pressure Rating
(Meter clamps between customer's pipeline flanges)

ANSI Class 150	P
ANSI Class 300	Q
BS10 Table D	S
BS10 Table E	T
BS10 Table F	U
DIN PN 16	D
DIN PN 40	F
U.S.D.A. Sanitary TRI-CLAMP Fittings##	1

Electrode Material
Platinum — M

Electrode Type
Flush — 2

Flange Material
Flangeless Design — 9

Certifications (See NOTE)
Without FM Approval (General Purpose)
Integral or Remote Converter — A

FM Approved
Primary Flowmeter and remote mounted Signal Converter:
Nonincendive for Cl I, Div 2, Gp,A,B,C & D;
Electrodes Intrinsically Safe for Cl I, Div 1, Gp A,B,C & D;
Outdoor Hazardous Locations, NEMA 4X.
Integral Signal Converter enclosure additionally approved:
Dust-Ignition proof Cl II, Div 1, Gp E,F & G;
Suitable for Cl III, Div 1
Accidental Submergence, 30 ft H_2O/48 h (9 m H_2O/48 h) — K

U.S.D.A. Approved Meat and Poultry Equipment‡ — N
(Also certified for F.D.A. and 3A Sanitary Applications)

1.2.2 Model 10D1476P (continued)

10D 1476 P H _ _ M 2 9 _ _ _ _ _ _ _ _ _

Power Requirement

Signal Converter Integral Mounted

240 V ac, 50/60 Hz*	A
220 V ac, 50/60 Hz*	B
120 V ac, 50/60 Hz	C
110 V ac, 50/60 Hz	D
24 V dc	H
Remote Converter with separate Model Number**	Y

Enclosure Classification

IEC 529 IP 65, NEMA 4X	1
Accidental submergence, IEC 529 IP 67 30 ft H_2O/48 h (9 m H_2O/48 h), Remote Mounted Converter	5

Fluid Temperature Range

Integral Converter to 65°C (149°F)	1
Remote Converter to 180°C (356°F)	3

NOTE: See Process Limits under Section 1.3.

Output Current

No Output Signal Required, Remote Mounted Converter	A
4-20 mA dc	C

Output Options

No Scaled Output Required	1
Active Scaled Pulse Forward and Zero Return#	2
Active Scaled Pulse Forward and Reverse#	4
Data Link RS 232C	5
Data Link RS 485	6
Active Scaled Pulse Forward and 10 kHz Unscaled Pulse+	7

Communication Mode Over Data Link

Not applicable	1
ASCII	2
MICRO-DCI Binary	3
HART Protocol	4

Coil Drive Frequency

7-1/2 Hz (60 Hz)	1
15 Hz (60 Hz)	2
DC 15 Hz (@60 Hz Line Frequency)#	3

Additional Options

None	2
HART Protocol++	3

* Safety Classification must be "A".
\+ 4 kHz max pulse configurable from .032 ms to 2000 ms.
\# Must be approved by Product Manager.
++ Communications Mode must be "4", Output Options can be "1", "2","4" or "7".
** Meter has no optional outputs.
\#\# Must be approved by Product Manager. No grounding rings or mounting hardware supplied.
‡ Flange Standard must be "1".

NOTE: Certification options "K" and "N" are not mutually exclusive; i.e., an FM approved meter can be supplied for sanitary applicatons.

1.3 Specifications

Power Requirements — See Section 1.2 Model Number Breakdown

Power Consumption — Refer to Signal Converter Instruction Bulletin for power input requirements
Typically, 10D1476C......15VA
10D1476P......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 µS/cm

System Accuracy

Model 10D1476C

	Flowrate	Accuracy
Analog Output*	< 10%	± 0.2% fsc
	≥ 10%	± 1.0% of rate +0.1% fsc
Frequency Output*	< 10%	± 0.1% fsc
	≥ 10%	± 1.0% of rate

* For Converters with dc power input add ± 0.03 ft/s (± 0.01m/s) to tabulated accuracy values. This number corresponds to 0.1% of meter calibration factor.

Model 10D1476P

	Flowrate	Accuracy
Frequency Output	< 4% Cal Factor	± 0.02% Cal Factor
	≥ 4% Cal Factor	± 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 integral 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_2O/48 h (9 m H_2O/48 h)

Environmental Temperature Limits at Flowmeter.

	10D1476C	10D1476P
Remote Converter	–40 to 65° C (–40 to 150° F)	–40 to 65° C (–40 to 150° F)
Integral Converter	–40 to 65° C (–40 to 150° F)	–10 to 55° C (14 to 131° F)

Process Limits

Temperature Limits, Process Liquid for integrally mounted Converter

Model 10D1476C

Ambient Temp		Max Liquid Temp	
° C	° F	° C	° F
0	32	130	266
20	68	110	230
35	95	95	203
45	113	85	185
50	122	80	176
60	140	70	158
65	149	65	149

Model 10D1476P

Ambient Temp		Max Liquid Temp	
° C	° F	° C	° F
0	32	121	250
10	50	110	230
20	68	100	212
30	86	90	194
40	104	80	176
50	122	70	158
55	131	65	149

> **NOTE**
> Signal Converter must be remote mounted if the liquid temperature exceeds value listed for a given ambient temperature. Process liquid temperature may not exceed 180° C (356° F) in any case.

Thermal Shock — positive temp change, 100°C
negative temp change, 70°C

> **NOTE**
> The temperature gradient between the liquid and the ceramic spool should not exceed 100°C when increasing the temperature, or 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 integral 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 Bulletin

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

Meter Weight

Magnetic Flowmeter with Integral Signal Converter — See Table 1-2

Remote Mounted Signal Converter	See Signal Converter Instruction Bulletin
Signal Converter Vibration Limit	
Integral Mounted	* 5 to 14 Hz, 0.10"; 14 to 200 Hz, 1 g *Signal Converter must be remote mounted if these limits are exceeded.
Remote Mounted	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, gasketed 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 and P. 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^3/H		m^3/H		m^3/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

TABLE 1-2. METER WEIGHTS

Meter Size		Weight	
mm	inch	kilograms	pounds
1	1/25	4	9
2	1/12	4	9
3	1/10	4	9
4	5/32	4	9
6	1/4	4	9
10	3/8	4	9
15	1/2	4	9
25	1	5	11
40	1 1/2	8	18
50	2	6	13
80	3	9	20
100	4	14	31

2.0 INSTALLATION

2.1 Inspection

All F&P 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.

Depending upon the particular model specified, the shipment will generally consist of:

1) Magnetic Flowmeter with integral mounted Signal Converter and appropriate mounting hardware kit, or,

2) 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 foot (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 2-6) or adaptor sleeves (see Figure 2-7) required for the particular meter installation are supplied by F&P 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.

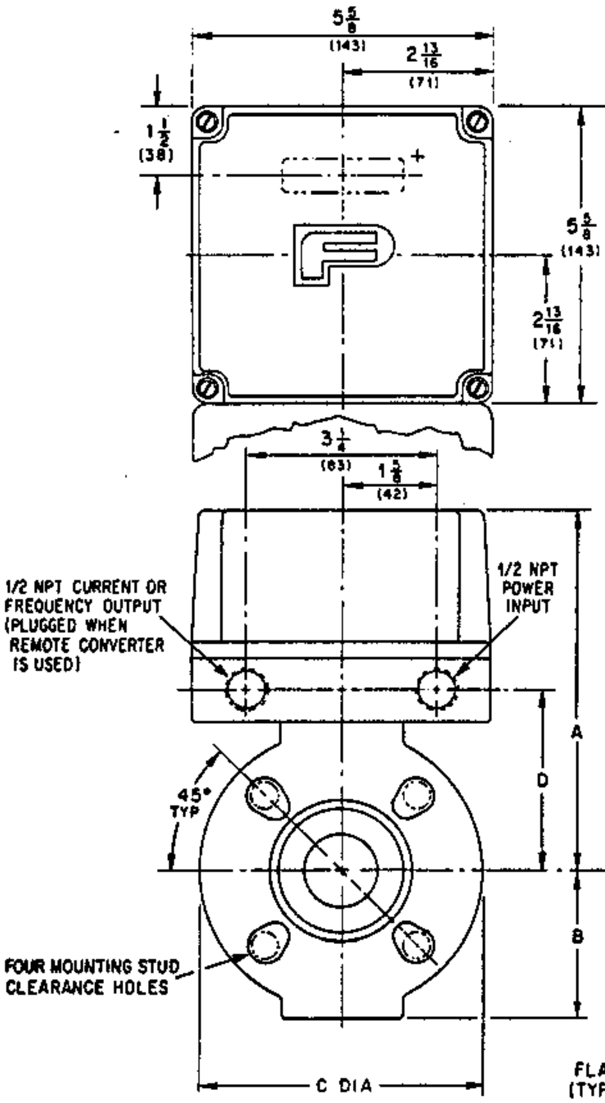
Inspect all items included in the shipment immediately for indications of damage which may have occurred during shipment. All damage claims should be reported to the shipping agent involved before attempting to install or operate the equipment.

