INSTRUCTION BULLETIN
MAGNETIC FLOWMETERS
10DX3111A & 10DX3311S
Sizes 14 through 24 Inches

COPA-XM™ AND MAG-X®
SERIES 3000 MAGNETIC FLOWMETER
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- COPA-XM™
- MAG-X®

The following is a registered trademark of Du Pont:

- TEFLOW®

The following is a trademark of Haynes International Incorporated:

- HASTELLOY™

The following is a trademark of International Nickel Company, Incorporated:

- MONEL

**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.

---

**POSSIBLE PROCESS UPSETS**

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

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**NOTICE**

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SAFETY SUMMARY

GENERAL WARNINGS

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

RETURN OF EQUIPMENT
All Flowmeters and/or Signal Converters being returned to Bailey-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 Bailey-Fischer & Porter for authorization prior to returning equipment.

INSTRUCTION MANUALS
Do not install, maintain or operate this equipment without reading, understanding and following the proper Bailey-Fischer & Porter instructions and manuals, otherwise injury or damage may result.

ELECTRICAL SHOCK HAZARD
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 or service.

SPECIFIC WARNINGS

ELECTRICAL SHOCK HAZARD. Equipment powered by an AC line voltage presents a potential electric shock hazard to the user. Make certain that the system power is disconnected from the branch circuit before attempting electrical interconnections. (pg. 2-14)

The high voltage ultrasonic pulses applied to the Magnetic Flowmeter from the Ultrasonic Generator constitute a potential safety hazard. Extreme care must be exercised when servicing or troubleshooting this equipment. Wait two minutes after power shutdown before removing the terminal cover from the Ultrasonic Generator or the Ultrasonic Junction box. (pg. 2-14)

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. (pg. 6-2)

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. (pg. 6-2)

Do not attempt electrode inspection or replacement with a filled or pressurized pipeline. Personal injury may result from such practice. (pg. 6-6, 6-9)
SPECIFIC CAUTIONS

Never allow any support for the Magnetic Flowmeter to bear upon the inner surface of the meter pipe section, as the liner may become damaged. (pg. 2-2)

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

Some of the 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. (pg. 6-1)

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. (pg. 6-5)

For Teflon-lined meters, replacement of the electrodes must not be attempted in the field. The meter must be returned to the factory for electrode replacement. (pg. 6-7, 6-8)

Exercise extreme care when withdrawing the electrode from its seat so that little or no tension is exerted on the connecting electrode wire. If this wire should break within the meter pipe, the meter is not repairable. (pg. 6-7)

For Teflon lined meters, field replacement of the transducer assemblies must be done only by factory-trained personnel. Contact your Bailey-Fischer & Porter Field Service Representative, if transducer replacement becomes necessary. (pg. 6-8)
READ FIRST

WARNING

INSTRUCTION MANUALS
Do not install, maintain, or operate this equipment without reading, understanding and following the proper Bailey-Fischer & Porter instructions and manuals, otherwise injury or damage may result.

RETURN OF EQUIPMENT
All Flowmeters and/or Signal Converters being returned to Bailey-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 Bailey-Fischer & Porter for authorization prior to returning equipment.

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

All magnetic flowmeters supplied after March 1992 are provided with a corrosion resistant NEMA 4X finish. 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 Bailey-Fischer & Porter representative to obtain the correct touch-up paint.
1.0 INTRODUCTION

1.1 General
1.1.1 Description
The Bailey-Fischer & Porter Series 3000 COPA-X™ and MAG-X® Magnetic Flowmeters are compact, volumetric, liquid flow rate detectors that use the characteristic of a conductive liquid to generate an induced voltage when flowing through a magnetic field as the process transducing method. The amplitude of the voltage produced is directly proportional to the flow rate of the metered fluid.

Being a completely obstructionless metering instrument, the Bailey-Fischer & Porter Series 3000 Magnetic Flowmeter can be used to meter liquids without regard to heterogeneous consistency and will resist plugging or fouling as much as the pipeline it is mounted in. An inherent advantage of obstructionless construction is that pressure losses are reduced to levels occurring in equivalent lengths of equal diameter pipeline. This reduces or conserves pressure source requirements in new or existing hydraulic lines as compared to other metering methods. The compact size of the meter results in a light-weight unit which requires no additional support other than that used normally on pipe runs. Short laying lengths minimize the need for altering existing pipe runs to accommodate metering. A basic construction of corrosive resistant wetted parts and a variety of meter lining materials permit metering of most corrosive and reactant liquids.

FIGURE 1-1. CUTAWAY VIEW OF TYPICAL FLOWMETER
Factors such as liquid viscosity and density require no compensation and have no effect on the measurement accuracy of the Magnetic Flowmeter. 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 metering accuracy as long as it is greater than this minimum level. Liquid temperature is limited only to the extent that it may affect liquid conductivity and, like liquid pressure, to the extent that it can not exceed the meter material specification limits.

The associated electronics package is called the Signal Converter and may be either integrally or remotely mounted. A typical COPA-X Magnetic Flowmeter is shown in cutaway view in Figure 1-1. Figure 1-2 shows an electronics housing without the Signal Converter. A microprocessor-based Signal Converter (50XM1000) is available for use with the Series 3000 Magnetic Flowmeter. The Flowmeter without the electronics package is used with a remote mounted Signal Converter. A remotely mounted Signal Converter is recommended for any or all of the following conditions:

- if the summation of ambient and process temperature is greater than 262°F (110°C) for COPA-XM™, the Signal Converter must be remotely mounted.
- vibrations above the specification given in Section 1.3

The Signal Converter also contains a magnet driver unit that is used to power the meter’s magnet coils. The steady bipolar state magnetic field principle, referred to as the MAG-X® design concept, provides optimum zero point stability at an optimized drive frequency.

For information concerning the Signal Converter, refer to the Signal Converter Instruction Bulletin.

**FIGURE 1-2. ELECTRONICS COMPARTMENT WITHOUT SIGNAL CONVERTER**
1.1.2 Construction
The Bailey-Fischer & Porter Series 3000 Magnetic Flowmeter consists of a flanged, carbon steel pipe spool which serves as a meter body. A pair of arched, oval shaped magnet coils fit on opposite sides of the meter body inner surface as shown in Figure 1-1. The meter body provides a flow return path for the magnetic field generated by the coils. These latter components are potted inside the pipe spool to form an encapsulated assembly. Unless otherwise specified, the meter flanges are carbon steel and mate with ANSI Class 150 pipe flanges.

An insulating interior liner of either TEFLON (PTFE), neoprene or polyurethane is inserted into the spool and turned-out against the flange faces. Two cylindrical electrodes are mounted diametrically opposed within the central portion of the meter body and are completely insulated from the metal pipe. The end surfaces of the standard electrodes are virtually flush with the inner surface of the insulating liner and come into contact with the liquid to be metered. Bullet nosed electrodes are mounted in a similar way; however, these electrodes protrude slightly beyond the inner surface of the liner. Standard or bullet nosed electrodes, with or without ultrasonic cleaning, are available. (Ultrasonic cleaning is not available with meters designed for continuous submersion applications.)

