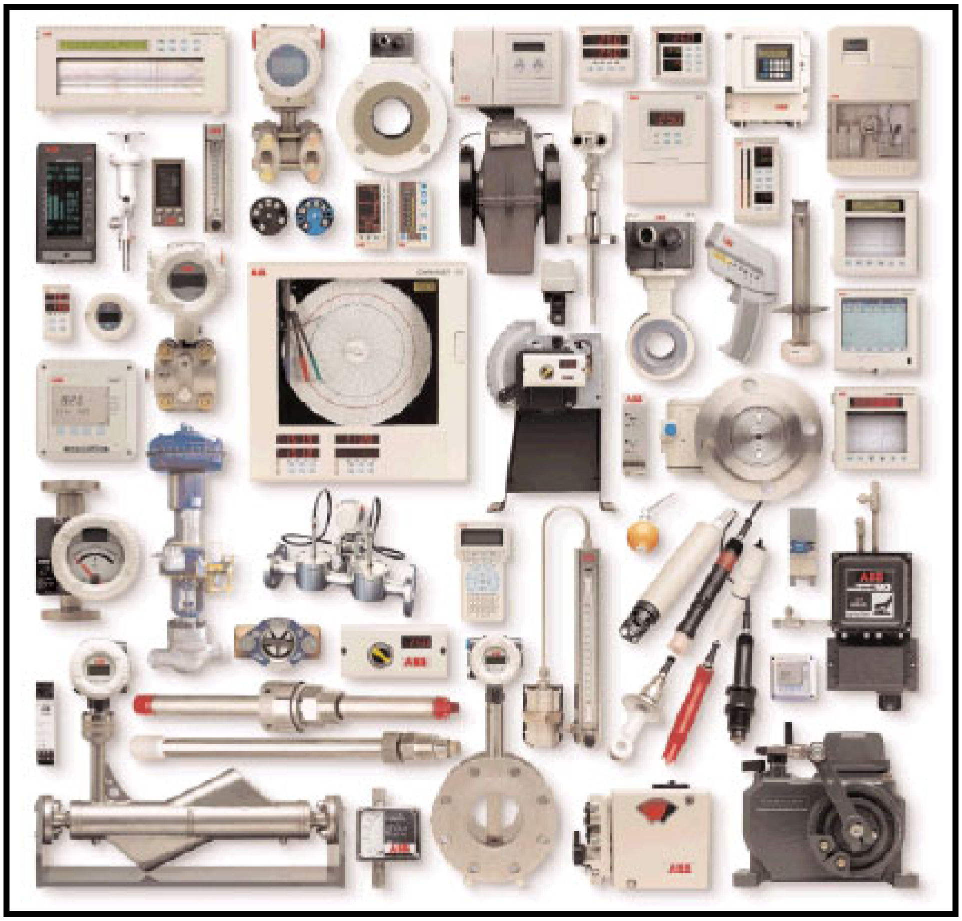
INSTRUCTION MANUAL

MAGNETIC FLOWMETERS
10DS3111 Design Level A
Sizes 14 through 24 inches

SERIES 3000 AC MAGNETIC FLOWMETER



PN25012

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

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

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

WARNING

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

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

Table of Contents

List of Figures

List of Tables

READ FIRST

WARNING

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

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

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

Contacting the Manufacturer

Should assistance be required with any Instrumentation product, contact the following:

Telephone:

Automation Services Call Center
1-800-HELP-365

E-Mail:

ins.techsupport@us.abb.com

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

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

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

1.0 INTRODUCTION

1.1 General

The Series 10DS3111 COPA-AC magnetic flowmeter is an electromagnetic liquid flow rate detector. The meter uses the characteristics of a conductive liquid to generate an induced 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 flowmeter's design provides a low power, obstructionless 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, reducing or conserving pressure source requirements as compared to other metering methods. The meter requires no additional support other than that used on normal pipe runs.

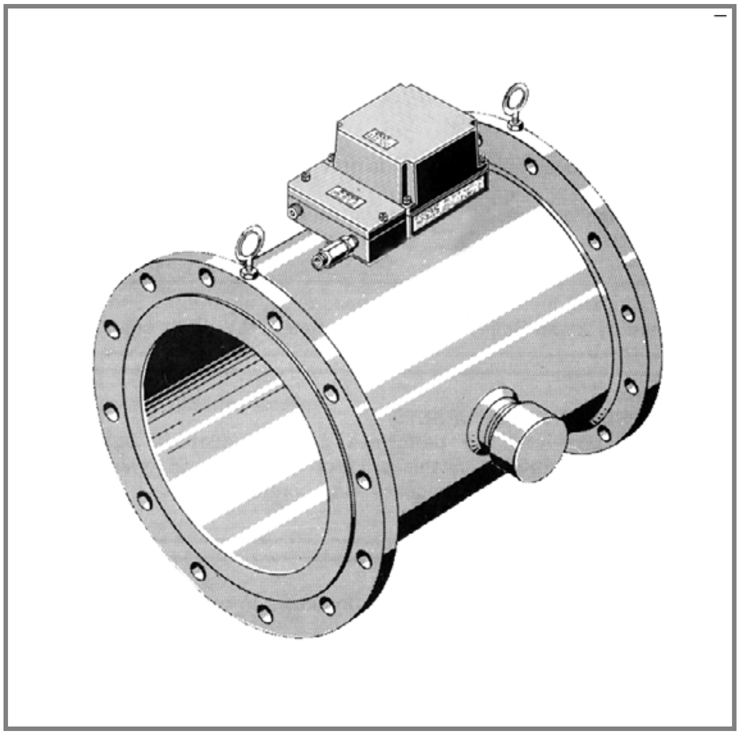


FIGURE 1-1. TYPICAL 10DS3111A MAGNETIC FLOWMETER

This flowmeter can be used to meter either clean or dirty liquids. The meter may be used with many non-homogeneous liquids and is as independent of the tendency to plug or foul as the pipeline in which it is mounted. By design, only the liner 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 only to the meter material specification limit.

Figure 1-1 shows the general configuration of a typical meter while Figure 1-2 shows the meter's electronics housing with the cover removed.

1.2 Signal Converters

The 10DS3111 COPA-AC magnetic flowmeter has been designed for operation with AC driven magnet coils. This design requires a 50/60 Hz reference and zero assembly, which is **integrally mounted** in the flowmeter electronics housing. The **signal converter** must be **remotely mounted** and is supplied in an enclosure suitable for either wall, panel, or pipe mounting.

The signal converter used with the 10DS3111 is the model 50SM1000 and it must conform to the following requirements:

Operating Mode: Signal Converter operating mode (Primary) shall be set to "1OD1462".

Reference Impedance: The model 50SM1000 signal converter is available with a reference input option which must always be 1000 ohms and must be specified at time of order. The S901 switch on the terminal board, located in the base of the converter housing, must be set in the closed position (hooked) to select 1000 ohms.

Power Consumption: <250 VA
Line power shall be 110/120 VAC, 50/60 Hz.

Interconnections: The interconnection wiring diagram shown in Figure 2-3 of the 50SM1000 signal converter instruction manual applies only to sizes **below 14 inches**. Power and signal interconnections for the 10DS3111 must be made as shown in **Figure 2-9** of this manual.

