DYNASONICS

Series TFXM

Ultrasonic Multi-Channel Flow Meter

Operations & Maintenance
Manual

REV 8/02

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QUICK-START OPERATING INSTRUCTIONS

This manual contains detailed operating instructions for all aspects of the TFXM instrument. The following condensed instructions are provided to assist the operator in getting the instrument started up and running as quickly as possible. This pertains to basic operation only. If specific instrument features are to be used or if the installer is unfamiliar with this type of instrument, refer to the appropriate section in the manual for complete details.

Transducer Location

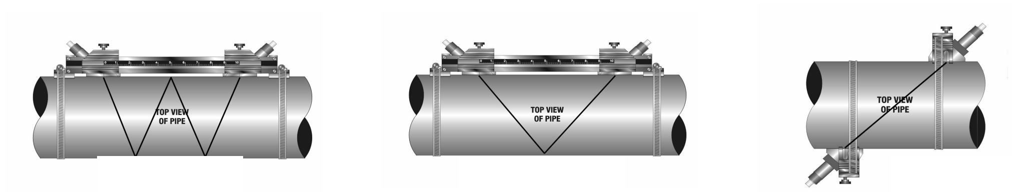
1. TRANSDUCER LOCATION

A. In general, select a mounting location on the piping system with a minimum of 10 pipe diameters (10 X the pipe inside diameter) of straight pipe upstream and 5 straight diameters downsteam. The installation location should also be positioned so that the pipe remains full when the liquid is flowing through it. On horizontal pipes the transducers should be located on the sides of the pipe. **See Figure 1.2**. See **Table 2.1** for additional configurations.

B. Select a mounting method, **Figure 1.1,** for the transducers from **Table 2.2**, based on pipe size and liquid characteristics. In General, select **W-Mount** for plastic and steel pipes flowing clean, non-aerated liquids in the 1-6 inch [25-150 mm] internal diameter range. Select **V-Mount** for pipes of all materials and most liquids in pipe sizes from 3-10 inches [75-400 mm]. Select **Z-Mount** for pipes larger than 10 inches [400 mm].

C. For each measuring channel integrated into the TFXM, enter the parameters listed in **Table 1.1** via the TFXM keypad or UltraLink software utility.

D. Record the value calculated and displayed as Transducer Spacing/XDCR SPC.



W-Mount **V-Mount** **Z-Mount**

Figure 1.1

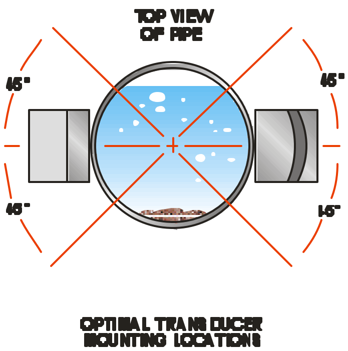


Figure 1.2 Transducer Orientation

TABLE 1.1			
1.	Transducer mounting method	7.	Pipe liner thickness
2.	Pipe O.D. (Outside Diameter)	8.	Pipe liner material
3.	Pipe wall thickness	9.	Fluid type
4.	Pipe material	10.	Fluid sound speed*
5.	Pipe sound speed*	11.	Fluid viscosity*
6.	Pipe relative roughness*	12.	Fluid specific gravity*

* Nominal values for these parameters are included within the TFXM operating system. The nominal values may be used as they appear or may be modified if exact system values are known.

2. PIPE PREPARATION AND TRANSDUCER MOUNTING

A. The piping surface where the transducers are to be mounted needs to be clean and dry. Remove loose scale, rust and paint to ensure satisfactory acoustical bonds.

B. Apply a 3/8" [8 mm] wide bead of couplant lengthwise onto the transducer faces. Place each transducer onto the pipe ensuring proper linear and radial placement.

C. Tighten the transducer mounting straps sufficiently to squeeze the couplant out along the flat surface of the transducer, filling the void between the transducer and the pipe wall.

Connections

3. TRANSDUCER/POWER CONNECTIONS

A. If additional cable is to be added to the transducers, utilize RG59 (75 Ohm) cable splices and ensure that both cables are of equal length.

B. Refer to the TFXM Field Wiring Diagram, Figure 1.4, and the terminal block labels for proper power and transducer connections. Verify that the voltage level listed on the product identification label—located on the side of the instrument enclosure– matches the power source where connection is being made.

Startup

4. INITIAL SETTINGS AND POWER UP

A. Apply power to the instrument.

B. Verify that SIG STR is greater than 2% on all channels.

C. Verify that measured liquid SSPD is within 0.5% of the configuration value on all channels.

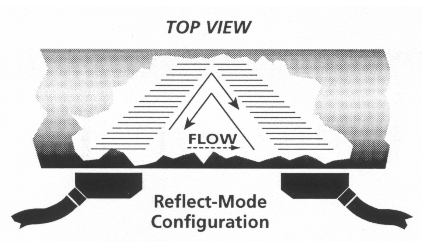
D. Input proper units of measure and I/O data.

PART 1 - INTRODUCTION

General

The TFXM ultrasonic flow meter is designed to measure the fluid velocity of liquid within closed conduit. The transducers are a non-contacting, clamp-on type, which will provide benefits of non-fouling operation and ease of installation.

TFXM transit time flowmeters utilize two transducers that function as both ultrasonic transmitters and receivers. The transducers are clamped on the outside of a closed pipe <u>at a specific distance from each other</u>. The transducers can be mounted in V-mode where the sound transverses the pipe two times, W-mode where the sound transverses the pipe four times, or in Z-mode where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once. This selection is based on pipe and liquid characteristics. The flowmeter operates by alternately transmitting and receiving a frequency modulated burst of sound energy between the two transducers (contrapropogation) and measuring the time interval that it takes for sound to travel between the two transducers. The difference in the time interval measured is directly related to the velocity of the liquid in the pipe.



Application Versatility

The TFXM flow meter can be successfully applied on a wide range of metering applications. The simple to program transmitter allows the standard product to be used on pipe sizes ranging from 2 - 100 inch [50 - 2540 mm] pipe. A variety of liquid applications can be accommodated: ultrapure liquids, potable water, chemicals, raw sewage, reclaimed water, cooling water, river water, plant effluent, etc. Because the transducers are non-contacting and have no moving parts, the flow meter is not affected by system pressure, fouling or wear. Standard DTTN transducers are rated to 300?F [150?C]. Temperatures to 450?F [230?C] can be accommodated with Series DTTH transducers. Please consult the Dynasonics factory for assistance.

PART 1 - INTRODUCTION

User Safety

The TFXM employs modular construction and provides electrical safety for the operator. The display face and keypad contains voltages no greater than 10 Vdc. The wiring access panel provides users access to wiring terminals without risking damage to flow meter circuits. Disconnect electrical power before opening the instrument enclosure.

Data Integrity

Non-volatile flash memory retains all user-entered configuration values in memory indefinitely, even if power is lost or turned off. Password protection is provided as part of the Security menu and prevents inadvertent configuration changes or totalizer resets.

Product Identification

The serial number and complete model number of your TFXM is located on the side of the instrument enclosure. Should technical assistance be required, please provide the Dynasonics Customer Service Department with this information.

Product Matrix

D T F X M □ • □ □ □ □ □ • □ □

Channels

1) One internal Channel
2) Two internal Channels

Power Supply

A) 115 VAC
B) 230 VAC
C) 100 VAC
E) 9-28 VDC

Channel 1 Input/Output
(RS485 is Standard on all Models)

1) 4-20mA and Dual-Relay
2) Dual-Relay and One Option
3) 4-20mA and One Option

Channel 1 Option Input/Output

N) None (If "1" is selected above)
1) 4-20mA (secondary)
2) Dual-Relay (secondary)
3) Rate Pulse
4) RS232
6) Data Logger
7) Heat Flow

Channel 2 Input/Output [DTFXM2]

N) none—[DTFXM1]
1) 4-20mA and Dual-Relay
2) Dual-Relay and One Option
3) 4-20mA and One Option

Channel 2 Input/Output [DTFXM2]

N) none—[DTFXM1 or if "1" is selected above]
1) 4-20mA (secondary)
2) Dual-Relay (secondary)
3) Rate Pulse
4) RS232
6) Data Logger
7) Heat Flow

Approvals
N) Ordinary Area
X) Class 1 DIV1 (pending)

Options

N) None

D T T □ • □ □ □ • □ □ □ □ • □

Construction

N) Standard
H) High Temp

Cable Length

020) 20 feet [6.1 m]
050) 50 feet [15 m]
100) 100 feet [30 m]
Maximum length: 990 feet [306 m] in 10 foot [3 m] increments

Conduit Type

A) Flexible armored
N) none

Conduit Length
(Standard construction: Conduit length = Cable length)

000) none
020) 20 feet [6.1 m]
050) 50 feet [15 m]
100) 100 feet [30 m]
Maximum length: 990 feet [306 m] in 10 foot [3 m] increments

Options

N) standard
X) Intrinsically Safe

PART 1 - SPECIFICATIONS

TRANSMITTER

DESCRIPTION	SPECIFICATION
Power Requirements	10-28 VDC @ 8 VA max.; 115/230 VAC 50/60 Hz ±15% @ 14 VA max.
Velocity	-40 to +40 FPS [-12 to +12 MPS]
Outputs	All output modules are optically isolated from earth and system grounds
Standard (integrated)	**RS485** standard; choice of either **4-20 mA** and/or **Dual-Relay**
Optional (plug-in)	**4-20 mA** (secondary) 800 Ohms max.; 12-bit resolution; passive or active **Dual-Relay** (secondary) Two separate Form C relays, 200 VAC max. @ 0.5 A resistive **Pulse Output** FET output (open collector action), 0-2,500 Hz max., 1 A max. **RS232** data rate to 57.6K **Data Logger** 200,000-event, 16-bit, DB-9 connection, removable, can be removed and installed without disconnecting system power **Heat Flow** (see TFX BTU-Pro Data Sheet); Supports two 1000 Ω RTDs, multiplexed, 12-bit resolution
Display	128 x 64 pixel graphics LCD, LED back lit. Two user selectable font sizes 0.35" [8.9 mm] or 0.2" [5.0 mm]; configure for either two or four data lines
Data	The following data can be displayed for up to 8 pipes or paths: 8 digit rate, 8 digit totalizer, liquid sound speed, signal strength
Units: **Rate** **Totalizer**	User configured - feet, gallons, ft^3, mil-gal, oil barrels, liquor barrels, acre-feet, lbs., meters, liters, m^3, mil-liters, Kg Rate time: sec, min, hr, day Forward, reverse, batch and net total
Ambient Conditions	-40 to 185°F [-40 to 85°C], 0-95% relative humidity, non-condensing
Enclosure	NEMA 4, [IP-66] epoxy-coated steel, polycarbonate keypad and SS hardware. 11.0H x 11.4W x 4.1D inches [280H x 290W x 104D mm]; 11.5 lbs. [5.2 Kg]
Accuracy Flow Rate	±0.5% of reading at rates > 1 FPS [0.3 MPS] for field calibrated systems; ±1% of reading at rates > 1 FPS [0.3 MPS] uncalibrated ±l0.01 FPS [0.003 MPS]l at rates < 1 FPS [0.3 MPS]
Sensitivity	Flow: 0.001 FPS [0.0003 MPS]
Repeatability	±0.01% of reading
Response Time	Flow: 1-10 seconds, user configured, to 90% of value, step change in flow
Security	Keypad lockout, four-digit user selected access code

TRANSDUCER

DESCRIPTION	SPECIFICATION
Liquid Types Supported	Virtually all non-aerated homogeneous liquids
Transducer to Transmitter Distance	(Std) 20 to 100 feet [6 to 30 meters], (Opt) lengths to 990 feet [300 meters]
Pipe Sizes	(Std) 1 to 100 inches [25 to 2540 mm] pipe I.D.
Temperature	(Std) -40° to 300°F [-40° to 150°C]; (Opt) -40° to 450°F [-40° to 230°C]
Environment	(Std) NEMA 6 [IP 67]; (Opt) Class I, II, III; Div 1, Groups C-G (pending)
Housing Material	(Std) CPVC, nylon, Ultem®; (Opt) Stainless, nickel-plated brass and Vespel®
Mounting	(Std) Stainless steel hose clamps (P.N. D002-2007-001), not included; (Opt) aluminum track assembly for pipes smaller than 10 inches [250 mm]

PART 1 - TRANSMITTER INSTALLATION

Transmitter Installation

After unpacking, it is recommended to save the shipping carton and packing materials in case the instrument is stored or re-shipped. Inspect the equipment and carton for damage. If there is evidence of shipping damage, notify the carrier immediately.

The enclosure should be mounted in an area that is convenient for servicing, calibration or for observation of the LCD readout.

1. Locate the transmitter within the length of transducer cable that was supplied with the TFXM system. If this is not possible and additional cable is to be added to the transducers, utilize RG59 (75 Ohm) cable and splices. Ensure that both cables are of equal length. If additional cable cannot be added in the field, contact the Dynasonics factory to coordinate an exchange for the proper cable length. Transducer cables that are up to 990 feet [300 meters] are available.

2. Mount the TFXM transmitter in a location that is:

? ? Where little vibration exists.

? ? Protected from falling corrosive fluids.

? ? Within ambient temperature limits -40 to 185°F [-40 to 85°C]

? ? Out of direct sunlight. Direct sunlight may increase temperatures within the transmitter to above the maximum limit.

3. Mounting: Refer to **Figure 1.3** for enclosure and mounting dimension details. Ensure that enough room is available to allow for maintenance and conduit entrances. Secure the enclosure to a flat surface with four appropriate fasteners.

4. Conduit holes. Conduit hubs should be used where cables enter the enclosure. Holes not used for cable entry should be sealed with plugs.

NOTE: Use NEMA 4 [IP65] rated fittings/plugs to maintain the water tight integrity of the enclosure. Generally, the left conduit hole (viewed from front) is used for line power; the center conduit holes for transducer connections and the right holes are utilized for I/O wiring.

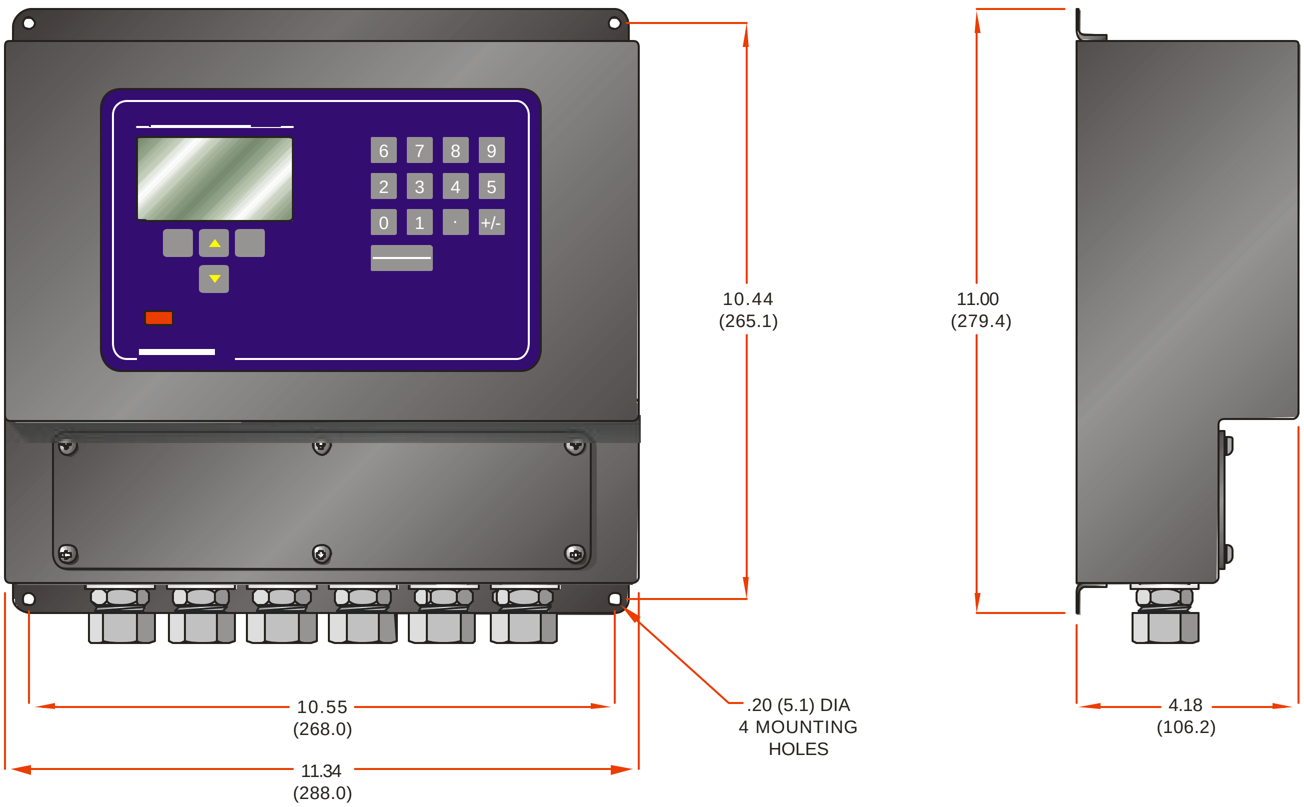


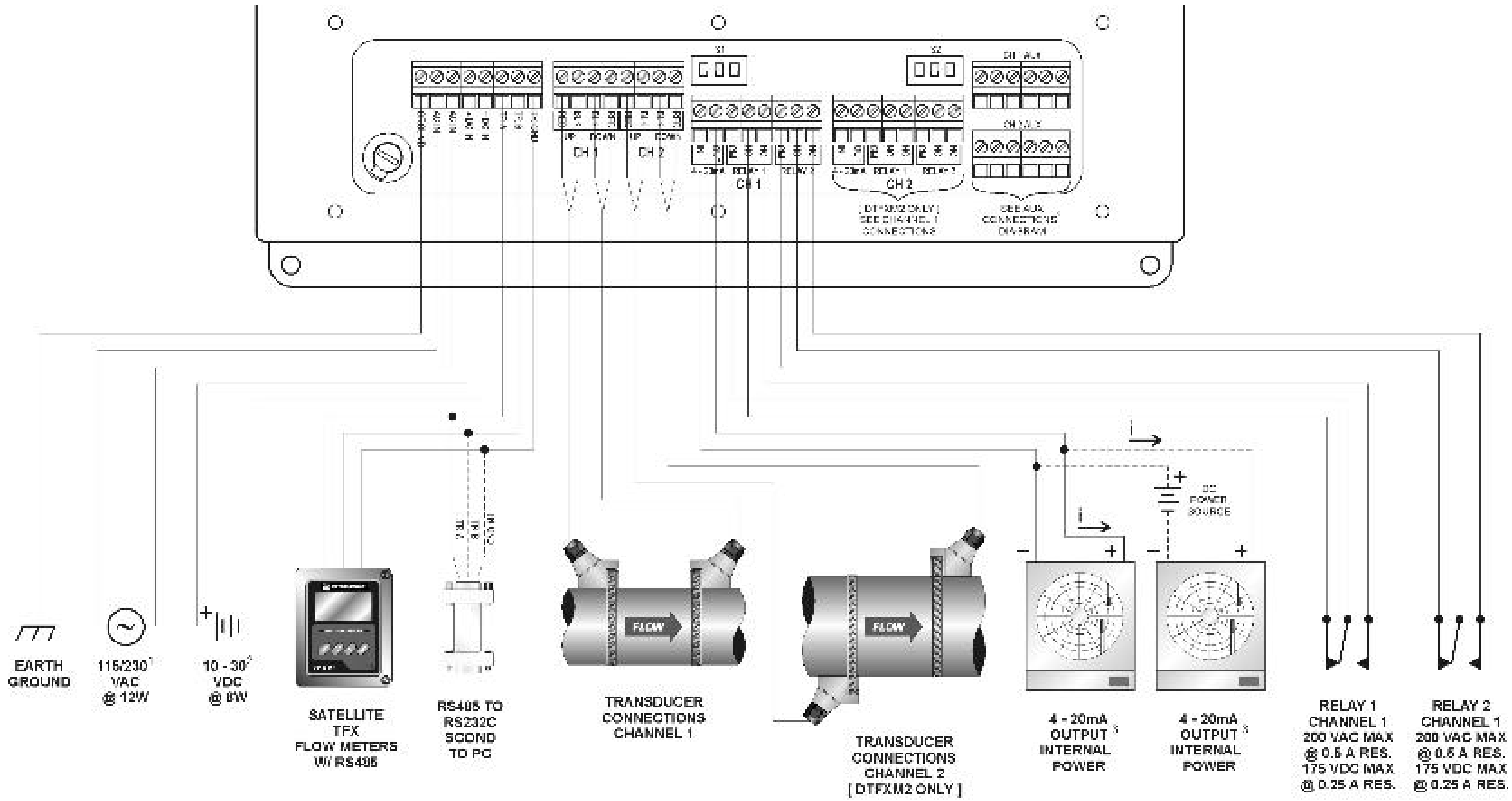
Figure 1.3 - TFX Transmitter Installation Dimensions

To access terminal strips for electronic connections, loosen the six screws in the wiring access panel located on the bottom of the enclosure.