Electrode, magnet coil and, when specified, ultrasonic transducer wiring is brought out through two access holes in the top of the meter body. Typically, electrical interconnections enter the electronic housing through a watertight cable seal fitting (see Figure 1-1). The use of metal electrical conduit is recommended for both physical protection of signal wiring and for reduction of spurious electrical signals and interference.
### 1.2 Model Number Breakdown

Refer to the Bailey-Fischer & Porter data sheet or 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 10DX3111A

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<th>Component</th>
<th>Description</th>
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<tr>
<td>Primary Series 3000</td>
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<td>Connection Type</td>
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<td>Design Level</td>
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<tr>
<td>Meter Lay Length</td>
<td>Replacement for 10D1435 &amp; 10D1465</td>
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<td>Bullet Nose</td>
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<td>Slurry Service (Flush) Ultrasonic Cleaned</td>
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<td>Accidental Submergence, IEC 529 IP 67, NEMA 4X, 33ft H₂O/48h (10m H₂O/48h)</td>
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### 1.2 Model Number (continued)

#### 1.2.2 Model Number 10DX3311S

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<td>Meter Lay Length</td>
<td>Replacement for 10D1419 &amp; 10D1465</td>
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<td>500</td>
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</tr>
<tr>
<td>600</td>
<td>24</td>
</tr>
<tr>
<td>Flange Standard Pressure Rating</td>
<td>ANSI Class 150</td>
</tr>
<tr>
<td>Flange Material</td>
<td>Carbon Steel</td>
</tr>
<tr>
<td>Protector Plate (Teflon Liner only)</td>
<td>None Required</td>
</tr>
<tr>
<td>Electrode Type</td>
<td>Flush</td>
</tr>
<tr>
<td></td>
<td>Bullet Nose</td>
</tr>
<tr>
<td></td>
<td>Plain Ultrasonic Cleaned (Flush)</td>
</tr>
<tr>
<td></td>
<td>Ultrasonic Cleaned (Bullet Nosed)</td>
</tr>
<tr>
<td></td>
<td>Slurry Service (Flush)</td>
</tr>
<tr>
<td></td>
<td>Slurry Service (Flush) Ultrasonic Cleaned</td>
</tr>
<tr>
<td>Electrode Material</td>
<td>316 Sln. Steel</td>
</tr>
<tr>
<td></td>
<td>HASTELLOY B</td>
</tr>
<tr>
<td></td>
<td>HASTELLOY C</td>
</tr>
<tr>
<td></td>
<td>Titanium</td>
</tr>
<tr>
<td></td>
<td>Tantalum</td>
</tr>
<tr>
<td></td>
<td>&quot;K&quot; Monel</td>
</tr>
<tr>
<td></td>
<td>Nickel</td>
</tr>
<tr>
<td></td>
<td>Alloy 20</td>
</tr>
<tr>
<td></td>
<td>Zirconium</td>
</tr>
</tbody>
</table>
1.2.2 Model Number 10DX3311S (continued)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certification</td>
<td></td>
</tr>
<tr>
<td>Standard (None)</td>
<td></td>
</tr>
<tr>
<td>FM Approval Applied for - Nonincendive for CL I, Div 2, Gp A,B,C &amp; D, Outdoor Hazardous Locations, NEMA 4X, Dust-Ignitionproof CL II, Div 1, Gp E,F &amp; G: Suitable for CL III, Div 1, Accidental Submergence, 33ft H2O/48h (10m H2O/48h)</td>
<td></td>
</tr>
<tr>
<td>Enclosure Classification</td>
<td></td>
</tr>
<tr>
<td>IEC 529 IP 65, NEMA 4X</td>
<td></td>
</tr>
<tr>
<td>Accidental Submergence, IEC 529 IP 67, NEMA 4X, 33ft H2O/48h(10m H2O/48h)</td>
<td></td>
</tr>
<tr>
<td>Continuous Submergence, IEC 529 IP 68, NEMA 4X, 33ft H2O (10m H2O), Signal Cable permanently installed</td>
<td></td>
</tr>
<tr>
<td>Liquid Temperature Range</td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Line Excitation Frequency</td>
<td></td>
</tr>
<tr>
<td>50 Hz / 6-1/4 Hz</td>
<td></td>
</tr>
<tr>
<td>50 Hz / 12-1/2 Hz</td>
<td></td>
</tr>
<tr>
<td>60 Hz / 7-1/2 Hz</td>
<td></td>
</tr>
<tr>
<td>60 Hz / 15 Hz</td>
<td></td>
</tr>
<tr>
<td>12-1/2 Hz (DC Power, in vicinity of 50 Hz Line)</td>
<td></td>
</tr>
<tr>
<td>15 Hz (DC Power, in vicinity of 60 Hz Line)</td>
<td></td>
</tr>
<tr>
<td>Other Frequency</td>
<td></td>
</tr>
<tr>
<td>Customer Information Language</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td></td>
</tr>
<tr>
<td>Software Level</td>
<td></td>
</tr>
<tr>
<td>Generation</td>
<td></td>
</tr>
<tr>
<td>Pulse Output / Data Link</td>
<td></td>
</tr>
<tr>
<td>None / None</td>
<td></td>
</tr>
<tr>
<td>Active Scaled Pulse Fwd &amp; Rev / None</td>
<td></td>
</tr>
<tr>
<td>None / RS485 Port</td>
<td></td>
</tr>
<tr>
<td>None / RS232 Port</td>
<td></td>
</tr>
<tr>
<td>Measuring Mode</td>
<td></td>
</tr>
<tr>
<td>Continuous Flow Measurement</td>
<td></td>
</tr>
<tr>
<td>Option Terminals</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>External Zero Return</td>
<td></td>
</tr>
<tr>
<td>External Totalizer Reset</td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td></td>
</tr>
<tr>
<td>Without</td>
<td></td>
</tr>
<tr>
<td>Empty Pipe Detection (standard)</td>
<td></td>
</tr>
<tr>
<td>HART Protocol</td>
<td></td>
</tr>
<tr>
<td>Empty Pipe Detection &amp; HART Protocol</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td></td>
</tr>
<tr>
<td>220/230/240 V, 50/63 Hz</td>
<td></td>
</tr>
<tr>
<td>110/115/120 V, 50/63 Hz</td>
<td></td>
</tr>
<tr>
<td>24 VDC</td>
<td></td>
</tr>
<tr>
<td>Converter</td>
<td></td>
</tr>
<tr>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>Not-Required</td>
<td></td>
</tr>
</tbody>
</table>
1.3 Specifications

Power Requirements: See 1.2 Model Number Breakdown

Power Consumption: 23VA typical
Refer to Converter Instruction Bulletin, as specified, to supplement this data.

Flowmeter Characteristics:

Meter Size/Flow Capacity: See TABLE 1-2.

Span: Factory set at specified range between extremes listed in TABLE 1-2; can be field adjusted.

Rangeability: 100:1

Minimum Fluid Conductivity: 5 µS/cm

System Accuracy:

<table>
<thead>
<tr>
<th>Frequency Output</th>
<th>Flowrate</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;2% of meter capacity</td>
<td>±0.01% of meter capacity</td>
</tr>
<tr>
<td></td>
<td>&gt;2% of meter capacity</td>
<td>±0.5% of rate</td>
</tr>
<tr>
<td>4-20 mA Output</td>
<td></td>
<td>add ±0.1% of span to above numbers</td>
</tr>
</tbody>
</table>

Meter Capacity: 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.

Ultrasonic Cleanoff Frequency: specified on meter data tag, when applicable

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 (Standard Meter w/integral or remote signal Converter): IEC 529 IP65; NEMA 4X, indoor or outdoor installation

Accidental Submergence Option (w/integral or remote Converter): IEC 529 IP67, NEMA 4X, 30 ft. H₂O/48h (9m H₂O/48 h)

Continuous Submergence Option (remote Converter only): IEC 529 IP68; NEMA 4X, 30 ft. H₂O depth (9m H₂O depth)
Relative Humidity
10% to 90% (non-condensing)

Ambient Temperature Limits at primary

<table>
<thead>
<tr>
<th>Remote Mounted</th>
<th>Integral Mounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40 to 65°C</td>
<td>-10 to 55°C</td>
</tr>
<tr>
<td>(-40 to 150°F)</td>
<td>(14 to 131°F)</td>
</tr>
</tbody>
</table>

Note: Electronics must be remote-mounted when the sum of process and ambient temperatures exceeds 120°C (248°F)

Process Limits:

Liner Temperature

TEFLON 150°C (302°F)

Polyurethane/Neoprene 88°C (191°F)

Pressure Limits at 38°C (100°F) and Carbon Steel Flanges (ANSI Class 150)