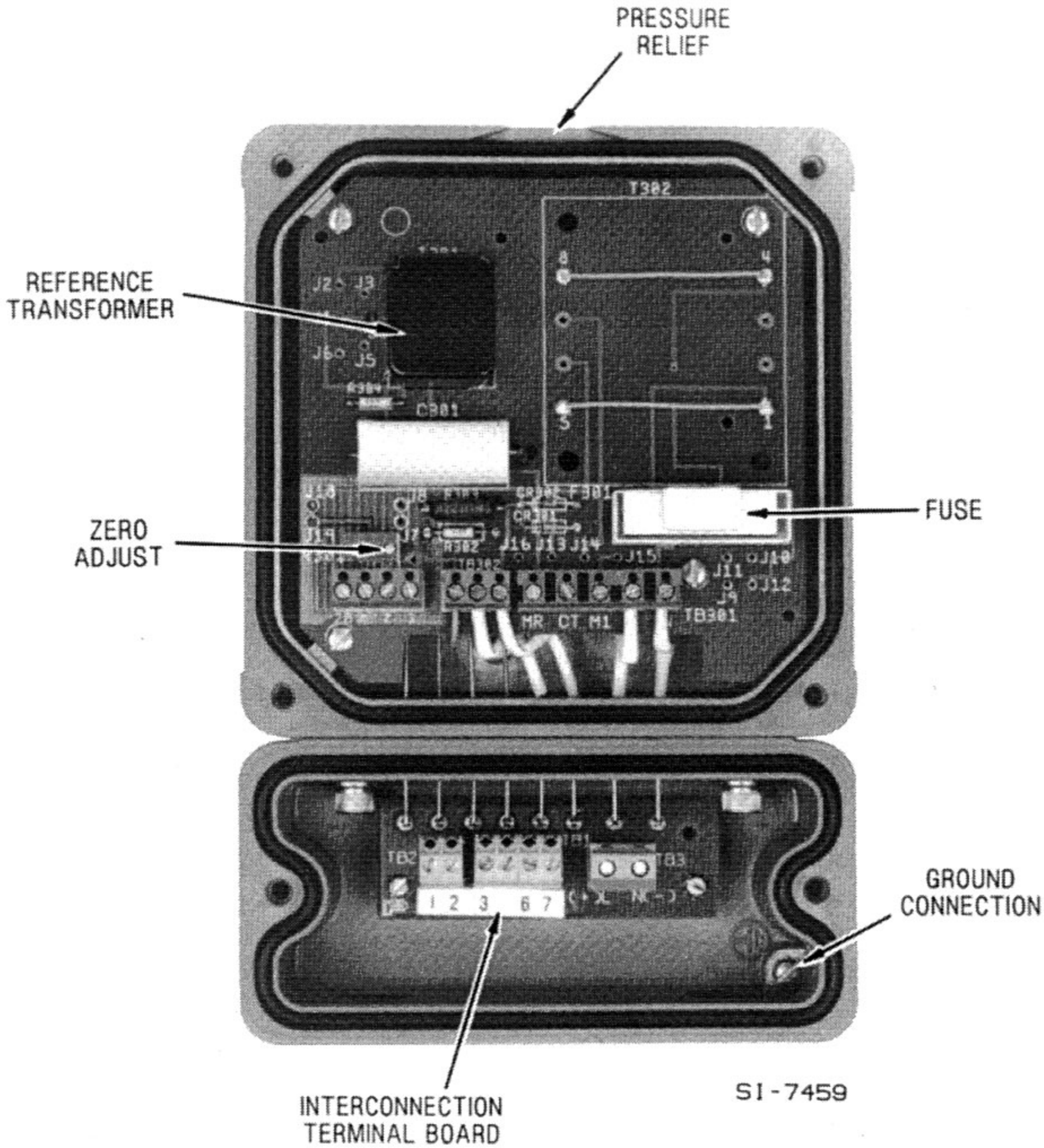


FIGURE 1-2. ELECTRONIC COMPARTMENT WITH COVERS REMOVED

1.3 Model Number Breakdown

Refer to the instrument data sheet or the data tag on the equipment for the model number of the instrument furnished. The details of a specific number are shown on the following pages.

10DS3111	A	E	_	_	P	1	A	_	_	_	_	_	_	2	_

Description	Code
Engineering Reference	
AC Magnetic Flowmeter	10DS3111
Design Level	A
Meter Lay Length	
Replacement for 10D1462	E
Liner Material	
Hard Rubber	A
Polyurethane	D
PTFE Teflon	E
Neoprene	L
Size	
in. (mm)	
14 (350)	21
16 (400)	22
18 (450)	35
20 (500)	23
24 (600)	24
Flange Standard/Pressure Rating	
Mates with ANSI Class 150	P
Flange Material	
Carbon Steel	1
Protector Plates	
None Required	A
Electrode Type	
Flush	2
Bullet Nose	3
Slurry Service	7
Electrode Material	
316 Stainless Steel	B
Hastelloy "B"	C
Hastelloy "C"	D
Titanium	E
Tantalum	F
Zirconium	L

1.3 Model Number Breakdown [Cont.]

10DS3111	A	E	_	_	P	1	A	_	_	_	_	_	_	2	_

Certifications

Standard (None)	A
FM Approved - Nonincendive for CLI, Div2, Gp A,B,C & D: Electrodes Intrinsically Safe for CLI, Div 1, Gp A,B,C&D: Outdoor Hazardous Locations, NEMA 4X. Dust Ignitionproof CLII, Div 1, Gp E,F&G: Suitable for CLIII, Div 1	K

Enclosure Classification

General Purpose: IEC 529 IP65, NEMA 4X	1
Accidental Submergence: IEC 529 IP67, NEMA 4X 33 ft. H_2O/48 hr (10m H_2O/48 hr)	2
Accidental Submergence: IEC 529 IP67, NEMA 4X 33 ft. H_2O/48 hr (10m H_2O/48 hr) Tropical - Improved Moisture Protection signal cable permanently installed.	9

Fluid Temperature Range

Hard Rubber, <176°F (80°C)	3
Neoprene, Polyurethane, <190°F (88°C)	4
TEFLON, <212°F (100°C)	6

Line / Excitation Frequency

50 Hz	1
60 Hz	3

Customer Information Language

English	2

Converter Type (Ref.)

50SM1000	1
Other	9
None	X

1.4 Specifications

Power Requirements	120 VAC, 60 Hz, <50 VA
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	20:1
Minimum Liquid Conductivity	5 µS/cm (20 µS/cm with 100 ft signal cable)
System Accuracy	

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

RFI Susceptibility	Class 2-abc-0.5% (10 V/m-20 to 1000 MHz) Per SAMA Standard PMC 33.1-1978.
Enclosure Classification	
Standard	NEMA 4X, IEC 529 IP65
Accidental Submergence	NEMA 4X, IEC 529 IP67, 30 feet H_2O/48 h (9 m H_2O /48 h)
Environmental Temperature Limits	-40 to 150^o F (-40 to 65^o C)
Meter Capacity	Specified on flowmeter data tag
Physical Characteristics	
14 - 24 inch (350 - 600mm)	Refer to Figure 2-5
Conduit Connections	two ½ inch NPT internally threaded openings
Vibration Limits (flowmeter)	5 to 14 Hz, 0.20 inch 14 to 2000 Hz, 1.5 g
Materials of Construction	
Meter Liner	Refer to Section 1.3
Electrodes	Refer to Section 1.3

Electronics Housing	die cast aluminum, epoxy finish, 316 sst cover screws, gasketed covers
Certifications	Refer to Section 1.3

Process Limits

Consult the factory for vacuum limits

TABLE 1-1. MAXIMUM LIQUID TEMPERATURE

Liner Material	Temperature
TEFLON (PTFE)	212^{o}F(100^{o}C)
Neoprene/Polyurethane	190^{o}F (88^{o}C)
Hard Rubber	176^{o}F (80^{o}C)

TABLE 1-2. FLOW RANGES

		Flow Ranges 0 to value tabulated				Span Setting by factory if not specified by user	
Meter Size		Minimum Span Setting		Maximum Span Setting			
inch	mm	gpm	m3/h	gpm	m3/h	gpm	m3/h
14	350	1520	350	15200	3500	4500	1000
16	4000	1980	450	19800	4500	6000	1400
18	450	2500	570	25000	5700	8000	1800
20	500	3100	700	31000	7000	9000	2000
24	600	4500	1000	45000	10000	13000	3000

2.0 INSTALLATION

2.1 Inspection

All meters are shipped in heavy-duty containers which are specially designed to provide adequate protection during transit. Because the meter will be operated in conjunction with a signal converter, it is likely that both instruments will be included in the same shipping container. An itemized list of all items included in the shipment is attached to the shipping container. Refer to the instruction manual supplied with the signal converter for operation and maintenance procedures for the converter.

The meter is supplied with a signal converter, a 30-ft length (standard) of interconnection cable and conduit seals.

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 this equipment. If the damage is such that faulty operation is likely to result, the damage should be brought to the attention of the factory Service Department.

2.2 Meter Handling

During shipment, the meter liner is protected by wood or composition protectors attached to the meter flanges. These are removed before the meter is installed; leave them in position while moving the meter to the installation site

To place the meter in the pipeline a sling and hoist may be necessary. Do not pass a rope or wire sling through the meter; the liner will be damaged if the meter is supported by the liner. Lift the meter as shown in Figure 2-1.

The meter weights are listed in Figure 2-2.

2.3 Location

The meter is suitable for either indoor or outdoor installation. When selecting the installation site, consideration should be given to the enironmental and process temperature limits, as stated in the specifications. Consideration should be given to access for servicing the meter. The standard watertight corrosion-resistant meter enclosure is rated NEMA 4X, watertight, and will withstand rain and hose down. If flooding is a problem, the optional IEC 529 IP67 flowmeter is rated for accidental submersion. For added protection, a "tropicalized" version is available which includes electronics encased in a watertight silicone rubber material and a permanently-installed cable.

Outline dimensions of the meter are given in Figure 2-2. Access for wiring interconnections, cover removal and servicing should be considered when selecting the installation site.

Outline dimensions of the signal converter are given in the instruction manual supplied with the signal converter.

The installation site must be provided with a source of power as specified for the signal converter. The power line should have a disconnect switch, and suitable fuse or circuit breaker as shown on the applicable interconnection diagram provided in the instruction manual supplied with the Signal Converter.

It is recommended that the meter not be installed within the immediate proximity of heavy induction equipment.

NOTE
Refer to the 50SM1000 converter Instruction Manual for the interconnection wiring diagram. Note that these larger size meters are wired differently from the 1/2 through 12 inch sizes and should be wired according to Figure 2-2 (ID-50-1824) and Figure 2-4 (ID-50-1822) in the 50SM1000 Instruction Manual.