Transducer Connections

1. Guide the transducer cables through the transmitter conduit holes located in the bottom of the enclosure. Secure the transducer's flexible conduit with the supplied conduit nut (if flexible conduit was ordered with the transducer) or tighten the cord grip on the coaxial cable.

2. The terminals within TFXM are a screw terminal type. Connect the appropriate wires to the corresponding screw terminals in the transmitter. Observe **UP/DOWN** and **CH1** or **CH2** orientation. CH1 and CH2 correspond to the measuring channels contained within the TFXM flow meter. DTFXM1 flow me-



FOOT NOTES:

1. JUMPERS MUST BE SET TO PROPER POWER SUPPLY VOLTAGE
2. A BATTERY CAN BE CONNECTED IN CONJUNCTION WITH THE AC POWER SOURCE TO FACILITATE AN UNINTERRUPTIBLE POWER SUPPLY. THE BATTERY WILL NOT BE CHARGED BY THE TFXM
3. INTERNAL AND EXTERNAL POWER SELECTION IS MADE BY POSITIONING SW1 ON S1 AND S2 DIP SWITCHES
4. IF AN AUX INPUT/OUTPUT OPTION WAS INSTALLED, EITHER THE 4-20mA OR RELAYS WILL NEED TO BE DISABLED AT S1 OR S2 FOR THE CHANNEL THAT CONTAINS THE AUX OPTION

Figure 1.4
TFXM Wiring Diagram

ters only have one measuring channel, so transducers will only be connected to the CH1 terminals. DTFXM2 flow meters have two measuring channels, so transducers will be connected to both the CH1 and CH2 terminals. See **Figure 1.4**. Secure wires by tightening to between 0.5 and 0.6 Nm of torque.

NOTE: The transducer cables carry low level signals. It is typically not recommended to add additional cable to the factory supplied coaxial cables. If an exchange is not possible and additional cable is to be added to the transducers, utilize RG59 (75 Ohm) cable and splices. Ensure that both cables are of equal length. If additional cable cannot be added in the field, contact the Dynasonics factory to coordinate an exchange for the proper cable length. Cables to 990 feet [300 meters] are available.

Transmitter Power Connections

Connect line power to the two screw terminals marked **AC IN** and the one marked **GROUND** in the transmitter. See **Figure 1.4**. Utilize the conduit hole on the left side of the enclosure for this purpose. Use wiring practices that conform to local codes (National Electric Code Hand book in the USA). Use only the standard three wire connection. The ground terminal grounds the instrument, which is mandatory for safe operation.

CAUTION: Any other wiring method may be unsafe or cause improper operation of the instrument.

It is recommended not to run line power with other signal wires within the same wiring tray or conduit.

NOTE: This instrument requires clean electrical line power. Do not operate this unit on circuits with noisy components (i.e. Fluorescent lights, relays, compressors, variable frequency drives, etc.).

DC Power Supply

The TFXM can be operated from a 10-28 Vdc source, as long as it is capable of supplying at least 8 Watts. DC power is connected to the screw terminals labeled +DC IN and –DC IN on the terminal block located on the left side of the enclosure. Observe proper polarity in making these connections. It is recommended that a 1 A fuse be installed in DC connections to protect the TFXM and the battery source from damage should a fault occur. See the Wiring Diagram located at **Figure 1.4**.

Uninterruptible Power Configuration

Both **AC** and a 12 VDC battery power can be connected to the TFXM to facilitate an uninterruptible power source to the flow meter. The flow meter will operate on the AC power source until AC power is interrupted—at that point the flow meter will continue to operate on the battery until AC power is restored. In this configuration the battery will not be trickle-charged by the TFXM. Batteries are rated in Amp Hour capacity. Select a battery that can maintain operation of the flow meter for the length of anticipated AC power outages.

Example: The TFXM draws approximately 700 mA of current at 12 VDC. A 7 Amp Hour 12 Volt battery will be able to operate the TFXM for approximately 7 Amp Hours / 0.7 Amps = 10 Hours.

As an alternate uninterruptible configuration, connect a battery to the TFXM as the primary source of power and permanently connect a trickle-charger to the battery. Ensure that the trickle-charger is rated to output a minimum of 10 Watts.

PART 1 - INPUT/OUTPUT CONFIGURATION

General

Series TFXM contains integrated RS485 communications, one 4-20 mA output per measurement channel and two SPDT relays per measurement channel. Other auxiliary input/output options are available. All outputs are 2,500 V optically isolated from TFXM power and Earth grounds -- eliminating the potential for ground loops and reducing the chance of severe damage in the event of an electrical surge.

Auxiliary options that are available include: secondary 4-20 mA, secondary dual-relay, rate pulse, RS232C, a 200,000-event datalogger and BTU-Pro heat-delivered option. In order for an Auxiliary output option to be operational, either the 4-20mA or the dual-relays must be disabled for that measurement channel. All outputs are field configurable by utilizing the keyboard or ***ULTRA****LINK* interface. Field wiring connections to the outputs are made to the terminal blocks located within the wiring access panel.

DIP-Switch Configuration

The two, three-position DIP-switches located within the wiring access panel configure the TFXM for input/output options. The flow meter is shipped from the Dynasonics factory with the options ordered configured and installed. Typically no adjustments to these switches are necessary. The switch lever to the left in each DIP switch block is utilized to configure the 4-20 mA output as either internally or externally powered. The other two switches in each DIP-switch block are used to disable either the 4-20 mA or dual-relay output should an Auxiliary output be installed within the TFXM enclosure.

4-20 mA Output Configuration

The 4-20 mA Output interfaces with virtually all recording and logging systems by transmitting an analog current signal that is proportional to system flow rate. The output can be configured to be either internally or externally powered by setting the left DIP-switch at SW1 for Channel 1 and SW2 for Channel 2. Refer to the Field Wiring Diagram at **Figure 1.4** for terminal block and DIP-switch locations.

When powered from internal power, the 4-20 mA output can provide loop current for a maximum of 800 ohms of total loop resistance. When powered externally, the maximum load varies with the level of the voltage source. The insertion loss of the 4-20 mA circuit is 5Vdc, so the maximum loop load that can be powered is calculated by the equation:

$$\text{Max Loop Load} = \frac{\text{(External Supply Voltage - 5)}}{0.02}$$

Cable used to transmit 4-20 mA signals should be routed in wiring trays or conduits that carry instrumentation signals. It should not be run with AC power or other potential sources of noise. Very long cables can be accommodated, but the resistance of the wire must be added to the total loop load to ensure that adequate power is available to power the load. Shielding of the wires carrying 4-20mA signals are typically not necessary, but is recommended when wires must be run past or in proximity of electrically noisy circuits.

Control Relays Configuration

Two independent SPDT (single-pole, double-throw, Form C) relays are integrated into the TFXM for each measuring channel installed within the flow meter enclosure. The relay operations are user configured via software to act in a flow rate alarm, signal strength alarm or totalizer/batching mode. See **Figure 1.4** for terminal block locations. The relays are rated for 200 Vac max. and have a current rating of 0.5 A resistive load [175 Vdc @ 0.25 A resistive]. It is highly recommended that a slave relay be utilized whenever the control relays are used to control inductive loads such as solenoids and motors.

RS485 Configuration

An RS485 driver and Modbus protocol is utilized by the TFXM to communicate between the two channels located within the TFXM flow meter enclosure (if so equipped), communicate with satellite TFX flow meters and to interface with a personal computer system. The TFXM can be used as the Primary meter (Master) to program other Secondary (Slave) meters located on the RS485 network. The TFXM contains a feature that permits up to 8 flow measurement channels to be mathematically manipulated. Software configuration is covered in Section 4 of this manual.

RS485 interconnections are made at the terminal block located within the TFXM Field Wiring Access Panel. See **Figure 1.4**. Utilize two conductor plus shield wiring cable for this purpose. Avoid running these cables in wiring trays or conduits carrying AC power or other electrically noisy devices.

PART 2 - TRANSDUCER POSITIONING

General

The transducers that are utilized by the Series TFXM contain piezoelectric crystals for transmitting and receiving ultrasound signals through walls of liquid piping systems. DTTN and DTTH transducers are relatively simple and straight-forward to install, but spacing and alignment of the transducers is critical to the system's accuracy and performance. Extra care should be taken to ensure that these instructions are carefully executed.

Mounting of the DTTN and DTTH clamp-on ultrasonic transit time transducers is comprised of four steps. In general, these steps consist of:

1. Selection of the optimum location on a piping system.
2. Entering the pipe and liquid parameters into either the optional software utility (UltraLink) or keying in the parameters into the TFXM keypad. The software embedded in UltraLink and TFXM will calculate proper transducer spacing based on these entries.
3. Pipe preparation and transducer mounting.

1. Mounting Location

The first step in the installation process is the selection of an optimum location for the flow measurement to be made. For this to be done effectively, a basic knowledge of the piping system and its plumbing are required.

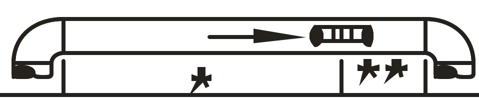
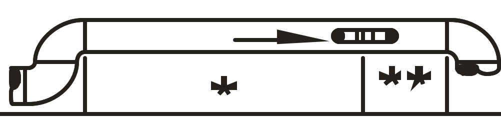
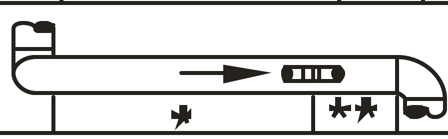
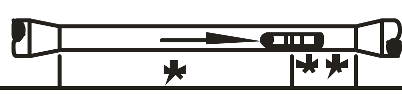
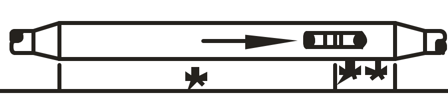
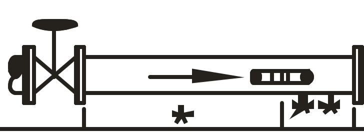
An optimum location would be defined as a piping system that is completely full of liquid when measurements are being taken and has lengths of straight pipe such as those described in **TABLE 2.1**. The optimum straight pipe diameter recommendations apply to pipes in both horizontal and vertical orientation.

TFXM transit time flowmeters utilize two transducers that function as both ultrasonic transmitters and receivers. The transducers are clamped on the outside of a closed pipe <u>at a specific distance from each other</u>. The transducers can be mounted in V-mode where the sound traverses the pipe two times, W-mode where the sound traverses the pipe four times, or in Z-mode where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once.

See Figures 2.1-2.3. This selection is based on pipe and liquid characteristics. The flowmeter operates by alternately transmitting and receiving a frequency modulated burst of sound energy between the two transducers and measuring the time interval that it takes for sound to travel between the two

Table 2.1[1]

Upstream Downstream

Piping Configuration and Transducer Position	Upstream Dimension: Pipe Diameters *	Downstream Dimension: Pipe Diameters **
	9	3
	14	3
	24	4
	8	3
	8	3
	24	4

[1] *The TFXM system will provide repeatable measurements on piping systems that do not meet these requirements, but the accuracy of these readings may be influenced to various degrees.*

V-Mount Configuration

transducers.

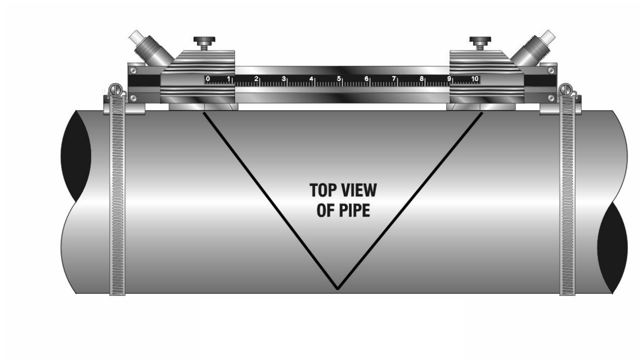


Figure 2.1 - Transducer V-Mount

W-Mount Configuration

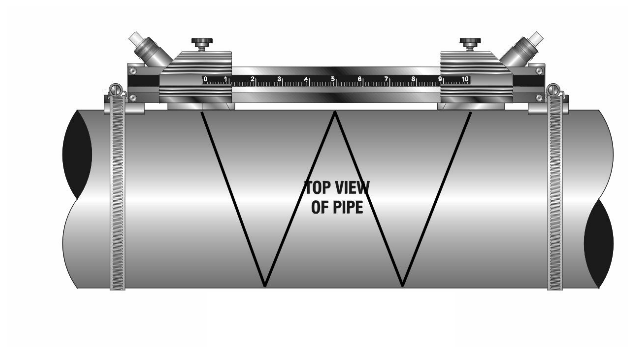


Figure 2.2 - Transducer W-Mount

Z-Mount Configuration

Figure 2.3 Z-Mount. Direct type — transducers mounted on opposite sides of the pipe. See **Table 2.2** for a list of Initial Transducer Mounting Modes.

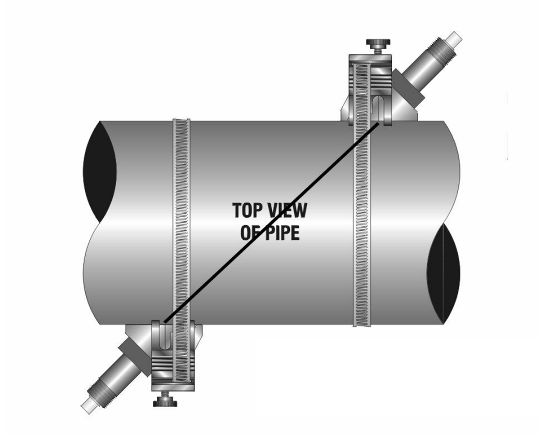


Figure 2.3 - Transducer Z-Mount

Table 2.2
Initial Transducer Mounting Modes

Transducer Mount Mode	Pipe Material	Pipe Size	Liquid Composition*
W-mode (Weakest signal, longest time of flight)	Plastic (all types) Carbon Steel Stainless Steel Copper Ductile Iron Cast Iron	2-6 in. (50-150 mm) 2-4 in. (50-100 mm) 2-6 in. (50-150 mm) 2-6 in. (50-150 mm) Not recommended Not recommended	Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated
V-mode	Plastic (all types) Carbon Steel Stainless Steel Copper Ductile Iron Cast Iron	6-30 in. (150-750 mm) 4-24 in. (100-600 mm) 6-30 in. (150-750 mm) 6-30 in. (150-750 mm) 3-12 in. (75-300 mm) 3-6 in. (75-150 mm)	Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated
Z-mode (Strongest signal, shortest time of flight)	Plastic (all types) Carbon Steel Stainless Steel Copper Ductile Iron Cast Iron	>30 in. (>750 mm) >24 in. (>600 mm) >30 in. (>750 mm) >30 in. (>750 mm) >12 in. (>300 mm) >6 in. (>150 mm)	Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated Low TSS, non-aerated

*If the liquid to be measured is high in TSS (total suspended solids) or aerated, more than likely the installation will require configuration and setup in the next category lower than the recommendations in this chart. For example, if the pipe is 10-inch (250 mm) carbon steel and the liquid contains concentrations of suspended solids, a Z-mode will probably yield the best performance results, not the V-mode suggested in the chart.

2. Transducer Spacing

The TFXM system calculates proper transducer spacing by utilizing piping and liquid information entered by the user. This information can be entered via the keypad on TFXM or via the UltraLink Windows software utility.

IMPORTANT: Since the time interval being measured is influenced by the transducer spacing, it is critical that the transducer spacing be measured on the pipe accurately to assure optimum performance from the TFXM system.

The following information will be required before programming the instrument:

1. Transducer mounting configuration
2. Pipe O.D. (Outside Diameter)
3. Pipe wall thickness
4. Pipe material
5. Pipe sound speed[1]
6. Pipe relative roughness[1]
7. Pipe liner thickness
8. Pipe liner material
9. Fluid type
10. Fluid sound speed[1]
11. Fluid viscosity[1]
12. Fluid specific gravity[1]

[1]Nominal values for these parameters are included within the TFXM operating system. The nominal values may be used as they appear or may be modified if exact system values are known.

Keypad

The TFXM can be configured through the keypad interface or by using the *UltraLink* Windows® software utility. Of the two methods of configuration, the *UltraLink* software utility provides more advanced features and offers the abililty to store and transfer meter configurations between TFXM meters.

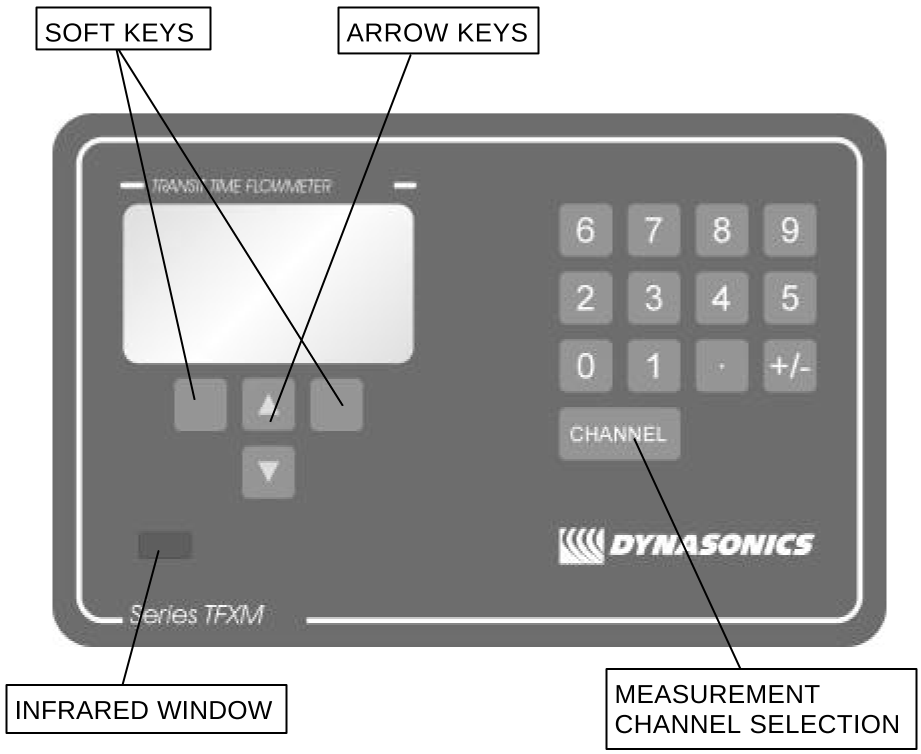


Figure 2.4
Keypad Description

The following “Soft Key” menu items will be displayed immediately above the two keys located in the lower corners of the Graphics Display. See **Figure 2.4**.

?? The (soft)MENU key is pressed from RUN mode to enter PROGRAM mode. The (soft)EXIT key is pressed in PROGRAM mode to exit configuration parameters and menus. If changes to any configuration parameters have been made, the user will be prompted with a SAVE? (soft) YES or (soft)NO when returning to RUN mode. If no changes have been made, the user will not be prompted to SAVE.

1. The UP/DOWN ARROW keys are used to scroll through menus and configuration parameters. The ARROW keys can also be used to adjust parameter numerical values. In RUN mode the UP/DOWN ARROW keys are used to adjust the display contrast level.

2. The Numerical Keypad is used for entering numerical values.

3. The (soft)ACCEPT key is used to

?? accept configuration parameter changes.