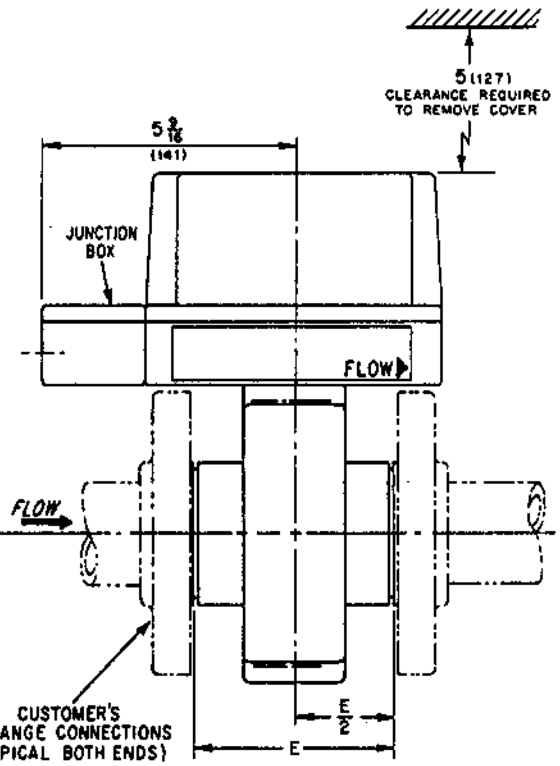
The proper use of the items included in the mounting hardware kit and the proper employment of them during installation is necessary to maintain a valid instrument warranty. (An installation and warranty tag is furnished with the mounting hardware kit that provides the basic information essential for 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 ±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		6-13/16	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

BI-2577

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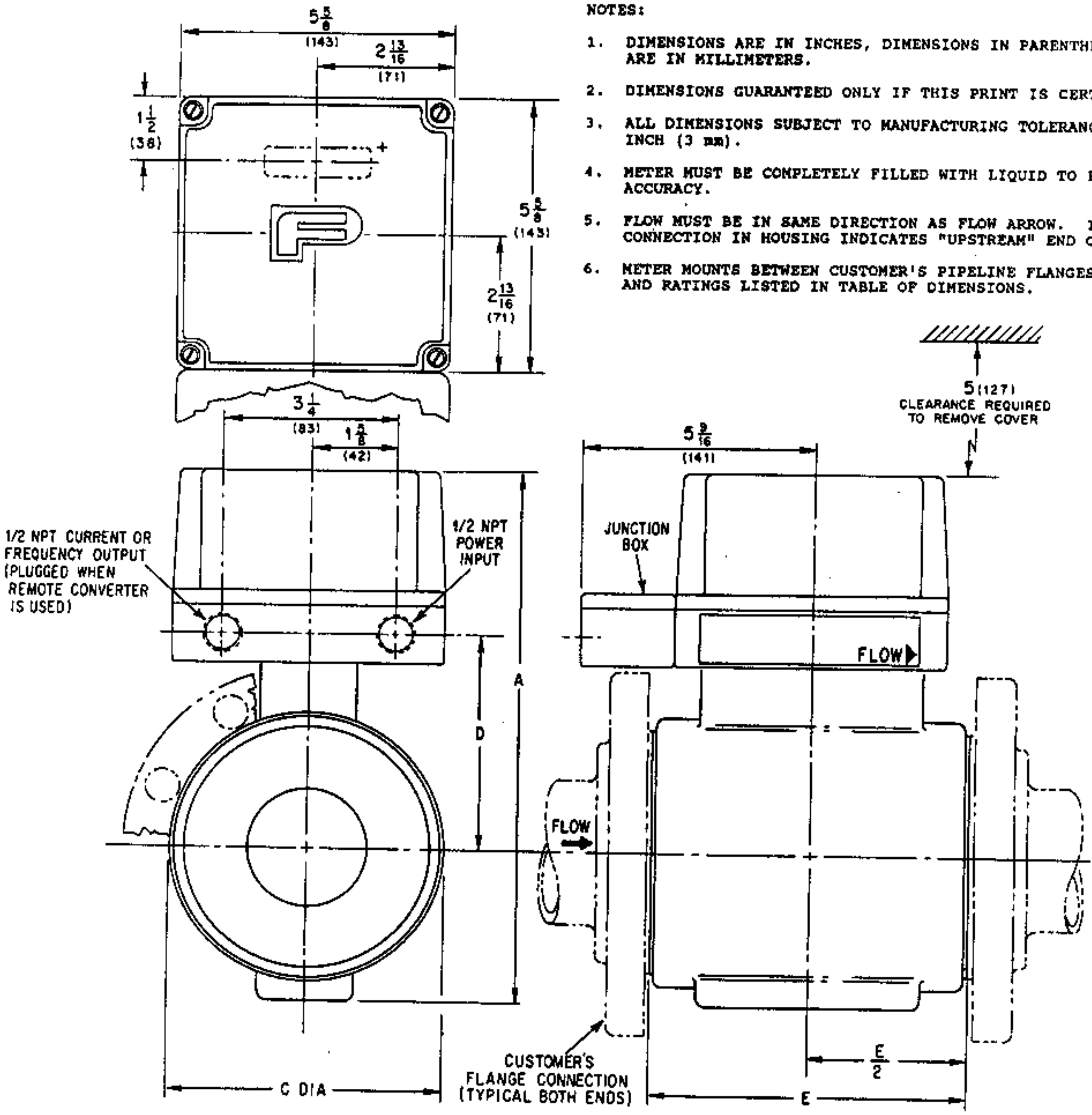
FIGURE 2-1. OUTLINE DIMENSIONS, SIZES 1/25" THROUGH 1-1/2"

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 ±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 & 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

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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 4, (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_2O/48 h
(9 m H_2O/48 h) may occur.

The integrally mounted Signal Converter includes RFI filters that provide excellent protection against radiated RFI/EMI. Therefore, stray electromagnetic and electrostatic fields, low power radio transmissions, etc. will have no effect upon the operating characteristics of the electronic package 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. When applicable, allow access for occasional servicing of an integrally mounted Signal Converter. At least 5 inches of overhead clearance is required for cover removal.

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 Bulletin supplied with the particular Signal Converter.

2.3 Mounting

2.3.1 Meter Orientation

The F&P 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 2-9. 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.

NOTES:

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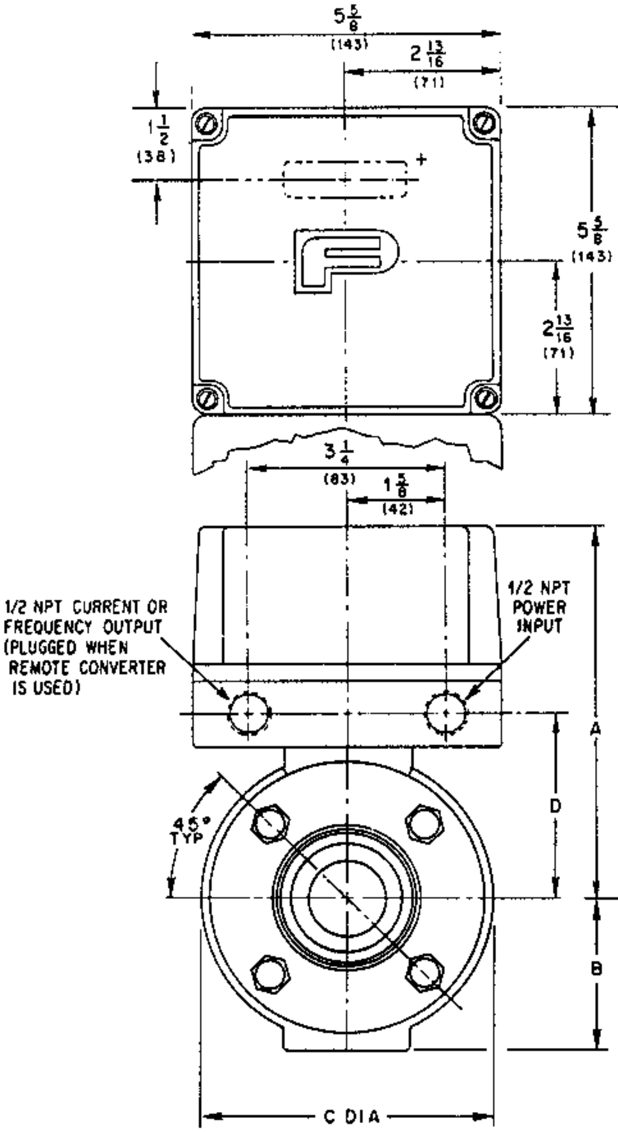
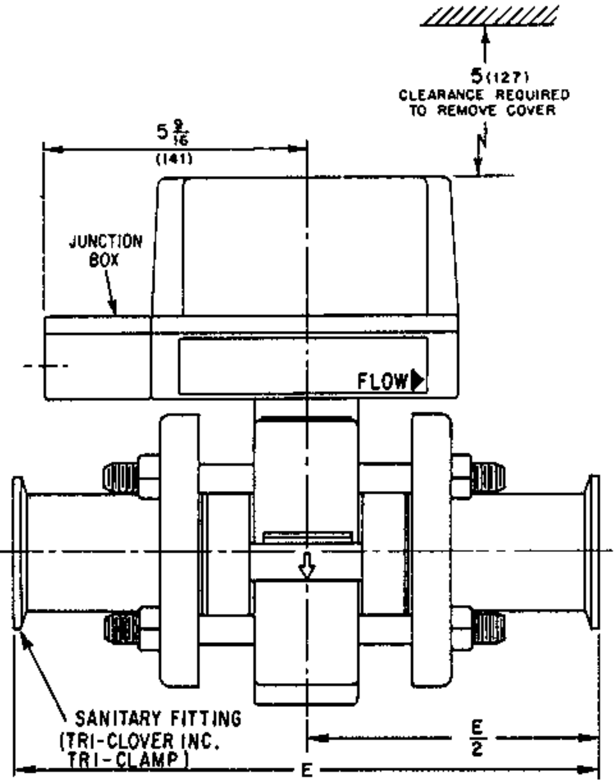
2. DIMENSIONS GUARANTEED ONLY IF THIS PRINT IS CERTIFIED.
3. ALL DIMENSIONS SUBJECT TO MANUFACTURING TOLERANCE OF ±1/8 INCH (3 mm).
4. METER MUST BE COMPLETELY FILLED WITH LIQUID TO ENSURE ACCURACY.
5. FLOW MUST BE IN SAME DIRECTION AS FLOW ARROW. 1/2 NPT CONNECTION IN HOUSING INDICATES "UPSTREAM" END OF METER.
6. METER MOUNTS BETWEEN CUSTOMER'S PIPELINE SANITARY FITTINGS.