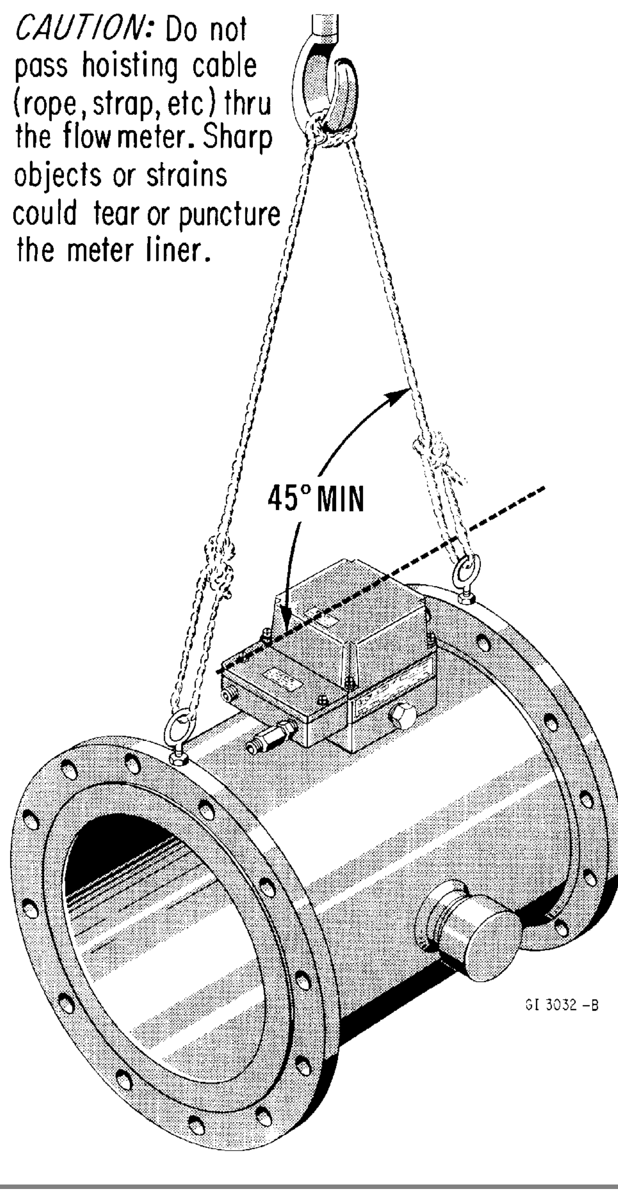
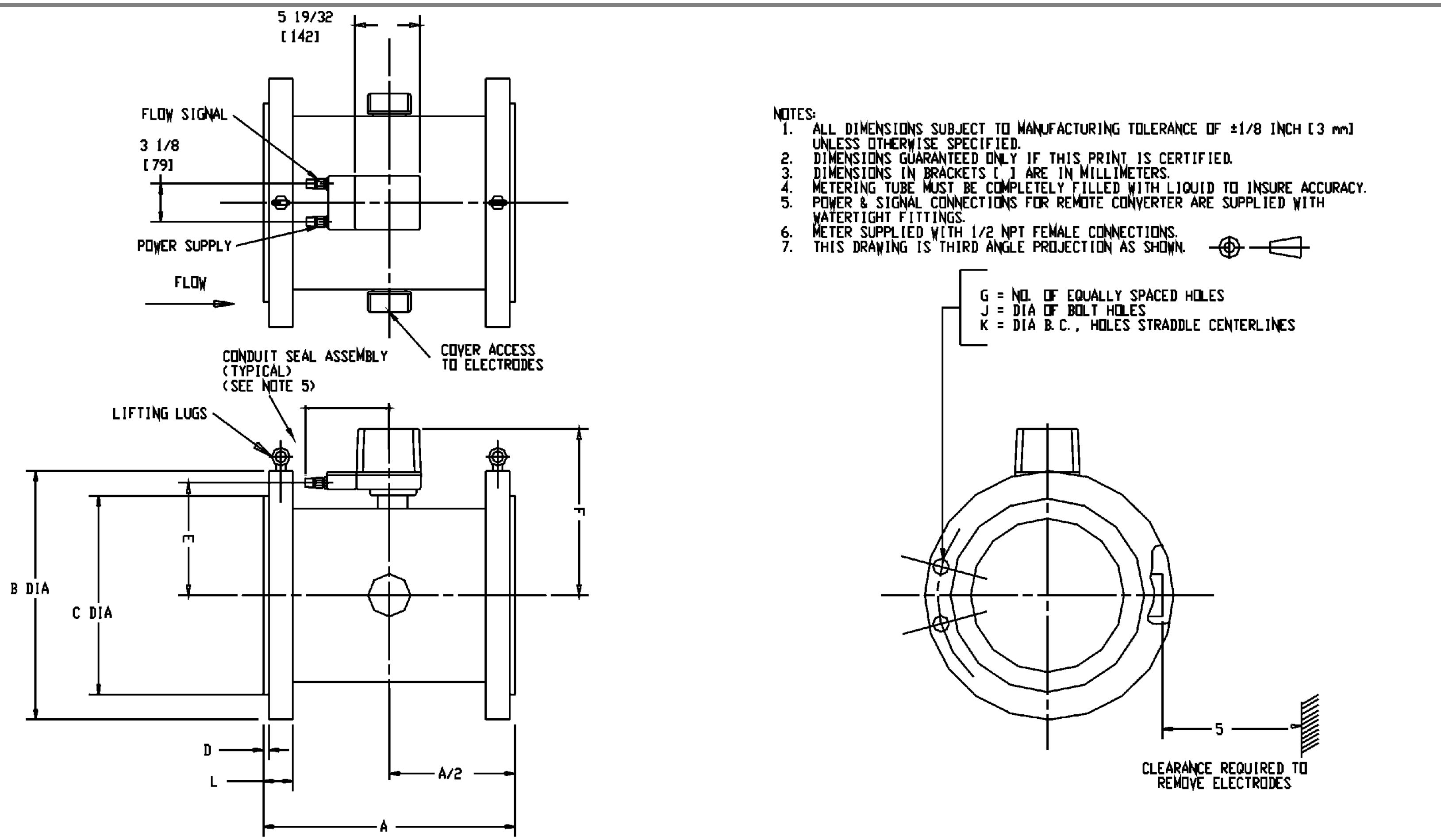


FIGURE 2-1. PROPER HOISTING TECHNIQUE



METER SIZE & STYLE	A		B		C		D		E		F		G	J		K		L	
	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm		INCH	mm	INCH	mm	INCH	mm
14IN ANSI CL. 150	21	533	21	533	16-1/4	413	5/16	8	10-13/16	275	13-1/16	332	12	1-1/8	29	18-3/4	476	1-5/8	41
16IN ANSI CL. 150	24	406	23-1/2	597	18-1/2	470	5/16	8	11-13/16	300	14-1/16	357	16	1-1/8	29	21-1/4	540	1-11/16	43
18IN ANSI CL. 150	27	686	25	635	21	533	5/16	8	12-13/16	325	15-1/16	382	16	1-1/4	32	22-3/4	578	1-13/16	46
20IN ANSI CL. 150	30	762	27-1/2	699	23	584	5/16	8	13-13/16	351	16-1/16	408	20	1-1/4	32	25	635	1-15/16	49
24IN ANSI CL. 150	36	914	29-1/2	749	27-1/4	692	5/16	8	15-13/16	402	18-1/16	459	20	1-3/8	35	29-1/2	749	2-1/8	54
14IN ANSI CL. 300	21	533	23	584	16-1/4	413	5/16	8	10-13/16	275	13-1/16	332	20	1-1/4	32	20-1/4	514	2-3/8	60
16IN ANSI CL. 300	24	406	25-1/2	648	18-1/2	470	5/16	8	11-13/16	300	14-1/16	357	20	1-3/8	35	22-1/2	572	2-1/2	64
18IN ANSI CL. 300	27	686	28	711	21	533	5/16	8	12-13/16	325	15-1/16	382	24	1-3/8	35	24-3/4	629	2-5/8	67
20IN ANSI CL. 300	30	762	30-1/2	775	23	584	5/16	8	13-13/16	351	16-1/16	408	24	1-3/8	35	27	686	2-3/4	70
24IN ANSI CL. 300	36	914	36	914	27-1/4	692	5/16	8	15-13/16	402	18-1/16	459	24	1-5/8	41	32	813	3	76

FIGURE 2-2. OUTLINE DIMENSIONS, 14 THROUGH 24 INCHES

2.4 Mounting

2.4.1 Orientation

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

For horizontal or sloping installations the meter should be placed so that the electronic housing of the meter is on top. This will align the meter electrodes in a lateral plane. Positioning the meter in this way eliminates the possibility of entrained air acting as an electrode insulator.

The meter must be oriented in accordance with the direction of process flow, as indicated by the **FLOW ARROW** on the meter data tag. For accurate metering, a straight pipe run equivalent to a minimum of three straight pipe diameters are required upstream of the meter, measured from the center of the meter. See Figure 2-3 for recommended piping diagram.

If a control valve is required, it is recommended that it be placed downstream of the meter. Upstream valves can create turbulence that result in air pockets and may affect the meter's accuracy or cause its output to be noisy. A minimum of ten pipe diameters of straight pipe are required upstream between the meter and a control valve or pump (refer to Figure 2-3).