5. The (soft)CHAN key is used to

?? Configure the engineering units on the graphics display— Press the (soft)SELECT key from RUN mode to highlight the engineering unit presently being displayed on the graphics display (pressing the SELECT key multiple times will toggle the highlighted unit from line to line). Use the UP/DOWN ARROW keys to select display units of

    ?? RATE
    ?? TOTALizer
    ?? VELocity
    ?? SIGNAL STRength
    ?? Sound Speed
    ?? TEMP1
    ?? TEMP2
    ?? TEMP Diff

6. When the (soft)MENU key is pressed, the user is prompted for the measurement channel that is to be configured. Use the UP/DOWN arrow keys to display the measurement channel that requires configuration. Press (soft)ACCEPT when the required channel is visible in the center of the display.

The BASIC menu contains all of the configuration parameters necessary to make the transducer spacing calculation.

UNITS Entry

UNITS

ENGLSH
METRIC

Installs a global measurement standard into the operation of the instrument. The choices are either English or Metric measurements.

?? Select ENGLSH if all configurations (pipe sizes, etc.) are to be made in inches. Select METRIC if the meter is to be configured in millimeters.

?? The ENGLSH/METRIC selection will also configure the TFXM to display sound speeds in pipe materials and liquids as either feet per second or meters per second respectively.

IMPORTANT!

NOTE: If the UNITS entry has been changed from ENGLSH to METRIC or from METRIC to ENGLSH, the entry must be saved and the instrument reset (power cycled or System Reset entered) in order for the TFXM to initiate the change in operating units. Failure to save and reset the instrument will lead to improper transducer spacing calculations and an instrument that may not measure properly.

Transducer Mount Configuration

XDCR MNT -- Transducer Mounting Method

V
W
Z

Selects the mounting orientation for the transducers. The selection of an appropriate mounting orientation is based on pipe and liquid characteristics. Refer to **Figures 2.1-2.3** and **Table 2.2** in this manual.

Pipe O.D. Entry

PIPE OD -- Pipe Outside Diameter Entry

ENGLSH (Inches)
METRIC (Millimeters)

Enter the pipe outside diameter in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected.

Pipe Wall Entry

PIPE WT -- Pipe Wall Thickness Entry

ENGLSH (Inches)
METRIC (Millimeters)

Enter the pipe wall thickness in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected.

Pipe Material Entry

PIPE MAT -- Pipe Material Selection

CARBON S - Carbon Steel
STAINLES - Stainless Steel
CAST IRO - Cast Iron
DUCTILE - Ductile Iron
COPPER - Copper
PVC - Polyvinylchloride
PVDF LOW - Low Density Polyvinylidene Flouride
PVDF HI - High Density Polyvinylidene Flouride
ALUMINUM - Aluminum
ASBESTOS - Asbestos Cement
FIBERGLA - Fiberglass
OTHER

This list is provided as an example. Additional materials are being added continuously. Select the appropriate pipe material from the list or select OTHER if the material is not listed.

Pipe Sound Speed Entry

PIPE SS -- Speed of Sound in the Pipe Material

ENGLSH (Feet per Second)
METRIC (Meters per Second)

Allows adjustments to be made to the speed of sound in the pipe wall. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second).

If a pipe material was chosen from the PIPE MAT list, a nominal value for speed of sound in that material will be automatically loaded. If the actual sound speed rate is known for the application piping system and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as PIPE MAT, a PIPE SS will need to be entered.

Pipe Roughness Entry

PIPE R -- Pipe Material Relative Roughness

UNITLESS VALUE

The DTFXM provides Reynolds Number compensation in its flow measurement calculation. The ratio of average surface imperfection as it relates to the pipe internal diameter is used in this compensation.

$$\text{PIPE R} = \frac{\text{Linear RMS measurement of the pipe internal wall surface}}{\text{Internal Diameter of the pipe}}$$

If a pipe material was chosen from the PIPE MAT list, a nominal value relative roughness in that material will be automatically loaded. If the actual roughness is known for the application piping system and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as PIPE MAT, a PIPE R may need to be entered.

Liner Thickness Entry

LINER T -- Pipe Liner Thickness Entry

ENGLSH (Inches)
METRIC (Millimeters)

Enter the pipe liner thickness. Enter this value in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected.

Liner Material Entry

[If a LINER Thickness was selected]
LINER MAT - Liner Material

TAR EPOXY
RUBBER
MORTAR
POLYPROPYLENE
POLYSTYROL
POLYSTYRENE
POLYESTER
POLYETHYLENE
EBONITE
TEFLON
Other

This list is provided as an example. Additional materials are being added continuously. Select the appropriate material from the list or select OTHER if the liner material is not listed.

Liner Sound Speed Entry

LINER SS -- Speed of Sound in the Liner

ENGLSH (Feet per Second)
METRIC (Meters per Second)

Allows adjustments to be made to the speed of sound in the liner. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second).

If a liner was chosen from the LINER MAT list, a nominal value for speed of sound in that media will be automatically loaded. If the actual sound speed rate is known for the pipe liner and that value varies from the automatically loaded value, the value can be revised.

Fluid Type Entry

FL TYPE - Fluid/Media Type

TAP *WATER*
SEWAGE
SEA WATE
KEROSENE
GASOLINE
FUEL OIL
CRUDE OI
PROPANE

BUTANE
OTHER

This list is provided as an example. Additional liquids are being added continuously. Select the appropriate liquid from the list or select OTHER if the liquid is not listed.

Fluid Sound Speed Entry

FLUID SS -- Speed of Sound in the Fluid
ENGLSH (Feet per Second)
METRIC (Meters per Second)

Allows adjustments to be made to the speed of sound in the liquid. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second).

If a fluid was chosen from the FL TYPE list, a nominal value for speed of sound in that media will be automatically loaded. If the actual sound speed rate is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as FL TYPE, a FLUID SS will need to be entered. A list of alternate fluids and their associated sound speeds are located in the Appendix at the back of this manual.

Fluid Viscosity Entry

FLUID VI -- Absolute Viscosity the Fluid
cps

Allows adjustments to be made to the absolute viscosity of the liquid.

If a fluid was chosen from the FL TYPE list, a nominal value for viscosity in that media will be automatically loaded. If the actual viscosity is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as FL TYPE, a FLUID VI will need to be entered. A list of alternate fluids and their associated viscosities are located in the Appendix at the back of this manual.

Fluid Specific Gravity Entry

SP GRVTY -- Fluid Specific Gravity Entry

unitless

Allows adjustments to be made to the specific gravity (density) of the liquid.

If a fluid was chosen from the FL TYPE list, a nominal value for specific gravity in that media will be automatically loaded. If the actual specific gravity is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as FL TYPE, a SP GRVTY may need to be entered if mass flows are to be calculated. A list of alternate fluids and their associated specific gravities are located in the Appendix at the back of this manual.

Transducer Spacing Calculation

XDCR SPAC -- Transducer Spacing Calculation

ENGLSH (Inches)
METRIC (Millimeters)

This value represents the one-dimensional linear measurement between the transducers (the upstream/downstream measurement that runs parallel to the pipe). This value is in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected. This measurement is taken between the lines which are scribed into the side of the transducer blocks.

Important note for pipe sizes under 2 inches [50 mm]. If the transducer spacing that is calculated is lower than 2.65 inches [67 mm], enter W-mount as the transducer mount method or enter V-mount and place the transducers at 2.65 inches [67 mm]. See Page 3.11 for additional details.

UltraLink Entry

UltraLink Data Entry

The UltraLink Windows®-based software utility provides an efficient means for entering piping and liquid parameters through the use of pop-up window/pull-down menu structures. Data can be entered into UltraLink, stored, later retrieved and downloaded at the TFXM installation site (provided that UltraLink and TFXM communications are not enabled at the time of data entry) or it can be downloaded immediately to the TFXM meter (provided that UltraLink and TFXM communications are enabled during data entry).

To install UltraLink and establish communications with a PC, please follow the instructions detailed in Section 4 of this manual.

The system information required for entry into the UltraLink package is identical to that required for Keypad Entry covered in the previous section. See pages 2.3.

After initializing UltraLink, click on the button labeled **Config**. The window shown in **Figure 2.5** will appear. Enter the pipe and liquid parameters into the appropriate data fields in the **Basic** window. The correct transducer spacing will appear in the **Transducer - Spacing** data field.

After all data fields have been entered **Download** to the TFXM or **File Save** to a disk by clicking on the appropriate button in the **Config** window. **Download** is not possible unless communications are enabled between the TFXM and UltraLink. Communications are enabled when a green OK is indicated in the lower right-hand **COMM:** status box. If communications are not enabled, please review the documentation that is detailed in Section 4 of this manual.

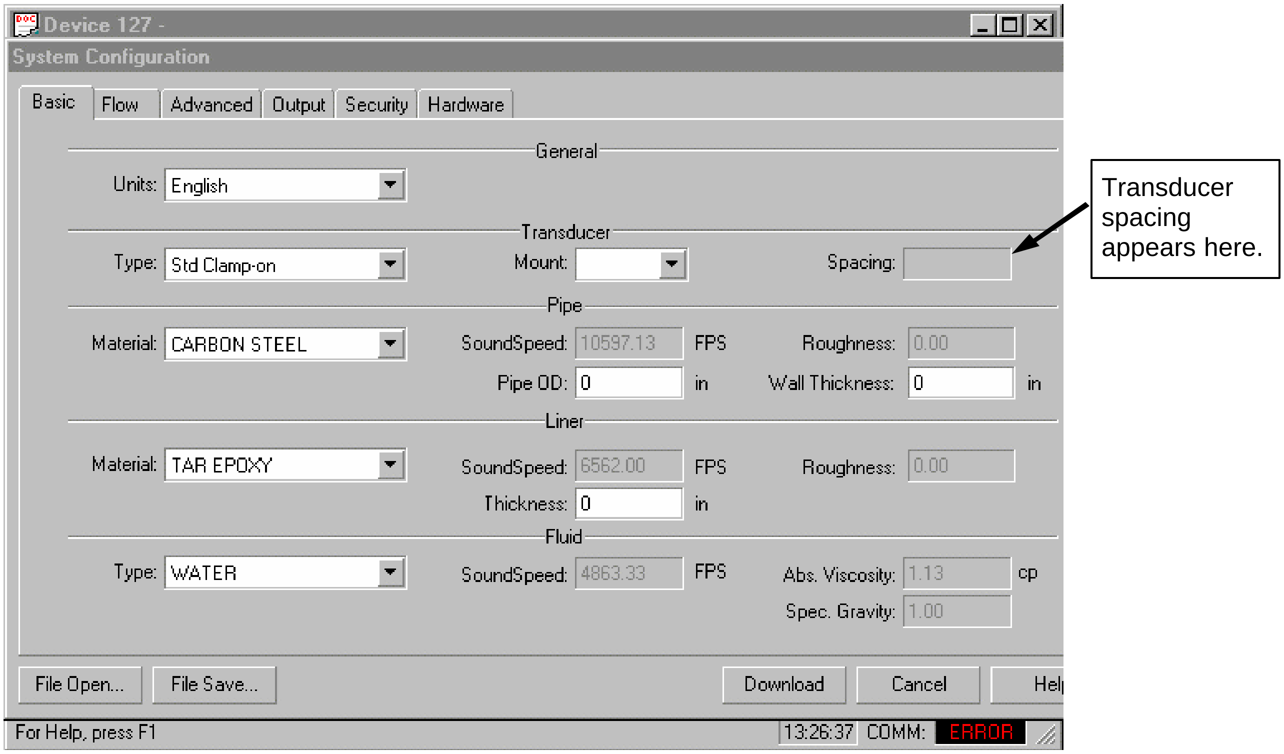


Figure 2.5 UltraLink Windows-based software utility configuration screen.

3. Transducer Mounting

After selecting an optimal mounting location, Step 1, and successfully determining the proper transducer spacing, Step 2, the transducers can now be mounted onto the pipe.

The DTT transducers need to be properly oriented on the pipe to provide optimum reliability and performance. On horizontal pipes, the transducers should be mounted 180 radial degrees from one another and at least 45 degrees from the top-dead-center and bottom-dead-center of the pipe. See **Figure 2.5**. **Figure 2.5** does not apply to vertically oriented pipes.

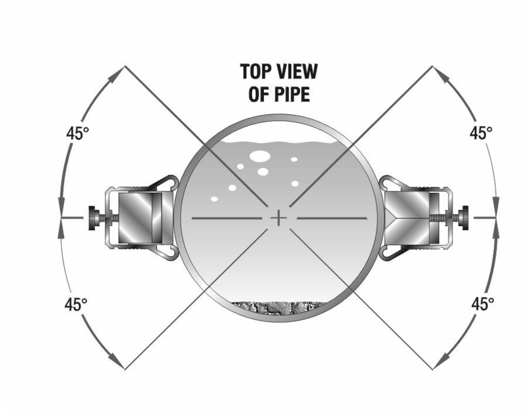


Figure 2.5 Transducer mounting locations on horizontal pipe.

Pipe Preparation

Before the transducers are bonded to the pipe surface, two areas slightly larger than the flat surface of the transducer heads must be cleaned of all rust, scale and moisture. Finish the surface with some emery paper, and wipe the surface with a degreasing solvent such as trichlorethylene. Paint and other coatings, if not flaked or bubbled, need not be removed. Plastic pipes typically do not require surface preparation other than soap and water cleaning.

Installation on Large Pipes

Mounting Transducers in Z-Mount Configuration

Installation on larger pipes requires careful measurements to the linear and radial placement of the DTT transducers. Failure to properly orient and place the transducers on the pipe may lead to weak signal strength and/or inaccurate readings. The section below details a method for properly locating the transducers on larger pipes. This method requires a roll of paper such as freezer paper or wrapping paper, masking tape and a marking device.

Wrap the paper around the pipe in the manner shown in **Figure 2.6**. Align the paper ends to within 0.25 inches [6mm].

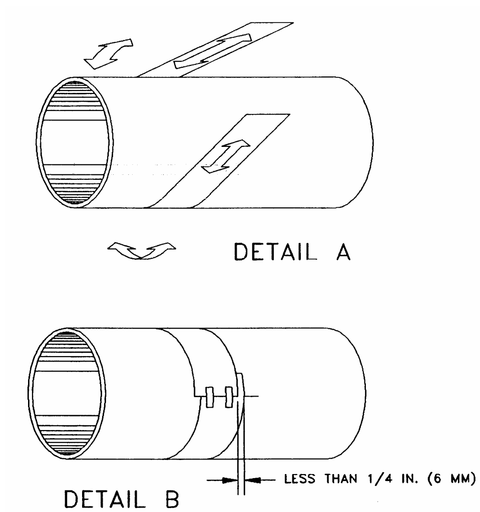


Figure 2.6 Paper Template Alignment

Mark the intersection of the two pieces of paper to indicate the circumference. Remove the template and spread it out on a flat surface. Fold the template in half, bisecting the circumference. See **Figure 2.7**.

Crease the paper at the fold line. Mark the crease. Place a mark on the pipe where one of the transducers will be located. See **Figure 2.5** for acceptable radial orientations. Wrap the template back around the pipe, placing the beginning of the paper and corner in the location of the mark. Move to the other side of the pipe and mark the ends of the crease. Measure from the end of the crease (directly across the pipe from the first transducer location) the dimension derived in Step 2, Transducer Spacing. Mark this location on the pipe.

The two marks on the pipe are now properly aligned and measured.

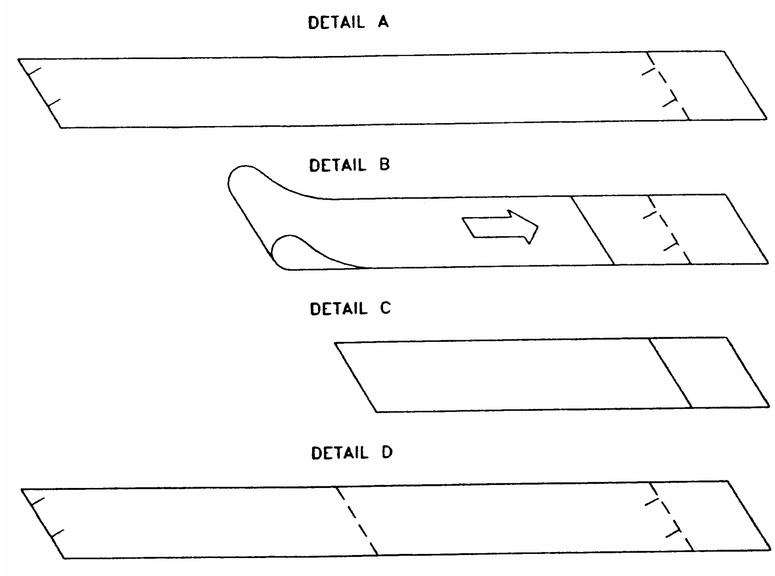


Figure 2.7 Bisecting the pipe circumference

If access to the bottom of the pipe prohibits the wrapping of the paper around the circumference, cut a piece of paper to these dimensions and lay it over the top of the pipe.

Length = Pipe O.D. x 1.57

Width = Spacing determined on Pages 2.14 or 2.16

Mark opposite corners of the paper on the pipe. Apply transducers to these two marks.

Transducer Mounting

1. Place a single bead of couplant, approximately 3/8 inch [6 mm] thick, on the flat face of the transducer. See **Figure 2.8**. Use Dow 732 for permanent and Dow 44 or Dow 111 for temporary (less than 12 months) installations. [For high temperature installations, utilize the Dow 112 and orange silicone pads that were shipped with the DTTH transducers. Apply the couplant to the transducer face as shown in **Figure 2.8**, then place the silicone pad over the couplant. Apply the couplant to the exposed surface of the silicone pad.

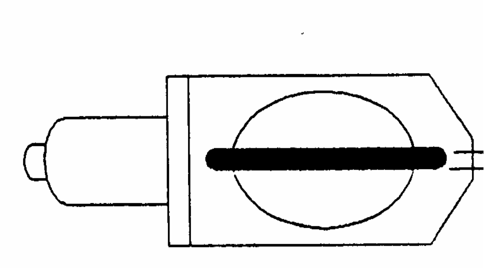


Figure 2.8 Transducer Couplant Application

2. Install the first transducer on the pipe, with the alignment groove placed over one of the marks created in the previous section. The stainless steel clamping band will be positioned within the groove on the front of the transducer. See **Figure 2.9**.

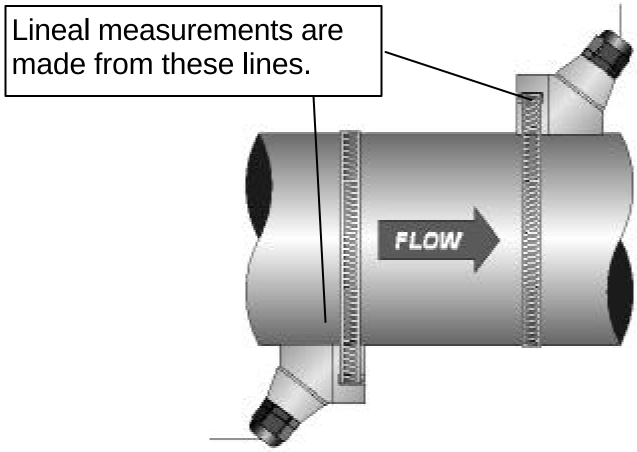


Figure 2.9 Z-Mode Transducer Mounting

3. Secure the transducer by tightening the stainless steel strap. (Excessive pressure is not required. Apply just enough pressure so that the couplant fills the gap between the pipe and transducer.) If DOW 732, or some other silicone RTV type sealant, was used ensure that no relative movement between the transducer and pipe takes place during the setting time and do not apply instrument power for at least 24 hours. If Dow 44 or Dow 111 or an alternate form of grease has been used as a couplant, setting time is not necessary.

4. Mount the transducer in the same manner as the first, but at the second mark on the pipe. Slide the transducer clamp over the transducer and secure with the stainless strap. Refer to **Figure 2.9** for proper orientation.

   NOTE: Since pipes larger than 20 inches (500 mm), typically can be out-of-round by a substantial amount, it is advised that the second transducer be left loose so that it can be positioned at the location of greatest Signal Strength. See Section 3 of this manual for Diagnostics and Signal Strength Measurement. Maximum Signal Strength can typically be obtained within 1 inch [25 mm] of the calculated lineal distance.