**TABLE 1-1. PRESSURE RATING vs. TEMPERATURE - MPa (psi)**

<table>
<thead>
<tr>
<th>METER SIZE (INCHES)</th>
<th>ANSI CLASS</th>
<th>FLANGE MATERIAL</th>
<th>NEOPRENE/POLYURETHANE</th>
<th>TEFLON</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td></td>
<td></td>
<td>38°C(100°F)</td>
<td>88°C(190°F)</td>
</tr>
<tr>
<td>350 (14)</td>
<td>150</td>
<td>Carbon St.</td>
<td>1.90 (275)</td>
<td>1.65 (240)</td>
</tr>
<tr>
<td>400 (16)</td>
<td>150</td>
<td>Carbon St.</td>
<td>1.90 (275)</td>
<td>1.56 (240)</td>
</tr>
<tr>
<td>450 (18)</td>
<td>150</td>
<td>Carbon St.</td>
<td>1.41 (205)</td>
<td>1.34 (193)</td>
</tr>
<tr>
<td>500 (20)</td>
<td>150</td>
<td>Carbon St.</td>
<td>1.55 (225)</td>
<td>1.45 (210)</td>
</tr>
<tr>
<td>600 (24)</td>
<td>150</td>
<td>Carbon St.</td>
<td>1.52 (220)</td>
<td>1.41 (205)</td>
</tr>
</tbody>
</table>

**Physical Characteristics:**

Outline Dimensions
Standard & Accidental Submergence See Figure 2-2

Continuous Submergence Option See Figure 2-3

Vibration Limit (w/Integral Converter) 5 to 14 Hz, 0.10": 14 to 200 Hz, 1 g

NOTE: A remote mounted Signal Converter must be used when vibration limit is exceeded.
Signal Cable for remote Converter (supplied by Bailey-Fischer & Porter, when applicable)

- Standard Length: 30 ft (9 m)
- Optional Length: Up to 300 ft (100 m) available in 10 ft increments, as specified.
- Continuous Submergence Option: 50 ft (15 m) lead wires and fittings attached to primary

Materials of Construction:
- Meter Liner: PTFE (TEFLON), Polyurethane, or Neoprene, as specified.
- Electrode Assembly: see Section 1.2 Model Number Breakdown
- Meter Body: carbon st, epoxy finish
- Flanges: carbon steel
- Meter Housing: aluminum, epoxy finish
- Electronics Housing: die case aluminum, epoxy finish, 316 sst attachment screws, gasketed covers
- Conduit Connections: (2) 1/2" NPT internally threaded entrances
- Safety Certification: refer to Section 1.2, Model Number Breakdown
- RFI Protection (Magnetic Flowmeter): with RFI filters, equivalent to SAMA Class 2, a, b, c, 0.2% (10 V/m, 20-1000 MHz)

**TABLE 1-2. METER CAPACITY TABLE**

<table>
<thead>
<tr>
<th>METER SIZE (INCHES)</th>
<th>METER CAPACITY*</th>
<th>FLOW RANGES, GPM TO TABULATED VALUE</th>
<th>MINIMUM</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>GPM</td>
<td>GPM</td>
<td>m³/h</td>
<td>GPM</td>
</tr>
<tr>
<td>350 (14)</td>
<td>14,530</td>
<td>740</td>
<td>165</td>
<td>15,600</td>
</tr>
<tr>
<td>400 (16)</td>
<td>19,814</td>
<td>1,010</td>
<td>225</td>
<td>22,500</td>
</tr>
<tr>
<td>450 (18)</td>
<td>25,418</td>
<td>1,350</td>
<td>300</td>
<td>30,000</td>
</tr>
<tr>
<td>500 (20)</td>
<td>29,061</td>
<td>1,480</td>
<td>330</td>
<td>33,000</td>
</tr>
<tr>
<td>600 (24)</td>
<td>42,270</td>
<td>2,150</td>
<td>480</td>
<td>48,000</td>
</tr>
</tbody>
</table>

* Flow Velocity (ft/s) = (Operating GPM x 32.81)/Meter Capacity
2.0 INSTALLATION

2.1 Inspection

The Series 3000 COPA-X and MAG-X Magnetic Flowmeter and the associated Signal Converter are normally combined for shipment. For example, the 14" size meter is shipped in a heavy-duty carton which is specially designed to protect the equipment during shipment. The 16" and larger size meters are strapped to a wooden skid that both protects the metering system and facilitates handling of this heavy equipment with a fork lift truck (typical). A table of meter weights is provided on the outline dimension drawing (see Figure 2-2). An itemized list of all items included in the shipment is attached to the package or container.

Inspect all items included in the shipment immediately for indications of damage which may have occurred during shipment. A thorough visual inspection of the shipment contents is normally all that is required to determine whether damage is evident. All claims of damage should be reported to the shipping agent involved before attempting to install or operate this equipment. If damage is such that faulty operation is likely to result, the damage should be brought to the attention of the Bailey-Fischer & Porter Service Department.

Performing inspection at the installation site is preferred because it is easier to transport the meter and Signal Converter in the original shipping container. Should it be necessary to lift the Magnetic Flowmeter, attach the cables from a winch or block and tackle to the lifting lugs in the meter flanges as shown in Figure 2-1. The cable used must be able to support meter weights as tabulated on the outline dimension diagram. The cable must be long enough to form an angle of 45° or more between the lifting line and the meter pipe axis. **DO NOT** try to lift the meter by attaching cables to the electrode bosses.

**FIGURE 2-1. PROPER HOISTING TECHNIQUE**
2.2 Meter Handling

The exposed liner material on the faces of both meter flanges are susceptible to damage if mishandled. Do not walk the meter on its ends. Always use the protective end covers when the meter is transported. These protective end covers can be removed for inspection and must be removed before mounting the meter in the pipeline.

**CAUTION**

Never allow any support for the Magnetic Flowmeter to bear upon the inner surface of the meter pipe section, as the liner may become damaged.

As shown in Figure 2-9, Bailey-Fischer & Porter has developed a liner protector/grounding ring for the 14 inch TEFON lined meters. These protector plates are turned on both the inside and outside edges. Turning the inside edge protects the leading edge of the meter liner from process abrasion. Turning the outside edge reduces the probability that a prying tool will be jammed against the liner during removal of the meter from the line.

**NOTE**

When liner protector plates/grounding rings are attached to the meter flanges, do not remove them; removal will cause the TEFON liner to have a tendency to curl away from the meter flange where it can be easily damaged.

A TEFON liner of the flowmeter must be protected at all times for two reasons:

- the TEFON can be damaged by sharp objects or cut by undue pressure
- if the pressure on the flanges is relieved the TEFON will tend to curl away from the flange

Also included in the shipping crate is an installation kit, which consists of the following items:

a) Two gaskets,

b) One package of talc powder

c) Required seal fittings (depending on model).

The proper use of these items as described in the following text, and the proper employment of them during installation is necessary to maintain a valid instrument warranty.
2.3 Location

2.3.1 Standard and Accidental Submergence

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 Section 1.3 Specifications. Consideration should be given to access for servicing the meter. The standard meter is rated NEMA 4X, watertight, and will thus stand rain and hose down. If flooding is a problem, the optional IEC 529 IP67 flowmeter is well suited for occasional submersion.

The internally 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 COPA-X and MAG-X Magnetic Flowmeter systems. It is recommended, however, that the meter not be installed within the immediate proximity of heavy induction equipment.

Provide access for wiring interconnections and occasional servicing of the integrally mounted Signal Converter. At least 5 inches overhead clearance is required for cover removal. Outline dimensions of the optional Remote Mounted Signal Converter are given in the Instruction Bulletin supplied with the Signal Converter.

The installation site must be provided with a convenient source of power as specified for the Signal Converter. The power line should have a disconnect switch, and a suitable fuse or circuit breaker as shown on the applicable interconnection diagram (provided in the Instruction Bulletin supplied with the Signal Converter). If the pipeline is not a good ground, a suitable earth ground must be made available in proximity to the installation site.

In-line meter maintenance is minimized as no operating adjustments are required in the Magnetic Flowmeter. Servicing accessibility is of secondary importance unless greasy sludges or liquids bearing insulating materials which tend to coat pipe walls are to be metered. However, sufficient access room should be allocated to facilitate electrical interconnection and permit field replacement of electrodes should the need arise.

Outline dimensions for standard and accidental submersion flowmeters are shown in Figure 2-2.

2.3.2 Continuous Submergence

The continuous submergence option, when specified, contains special design features that permit the meter to operate properly when submerged completely under water or buried in the ground. The Primary contains special liquid-tight fittings on top of the meter that properly seal the signal and coil excitation cable entry ports. The interconnection between primary and converter may be seen in Figure 2-10.

