

PanaFlow™ LC

User's Manual



PanaFlow™ LC

Ultrasonic Liquid Flowmeter

User's Manual

BH029C11 EN C
March 2024

panametrics.com

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Please visit <https://www.bakerhughes.com/panametrics/panametrics-services> for more details.

Typographical Conventions

Note: These paragraphs provide information that provides a deeper understanding of the situation, but is not essential to the proper completion of the instructions.

IMPORTANT: These paragraphs provide information that emphasizes instructions that are essential to proper setup of the equipment. Failure to follow these instructions carefully may cause unreliable performance.



CAUTION! This symbol indicates a risk of potential minor personal injury and/or severe damage to the equipment, unless these instructions are followed carefully.



WARNING! This symbol indicates a risk of potential serious personal injury, unless these instructions are followed carefully.

Safety Issues



WARNING! It is the responsibility of the user to make sure all local, county, state and national codes, regulations, rules and laws related to safety and safe operating conditions are met for each installation.



Attention European Customers! To meet CE Mark requirements for all units intended for use in the EU, all electrical cables must be installed as described in this manual.

Auxiliary Equipment

Local Safety Standards

The user must make sure that he operates all auxiliary equipment in accordance with local codes, standards, regulations, or laws applicable to safety.

Working Area



WARNING! Auxiliary equipment may have both manual and automatic modes of operation. As equipment can move suddenly and without warning, do not enter the work cell of this equipment during automatic operation, and do not enter the work envelope of this equipment during manual operation. If you do, serious injury can result.



WARNING! Make sure that power to the auxiliary equipment is turned OFF and locked out before you perform maintenance procedures on this equipment.

Qualification of Personnel

Make sure that all personnel have manufacturer-approved training applicable to the auxiliary equipment.

Personal Safety Equipment

Make sure that operators and maintenance personnel have all safety equipment applicable to the auxiliary equipment. Examples include safety glasses, protective headgear, safety shoes, etc.

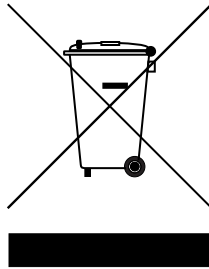
Unauthorized Operation

Make sure that unauthorized personnel cannot gain access to the operation of the equipment.

Environmental Compliance

Waste Electrical and Electronic Equipment (WEEE) Directive

Panametrics is an active participant in Europe's *Waste Electrical and Electronic Equipment (WEEE)* take-back initiative, directive 2012/19/EU.



The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end of life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Please visit www.bakerhughes.com/health-safety-and-environment-hse for take-back instructions and more information about this initiative.

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Chapter 1. Introduction

1.1 Overview

Thank you for purchasing the PanaFlow LC ultrasonic flowmeter. The PanaFlow LC flowmeter is a one, two, or three channel ultrasonic transit time flowmeter that utilizes clamp on transducers on external pipe surfaces to allow for uninterrupted flow operation during flow measurement. The PanaFlow LC flowmeter has up to 3 independent channels. These channels are capable of measuring the flow rate of acoustically conductive single-phase liquid, which may have limited amount of second phase. With the three channels, the user will have the capability to average them with equal weights, or with different weights that will better suit the flow profile. The meter is designed for pipe sizes ranging from ½ in. (15 mm) to 300 in. (7600 mm) with wall thickness up to 4 in. (102 mm) for flow velocities up to 80 ft/s (25 m/s).

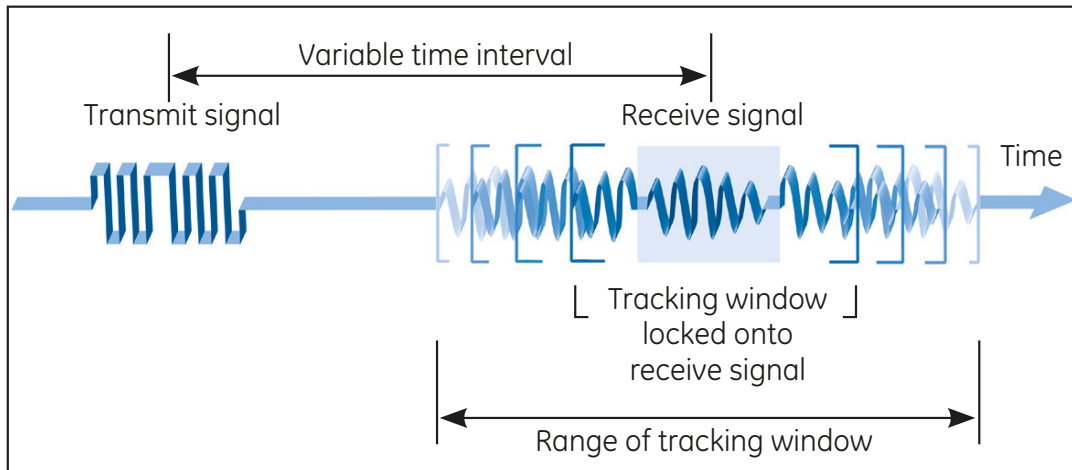
This manual will serve as a guide to install the clamping fixture and transducers necessary for accurate flow readings, programming the meter, error codes and troubleshooting walk through, and general maintenance and service recommendations.



Figure 1: PanaFlow LC

1.2 Theory of Operation

The PanaFlow LC uses a procedure called **Transit-Time Flow Measurement**. In this method, the flowmeter transmits ultrasonic pulses through a moving liquid. The pulses that travel in the same direction as the fluid flow (downstream) travel slightly faster than the pulses that travel against the fluid flow (upstream). The difference in transit times is then used to calculate flow velocity.



ATW ensures accuracy when fluid conditions change

Figure 2: Transit - Time Flow Measurement

1.3 SIL Application

The PanaFlow LC with appropriate flow meter selection can be a SIL2 ultrasonic flowmeter (sensor) with the capability of providing a SIL3 system in a redundant design configuration. The PanaFlow LC system is IEC61508 certified (when selection) through a complete design validation from a third-party organization. By achieving a third-party certification, we have proven the required design rigor through the product safety lifecycle, and the implementation of functional safety management. This added design, manufacturing, and control rigor ensures that it is the optimal ultrasonic flowmeter for your safety or process control system.



CAUTION! Only qualified and trained personnel are allowed to change and validate safety parameters. Please refer to the XMT1000 safety manual for details on these parameters.

Chapter 2. Installation

2.1 Installation Guidelines

This section provides general information with respect to the mechanical and electrical installation, and should be thoroughly reviewed before the system is installed. To ensure safe and reliable operation of the PanaFlow LC, the system must be installed in accordance with the established guidelines. Those guidelines, explained in detail in this chapter, include the following topics:

- Unpacking the PanaFlow LC system
- Selecting suitable sites for the electronics enclosure and transducer mounting
- Installing the clamping fixture and transducers
- Installing the electronics enclosure
- Wiring transducers to the XMT1000 electronics
- Wiring PanaFlow LC transmitter



WARNING! The PanaFlow LC flow meter can measure the flow rate of many fluids, some potentially hazardous. The importance of proper safety practices cannot be overemphasized.



WARNING! Be sure to follow all applicable local safety codes and regulations for installing electrical equipment and working with hazardous fluids or flow conditions. Consult company safety personnel or local safety authorities to verify the safety of any procedure or practice.



Attention European Customers! To meet CE Mark requirements, all cables must be installed as described in *Appendix D, CE Mark Compliance*.

2.2 Unpacking

Before removing the PanaFlow LC from its box, please inspect both the box and the instrument carefully. Each instrument manufactured by Panametrics is warranted to be free from defects in material and workmanship. Before discarding any of the packing materials, account for all components and documentation listed on the packing slip. The discarding of an important item along with the packing materials is all too common. If anything is missing or damaged, contact Panametrics Customer Care immediately for assistance.

The PanaFlow LC flowmeter shall consist of one set of XMT1000 Electronics, a pair of transducer cables, a pair of clamp on transducers and a clamping fixture to mount the transducers to a pipe. Due to a variety of configurations your kit may include additional cables, clamping fixtures, transducers and junction boxes. Please refer to your packing slip and ordered parts string and lists for your specific components.

2.2.1 Identification

The PanaFlow LC is supplied with both a serial number label and a certification label for identification of the instrument.

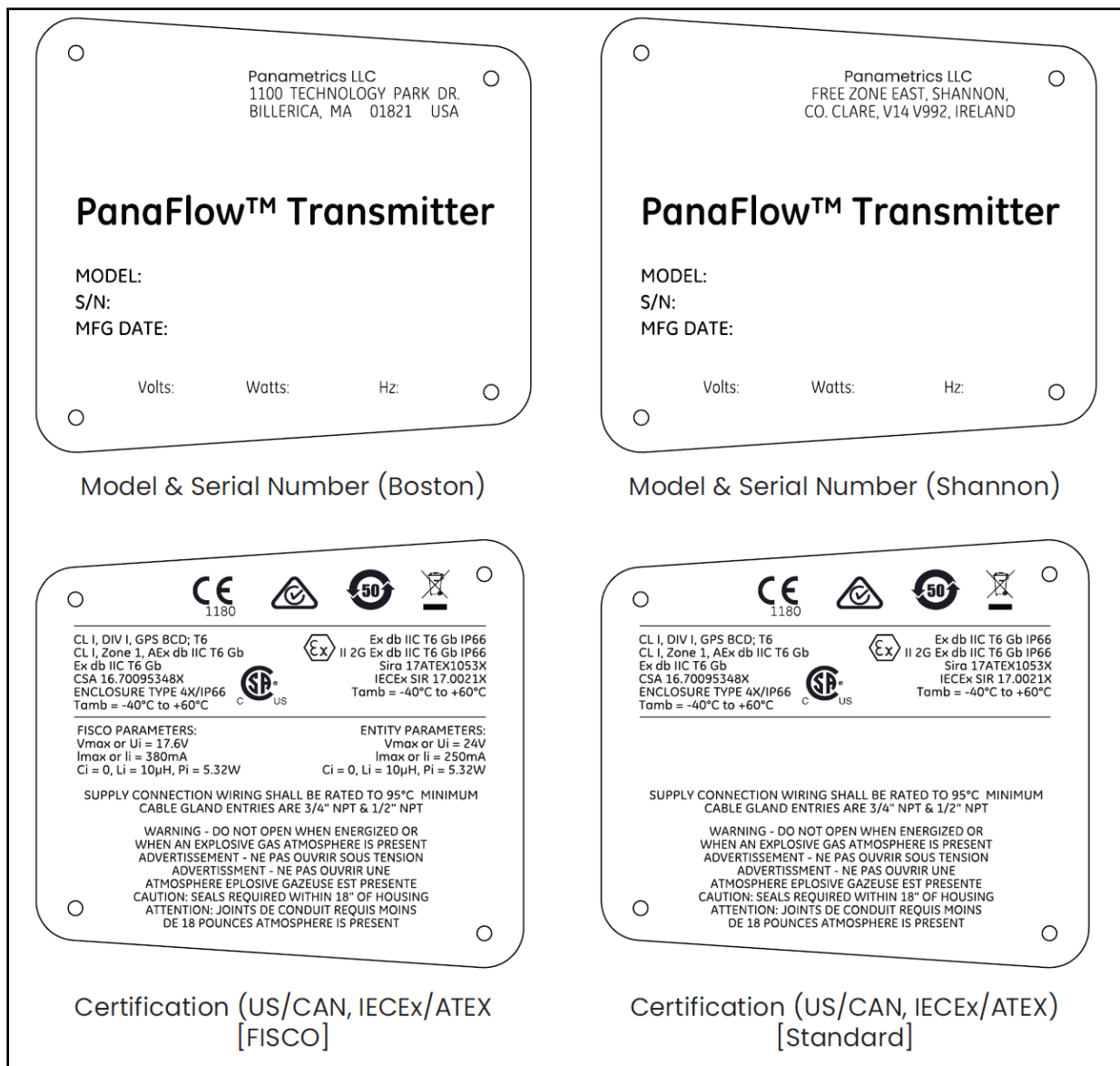


Figure 3: Typical PanaFlow LC Labels

2.3 Site Considerations

Proper installation of the PanaFlow LC is important to achieve optimum performance from the system. The following installation recommendations provide general guidelines of how this system should be installed. If the following recommendations cannot be met, please consult the factory for a more detailed review of the application to see what performance may be achievable.

2.3.1 Installation Location

Ideally, choose a section of pipe with unlimited access; for example, a long stretch of pipe that is above ground. However, if the meter body is to be mounted on an underground pipe, dig a pit around the pipe to facilitate installation or removal of the transducers.



CAUTION! Local mounting of the XMT1000 meter is not permitted for vertical pipes.



CAUTION! Remote mounting of the XMT1000 meter is always required with vertical pipes. For vertical pipes, the fluid flow is / must be upwards as the measurement method requires the pipe to be full.

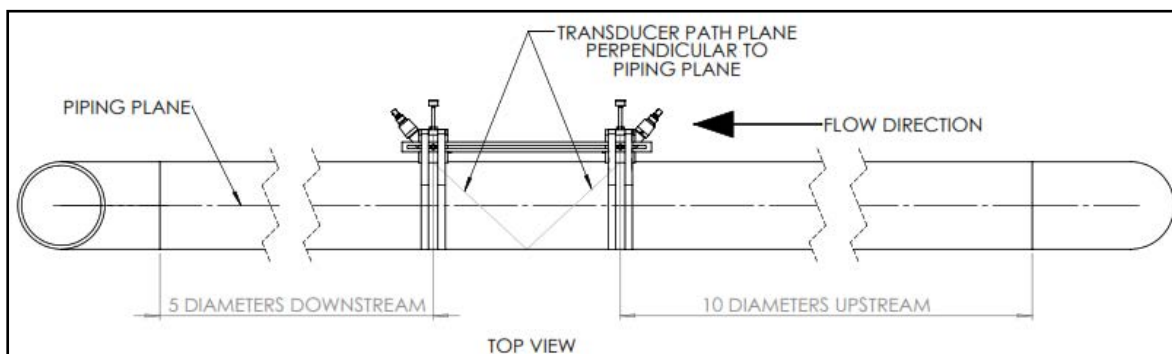


CAUTION! Avoid mounting the clamp-on transducers over or near welded seams.

2.3.1.1 Transducer location

For a given fluid and pipe, the PanaFlow LC accuracy depends on the location and alignment of the transducers. In addition to accessibility, when planning for transducer location, adhere to the following guidelines:

- Locate the meter body so that there are at least 10 pipe diameters of straight, undisturbed flow upstream and 5 pipe diameters of straight, undisturbed flow downstream from the measurement point. Undisturbed flow means avoiding sources of turbulence in the fluid such as valves, flanges, expansions, and elbows; avoiding swirl; and avoiding cavitation clamping fixture and transducers.



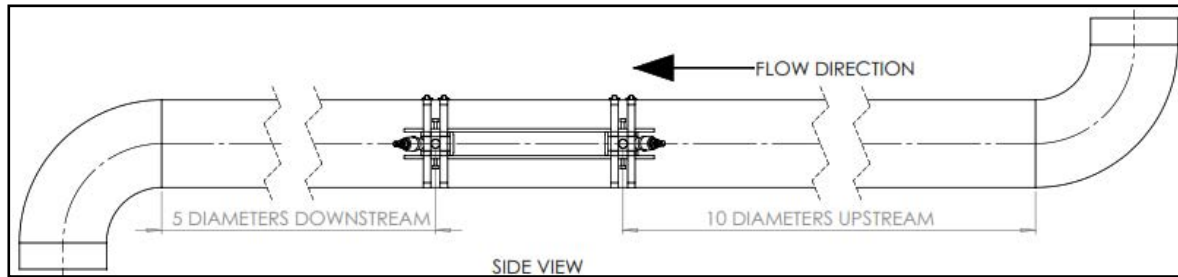


Figure 4: Recommended Installation Location and Orientation

- If the clamping fixture is to be placed downstream of an elbow, the orientation of the clamping fixture must be placed in such a way that the transducer path is perpendicular to the plane of the piping to compensate for swirl.
- For permanent installations, the clamping fixture should be oriented in a way where the transducer paths are out of the vertical plane. Pipe fouling can produce erroneous meter readings. If this placement contradicts with the placement listed in the previous note, then the fixture can be oriented in the 11-5 o'clock or 1-7 o'clock positions. NEVER orient the transducers in the 12 o'clock or 6 o'clock positions.
- Once the location has been scoped out, make sure there is enough clearance around the area to install the clamping fixture and transducers.