Mounting Track Installation

Mounting Track Installation

1. Install the single mounting track on the pipe in an orientation suggested by **Figure 2.5** (minus the rail mounted across the pipe) with the stainless steel bands provided. Orientation on vertical pipe is not critical. Ensure that the track is parallel to the pipe and that all four mounting feet are touching the pipe.

2. Slide the two transducer clamp brackets towards the center, 5 inch [125 mm] mark, on the mounting rail.

3. Place a single bead of couplant, approximately 3/8 inch [6 mm] thick, on the flat face of the transducer. See **Figure 2.10**. Use Dow 732 for permanent and Dow 44 for temporary (less that six months) installations. [High temperature installations require the use of Dow 112 and silicone pads.]

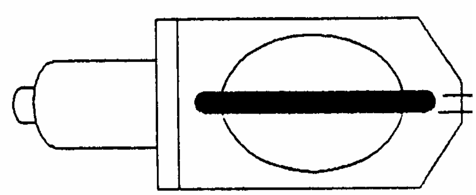


Figure 2.10 Transducer Couplant Application

4. Place the first transducer in between the mounting rails near the zero point on the mounting rail scale. Slide the transducer clamp over the transducer. Adjust the clamp/transducer such that the notch in the clamp aligns with zero on the scale. See **Figure 2.11**.

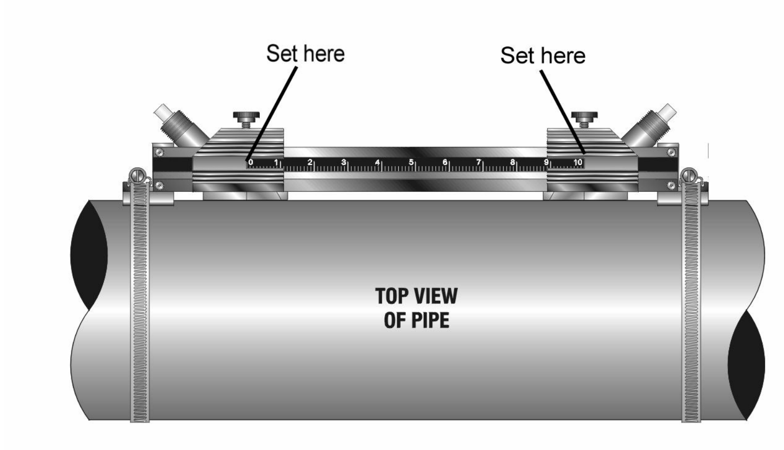


Figure 2.11 Transducer Space Measurement

5. Secure with the thumb screw. Ensure that the screw rests in the counter bore on the top of the transducer. (Excessive pressure is not required. Apply just enough pressure so that the couplant fills the gap between the pipe and transducer.) If DOW 732 or some other silicone RTV type sealant was used, ensure that no relative movement between the transducer and pipe takes place during the setting time and do not apply instrument power for at least 24 hours. If Dow 44 or Dow 111 or an alternate form of grease has been used as a couplant, setting time is not necessary.

6. Place the second transducer in between the mounting rails near the dimension derived in the Transducer Spacing section. Read the dimension on the mounting rail scale. Slide the transducer clamp over the transducer and secure with the thumb screw.

PART 3 - STARTUP AND CONFIGURATION

Before Starting the Instrument

Note: **<u>The TFXM flow meter system requires a full pipe of liquid before a successful startup can be completed.</u>** Do not attempt to make adjustments or change configurations until a full pipe is verified.

Note: If Dow 732 RTV was utilized to couple the transducers to the pipe, the adhesive must fully cure before power is applied to the instrument. Dow 732 requires 24 hours to cure satisfactorily. If Dow 111 silicone grease was utilized as a couplant, the curing time is not required. [DTTH—High Temperature Transducers utilize Dow 112 couplant and orange silicone pads mounted between the transducer and the pipe. This setup does not require any curing time.]

Instrument Startup

<u>Procedure:</u>

1. Verify that all wiring is properly connected and routed as described previously in this manual.
2. Verify that the transducers are properly mounted as described in Part 2 of this manual.
3. Apply power to the flow meter. The TFXM display backlighting will illuminate and the software version number will appear on the display.
4. Confirm that Signal Strength is greater than 2% for each measurement channel. If it is not, verify that proper transducer mounting methods and liquid/pipe characteristics have been entered. **<u>The pipe must be full of liquid in order to make this measurement.</u>**
5. Verify that the actual measured Sound Speed of the liquid is within 0.5% of the table value utilized in the BASIC menu setup.
6. Once the meter is properly operating (proper signal strength and measured sound speed has been achieved), refer to the later portions of this manual section for additional programming features.

PART 3 - KEYPAD CONFIGURATION

General

After an installation of the transducer track or cradle assembly and connection of appropriate power supplies to the TFXM, keypad configuration of the instrument can be undertaken. All entries are saved in non-volatile FLASH memory and will be retained in the event of power loss.

The TFXM can be configured through the keypad interface or by using the *UltraLink* Windows® software utility. Of the two methods of configuration, the *UltraLink* software utility provides more advanced features and offers the abililty to store and transfer meter configurations between TFXM meters.

Keypad Operation

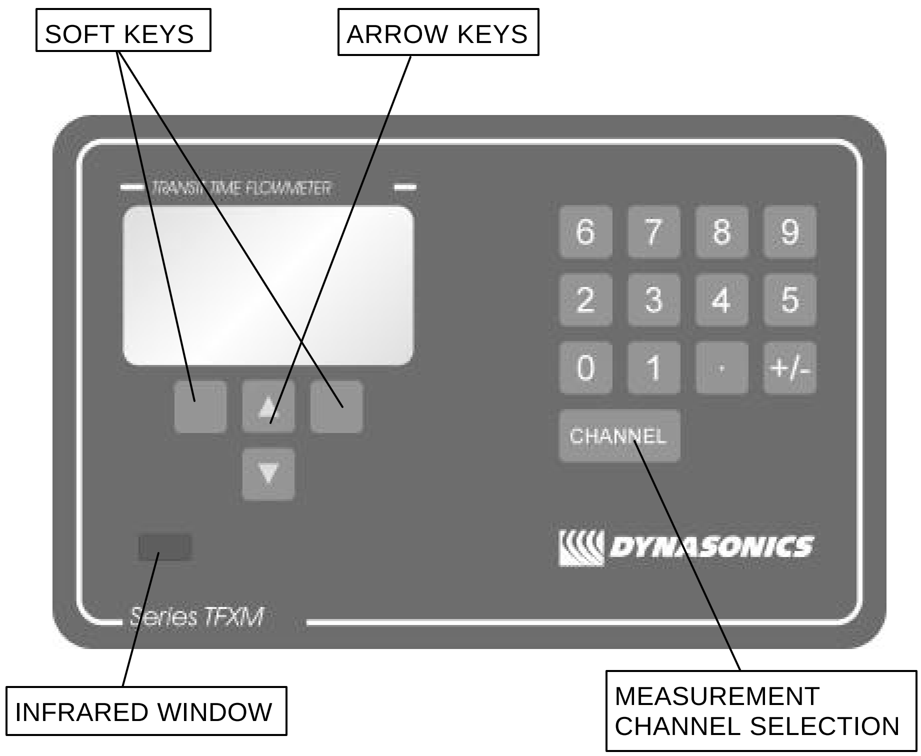


Figure 3.1
Keypad Description

The following “Soft Key” menu items will be displayed immediately above the two keys located in the lower corners of the Graphics Display. See **Figure 3.1**.

PART 3 - KEYPAD CONFIGURATION

1. The (soft)MENU key is pressed from RUN mode to enter PROGRAM mode. The (soft)EXIT key is pressed in PROGRAM mode to exit configuration parameters and menus. If changes to any configuration parameters have been made, the user will be prompted with a SAVE? (soft) YES or (soft)NO when returning to RUN mode. If no changes have been made, the user will not be prompted to SAVE.

Measurement Channel Configuration

2. When the (soft)MENU key is pressed, the user is prompted for the measurement channel that is to be configured. Use the UP/DOWN arrow keys to display the measurement channel that requires configuration. Press (soft)ACCEPT when the required channel is visible in the center of the display.

Display Contrast

3. The UP/DOWN ARROW keys are used to scroll through menus and configuration parameters. The ARROW keys can also be used to adjust parameter numerical values. In RUN mode the UP/DOWN ARROW keys are used to adjust the display contrast level.

Graphics Display Configuration

4. The Numerical Keypad is used for entering numerical values.
5. The (soft)ACCEPT key is used to

?? accept configuration parameter changes.

6. The (soft)SELECT key is used to

?? Configure the engineering units on the graphics display— Press the (soft)SELECT key from RUN mode to highlight the engineering unit presently being displayed on the graphics display (pressing the SELECT key multiple times will toggle the highlighted unit from line to line). Use the UP/DOWN ARROW keys to select display units of

?? RATE
?? TOTALizer
?? VELocity
?? SIGNAL STRength
?? Sound Speed
?? TEMP1
?? TEMP2
?? TEMP Diff

7. The (soft)CHAN UP/DOWN arrow keys are used to select a measuring entity for a particular display position and measuring channel.
8. The CHANNEL key is used during display setup to select what channel's information will be displayed on the graphics display.

The eight menus used in the structure of the TFXM are as follows:

1. BASIC MENU -- It contains all of the configuration parameters necessary to program the meter to measure flow.
2. OUTPUT 1 MENU -- Configures the type and operating parameters of the input/output features located internally in the TFXM flow meter.
3. OUTPUT 2 MENU -- Configures the type and operating parameters of the input/output features located internally in the TFXM flow meter.
4. AUX COM PORT -- Configures BAUD rate, addresses and scale factors applied to all flow meters on the RS485 network.
5. SENSOR MENU -- menu is for future use.
6. SECURITY -- utilized for resetting totalizers, resetting the operating system and revising security passwords.
7. SERVICE MENU -- contains system measurements that are used by service personnel for troubleshooting instruments installed on piping systems. On-the-pipe “zero flow” can be captured in this menu.
8. DISPLAY MENU — used to select either 2 or 4 lines on the graphics display.

The following sections define the configuration parameters located in each of the menus.

1. BSC MENU -- BASIC MENU

The BASIC menu contains all of the configuration parameters necessary to make the TFXM operational.

UNITS Selection

UNITS

ENGLSH
METRIC

Installs a global measurement standard into the operation of the instrument. The choices are either English or Metric measurements.

- Select ENGLSH if all configurations (pipe sizes, etc.)are to be made in inches. Select METRIC if the meter is to be configured in millimeters.
- The ENGLSH/METRIC selection will also configure the TFXM to display sound speeds in pipe materials and liquids as either feet per second or meters per second, respectively.

NOTE: If the UNITS entry has been changed from ENGLSH to METRIC or from METRIC to ENGLSH, the entry must be saved and the instrument reset (power cycled or System Reset entered) in order for the TFXM to initiate the change in operating units. Failure to save and reset the instrument will lead to improper transducer spacing calculations and an instrument that may not measure properly.

Transducer Mount

XDCR MNT -- Transducer Mounting Method

V
W
Z

Selects the mounting orientation for the transducers. The selection of an appropriate mounting orientation is based on pipe and liquid characteristics. See PART 2 - Transducer installation in this manual.

V -- Mount. A reflective type (transducers mounted on one side of the pipe) of installation used primarily on pipe sizes in the 3-10 inch [75-200 mm] internal diameter range.

W -- Mount. A reflective type (transducers mounted on one side of the pipe) of installation used primarily on pipe sizes in the 1-6 inch [25-75 mm] internal diameter range.

Z -- Mount. A direct type (transducers mounted on opposite sides of the pipe) of installation used primarily on pipe sizes in the 10-100 inch [200-2540 mm] internal diameter range.

Pipe Diameter

PIPE OD -- Pipe Outside Diameter Entry

ENGLSH (Inches)
METRIC (Millimeters)

Enter the pipe outside diameter in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected.

IMPORTANT NOTE: Charts listing popular pipe sizes have been included in the Appendix of this manual. Correct entries for pipe O.D. and pipe wall thickness are critical to obtaining accurate flow measurement readings.

Pipe Wall Thickness

PIPE WT -- Pipe Wall Thickness Entry

ENGLSH (Inches)
METRIC (Millimeters)

Enter the pipe wall thickness in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected.

IMPORTANT NOTE: Charts listing popular pipe sizes have been included in the Appendix of this manual. Correct entries for pipe O.D. and pipe wall thickness are critical to obtaining accurate flow measurement readings.

Pipe Material

PIPE MAT -- Pipe Material Selection

CARBON S - Carbon Steel
STAINLES - Stainless Steel
CAST IRO - Cast Iron
DUCTILE - Ductile Iron
COPPER - Copper
PVC - Polyvinylchloride
PVDF LOW - Low Density Polyvinylidene Flouride
PVDF HI - High Density Polyvinylidene Flouride
ALUMINUM - Aluminum
ASBESTOS - Asbestos Cement
FIBERGLA - Fiberglass
OTHER

This list is provided as an example. Additional pipe materials are being added continuously. Select the appropriate pipe material from the list or select OTHER if the material is not listed.

Pipe Sound Speed

PIPE SS -- Speed of Sound in the Pipe Material

ENGLSH (Feet per Second)
METRIC (Meters per Second)

Allows adjustments to be made to the speed of sound in the pipe wall. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second).

If a pipe material was chosen from the PIPE MAT list, a nominal value for speed of sound in that material will be automatically loaded. If the actual sound speed rate is known for the application piping system and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as PIPE MAT, a PIPE SS will need to be entered.

Pipe Roughness

PIPE R -- Pipe Material Relative Roughness

UNITLESS VALUE

The TFXM provides Reynolds Number compensation in its flow measurement calculation. The ratio of average surface imperfection as it relates to the pipe internal diameter is used in this compensation.

$$\text{PIPE R} = \frac{\text{Linear RMS measurement of the pipe internal wall surface}}{\text{Internal Diameter of the pipe}}$$

If a pipe material was chosen from the PIPE MAT list, a nominal value relative roughness in that material will be automatically loaded. If the actual roughness is known for the application piping system and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as PIPE MAT, a PIPE R may need to be entered.

Liner Thickness

LINER T -- Pipe Liner Thickness Entry

ENGLSH (Inches)
METRIC (Millimeters)

Enter the pipe liner thickness. Enter this value in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected.

Liner Type

[If a LINER Thickness was selected]
LINER MAT - Liner Material

TAR EPOXY
RUBBER
MORTAR
POLYPROPYLENE
POLYSTYROL
POLYSTYRENE
POLYESTER
POLYETHYLENE
EBONITE
TEFLON

Other

This list is provided as an example. Additional materials are being added continuously. Select the appropriate material from the list or select OTHER if the liner material is not listed.

Liner Sound Speed

LINER SS -- Speed of Sound in the Liner

ENGLSH (Feet per Second)
METRIC (Meters per Second)

Allows adjustments to be made to the speed of sound in the liner. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second).

If a liner was chosen from the LINER MAT list, a nominal value for speed of sound in that media will be automatically loaded. If the actual sound speed rate is known for the pipe liner and that value varies from the automatically loaded value, the value can be revised.

Fluid Type

FL TYPE - Fluid/Media Type

WATER
SEA WATE
KEROSENE
GASOLINE
FUEL OIL
CRUDE OI
PROPANE
BUTANE
OTHER

This list is provided as an example. Additional liquids are being added continuously. Select the appropriate liquid from the list or select OTHER if the liquid is not listed.

Fluid Sound Speed

FLUID SS -- Speed of Sound in the Fluid

ENGLSH (Feet per Second)
METRIC (Meters per Second)

Allows adjustments to be made to the speed of sound in the liquid. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second).

If a fluid was chosen from the FL TYPE list, a nominal value for speed of sound in that media will be automatically loaded. If the actual sound speed rate is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as FL TYPE, a FLUID SS will need to be entered. A list of alternate fluids and their associated sound speeds are located in the Appendix at the back of this manual.

Fluid Viscosity

FLUID VI -- Absolute Viscosity the Fluid

cps

Allows adjustments to be made to the absolute viscosity of the liquid.

If a fluid was chosen from the FL TYPE list, a nominal value for viscosity in that media will be automatically loaded. If the actual viscosity is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as FL TYPE, a FLUID VI will need to be entered. A list of alternate fluids and their associated viscosities are located in the Appendix at the back of this manual.

Fluid Specific Gravity

SP GRVTY -- Fluid Specific Gravity Entry

unitless

Allows adjustments to be made to the specific gravity (density) of the liquid.

If a fluid was chosen from the FL TYPE list, a nominal value for specific gravity in that media will be automatically loaded. If the actual specific gravity is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

If OTHER was chosen as FL TYPE, a SP GRVTY may need to be entered if mass flows are to be calculated. A list of alternate fluids and their associated specific gravities are located the Appendix located at the back of this manual.

Transducer Spacing

XDCR SPAC -- Transducer Spacing Calculation

ENGLSH (Inches)
METRIC (Millimeters)

This value represents the one-dimensional linear measurement between the transducers (the upstream/downstream measurement that runs parallel to the pipe). This value is in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected. This measurement is taken from the line which is scribed into the side of the transducer block.

If the transducers are being mounted using the transducer track assembly, a measuring scale is etched into the track. Place one transducer at 0 inches and the other at the appropriate measurement.

NOTE: If V-mounting is used on pipes that are smaller than 2 inches [50 mm], the transducers will be mounted "nose-to-nose" as illustrated in **Figure 3.2**.

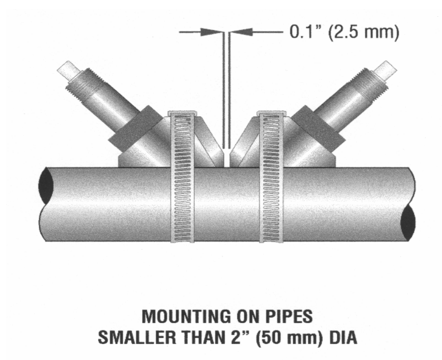


Figure 3.2

Engineering Units RATE

RATE UNT - Engineering Units for Flow Rate

GALLONS - U.S. Gallons
LITERS - Metric Liter
MGAL - Millions of U.S. Gallons
CUBIC FT - Cubic Feet
CUBIC ME - Cubic Meters
ACRE FT - Acre Feet
OIL BARR - Oil Barrels (42 U.S. Gallons)
LIQ BARR - Liquor Barrels (31.5 U.S. Gallons)
FEET - Linear Feet
METERS - Linear Meters

Select a desired engineering unit for flow rate measurements.

Engineering Units RATE INTERVAL

RATE INT - Time Interval for Flow Rate

MIN - Minutes
HOUR - Hours
DAY - Days
SEC - Seconds

Select a desired engineering unit for flow rate measurements.

Engineering Units TOTAL

TOTL UNT - Engineering Units for Flow Totalizer

GALLONS - U.S. Gallons
LITERS - Metric Liter
MGAL - Millions of U.S. Gallons
CUBIC FT - Cubic Feet
CUBIC ME - Cubic Meters
ACRE FT - Acre Feet
OIL BARR - Oil Barrels (42 U.S. Gallons)
LIQ BARR - Liquor Barrels (31.5 U.S. Gallons)
FEET - Linear Feet
METERS - Linear Meters

Select a desired engineering unit for flow accumulator (totalizer) measurements.

Engineering Units TOTAL Exponent

TOTL E - Flow Totalizer Exponent Value
E-1 to E6

Utilized for setting the flow totalizer exponent. This feature is useful for accommodating a very large accumulated flow. The exponent is a "X10^{n}" multiplier, where "n" can be from -1 (X 0.1) to +6 (X 1,000,000).

Exponent	Display Multiplier
E-1	X 1 (No multiplier)
E0	X 1 (No multiplier)
E1	X10
E2	X100
E3	X1,000
E4	X10,000
E5	X100,000
E6	X1,000,000

Minimum Flow Rate

MIN RATE - Minimum Flow Rate Settings
Rate Unit/Rate Interval

A minimum volumetric flow rate setting is entered to establish

NOTE: The Minimum Rate may be set anywhere in the flow measurement range of -40 to +40 FPS. For example: If bi-directional flow needs to be logged, set the MIN RATE at a negative value.

filter software settings.

Maximum Flow Rate

MAX RATE - Maximum Flow Rate Settings
Rate Unit/Rate Interval

A maximum volumetric flow rate setting is entered to establish filter software settings and as a baseline for the FL C-OFF entry below.