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: OD-10D-4067 R1

BI-2579

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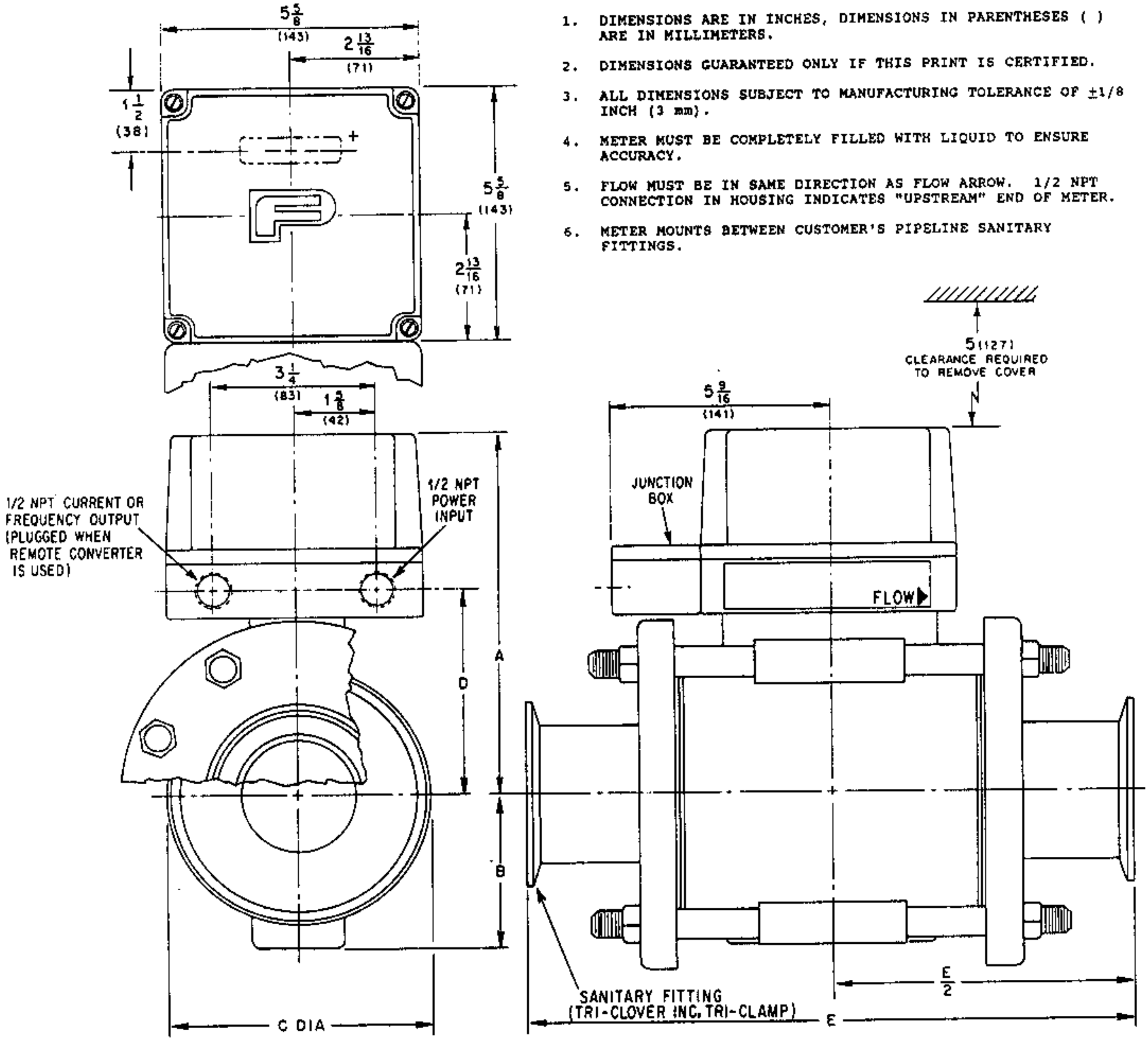
FIGURE 2-3 OUTLINE DIMENSIONS, WITH SANITARY FITTINGS, SIZES 1/25" THROUGH 1-1/2"

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 ±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 SANITARY FITTINGS.



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.

8I-2580

THIS DRAWING IS THIRD ANGLE PROJECTION AS SHOWN

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

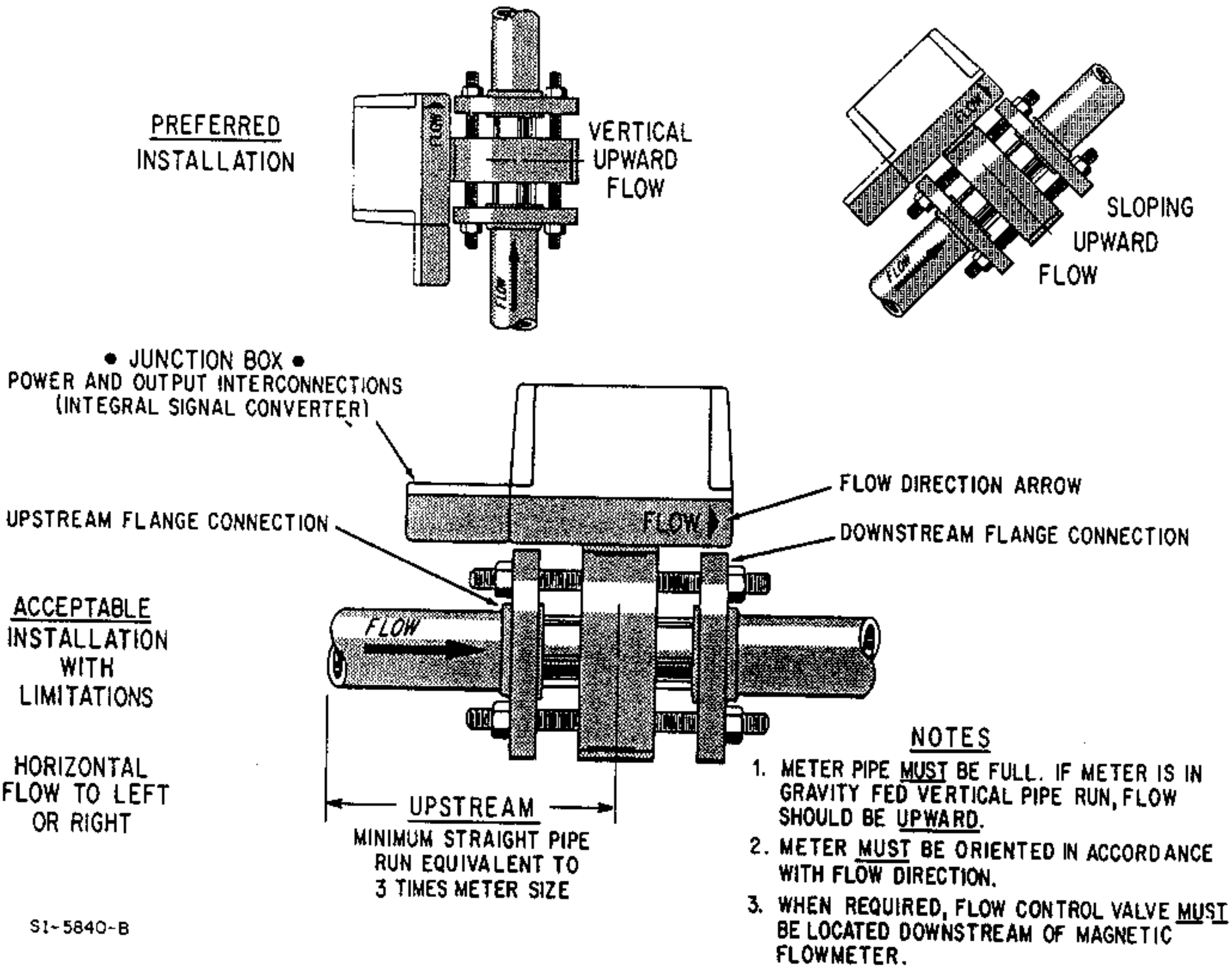


FIGURE 2-5. RECOMMENDED PIPING DIAGRAM

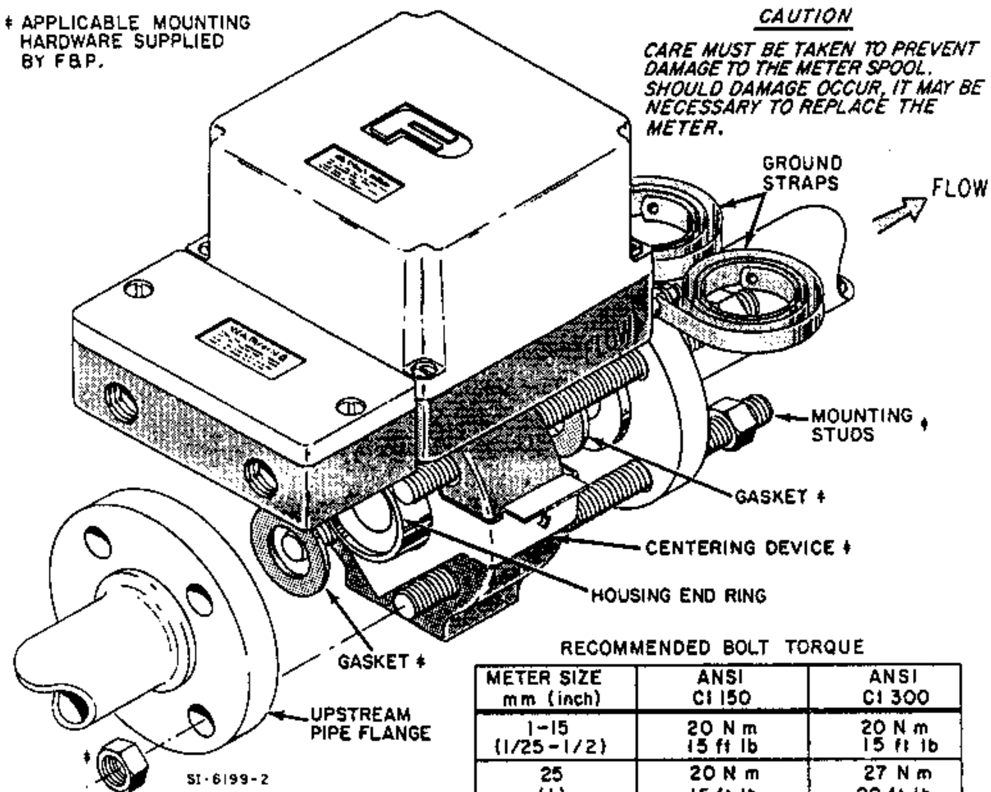
TABLE 2-1. RECOMMENDED BOLT TORQUE

Meter Size mm (inch)	ANSI CL 150 DIN PN 16 BS TABLE D & F	ANSI CL 300	DIN ON 40 BS TABLE F
1 - 15 (1⁄25 - 1⁄2)	15 ft lb 20 N • m	15 ft lb 20 N • m	15 ft lb 20 N • m
25 (1)	15 ft lb 20 N • m	20 ft lb 27 N • m	20 ft lb 27N • m
40 (1 1⁄2)	20 ft lb 27 N • m	40 ft lb 54 N • m	40 ft lb 54 N • m
50 (2)	25 ft lb 35 N • m	25 ft lb 35 N • m	50 ft lb 70 N • m
80 (3)	40 ft lb 54 N • m	50ft lb 70 N • m	50 ft lb 70 N • m
100 (4)	30 ft lb 40 N • m	-------	-------

> **NOTE**
> The recommended bolt torque limits are based on the use of gaskets supplied by F&P. 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 F&P for ANSI Class 150 flanges in 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 F&P model number and size of the meter being replaced to facilitate pipe spool selection.