2.4 Installing Clamping Fixtures

Installation of clamp-on transducers for transit-time measurements consists of mounting the clamping fixture to the pipe and then mounting the transducers into the clamping fixture. When installing transducers in clamp-on applications, you can use one of the following methods to hold the transducer against the pipe wall (this manual will only cover the SCF and V-Series clamping fixture):

- Strap Clamping Fixture (SCF)
- V-Series Clamping Fixture (CFG)
- Universal Clamping Fixture (UCF)
- Magnetic Clamping Fixture (MCF)
- Small Clamping Fixtures (CF-JR, CF-LP)

Note: The accuracy and performance of the flowmeter depends on the location, spacing, and alignment of the transducers. This manual provides general instructions for locating and installing most transducer types. However, the specific spacing of your transducers is unique to your installation.

2.4.1 Determining the Number of Traverses

The first step in the installation is determining the number of traverses (see Figure 5 below). The transducers can be mounted using one of two methods:

- **Even number of-traverse method** - the transducers are mounted on the same side of the pipe and the ultrasonic signal is transmitted from one transducer to the other by reflection off the opposite pipe wall.
- **Odd number of-traverse method** - the transducers are mounted diagonally across from each other. The ultrasonic signal is transmitted across the pipe directly from one transducer to the other.

Always try the even number of-traverse method first because it is easier to configure and yields greater accuracy. However, if the pipe has poor inside surface conditions or the fluid is highly attenuating, you may not be able to obtain a reliable signal. Therefore, you may have to use the Odd number of-traverse method in such applications. The spacing of the transducers is calculated by the system after all the installation parameters have been programmed into the flowmeter.

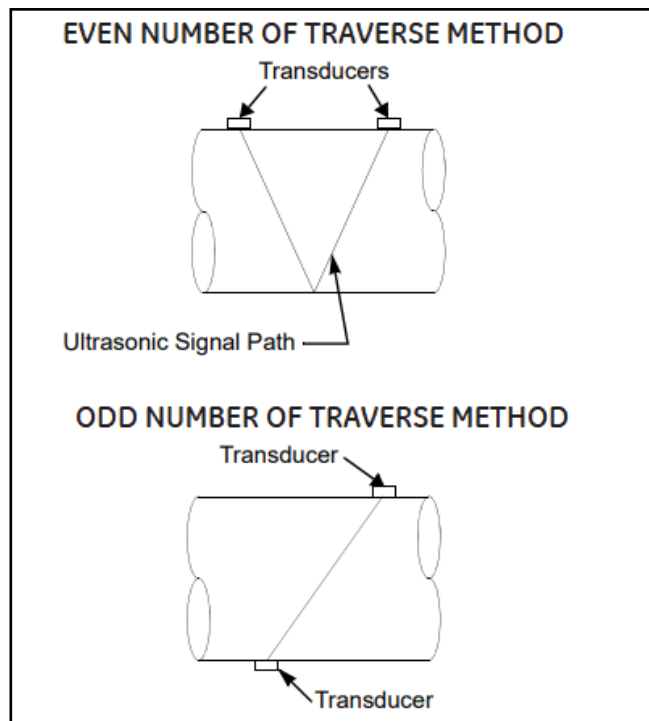


Figure 5: Even and Odd Number of Traverse Installation

2.4.2 Determining Transducer Spacing

Transducer spacing is determined by programming the PanaFlow LC transmitter with process conditions as described in the programming menu section of the XMT1000 manual. Final spacing will be determined by the pipe specification, fluid, transducers, and traverses. Please refer to the XMT1000 manual determining transducer spacing.

For installation of SCF Fixture, please go to Section 2.4.3.

For installation of CFG Fixture, please go to Section 2.4.4.

2.4.3 Strap Clamping Fixture

The *Strap Clamping Fixture (SCF)* (see Figure 6 below) acts as a spacing device, a transducer holder, and a transducer aligner. The SCF includes two U-shaped blocks connected by a slotted bar and four hose straps.

The SCF is strapped around the pipe, and the blocks are used to hold the transducers in position for accurate measurements. The blocks must be positioned properly using the spacing dimension calculated by the flowmeter. Then, the transducers are mounted into the blocks.

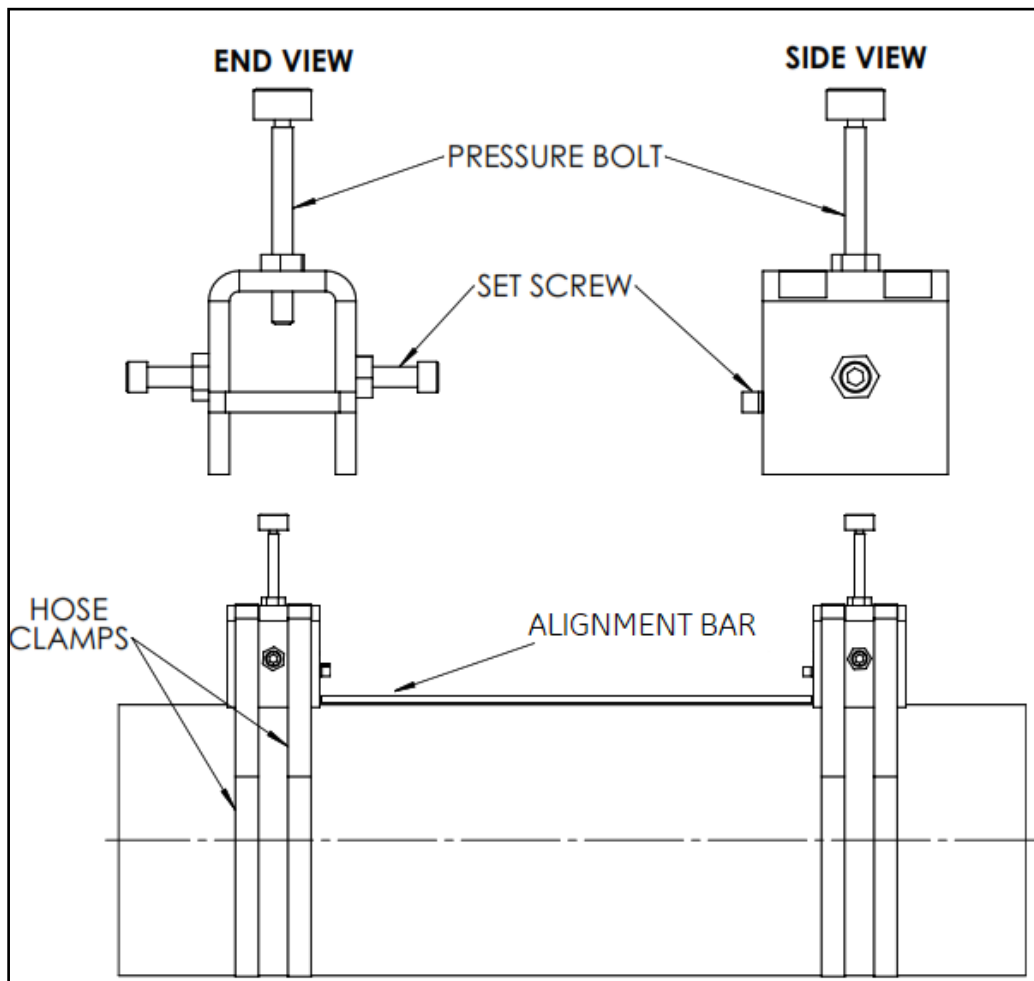


Figure 6: Components of the SCF

2.4.3.1 Install of SCF Fixture (Even Traverses)

Note: The instructions in this section can also be used for a multiple-traverse method. However, you must use an **EVEN** number of traverses. The distance the signal travels from one side of the pipe wall to the opposite side of the pipe wall is considered one traverse. For installations with more than two traverses, contact Panametrics for assistance.

The installation procedure for transducers using the even number of-traverse method is as follows:

1. Prepare the pipe where you intend to place the clamping fixture by making sure it is clean and free of loose material. Sanding, though usually not required, may be necessary to remove any high spots. However, be careful to preserve the original curvature of the pipe.
2. Secure one of the blocks to the alignment bar by tightening one of the nuts on the block so the block will not be able to slide along the alignment bar's slot.
3. Obtain the transducer spacing dimension (**S**) after programming the PanaFlow LC transmitter. Using the alignment bar as a guide, move the second block so that the distance between the blocks equals the **S** dimension. Use the pressure bolts or the edges of the blocks as reference points, as shown below

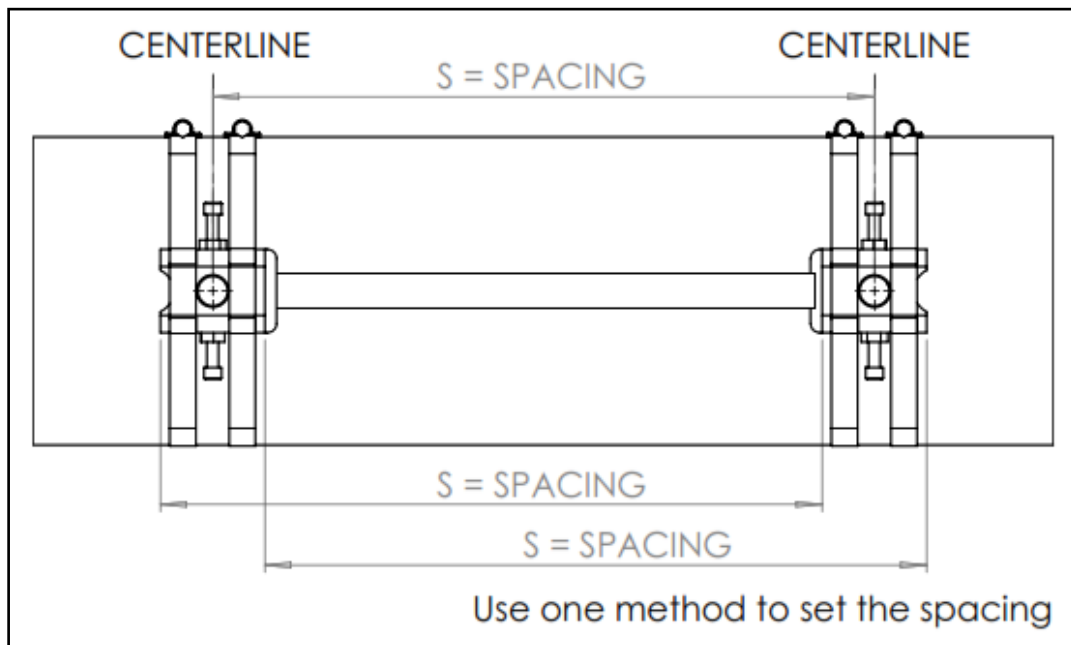


Figure 7: SCF Setup, Spacing

4. Position the clamping fixture on top of the pipe and wrap the clamping fixture blocks with the hose clamps. Tighten the clamps until the blocks are snug but ensure that they can still be rotated around the pipe.
5. Rotate the blocks so that they are away from the vertical plane and in an orientation that satisfies the criteria listed in Section 2.6: *Even and Odd Number of Traverse Installation*.
6. Fully tighten the hose clamps so no movement on the fixture will occur.

Figure 8 below shows a completed even-traverse installation without the transducers. Proceed to the section on mounting the transducers later in this chapter.

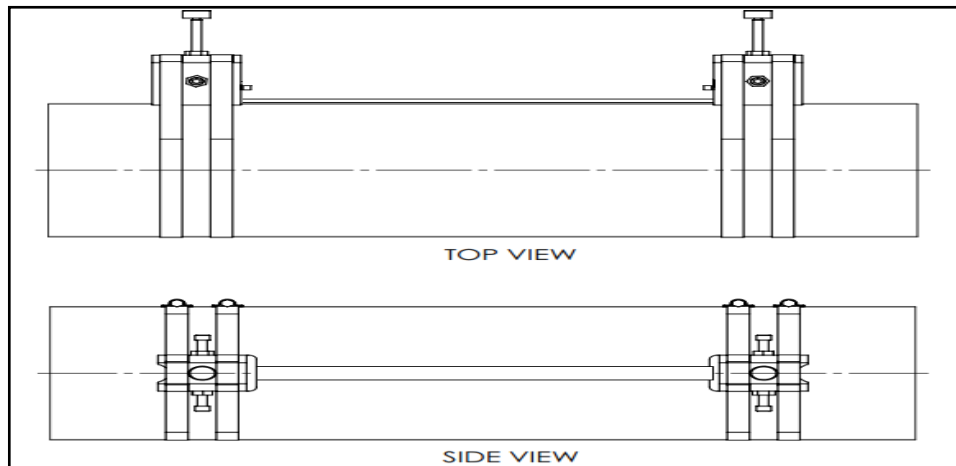


Figure 8: Finished SCF Installation without Transducers

2.4.3.2 Install of SCF Fixture (Odd Traverses)

Note: The instructions in this section can also be used for a multiple-traverse method. However, you must use an **ODD** number of traverses. The distance the signal travels from one side of the pipe wall to the opposite side of the pipe wall is considered one traverse. For installations with more than one traverse, contact Panametrics for assistance.

The procedure for mounting the SCF for the odd number of-traverse method includes marking the pipe for the required transducer spacing, fastening the fixture to the pipe, and then mounting the transducers into the fixture.

To install the SCF odd traverse, complete the following steps:

Note: For simplicity, all figures will show the clamping fixture oriented on the horizontal plane (3 o'clock and 9 o'clock positions). Exact orientation will depend on the piping upstream and downstream of the fixture determined in Section 2.6: Even and Odd Number of Traverse Installation.

1. Prepare the pipe where you intend to place the SCF by making sure it is clean and free of loose material. Sanding, though usually not required, may be necessary to remove any high spots. However, be careful to preserve the original curvature of the pipe.
2. Use a level to find the top of the pipe and then draw a line parallel to the centerline of the pipe.

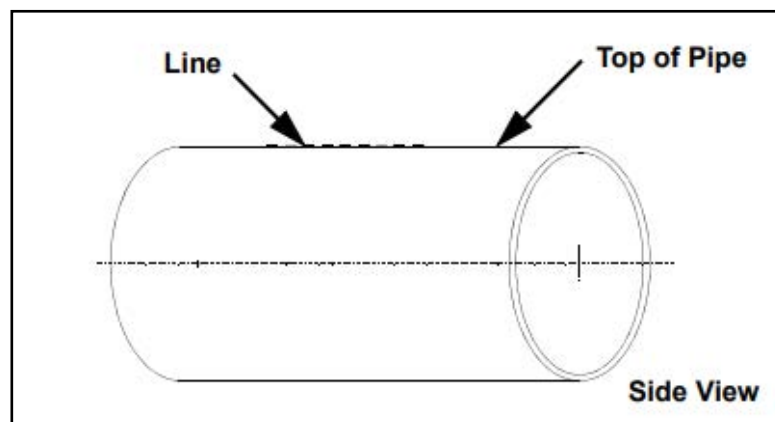


Figure 9: SCF Odd Number of Traverse Installation, Step 3

3. Using a level and center punch, make two marks on the line drawn in step 3. These marks must be separated by the transducer spacing distance **S**, as calculated by the flowmeter.

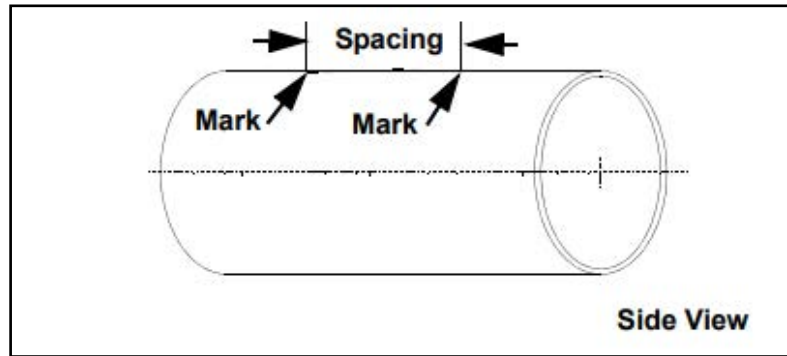


Figure 10: SCF Odd Number of Traverse Installation, Step 4

4. From one of the marks on the top of the pipe, measure around the pipe a distance equal to $1/4$ of the pipe circumference, or a distance that will satisfy the orientation found in Step 1. Use the center punch to make a mark at this point.