NOTE: The Maximum Rate may be set anywhere in the flow measurement range of -40 to +40 FPS. For example: If bi-directional flow needs to be logged, set the MIN RATE at a negative value and MAX RATE at a positive value.

Low Flow Cut-off

FL C-OFF - Low Flow Cut-off

Percent of MAX RATE

A Low Flow Cut-off entry is provided to allow very low flow rates (that can be present when pumps are off and valves are closed) to be displayed as Zero flow. Typical values that should be entered are between 1.0% and 5.0% of full-scale.

Flow Reading Damping

DAMP PER - System Damping

Relative Percent Entry

DAMP PER establishes a maximum adaptive filter value. Under stable flow conditions (flow that varies less than the **Flow Filter Hysteresis** entry) this adaptive filter will increase the number of successive flow readings that are averaged together up to this maximum value. If flow changes outside of the **Flow Filter Hysteresis** window (typically ±5% of flow rate), the Flow Filter adapts by decreasing and allows the meter to react faster. Increasing this value tends to provide smoother steady-state flow readings and outputs. The DAMP PER setting increases and decreases the response time of the flow meter display and outputs. Enter a value between 1 and 100 percent, a setting of 1 having the fastest response and 100 having the slowest response.

2&3. OUTPUT 1 and 2 MENUS

***Standard* 4-20mA**

Integral 4-20mA Output

FL 4MA
FL 20MA
CAL 4MA
CAL 20MA
4-20 TST

The 4-20 mA Output interfaces with virtually all recording and logging systems by transmitting an analog current signal that is proportional to system flow rate. The output can be configured to be either internally or externally powered by setting the left DIP-switch at SW1 for Channel 1 and SW2 for Channel 2. Refer to the Field Wiring Diagram at **Figure 1.4** for terminal block and DIP-switch locations.

When powered from internal power, the 4-20 mA output can provide loop current for a maximum of 800 ohms of total loop resistance. When powered externally, the maximum load varies with the level of the voltage source. The insertion loss of the 4-20 mA circuit is 5Vdc, so the maximum loop load that can be powered is calculated by the equation:

$$\text{Max Loop Load} = \frac{(\text{External Supply Voltage} - 5)}{0.02}$$

4-20mA Span

The FL 4MA and FL 20MA entries are used to set the span of the 4-20 mA analog output. These entries are volumetric rate units that are equal to the volumetric units configured as Engineering Rate Units and Engineering Units Time Interval entered on page 3.10. These entries may be entered anywhere in the flow measurement range of the instrument (velocity range of –40 to +40 FPS [-12 to +12 MPS]).

For example, to span the 4-20mA output from –100 GPM to +100 GPM, with 12mA being 0 GPM, set the FL 4MA and FL 20MA inputs as follows:

FL 4MA = -100.0

FL 20MA = 100.0

For example, to span the 4-20mA output from 0 GPM to +100 GPM, with 12mA being 50 GPM, set the FL 4MA and FL 20MA inputs as follows:

FL 4MA = 0.0
FL 20MA = 100.0

4-20mA Calibration

The 4-20mA ISO-MOD is factory calibrated and should not require adjustment unless it is replaced.

NOTE: The CAL 4MA and CAL 20MA entries should not be used in a attempt to set the 4-20mA range. Utilize FL 4MA and FL 20MA, detailed above, for this purpose.

The CAL4MA entry allows fine adjustments to be made to the "zero" of the 4-20mA output. To adjust the 4mA output, an ammeter or reliable reference connection to the 4-20mA output must be present.

Procedure:

1. Disconnect one side of the current loop and connect the ammeter in series (disconnect either wire at the terminals labeled 4-20mA IN or 4-20mA OUT, Fig. 1.4).
2. Using the arrow keys, increase the numerical value to increase the current in the loop to 4mA. Decrease the value to decrease the current in the loop to 4mA. Typical values range between 40-80 counts.

Re connect the 4-20mA output circuitry as required.

Calibration of the 20mA setting is conducted much the same way as the 4mA adjustments.

Procedure:

1. Disconnect one side of the current loop and connect the ammeter in series (disconnect either wire at the terminals

labeled 4-20mA IN or 4-20mA OUT, Fig. 1.4).

2. Using the arrow keys, increase the numerical value to increase the current in the loop to 20mA. Decrease the value to decrease the current in the loop to 20mA. Typical values range between 3700-3900 counts.

Re connect the 4-20mA output circuitry as required.

4-20mA Test

4-20 TST - 4-20mA Output Test

4-20

Allows a simulated value to be output from the 4-20mA output. By incrementing this value, the 4-20mA output will transmit the indicated current value.

Relay Setup

Integral Dual Relay Configuration

RELAY 1 AND RELAY 2

- *NONE*
- *TOTALIZE*
  - *TOT MULT*
- *FLOW*
  - *ON*
  - *OFF*
- *SIG STR*
- *ERRORS*

Two independent SPDT (single-pole, double-throw, Form C) relays are integrated into the TFXM for each measuring channel installed within the flow meter enclosure. The relay operations are user configured via software to act in either a flow rate alarm, signal strength alarm or totalizer/batching mode. See **Figure 1.4** for terminal block locations. The relays are rated for 200 Vac max. and have a current rating of 0.5 A resistive load [175 Vdc @ 0.25 A resistive]. It is highly recommended that a slave relay be utilized whenever the control relays are used to control inductive loads such as solenoids and motors.

Batch/Totalizer Relay

When one of the relays is set to TOTALIZE mode, an entry of TOT MULT must be programmed to establish the accumulated flow volume that needs to pass before the relay will “pulse”. The relay will pulse every time that volume is accumulated. The pulse has a duration of approximately 50mSec. Enter a value using the same units that were established as Engineering Units TOTAL on page 3.12.

Flow Rate Relay

When a relay is set to FLOW mode, two entries must be made: ON and OFF. The ON and OFF entries dictate at what volumetric flow rate (using the volumetric units established as Engineering Units RATE and RATE INTERVAL on page 3.12) the relay turns ON and at what flow rate the relay turns OFF - establishing a deadband. For “fail-safe” mode, the ON setting should be set higher than the OFF setting.

Signal Strength Alarm

When a relay is set to SIG STR mode, the relay will activate when the measured Signal Strength falls below the Signal Strength Cutoff setting. See page 3.26.

Error Alarm Relay

When a relay is set to ERROR mode, the relay will activate when any error occurs in the flow meter that has caused the meter to stop measuring reliably. See the Appendix of this manual for a list of potential error codes.

4. *AUX COMM MENU* -- RS485

RS485 MODBUS Communications

Integral RS485 Communications

RS485 MO — MODE
- *SLAVE*
- *MASTER*

RS485 BA — BAUD RATE
- *1200*
- *2400*
- *9600*
- *19200*

ADDRESS — Device Address
- *1-127*

An RS485 driver and Modbus protocol is utilized by the TFXM to communicate between the two channels located within the TFXM flow meter enclosure (if so equipped), communicate with satellite TFX flow meters and to interface with a personal computer system. The TFXM can be used as the Primary meter (Master) to program other Secondary (Slave) meters located on the RS485 network. The TFXM contains a feature that permits up to 8 flow measurement channels to be mathematically manipulated. Software configuration is covered in Section 4 of this manual.

RS485 interconnections are made at the terminal block located within the TFXM Field Wiring Access Panel. See **Figure 1.4**. Utilize two conductor plus shield wiring cable for this purpose. Avoid running these cables in wiring trays or conduits carrying AC power or other electrically noisy devices.

RS485 MO

Select SLAVE for all of the TFXD meters.

RS485 BA

Select a Baud rate that is compatible with the operating system – typically 9600.

ADDRESS

Each TFXD connected on the communications bus must have an unique address number assigned.

Optional
Rate Pulse

ISO-MOD RATE PULSE

FL 100H
FL 10KH
CAL 100H
CAL 10KH

The Rate Pulse Output Module is utilized to transmit information to external counters and PID systems via a frequency output that is proportional to system flow rate. Independent Zero and Span settings are established in software using the Flow Measuring Range entries. These entries can be set anywhere in the –40 to +40 FPS [-12 to +12 MPS] measuring range of the instrument. Output resolution of the module is 12-bits (4096 discrete points) and the maximum output frequency setting is 2,500 Hz. The 0.21-Ohm FET output is rated to operate at 100 V and 1 A maximum. This module does not source an output voltage and should be treated as an open collector type of output. An external voltage source and limit resistor must be present.

Rate Pulse Span

The FL 100H and FL FL10KH entries are used to set the span of the 0-2.5KHz frequency output. These entries are volumetric rate units that are equal to the volumetric units configured as Engineering Rate Units and Engineering Units Time Interval entered on page 3.12. These entries may be entered anywhere in the flow measurement range of the instrument (velocity range of –40 to +40 FPS [-12 to +12 MPS]).

For example, to span the 0-2.5KHz output from –100 GPM to +100 GPM, with 1.25KHz being 0 GPM, set the FL 100H and FL 10KH inputs as follows:

FL 100H = -98.0 (1% of span)
FL 10KH = 100.0

For example, to span the Rate Pulse output from 0 GPM to +100 GPM, with 1.25 kHz being 50 GPM, set the FL 100H and FL 10KH inputs as follows:

FL 100H = 1.0 (1% of span)
FL 10KH = 100.0

Rate Pulse Calibration

The Rate Pulse ISO-MOD is factory calibrated and should not require adjustment unless it is replaced.

The CAL 100H entry allows fine adjustments to be made to the "zero" of the 0-2.5KHz output. To adjust the 25Hz setting, frequency counter or reliable reference connection to the 0-2.5KHz output must be present. The output of the module must be powered externally.

NOTE: The CAL 100H and CAL 10KH entries should not be used in a attempt to set the 0-2.5KHz range. Utilize FL 100H and FL 10KH, detailed above, for this purpose.

Procedure:

1. The module must be powered to perform this calibration. Connect the frequency counter at the terminals labeled +/- on the **ISO-MOD** 0-2.5KHz module). Set the counter to the appropriate measuring range for measuring 25 Hz.
2. Using the arrow keys, increase the numerical value to increase the output frequency to 25 Hz ±1 Hz. Decrease the value to decrease the output frequency to 25 Hz ±1 Hz. Typical values range between 40-80 counts.

The CAL 10KH entry allows fine adjustments to be made to the "span" of the 0-2.5KHz output. To adjust the 2.5KH setting, frequency counter or reliable reference connection to the 0-2.5KHz output must be present. The output of the module must be powered externally.

Procedure:

1. The module must be powered to perform this calibration. Connect the frequency counter at the terminals labeled +/- on the **ISO-MOD** 0-2.5KHz module). Set the counter to the appropriate measuring range for measuring 2.5 KHz.
2. Using the arrow keys, increase the numerical value to increase the output frequency to 2.5 KHz ±3 Hz. Decrease the value to decrease the output frequency to 2.5 KHz ±3 Hz. Typical values is 4000 counts.

RTD Module

Details of the RTD Module and its configuration are located in an Addendum to this manual. Those details are included with the purchase of the RTD module.

Optional
RS232C Module

ISO-MOD RS-232C

RS232 MO — MODE
HOST
UIF
RS232 BA — BAUD RATE
1200
2400
9600
19200

The RS232 Module can be interfaced with serial communication ports of PCs, PLCs and SCADA systems, running a Modbus protocol, detailed in the Appendix of this manual, that are used to monitor flow rate information in piping systems. The RS232 Module may also be used to form a hardwire connection to a PC that is running the UltraLink software utility. Baud rates up to 19.2 K are supported.

5. SENSOR MENU

The SEN MENU is presently not utilized.

6. SECURITY MENU

The SEC MENU allows the user to make password revisions, reset the flow totalizer and reset the transmitter microprocessor.

Totalizer RESET

TOT RES

NO
YES

Select YES to reset the flow totalizer/accumulator to Zero.

System RESET

SYS RSET

NO
YES

Select YES to initiate a microprocessor reset. Totalizer values will be lost, but all other system configurations will be maintained.

Change Password

CH PSWD? -- Change the Security Password

0-9999

By changing the Security Password from 0 to some other value (any value between 1-9999), configuration parameters will not be accessible without first entering that value when prompted. If the value is left at 0, no security is invoked and unauthorized changes could be made.

7. SERVICE MENU

The SERVICE Menu makes available two different system measurements that are used for trouble-shooting and fine tuning of the instrument. Actual liquid sound speed and system signal strength readings can be accessed through this menu.
The SERVICE Menu also has features that allow adjustment of Signal Strength Cutoff, Error-Mode outputs and Zero Flow Rate Set.

SSPD MPS - Sound Speed in the Liquid Metric
SSPD FPS - Sound Speed in the Liquid U.S.

The TFXM performs an actual speed of sound calculation for the liquid it is measuring. This speed of sound calculation will vary with temperature, pressure and fluid composition. The value indicated in this measurement should be within a couple of percent of the value entered/indicated in the BASIC menu item FLUID SS. (This value cannot be edited.) If the actual measured value is significantly different than the BASIC MENU's FLUID SS value, it typically indicates a problem with the instrument setup. An entry such as PIPE O.D. or wall thickness was probably entered in error, the pipe may not be round, or the transducer spacing is not correct. **Table 3.1** lists sound speed values for water at varying temperatures. If the TFXM is measuring sound speed within 0.5% of the table values, the installation and setup of the instrument is proper and accurate readings can be assured.

TABLE 3.1 Sound Speed in Liquid Water Vs. Temperature

Deg. C	Deg. F	Vs (m/s)	Vs (f/s)
0	32	1402	4600
10	50	1447	4747
20	68	1482	4862
30	86	1509	4951
40	104	1529	5016
50	122	1543	5062
60	140	1551	5089
70	158	1555	5102
80	176	1554	5098
90	194	1550	5085
100	212	1543	5062
110	230	1532	5026
120	248	1519	4984
130	266	1503	4931
140	284	1485	4872
150	302	1466	4810
160	320	1440	4724
170	338	1412	4633
180	356	1390	4560
190	374	1360	4462
200	392	1333	4373
220	428	1268	4160
240	464	1192	3911
260	500	1110	3642

SIG STR - Signal Strength

Signal Strength

The measurement of Signal Strength assists service personnel with troubleshooting the TFXM system. In general, expect the signal strength readings to be greater than 5% on a full pipe with the transducers properly mounted. Signal strength readings that are less than 5% may indicate a need to chose an alternative mounting method for the transducers or that an improper pipe size has been entered.

Signal Strength readings in excess of 95% may indicate that a mounting method with a longer path length may be required. For example, if mounted on a 3 inch PVC pipe in V-mode causes the measured Signal Strength value to exceed 95%, change the mounting method to W-mode for greater stability in readings.

Signal Strength Cutoff

Signal Strength Cutoff

Signal Strength Cutoff SIG C-OF is used to drive the flowmeter and its outputs to a zero flow state should conditions occur that cause low signal strength. A signal strength indication of between 0.5 and 0.8 is considered to be inadequate for measuring flow reliably, so typical settings for SIG C-OF are in the range of 1.0 to 2.0.

Signal Strength indication of 0.5 to 0.8 is considered to be no signal at all. Verify that the pipe if full of liquid, the pipe size and liquid parameters are entered correctly and that the transducers have been mounted accurately.

Substitute Flow Entry

Substitute Flow

Substitute Flow or SUB FLOW is a value that the analog outputs will be driven at when an error condition in the flowmeter occurs. Typical settings are either –5% or 105% - a value outside of the normal operating range that can be used to indicate a fault condition to the target device.

MIN RATE SETTING	MAX RATE SETTING	SUB FLOW SETTING	DISPLAY READING READING DURING ERRORS
0.0	1,000.0	0.0	0.000
-500.0	500.00	50.0	0.000
-100.0	200.0	33.3	0.000
0.0	1,000.0	-5.0*	-50.00

Setting/ Calibrating Zero Flow

Setting Zero Flow

Because every flowmeter installation is slightly different and sound waves can travel in slightly different ways through these various installations, a provision is made in this entry to establish "Zero" flow—SET ZERO.

To zero the meter:

1. The pipe must be full of liquid.
2. Flow must be absolute zero—verify by closing a valve securely. Allow time for any settling to occur.
3. Press ENTER, use the arrow keys to make the display read YES.
4. Press ENTER.
5. The procedure is complete.

Setting/ Calibrating Zero Flow

Reset Zero—Factory Default Zero

If the flow in a piping system cannot be shutoff, allowing the SET ZERO procedure described above to be performed, the factory default zero should be utilized. To utilize the D-FLT 0 function, simply press ENTER, then press an ARROW key to display YES on the display and then press ENTER. This function can also be utilized to correct an inadvertently entered or erroneous SET ZERO entry.

Universal Correction Factor

COR FTR - Universal Correction Factor

This function can be used to make the TFXM system agree with a different or reference flow meter, by applying a correction factor/multiplier to the readings and outputs. A factory calibrated system should be set to 1.000. The range of settings for this entry is 0.500 to 1.500. The following examples describe two uses for the COR FTR entry.

?? The TFXM meter is indicating a flow rate that is 4% higher than another flow meter located in the same pipe line. To make the TFXM indicate the same flow rate as the other meter, enter a COR FTR of 0.960, to lower the readings by 4%.

?? An out-of-round pipe, carrying water, causes the TFXM to indicate a measured sound speed that is 7.4% lower than the **TABLE 3.1** value. This pipe condition will cause the flow meter to indicate flow rates that are 7.4% lower than actual flow. To correct the flow readings, enter 1.074.

8. DSP MENU -- DISPLAY MENU

Graphics Display Mode

DISPLAY LINES

Allows the selection of a two line or four line display format on the graphics display module.

In 2 Line mode, the display will display flow measurements with larger characters on the top half of the window and smaller standard sized characters on the lower half of the window. In 4 Line mode, the display will display flow measurements with standard sized characters on four lines in the window.

Display Units

DISPLAY UNITS SELECTION

The (soft)SELECT key is used to conifgure the engineering units on the graphics display—Press the (soft)SELECT key from RUN mode to highlight the engineering unit presently being displayed on the graphics display (pressing the SELECT key multiple times will toggle the highlighted unit from line to line). Use the UP/DOWN ARROW (soft)CHAN keys to select display units of

- RATE
- TOTALizer
- VELocity
- SIGNAL STRength
- Sound Speed
- Temp 1
- Temp 2
- Temp Diff

SOFTWARE UTILITIES

Important Notice!

The TFXM flow meter is available with two software utilities, ***UltraLink*** and ***DataLink***. The UltraLink utility is used for configuration, calibration and communication with the TFXM flow meter. The DataLink utility is used for uploading and translating data accumulated in the optional datalogger module.

UltraLink has been designed to provide TFX users with a powerful and convenient way to configure and calibrate all TFX flowmeters. UltraLink can be used in conjunction with an infrared communications adapter (Dynasonics P.N. D005-2115-001), RS232 or RS485.

System Requirements

Computer type - PC, operating system Windows 95/98/2000/XP, a communications port, hard disk and 3.5" diskette drive.

Installation

1. Backup/Copy all files from the enclosed disk to a folder on the computer hard disk.
2. Remove the diskette from the computer and store.
3. From the "Start" command, RUN **UlSetup.exe** from the hard disk folder.
4. **UlSetup** will automatically extract and install on the hard disk and place a short-cut icon on the desktop.
5. Most PCs will require a restart after a successful installation.

Initialization

1. Connect the PC to the TFX flowmeter using the infrared communications adapter (Dynasonics P.N. D005-2115-001), ISO-MOD RS232 or ISO-MOD RS485.
2. Double-click on the **UltraLink** icon. The first screen is the “RUN-mode” screen, See **Figure 4.1**, which contains real-time

information regarding flow rate, totalizer accumulation, system signal strength, diagnostic data and the flow meter's serial number. The indicator in the lower right-hand corner will indicate communications status. If a red **ERROR** is indicated, click on the Communications button on the top bar. Click on Initialize. Choose the appropriate COM port and interface type. Proper communications are established when a green **OK** is indicated in the lower right-hand corner of the PC display.

Notes: The range of the infrared communications adapter is roughly 3 meters. Some high-intensity lighting systems will significantly reduce the communications range of the infrared system.