The 50XM converter furnished with this design has an additional circuit assembly (P/N 686E735U07) which establishes the correct coil excitation current for the primary. Take notice of the required connections to converter terminals M1 & MR for this configuration. In addition, the heavy black wire connected to terminal #3 of the primary must be connected to terminal #3 in the converter along with the .025 square post connection already present.

Once installation is complete, full flow must be established to purge all entrapped air in the pipeline. A system zero must then be performed under a full pipe, no flow condition. Refer to the instruction bulletin provided with the converter for instructions on performing this procedure.

Outline dimensions for the continuous submergence meter are shown in Figure 2-3.
NOTES
1. DIMENSIONS IN PARENTHESES ( ) ARE MILLIMETERS.
2. DIMENSIONS GUARANTEED ONLY IF THIS PRINT IS CERTIFIED.
3. ALL DIMENSIONS SUBJECT TO MANUFACTURING TOLERANCE OF ±0.01 INCH (0.3 MM) UNLESS OTHERWISE SPECIFIED.
4. FLANGE BOLT HOLES STRADDLE CENTER LINES.
5. FLANGES ARE ANSI G.D. AND DRILLING ONLY.
6. WELDING TUBE MUST BE COMPLETELY FILLED WITH LIQUID TO INSURE ACCURACY.
7. POWER AND SIGNAL CONNECTIONS ARE SUPPLIED WITH WATER-TIGHT FITTINGS.
8. THIS DRAWING IS THIRD ANGLE PROJECTION AS SHOWN.
9. ADD 1/4" (6.35 mm) TO DIMENSION "F" WHEN HOUSING COVER WITH WINDOW IS SPECIFIED.

G = no. of holes
J = dia. of holes
K = bolt circle

FIGURE 2-2. OUTLINE DIMENSIONS, 14" TO 24" METER SIZE (STANDARD & ACCIDENTAL SUBMERGENCE OPTION)
FIGURE 2-3. OUTLINE DIMENSIONS, 14" to 24" METER SIZE
(CONTINUOUS SUBMERGENCE OPTION)
2.4 Mounting

2.4.1 Orientation

The Bailey-Fischer & Porter Series 3000 Magnetic Flowmeter may be installed in horizontal, vertical or sloping pipe runs. However, precautions must be taken to assure that the metering tube is filled at all times during measurement. A vertical installation, with the pipe line carrying fluid upwards assures a filled hydraulic 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. (Electrodes must not be on "top" when the meter is horizontally mounted.)

The COPA-X Magnetic Flowmeter 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 2-4 for recommended piping diagrams.

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. If greasy sludges or insulating materials which tend to coat pipe walls are to be metered, it is recommended that in addition to standard block valves and bypass line, a clean-out tee be installed to facilitate meter cleaning without removal or interruption of the process.
FIGURE 2-4. TYPICAL PIPING DIAGRAMS
2.4.2 Pipe Connections

Standard meter piping connections are made by means of flanges that conform to ANSI standards in outside diameter and bolt circle. The bearing surfaces of the flanges are insulated with the meter pipe liner. Figures 2-2 and 2-3 provide outline and mounting dimensions of the standard Series 3000 large diameter Magnetic Flowmeters. Note that Figure 2-2 is for meters of standard or accidental submergence design, while Figure 2-3 is applicable to meters specified for continuous submergence applications. Outline and mounting dimensions for a remote mounted Signal Converter are shown in the Instruction Bulletin supplied with the Signal Converter.

It is generally recommended that two pipe spools be installed, one on each end fitting of the Magnetic Flowmeter, while it is out of the pipeline in order to minimize the possibility of damage to the meter pipe and flange liner during mounting. Lined spool pieces and/or special length spools are available on special order. (Exception - see NOTE below. TEFLOM Lined Meters).

NOTE
TEFLON Lined Meters

Bailey-Fischer & Porter has developed a protector plate for Teflon lined meters. This protector plate is available in 316 stainless steel, Hastelloy "C" and Alloy 20 materials for 14" size Magnetic Flowmeters (see Table 2-1 for part numbers). When specified at time-of-purchase, two protector plates (one on each flange face) are factory installed and serve to prevent damage to the liner during either shipment, installation or removal of the meter from the process line.

A pair of the proper gaskets to suit the particular lining option of the meter supplied is included within the installation kit which accompanies the Magnetic Flowmeter. Before connections are made, the bearing surfaces of neoprene or polyurethane-lined meter flanges, their neoprene gaskets and adjacent pipeline flanges must be thoroughly dusted with the talc gasket powder provided with the installation kit. This is done to prevent possible damage to the meter lining or gaskets, should the meter be removed from the line.

If the Magnetic Flowmeter is to be mounted in a non-conductive pipeline or a metal pipeline with an insulating liner, the user must provide a pair of suitable gaskets between the customer-supplied annular meter grounding rings (discussed under Section 2.5.2) and the adjacent pipeline flange surfaces.

The standard coarse thread flange bolts supplied by the user must be well lubricated and tightened in even increments around the flange surface using a "star" pattern. An example of this bolt-tightening procedure is shown in Figure 2-5. Note that 14 through 24 inch meters will have a correspondingly larger number of bolt holes. Bolt torque should be limited to that which will produce a positive seal for the application.

FIGURE 2-5. BOLT TIGHTENING SEQUENCE
2.5 Grounding Procedure

2.5.1 General

Satisfactory operation of Bailey-Fischer & Porter Magnetic Flowmeter Systems requires that carefull 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, and 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.

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 ensuring that the meter body 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 liquid in 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 as shown in Figure 2-6. 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 pipe, bituminous-coated cast iron pipe, concrete, etc.) or lined with a non-conductive material (rubber, TEFLEX, etc.). These non-conductive pipelines require the use of metal grounding rings or grounding probes (see Figures 2-7 through 2-9) to bond the process liquid to ground. The grounding procedure to use with a nonconductive pipeline is described in 2.5.3.

Proper grounding of the Magnetic Flowmeter is required for optimum system performance.

2.5.2 Conductive Pipeline

If the 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 2-6 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 metric M6 fasteners (a 1/4" hex head bolt).
2) Obtain a bright metal surface around the edges of the tapped hole with a file or burnishing tool.
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; NON-INSULATED PIPELINE

TABLE 2-1. PROTECTOR PLATE AND GROUNDING RING PART NUMBERS

<table>
<thead>
<tr>
<th>FLANGE RATING (ANSI)</th>
<th>ANSI CLASS 150</th>
</tr>
</thead>
<tbody>
<tr>
<td>RING MATERIAL</td>
<td>304 SS</td>
</tr>
<tr>
<td>GASKET MATERIAL</td>
<td>316 SS</td>
</tr>
<tr>
<td>HAST. C</td>
<td>ALLOY 20</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>FLANGE SIZE (Inches)</th>
<th>BASIC PART NUMBER</th>
<th>PART NUMBER / SUFFIX*</th>
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<tr>
<td>14</td>
<td>614B452</td>
<td>GROUNDING RING U12</td>
</tr>
<tr>
<td></td>
<td>644B009</td>
<td>PROTECTOR PLATE/GROUNDING RING U26</td>
</tr>
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<td></td>
</tr>
<tr>
<td>16</td>
<td>644B009</td>
<td>U09</td>
</tr>
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<td>18</td>
<td>644B009</td>
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<td>U15</td>
</tr>
<tr>
<td>24</td>
<td>644B009</td>
<td>U17</td>
</tr>
</tbody>
</table>

* Add suffix to basic part number to complete the part number, e.g., 644B009U11 for a 16" 304 stainless steel grounding ring with a NEOPRENE gasket.
FIGURE 2-7. GROUNDING PROCEDURE; INSULATED PIPELINE

- **Metal Ring in Contact with Liquid** (Supplied by User 1/8" Thk Minimum)
- **F & P Supplied** (Required When Pipe Flange Is in Ohmic Contact with Pipeline)
- **Liquid Not in Electrical Contact with Pipe Line**
- **Ground Straps** (Supplied by F & P)
- **Ground Straps Must Be Added** (Supplied by User)
- **Good Ground** (E.g., Cold Water Pipe)
FIGURE 2-8. GROUNDING RINGS and GASKETS
2.5.3 Non-Conductive or Electrically Insulated Pipeline

If the flowmeter is included 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) Usually, for this service, the meter has been specified to have liner protector/grounding rings. If not, obtain a pair of grounding rings and attach them to the meter as shown in Figure 2-7. No gasket is required between the grounding ring and the meter since it mates with the liner. However, a gasket is required between the grounding ring and the process flange of the pipeline.