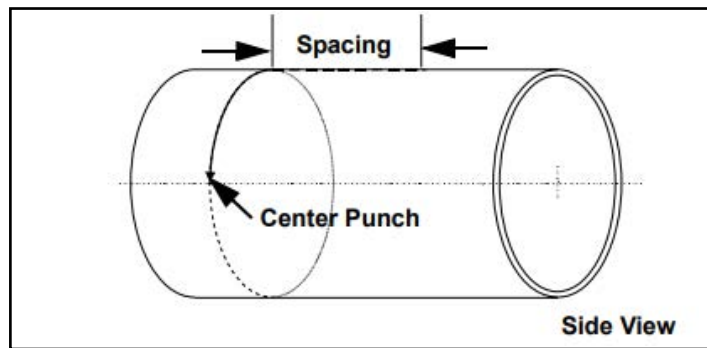


Figure 11: SCF Odd Number of Traverse Installation, Step 5

5. From the other mark on the top of the pipe, measure around the pipe in the opposite direction a distance equal to $1/4$ of the pipe circumference, or the same distance used in Step 5. Use the center punch to make a mark at this point.

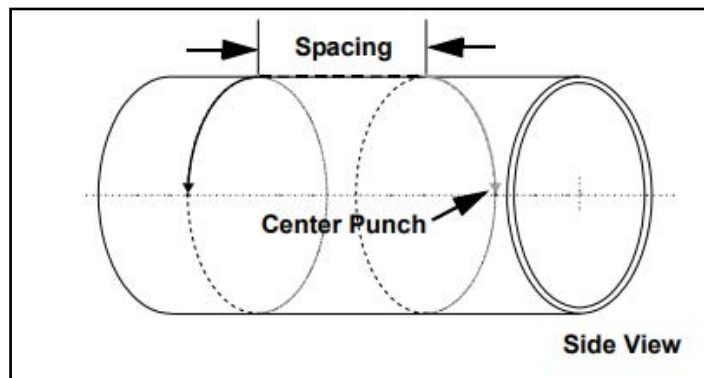


Figure 12: SCF Odd Number of Traverse Installation, Step 6

6. Center one of the blocks over one of the center punch marks on the side of the pipe. Align the block so that the pressure bolt is directly over the punch mark. Secure the block by wrapping the two steel straps around both the block and the pipe and tightening the straps.

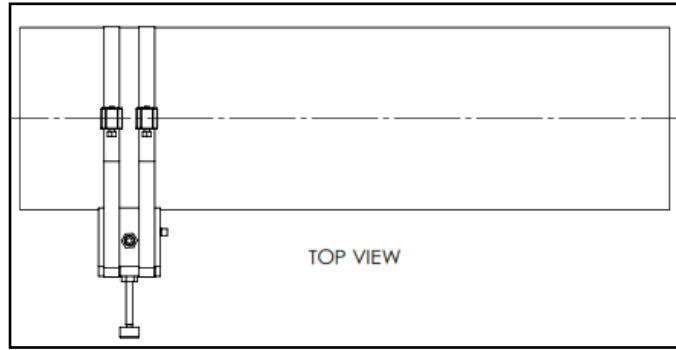


Figure 13: SCF Odd Number of Traverse Installation, Step 7

7. Repeat Step 7 to install the other block on the pipe.

IMPORTANT: Make sure both straps are perpendicular to the bottom of the block. If the straps are slanted, the slack will cause the block to move. Also, the transducer spacing dimension may change after the transducers are mounted.

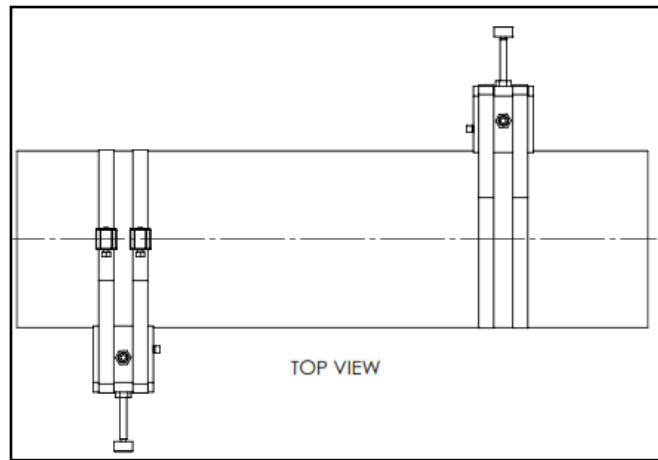


Figure 14: SCF Odd Number of Traverse Installation, Step 8

Figure 15 below shows an odd traverse installation without the transducers. Proceed to the section on mounting the transducers later in this chapter.

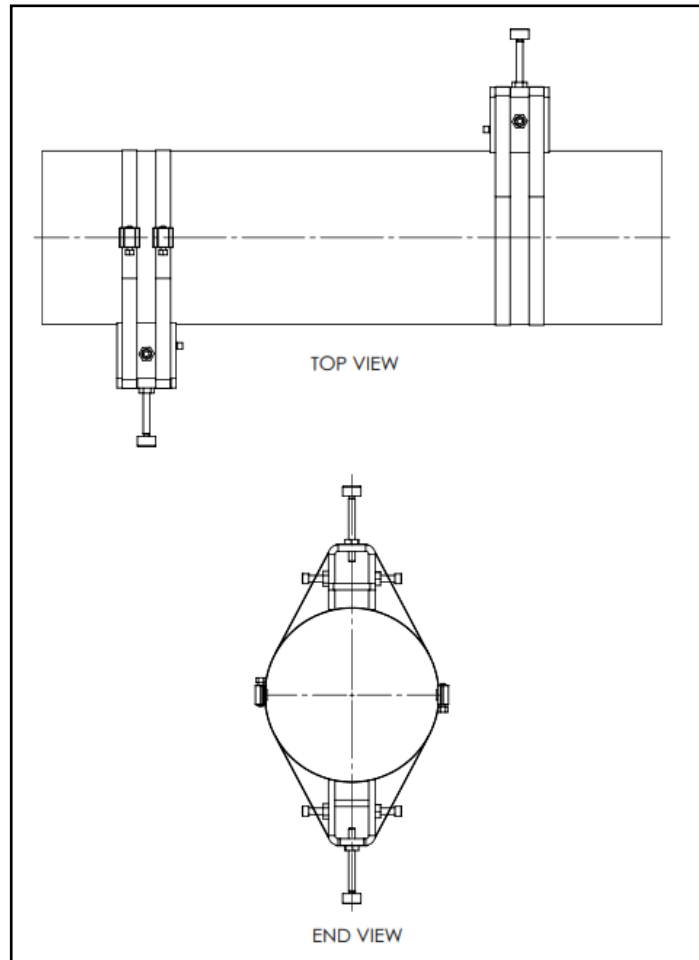


Figure 15: Odd Number of Traverse SCF Installation without Transducer

2.4.3.3 Installation of Transducer

For any of the fixtures above except for the SPCF, the last step in the installation is mounting the transducers into the clamping fixture. Although not all transducer models are installed the same way, the following information provides some general guidelines to help you. The face of the transducer must be in contact with the pipe because this is where the ultrasonic signal is emitted. All Panametrics transducers include a dimple, depression as it is illustrated in *Figure 21*, drill point or slot on the opposite side of the transducer wedge face, for use as a guide in aligning and securing the transducer. In addition, some transducers have scribe marks on the side to assist in setting the transducer spacing. *Figure 16* below shows an example of the dimple and scribe marks on the transducers.



Figure 16: Transducer Samples

To mount the transducers into a clamping fixture, complete the following steps:

1. To ensure that the minimum bend radius of the cable is met, the cable adapter is added in series with the transducer cable assembly and the transducer. Connect the transducer cables to the BNC connectors on the transducers, ensuring that the labels on the cables match with the transducers. For example, the cable labeled 'downstream' must be connected to the downstream transducer.



Figure 17: Transducer Cable Connection with Cable Jumper, PN133M7313-03



Figure 18: Transducer Mounting, Step 1

2. Apply a thin bead of couplant to one of the transducers. A bead approximately the size of a toothpaste bead should be placed down the center of the transducer face.

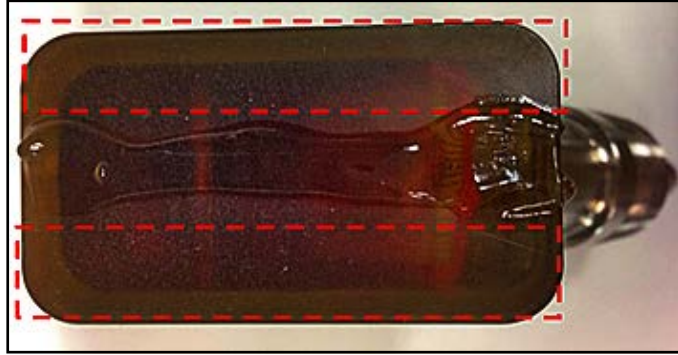


Figure 19: Transducer Mounting, Step 2

Panametrics supplies an ultrasonic couplant for your clamp-on installation. The purpose of the couplant is to provide reliable transmission of ultrasound between two adjacent solid surfaces. Couplants perform this task by excluding air from the space between the adjacent surfaces. Accordingly, the clamp-on transducers should be pressed tightly against the pipe, using hand pressure on the set screw to squeeze the couplant to as thin a film as practical for the given pipe surface.

Panametrics provides couplants for both permanent and temporary use as well as for high-temperature and low-temperature applications. For long-term installations, make sure the couplant does not dry out or extrude. Standard couplants supplied from Panametrics for the *PanaFlow LC* are listed in *Table 1* below.

Table 1: Standard Panametrics Couplants

Part No.	Type	Temp. Range	Use
CPL-1	Standard	-40 to +240°C	Semi-Permanent
CPL-8	Solid Sheet	-40 to +260°C	Permanent

- Determine the upstream and downstream ends of the pipe and place the appropriate transducer into the corresponding block on one of the sub-assemblies. Make sure the transducer cable connector faces away from the center of the installation.

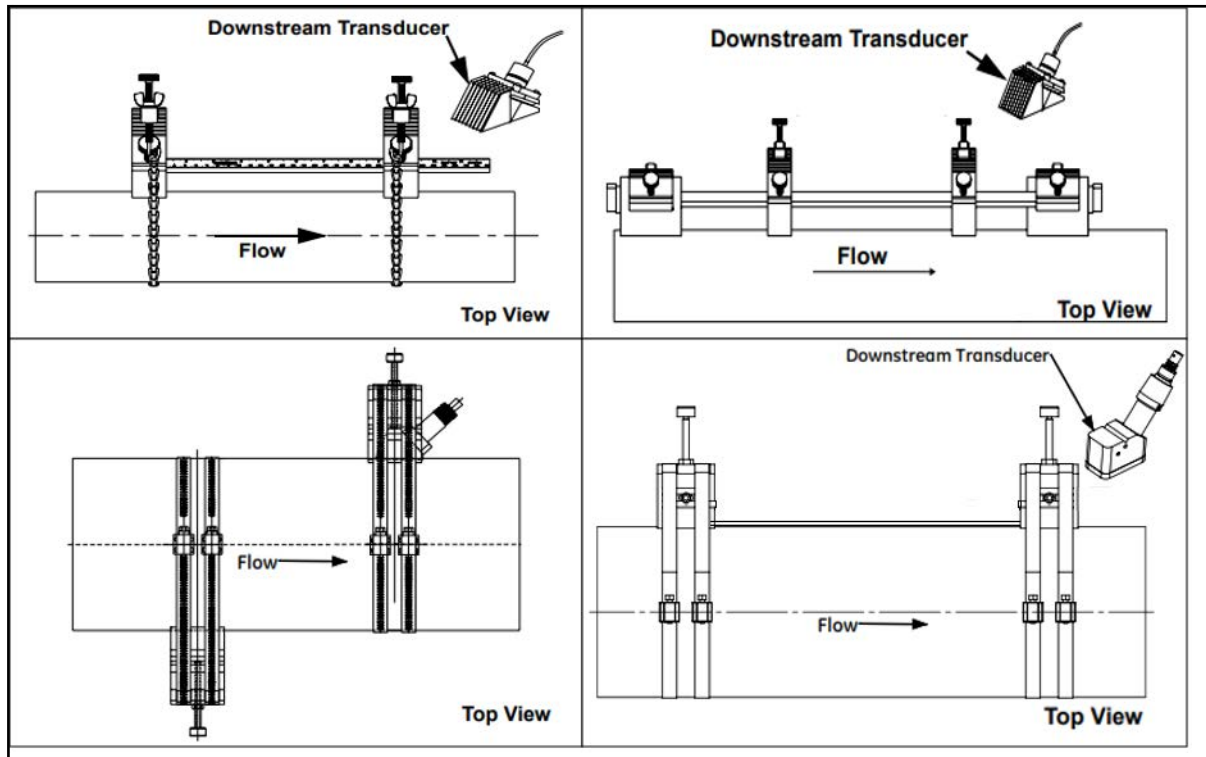


Figure 20: Transducer Mounting on UCF (Top Left), MCF (Top Right), GCF (Bottom Left), and SCF (Bottom Right)

- Use the pressure bolt to secure the transducer in place. The pressure bolt should fit into the dimple on the transducer. Hand tighten the bolt just enough to hold the transducer in place, but do not overtighten it or the fixture will lift off the pipe.
- Repeat Steps 1-4 to mount the other transducer in the fixed short block. See *Figure 21* below for completed typical clamping fixture installations.
- Connect the other end of the transducer cables to the junction box in Section 4: Transducer Wiring of this manual.

Note: *If the transducers are mounted into the clamping fixtures properly, the two transducer cable connectors will face away from each other as shown above.*

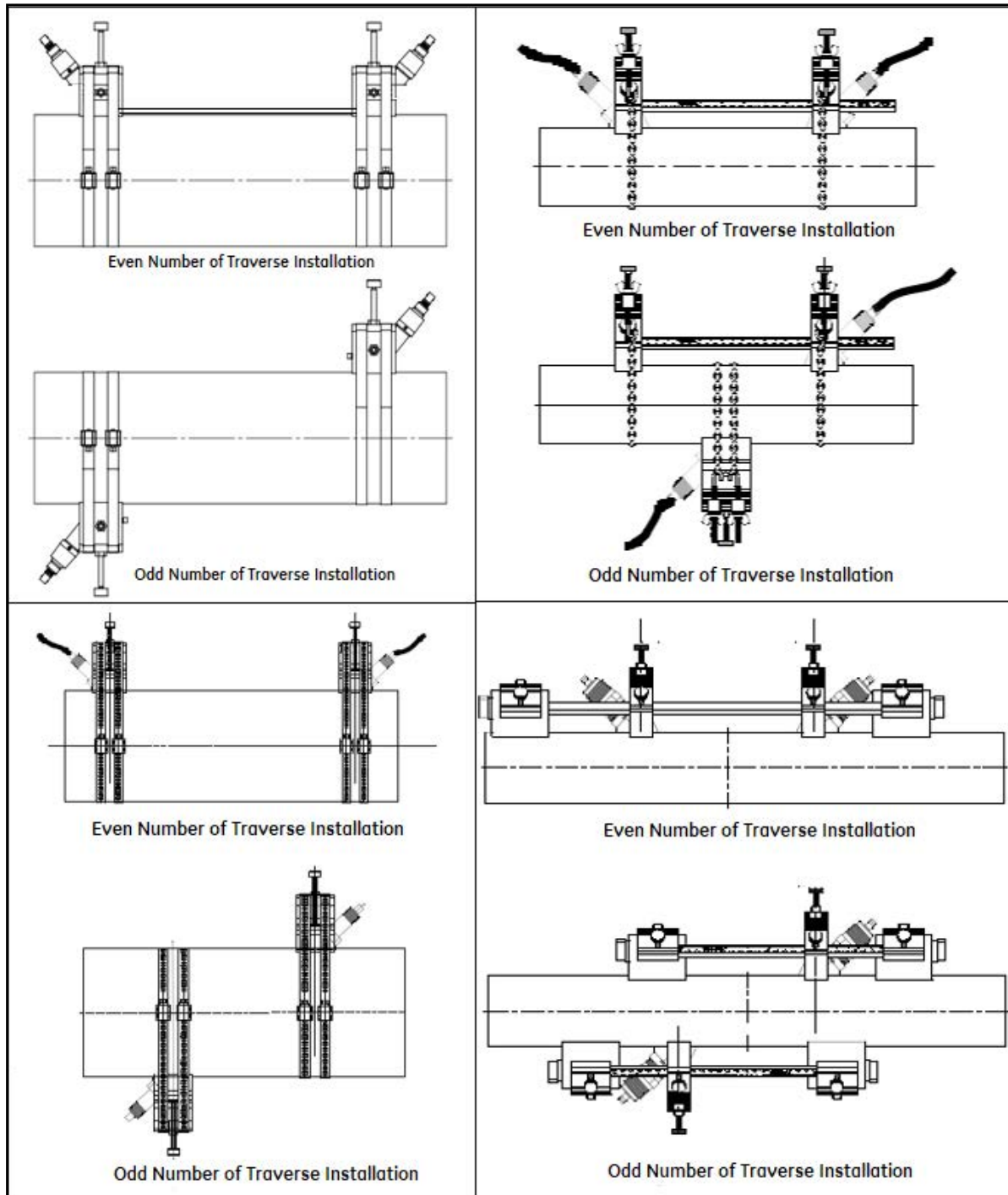


Figure 21: SCF Clamping Fixture (Top Left), UCF Clamping Fixture (Top Right), GCF Clamping Fixture (Bottom Left), MCF Clamping Fixture (Bottom Right)

2.4.4 Installation of CFG fixture

To install the V Series clamping fixture and transducers, complete the following steps:

2.4.4.1 Installing the Fixture

1. Position the half of the clamping fixture with the threaded rods around the pipe, as shown in *Figure 22* below. Orient the fixture in the 3 o'clock position on a horizontal pipe.