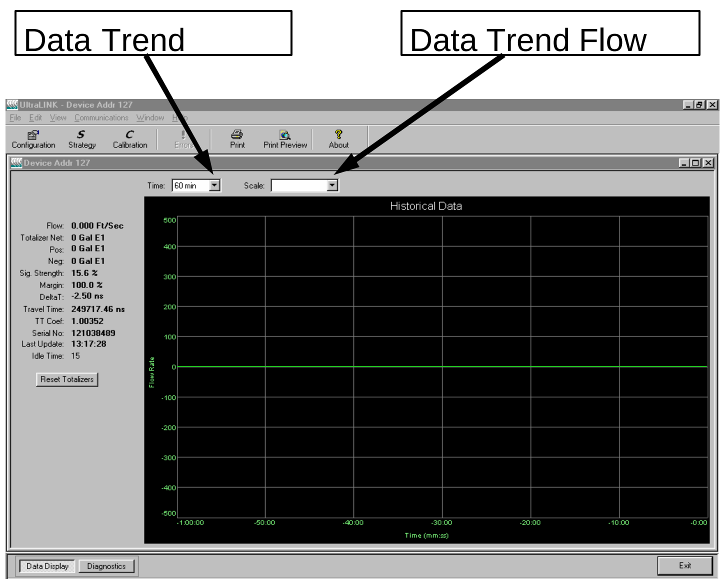


Figure 4.1
UltraLink Data Screen

Using UltraLink For Configuration

Click on the button labeled **Configuration** for updating flow range, liquid, pipe and I/O operating information. The first screen that appears after clicking the **Configuration** button is the **BASIC** tab. See **Figure 4.2**.

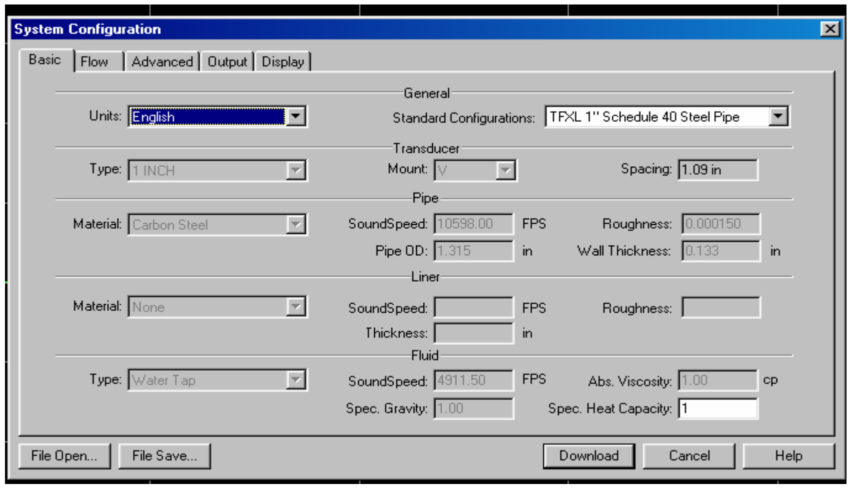


Figure 4.2
Basic Tab

1. **BASIC** TAB—See **Figure 4.2**

?? **General Units** allows selection of either English (U.S.) or Metric units of measure. If measurements of the pipe are to be entered in inches, select English. If pipe measurements are to be entered in millimeters, select Metric. It is recommended that if the General Units are altered from those at instrument startup, that the Download button be pressed on the lower right-hand portion of the screen and that the TFXM have its power cycled.

?? **Standard Configurations** contains the most popular applications for the TFXM. The TFXM has been constructed and configured at the Dynasonics factory for a specific pipe size. If the Standard Configuration does not match the pipe schedule or material, select the proper configuration from the drop down list. If the pipe schedule is not listed or if the liquid is not water, select **Other** on the drop down list and fill in the proper information on the setup screen.

2. **FLOW** Tab—See **Figure 4.3**

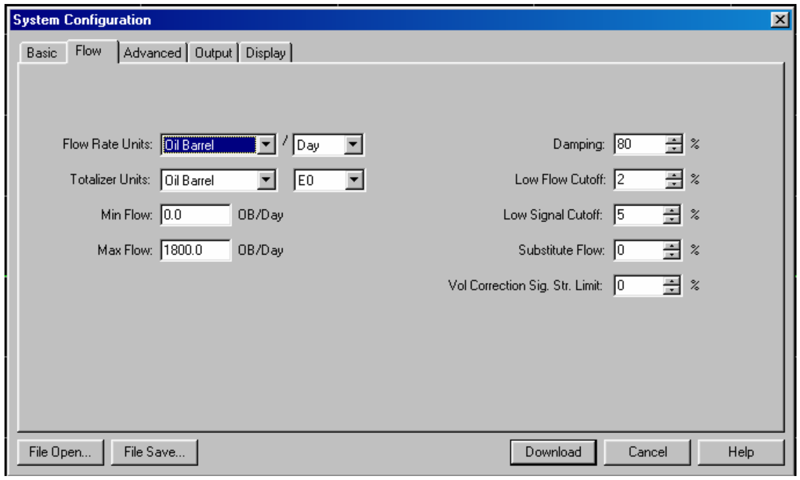


Figure 4.3
Flow Tab

?? **Flow Rate Units** are selected from the pull down lists. Select an appropriate rate unit and rate time-base from the two lists.

?? **Totalizer Units** are selected from pull down lists. Select an appropriate totalizer unit and totalizer exponent. The totalizer exponents are in Scientific Notation and permit the eight digit totalizer to accumulate very large values before the totalizer "rolls over" and starts again at zero. The Table on page 3.13 illustrates the Scientific Notation values and their respective decimal equivalents.

?? **MIN Flow** is used by the TFXM to establish filter settings in its operating system. Enter a flow rate that is the minimum flow rate anticipated within the system. For uni-directional systems, this value is typically zero. For bi-directional systems this value is set to a negative number that is equal to the maximum negative flow rate that is anticipated within the system.

?? **MAX Flow** is used by the TFXM to establish filter settings in its operating system. Enter a flow rate that is the maximum, positive flow rate anticipated within the system.

?? The **Damping** value is increased to increase stability of the flow rate readings. Damping values are decreased to allow the flow meter to react faster to changing flow rates.

?? **Low Flow Cutoff** is entered as a percentage between MAX Flow and MIN Flow and influences how the flow meter will act at flows very near zero. Generally, an entry of 1% provides for a stable zero indication, while providing a 100:1 turndown ratio for measurements.

?? **Low Signal Cutoff** is a relative value that should be entered after a successful flow meter startup. For an initial value, enter 5% [Signal Strength indications below 3% are considered to be below the noise ceiling and should not be indicative of a successful flow meter startup.] The entry has three purposes: It provides an error indication—Low Signal Strength [Error 0010 on the TFXM display] when liquid conditions within the pipe have changed to the point where flow measurements may not be possible. It warns if the pipe's liquid level has fallen below the level of the transducers. It can also signal that something with the flow meter installation or configuration may have changed. Examples would include such things as the couplant used to mount the transducer has become compromised, a cable has become disconnected or a pipe size setting has been altered.

?? **Substitute Flow** is used to provide an indication and output that signifies that an error exists with the flow meter or its setup. It is set as a percentage between MIN Flow and MAX Flow. In a uni-directional system this value is typically set to zero, to indicate zero flow while in an error condition. In a bi-directional system, the percentage can be set such that zero is displayed in a error condition. To calculate out where to set the Substitute Flow value in a bi-directional system perform the following operation:

$$\text{Substitute Flow} = \frac{100 \times \text{MAX Flow}}{\text{MAX Flow} + \text{MIN Flow}}$$

Downloading Configurations

?? Entry of data in the **Basic** and **Flow** tabs are all that is required to provide flow measurement functions to the flow meter. If the user is not going to utilize input/output functions, click on the **Download** button to transfer the configuration to the TFXM instrument.

Input/Output Configuration

3. To configure input/output elements that may be present within the TFX, click on the **Output Tab**. See **Figure 4.4**. The output menu allows selection, configuration, calibration and testing of various input/output modules. The window will appear as shown in **Figure 4.4**. Detailed information regarding all of the modules available and configuration options are available in section 3 of this manual.

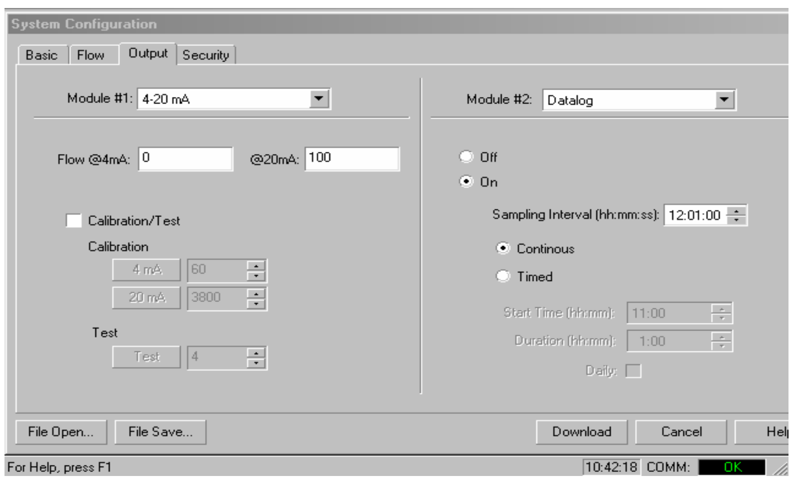


Figure 4.4
Output Tab

4. The Security tab, **Figure 4.6**, contains a provision for adding password protection to the configuration of the flow meter. Passwords between the values of 1 and 9999 are acceptable. The factory backdoor password is 8113. Use 8113 to access the flow meter should the entered password be forgotten. Leave the password set to 0 to avoid being prompted for password entry.

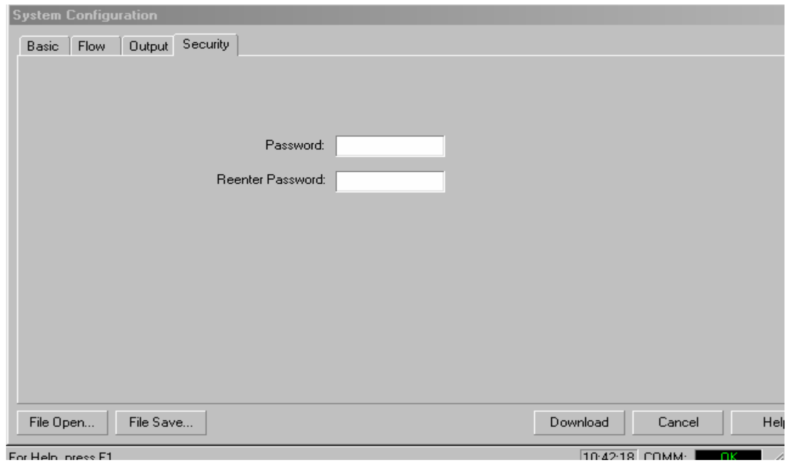


Figure 4.6
Security Tab

7. ADVANCED TAB—See **Figure 4.7**

The Advanced TAB contains several filter settings for the TFXM flow meter. These filters can be adjusted to match response times and data "smoothing" performance to a particular application. The factory settings are suitable for most installations.

?? **Time Domain Filter** adjusts the number of raw data sets (the wave forms viewed on the UltraLink Diagnostics Screen) that are averaged together. Increasing this value will provide greater damping of the data and slow the response time of the flow meter. This filter is not adaptive—it is operational to the value set at all times.

?? **Low Signal Cutoff** is a duplicate entry from Page 3.26. Adjusting this value adjusts the value on the Flow TAB.

?? **Substitute Flow** is a duplicate entry from Page 3.26. Adjusting this value adjusts the value on the Flow TAB.

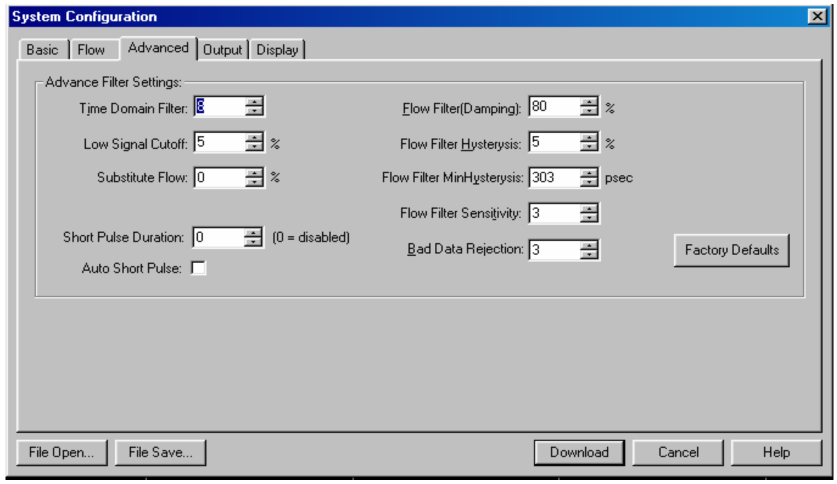


Figure 4.7
Advanced Tab

?? **Short Pulse Duration** is a function used on pipes larger than 8 inches [200 mm]. Set this value to zero to disable the function. Do not select the **Auto Short Pulse** box.

?? **Flow Filter Damping** establishes a <u>maximum</u> adaptive filter value. Under stable flow conditions (flow that varies less than the **Flow Filter Hysteresis** entry) this adaptive filter will increase the number of successive flow readings that are averaged together up to this maximum value. If flow changes outside of the **Flow Filter Hysteresis** window, the Flow Filter adapts by decreasing and allows the meter to react faster. Increasing this value tends to provide smoother steady-state flow readings and outputs.

?? **Flow Filter Hysteresis** creates a window around the average flow measurement reading whereby if the flow varies within that window, greater **Flow Filter Damping** will occur. The filter also establishes a flow rate window where measurements outside of the window are captured by the **Bad Data Rejection Filter**. The value is entered as a percentage of actual flow rate.

Example:

If the average flow rate is 100 GPM and the Flow Filter Hysteresis is set to 5%, a filter window of 95-105 GPM is established. Successive flow measurements that are measured within that window are recorded and averaged in accordance with the **Flow Filter Damping** setting. Flow readings outside of the window are held up in accordance with the **Bad Data Rejection Filter**.

?? **Flow Filter MinHysteresis** sets a minimum hysteresis window that is invoked at low flow rates, where the "of rate" **Flow Filter Hysteresis** is very small and ineffective. This entry is entered in pico-seconds and is differential time. This value is factory set and should not be altered without consulting the Dynasonics technical services department.

?? **Flow Filter Sensitivity** allows configuration of how fast the **Flow Filter Damping** will adapt in the positive direction. Increasing this value allows greater damping to occur faster than lower values. Adaptation in the negative direction is not user adjustable.

?? **Bad Data Rejection** is a value related to the number of successive readings that must be measured outside of the **Flow Filter Hysteresis** and **Flow Filter MinHysteresis** windows before the flow meter will use that flow value. Larger values are entered into the Bad Data Rejection when measuring liquids that contain gas bubbles, as the gas bubbles tend to disturb the ultrasonic signals and cause more extraneous flow readings to occur. Larger Bad Data Rejection values tend to make the flow meter more sluggish to rapid changes in actual flow rate.

Field Calibration

Setting Zero and Calibration

UltraLink contains a powerful multi-point calibration routine that can be used to calibrate the TFXM flow meter to a primary measuring standard in a particular installation. To initialize the three step calibration routine, press the Calibration button located on the top of the **UltraLink Data Screen**. The display shown in **Figure 4.8** will appear. The first step in the calibration process is the selection of the engineering units that the calibration will be performed with. Select the units and press the Next button at the bottom of the window.

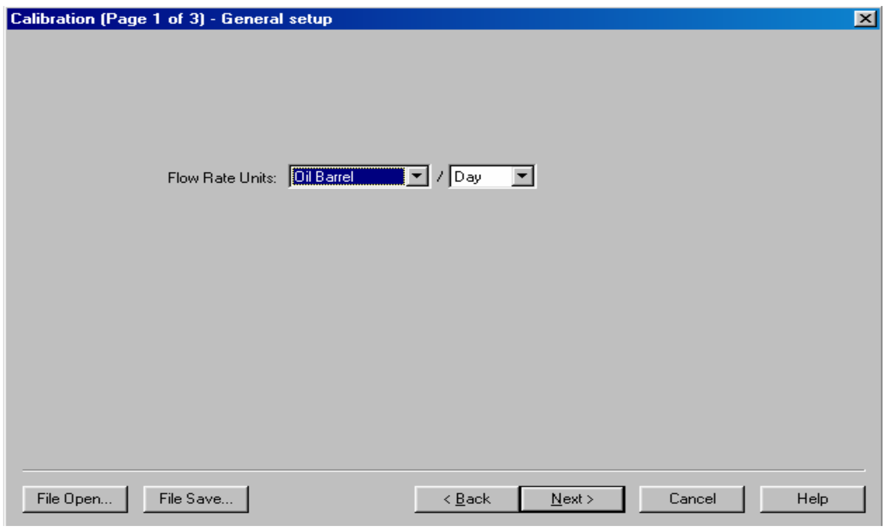


Figure 4.8
Calibration Units

Establish Zero Flow Rate

The second screen, **Figure 4.9**, establishes a baseline zero flow rate measurement for the instrument. To zero the flow meter, establish zero flow in the pipe (turn off all pumps and close a dead-heading valve). Wait until the delta-time interval shown in **Figure 4.9** is stable (and typically very close to zero). Press the **Set** button. Press the **Next** button when complete, then press the **Finish** button on the Calibration Screen. If the **Set** button was pressed, do not proceed with Flow Rate Calibration before pressing the **Finish** button to save the Zero setting.

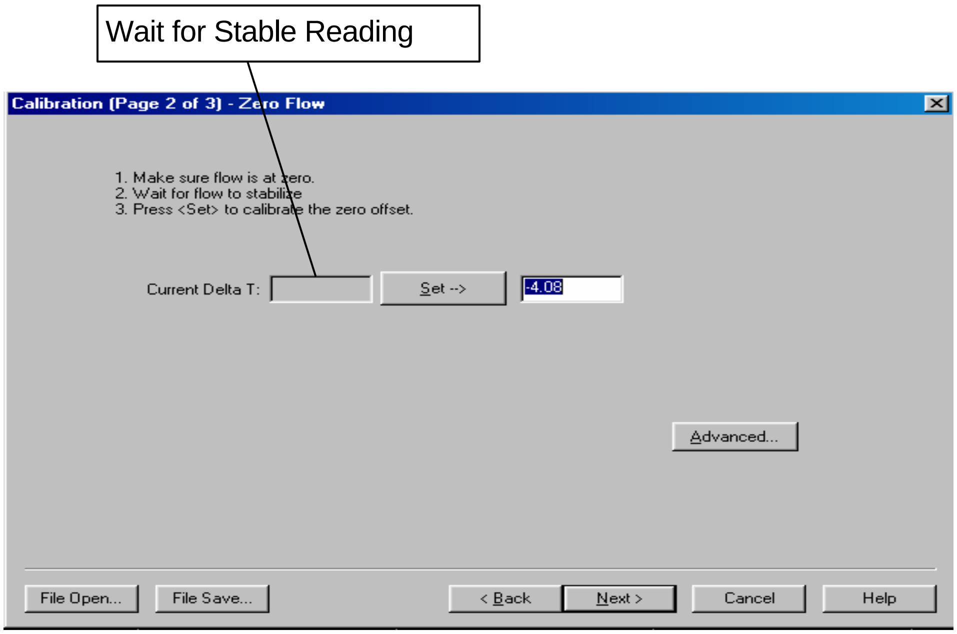


Figure 4.9
Setting Zero Flow

Calibrating with Actual Flow

The screen shown in **Figure 4.10** allows multiple actual flow rates to be run past the meter and the values recorded by the TFXM. To calibrate a point, establish a stable, known flow rate (verified by a real-time primary flow instrument), enter the actual flow rate in the **Figure 4.10** window and press the **Set** button. Repeat for as many points as desired. Note: If only two points are to be used (zero and span), it is preferred that a flow rate as high as anticipated in normal operation is used as the calibration point. If an erroneous data point is collected, the point can be removed by pressing the **Edit** button, selecting the bad point and selecting Remove.

Press the **Finish** button when all points have been gathered.