> **NOTE**
> All 1 - 15 mm (1⁄25 - 1⁄2 inch) size Magnetic Flowmeters are sized to mate with 15 mm (1⁄2 inch) pipe flanges.



RECOMMENDED BOLT TORQUE

METER SIZE mm (inch)	ANSI Cl 150	ANSI Cl 300
1-15 (1/25-1/2)	20 N m 15 ft lb	20 N m 15 ft lb
25 (1)	20 N m 15 ft lb	27 N m 20 ft lb
40 (1-1/2)	27 N m 20 ft lb	54 N m 40 ft lb

FIGURE 2-6. MOUNTING DIAGRAM FOR 1-40 mm (1/25 - 1-1/2") SIZES

2.3.4 Basic Mounting Procedure, Standard Coupling

Select the procedure, below, as 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 2-6. 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 2-9,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 2-7 to supplement the following procedure.

1. Insert both of the two lower mounting studs (see Figure 2-7, 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 2-7 - 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 2-7. 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 2-9 (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 given in Table 2-1.

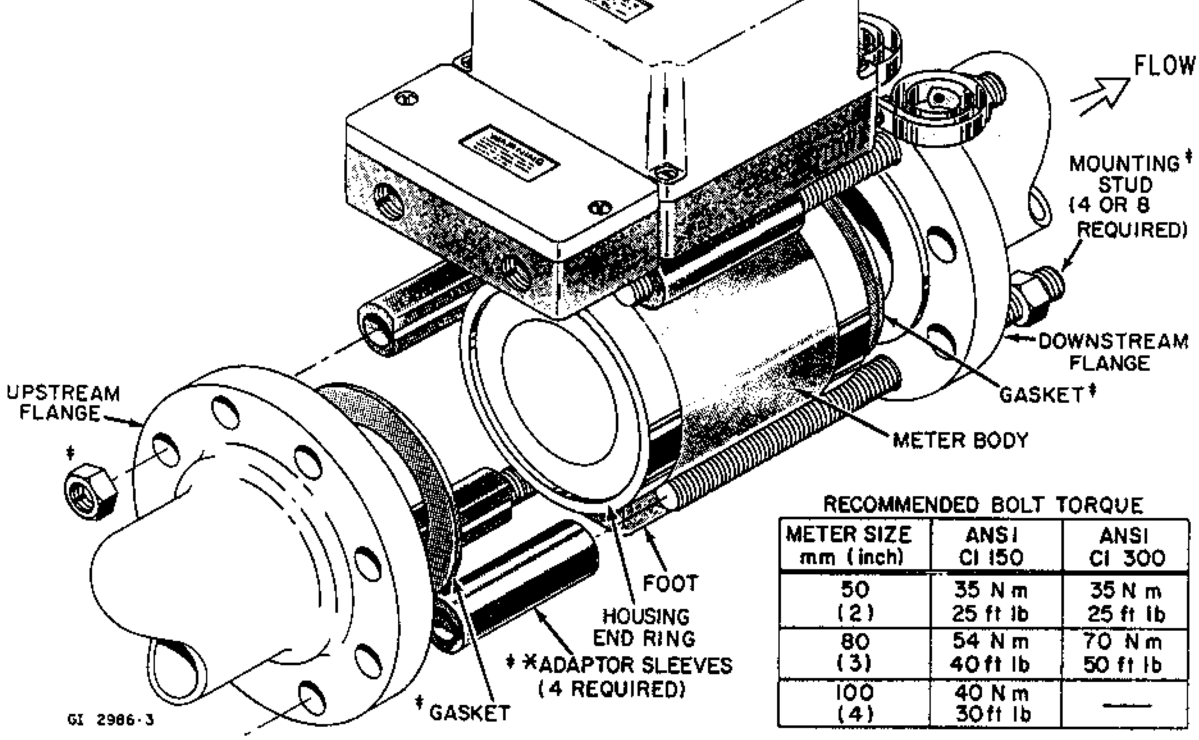
*Exception: Adaptor sleeves not required for type BS 10 - Table D or E flanges in 50 - 100 mm sizes, or for DIN PN 10/16 in 100 mm size.

CAUTION

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

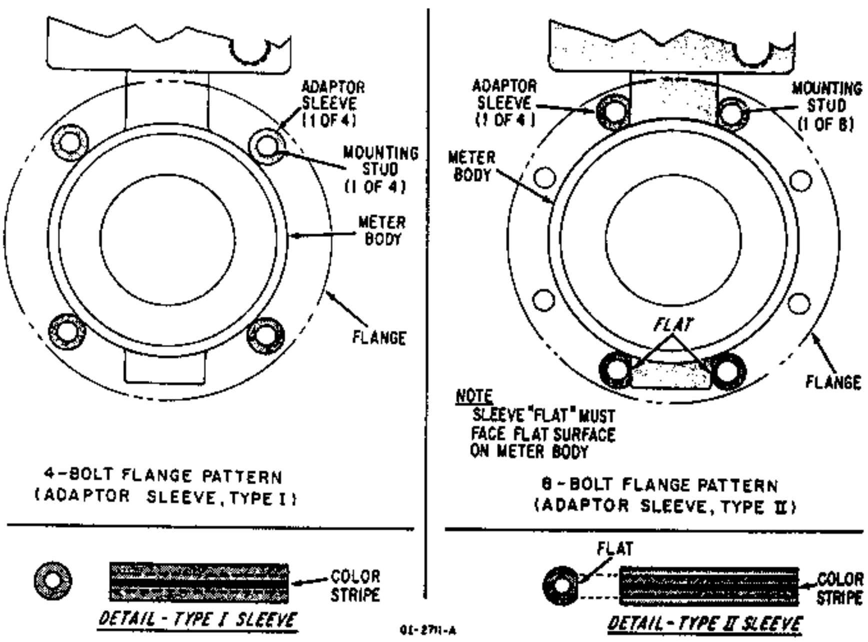
*REFER TO DETAIL BELOW FOR TYPE I & II ADAPTORS.

† APPLICABLE MOUNTING HARDWARE SUPPLIED BY F&P.



RECOMMENDED BOLT TORQUE

METER SIZE mm (inch)	ANSI Cl 150	ANSI Cl 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	—



TYPE I ADAPTOR SLEEVES

METER SIZE	FLANGE RATING	COLOR CODE	† P/N
2-INCH (50mm)	ANSI CLASS 150	BLUE	U01
3-INCH (80mm)	ANSI CLASS 150	BLUE	U02
2-INCH (50mm)	BS 10 "F" & DIN 10-40	GREEN	U03
TYPE II ADAPTOR SLEEVES			
2-INCH (50mm)	ANSI CLASS 300	YELLOW	U04
3-INCH (80mm)	DIN 10-40	YELLOW	U05
4-INCH (100mm)	ANSI 150 & BS 10 "F"	YELLOW	U06
3-INCH (80mm)	ANSI 300 & BS 10 "F"	RED	U07
4-INCH (100mm)	ANSI 300	RED	U08
4-INCH (100mm)	DIN 25-40	WHITE	U09

† F&P PART No. 430E013___ (ADD U0_ 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 2-7. MOUNTING DIAGRAM FOR 50 - 100 mm (2 - 4") SIZES

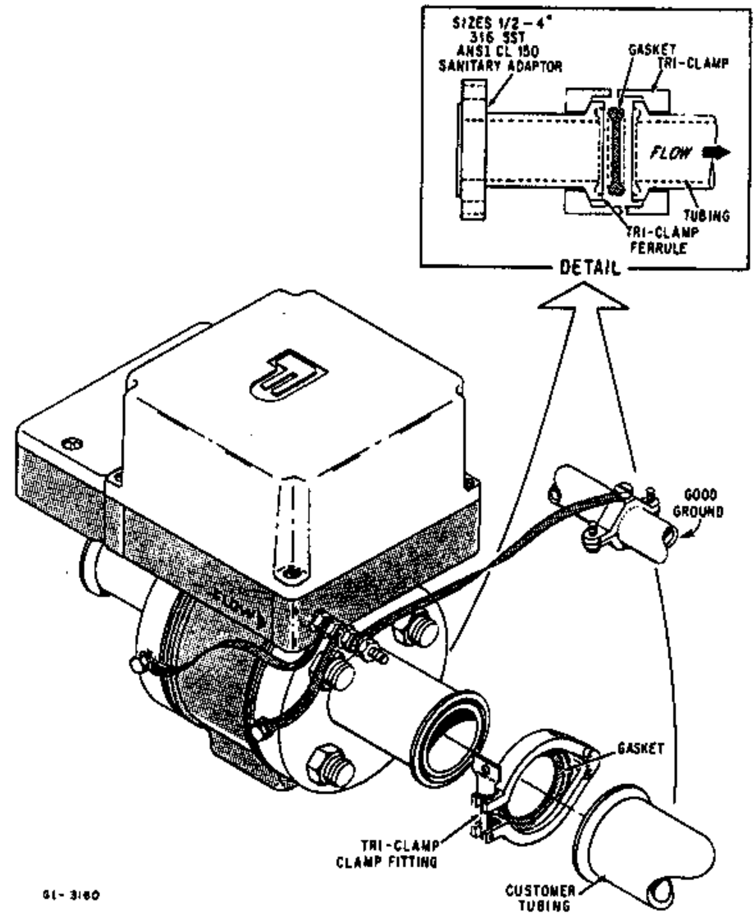


FIGURE 2-8. TYPICAL MOUNTING DIAGRAM, SANITARY FITTINGS

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 2-8 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.