2) Attach the bonding wire and another length of ground wire to the tab of the grounding ring. Use internal tooth lockwashers and hex head nut and bolts for attachment as shown in the detail on Figure 2-7. The wire to the good ground should be #12 AWG, or heavier, copper wire.

2.5.4 Grounding Probes (2 required)

The grounding probe shown in Figure 2-10 can be substituted for grounding rings in many applications when non-conductive or electrically insulated pipe is used. The pipeline must be drilled and tapped as shown in Figure 2-10, with the grounding probes installed adjacent to each of the pipeline mounting flanges. Connect a grounding strap or wire from each probe to the meter flanges.

 NOTE:
 WATERPROOF SEAL, DRILLING AND TAPPING OF CUSTOMER'S PIPE, ETC. TO BE PERFORMED BY CONTRACTOR.

FIGURE 2-9. GROUNDING PROBE (OPTIONAL)
2.6 Electrical Interconnection

2.6.1 General

The Series 3000 COPA-X and MAG-X Magnetic Flowmeters may be furnished with either an integrally or remotely mounted (optional) Signal Converter. Interconnection wiring is arranged differently for the two systems. Interconnection details are provided in the Instruction Bulletin provided with the Signal Converter.

WARNING

ELECTRICAL SHOCK HAZARD. 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.

2.6.2 Ultrasonic Cleaning (Option)

Integrally mounted ultrasonic transducers can be supplied for electrode cleaning. When this option is specified, a special junction box is mounted on the side of the meter housing for ultrasonic interconnections, as shown in Figure 2-2 for standard and accidental submergence options. When the continuous submergence option is specified, shown in Figure 2-3, interconnection wiring is as shown in Figure 2-10. Conduit seals must be used at all cable entrances to maintain the NEMA 4X rating.

A Bailey-Fischer & Porter Series 55UC2000 Ultrasonic Generator is required for use with all Magnetic Flowmeters supplied with ultrasonic cleaning electrodes. A single interconnection cable is required for interconnection of the Ultrasonic Generator to the Flowmeter. This coaxial cable is used for the high voltage ultrasonic signal and a single wire for the ground. The Ultrasonic Generator is supplied in a wall mounting enclosure for permanent installation. Refer to the Instruction Bulletin covering the Ultrasonic Generator, IB 55UC2000 (PN23931), for recommended installation and interconnection procedures.

WARNING

The high voltage ultrasonic pulses applied to the Magnetic Flowmeter from the Ultrasonic Generator constitute a potential safety hazard. Extreme care must be exercised when servicing or troubleshooting this equipment. Wait two minutes after power shutdown before removing the terminal cover from the Ultrasonic Generator or the Ultrasonic junction box.
**NOTES**

1. * Indicates supplied by customer.

2. Unused connections must be plugged to maintain NEMA A rating.

3. Miter flange bonding wires (one each plunger) are used to prevent stray electrical currents from passing thru the return liquid. See Instruction Bulletin for details.

---

**TERMINAL ASSIGNMENT TABLE**

a) AC power supply: 85-265V AC or 24 VDC (specified on data sheet)

b) Zero return feature

c) Field contacts: Zero return field contacts to close when motor supply pump or valve stops flow thru meter.

- Terminal 22 & 03 remain open if this feature is not used.

- Output signal: 4-20mA

- Current output R1 = 750 Ω

d) 0 to 10 VDC, active-trip, 50 ft cable length

- Scaled pulse output: active trip, 24VDC load 20mA

- Terminal 6 x 11, forward flow

- Terminal 2 x 11B, reverse flow

- Data link RS 485

- Data link 9450 C

- Reverse flow indication: via relay contacts, max contact rating: 25 VAC, 250mA, 125 VDC

- Flow direction indication: same as above

- Opto coupled scaled pulse forward: 10mA, <25 VAC

---

**Figure 2-10** Interconnection diagram, continuous submergence option
3.0 OPERATION and START-UP

The Bailey-Fischer & Porter Series 3000 COPA-X Magnetic Flowmeter (which includes the integral or remote Signal Converter) is precision calibrated at the factory 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. The basic primary mounted electronic 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 Section 2.0 Installation. Particular attention should be paid to the meter grounding procedures; 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 the AC power for the 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.
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 pictorially in Figure 4-1. Normally, the standard and accidental submergence type meters have their primary interconnection wiring terminated at a printed circuit assembly located in the base of the meter housing. The continuous submergence option is supplied with signal wiring that is terminated in a remote mounted Signal Converter housing (Division 2 and NEMA 4X) rated. This wiring is shown in Figure 2-10.

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 (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. A detailed discussion of primary meter operation is provided in Chapter 5.0, Circuit Description.

4.1 Basic Operating Principle

4.1.1 Signal Voltage Generation

The operating principle of the Bailey-Fischer & Porter Series 3000 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 Bailey-Fischer & Porter Magnetic Flowmeter constitutes a modified form of an ac generator.

Figure 4-1 graphically illustrates the basic operating principle. A magnetic field, "B", 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 voltage, signal "ES", 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.

FIGURE 4-1. BASIC OPERATING PRINCIPLE
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:

\[ E_s = \frac{1}{\alpha} B D V \]

where:

- \( E_s \) = induced electrode voltage
- \( B \) = magnetic field strength
- \( D \) = meter pipe diameter
- \( \alpha \) = 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 Magnet Coi1 Drive Circuits

In many 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 Bailey-Fischer & Porter Series 3000 Magnetic Flowmeter uses magnet drive circuits which are alternately energized bi-directionally at a low frequency rate as commanded by the associated Converter/Driver electronics.

4.1.3 Volumetric Flow Rate Measurement

The Bailey-Fischer & Porter Magnetic 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:

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

Substituting for \( V \) in equation #1

\[ E_s = \frac{1}{\alpha} B D \frac{4Q}{\pi D^2} \]

and solving for \( Q \):

\[ Q = \frac{\pi \alpha D^2}{4} \cdot \frac{E_s}{B} \]

Since \( B = \beta E_r \)

and since \( \alpha, D \) and \( \beta \) are constant:
(Equation #3)

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

where:

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

Therefore, volumetric flow rate is directly proportional to the induced signal voltage as measured by the Bailey-Fische & Porter Magnetic Flowmeter.

### 4.2 Operating Characteristics

#### 4.2.1 Liquid Variables

##### 4.2.1.1 Liquid Conductivity

The COPA-X and Mag-X Magnetic Flowmeters require a liquid conductivity of 5 microsiemens per centimeter 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 Bailey-Fischer & Porter supplied interconnection cable (with driven shields) is utilized. The nominal maximum transmission distance is limited to (100 meters) 300 feet; however standard cable length is 30 feet (9 m) unless otherwise specified.

The conductivity of a given liquid, $\sigma$, 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., 36 k x 2/10^6

and,

typical electrode diameter is 0.375" (0.952 cm)

For example, assuming the measured ac electrode resistance (full pipe and zero flow) is 192,000 ohms and electrode diameter is 0.952 cm, then

\[ \sigma = \frac{1}{(0.192 - 0.072) \times 0.952} = 8.75 \mu \text{s/cm} \]

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

4.2.1.2 Liquid Temperature

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

Most liquids exhibit a positive temperature coefficient of conductivity. It is possible for certain marginal liquids to become sufficiently non-conductive at lower temperatures so as to hamper accurate metering; whereas, 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, such as the leakage pressure of the meter pipe flange connectors.

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 Magnetic 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. See Figure 2-4 for recommended meter installation orientations.