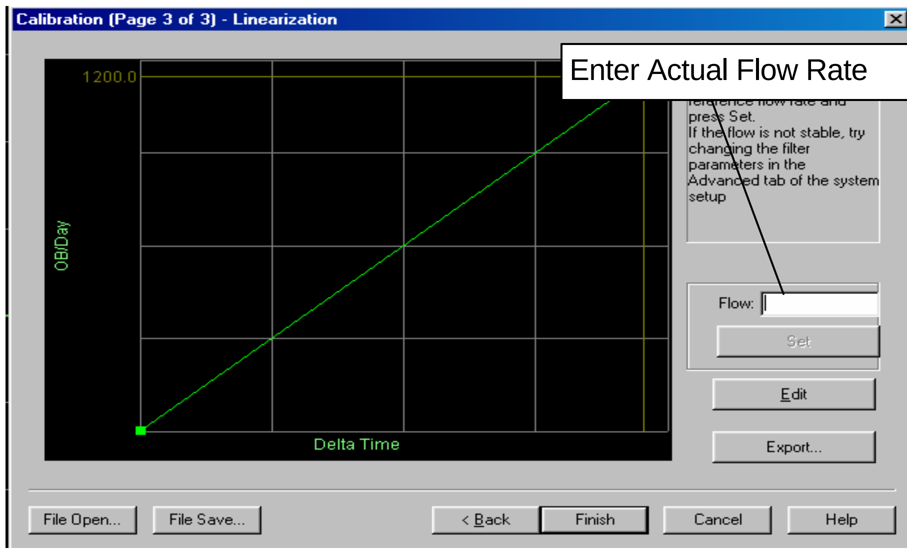


Figure 4.10
Flow Rate Calibration

Saving the Configuration

Saving Meter Configuration on a PC

The complete configuration of the flow meter can be saved from the **Configuration** screen. Select **Save** and name the file. This file may be transferred to other flow meters or may be recalled should the same pipe be surveyed again or multiple meters programmed with the same information.

Printing a Report

Printing Out a Flow Meter Configuration and Calibration Report

Select **File** from the upper task bar and **Print** to print out a calibration/configuration information sheet for the flow meter installation.

Uploading Data from the Logger

During the installation of UltraLink, a file called **DatLog** was installed and its icon will appear on the Desktop of the computer. Click on the icon to start the utility. The screen shown in **Figure 4.11** will appear as the computer is attempting to establish communications with the logger module.

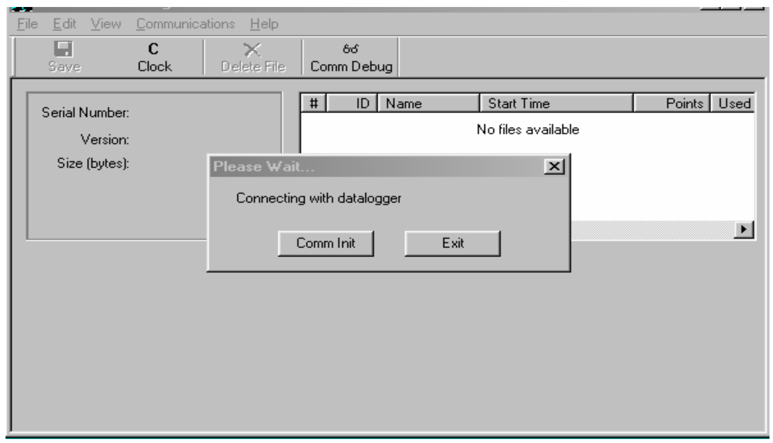


Figure 4.11
Data Logger Initialization

Connect the logger to the terminal strip (see Fig. 1.4). After a few moments, the Please Wait window will disappear and a green OK will appear in the lower right-hand corner of the window. After communications are established (and the OK is displayed) the utility will scan the logger for all existing files. The scanning of the

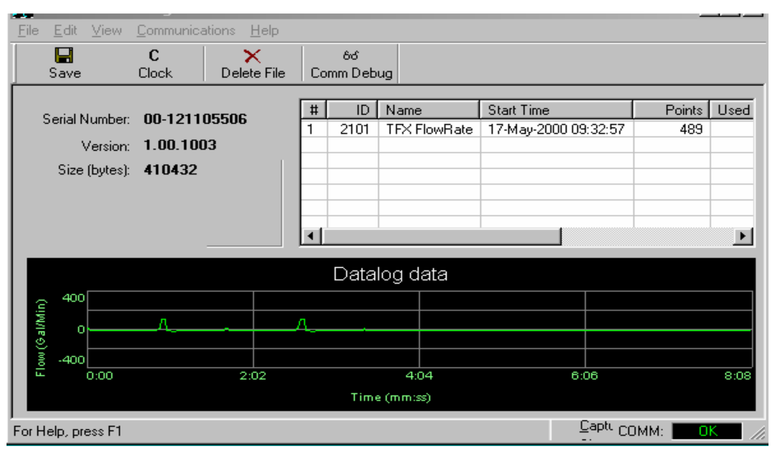


Figure 4.12
Data Logger Upload

logger module and the uploading of the file data can take up to several minutes. The files will appear on the table, See **Figure 4.12**, in a list running from the earliest file to the latest file. Information regarding starting time and date and points collected will appear.

If a file is selected, the time stamped data will appear on the strip chart located on the bottom of the window. The mouse can be used to select a small portion of the graph and expand the data to the width of the screen. To revert to the entire data file, right-click the graph.

To save the file to a file on your computer, select the file from the file table and press the Save button located on the top task bar. See **Figure 4.13**. Datalog saves the files as a .CSV (Comma Separated Value). These files can be opened in programs such as Microsoft Excel® or Borland QuattroPro® for manipulation or graphical purposes.

Note: The spreadsheet programs listed above are limited to the number of lines of data that can be imported. Very large files may need to be opened in a program like Microsoft WordPad and saved in two or more sections.

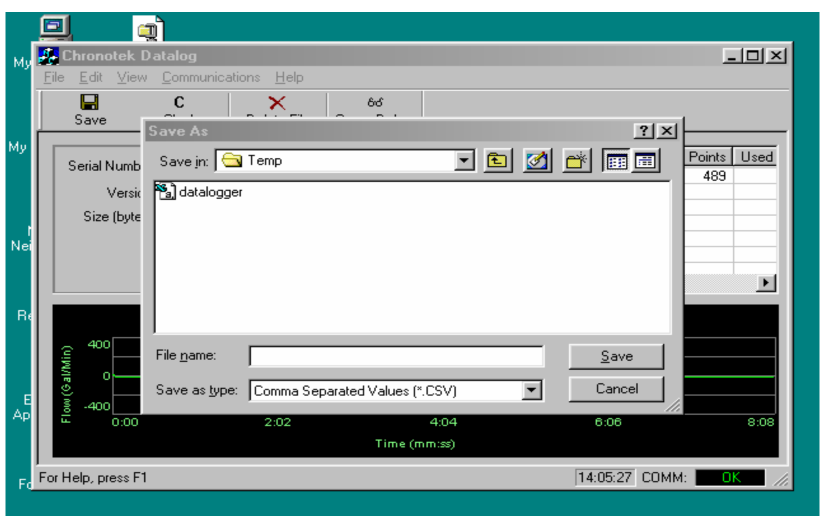


Figure 4.13
Save Data Logger Files

The datalogger module contains a real-time clock that can be set by pressing the Clock button on the top task bar. See **Figure 4.14**. Activating the window compares the datalogger clock to the clock located in the PC. Adjustments can be made and uploaded to the logger.

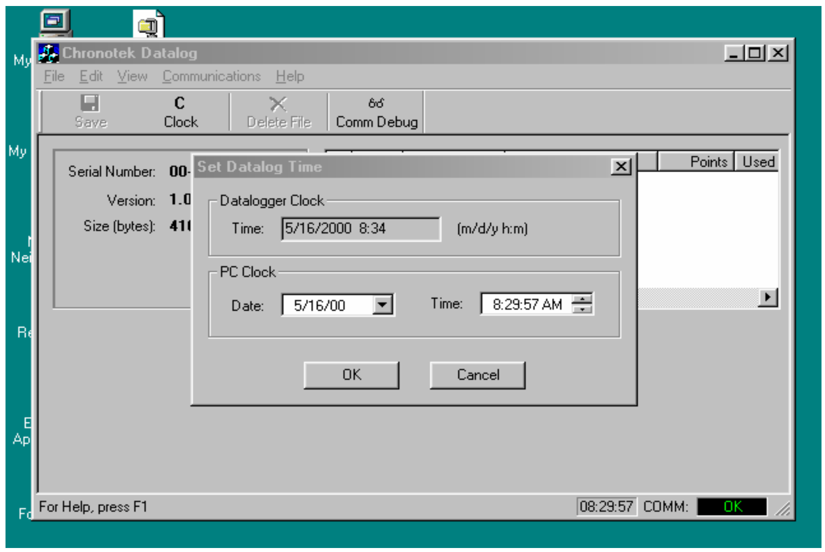


Figure 4.14
Setting Data Logger Clock

MULTICHANNEL OPERATION

General Information

Series TFXM is a multiple channel flow meter designed with maximum user flexibility in mind. The product can be configured as a simple flow meter, showing flow on multiple pipe simultaneously. It can also be used to perform mathematical manipulation of flow rates between pipes using its powerful, yet simple to use, algorithms. This manual will provide instructions as to configuration of the TFXM in the following scenarios:

1. Multiple Pipe Flow Network
2. Multiple Path Flow Averaging
3. Flow Summations of Multiple Pipes
4. Flow Differences of Multiple Pipes
5. Leak Detection in Pipe Lines

Multiple Channel Display Configuration

Configuring of the graphics display

The graphics display on the TFXM can be configured to show either two or four lines of information. This information can be displayed for any flow meter on the TFXM RS485 network. The procedure to configure the display is as follows:

1. Menu Item 8 can be accessed to select either two or four lines of display information. See Page 3.29 for details.
2. Press the (soft)Select key on the right side of the graphics display to highlight the upper most display entity.
3. Utilize the soft(CHAN) keys UP/DOWN arrows to select what measuring entity is required: Flow RATE, Net TOTAL, Temp Difference, Temp 2, Temp 1, Signal Strength or liquid Sound Speed.
4. Utilize the CHANNEL key to select which measurement channel on the flow meter network is to be displayed:

   M = Master Measurement
   1 = Secondary Channel (Slave 1) integral to DTFXM2
   2, 3, 4...119 = Secondary Channels (Slaves) external to DTFXM
   No Designation = Multichannel Manipulated Value

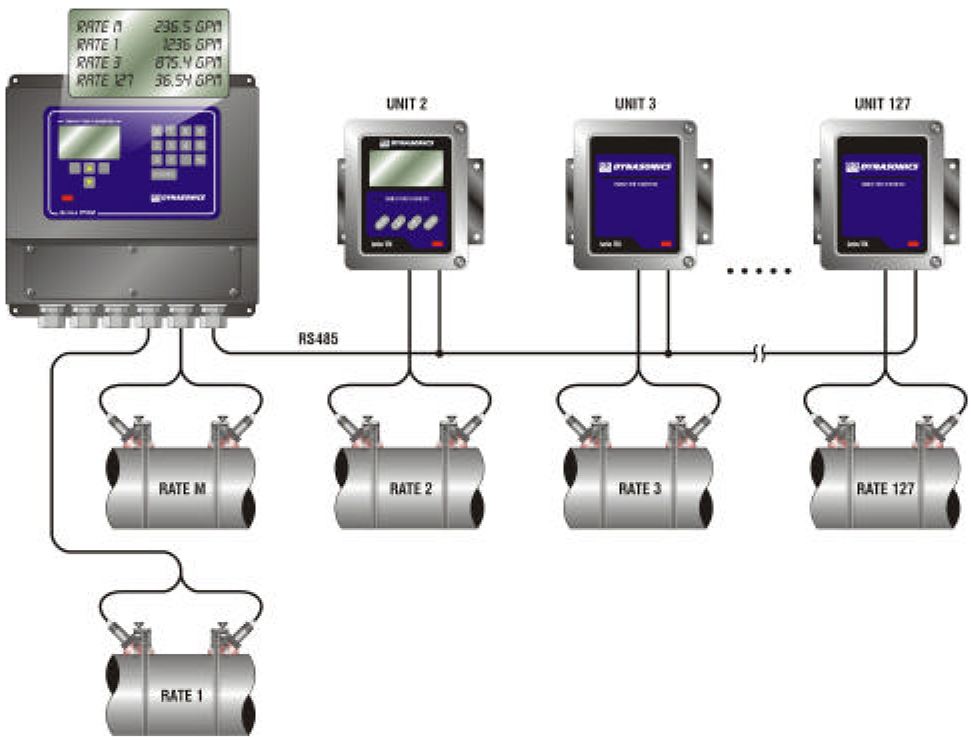
5. After the entity and measurement channel have been selected for a particular line, press the (soft)SELECT key to move the

highlighting to the next line of the display. Pressing the (soft) SELECT key on the bottom line of the display will cause the display configuration to end and the setup will be saved.

Multiple Pipe Configuration

Multiple Pipe Flow Network

The TFXM is designed to be the Primary (Master) flow controller in a network of Secondary (Slave) flow meters. The TFXM can be used to display flow information and configure up to 119 satellite flow meters connected on its RS485, two-wire network.



To configure a multiple pipe setup, follow the entries shown in **Figure 5.1**. The Primary board in the TFXM is established as the Master and all of the Secondary boards are considered slaves. The **coefficient** values located on the bottom of the window do not have a bearing on the display, because manipulated display values are not being shown on the graphics display.

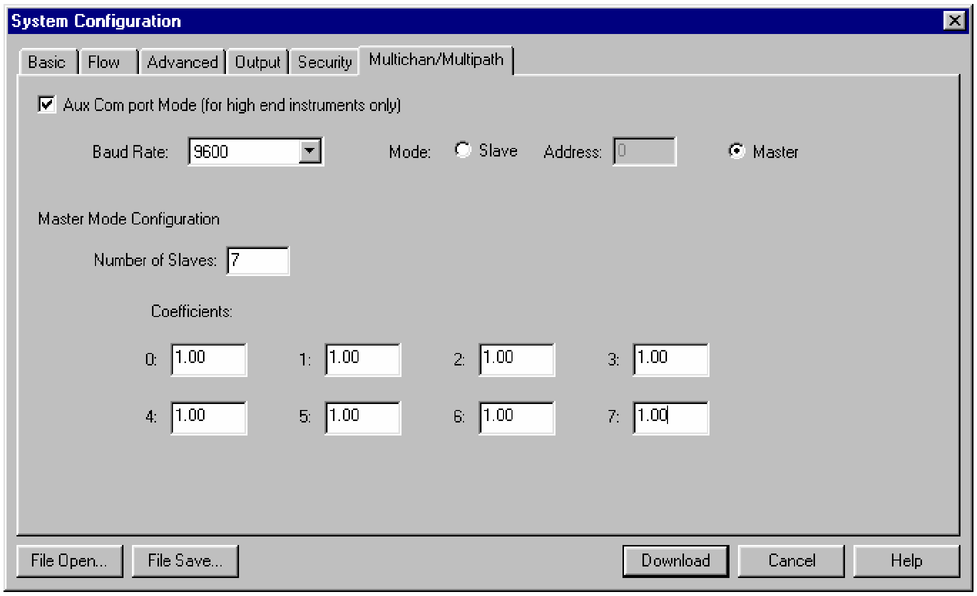


Figure 5.1
Configuration for Multiple Pipe Readings

Multiple Path Configuration

Multiple Path Flow Meter

By applying more than one set of transducers radially around a pipe, accuracy can be improved in conditions where optimum straight pipe diameters are not available. Typical installations only involve two paths, but on large pipes several paths could be employed. See **Figure 5.2**. **Only one multiple path system is permitted per flow measurement network.**

To configure the flow meter for multiple path operation, apply the transducers radially around the pipe and apply equal coefficients to each channel that total up to 1.00. For two path systems, 0.50 +0.50 = 1.00; for three path systems 0.333+0.333+0.334 = 1.000; etc.

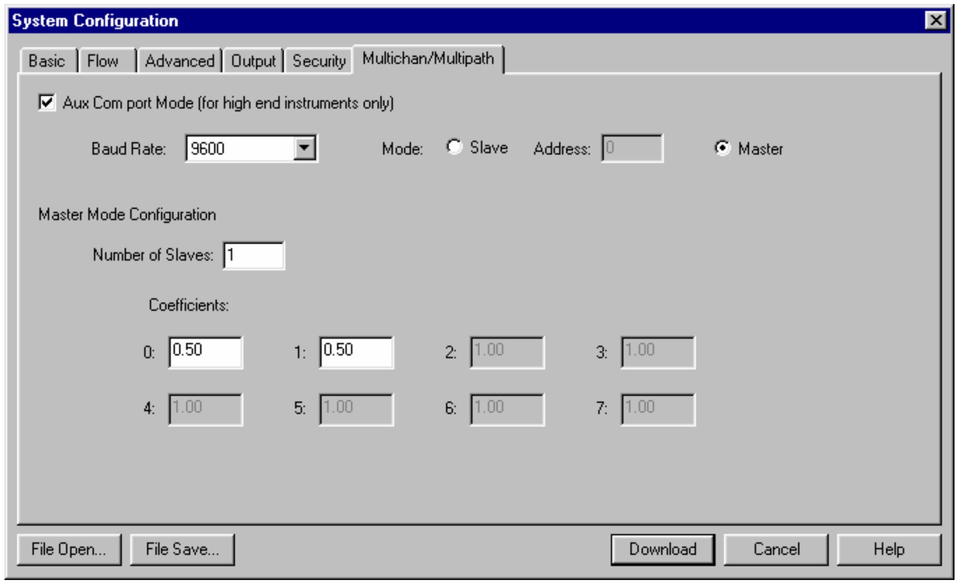


Figure 5.2
Multiple Path Flow Meter

Summation Configuration

Multiple Pipe Summation Flow Meter

The TFXM can be used to measure the summation of several flow pipes. By entering coefficients of 1.00 for each channel, the sum of the channels will be displayed on the mathematically manipulated display configuration. See **Figure 5.3**.

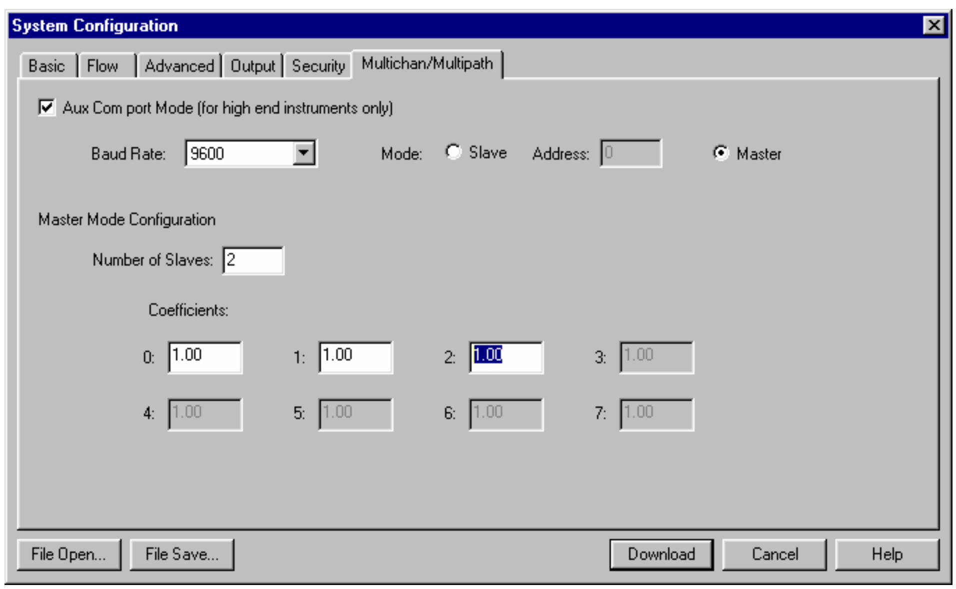


Figure 5.3
Summation Flow Meter

Difference Configuration

Difference Flow Meter

The difference of two pipes can be utilized to measure the flow in two pipes and calculate the flow rate in a third trunk line in a piping system. (The difference meter can also be applied to two ends of a piping system to display an alarm to leak between the two measuring points.) Apply a coefficient of +1.00 to one channel and a coefficient of –1.00 to the second channel. The sum of the two manipulated values will be the difference in the flow rates. See **Figure 5.4**.