2. Position the mating half of the fixture over the threaded rods in the 9 o'clock position. *Figure 22* below shows the two mounted halves.

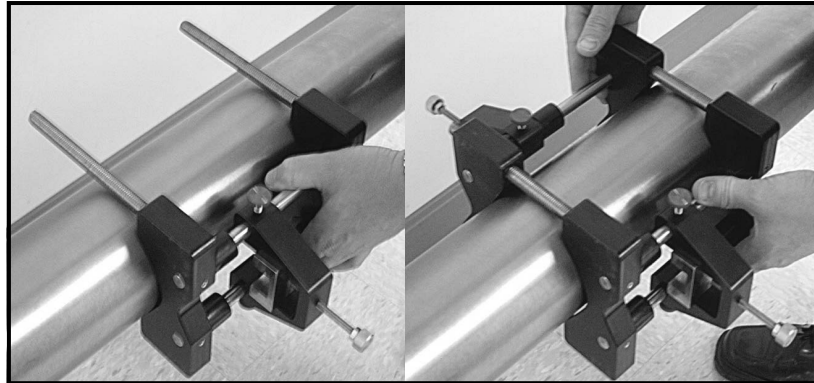


Figure 22: Mounting the Two Halves of the Fixture

The two fixture halves have measuring scales; ensure that the scales are on the same side of the fixture, so that both zeros start at the same origin, as shown in *Figure 23* below.

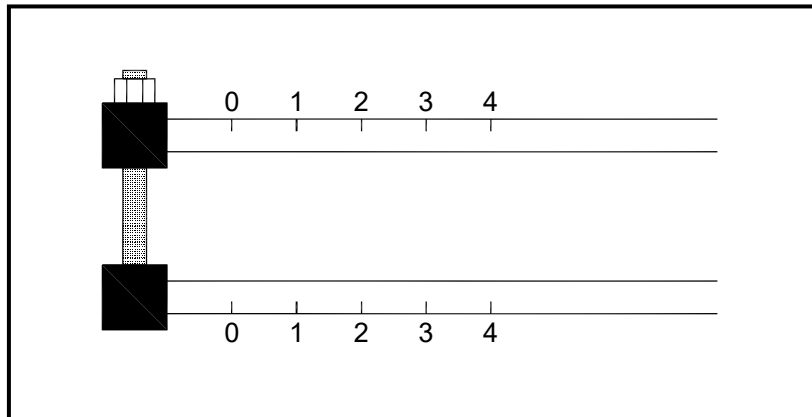


Figure 23: Fixture with Scale Origins Properly Aligned

3. Install the four nuts onto the threaded rods with the convex side of the nut facing the fixture. Hand tighten the nuts on each V block evenly, as shown in *Figure 24* on the next page. Do not use a cross tightening pattern on the four installation nuts.

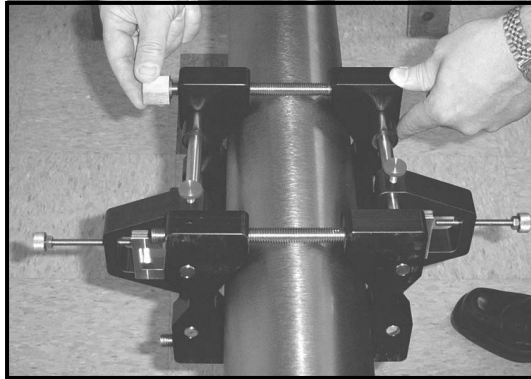


Figure 24: Installing Nuts onto the Fixture

2.4.4.2 Installing the Transducers

1. Apply a bead of couplant 6 mm (0.25 in.) wide along the entire length of each transducer face, as shown in *Figure 25* below.



Figure 25: Couplant on Transducer Face

Note: Do not slide the transducer with couplant along the surface of the pipe when mounting the transducer.

2. Set the first mounting block (either left edge or right edge) at a convenient number on the scale, such as 2 in. or 5 cm. Install the first transducer with the BNC connector pointing away from the center of the V block fixture. Tighten the transducer mounting thumbscrew onto the slider, which in turn applies pressure to the transducer. Use a handtight grip to set the transducer in contact with the pipe, as shown in *Figure 26* below. Use a wrench to tighten the backing nut to prevent loosening due to vibration and thermal expansion.

IMPORTANT: Do not use a wrench or pliers on the thumbscrew.



Figure 26: Installing the First Transducer

3. Slide the second mounting block to the calculated spacing *plus* the initial scale number selected for the first mounting block. (For example:
 - a. Initial convenient number for the first mounting block = 5 cm or 2 in.
 - b. Spacing as calculated by the GC868 = 0.5 in. or 12.5 mm
 - c. Second mounting block final location = 2 + 0.5 in. = 3.5 in. or 5 cm + 1.25 cm = 6.25 cm

The overall spacing between yokes should be left edge to left edge, or right edge to right edge. *Figure 27* below shows typical positioning.

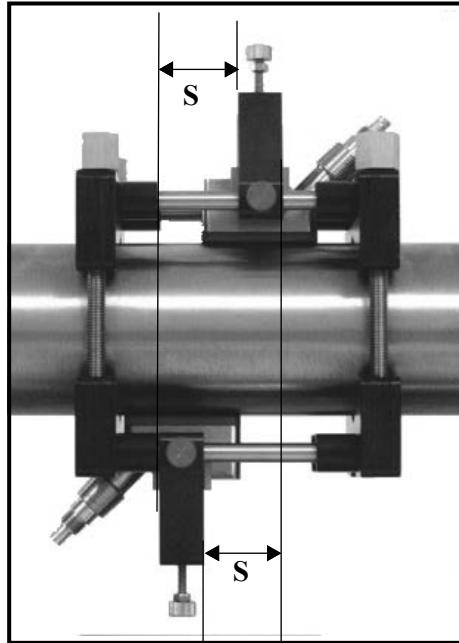


Figure 27: V4 Fixture, Top View

4. In a similar manner, install the second transducer as shown in *Figure 27* above.

2.5 Electronic enclosure accessibility

Typically, the enclosure is mounted as close as possible to the transducers. When choosing a site for remote mount installation, make sure the location permits easy access to the electronics enclosure for programming, maintenance, and service. The maximum standard distance is 1000 feet (300 meters). If longer cable is required, please consult Panametrics for assistance.

Note: For compliance with the European Union's Low Voltage Directive, this unit requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit.

See figure below for mounting the XMT1000 electronics.

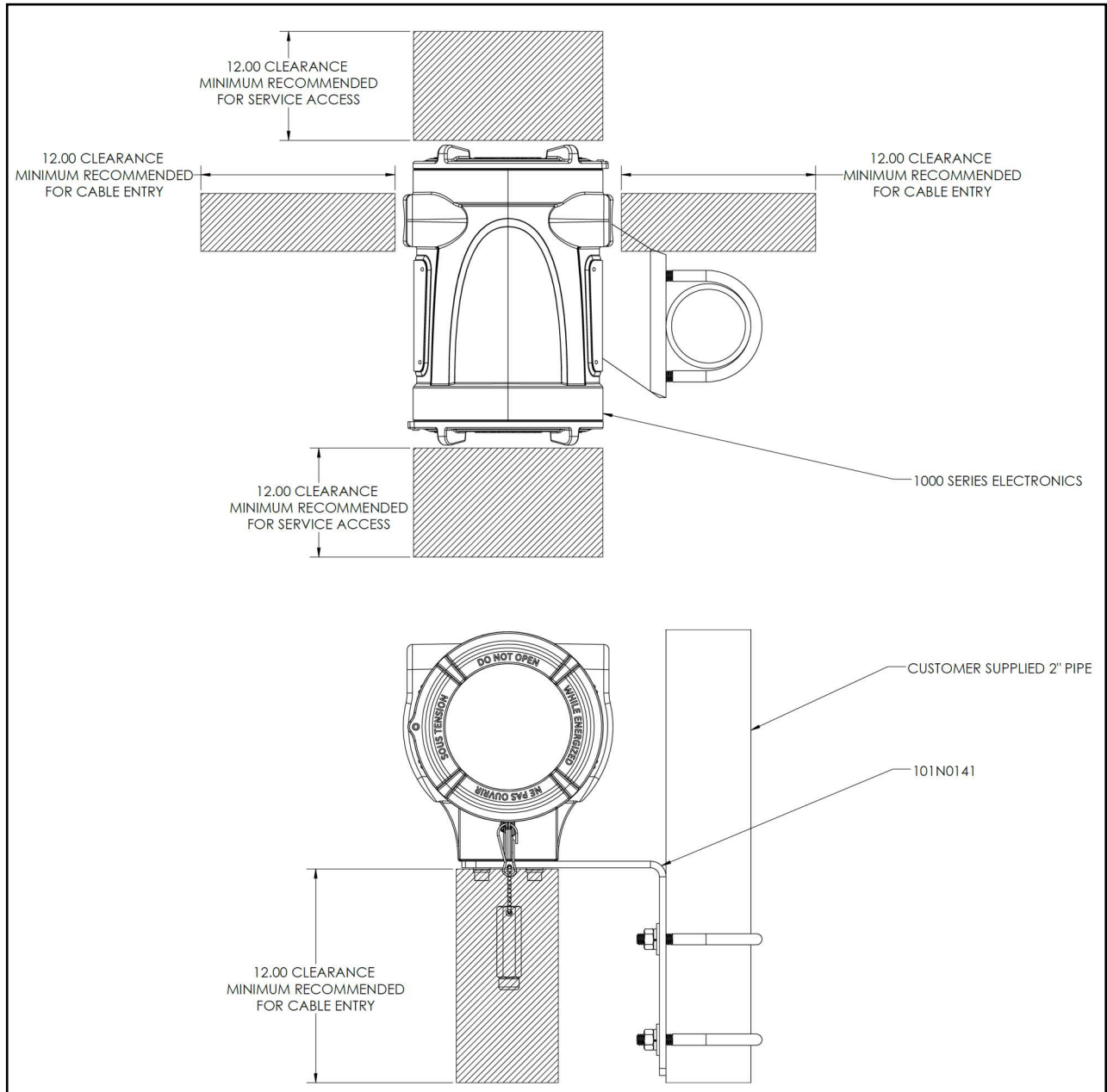


Figure 28: XMT1000 Enclosure clearances (ref. dwg. 712-2164)

2.6 Wiring instructions

Please refer to the XMT1000 User Manual for wiring of:

- Analog outputs
- Digital outputs (totalizer, frequency, calibration)
- Modbus or Service port
- Hart or Foundation Field Ports (if applicable)
- Additional analog input or output (if applicable)
- Additional SIL analog output (if applicable)
- Transducer (flying leads)
- Line power

2.6.1 Three Channel Setup

The XMT1000 User manual details wiring for a one or two channel installation. However, for a three channel system, please follow the instructions below.

Components of a three channel PanaFlow LC will be: a meter head, 6 conductor “trunk” cable, 3 channel junction box, 6 transducer cables and 3 sets of transducers and clamping fixtures. Mount meter head and junction box to a two inch post using included hardware or another location following local electrical and building codes.

Install transducers as mentioned in *Section 2.4.3.3 “Installation of Transducer”*. Prepare to wire transducer cables.

Note: *US/ Canada installations will be required to provide conduit per their particular location. European installations will include armored cable.*

2.6.1.1 Transducer Wiring (ATEX installations)

1. Thread MCX end of 6 conductor cable trunk into XMT1000 meter head and the BNC connector end of the cable into the 3 channel Junction box as seen in *Figure 29*.

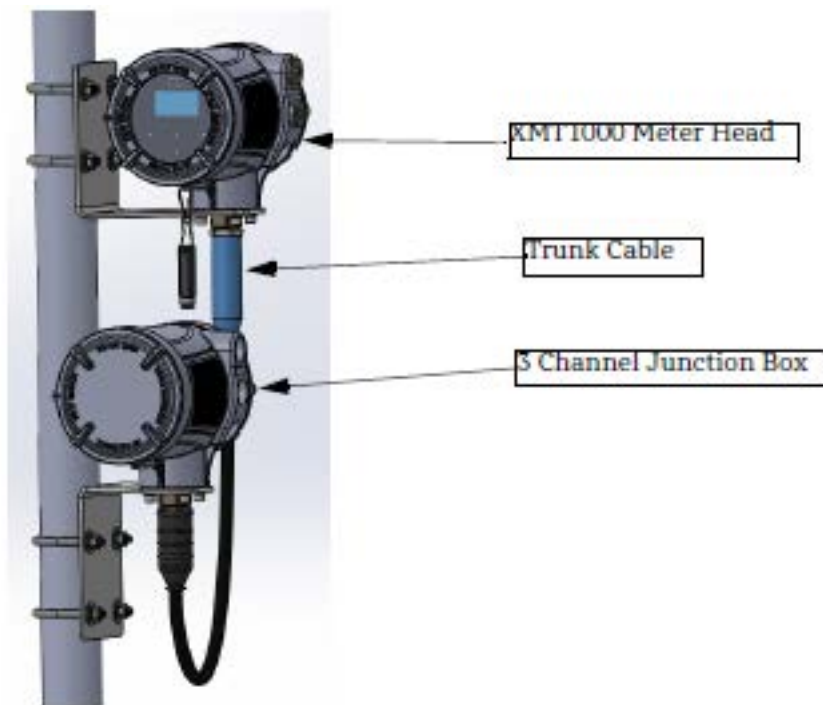


Figure 29: XMT1000 Trunk cable Placement

- Thread one end of transducer cables into 3 channel junction box as shown in *Figure 30*. (Cable locations in *Figure 30* are for reference only. Transducer cables can be placed in any orientation)