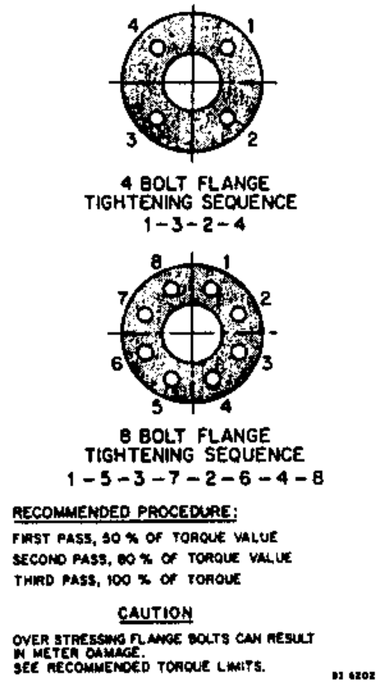


FIGURE 2-9. FLANGE BOLT TIGHTENING SEQUENCE

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 F&P 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 2-10 and 2-11 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 2-12 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 2-11) 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 F&P).

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.)

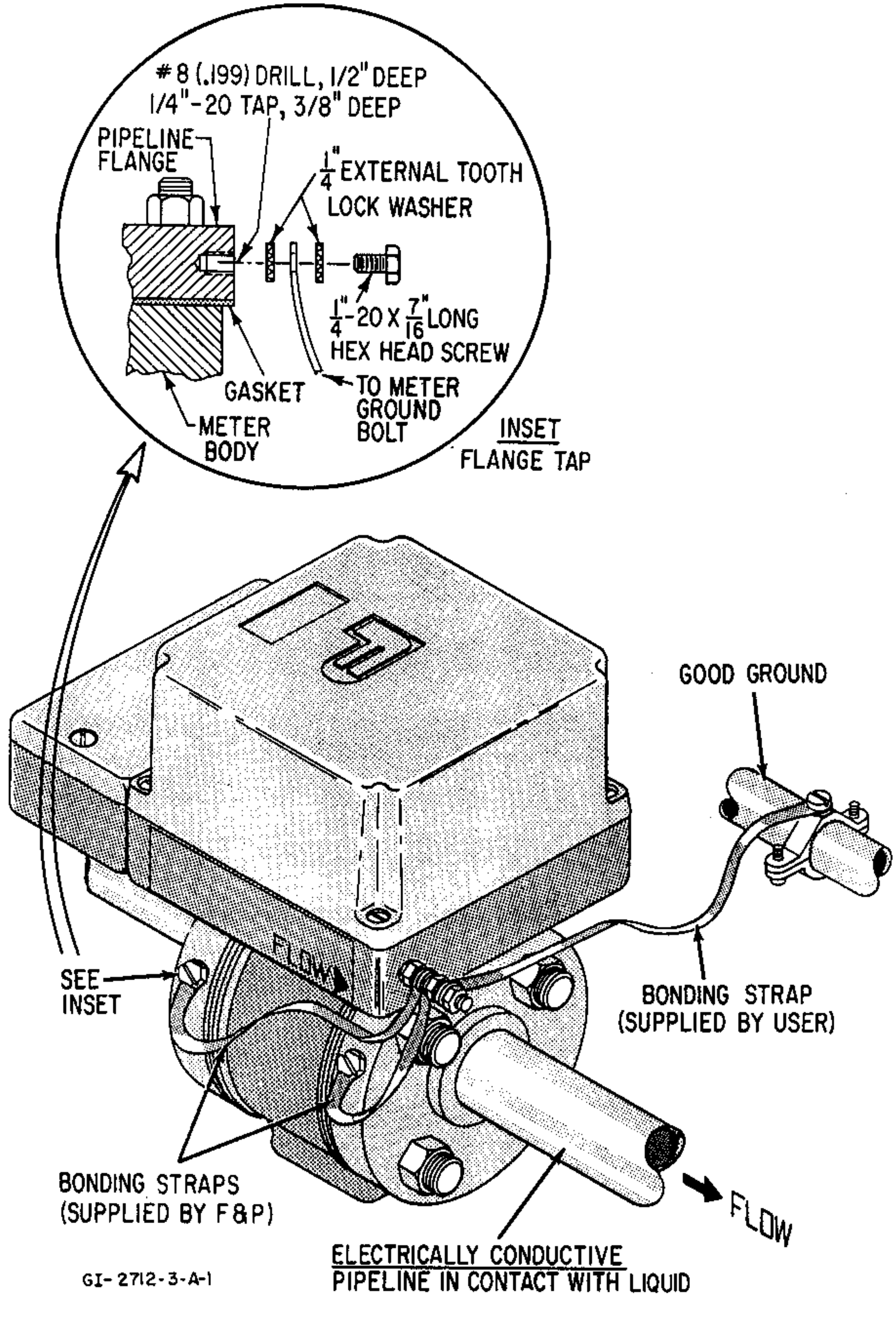


FIGURE 2-10. GROUNDING PROCEDURE, NON-INSULATED PIPE

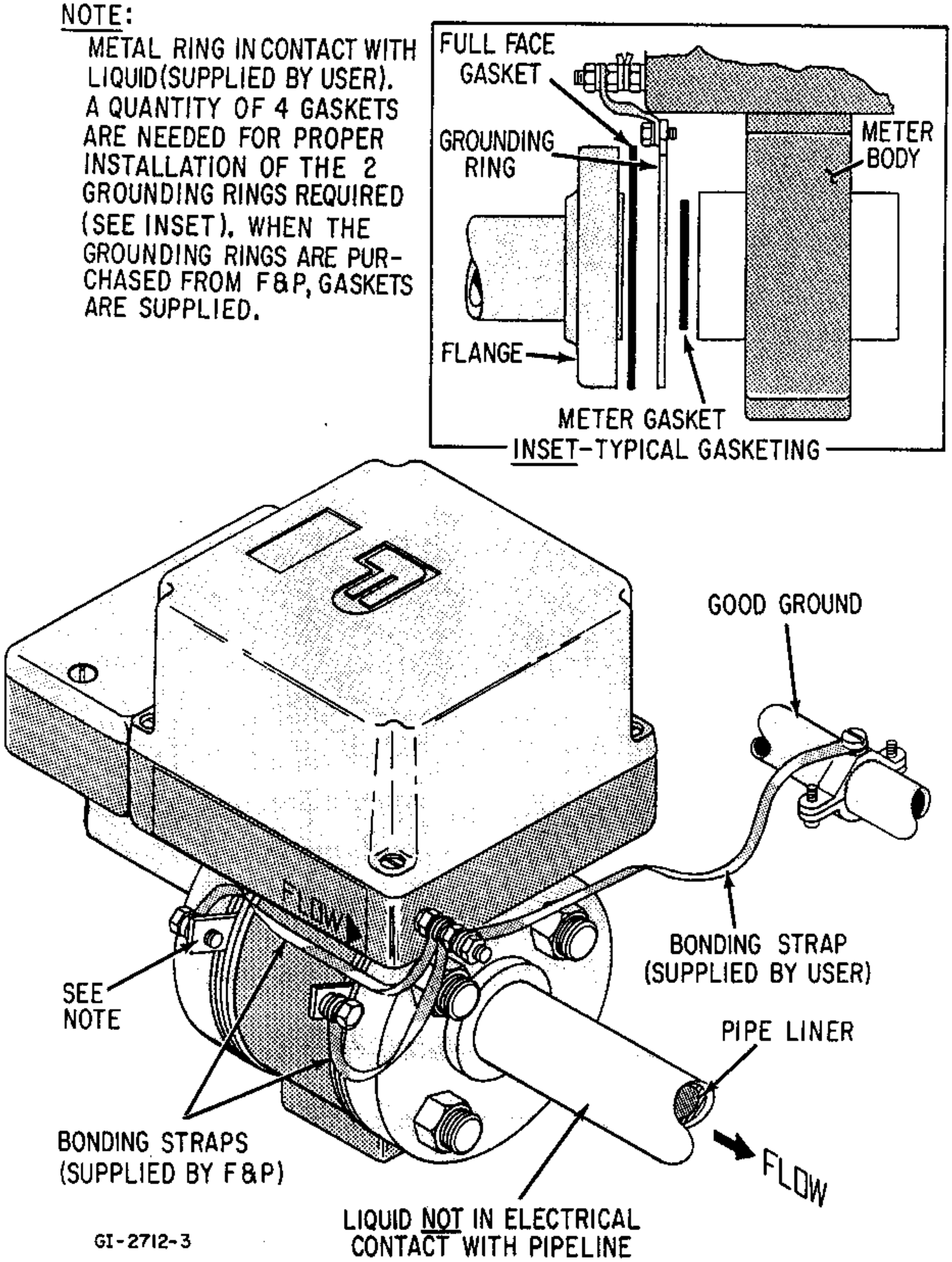


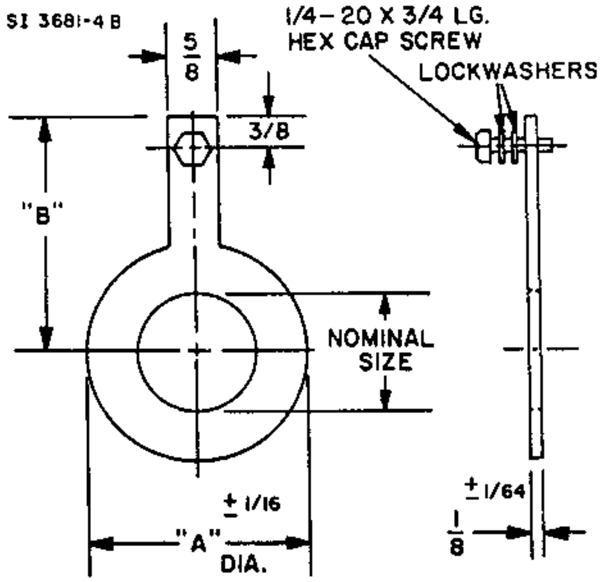
FIGURE 2-11. GROUNDING PROCEDURE, INSULATED PIPE

2.5 Electrical Interconnection

The Series 10D1476 K-MAG Magnetic Flowmeter may be furnished with either an integrally or remotely mounted Signal Converter. Interconnection wiring is arranged differently for the two systems. Interconnection details are provided in the Instruction Bulletin supplied with the Signal Converter specified.

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.

Regardless of the interconnection procedure used, the grounding procedures given in Section 2.4 must be followed.