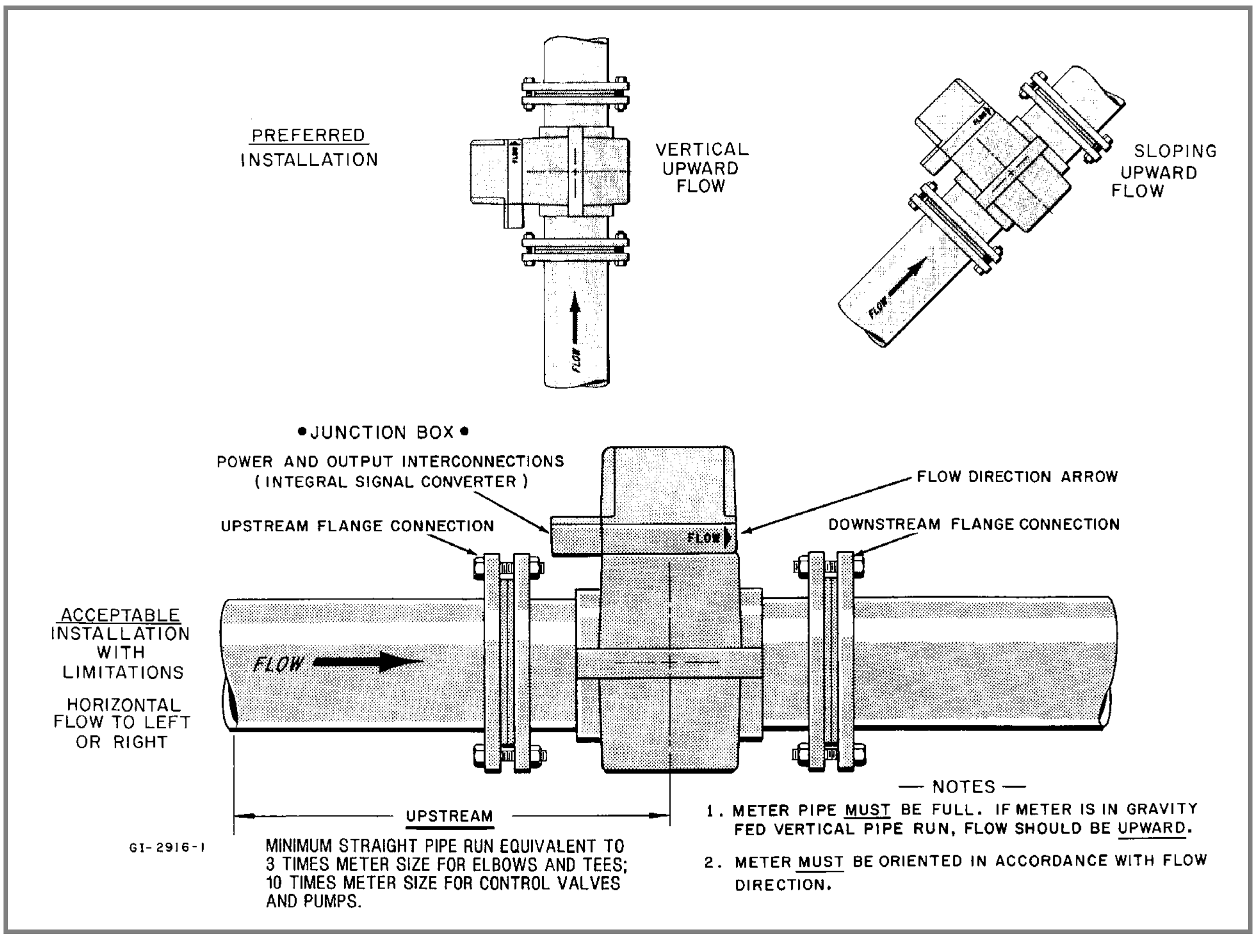


FIGURE 2-3. RECOMMENDED PIPING DIAGRAM

2.4.2 Pipe Connections

The TEFLON and polyurethane lined meters have ANSI raised faced flanges rated as Class 150. The neoprene lined meters have ANSI full faced flanges rated as Class 150. Two flange gaskets are supplied per meter; the mounting studs and nuts are furnished by the user.

Fastener threads must be clean and lubricated and flange nuts should be tightened in an alternate pattern (Refer to Figure 2-4) to produce equal pressure distribution around the flange face. Bolt torque should be limited to the values shown in TABLE 2-1 for the liner materials shown. PTFE lined meters should be retorqued after 24 hours. Due to their resiliency, Polyurethane and Neoprene lined meter bolts should be tightened to 1/2 the values listed in TABLE 2-1. Additional tightening up to the values listed may be necessary to achieve an effective seal.

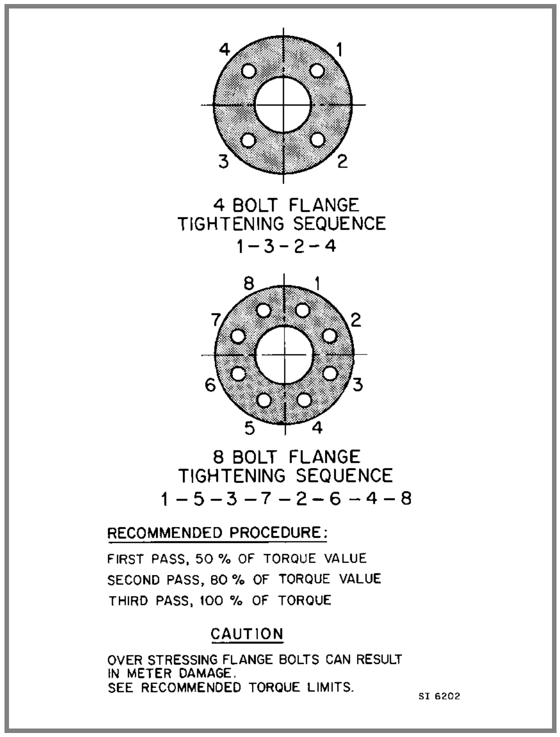


FIGURE 2-4. FLANGE BOLT

TABLE 2-1. RECOMMENDED BOLT TORQUES

METER SIZE	PTFE TEFLON, HARD RUBBER ft-lbs (Nm)
14 in.	120 (160)
16 in.	115 (155)
18 in.	175 (240)
20 in.	155 (210)
24 in.	220 (300)

Refer to Figure 2-3 for recommended piping arrangement and Figure 2-5 for proper gasket locations.

If a throttling valve is required, it is strongly recommended that it be placed downstream of the meter. Upstream valves can create turbulence that result in undesirable air pockets and may affect the meter's accuracy or cause its output to be noisy.

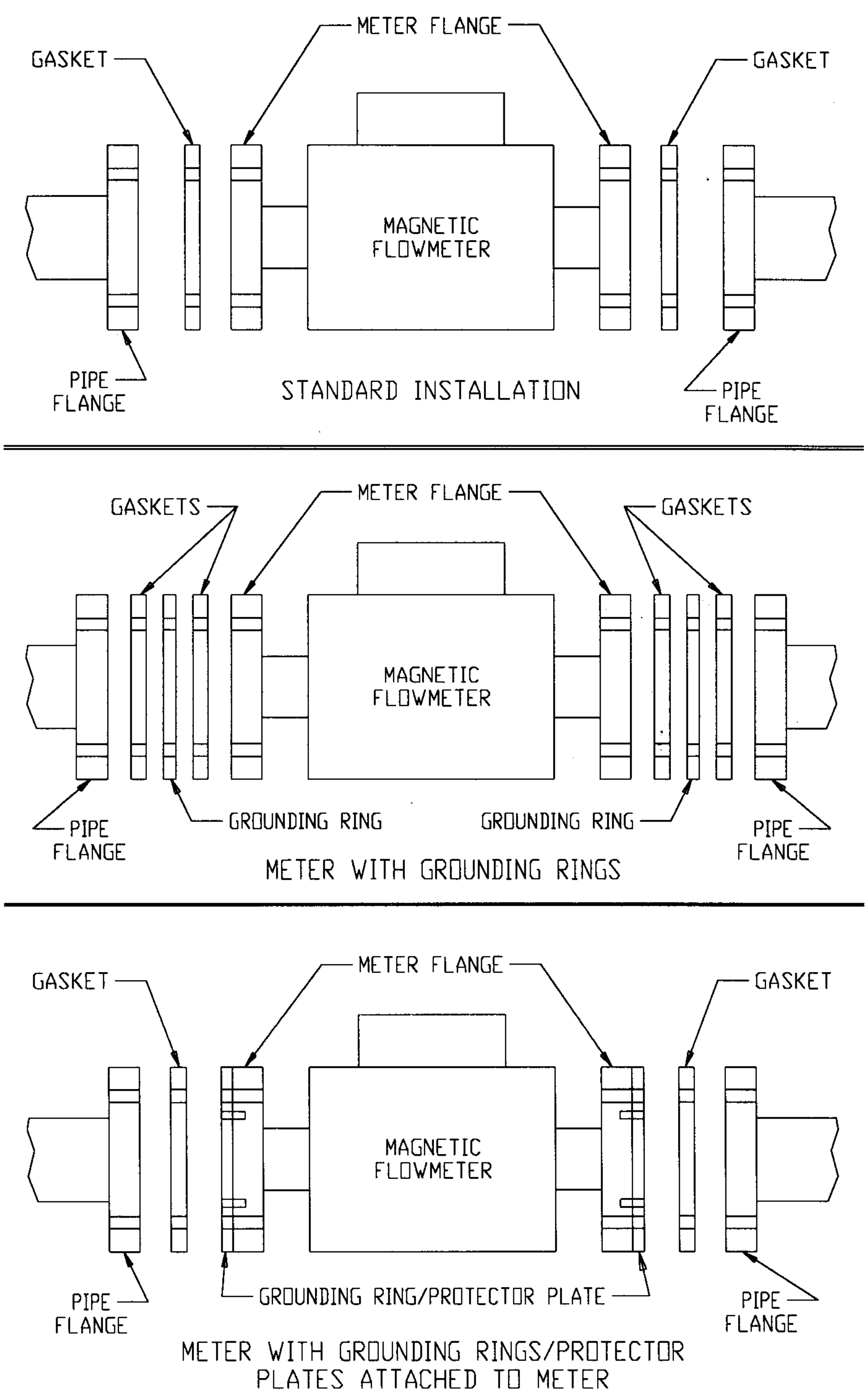


FIGURE 2-5. GASKET LOCATIONS

2.5 Grounding Procedure

2.5.1 General

Satisfactory operation of the flowmeter system requires that careful attention be paid to proper grounding techniques. A good ground is one that is in contact with the earth over a large conductive area. An excellent example of this is a cold water pipe which is buried in the earth and travels many miles in its distribution system. A great number of pipe branches form a large conductive area of contact which provides a low resistance connection to earth. A hot water or steam pipe must first return to a boiler before it becomes a cold water pipe, therefore, its greater length of ungrounded path offers a less desirable ground bus. A metallic structural member of a building, such as a supporting "**I**" beam, may be a good earth ground, but it is a second choice to a cold water pipe.