The Bailey-Fischer & Porter 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. 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 determined that the higher concentrations of mixant will not drive the average conductivity of the liquid mixture below the minimum conductivity level for the given installation.
5.0 CIRCUIT DESCRIPTION

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 (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

The CMF Assembly provides several functions:

1. Establishes interconnections between the primary internal wiring and the secondary.

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

3. Permits adjustment of primary zero.

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

**NOTE - CMF EXCEPTION**

Certain combinations of meter size and Signal Converter cannot supply sufficient magnet current to achieve the Meter Capacity given in Table 1-2. The user should verify that the Meter Capacity given on the meter data tag (see Figure 3-1) is being used in the associated Signal Converter, especially as this factor can be different from the standardized value given in Table 1-2.
FIGURE 5-1. SCHEMATIC for PRIMARY WIRING WHEN USING INTEGRAL 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.

Capacitors C3 and C4 are added to primaries with ultrasonic cleaning to minimize transients which occur when the Ultrasonic Generator is activated.

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 inset) via the connection of J3 to P3, while the 666B630 Adaptor Board routes the reference and electrode signals to the proper positions of J1, J2, and their corresponding RFI filters. Typical wiring is shown in Figure 5-2.

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. 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 Series 3000 COPA-X and MAG-X Magnetic Flowmeters. As the meter has no moving parts, the necessity for specifying or requiring replacement parts is reduced. For example, electrodes can be replaced in neoprene or polyurethane lined meters without removal of the meter from the pipeline (replacement of electrodes in TEFLEX lined meters must be performed by the factory). When supplied, ultrasonic electronic transducer assemblies can be replaced without removing electrodes from the meter, as will be discussed later.

The associated electronic Signal Converter can be replaced as a complete assembly, as described in the Instruction Bulletin provided with the particular Signal Converter. Bailey-Fischer & Porter offers a Repair/Exchange Program to facilitate replacement of a defective Converter assembly. If the equipment is beyond the warranty limit, under this program a fixed price will be charged to the account of Buyer for replacement of defective equipment, with appropriate credit issued when the repairable unit is received by Bailey-Fischer & Porter (charges prepaid).

Special service or installation problems should be referred to the manufacturer's Service Department or to the local Bailey-Fischer & Porter field office with complete information as to the nature of the difficulty. Instructions covering corrective measures will be furnished promptly. When communicating with Bailey-Fischer & Porter in regard to replacement of a defective assembly, it is important to refer to the complete instrument serial number and model number to assure that the correct replacement will be supplied. This information is provided on the manufacturing specification sheet supplied with the Magnetic Flowmeter, and on the instrument 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 V-O-M type multimeter and an oscilloscope are suitable for making most of the test measurements.

To supplement the following discussion refer to:

Chapter 5 0 Circuit Description
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

CAUTION
Some of the 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 inadvertent damage to the integral solid state circuitry.
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 Microprocessor-Based Converter
   - remotely 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 part 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 fluid

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 V-O-M type Multimeter is suitable for making the resistance checks. These measurements can be made at the Primary Base Board.
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 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 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 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 in turn from wire lead M1 or MR to the meter body (case ground). The resistance readings 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. Meter Coil Resistance**

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<th>METER SIZE</th>
<th>COIL RESISTANCE (Nominal, ohms)</th>
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<td>mm</td>
<td>inches</td>
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<tr>
<td>350</td>
<td>14</td>
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<td>500</td>
<td>20</td>
</tr>
<tr>
<td>600</td>
<td>24</td>
</tr>
</tbody>
</table>
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. 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 integral Signal Converter is supplied, begin with step a), below. If a remote Signal Converter is supplied, begin with 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. This will allow access for test measurements on the CMF board. Proceed to step 2).

   b) Disconnect and identify the electrode signal leads, 1 and 2, from the terminal board in the remote Signal Converter (or from the terminal board in the base of the meter housing). Electrode wiring is shown in Figure 5-2. Proceed to step 2).

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 1 or terminal "1A", as applicable. 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 or terminal "2A". 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 indicates an infinite resistance reading, the meter may then be returned to on-stream operation. In the remote Signal Converter, lines 1 and 2 from the respective electrodes must be reconnected to terminals 1 and 2 of the terminal board. Do not interchange these process signal connections.

6.3.3 Primary CMF Board
Ref: Schematic Diagram of CMF Board, Figure 5-3

In meters supplied for NEMA 4 and accidental submergence applications, the Primary Board is located in the base of the electronics housing as shown in Figure 6-1. When the meter is supplied for continuous submersion, the CMF board is located in the remote intermediate housing, as shown in Figure 2-11. This board includes the constant meter factor/size network (CMF/S). The CMF/S network is utilized to standardize the particular flowmeter, i.e., provide a meter capacity that will be the same for all meters of the same size. However, in some cases, the particular combination of meter size and Signal Converter type cannot supply sufficient magnet current to produce the standardized meter capacity. In these cases, the user must obtain the actual meter capacity from the data provided on the instrument tag; using the meter capacity given in Table 1-1 of Chapter 1.3, Specifications could result in erroneous flow measurement.

Replacement of the Primary CMF Board in the field is not recommended. However, 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). Note that the following procedure is applicable only for CMF/S assembly 686B623U01, shown in Figure 6-1.

2. Before removing the CMF 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 CMF Board have been disconnected, remove the 3 #4-40 board mounting screws. The CMF Board can now be removed from the meter base.

The following procedure is required to maintain the accuracy of the "standardized" meter capacity.

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 to an accuracy of 0.1%:

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

Calculate the following:

   \[ K = \frac{(R15 - R14 \text{ pin } 1 - 2)}{(R15 + R14 \text{ pin } 1 - 2 + R14 \text{ pin } 3 - 2)} \]

5. Remove R14 and R15 from the replacement assembly. Measure R15 and adjust R14 to obtain the same "K" as calculated in step 4. Place R14 and R15 back into the circuit board, noting the proper orientation of R14.

6. Note which positions of shunt S1 were opened in the old CMF Board. Open the identical shunt positions of S1 in the replacement board.

7. Replace the CMF Board in the meter base and restore interconnection wiring.

   **CAUTION**

   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. The metering tube must be full, but with zero flow and the system powered. An oscilloscope must be connected to MP302 (MP301 common) of the XM Converter. R3 of the CMF assembly must be adjusted to obtain the smallest possible peak to peak waveform value. 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 must be set so that the Converter output is zero. 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.

6.4 Electrode Disassembly

Standard flush and bullet-nosed electrodes, as well as electrode-transducer assemblies for use with Ultrasonic Generator electrode cleaning, may be replaced in neoprene and polyurethane-lined Series 3000 Magnetic Flowmeters without removal of the meter from the pipeline. Replacement of the electrodes in TEFLOm lined meters is a factory procedure only and should not be attempted in the field. However, in the case of a TEFLOm lined meter for use with the Ultrasonic Generator, the transducer section of the electrode-transducer assembly may be replaced in the field by factory-trained personnel. The seated electrodes may be inspected in all meters.

Unless specified otherwise at the time of purchase, neoprene and polyurethane lined meters were equipped with stainless steel electrodes. A variety of electrode materials to suit a wide range of fluid conditions is given in the applicable Model Number Breakdown of Chapter 1.0.

Perform the following procedure for seated electrode inspection or electrode replacement:

6.4.1 Non-Ultrasonic Meters (See Figure 7-1)

6.4.1.1 Inspection

1) Empty the meter pipe.

    WARNING
    Do not attempt electrode inspection or replacement with a filled or pressurized pipeline. Personal injury may result from such practice.

2) Unscrew and remove the 2-inch pipe cap from the electrode boss.

3) Remove the three #10-32 x 1/2" fillister head cap screws which clamp the electrode cover on the assembly.

4) Remove the electrode cover and its 'O' ring.

5) For neoprene and polyurethane lined meters, remove the insulator disc. The seated electrode and wiring are open for inspection.
6.4.1.2 Electrode Replacement (All Except Teflon lined Meters)

CAUTION
For Teflon lined meters, replacement of the electrodes must not be attempted in the field. The meter must be returned to the factory for electrode replacement.