NOMINAL SIZE		ANSI CLASS 150	
mm	(inch)	"A"	"B"
1 - 15	(1/2)	1 - 7/8	2 - 7/8
25	(1)	2 - 5/8	3 - 1/4
40	(1-1/2)	3 - 3/8	3 - 5/8
50	(2)	4 - 1/8	4
80	(3)	5 - 3/8	4 - 5/8
100	(4)	6 - 7/8	5 - 3/8

(Ref: OD-10D-3627R2)

NOTES:

1. ALL DIMENSIONS IN INCHES, EXCEPT AS NOTED.
2. GENERAL TOLERANCE = ± 1/8.
3. GROUNDING RING CENTERED BY FLANGE BOLTS.

FIGURE 2-12. OUTLINE DIMENSIONS, GROUNDING RINGS*

* For applications other than ANSI CLASS150, contact F&P.

3.0 START-UP and OPERATION

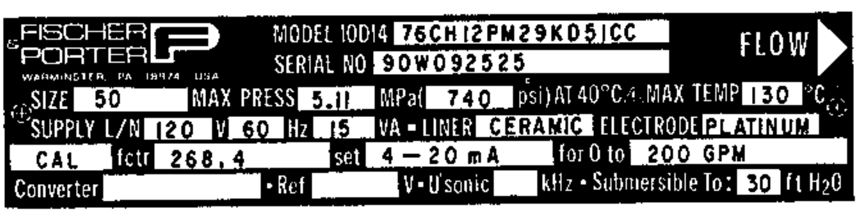
The F&P Series 10D1476 K-MAG Magnetic Flowmeter (which includes the integral or remote Signal Converter) is precision calibrated at the factory for the values stated on the instrument tags. If specific values were not specified, the meter is calibrated at some nominal maximum flow rate and for a 4-20 mA current output span. In either case, the calibration data is noted on the instrument tag as shown in Figure 3-1. The basic primary mounted components are identified in Figure 3-2.

There are no operating controls that require field adjustment unless the full scale range setting was not specified. If a change in the full scale range setting is required, refer to the Instruction Bulletin supplied with the Signal Converter. If no change is required the equipment is ready for operation as received.

Prior to initial system start-up, verify that the meter is properly installed; check flow direction, wiring interconnection and grounding as discussed in the Installation Section 2.0. Particular attention should be paid to the procedure for grounding the liquid passing through the meter. Improper grounding may result in unsatisfactory performance.

Start flow through the process piping system that includes the meter. Allow a nominal flow through the pipeline for several minutes to purge entrapped air. The pipeline must be full for accurate flow measurement. Apply power to the K-MAG Magnetic Flowmeter by closing the external switch or circuit breaker; there are no switches inside of the equipment. Also, energize any auxiliary equipment associated with the flow metering system, such as remote analog recorders, controllers or rate indicators.

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.



SI-6698-F

FIGURE 3-1. TYPICAL INSTRUMENT TAG

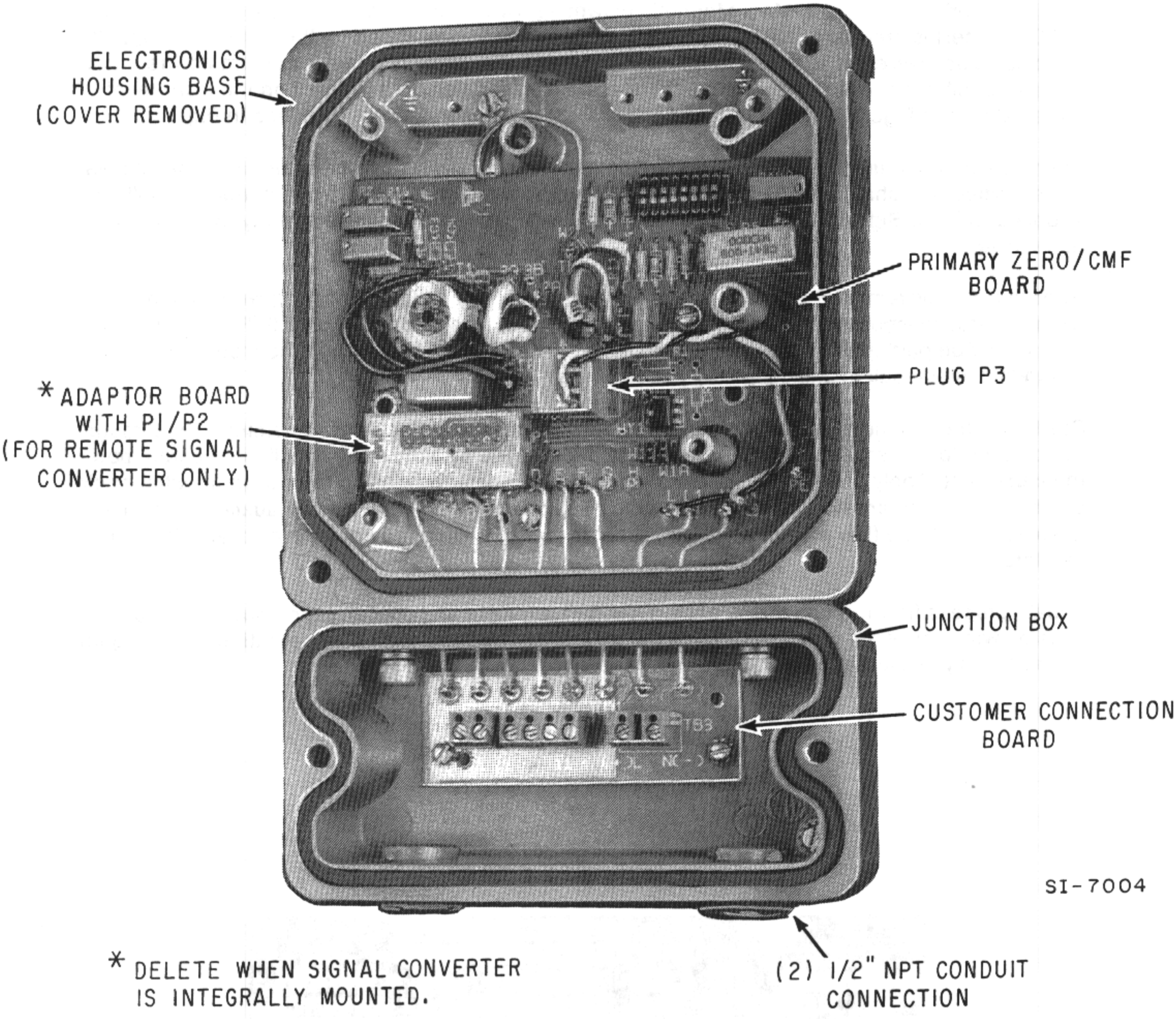


FIGURE 3-2. PRIMARY MOUNTED PC ASSEMBLIES

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 Fischer & Porter 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 F&P Magnetic Flowmeter constitutes a modified form of a generator.

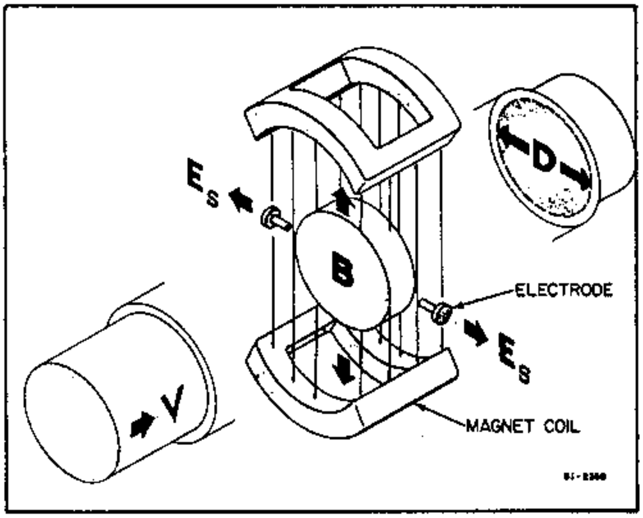


FIGURE 4-1. BASIC OPERATING PRINCIPLE

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
α = 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 F&P 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 F&P 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:

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

Since $B = \beta E_r$
and since α, D and β 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
α = dimensionless constant
β & γ = dimensional constant
V = liquid velocity

Therefore, volumetric flow rate is directly proportional to the induced signal voltage as measured by the F&P 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 µS/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 F&P 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 µS/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 k x $2/10^6$

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

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

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. F&P 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 nonconductive 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 F&P 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, nonconductive mixing agents, it must be ascertained 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

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 and 5-2. 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 $\frac{d\phi}{dt} = 0$.

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 Bulletin supplied with the particular Signal Converter.

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

The CMF Assembly provides several functions. These include:

1. Establishes interconnections between the Flowmeter internal wiring and the Converter.

2. Permits adjustment of meter calibration factors to a fixed value for each nominal size primary.

3. Permits adjustment of primary zero.

4. Establishes proper wiring connections for integrally or remotely mounted Converters.

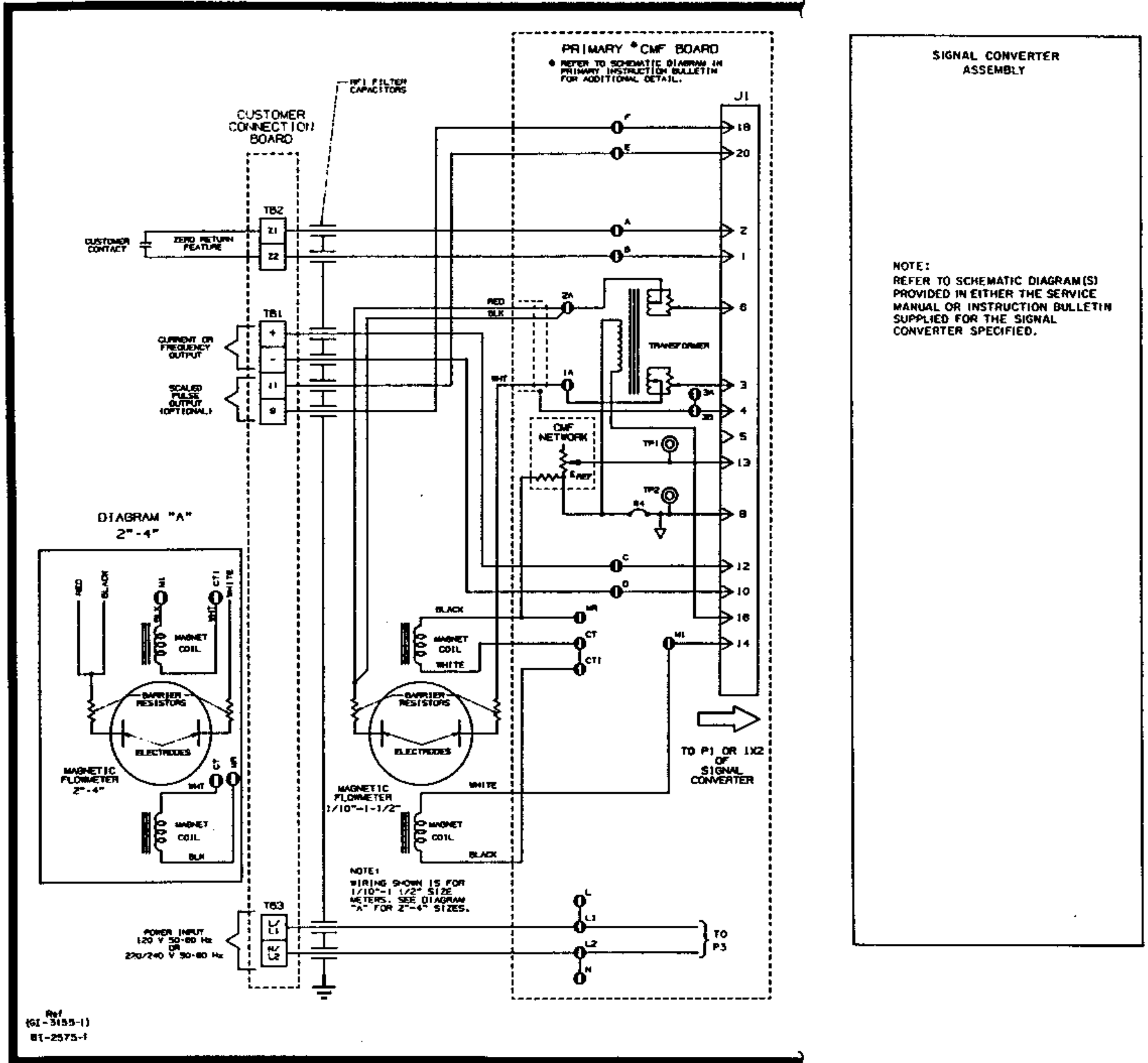


FIGURE 5-1. SCHEMATIC for PRIMARY WIRING WHEN USING INTEGRAL CONVERTER

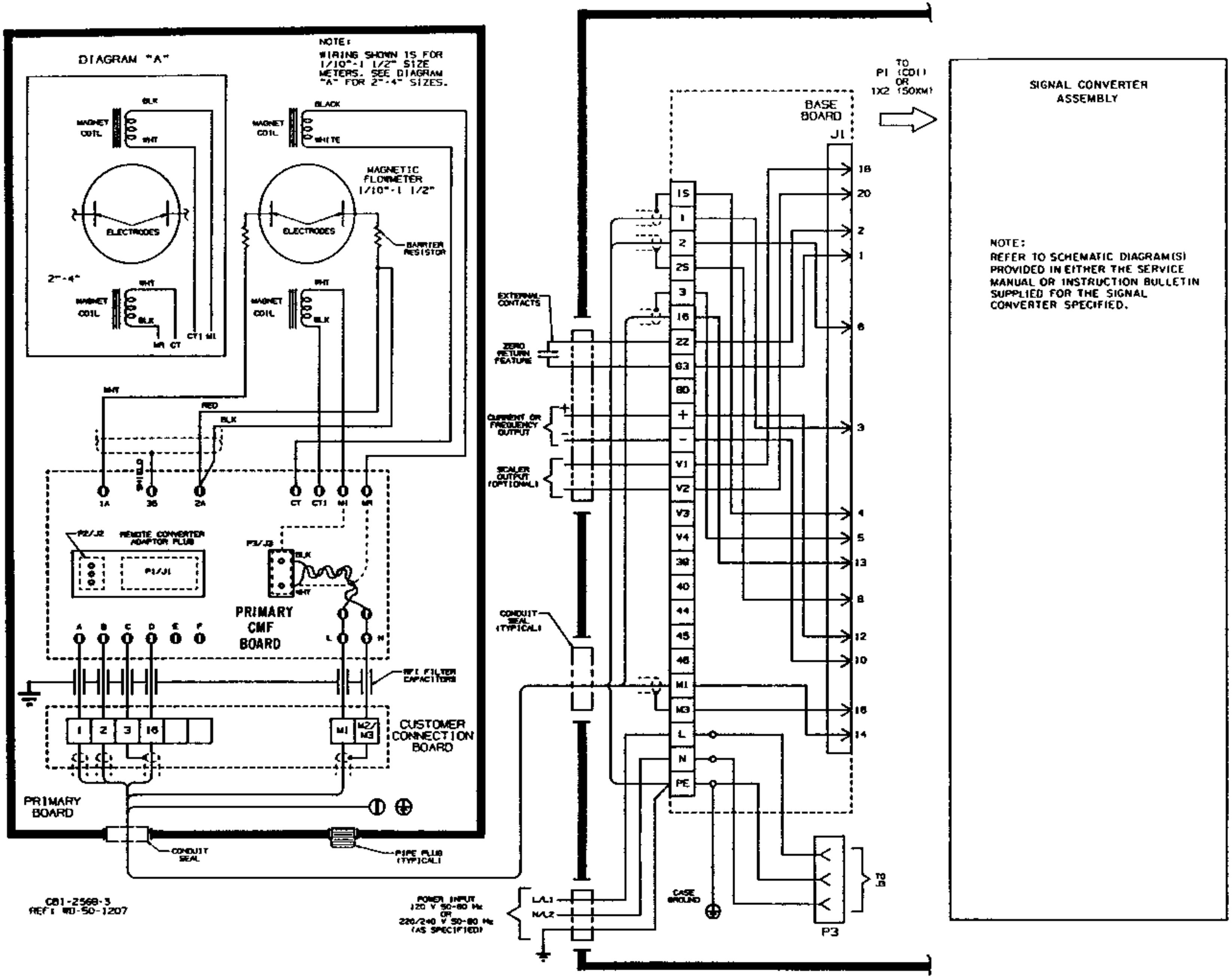


FIGURE 5-2. SCHEMATIC for PRIMARY WIRING WHEN USING REMOTE CONVERTER

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 from electrode signal 2 the voltage impulse 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.

Connections to the Converter are established by one of two means. For integral Converters, power is applied to receptacle P3 and signals pass through connector J1 to the Converter assembly as shown in Figure 5-1. For remotely mounted Converters, the magnet coils are driven (see Figure 5-2) 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).

For integrally mounted Converters, zero return and other options associated with the 50XM1000 Signal Converter are established by the movable jumpers at terminals B1 and A2 as shown in Figure 5-3. Refer to the Instruction Bulletin provided with the Signal Converter for interconnection wiring.

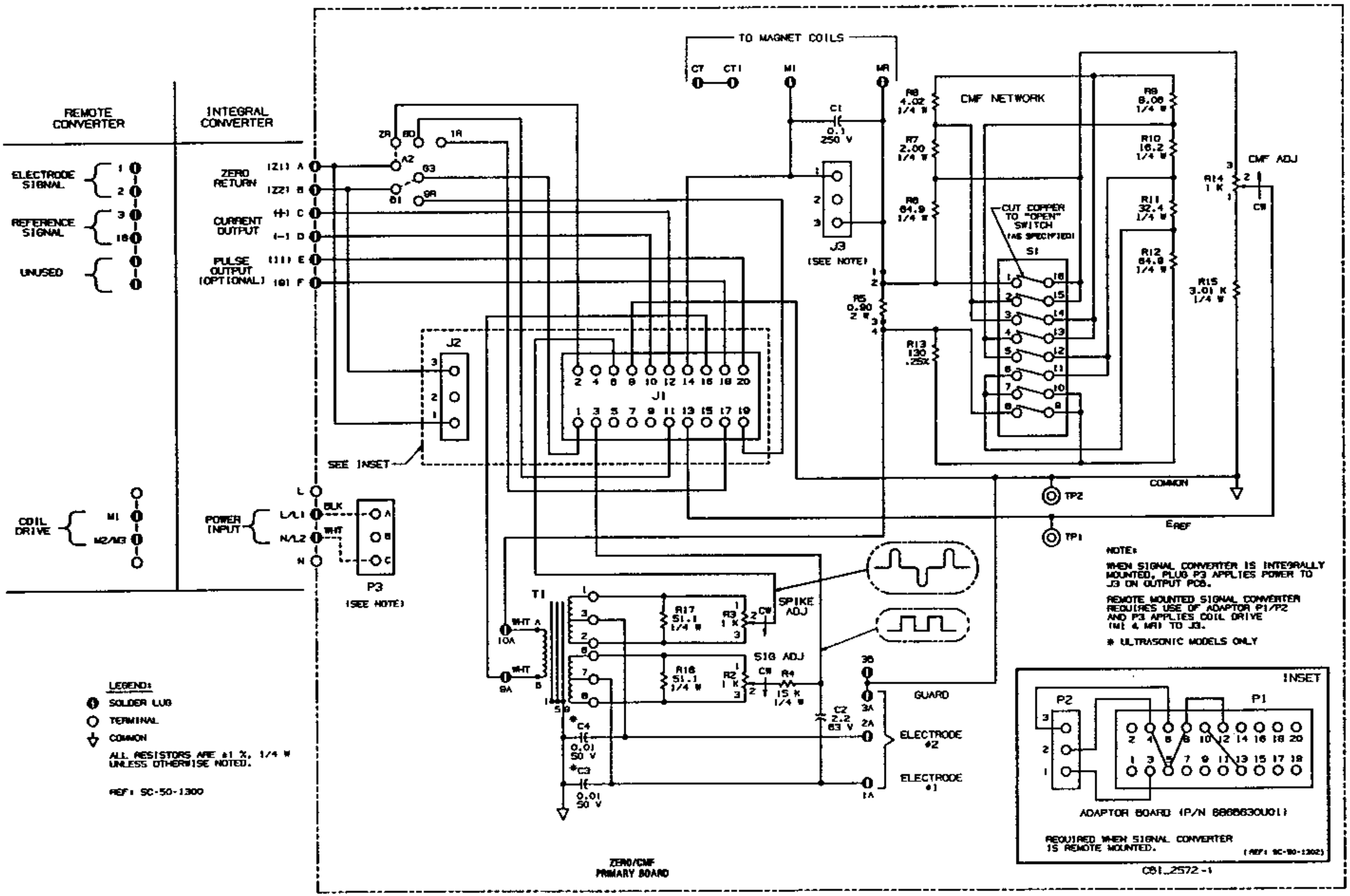


FIGURE 5-3. SCHEMATIC for CMF BOARD

6.0 MAINTENANCE

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.