NOTE
If selecting a cold water pipe for meter grounding purposes, the user should be aware that is becoming more common to use sections of PVC piping in the cold water piping system. It is the user's responsibility to make certain that there is electrical continuity between where the meter is grounded on the copper cold water pipe and where the copper cold water pipe actually enters the earth

Meter grounding requirements are 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 insuring that the meter body is in contact with the process liquid at both ends of the meter body. The bonding process places an electrical short circuit across the meter, thereby routing any stray current around the meter (rather than through it).

From the point of view of grounding there are two basic types of piping systems:

- electrically conductive pipeline: the process liquid comes in contact with conductive pipe. This piping requires that each meter flange be connected with a bonding wire to the adjacent pipeline flange. The grounding procedure to use with conductive pipeline is described in 2.5.2.
- non-conductive or electrically insulated pipeline: the pipeline may be made of an electrically non-conductive material (plastic, concrete, etc.) or lined with a non-conductive material (rubber, TEFLON, etc). These non-conductive pipelines require the use of metal grounding rings or grounding probes to bond the process to ground. The grounding procedure to use with nonconductive pipeline is described in 2.5.3.

NOTE
Proper grounding of the meter is required for optimum system performance.

2.5.2 Conductive Pipeline

If the meter is included as part of a conductive pioeline that is not electrically insulated from the liquid to be metered, the following grounding procedure should be followed. Refer to Figure 2-6 to supplement the text.

1) Drill and tap both pipeline flanges adjacent to the bonding connections on the flowmeter. The lugs on the bonding cables are sized for a 1/4 inch bolt.

2) Obtain a bright metal surface around the edges of the both tapped holes with a file or emery cloth.

3) Attach the bonding wire and another length of ground wire to the flanges as shown. Use internal tooth lockwashers as shown in the detail. The wire to the good external ground should be #12 AWG, or heavier, copper wire.

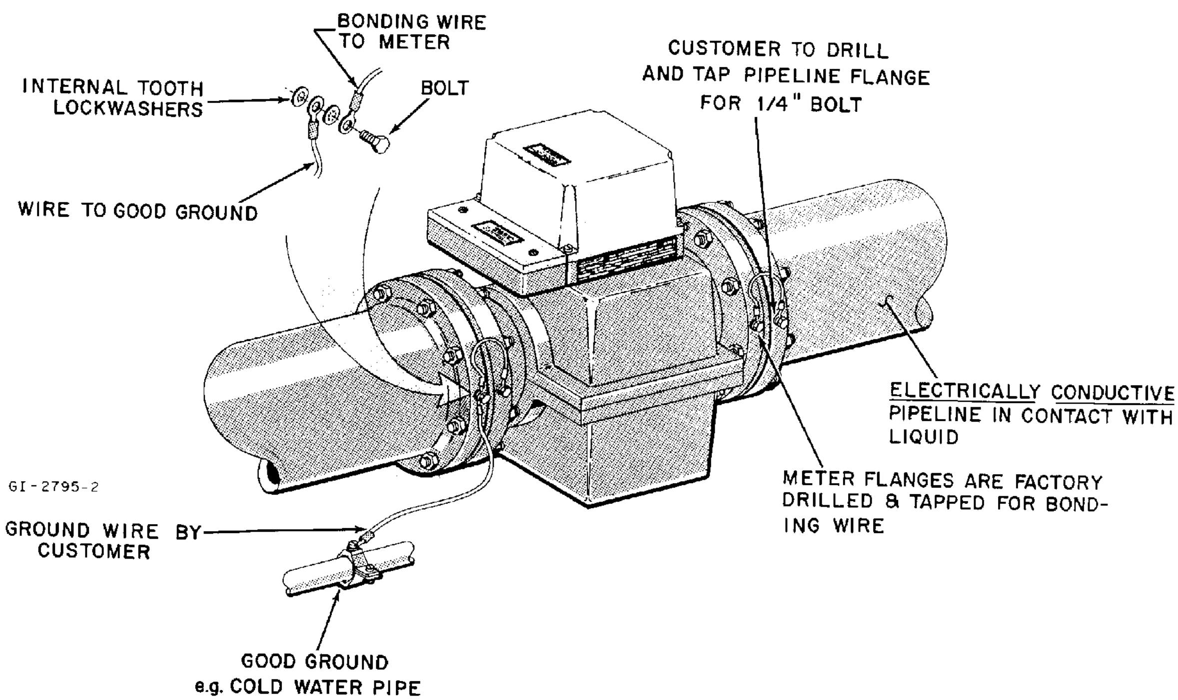


FIGURE 2-6. GROUNDING PROCEDURE, CONDUCTIVE PIPELINE

2.5.3 Non-Conductive or Electrically Insulated Pipeline

If the meter is installed as part of a non-conductive or liquid insulated pipeline (such as totally plastic pipe, ceramic lined iron pipe, or cast pipe with internal bitumastic coating), the following grounding procedures apply. Refer to Figure 2-7 to supplement the following text.

1) For this service, the meter requires the use of grounding rings. The grounding rings should be installed between the meter flanges and the mating flanges of the pipeline. A gasket is required on both sides of the grounding ring. If the meter is supplied with a grounding ring/protector plate fastened to the meter flange, only one gasket is required between the grounding ring/protector plate and the pipeline flange. Proper gasket locations are shown in Figure 2-5.

2) Attach the bonding wire and ground wire to the tab of the grounding ring. Use internal tooth lock washers and hex head nut and bolts. The ground wire should be #12 AWG, or heavier, copper wire.

NOTE
THE GROUNDING PROBE SHOWN IN FIGURE 2-8 CAN BE SUBSTITUTED FOR GROUNDING RINGS IN MANY APPLICATIONS. THE PIPELINE MUST BE DRILLED AND TAPPED AS NOTED IN FIGURE 2-8, WITH THE RESPECTIVE GROUNDING PROBE INSTALLED ADJACENT TO EACH OF THE PIPELINE MOUNTING FLANGES.