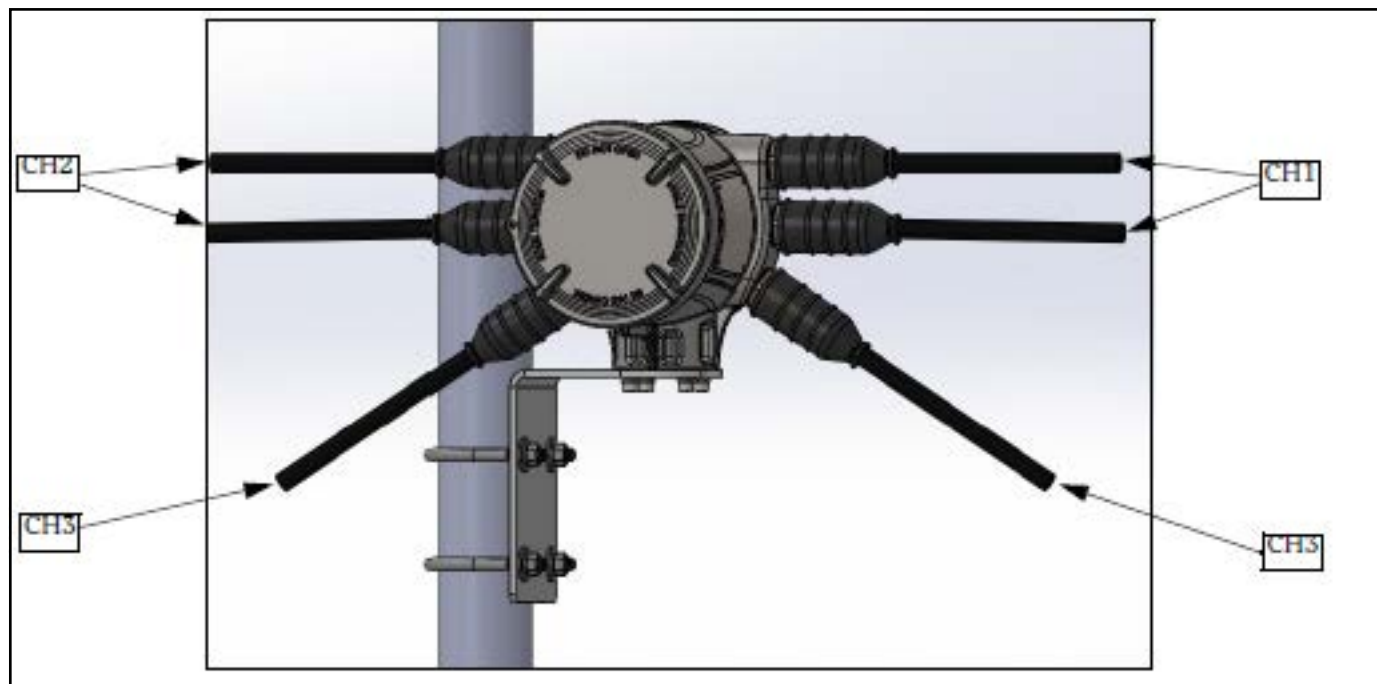


Figure 30: XMT1000, 3 Channel Junction Box

- Thread CHI UP transducer cable into upstream junction box of the transducer set you will use for channel one. Repeat for CHI DN and remaining channels.
- Remove cover on transducer junction box and terminate BNC end of transducer cable to the BNC on the transducer for each channel. Replace junction box covers.
- Open cover to 6 channel junction box and make connections between transducer cable BNCs and trunk cable BNCs. Verifying transducer cables have the same channel labels as the trunk cable wires. Replace junction box cover.
- Open the back lid of the XMT1000 meter to access the wiring connections of the meter.
- Connect the MCX ends of the 6-connector cable to the corresponding labeled MCX connector in the back of the XMT1000 meter. UPI must connect to UPI and so on.

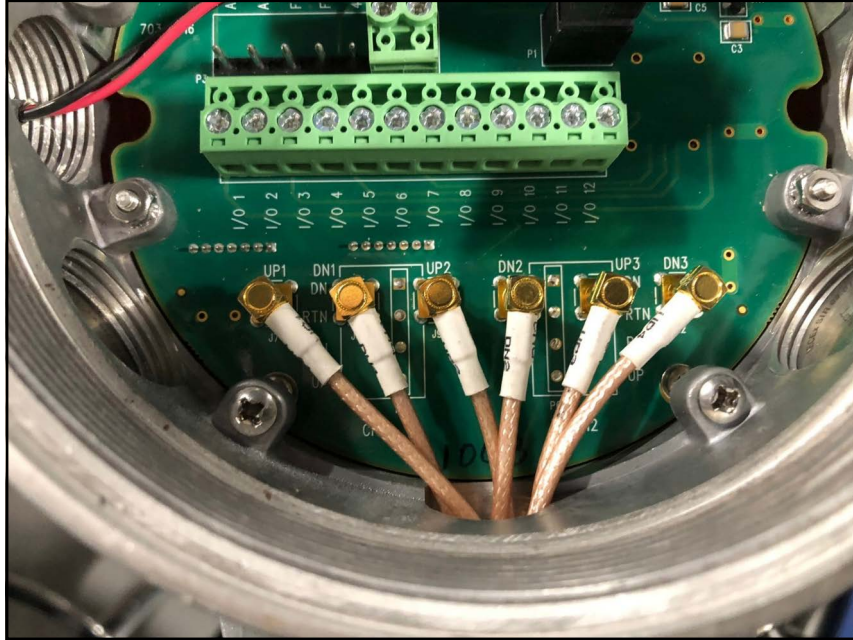


Figure 31: XMT1000 3-Channel Backplane

Chapter 3. Programming

3.1 Introduction

This chapter has instructions for programming various features of the *PanaFlow LC* flow transmitter. In this chapter, we will list all available options. The user can then change the *User Preferences* and *Inputs/Outputs* settings, *Programming* for flow measurements and *Calibration* to meet their needs.

IMPORTANT: Only qualified and trained personnel are allowed to change and validate Safety parameters. Please refer to the XMT1000 safety manual for details on these parameters. Not all users will have access to all of the menus. Some menus are restricted to only those users with the proper passcodes.

3.1.1 HMI Features



Figure 32: PanaFlow LC HMI

The six keys on the magnetic keypad are used to program the PanaFlow LC:

Key Symbol	Key Name	Functions
✘	Escape Key	To cancel a numeric entry change, exit a menu or as Back key
✔	Enter Key	To accept a numeric entry or select a menu option
◀	Left Arrow Key	To navigate among menu choices, pages or set cursor position
▶	Right Arrow Key	To navigate among menu choices, pages or set cursor position
▲	Up Arrow Key	To navigate among menu choices, pages or increase/decrease numeric entries
▼	Down Arrow Key	To navigate among menu choices, pages or increase/decrease numeric entries

3.1.2 Indicator Lights

- The blue light on the top right above the display is the **Power Indicator** that is normally lit when the instrument is powered.
- The red light on the top left above the display is the **Error Indicator**. The *Error Indicator* light blinks if an instrument error is detected. A short error message will be displayed in the lower left-hand corner of the *Measurement View*. If the instrument is operating without error, red light is turned OFF.

3.2 Passcodes

IMPORTANT: Not all users will have access to all of the menus. Some menus are restricted to only those users with the proper passcodes.

The default passcodes for the PanaFlow LC flow transmitter are:

- Keypad Lockout Password, default (fixed) = 102719 [this password cannot be changed]
- Operator Password, default (changeable) = 111111
- Software Upgrade Password, System Generated specific for the System Serial Number [this password cannot be changed].

IMPORTANT: Panametrics recommends changing all default (changeable) passwords after commissioning the meter.

3.2.1 Unlock from Keypad Lockout

After power up, if the meter's *Measurement View* (Refer *Figure 33*) shows a lock icon  on the top right of the display, use the following steps to unlock the meter from keypad lockout mode.

- Press ESC-ENT-ESC [\times \checkmark \times] followed by either "Operator" password or the "Keypad Lockout" password. The lock icon  on the top right of the display will show an open lock indicating the meter keypad is unlocked.

3.3 Measurement View Pages

3.3.1 Measurement View

On power up, the PanaFlow LC meter shows the following screens:

- Panametrics Logo screen
- Meter Initialization screens
- Power-on self-tests and results
- Finally, the *Measurement View* (Refer *Figure 33*)

This screen (Refer *Figure 33*) will be referred to as "*Measurement View*" throughout this chapter. User can choose the measurement to be displayed in this view from a list of options. The Error indicator at the bottom left of the display will be blank if the meter has no error.

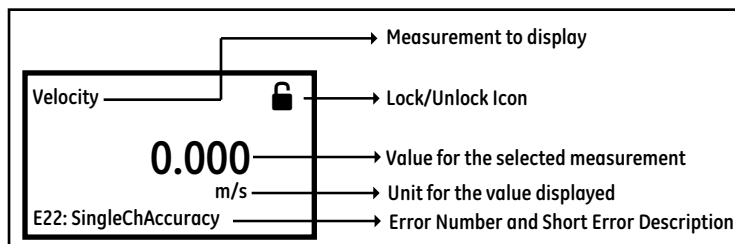


Figure 33: Measurement View

3.3.1.1 Changing Display Format

To change Display Format, do the following steps and refer *Figure 34*.

1. Press [▶] until the lock icon on the meter's *Measurement View* display is highlighted, and press [ENTER].
2. In the *Main Menu* select [Display Format], then press [ENTER].
3. Select [One Variable] or [Two Variable] or [Totalizer] format to suit your needs.

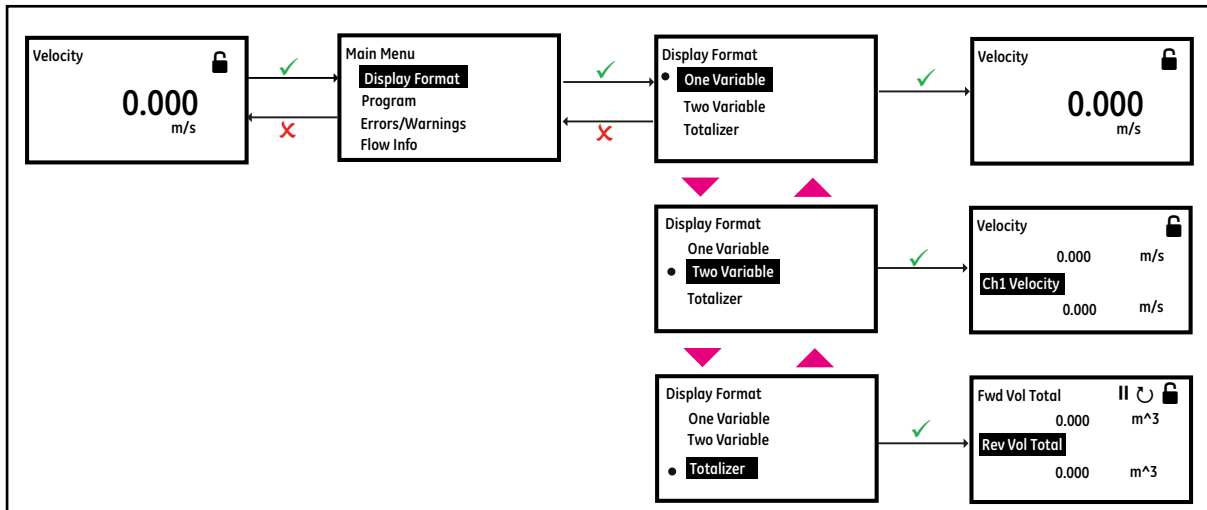


Figure 34: Changing Display Format

3.3.1.2 Selecting a Composite Measurement to Display

To select a composite measurement to display on the *Measurement View*, do the following steps and refer *Figure 35*.

1. Press [▶] until the Measurement name on the meter's Measurement View display is highlighted, and press [ENTER].
2. In the *Display Measurement* select [Composite], then press [ENTER].
3. Then, select the measurement you would like to see on the *Measurement View* and press [ENTER].

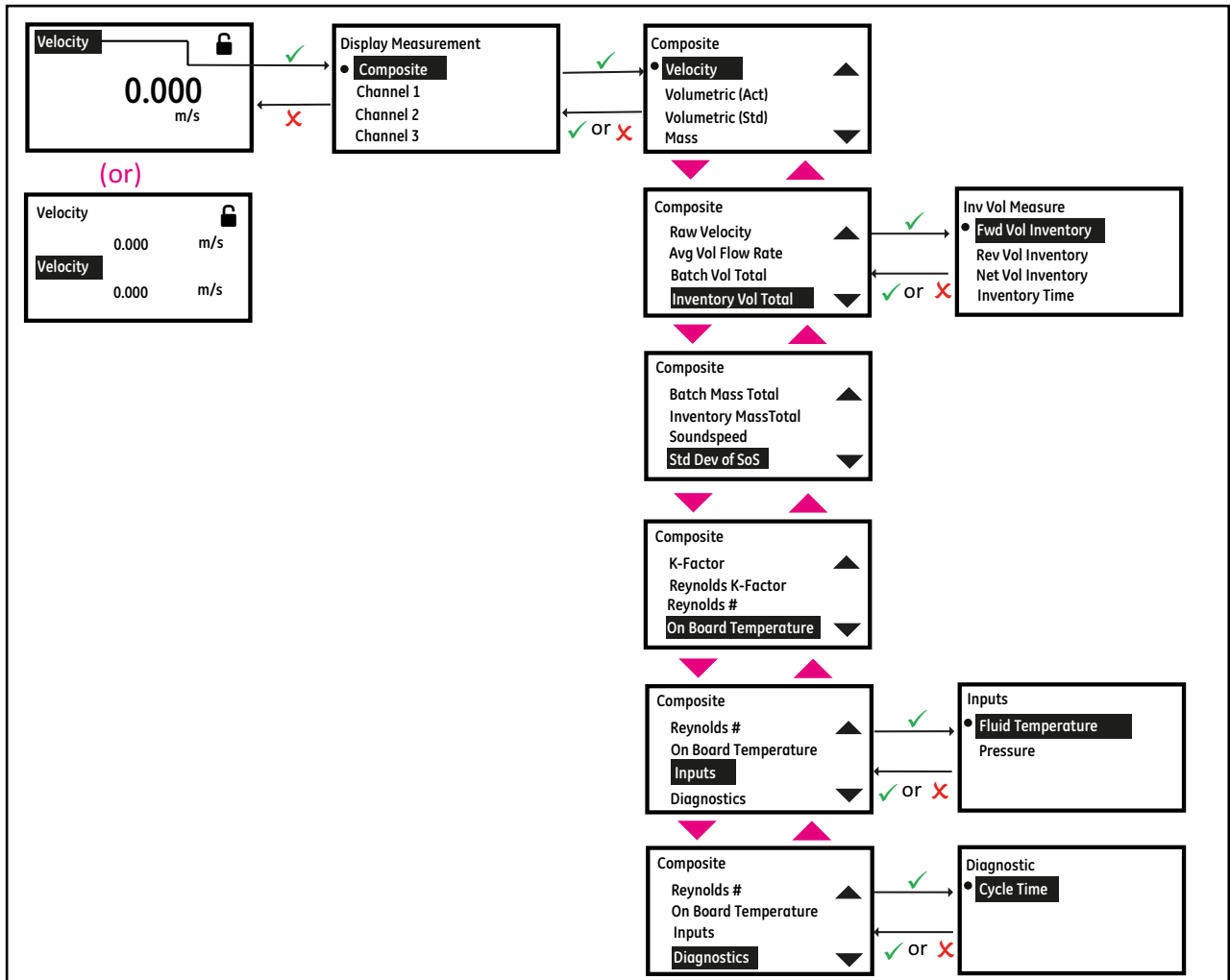


Figure 35: Selecting a Composite Measurement to Display

3.3.1.3 Selecting a Channel Measurement to Display

To select a Channel measurement to display on the *Measurement View*, do the following steps and refer *Figure 36*.

1. Press [▶] until the Measurement name on the meter's *Measurement View* display is highlighted, then press [ENTER].
2. In the *Display Measurement* select [Channel x], then press [ENTER].
3. Then, select the measurement you would like to see on the *Measurement View* and press [ENTER].