1) Pull the electrode from its seat in the side of the meter spool and liner. This is facilitated by partially running one of the removed #10-32 cap screws that held the electrode cover in place into the tapped hole in the electrode head and using this as a grip for electrode withdrawal. In polyurethane lined meters an "O"-ring on the underside of the electrode head also must be withdrawn.

CAUTION
Exercise extreme care when withdrawing electrode from its seat so that little or no tension is exerted on the connecting electrode wire. If this wire should break within the meter pipe, the meter is not repairable.

2) Loosen the #4-40 x 1/8" hex socket set screw in the head of the electrode. Withdraw the electrode wire with its sleeve tip from its electrical connection seat in the side of the electrode head.

3) Insert and reseat replacement electrode. For polyurethane lined meters, be certain the new "O"-ring which accompanies the new electrode is seated in the groove under the head of the electrode.

4) Reassemble by reversing the procedure given 6.4.1.1, steps #2) through 5). Use pipe dope on the threads of the 2-inch pipe cap when replacing on the electrode boss.

NOTE
It is possible to interchange electrodes and electrode-transducer assemblies in neoprene and polyurethane lined meters, if the meter body was manufactured with ultrasonic transducer leads installed and if proper accessory parts such as electrode and dust covers, insulators, etc., are obtained.

6.4.2 Ultrasonic Meters (See Figure 7-2)

6.4.2.1 Inspection

1) Unscrew and remove the electrode-transducer housing dust cover.

2) For Teflon lined meters, perform steps given in 6.4.1.1, steps #3) & 4). The seated transducer-electrode assembly is open for inspection.

3) For neoprene and polyurethane lined meters, loosen the two clamp lock screws that retain the transducer cover in the electrode caps. Remove the transducer cover complete with "O" ring and insulating sleeve. The transducer assembly and wiring are open for inspection.
6.4.2.2 Transducer Replacement (Neoprene and Polyurethane Lined Meters)

**CAUTION**
For TEFLOWI lined meters, field replacement of the transducer assemblies must be done only by factory-trained personnel. Contact your Bailey-Fischer & Porter Field Service Representative, if transducer replacement becomes necessary.

1) Unsolder and disconnect the three wires at transducer solder tabs, designated "SIGNAL", "U1" and "U2" as shown in Figure 7-2. Identify the leads for later reconnection.

2) Using a 7/16-inch open end wrench on the hexagonal base of the transducer assembly, unscrew this assembly from the electrode head.

3) Remove the transducer assembly. If replacement is required, discard the transducer assembly. Discard the cone washer at the base of the transducer assembly as this washer cannot be re-used.

4) For electrode replacement, proceed directly to Section 6.4.2.3. If only transducer assembly replacement is required, place new cone washer, cup down, on transducer assembly threaded shaft and screw this unit back into electrode head seat firmly using 7/16-inch open end wrench.

**NOTE**
Transducer assemblies are furnished as matched pairs. Replacement sets must not be broken, interchanged or used on only one electrode. Both elements of a set must be used within the same meter.

5) Reconnect the signal lead and ultrasonic transducer pair to the proper tabs of the replacement assembly. Dress each wire back over its bent solder tab, as shown in Figure 7-2. Make good solder connections using solder and flux for electrical connections.

6) Reassemble covers by reversing the procedures given in 6.4.2.1 steps 1) and 3).

6.4.2.3 Electrode Replacement (Neoprene and Polyurethane Lined Meters)

**CAUTION**
For TEFLOWI lined meters replacement of the electrodes must not be attempted in the field. The meter must be returned to the factory for electrode replacement.

1) Empty the meter pipeline.

**WARNING**
Do not attempt electrode inspection or replacement with a filled or pressurized pipeline. Personal injury may result from this practice.
2) Remove the three #10-32 x 1/2 fillister head cap screws and lock-washers that clamp the electrode cap to the meter boss.

3) Remove the electrode cap, its "O"-ring and the insulating disc on the electrode head.

4) Pull the electrode from its seat in the meter spool and liner. This is facilitated by partially running one of the removed #10-32 cap screws into the tapped electrode head and then using this as a grip for electrode withdrawal. For polyurethane-lined meters, an "O"-ring on the underside of the electrode must also be withdrawn.

5) Insert the replacement electrode shaft fully into its meter seat. For polyurethane meters, be certain that the new "O"-ring which accompanies the replacement electrode is seated in the groove under the electrode head.

6) Reassemble the electrode-transducer assembly by following the procedures in paragraph 6.4.2.2, steps 4) through 6).

6.5 Electronic Parts Replacement

Any circuit malfunction which cannot be quickly identified by use of conventional voltage and resistance analysis technique should be brought to the attention of Bailey-Fischer & Porter Service Department, with complete details as to the nature of the malfunction. Recommended corrective measures and/or parts replacement, if indicated, will be transmitted promptly. Please reference the complete instrument model number and serial number in all communications or spare parts orders for the respective equipment.

The Basic Meter Parts List (Section 7.0) is cross referenced by symbol number to Figure 6-1, Exploded View. Separate Parts Lists for electrode assemblies, etc., are provided with Figures 7-1 through 7-3.
FIGURE 6-1. EXPLODED VIEW, BASIC INTEGRAL FLOWMETER PARTS
## 7.0 PARTS LIST

### BASIC METER PARTS
(REF: Figure 6-1)

<table>
<thead>
<tr>
<th>KEY</th>
<th>QR</th>
<th>DESCRIPTION</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Cover</td>
<td>375D359U01</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Screw, Pan Hd: #6-32 x 2-1/4&quot;</td>
<td>006H228T10</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>Lockwasher, Internal Tooth</td>
<td>085F000V11</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Signal Converter Assembly (See Note 2)</td>
<td>Series 50XM</td>
</tr>
<tr>
<td>5A</td>
<td>1</td>
<td>CMF/S Primary PC Board Assembly</td>
<td>686B623U01</td>
</tr>
<tr>
<td>5B</td>
<td>1</td>
<td>Adapter Board (for Remote Converter)</td>
<td>686B630U01</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>Screw, Flat Hdg: 1/4-20 x 5/8&quot;</td>
<td>023B010T10</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>Lockwasher, External Tooth</td>
<td>085H416T10</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>O-Ring, Converter Cover</td>
<td>102E077V52</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>Base, Converter</td>
<td>610B242U07</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>Ring, Threaded</td>
<td>376B072S18</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>Nut, Hex</td>
<td>397A089S14</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>Washer, External Tooth</td>
<td>085H102S10</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>Eyebolt</td>
<td>14, 16 &amp; 18 in. Meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 &amp; 24 in. Meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>124D041U03</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>Pipe Plug, Hex Socket</td>
<td>112A352U23</td>
</tr>
<tr>
<td>15</td>
<td>6</td>
<td>Screw, Pan Hd: #10-32 x 2-1/4&quot;</td>
<td>006L012T10</td>
</tr>
<tr>
<td>16</td>
<td>6</td>
<td>Lockwasher, External Tooth</td>
<td>085D010T10</td>
</tr>
<tr>
<td>17</td>
<td>6</td>
<td>Washer, Screw Retaining</td>
<td>333C596U01</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>Cover, Customer Connection Box</td>
<td>375D371U01</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>O-Ring, Customer Connection Box</td>
<td>102E077V51</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>Pipe Plug, Hex Socket (Note 4)</td>
<td>112A352U22</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>Fitting, Pipe (Note 4)</td>
<td>(Not required for submersible meters)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>384D138S11</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>Grommet (Note 4)</td>
<td>366A140R60</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>Fitting, Pipe (Note 4)</td>
<td>384D127S14</td>
</tr>
<tr>
<td>24</td>
<td>X</td>
<td>Tape, Teflon (Sealant)</td>
<td>174D001U04</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>O-Ring</td>
<td>101A825U01</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
<td>Adapter Housing</td>
<td>365B077U02</td>
</tr>
</tbody>
</table>

### NOTES:

1. The meter body is not a field repairable item. In the event of failure of the meter's internal components, such as magnet coils or electrode wiring, the flowmeter must be returned to Bailey-Fischer & Porter for repair. All correspondence should reference the complete meter model number and serial number.