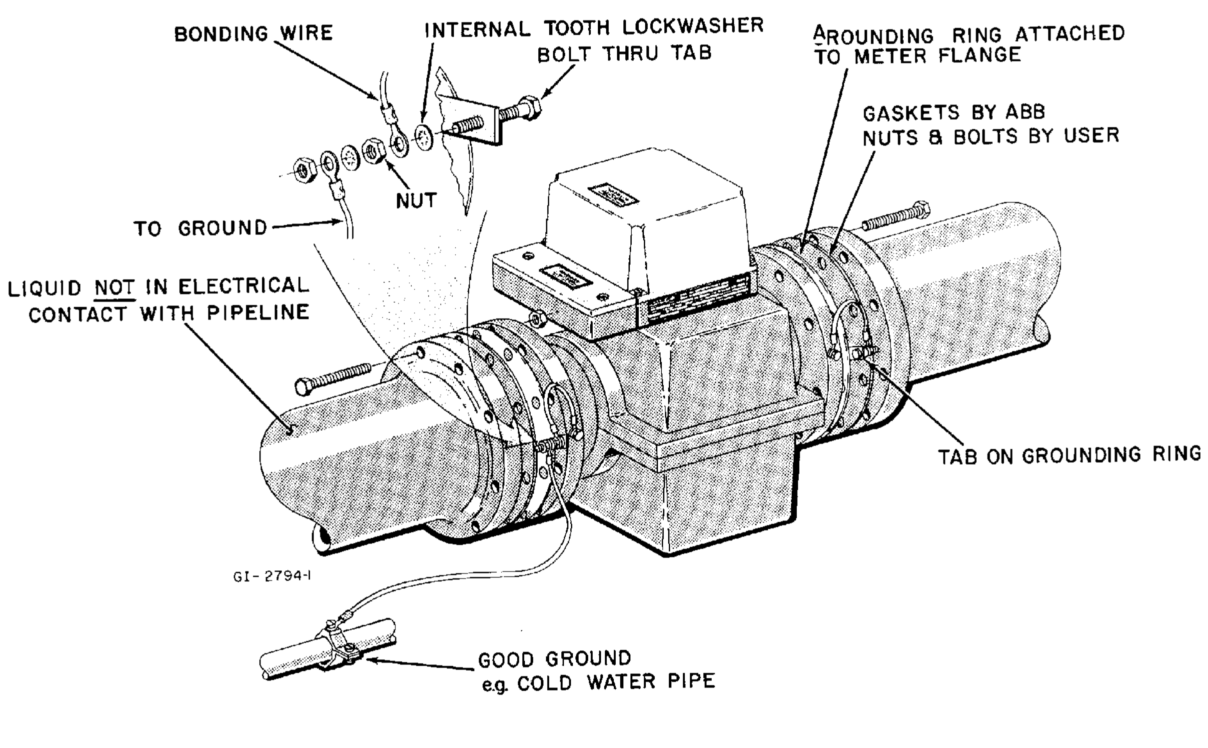


FIGURE 2-7. GROUNDING PROCEDURE, NON-CONDUCT. PIPELINE

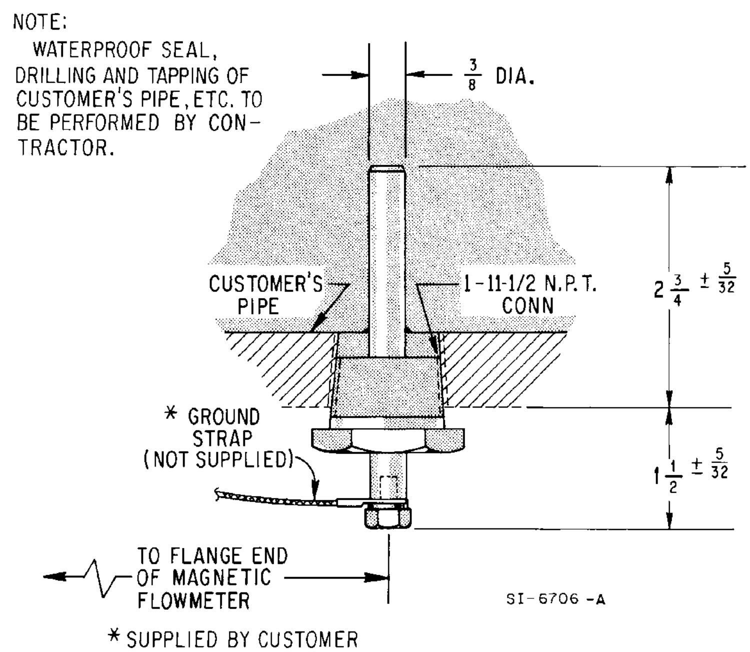


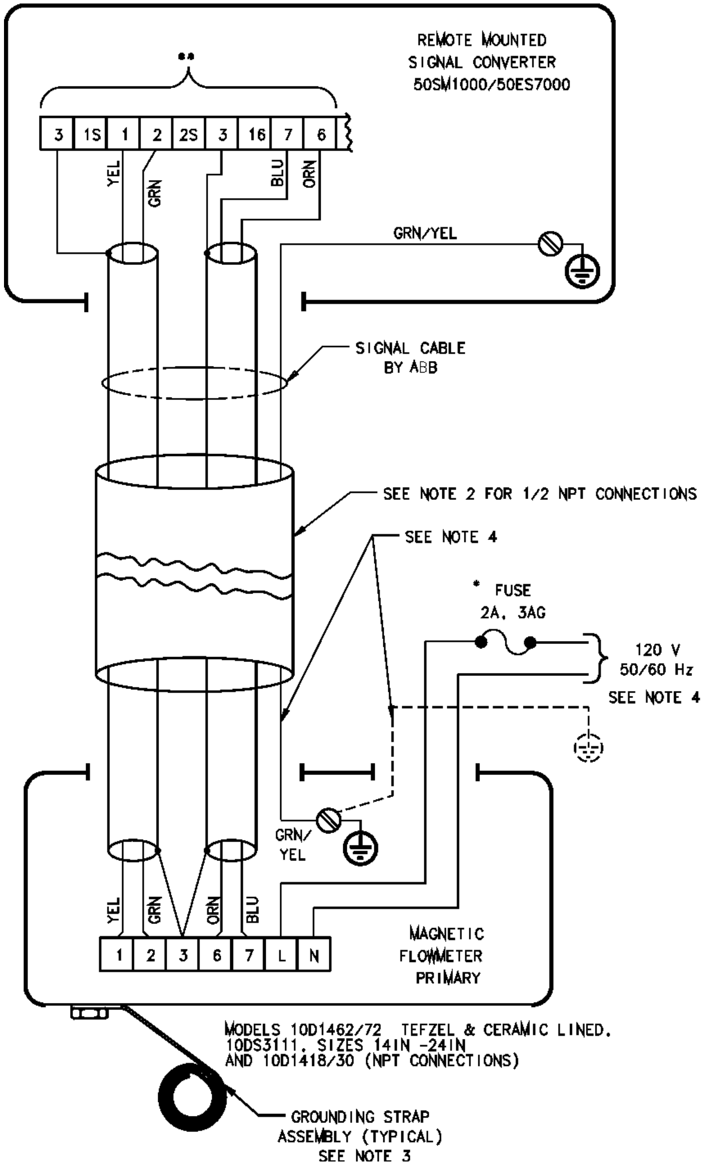
FIGURE 2-8. GROUNDING PROBE (OPTIONAL)

2.6 Electrical Interconnection

Interconnection details for 14 through 24 inch meter sizes are shown in Figure 2-9.

> **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 2.5 must be followed.



NOTES:

1.* INDICATES SUPPLIED BY CUSTOMER.

2. UNUSED CONDUIT CONNECTIONS MUST BE PLUGGED TO MAINTAIN NEMA 4X RATING

3. METER GROUNDING STRAPS ARE USED TO PREVENT STRAY ELECTRICAL CURRENTS FROM PASSING THROUGH THE METERED LIQUID. SEE INSTRUCTION BULLETIN FOR DETAILS.

4. WHEN METER PRIMARY IS CONNECTED TO A SOURCE OF SUPPLY (120Vac) DIFFERENT THAN THE SOURCE OF SUPPLY FOR THE 50SM1000/50ES7000, THE METER PRIMARY SHALL BE CONNECTED TO THE PROTECTIVE GROUND (GREEN WIRE) AT THE LOCAL SUPPLY SOURCE. THE GREEN/YELLOW LEAD FROM THE 50SM1000/50ES7000 SHOULD NOT BE CONNECTED AT THE PRIMARY END.

NOTES FOR NPT CONNECTIONS:

1. ALL WIRING TO BE ENCLOSED IN METAL CONDUIT SUPPLIED BY CUSTOMER

2. CONDUIT CONNECTIONS ON 10DS3111, 10D1462/72 & 50SM1000/50ES7000 ARE 1/2 NPT. CONDUIT CONNECTIONS ON 10D1418/30 ARE 3/4" NPT.

THIS DRAWING SERVES TO ILLUSTRATE THE INTERCONNECTIONS BETWEEN THE REMOTE SIGNAL CONVERTERS (50SM/50ES) AND THE FLOWMETER PRIMARY (10DS3111,10D1418/30 & 10D1472 OR 10D1476 SPECIAL). ALL OTHER CONNECTIONS TO THE SIGNAL CONVERTER ARE IMPLEMENTED PER THE CONVERTER (50SM/50ES) INSTRUCTION BULLETIN. 1S, 2S & 16 ARE NOT USED WHEN INTERCONNECTED WITH THESE FLOWMETER PRIMARIES.

Ref. ID-50-1824 r.4

FIGURE 2-9. 10DS3111 INTERCONNECTION WIRING, 14-24 in.

2.7 Conduit Seal and Pressure Relief

In accordance with the National Electrical Code (NEC) ANSI/NFPA 70, Article 501-5(f)(3), the flowmeter includes a conduit entry seal and pressure relief to prevent the process liquid from entering the electrical conduit system. This safety feature considers the remote possibility of a primary seal failure between the meter body and the electronic housing.

The conduit entry seal will prevent the process liquid from entering the electrical conduit system. The conduit entry seal consists of a conduit entry cable seal on the meter junction box. It is the user's responsibility to properly install the conduit entry cable seal fitting supplied with the signal converter interconnection cable. This will ensure proper performance of this safety feature. Refer to Figure 2-9.

A pressure relief is provided in the electronics housing for the meter. The pressure relief is located in the center of the cover joint on the side opposite from the conduit connection. If the primary seal should fail, the pressure relief will vent the process preventing an over pressurization and potentially dangerous failure of the electronics housing. It is the user's responsibility to be aware of this safety feature and to consider the unlikely event of its functioning. Based on knowledge of the process and meter application, the user should consider the use of deflectors to safely direct the vented process.