F&P 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 F&P (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 Fischer & Porter 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 F&P 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 F&P 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

In the event faulty operation of the Magnetic Flowmeter is evident, 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, Integral Converter

Figure 5-2 Primary Wiring, Remote Converter

Figure 5-3 Schematic Diagram for Primary CMF Board

Signal Converter Assembly ... refer to applicable Instruction Bulletin

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 meter operation is suspect, 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:
   - integrally mounted Analog Signal Converter
   - remote mounted Analog Signal Converter
   - integrally mounted Microprocessor-Based 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.) Figures 5-1 and 5-2 show 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.

If a remote mounted Signal Converter was supplied, proceed to step 1). If the K-MAG Magnetic Flowmeter is supplied with an integrally mounted Signal Converter, loosen and remove the four screws that hold the Signal Converter to the base. Disconnect the plugs supplying signal (P1) and power (P3) connections to the Converter and set the Converter aside. This will enable access to the CMF board.

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 (±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 ±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	¼	18
10	⅜	18
15	½	18
25	1	41
40	1½	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) If an integrally mounted Signal Converter is supplied, perform step a), below. If a remotely mounted Signal Converter is supplied, proceed to step b).

a) Remove meter housing cover from electronics compartment. Loosen the four mounting screws that secure the integral Signal Converter to the meter base. Disconnect plugs P1 and P3; set the Converter aside. Proceed to step 2.

b) Remove field wiring connected to electrode leads "1" and "2". Proceed to step 2). Electrode wiring is shown in Figure 5-1 and 5-2, as applicable.

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 integrally mounted Signal Converter, if applicable, and replace the housing cover.

NOTE

If the Signal Converter has been removed from the housing, use care when reconnecting the Converter interface cable to ensure that plug P1 is in proper alignment with the pins of receptacle J1. (J1 is located on the base board in either the primary or the remote Converter housing, as the case may be.) If these connectors do not mate correctly, the Signal Converter will be inoperable and could be damaged when power is applied.

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 uses 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 pin 1-2) / (R15 + R14 pin 1-2 + R14 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.

NOTE

If the Signal Converter has been removed from the housing, use care when reconnecting the Converter interface cable to ensure that plug P1 is in proper alignment with the pins of receptacle J1. (J1 is located on the base board in either the primary or the remote Converter housing, as the case may be.) If these connectors do not mate correctly, the Signal Converter will be inoperable and could be damaged when power is applied.

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). For integrally mounted Converters, it will be necessary to place an insulator under the Converter and set it on the lip of the meter housing to permit access for adjustment of the CMF Board.

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 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.

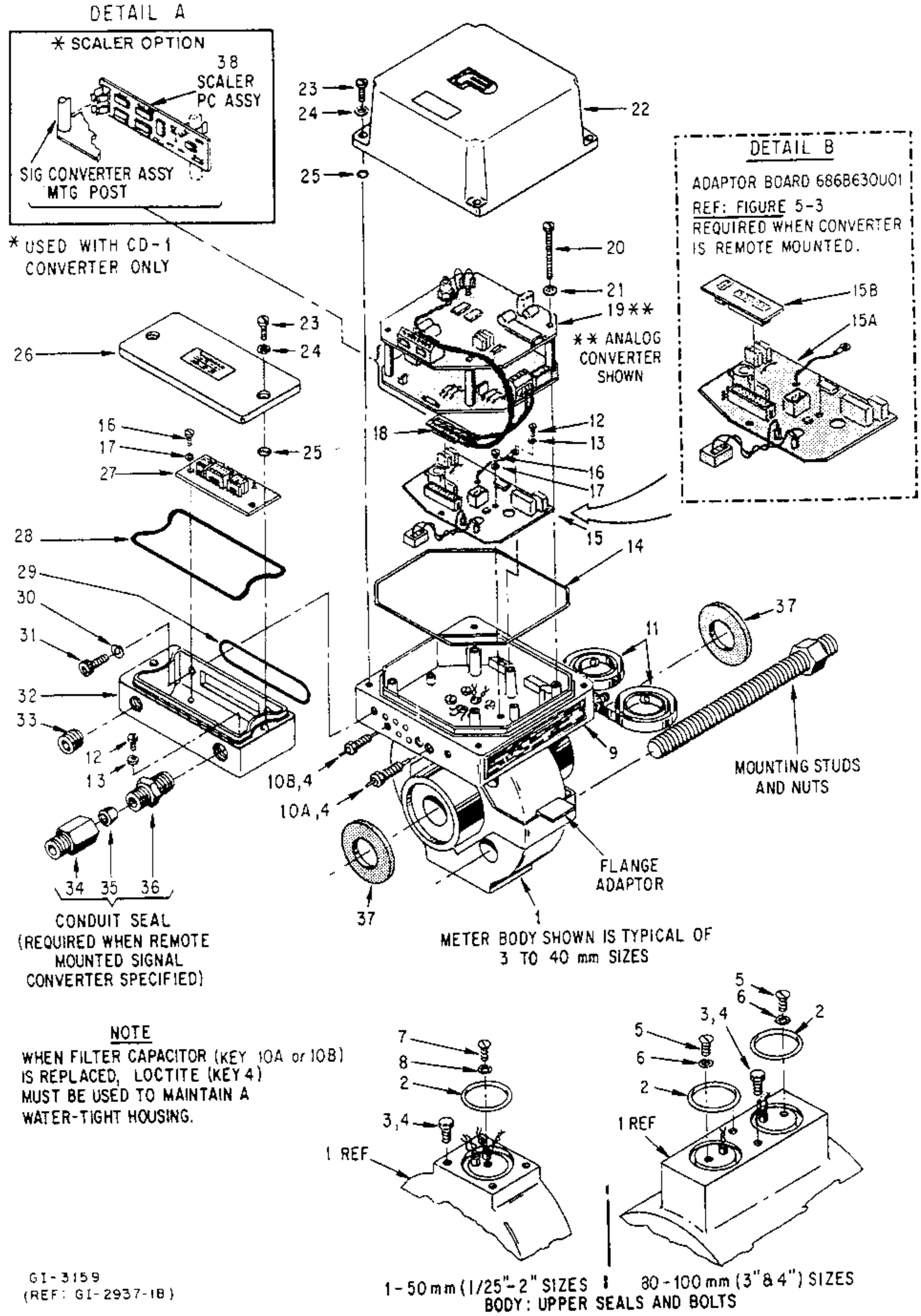


FIGURE 6-1. EXPLODED VIEW, BASIC FLOWMETER PARTS

7.0 PARTS LIST

TABLE 7-1. BASIC METER PARTS (REF.: FIGURE 6-1)

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 Hd: #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 V ac		C160C102U01
10B	6	FILTER CAPACITOR ASSY (RFU), 1000 pF, 500 V dc		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) (See NOTE 5)		686B623U01
15B	1	ADAPTOR BOARD (for remote Converter)		686B630U01
16	5	SCREW, Pan Hd: #4-40 x 1/4"		006F004T10
17	5	LOCKWASHER, Ext. Tooth: #4		085H004V11
18	1	CABLE ASSEMBLY: CD1 Converter*		686B631U01
19	1	SIGNAL CONVERTER ASSY: SEE NOTE 2		
20	4	SCREW, Pan Hd: #6-32 x 2-1/4"		006H228T10
21	4	LOCKWASHER, Int Tooth: #6		085F006V11
22	1	COVER, Converter Base: w/o Window		379D358U01
		with Window		D612A083U01
23	6	SCREW, Pan 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 Base		101A001U08
30	2	LOCKWASHER, Ext Tooth: 1/4"		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 3		112A352U22
34	1	FITTING, Pipe SEE NOTE 3		364D297U01
35	1	GROMMET SEE NOTE 3		368D145R90
36	1	FITTING, Pipe SEE NOTE 3		364D257U01
37	2	GASKET, See TABLE 7-4		
38	1	SCALER BOARD: (Option)**		
		10 Hz max range		686B518U02
		10 kHz max range		686B518U03

NOTES:

1. Meter body (Key 1) is a welded assembly and is not a repairable item. F&P 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 F&P 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. The same Signal Converter is used for integral or remote mounting. Refer to the Instruction Bulletin supplied for the Signal Converter model specified for the applicable replacement part number. F&P maintains a repair/exchange program for this assembly; simply add "RE" to the part number given in the IB. For example: 50CD9001 - PN 698B076U65RE.

3. Pipe plug (Key 33) and conduit seal (Keys 34, 35 & 36) are not used when Signal Converter is integrally mounted. Parts are supplied with signal cable, when specified.

4. Mounting hardware and gaskets (supplied by F&P) are selected according to meter size.

5. 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 an F&P service representative for assistance.

* Included with replacement Converter.
** Used with CD1 Converter only. See IB 50CD9001

7.0 PARTS LIST (continued)

TABLE 7-2. ANSI CLASS 150 GROUNDING RINGS

Meter Size		F&P Part	Part Number Suffix (Material)			
mm	inch	Number*	316 sst	Hast. "C"	Hast. "B"	Alloy 20
1 - 15	1⁄25 - ½	800D508	U01	U09	U34	U27
25	1	800D508	U02	U10	U18	U24
40	1½	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 7-3. GASKETS FOR ANSI CLASS 150 GROUNDING RINGS (2 required)

KLINGER SIL C-4401-------Part Number 333J089U__*
GYLON Style 3500-----------Part Number 333J090U__*

	Meter Size					
Flange Rating ANSI CL150	1 - 15 mm	25 mm	40 mm	50 mm	80 mm	100mm
	1⁄25 - ½ inch	1 inch	1½ 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 F&P.

TABLE 7-4. 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 - ½ inch	1 inch	1½ 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.

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