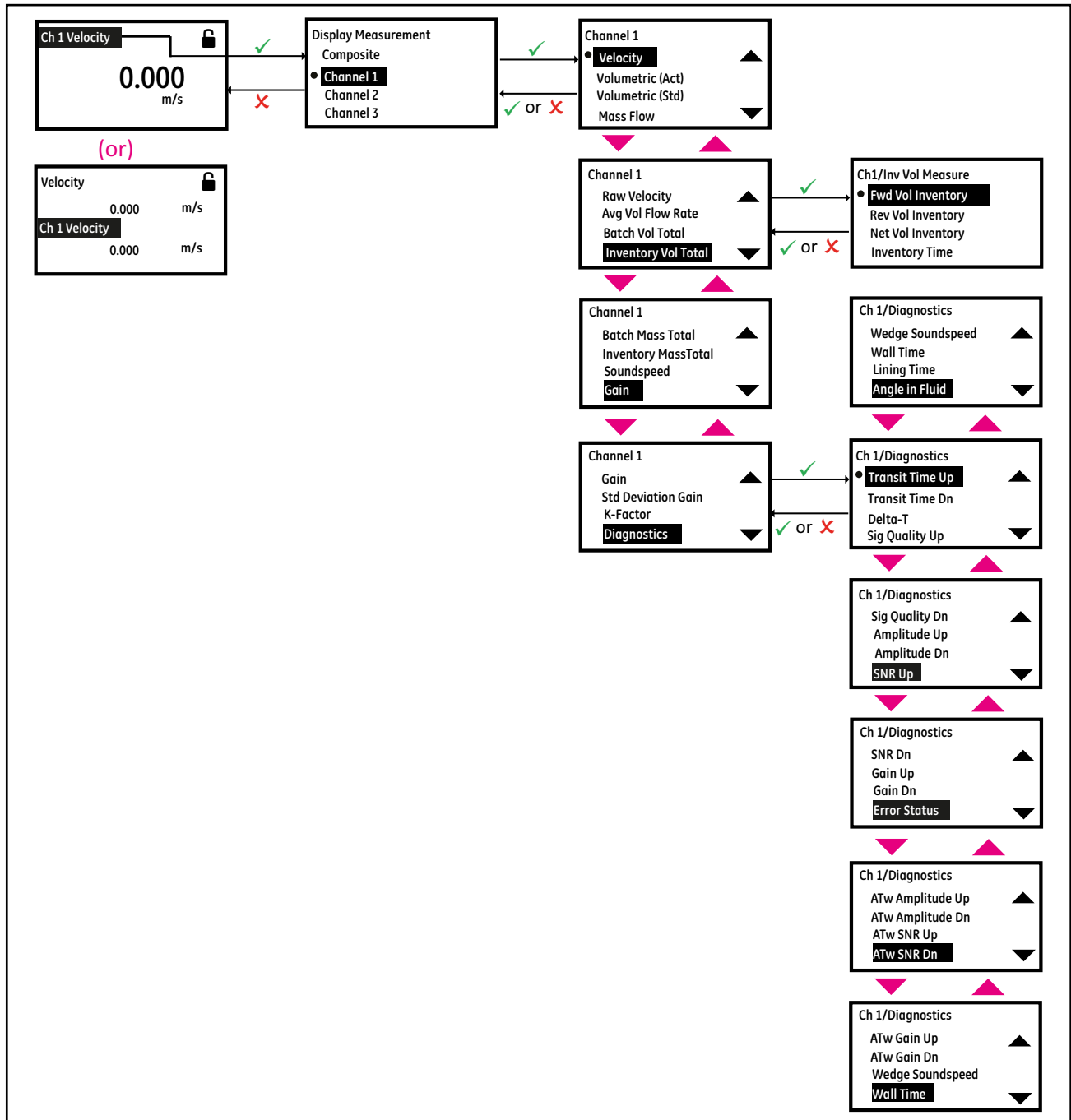


Figure 36: Selecting a Channel Measurement to Display

3.3.1.4 Totalizer Display

The Totalizer display on the *Measurement View* shows the totaled measurements and provides the ability to start, stop and reset totals. Refer to *Figure 34* to set Display format to Totalizer. Do the following steps to select the appropriate Totalizer measurements to view on the *Measurement View*. Refer to *Figure 37*.

1. Press [▶] button on the keypad until the Measurement name on the meter's *Measurement View* display is highlighted, and press [ENTER].
2. In the *Display/Totalizer*, select [Composite] or [Channel x], then press [ENTER].
3. Then, select the totalizer measurement you would like to see on the *Measurement View* and press [ENTER].
4. Press [▶] button on the keypad until the [|| or ▶] is highlighted to stop or start the totalizing respectively.
5. Press [▶] button on the keypad until the [⏪] is highlighted to reset/clear the totaled measurements.

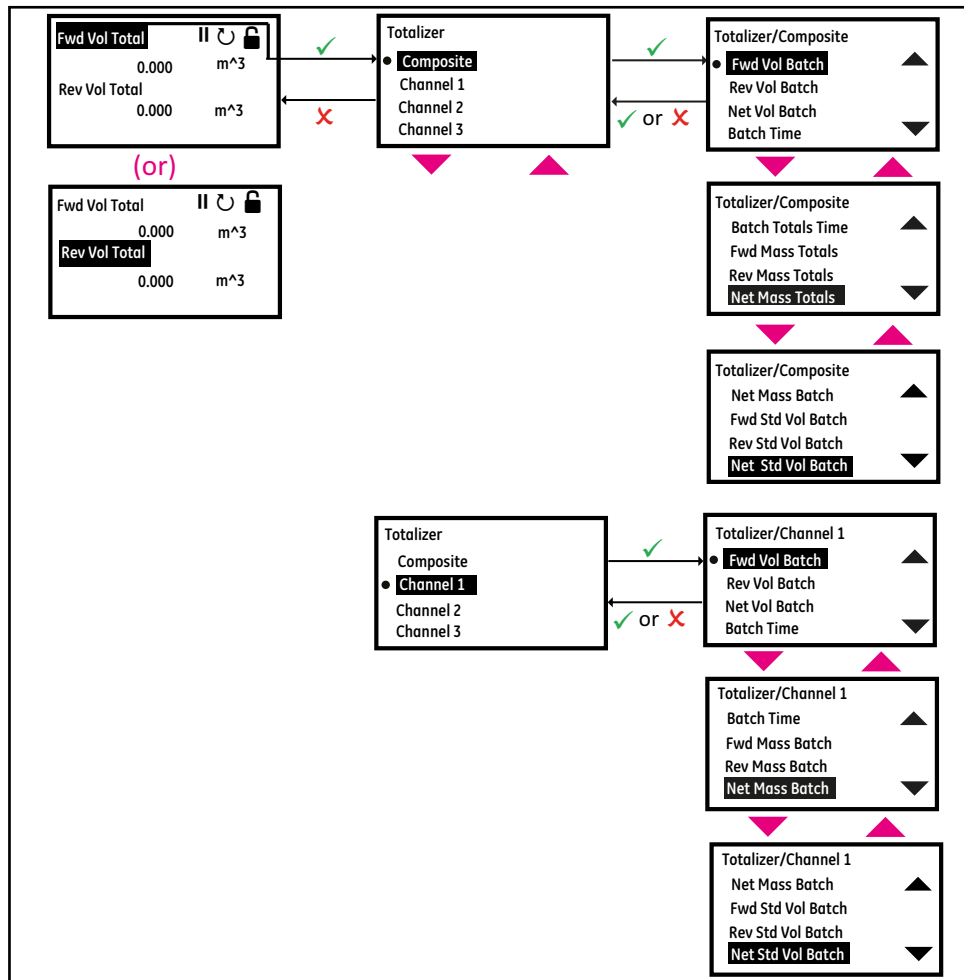


Figure 37: Selecting Totalizer Measurements for Display

3.3.2 Log-in and Primary Pages

To Log-in into the meter perform the following steps:

1. Press [▶] until the lock icon on the meter's *Measurement View* display is highlighted, then press [ENTER].
2. In the *Main Menu* Scroll down and select [Program], then press [ENTER].
3. Scroll and select desired access level [Operator], then press [ENTER].
4. Enter the password Operator access level, and press [ENTER].

5. After completing the log-in steps you will see the primary pages as shown in the *Figure 38*. To move from one page to the next, press [◀] or [▶] and to scroll to options within a page press [▲] and [▼].

Note: For ease of navigation up and down scroll is circular, meaning if you press [▲] when the first option is highlighted, then you will be taken to the last option in the page. Similarly, when you press [▼] when the last option is highlighted, then you will be taken to the first option in the page.

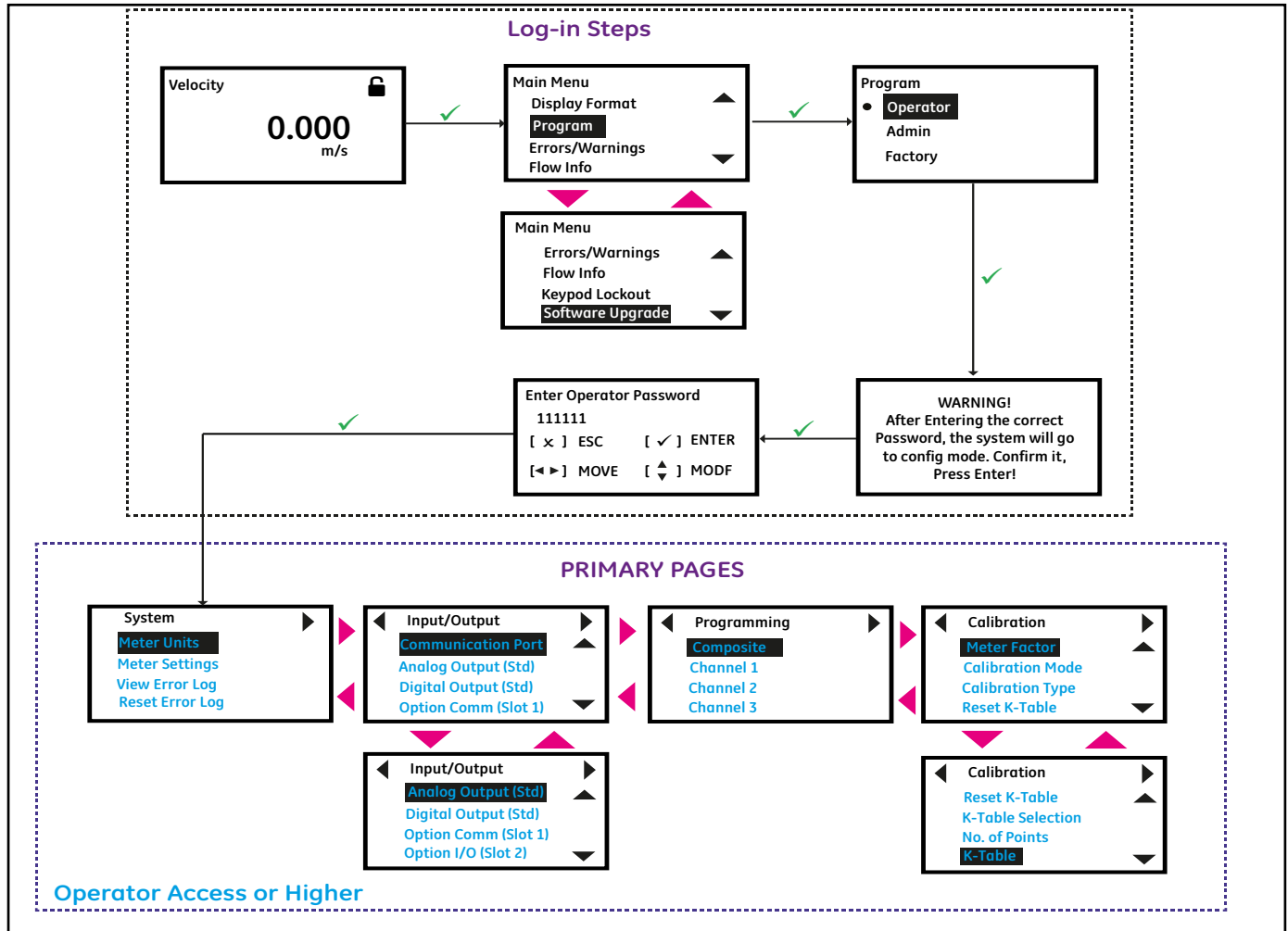


Figure 38: Log-in Steps and Primary pages

IMPORTANT: If the keypad has not been pressed for 5 minutes, the PanaFlow LC exits the Program and returns to displaying measurements. Because changes can only be retained after the user confirms them, the meter discards any unconfirmed configuration changes.

3.4 Main Program

Please refer to the XMT1000 User manual for detailed programming of the XMT1000 Electronics such as System Settings, Inputs/Outputs, Wetted Meter Programming, and Calibration. See chapter "Programming" for instrument programming step-by-step instructions, or refer to appendix "Menu map" for the full menu map reference guide.

Chapter 4. Error Codes and Troubleshooting

4.1 Introduction

The XMT1000 flow transmitter is a reliable, easy to maintain instrument. When properly installed and operated, as described in Chapter: Installation, the meter provides accurate flow rate measurements with minimal user intervention. However, if a problem should arise with the electronics enclosure or transducers, this chapter explains how to troubleshoot the XMT1000 flow meter. Indications of a possible problem include:

- Display of an error message on the LCD screen, Vitality PC software, or HART
- Erratic flow readings
- Readings of doubtful accuracy (e.g., readings that are not consistent with readings from another flow measuring device connected to the same process).

If any of the above conditions occur, proceed with the instructions presented in this chapter.

Note: For high electrical noise areas, it is recommended that you use the CE Installation methods in Appendix B.

4.2 Error Classification and Error Codes

The XMT1000 electronics includes two or more subsystems. The Transmitter, Flow Measurement unit and/or Option I/O. The purpose of the Error codes and string is to convey to the operator about the issues in the specific subsystem. The communication error indicates that the Transmitter subsystem has lost communication with Flow measurement sub-system or the Option I/O sub-system.

Errors in XMT1000 are classified into 5 types as indicated in the table below:

Table 2: XMT1000 error classification

Error Classification	Error Number	Subsystem
Flow Errors	E_n where n is the Error number	Flow subsystem
System Errors	S_n where n is the Error number	Transmitter or Flow subsystem
Communication Errors	C_n where n is the Error number	Transmitter to Flow or Option I/O
Transmitter Errors	X_n where n is the Error number	Transmitter subsystem
Option I/O Errors	A_n where n is the Error number	Option I/O subsystem

If a problem occurs with the electronics or transducers, a built-in error code message system greatly simplifies the troubleshooting process.

All the possible XMT1000 error code messages are discussed in this chapter, along with the possible causes and the recommended actions. When an error code is generated, it will appear in the lower left corner of the LCD screen, as discussed in Programming Chapter.

If an error message appears on the display screen during operation of the XMT1000, refer to the appropriate section of this chapter for instructions on how to proceed. You may be asked to contact Panametrics. Providing all of the diagnostic data and parameter information as in the *Diagnostics Data Table* prior to calling your local sales or service center will help to speed up the issue resolution.

In addition to the local display, error messages are provided in the relevant Modbus register using bit-field representation. For the location of the appropriate register see *Appendix C, Error code bit-field representation*

4.3 Flow Errors (E-Errors)

4.3.1 General Guidelines for Troubleshooting Flow Errors with Error codes

If the Error code on the LCD or Vitality PC software indicate E22: SingleChAccuracy or E23: MultiChAccuracy, refer to the appropriate section below. Also, refer to *Table 3* below for causes and recommended actions for each Error code.

4.3.1.1 Single Channel Error

If only one channel is in error, the most likely causes are:

1. Incorrect programming on Error Limits or flow condition changes that now make previous programming invalid.
2. Defective/Damaged cables, transducers, incorrect physical spacing, couplant, buffer or electronics.

After you have tried eliminating/correcting for any most likely causes mentioned above, if error still exists, also check Process/flow conditions such as:

1. Excessive turbulence.
2. Discontinuities in fluid characteristics such as multi-phase flow, flashing, pockets of gas, presence of bubbles or solid particles, cavitation or rapidly changing fluid type.
3. Extreme fluid properties, such as pressure or temperature.
4. Wax build-up inside the pipe.
5. Half-full pipe.

4.3.1.2 Multi-Channel Error

If more than one channel is in error, the most likely cause is changes in process/flow conditions such as:

1. Excessive turbulence.
2. Discontinuities in fluid characteristics such as multi-phase flow, flashing, pockets of gas, presence of bubbles or solid particles, cavitation or rapidly changing fluid type.
3. Extreme fluid properties, such as pressure or temperature.
4. Wax build-up inside the pipe.
5. Partially filled pipe.

After you have tried eliminating/correcting for any most likely causes mentioned above, if error still exists, also check:

1. Incorrect programming on Error Limits or flow condition changes that now make previous programming invalid.
2. Defective/Damaged cables, transducers, incorrect physical spacing, couplant, buffer or electronics.

In case you are unable to clear the errors, collect diagnostic data and parameter information for each channel in the *Diagnostics Data Table* prior to calling your local sales or service center.

4.3.1.3 Viewing Channel Specific Error/Warnings

To indicate the health of the meter, PanaFlow LC has built-in Error codes. The Channel specific errors are very critical in determining the corrective actions required. *Figure 39* below shows the steps to view current channel specific errors/warnings. The description of the Error Codes and the recommended actions are provided in *Table 3* below.