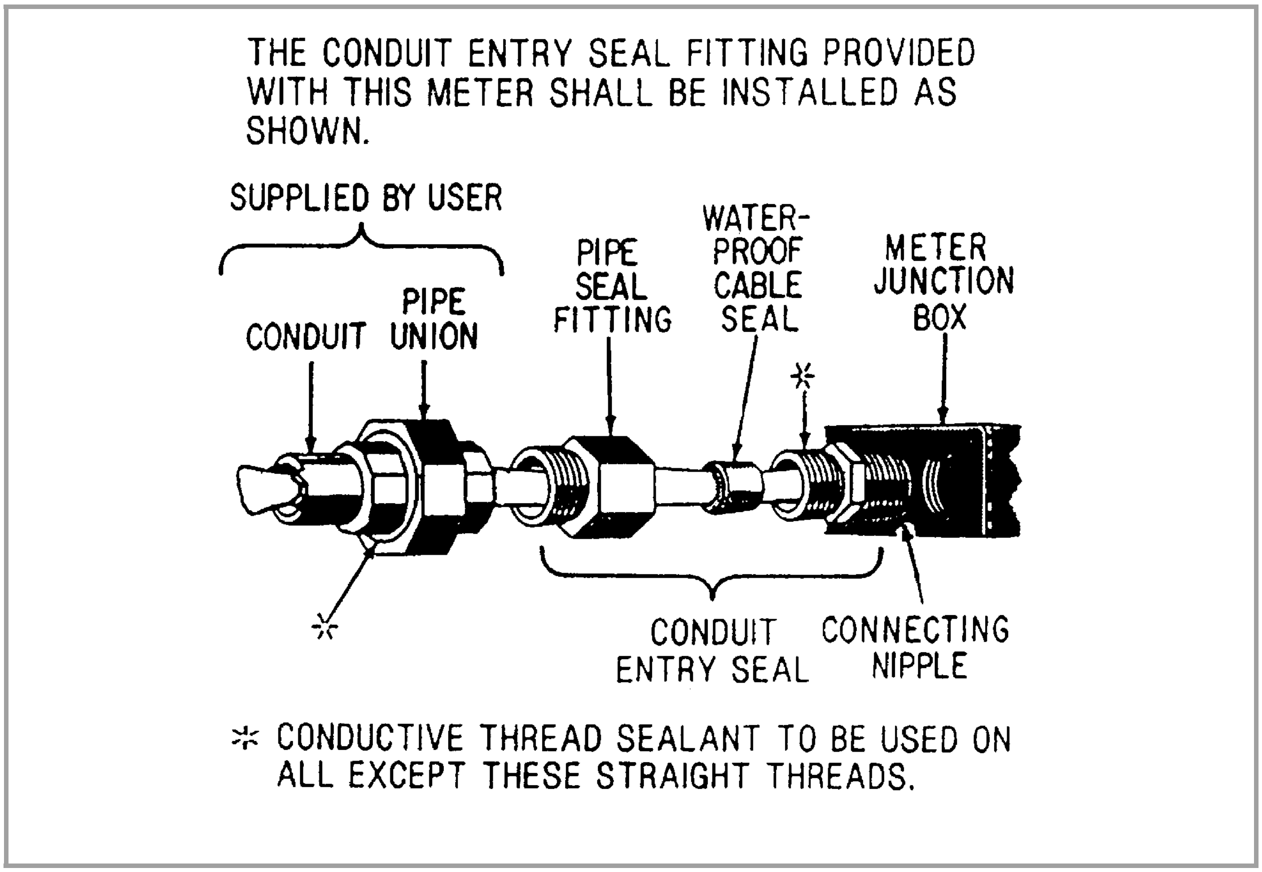


FIGURE 2-10. CONDUIT ENTRY SEAL INSTALLATION

3.0 START-UP and OPERATION

The meter is calibrated for the values stated on the instrument tag. 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 data tag as shown in Figure 3-1.

Prior to initial system start up, verify that the meter is properly installed; check flow direction, wiring interconnection and grounding as discussed in the Chapter 2.0. Particular attention should be paid to the meter grounding procedures; improper grounding may result in unsatisfactory performance. Refer to the signal converter instruction bulletin for interconnection wiring procedures.

Except for system zero adjustment, there are no operating controls that require field adjustment unless the full scale range setting was not specified at time of purchase. If the full scale range setting must be set or changed, refer to the instruction bulletin supplied with the signal converter.

The system zero adjustment must be performed prior to start-up. The procedure for zero adjustment is discussed in the signal converter instruction bulletin.

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 system power to the flowmeter and signal converter 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 signal converter.

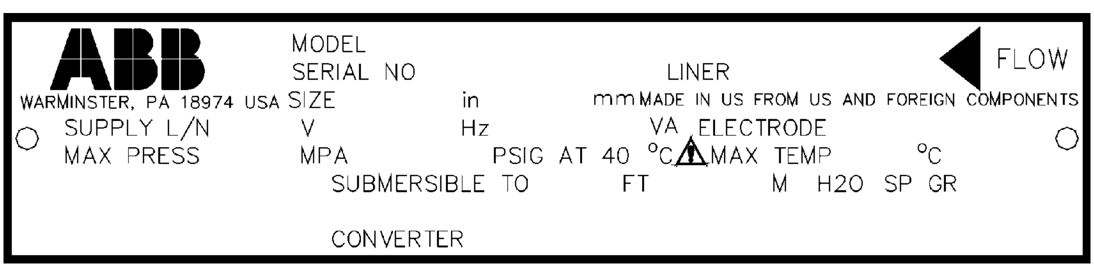


FIGURE 3-1. TYPICAL INSTRUMENT TAG

4.0 FUNCTIONAL DESCRIPTION

The Flowmeter body houses two signal electrodes and the flux producing magnet coils, as shown schematically in Figure 4-1. All Flowmeter intraconnection wiring is terminated at a printed circuit board assembly located in the base of the flowmeter housing.

The flowmeter 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 from a precision current transformer and its load impedance 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 converter circuitry will provide an exact ratio and thereby provide immunity to power supply variation. The magnet coils are excited by the 120 VAC 60 Hz power line. In some sizes, the line voltage is stepped down via an additional transformer.

4.1 Basic Operating Principle

4.1.1 Signal Voltage Generation

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

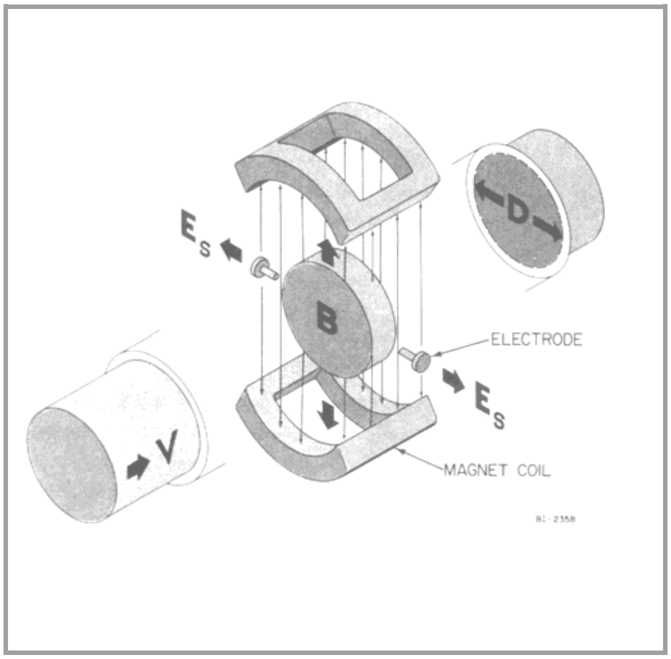


FIGURE 4-1. BASIC OPERATING PRINCIPLE

Figure 4-1 graphically illustrates the basic operating principle. A magnetic field, "B", is being generated in a plane which is perpendicular to the axis of the meter pipe. A disk of the metered liquid can be considered as a conductor. The transverse length "D" is equal to the meter pipe diameter. Since the velocity "V" of the liquid disk is directed along the axis of the meter pipe, a signal 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
α = dimensionless constant
V = liquid velocity

Thus, the metered liquid constitutes a continuous series of conductive liquid disks 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 Volumetric Flow Rate Measurement

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

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

Since B = β 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 meter.

4.2 Operating Characteristics

4.2.1 Liquid Variables

4.2.1.1 Liquid Conductivity

The Flowmeter requires a liquid conductivity of 5 microsiemens per centimeter or higher for operation. This minimum liquid conductivity requirement is effected by the length of the signal interconnection cable to the signal converter. The nominal maximum transmission distance is limited to 50 feet (15 m), however, a 100 foot (30 m) cable length can be accommodated with a minimum conductivity of 20 µS.

The conductivity of a given liquid, σ, 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 microsiemens/cm) may be determined from the electrode AC 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 megohms; i.e.,

$$\frac{36000 \times 2}{10^6}$$

For example, assuming the measured AC electrode resistance (full pipe and zero flow) is 192,000 ohms and electrode diameter is 7.92 mm (0.792 cm), then

$$\sigma = \frac{1}{(0.192 - 0.072) \times 0.635} = 13.16\ \mu S/cm$$

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. Field Engineers are equipped to determine the conductivities of special liquids at the user's site.

4.2.1.2 Liquid Temperature

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

Most liquids exhibit a positive temperature coefficient of conductivity. It is possible for certain marginal liquids to become sufficiently non-conductive at lower temperatures so as to hamper accurate metering. However, the same liquid at higher or normal environmental temperatures may be metered with optimum results. The possibility of an adverse temperature conductivity characteristic should be investigated before attempting to meter such a liquid. Process 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, such as the leakage pressure of the meter pipe flange connections.

4.2.2 Metering Characteristics

The metering pipe must be completely filled at all times for accurate results. Where there is possibility of operation with a partially filled horizontal pipeline, it is recommended that the Flowmeter be installed in a vertical section of that pipeline such that liquid flow moves upward. A vertical installation also offers the advantage of an even distribution of liner wear in the event that solid abrasives are being carried along in the liquid stream.

The 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. Also, in the case of a slurry, it will not differentiate the amount of liquid from solids. If the liquid to mixant ratio is of importance to process control, then separate measurements of the concentration of the desired medium must be made and appropriate correction factors must be applied to the Magnetic Flowmeter output.

In applications involving variable quantities of uniformly dispersed, non-conductive mixing agents, it must be 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

The 10D1472 Flowmeter contains circuitry in the electronics housing which provides two functions:

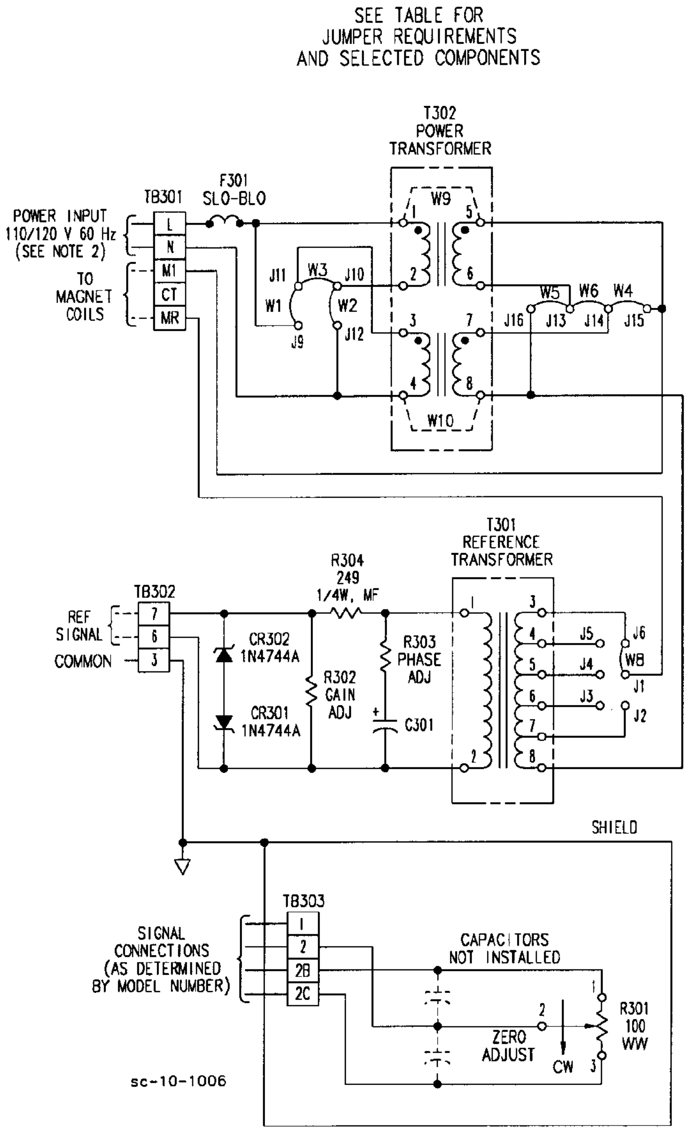
- Establishes primary zero
- Normalizes the flow signal by generating a voltage proportional to coil current.