2. The same Signal Converter is used for integral or remote mounting. Refer to the instruction Bulletin supplied with the Signal Converter for the applicable replacement part number. Bailey-Fischer & Porter maintains a repair/exchange program for this assembly; simply add "RE" to the part number given in the IB Parts List. For example:
   
   Model 50XM1000N = PN CD674A498U50RE

3. Mounting gaskets and hardware must be selected according to meter size.

4. Pipe plug (key 20) and conduit seal (keys 21, 22 & 23) are not provided with the meter when the Signal Converter is integrally mounted. Parts required are supplied with the signal cable, as specified.

5. The primary CMF PC board is not interchangeable (see procedure 6.3.3 in Chapter 6.0 - MAINTENANCE. It is suggested that the user return the flowmeter to the factory for repair and calibration. Consult a Bailey-Fischer & Porter service representative for assistance.  

---

7-1
### ELECTRODE ASSEMBLIES

<table>
<thead>
<tr>
<th>KEY</th>
<th>PART DESCRIPTION</th>
<th>PART NUMBER</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CAP, Plug: 2-inch</td>
<td>112A424U09</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>SCREW, Fillister Hd: #10-32 x 1/2&quot;</td>
<td>.004L008T10</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>LOCK WASHER, #10</td>
<td>085D010T10</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>COVER, Electrode: Teflon-Lined Meters Other Meters</td>
<td>641B078U01</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Other Meters</td>
<td>379C195T32</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>&quot;O&quot;-RING:</td>
<td>101W926U01</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Teflon-Lined Meters Other Meters</td>
<td>101A926U01</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>DISC, Insulating</td>
<td>358G182F90</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>SCREW, Hex Socket Set: #4-40 x 1/8&quot;</td>
<td>019F002I10</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>&quot;O&quot;-RING:</td>
<td>102G001U44</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Polyurethane-lined meters only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>ELECTRODE - SEE NOTE 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REF.: 614B350**

**NOTE 1:** Referenced items may be ordered only by specifying the complete Bailey-Fischer & Porter serial number.

**NOTE 2:** Replacement of the electrodes in Teflon-lined meters is a factory procedure and should not be attempted in the field.

---

**DISASSEMBLY LIMIT FOR ELECTRODE INSPECTION IN TEFLOM-LINED METERS**

**WARNING:**
DO NOT ATTEMPT ELECTRODE INSPECTION OR REPLACEMENT WITH A FILLED OR PRESSURIZED PIPELINE. PERSONAL INJURY MAY RESULT FROM SUCH PRACTICE.

**CAUTION:**
EXERCISE EXTREME CARE WHEN WITHDRAWING ELECTRODE FROM ITS SEAT THAT LITTLE OR NO TENSION IS EXERTED ON THE CONNECTING ELECTRODE WIRE. IF THIS WIRE SHOULD BREAK WITHIN THE METER PIPE, THE METER IS NOT REPAIRABLE.

---

**FIGURE 7-1. EXPLODED VIEW, ELECTRODE ASSEMBLIES**
PARTS LIST (continued)

<table>
<thead>
<tr>
<th>KEY</th>
<th>PART DESCRIPTION</th>
<th>PART NUMBER</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cover, Dust</td>
<td>379B1427S14</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Lock, clamp</td>
<td>106E021U01</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Cover, Electrode - Transducer</td>
<td>641B065U01</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Sleeve, Insulating</td>
<td>355C239U02</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>O-Ring, Cover</td>
<td>101A914U01</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Transducer Assembly, See Notes 2 &amp; 3</td>
<td>608B391U01</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Screw, Fillister Head: #10-32 x 1/2&quot;</td>
<td>004L008T10</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>Washer, Conical</td>
<td>085D010T10</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Washer, Conical</td>
<td>377C032U04</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Cap, Electrode</td>
<td>379C214T30</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>O-Ring</td>
<td>101A925U01</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>Disc, Insulating</td>
<td>376L189U00</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>O-Ring (Polyurethane-lined meters only)</td>
<td>102G001U44</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>Electrode - See Notes 1 &amp; 3</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

REF.: 614B350

NOTE 1. Referenced items may be ordered only by specifying the complete Bailey-Fischer & Porter serial number.

NOTE 2. Transducer assemblies (Key 6) are furnished as matched pairs. Please indicate "matched pair" with the part number noted.

NOTE 3. Replacement of the electrodes and transducer assemblies in Teflon-lined meters is a factory procedure and should not be attempted in the field.

---

**FIGURE 7-2. ULTRASONIC ELECTRODE TRANSDUCER ASSEMBLIES, EXPLODED VIEW**
ULTRASONIC JUNCTION BOX (Hardware), When specified,

<table>
<thead>
<tr>
<th>KEY</th>
<th>DESCRIPTION</th>
<th>PART NUMBER</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pipe Plug, Hex Socket, 3/4 NPT (*)</td>
<td>112A352U23</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Pipe Nipple, 3/4 NPT</td>
<td>362N402760</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Junction Box</td>
<td>1508C02U02</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Pipe Plug, Hex Socket, 1/2 NPT</td>
<td>112A352U22</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Cover Assembly (for Key 3)</td>
<td>641B060U01</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Tape, Teflon (Seal)</td>
<td>174D001U04RL</td>
<td>As Req'd</td>
</tr>
<tr>
<td>7</td>
<td>Fitting, 1&quot; - 14 to 3/4&quot; - 14 Reducer</td>
<td>36D1138T60</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Plug, Waterproof</td>
<td>366A14C060</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Fitting, Waterproof Connector, 1-14 to 3/4 NPT</td>
<td>36D127S14</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Adaptor Housing (See Figure 5:1)</td>
<td>365B077U02</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Cover, Electronics Housing - w/o Window</td>
<td>379D356U01</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>w/ Window</td>
<td>612A089U01</td>
<td>1</td>
</tr>
</tbody>
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(*) Not required when ultrasonic option is specified

**FIGURE 7-3. ULTRASONIC JUNCTION BOX**
PARTS LIST (continued)

**FLANGE GASKETS, ANSI CLASS 150 (2 REQUIRED)**

<table>
<thead>
<tr>
<th>METER SIZE</th>
<th>TEFLOM</th>
<th>PART NUMBER</th>
<th>POLYURETHANE (*)</th>
<th>NEOPRENE</th>
</tr>
</thead>
<tbody>
<tr>
<td>14&quot; (350 mm)</td>
<td>333N817P30</td>
<td>333N817Q10</td>
<td>333C584Q19</td>
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</tr>
<tr>
<td>16&quot; (400 mm)</td>
<td>333C526U04</td>
<td>333C526U03</td>
<td>333C580Q19</td>
<td></td>
</tr>
<tr>
<td>18&quot; (450 mm)</td>
<td>333C526U16</td>
<td>333C526U17</td>
<td>333C581Q10</td>
<td></td>
</tr>
<tr>
<td>20&quot; (500 mm)</td>
<td>333C526U08</td>
<td>333C526U07</td>
<td>333C588Q10</td>
<td></td>
</tr>
<tr>
<td>24&quot; (600 mm)</td>
<td>333C526U19</td>
<td>333C528U19</td>
<td>333C588Q19</td>
<td></td>
</tr>
</tbody>
</table>

(\*) Polyurethane-lined meters are supplied with NEOPRENE gaskets.

**PARTS KIT, Field Conversion**

Integral to Remote Conversion - 614B888U02

---

**FIGURE 7-4. TYPICAL CONDUIT SEAL**
(Ref: FIGURE 6-1)
DOCUMENTATION QUESTIONNAIRE

Your answers to the questions below and other comments assist us in publishing better documentation. If an answer requires explanation please use the space provided. All comments and suggestions become the property of Elseg Bailey Process Automation.

1. Title of Document? _IB 10DX3111/3311 SIZES 14 - 24 inches, PN 24792_

2. Does this document meet your needs?

3. Is the information:

   Easily understandable?

   Properly organized?

   Complete?

   Sufficiently illustrated?

OTHER COMMENTS

(Please include page and/or figure number.)

Name

Address

No postage necessary if mailed in the U.S.A.

If Bailey employee, please include department number.