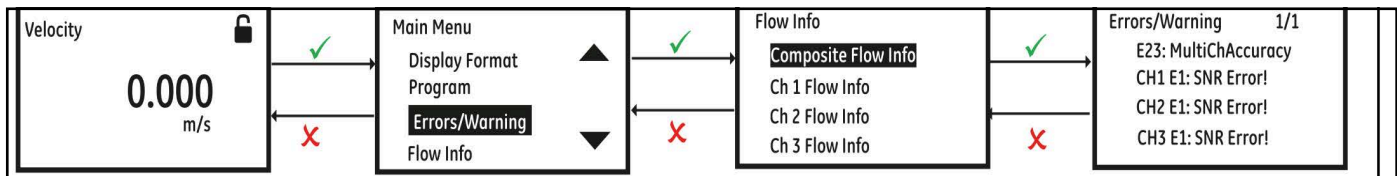


Figure 39: Viewing Current Channel Specific Errors

Table 3: Flow Error description and Recommended Actions

Error Code	Problem	Cause	Recommended Action
E1: SNR	The Signal to Noise ratio is low	The acoustic signal from the process is very weak. This could be due to bubbles, other fluid conditions, an empty pipe, broken cables, transducers, couplant or buffers	Check if the Active Tw measurement on upstream and downstream transducers is valid. If Active Tw measurement is valid then this error is an indication of the problem with the process conditions. If Active Tw measurement is not valid then check the value entered in SNR Min Error Limits option (Refer Programming Chapter). Also, refer to "Fluid and Pipe Problems" and "Transducer Problems" sections to correct for any issues
E2: Soundspeed	The measured sound speed exceeds programmed limits	The error may be caused by incorrect programming, poor flow conditions or poor transducer orientation. It may also occur if signal quality is poor	Compare the measured sound speed to programmed nominal values for the process fluid and correct any programming errors. Refer to "Fluid and Pipe Problems" and "Transducer Problems" sections to correct for any issues. In case you are unable to clear the errors, gather the required diagnostics before contacting Panametrics
E3: Velocity Range	The measured velocity exceeds programmed limits	This error may be caused by incorrect programming, poor flow conditions and/or excessive turbulence	Make sure the actual flow rate is within the programmed Error limits (Refer Programming Chapter). Refer to "Fluid and Pipe Problems" and "Transducer Problems" sections to correct any issues
E4: Signal Quality	The signal quality is lower than the programmed limits	This means the signal shape, upstream to downstream reciprocity, or signal correlation value has fallen below the correlation peak limit. The cause is usually the same as E6 or E5	Make sure the Signal Quality is greater than the programmed Error limits (Refer Programming Chapter). Refer to "Fluid and Pipe Problems" and "Transducer Problems" sections to correct any issues. Gather required diagnostics data before contacting Panametrics
E5: Amplitude	The signal amplitude exceeds the programmed limits	This error may occur due to high signal attenuation or amplification due to changes in fluid properties, transducer, buffer and/or couplant issues	Make sure the amplitude is within the programmed limits. If the gain is negative and Amplitude > 32, change the Transmit Voltage to "Low". If it is still negative, enable Attenuator. Do not enable Attenuator if the Transmit Voltage is high. If the gain is greater than 35 dB, change the Transmit Voltage to "High" (Refer Programming Chapter). Refer to "Fluid and Pipe Problems" and "Transducer Problems" sections to correct any issues. Gather required diagnostics data before contacting Panametrics

Table 3: Flow Error description and Recommended Actions

Error Code	Problem	Cause	Recommended Action
E6: Cycle Skip	A cycle skip is detected while processing the signal for measurement	This is usually due to poor signal integrity, possibly because of bubbles in the pipeline, sound absorption by very viscous fluids, or cavitation	If this error is caused by changes in flow rate, this error will be auto corrected when flow rate stabilizes after initial acceleration. But, if the error stays refer to <i>"Fluid and Pipe Problems"</i> section to correct any issues. Check Threshold Peak percentage, and gather required diagnostics data before contacting Panametrics
E15: Active Tw	The Active Tw measurement is invalid	A transducer, cable is damaged, or a transducer needs to be re-coupled. This may also be due to incorrect programming, or extreme process temperatures	Refer to <i>"Transducer Problems"</i> sections to correct any issues. In case you are unable to clear the errors, gather required diagnostics before contacting Panametrics
E22: Single Channel Accuracy	One of the measurement channels is in error	One measurement channel is in error; accuracy of the measurement may be compromised because the meter might be using a sister chord substitution	Check individual channel errors, refer to this table for recommended actions to correct channel errors
E23: Multi Channel Accuracy	Two or more measurement channels are in error	Two or more measurement channels are in error; accuracy of the measurement may be compromised because the meter is using a sister chord substitution	Check individual channel errors, refer to this table for recommended actions to correct channel errors
E27: Invalid K-Table	K-Table is invalid	The entered K-table is invalid	Check the K-table values and ensure the Velocity or Reynolds Number in the table is in ascending order
E28: Software Fault	Software malfunction	This is a Software malfunction.	This condition is not self-recovering and will not automatically correct itself. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory.
E29: Velocity Warning	The measured velocity exceeds programmed warning limits	This error may be caused by incorrect programming, poor flow conditions and/or excessive turbulence	Make sure the actual flow rate is within the programmed Warning limits (Refer Programming Chapter). Refer to <i>"Fluid and Pipe Problems"</i> and <i>"Transducer Problems"</i> sections to correct any issues
E31: Not Calibrated	The flow meter has not been calibrated	The flow meter has not been calibrated at the factory and hence not making measurements. Please contact Panametrics factory	The condition is not self-recovering and will not automatically correct itself. Contact Panametrics factory to get more information on the meter setup

4.4 Fluid and Pipe Problems

If preliminary troubleshooting with the *Error Code Messages* and the *Diagnostic Parameters* indicates a possible problem, proceed with this section. Measurement problems fall into two categories:

- Fluid problems
- Pipe problems

Read the following sections carefully to determine if the problem is related to the fluid or the pipe. If the instructions in this section fail to resolve the problem, contact Panametrics for assistance.

4.4.1 Fluid Problems

Most fluid-related problems result from a failure to observe the flow meter system installation instructions, as described in Chapter: Installation.

If the physical installation of the system meets the recommended specifications, it is possible that the fluid itself may be preventing accurate flow rate measurements. The fluid being measured must meet the following requirements:

- *The fluid must be homogeneous, single-phase, relatively clean and flowing steadily.*
Although a low level of entrained particles may have little effect on the operation of the XMT1000, excessive amounts of solid particles will absorb or disperse the ultrasound signals. This interference with the ultrasound transmissions through the fluid will cause inaccurate flow rate measurements. In addition, temperature gradients in the fluid flow may result in erratic or inaccurate flow rate readings.
- *The fluid must not cavitate near the measurement point.*
Fluids with a vapor pressure relatively close to process pressure may cavitate near the measurement point. Cavitation can usually be controlled through proper system design.
- *The fluid must not excessively attenuate ultrasound signals.*
Some fluids, particularly those that are very viscous, readily absorb ultrasound energy. In such a case, signal warning and error message will appear on the display screen to indicate that the ultrasonic signal strength is insufficient for reliable measurements.
- *The fluid soundspeed must not vary excessively.*
The XMT1000 will tolerate relatively large changes in the fluid sound speed, as may be caused by variations in fluid composition and/or temperature. However, such changes must occur slowly. Also, fluctuations in fluid sound speed due to changes in temperature will likely recover independently. Rapid fluctuations in the fluid sound speed, to a value that is beyond $\pm 20\%$ from that programmed into the XMT1000, will result in erratic or inaccurate flow rate readings. This may occur when changing batch fluids.

Note: Refer to Chapter 3: Programming, to make sure the appropriate soundspeed is programmed into the meter.

4.4.2 Pipe Problems

Pipe-related problems may result from improper choice in meter location or errors in programming. The following may result in problematic installations:

- *The collection of material at the transducer location(s).*
Accumulated debris at the transducer locations will interfere with the transmission of the ultrasound signals. As a result, accurate flow rate measurements are not possible. Realignment of the transducers often corrects these problems but, in some cases, wetted transducers must be used. Refer to *Chapter: Installation* for more details on proper installation practices.
- *Inaccurate pipe measurements.*
The flow rate measurement accuracy relies greatly on the accuracy of the programmed pipe dimensions. Measure the pipe wall thickness and diameter with the same accuracy desired in the flow rate readings. Also, check the pipe for dents, pitting or rough surfaces, eccentricity, weld deformity, straightness and other factors that may cause inaccurate readings. Refer to the *Chapter: Programming*, for instructions on entering the pipe data.
- *The inside of the pipe or pipe is not sufficiently clean.*
Excessive buildup of scale, rust or debris inside the pipe will interfere with flow measurements. Generally, a thin coating or a solid well-adhered build up on the pipe wall will not cause problems. Loose scale and thick coatings (such as tar or oil) will interfere with ultrasound transmission and may result in incorrect or unreliable flow rate measurements.

4.5 Transducer Problems

Ultrasonic transducers are rugged, reliable devices. However, they are subject to physical damage from mishandling and chemical attack. The following list of potential problems is grouped according to transducer type. Contact Panametrics if you cannot solve a transducer-related problem.

4.5.1 Transducer Problems

- **Internal Damage:** An ultrasonic transducer consists of a ceramic crystal bonded to the transducer case. The bond between the crystal and the case or the crystal itself may be damaged by extreme mechanical shock and/or temperature extremes. Also, the internal wiring can be corroded or shorted if contaminants enter the transducer housing.
- **Physical Damage:** Transducers may be physically damaged by dropping them onto a hard surface or striking them against another object. The transducer connector is the most fragile part and is most subject to damage. Minor damage may be repaired by carefully bending the connector back into shape. If the connector can not be repaired, the transducer must be replaced.

IMPORTANT: Transducers must be replaced in pairs. Refer to *Appendix 3, Programming* to enter the new transducer data into the meter.

4.6 System Errors (S-Errors)

These errors are from the Flow subsystem. The system errors have 4 types of information.

1. Indicator
2. Warning
3. Error
4. Fault

The indicator is just a notification to the operator, no action is needed. The warnings are usually indicative of an operator error. Errors indicate failures that need attention. Operator should perform recommended actions to recover from these errors. Faults are usually indicative of more serious failures related to background hardware / software integrity checks performed by XMT1000 meter. See the table below for error codes, error messages, error type and recommended actions.

Table 4: System Error Description and Recommended Actions

Error Code	Error Message	Description / Recommended Action
S1: In Config Mode	In configuration mode indicator	Indicator: This is displayed when a user has logged in to either Operator, Admin or Factory access level. The indicator will clear automatically when the user logs out or saves the configuration changes
S2: Invalid User	Invalid user warning	Warning: The passcode entered for access level is incorrect. Please log in with the correct access level and passcode
S3: Invalid Request	Invalid request warning	Warning: An invalid communication packet was received and discarded. Or, the requested operation is invalid. Please send a valid packet or operation request
S4: Invalid Param Range	Invalid parameter range warning	Warning: The value programmed for the parameter was out of range and hence discarded. Please enter a valid range
S5: Unsupported Parameter	This parameter is not supported	Warning: A read or write request to an unsupported parameter was received
S6: Flow Measurement	One or more flow measurement channels are in error	Error: One or more flow measurement channels are in error; accuracy of the measurement may be compromised. For more details please check flow(E) errors
S7: Persistent Param CRC	Persistent parameter CRC fault	Fault: Persistent parameter CRC failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory

Table 4: System Error Description and Recommended Actions

Error Code	Error Message	Description / Recommended Action
S11: Clock Frequency	Clock frequency error	Fault: Input clock frequency failure. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S12: CPU	CPU error	Fault: CPU registers have stuck bits. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S13: Invariable Flash Memory	Flash memory fault	Fault: Flash memory test failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S14: Invariable SRAM	Invariable SRAM fault	Fault: Invariable SRAM memory test failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S15: Variable Memory	Variable SRAM fault	Fault: Variable SRAM test failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S16: FPGA Config	FPGA configuration error	Fault: FPGA configuration validation failure. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S17: Temperature	Temperature error	Error: Temperature of the electronics is outside the pre-defined operating range. Make sure that the ambient temperature is not outside the meter operating range
S18: Driver Fault	Driver failure	Fault: Driver failure. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S19: Watch Dog Failure	Watch dog failure	Fault: Watch dog test failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S21: Stack Overflow	Stack overflow	Fault: Stack overflow. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S22: Sequence or Window Watchdog	Sequence failed	Fault: Sequence failure detected. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S23: Initialization Failed	Initialization failed	Error: Initialization failed. Please verify all the configuration parameters. If error persists, contact Panametrics factory
S24: DSP Hardware Errors	DSP hardware failed	Fault: DSP hardware failure detected. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S25: DSP Exception	DSP exception	Fault: DSP exception. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S26: Default ISR	Exception within the ISR	Fault: Exception within the ISR. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S27: DSP Reset ISR	Exception within the DSP ISR	Fault: Exception within the DSP ISR. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S28: Software Fault	Software malfunction	Error: Software malfunction. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory

Table 4: System Error Description and Recommended Actions

Error Code	Error Message	Description / Recommended Action
S29: Output A Loop Open!	SIL Analog Output Open Error	Fault: SIL Analog Output is disconnected. Connect the SIL Analog output and try power cycling the meter. If error persists after power cycle, contact Panametrics factory
S30: Flash Save Failed	Save to Flash Failed	Error: Request to Save failed. Try again. If error persists, contact Panametrics factory.

4.7 Communication Errors (C-Errors)

The communication error indicates that the Transmitter subsystem has lost communication with Flow measurement sub-system or the Option I/O sub-system.

Table 5: Communication Error Description and Recommended Actions

Error Code	Error Message	Description / Recommended Action
C1: Flow COMM Error	Flow board communication error	Transmitter cannot communicate to the flow measurement unit. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
C2: MODE MISMATCH	Mode Mismatch Error	Fault: Mode Mismatch Error, Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
C3: Option I/O COMM Error	Optional I/O subsystem communication error	Transmitter cannot communicate to the Optional I/O in Slot-2. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory

4.8 Transmitter Errors

These errors are from the Transmitter subsystem. Should you encounter one of the Transmitter Errors, follow recommended actions as indicated in *Table 6* and contact Panametrics factory.