The magnetic flux in the metering system is directly proportional to the current through the metering coils.

Zero adjustment is accomplished by using a potentiometer to null a magnetic flux loop located within the flowmeter body. The meter calibration factor is established via the reference voltage (terminals 6 and 7). Current flowing through the coils is passed through a current transformer which has a load impedance network on its output winding. The output signal across this impedance and the parallel 1000 ohm resistive load in the signal converter generate a reference signal which is in phase with the electrode velocity signal and produces an appropriate meter calibration factor. Using current sensing, the Converter will make a ratiometric measurement of flow velocity which is unaffected by variations of line voltage or coil temperature.

All 10DS3111 are powered by a 110/120 VAC 50/60 Hz line source.

Refer to Figure 5-1 for electronic circuitry.



LINER MATERIAL	LINE FREQUENCY	METER SIZE (INCHES)	PCB ASS'Y 686B_____	R302 RESISTOR	R302 PART NUMBER 161_____	R303 RESISTOR	R303 PART NUMBER 161_____
NEOPRENE, HARD RUBBER, POLYURETHANE	60 Hz	14	807U01	511Ω, 3W	S128U69	909 Ω, 1%	T010U93
		16	807U02	432 Ω, 50 ppm	T052U62	562 Ω, 1%	T020U73
		18	807U03	649 Ω, 3W	S128U79	301 Ω, 1%	T020U47
		20	807U04	464 Ω, 50 PPM	T052U65	487 Ω, 3W	S128U67
		24	807U05	464 Ω, 50 PPM	T052U65	487 Ω, 3W	S128U67
	50 Hz	14	807U06	499 Ω, 1%	T020U68	422 Ω, 1%	T020U61
		16	807U07	261Ω, 1%	T020U41	402 Ω, 1%	T020U59
		18	807U08	499 Ω, 1%	T202U68	499 Ω, 1%	T020U68
		20	807U09	487 Ω, 3W	S128U67	909 Ω, 1%	T020U93
		24	807U10	690 Ω, 50 PPM	T058U03	487 Ω, 3W	S128U67
TEFLON	60 Hz	14	531U40	511Ω, 3W	S128U69	909 Ω, 1%	T010U93
		16	531U41	432 Ω, 50 ppm	T052U62	562 Ω, 1%	T020U73
		18	531U42	649 Ω, 3W	S128U79	301 Ω, 1%	T020U47
		20	531U43	464 Ω, 50 PPM	T052U65	487 Ω, 3W	S128U67
		24	531U44	464 Ω, 50 PPM	T052U65	487 Ω, 3W	S128U67
	50 Hz	14	531U52	499 Ω, 1%	T020U68	422 Ω, 1%	T020U61
		16	531U53	261Ω, 1%	T020U41	402 Ω, 1%	T020U59
		18	531U54	499 Ω, 1%	T202U68	499 Ω, 1%	T020U68
		20	531U55	487 Ω, 3W	S128U67	909 Ω, 1%	T020U93
		24	531U56	690 Ω, 50 PPM	T058U03	487 Ω, 3W	S128U67

NOTES:

1. Jumpers W1 through W6 not used
2. W8 jumpers between J1 & J2
3. C301 = 5μF, 63V
4. F301 = 2 A

FIGURE 5-1. DIAGRAM OF FLOWMETER CIRCUIT

6.0 MAINTENANCE

6.1 General

Except for an occasional performance verification check, there is no required routine maintenance for the flowmeter. In the event that the flowmeter body must be replaced, the company offers a repair/exchange program to facilitate replacement of a defective meter or converter.

If the equipment is beyond the warranty limit, under this programa fixed-price will be charged for the replacement of the defective equipment with appropriate credit issued when the repairable unit is received by the factory (charges prepaid).

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

When communicating with the company regarding replacement of a complete meter, it is important to reference the complete instrument serial number to assure that the correct replacement will be supplied. The serial number is referenced on the manufacturing specification sheet supplied with the flowmeter and on the instrument data tag.

NOTE
Operation and maintenance procedures for the signal converter are provided in the instruction manual supplied with the signal converter.

6.2 System Troubleshooting

If the flowmeter appears not to be operating properly, the following procedure can be used as a guide to isolate the malfunctioning device to either the flowmeter or the signal converter. A standard multimeter and an oscilloscope are suitable for making the test measurements.

WARNING
ELECTRICAL SHOCK HAZARD. 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.

CAUTION
Some of the surface-mounted IC devices used in the signal converter are static sensitive and may be damaged by improper handling. When adjusting or servicing the signal converter, use of a grounded wrist strap is recommended to prevent inadvertant damage to the integral solid-state circuitry.

1. If improper meter operation is suspected, proceed as follows:

   a) Remove access covers from the junction box and the flowmeter housing.
   b) Inspect for evidence of water entry in junction box and flowmeter housing.

If water entry is present, **de-energize system at power source**. Inspect conduit seals and cover gaskets for possible source of water entry. Replace the seals and/or gaskets if evidence of water entry is indicated. Allow interior of junction box and housing to dry completely before restoring system power.

Since operating procedures are dependent upon the type of signal converter selected, the user should refer to the instruction manual supplied with the signal converter for system troubleshooting procedures. A static performance test for the flowmeter is discussed in Section 6.3.

2. 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 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 flowmeter board located in the base of the electronics housing.

WARNING
ELECTRICAL SHOCK HAZARD. 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

14 through 24 inch meters have two magnet coils in the meter that are connected in series. The coil leads are connected to terminals M1, CT and MR on the pc board in the flowmeter electronics base.

Before making resistance measurements, **verify that the system power service has been de-energized.** Remove the flowmeter electronics housing cover to obtain access to the flowmeter pc 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 CT. 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 1/2 of the value 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), or shorted (zero resistance), the flowmeter must be replaced.

4. Carefully disconnect the four coil wires from the terminal lugs on the primary pc board. Identify each wire to ensure proper replacement.

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 replaced and the meter can be returned to service. Replace meter housing cover.

TABLE 6-1. METER COIL RESISTANCE-SIZES 14 THROUGH 24 INCHES

Meter Size		Coil Resistance, M1 to MR Ohms (nominal)	
inch	**mm**	**Each Coil**	**Series (both coils)**
14	350	10.6	21.2
16	400	9.6	19.2
18	450	9.3	18.6
20	500	9.3	18.6
24	600	9.5	19.0

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 the meter body.

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

1. Remove field wiring connected to electrode leads "1" and "2". Proceed to step 2.

2. Place the ohmmeter on the 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. The liners of magnetic flowmeters may become covered with conductive coatings (as well as with the more well known insulating types). The presence of a conductive coating will cause the electrode measurements outlined in procedures "3" and "4" above to appear faulty. If a coating is evident inside the magnetic flowmeter, it should be removed using a solvent compatible with the lining material or with a brush. Be extremely careful not to damage the liner when using either cleaning method.

Before returning the meter to service, verify that there is electrical continuity between the electrode tips and their meter field wiring connections. A resistance of either 36 Kohms or 100 Kohms will be in series with each electrode so make certain to set the ohmmeter to the appropriate scale.

6. 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 and the cover installed.

7.0 PARTS LIST

TABLE 7-1. FLOWMETER ELECTRONICS BOARD

Meter Size		ANSI Flange Class	Liner Material		
inch	mm		TEFLON	Polyurethane	Neoprene
12	350	150	333N817P30	333N817Q10	333C384Q10
16	400		333C526U04	333C526U03	333C380Q10
18	450		333C526U16	333C526U17	333C381Q10
20	500		333C526U08	333C526U07	333C388Q10
24	600		333C526U15	333C526U01	333C389Q10

TABLE 7-2. GROUNDING RINGS

NOTE
Polyurethane & Neoprene lined meters use Neoprene gaskets.
TEFLON lined meters use TEFLON gaskets

Order number consists of one grounding ring and mounting screws. Order a quantity of two for each meter. Order by the referenced part number.

Meter Size		ANSI Flange Class	304 SST with Gasket Material below:	
inch	mm		TEFLON	Neoprene
12	350	150	644B009U09	644B009U10
16	400		644B009U11	644B009U12
18	450		644B009U13	644B009U14
20	500		644B009U15	644B009U16
24	600		644B009U17	644B009U18

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