Table 6: Transmitter Error Description and Recommended Actions

Error Code	Error Message	Description / Recommended Action
X1: MCU RAM Error	Transmitter RAM Fail	Memory test on transmitter RAM failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
X2: MCU Flash CRC Error	Flash memory test failed	Flash memory test failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
X7: MPU not Detected	No flow board detected	Flow board is not detected by the transmitter. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
X12: System Command Fail	System command failed	System command failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
X13: Get GUI Node Fail	Failed to generate GUI	Failed to generate GUI. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
X14: Node Memory Fail	GUI node memory failed	GUI node memory failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory

Table 6: Transmitter Error Description and Recommended Actions

Error Code	Error Message	Description / Recommended Action
X15: Font API Initialize Fail	Failed to generate font	Failed to generate font. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
X16: XML File Initialize Fail	XML file initialization failed	XML file initialization failed. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
X17: Disconnect Std Dout	Transmitter Error	Fault: Transmitter Error. Connect the digital input to meter. If error persists, contact Panametrics factory
X18: Aout(Std) Out Of Range	Transmitter Out Of Range Error	Fault: Transmitter Out Of Range Error, Configure analog out with in the range, If error persists, contact Panametrics factory

4.9 Option I/O Errors

Table 7: Option I/O Errors Description

Error Code	Error Message	Description
A1:AnalogCh(S2:3) Error!	ADC Channel(S2:3) is not responding	Analog input /RTD input is not working. If error persists after power cycle, contact Panametrics factory
A2:AnalogCh (S2:4) Error!	ADC Channel(S2:4) is not responding	Analog input /RTD is not working. If error persists after power cycle, contact Panametrics factory
A3:AnalogCh (S2:1) Error!	DAQ Channel (S2:1) is not responding	Analog output (4-20mA) is not working. If error persists after power cycle, contact Panametrics factory
A4:AnalogCh (S2:2) Error!	DAQ Channel (S2:2) is not responding	Analog output (4-20mA) is not working. If error persists after power cycle, contact Panametrics factory
A6:(S2:3)Ch Not Calibrated	Error occurs when Analog Input/RTD(S2:3) are not calibrated	Calibrate the Analog Input/RTD input. If error persists after calibration, contact Panametrics factory
A7:(S2:4)Ch Not Calibrated	Error occurs when Analog Input/RTD (S2:4) are not calibrated	Calibrate the Analog Input/RTD input. If error persists after calibration, contact Panametrics factory
A8: (S2:1)Ch Not Calibrated	Error occurs when Analog Input/RTD (S2:1) are not calibrated	Calibrate the Analog Input/RTD input. If error persists after calibration, contact Panametrics factory
A9: (S2:2)Ch Not Calibrated	Error occurs when Analog Input/RTD (S2:1) are not calibrated	Calibrate the Analog Input/RTD input. If error persists after calibration, contact Panametrics factory
A10:(S2:3)Input NotConnect!	Analog Input: Error occurs when (4-20mA) input is not connected at Channel (S2:3). RTD Input: Error occurs when RTD input is not connected or temp greater than 390 deg C at Channel (S2:3)	Check connectivity for Analog Input/RTD input and RTD temperature. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory

Table 7: Option I/O Errors Description

Error Code	Error Message	Description
A11:(S2:4)Input NotConnect!	Analog Input: Error occurs when (4-20mA) input is not connected at Channel (S2:4). RTD Input: Error occurs when RTD input is not connected or temp greater than 390 deg C at Channel (S2:4)	Check connectivity for Analog Input/RTD input and RTD temperature. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
A12:(S2:3)Ch OverRange Err!	Exceeds input values. For analog input (S2:3) greater than 21mA	Ensure analog input current less than 21mA. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
A13:(S2:4)Ch OverRange Err!	Analog input(S2:4) greater than 21mA	Ensure analog input current less than 21mA. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
A18:SerialNo Error!	Optional I/O Serial Number Error	Fault: Optional I/O Serial Number Error. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
A24:Aout(S2:1)OutOfRange!	When output from analog output(S2:1) exceeds 21 mA or less than 3.6 mA	Check the flow velocity. If velocity is within limits and error still persists, contact Panametrics factory
A25:Aout(S2:2)OutOfRange!	When output from analog output(S2:2) exceeds 21 mA or less than 3.6 mA	Check the flow velocity. If velocity is within limits and error still persists, contact Panametrics factory
A30:Board Option Err!	Optional I/O Error	Fault: Optional I/O Error. Try power cycling the meter. If error persists after power cycle, contact Panametrics factory
A31:(S2:3)Ch UnderRange!	Lesser input values. For analog input(S2:3) between 3.6 mA to 0.25mA	Check input analog current is between 3.6 mA to 21mA. If error persists, contact Panametrics factory
A32:(S2:4)Ch UnderRange!	Lesser input values. For analog input(S2:4) between 3.6 mA to 0.25mA.	Check input analog current is between 3.6 mA to 21mA. If error persists, contact Panametrics factory

4.10 Diagnostics Data

To determine the health of the meter, PanaFlow™ LC has built-in diagnostic parameters. Please refer to *Table 8* below for diagnosing any problems with the system. If the meter shows errors and the diagnostics data indicate issues, fill in the User/Service record appendix before contacting Panametrics factory.

Table 8: Diagnostic Parameter Description and Health Indicators

Parameter	Description	Good	Bad
Sound Speed	Measured speed of sound of the fluid	<ul style="list-style-type: none"> Under ideal conditions sound speed should be within 5 ft/s (1.5 m/s) between channels. Depending on flow viscosity, flow rate, there can be slightly different sound speed showing on different channels. This could be normal due to different signal path. 	<ul style="list-style-type: none"> Under ideal conditions, sound speed spread of 30 ft/s (9 m/s) or more between the sound speed measurement of the channels can be an indication of a problem with the pipe installation or any other different local pipe condition.
SNR Up	Signal to noise ratio of the upstream transducer	>5	<2 SNR value between 2 and 5 shall provide valid measurements but can be an indication of a problem with the pipe installation or any other different local pipe condition. Verify the clamping fixture alignment, transducer spacing, transducers, couplant, all the other connections.
SNR Down	Signal to noise ratio of the downstream transducer	>5	<2 SNR value between 2 and 5 shall provide valid measurements but can be an indication of a problem with the pipe installation or any other different local pipe condition. Verify the clamping fixture alignment, transducer spacing, transducers, couplant, all the other connections.
Gain Up / Gain Down	Gain setting	>0 dB and <35 dB <ul style="list-style-type: none"> In water applications, under ideal conditions, gain should be greater than 0 dB and less than 20 dB. For higher viscous liquids, gain between 20dB and 35 dB is acceptable. 	>35 dB or <0 dB <ul style="list-style-type: none"> Gain spreads of 10dB or more between the channels can be an indication of a problem with the pipe installation or any other different local pipe condition. If the gain is negative, change the Transmit Voltage to "Low". If it is still negative, enable Attenuator. Do not enable Attenuator if the Transmit Voltage is high. If the gain is greater than 35 dB, change the Transmit Voltage to "High".
Peak Index Up	Threshold peak of the upstream transmit correlation signal	<ul style="list-style-type: none"> For pipe sizes greater than 1 inch, index should be between 400 - 700. For pipe sizes less than 1 inch, the index should be between 150 - 350. 	<ul style="list-style-type: none"> For pipe sizes greater than 1 inch, if the index <400 or >700 then there is an indication of problem with receive window location. For pipe sizes less than 1 inch, if the index <150 or >350 then there is an indication of problem with receive window location.

Table 8: Diagnostic Parameter Description and Health Indicators

Parameter	Description	Good	Bad
Peak Index Down	Threshold peak of the downstream transmit correlation signal	<ul style="list-style-type: none"> For pipe sizes greater than 1 inch, index should be between 400 - 700. For pipe sizes less than 1 inch, the index should be between 150 - 350. 	<ul style="list-style-type: none"> For pipe sizes greater than 1 inch, if the index <400 or >700 then there is an indication of problem with receive window location. For pipe sizes less than 1 inch, if the index <150 or >350 then there is an indication of problem with receive window location.
Wall Time	Transit time inside the pipe wall	N.A	If the value is negative, then there is an indication of problem with the configuration parameters.
Lining Time	Transit time inside the pipe lining	N.A	If the value is negative, then there is an indication of problem with the configuration parameters
Signal Quality Up	Signal quality of the upstream transducer	>1000	<1000
Signal Quality Down	Signal quality of the downstream transducer	>1000	<1000
Amplitude Up	Signal amplitude of the upstream transducer	>14 and <32	>32 or <14
Amplitude Down	Signal amplitude of the downstream transducer	>14 and <32	>32 or <14

Chapter 5. Maintenance and Service

Local requirements may or may not allow field replacement of any components in this flow metering system without a proper calibration of the entire system at an approved calibration facility. Check with your local Panametrics & Panametrics Flow meter representative to determine if field replacement of components is allowed.

5.1 Spare Parts

If a fault is found with the flow meter electronics, the entire measurement head can be replaced to ensure hardware and firmware compatibility or possibly specific electronic boards. To ensure that the correct part numbers are ordered, provide your local Panametrics & Panametrics Flow meter representative with the serial number of the meter, located as shown on the "Part String and Serial Number Tag Plate".

5.2 Installing Replacement Parts

If it is appropriate to replace any component of the flow metering system, the Panametrics & Panametrics Flow meter field service team is trained and equipped to perform the replacement on-site. Installation of these field replaceable parts by a Baker Hughes field service team member will maintain the accuracy of the system and any applicable warranty. Please consult Panametrics to order the appropriate components and to schedule installation in the field.

5.3 Hardware Maintenance and Inspection

Inspection after installation may be performed routinely to maintain the health of your flow measurement. Checking the tightness of the hose clamps (SCF Fixture) or nut tightness (CFG V fixture) and pressure bolt holding down the transducers may be performed as described in *section 2.4 "Installing Clamping Fixtures"*. Couplant replacement is not required with CPL-8 but may be required using other liquid based couplant such as the CPL-1 or CPL-2 at specific intervals based on installation location and conditions.

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Appendix A. Specifications and Model Configurations

A.1 Operation and Performance

Fluid Types

Liquids: acoustically conductive fluids, including most clean liquids, and many liquids with small amounts of entrained solids or gas bubbles. Maximum void fraction depends on transducer, interrogation carrier frequency, path length, and pipe configuration.

Flow Measurement

Correlation transit time technique

Accuracy

- $\pm 1\%$: ≥ 2 in pipe; greater than 1 ft/s velocity
- $\pm 2\%$: < 2 in pipe; greater than 1 ft/s velocity

Accuracy statement assumes measurement of a single phase homogenous liquid with a fully developed symmetrical flow profile passing through the meter (typically 10 diameters upstream and 5 diameters downstream of straight pipe run). Applications with piping arrangements (e.g. two out of plane elbow at upstream) that create an asymmetrical flow profile may require extended piping straight runs and/ or flow conditioning for the meter to perform to this specification.

Calibration

All meters are water calibrated and include a calibration certificate.

Repeatability

$\pm 0.15\%$ of reading

Range (Bidirectional)

-82 to 82 ft/s (-25 to 25 m/s)

Rangeability (Overall)

50:1

Transducers supported

- UTXDR 4 and 2 MHz
- CF-LP 4 MHz
- CRS 0.5, 1.0 and 2.0 MHz
- CPT HT 0.5, 1.0 and 2.0 MHz
- CET
- CRR 0.5, 1.0, and 2.0 MHz
- CAT 0.5, 1.0, and 2.0 MHz
- CF-JR 4.0 MHz

Process Fluid Temperature Range

Local mount: -40°F to 185°F (-40°C to 85°C)

A.2 Electronics

Refer XMT1000 user manual for the specifications.

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Appendix B. Digital Communication

For information on how to communicate using Foundation Fieldbus, Modbus, HART, or Wireless HART, refer the XMT1000 User Manual.

[no content intended for this page]

Appendix C. Error code bit-field representation

Table 9: Flow Error Codes in Bit Field Values

Error representation	Error Description	Error code (in Hex)
E0	No Error	0x00000000
E29	Velocity Warning	0x00000001
E22	Single Channel Accuracy Error	0x00000002
E23	Multi-Channel Accuracy Error	0x00000004
E15	Active TW Error	0x00000008
E6	Cycle Skip Error	0x00000010
E5	Amplitude Error	0x00000020
E4	Signal Quality Error	0x00000040
E3	Velocity Range Error	0x00000080
E2	Sound Speed Error	0x00000100
E1	SNR Error	0x00000200
E27	Invalid K-Table Error	0x08000000
E28	Software Fault	0x10000000
E31	Not Calibrated Error	0x40000000

Table 10: System Error Codes in Bit Field Values

Error representation	Error Description	Error code (in Hex)
S0	No Error	0x00000000
S1	In Config Mode	0x00000001
S2	Invalid User	0x00000002
S3	Invalid Request	0x00000004
S4	Invalid Parameter Range	0x00000008
S5	Unsupported Parameter	0x00000010
S6	Flow Measurement	0x00000020
S7	Persistent Parameters CRC failed	0x00000040
S8	Multiplexer Switch Test Failed	0x00000080
S9	ADC Bit Test Failed	0x00000100
S10	VGA Test Failed	0x00000200
S11	Clock Frequency Test Failed	0x00000400
S12	CPU Test Failed	0x00000800
S13	Invariable Flash Memory Test Failed	0x00001000
S14	Invariable SRAM Memory Test Failed	0x00002000
S15	Variable Memory Test Failed	0x00004000
S16	FPGA Configuration Test Failed	0x00008000
S17	Temperature Test Failed	0x00010000
S18	Driver Fault	0x00020000
S19	Watch-dog Test Failed	0x00040000
S20	Analog Readback Failure	0x00080000

Table 10: System Error Codes in Bit Field Values

Error representation	Error Description	Error code (in Hex)
S21	Stack overflow	0x00100000
S22	Sequence or Windowed watchdog failure	0x00200000
S23	Initialization failed	0x00400000
S24	DSP Hardware Errors	0x00800000
S25	DSP Exception	0x01000000
S26	Default ISR	0x02000000
S27	DSP Reset	0x04000000
S28	Software Fault	0x08000000
S29	Output A loop Open	0x10000000
S30	Flash Save Failed	0x20000000

Table 11: Communication Error Codes in Bit Field Values

Error representation	Error Description	Error code (in Hex)
C0	No Error	0x00000000
C1	Flow COMM Error	0x00000001
C2	MODE MISMATCH	0x00000002
C3	Option I/O COMM Error	0x00000004

Table 12: Transmitter Error Codes in Bit Field Values

Error representation	Error Description	Error code (in Hex)
X0	No Error	0x00000000
X1	MCU RAM Error	0x00000001
X2	Flash memory test failed	0x00000002
X3	MCU key chip error	0x00000004
X4	MCU voltage chip error	0x00000008
X5	MCU RTC chip error	0x00000010
X6	OPT board not detected	0x00000020
X7	MPU board not detected	0x00000040
X8	MCU voltage out of limit	0x00000080
X9	MCU Pulse registration fail	0x00000100
X10	MCU file read fail	0x00000200
X11	MCU register access fail	0x00000400
X12	System Command failed	0x00000800
X13	Get GUI Node Fail	0x00001000
X14	Node Memory Fail	0x00002000
X15	Font API Initialize Fail	0x00004000
X16	XML File Initialize Fail	0x00008000
X17	Disconnect Std Dout	0x00010000
X18	Aout(std) Out Of Range	0x00020000

Table 13: Option I/O Errors in Bit Field Values

Error representation	Error Description	Error code (in Hex)
A0	No Error	0x00000000
A1	AnalogCh (S2:3) Error!	0x00000001
A2	AnalogCh (S2:4) Error!	0x00000002
A3	AnalogCh (S2:1) Error!	0x00000004
A4	AnalogCh (S2:2) Error!	0x00000008
A6	(S2:3) Ch Not Calibrated	0x00000020
A7	(S2:4) Ch Not Calibrated	0x00000040
A8	(S2:1) Ch Not Calibrated	0x00000080
A9	(S2:2) Ch Not Calibrated	0x00000100
A10	(S2:3) Input NotConnect!	0x00000200
A11	(S2:4) Input NotConnect!	0x00000400
A12	(S2:3) Ch OverRange Err!	0x00000800
A13	(S2:4)Ch OverRange Err!	0x00001000
A18	SerialNo Error!	0x00020000
A24	Aout(S2:1)OutOfRange!	0x00800000
A25	Aout(S2:2)OutOfRange!	0x01000000
A30	Board Option Err!	0x20000000
A31	(S2:3) Ch UnderRange!	0x40000000
A32	(S2:4) Ch UnderRange!	0x80000000

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Appendix D. CE Mark Compliance

D.1 Introduction

For CE Mark compliance, the PanaFlow LC flow meter must be wired in accordance with the instructions in this appendix.

IMPORTANT: *CE Mark compliance is required for all units intended for use in EU countries.*

D.2 Wiring

The PanaFlow LC must be wired with the recommended cable, and all connections must be properly shielded and grounded. Refer to *Table 8*: below for the specific requirements.

Table 8: Wiring Requirements

Connection	Cable Type	Ground Termination
Transducer	Armored RG62 A/U	Grounded using a cable gland.
Input/Output	Armored 22 AWG shielded (e.g. Baystate #78-1197) with armored material added to outside of jacket	Grounded using a cable gland.
Power	Armored 14 AWG 3 conductor	Grounded using a cable gland.

Note: *If the PanaFlow LC is wired as described in this appendix, the unit will comply with the EMC Directive.*

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Warranty

Each instrument manufactured by Panametrics is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of Panametrics. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If Panametrics determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures
- one year from delivery for sensor shelf life

If Panametrics determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by Panametrics, the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties or merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a Panametrics instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify Panametrics, giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, Panametrics will issue a Return Material Authorization (RMA), and shipping instructions for the return of the instrument to a service center will be provided.
2. If Panametrics instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.
3. Upon receipt, Panametrics will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If Panametrics determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner's approval to proceed, the instrument will be repaired and returned.

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BH029C11 EN C (03/2024)

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