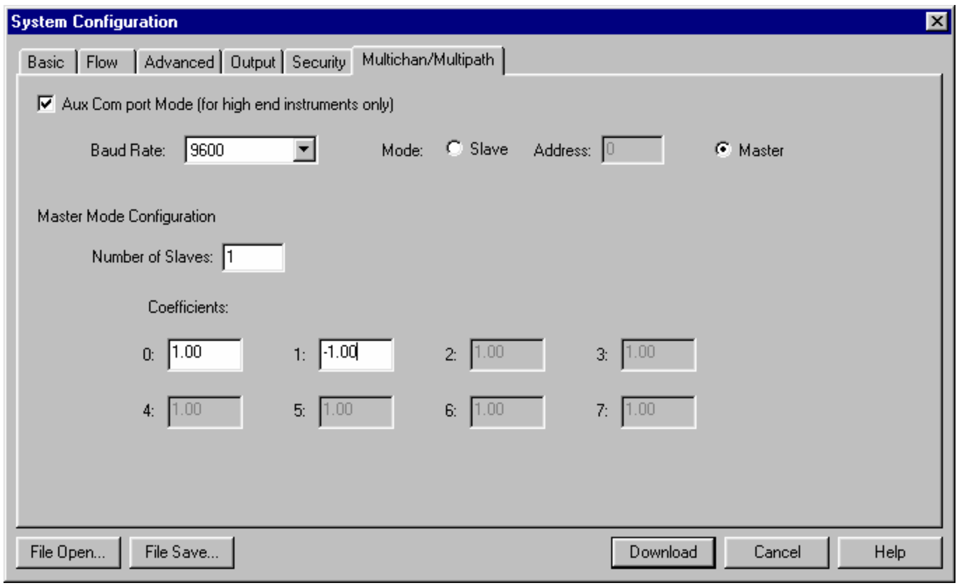


Figure 5.4
Subtraction Flow Measurement

Setting Coefficients on the Keypad

Coefficients for measurement channels can also be established on the TFXM keypad in the **AUX Com Port Menu**.

APPENDIX

MENU V /\ ENTER

TFX USER INTERFACE MAP

DYNASONICS

BSC MENU

UNITS
- *ENGLSH*
- *METRIC*

XDCR MNT
- *V*
- *W*
- *Z*

PIPE OD
- *ENGLSH (INCHES)*
- *METRIC (MM)*

PIPE WT
- *ENGLSH (INCHES)*
- *METRIC (MM)*

PIPE MAT*
- *CARBON S*
- *STAINLES*
- *CAST IRO*
- *DUCTILE*
- *COPPER*
- *PVC*
- *PVDF LOW*
- *PVDF HI*
- *ALUMINUM*
- *ASBESTOS*
- *FIBERGLASS*
- *OTHER*

PIPE SS
- *ENGLSH (FPS)*
- *METRIC (MPS)*

PIPE R
- (RELATIVE ROUGHNESS)

LINER T
- *ENGLSH (INCHES)*
- *METRIC (MM)*

LINER TYPE*
- *TAR EPOXY*
- *RUBBER*
- *MORTAR*
- *POLYPROPYLENE*
- *POLYSTYROL*
- *POLYSTYRENE*
- *POLYESTER*
- *TEFLON*
- *OTHER*

LINER SS
- *ENGLSH (FPS)*
- *METRIC (MPS)*

FL TYPE*
- *TAP WATER*
- *SEWAGE*
- *KEROSENE*
- *GASOLINE*
- *FUEL OIL*
- *CRUDE OI*
- *PROPANE*
- *BUTANE*
- *OTHER*

FLUID SS
- *ENGLSH (FPS)*
- *METRIC (MPS)*

FLUID VI
- *CPS*

SP GRVTY
- *UNITLESS*

SP HEAT
- *NOMINAL*
- *HEAT CAPACITY*

XDC SPAC
- *ENGLSH (INCHES)*
- *METRIC (MM)*

RATE UNT
- *GALLONS*
- *LITERS*
- *MGAL*
- *CUBIC FT*
- *CUBIC ME*
- *ACRE FT*
- *OIL BARR*
- *LIQ BARR*
- *FEET*
- *METERS*

RATE INT
- *MIN*
- *HOUR*
- *DAY*
- *SEC*

TOTL UNT
- *GALLONS*
- *LITERS*
- *MGAL*
- *CUBIC FT*
- *CUBIC ME*
- *ACRE FT*
- *OIL BARR*
- *LIQ BARR*
- *FEET*
- *METERS*

TOTL E
- *E-1 TO E6*

MIN RATE
- *RATE/INT*

MAX RATE
- *RATE/INT*

FL C-OFF
- *% of Full Scale*

DAMP PER
- *PERCENT*

OUT1 MEN

OUT1 — *OPTIONS*

4-20MA
- *FL 4MA*
- *FL 20MA*
- *4-20 TST*

0-10KHz
- *FL 100H*
- *FL 10KH*

RELAY
- *RELAY 1*
- *RELAY 2*

RTD
- *CAL 1*
- *CAL 2*
- *A*
- *B*
- *C*

RS232
- *RS232 MO*
  - *HOST*
  - *UIF*
- *RS232 BA*
  - *1200*
  - *2400*
  - *9600*
  - *19200*

RS485
- *RS485 MO*
  - *SLAVE*
  - *MASTER*
- *RS485 BA*
  - *1200*
  - *2400*
  - *9600*
  - *19200*
- *ADDRESS*
  - *1-127*

NONE

OUT2 MEN

OUT2 — *OPTIONS*

4-20MA
- *FL 4MA*
- *FL 20MA*
- *4-20 TST*

0-10KHz
- *FL 100H*
- *FL 10KH*

RELAY
- *RELAY 1*
- *RELAY 2*

RTD
- *CAL 1*
- *CAL 2*
- *A*
- *B*
- *C*

RS232
- *RS232 MO*
  - *HOST*
  - *UIF*
- *RS232 BA*
  - *1200*
  - *2400*
  - *9600*
  - *19200*

RS485
- *RS485 MO*
  - *SLAVE*
  - *MASTER*
- *RS485 BA*
  - *1200*
  - *2400*
  - *9600*
  - *19200*
- *ADDRESS*
  - *1-127*

NONE

SEN MENU

NOT USED

SEC MENU

TOT RES
- *NO*
- *YES*

SYS RSET
- *NO*
- *YES*

CH PSWD?
- *0-9999*

SER MENU

SSPD MPS

SSPD FPS

SIG STR

SIG C-OFF

SUB FLOW

SET ZERO

D-FLT 0

COR FTR

DSP MENU

DISPLAY
- *FLOW*
- *TOTAL*
- *BOTH*

TOTAL
- *NET*
- *POS*
- *NEG*
- *BATCH*

SCN DWL
- *1-10*

BTCH MUL
- *TOTALIZER UNIT W/ TOTAL E*

Keypad Operations

1. The MENU key is pressed from RUN mode to enter PROGRAM mode. The MENU key is pressed in PROGRAM mode to exit configuration parameters and menus. If changes to any configuration parameters have been made, the user will be prompted with a SAVE?YES when returning to RUN mode.
2. The ARROW keys are used to scroll through menus and configuration parameters. The ARROW keys are also used to adjust parameter numerical values.
3. The ENTER key is
   - ?? pressed from the RUN mode to view the current software version operating in the instrument.
   - ?? used to access the configuration parameters in the various menus.
   - ?? Used to initiate changes in configuration parameters.
   - ?? Used to accept configuration parameter changes.

Date: 3/21/2000
Revision: E Rev. Date: 7/10/2001
Software Version: 1.00.9799

*List provided for example only. Additional entries may be available.

Fluid Sound Speeds

Original Date: 7/30/99
Revision: none
Revision Date: none
File: I:/dynasonics/dyna_code/tables/fluid_ss.xls

Fluid	Specific Gravity 20 degrees C	Sound Speed m/s	ft/s	delta-v/degree C m/s/degree C	Kinematic Viscosity m^2/s
Acetate, Butyl (n)		1270	4163.9		
Acetate, Ethyl	0.901	1085	3559.7	4.4	0.489
Acetate, Methyl	0.934	1211	3973.1		0.407
Acetate, Propyl		1280	4196.7		
Acetone	0.79	1174	3851.7	4.5	0.399
Alcohol	0.79	1207	3960.0	4.0	1.396
Alcohol, Butyl (n)	0.83	1270	4163.9	3.3	3.239
Alcohol, Ethyl	0.83	1180	3868.9	4	1.396
Alcohol, Methyl	0.791	1120	3672.1	2.92	0.695
Alcohol, Propyl (I)		1170	3836.1		
Alcohol, Propyl (n)	0.78	1222	4009.2		2.549
Ammonia (35)	0.77	1729	5672.6	6.7	0.292
Anlline (41)	1.02	1639	5377.3	4.0	3.630
Benzene (29,40,41)	0.88	1306	4284.8	4.7	0.711
Benzol, Ethyl	0.867	1338	4389.8		0.797
Bromine (21)	2.93	889	2916.7	3.0	0.323
n-Butane (2)	0.60	1085	3559.7	5.8	
Butyrate, Ethyl		1170	3836.1		
Carbon dioxide (26)	1.10	839	2752.6	7.7	0.137
Carbon tetrachloride	1.60	926	3038.1	2.5	0.607
Chloro-benezene	1.11	1273	4176.5	3.6	0.722
Chloroform (47)	1.49	979	3211.9	3.4	0.550
Diethyl ether	0.71	985	3231.6	4.9	0.311
Diethyl Ketone		1310	4295.1		
Diethylene glycol	1.12	1586	5203.4	2.4	
Ethanol	0.79	1207	3960.0	4.0	1.390
Ethyl alcohol	0.79	1207	3960.0	4.0	1.396
Ether	0.71	985	3231.6	4.9	0.311
Ethyl ether	0.71	985	3231.6	4.9	0.311
Ethylene glycol	1.11	1658	5439.6	2.1	17.208
Freon R12		774.2	2540		
Gasoline	0.7	1250	4098.4		
Glycerin	1.26	1904	6246.7	2.2	757.100
Glycol	1.11	1658	5439.6	2.1	
Isobutanol	0.81	1212	3976.4		
Iso-Butane		1219.8	4002		
Isopentane (36)	0.62	980	3215.2	4.8	0.340
Isopropanol (46)	0.79	1170	3838.6		2.718
Isopropyl alcohol (46)	0.79	1170	3838.6		2.718
Kerosene	0.81	1324	4343.8	3.6	
Linalool		1400	4590.2		

Linseed Oil	.925-.939	1770	5803.3		
Methanol (40,41)	0.79	1076	3530.2	2.92	0.695
Methyl alcohol (40,44)	0.79	1076	3530.2	2.92	0.695
Methylene chloride (3)	1.33	1070	3510.5	3.94	0.310
Methylethyl Ketone		1210	3967.2		
Motor Oil (SAE 20/30)	.88-.935	1487	4875.4		
Octane (23)	0.70	1172	3845.1	4.14	0.730
Oil, Castor	0.97	1477	4845.8	3.6	0.670
Oil, Diesel	0.80	1250	4101		
Oil (Lubricating X200)		1530	5019.9		
Oil (Olive)	0.91	1431	4694.9	2.75	100.000
Oil (Peanut)	0.94	1458	4783.5		
Paraffin Oil		1420	4655.7		
Pentane	0.626	1020	3346.5		0.363
Petroleum	0.876	1290	4229.5		
1-Propanol (46)	0.78	1222	4009.2		
Refrigerant 11 (3,4)	1.49	828.3	2717.5	3.56	
Refrigerant 12 (3)	1.52	774.1	2539.7	4.24	
Refrigerant 14 (14)	1.75	875.24	2871.5	6.61	
Refrigerant 21 (3)	1.43	891	2923.2	3.97	
Refrigerant 22 (3)	1.49	893.9	2932.7	4.79	
Refrigerant 113 (3)	1.56	783.7	2571.2	3.44	
Refrigerant 114 (3)	1.46	665.3	2182.7	3.73	
Refrigerant 115 (3)		656.4	2153.5	4.42	
Refrigerant C318 (3)	1.62	574	1883.2	3.88	
Silicone (30 cp)	0.99	990	3248		30.000
Toluene (16,52)	0.87	1328	4357	4.27	0.644
Transformer Oil		1390	4557.4		
Trichlorethylene		1050	3442.6		
1,1,1-Trichloro-ethane	1.33	985	3231.6		0.902
Turpentine	0.88	1255	4117.5		1.400
Water, distilled (49,50)	0.996	1498	4914.7	-2.4	1.000
Water, heavy	1	1400	4593		
Water, sea	1.025	1531	5023	-2.4	1.000
Wood Alcohol (40,41)	0.791	1076	3530.2	2.92	0.695
m-Xylene (46)	0.868	1343	4406.2		0.749
o-Xylene (29,46)	0.897	1331.5	4368.4	4.1	0.903
p-Xylene (46)		1334	4376.8		0.662

TFX Error Codes

Revised 2-22-2002

Code Number	Description	Correction
Warnings		
0001	Serial number not present	Hardware serial number has become inoperative – system performance will not be influenced.
0010	Signal Strength is below Signal Strength Cutoff entry	Low signal strength is typically caused by one of the following: • Empty pipe • Improper programming/incorrect values • Improper transducer spacing • Non-homogeneous pipe wall
0011	Measured Speed of Sound the in the liquid is greater than 10% different than the value entered during meter setup	Verify that the correct liquid was selected in the BASIC menu. Verify that pipe size parameters are correct.
0020	Heat Flow Units of measure have been selected and an RTD module has not been installed	Verify that RTD Module PN D020-1045-106 has been installed in one of the I/O meter slots. Verify that OUTPUT1 or OUTPUT 2 has been configured for RTD measurements.
Class C Errors		
1001	System tables have changed	Initiate a meter RESET by cycling power or by selecting SYSTEM RESET in the SEC MENU.
1002	System configuration has changed	Initiate a meter RESET by cycling power or by selecting SYSTEM RESET in the SEC MENU.
Class B Errors		
3001	Invalid hardware configuration	Upload corrected file
3002	Invalid system configuration	Upload corrected file
3003	Invalid strategy file	Upload corrected file
3004	Invalid calibration data	Recalibrate the system
3005	Invalid speed of sound calibration data	Upload new data
3006	Bad system tables	Upload new table data
3007	Data Logger is off or not present	If desired, insert data logger and configure within the Datalog Operations Menu. If logger is not present, configure I/O port for no logger.
3010	One or more channels are not responding (Multi-channel meters only)	Display indicates which secondary units are not communicating with Master meter. Verify wiring, configuration and address of secondary instrument.
3011	All channels are not responding (Multi-channel meters only)	Verify wiring, configuration and address of secondary instruments.
Class A Errors		
4001	Flash memory full	Return unit to factory for evaluation

Host protocol

A Modbus type protocol is utilized. Each message is guarded with the standard CRC-16 error detection (C source code is included)

The host protocol is a master-slave type protocol with the flowmeter being the slave. The messages have the following format:

<addr><command><data>...<data><crc-16>

A unit may be assigned an address that responds to (valid addresses are 1-7E). All devices respond to address 7F (ie. this address may not be used for multidrop) and all devices listen to address 0 but do not respond (this is the "broadcast" address).

The following special commands are defined:

Command	Description
65	Special "short" commands
66	Special "long" commands

Command 65 allows up to 255 data items to be transferred while command 66 allows up to 65535 items (The actual maximum size is limited by the memory allocated for the communication buffers and for TOF it is 2048 bytes). There is special encoding for the data for commands 65 and 66 as follows:

Command 65:

<size><code><data$_1$>...<data$_{N-1}$> N = <size>

Command 66:

<size_h><size_l><code><data$_1$>...<data$_{N-1}$> N = <size_h>*256 + <size_l>

The target device will respond the same for both 65 and 66 commands. The host program needs to make sure that the proper opcode will be used based on the data size requested.

In case of an error, the target will reject the message by replying with an error code. The target will not reply to an ill-formed command (ie. incomplete or CRC-16 error). The error reply is:

<addr><opcode><errorcode><crc-16>

where:

<opcode> is the requested opcode with the Most Significant bit turned on.

The following error codes are defined:

Error Code	Description
1	Bad Command (Invalid command)
2	Bad Command Data
71h	Command not allowed.
72h	Buffer overflow (data exceeded internal allocated memory)
73h	Command not implemented in this version

Special codes

The following special 65 and 66 codes are supported.

Code	Description
00	Echo (for comm debugging)

0A	Read run time data (signal strength, flow rate and totalizers)
0B	Reset Totalizers

Code 00 – Echo

Command: <addr>65<size>00<data$_1$>…<data$_n$><crc-16>
Reply: <addr>65<size>00<data$_1$>…<data$_n$><crc-16>

Code 0A – Read Flow data

Command: <addr>65010A<crc-16>
Reply: <addr>65210A<data$_1$>…<data$_n$><crc-16>

The data section of the reply contains the byte stream representation of the flow data as follows (all numbers use the Intel format – ie. Least significant byte first):

Byte	Type	Description
0-1	2 byte integer	Signal Strength (0-1000)
2-9	8 byte floating point	Current flow rate in the units programmed
10-17	8 byte floating point	Net Totalizer in the units programmed
18-25	8 byte floating point	Positive Totalizer
26-31	8 byte floating point	Negative Totalizer

Code 0B – Reset Totalizers

Command: <addr>65010B<crc-16>
Reply: <addr>65010B<crc-16>

C Source Code

Flow Data Definition

```
struct FLOWDATA
{
      short        sSignalStrength;
      double       dCurFlowRate;
      double       dNetTotalizer;
      double       dPositiveTotalizer;
      double       dNegativeTotalizer;
};
```

CRC-16 Calculations

```
unsigned short crc_table[256] = {
   0x0000, 0xC0C1, 0xC181, 0x0140, 0xC301, 0x03C0, 0x0280, 0xC241,
   0xC601, 0x06C0, 0x0780, 0xC741, 0x0500, 0xC5C1, 0xC481, 0x0440,
   0xCC01, 0x0CC0, 0x0D80, 0xCD41, 0x0F00, 0xCFC1, 0xCE81, 0x0E40,
   0x0A00, 0xCAC1, 0xCB81, 0x0B40, 0xC901, 0x09C0, 0x0880, 0xC841,
   0xD801, 0x18C0, 0x1980, 0xD941, 0x1B00, 0xDBC1, 0xDA81, 0x1A40,
   0x1E00, 0xDEC1, 0xDF81, 0x1F40, 0xDD01, 0x1DC0, 0x1C80, 0xDC41,
   0x1400, 0xD4C1, 0xD581, 0x1540, 0xD701, 0x17C0, 0x1680, 0xD641,
   0xD201, 0x12C0, 0x1380, 0xD341, 0x1100, 0xD1C1, 0xD081, 0x1040,
   0xF001, 0x30C0, 0x3180, 0xF141, 0x3300, 0xF3C1, 0xF281, 0x3240,
   0x3600, 0xF6C1, 0xF781, 0x3740, 0xF501, 0x35C0, 0x3480, 0xF441,
   0x3C00, 0xFCC1, 0xFD81, 0x3D40, 0xFF01, 0x3FC0, 0x3E80, 0xFE41,
   0xFA01, 0x3AC0, 0x3B80, 0xFB41, 0x3900, 0xF9C1, 0xF881, 0x3840,
```

```
    0x2800, 0xE8C1, 0xE981, 0x2940, 0xEB01, 0x2BC0, 0x2A80, 0xEA41,
    0xEE01, 0x2EC0, 0x2F80, 0xEF41, 0x2D00, 0xEDC1, 0xEC81, 0x2C40,
    0xE401, 0x24C0, 0x2580, 0xE541, 0x2700, 0xE7C1, 0xE681, 0x2640,
    0x2200, 0xE2C1, 0xE381, 0x2340, 0xE101, 0x21C0, 0x2080, 0xE041,
    0xA001, 0x60C0, 0x6180, 0xA141, 0x6300, 0xA3C1, 0xA281, 0x6240,
    0x6600, 0xA6C1, 0xA781, 0x6740, 0xA501, 0x65C0, 0x6480, 0xA441,
    0x6C00, 0xACC1, 0xAD81, 0x6D40, 0xAF01, 0x6FC0, 0x6E80, 0xAE41,
    0xAA01, 0x6AC0, 0x6B80, 0xAB41, 0x6900, 0xA9C1, 0xA881, 0x6840,
    0x7800, 0xB8C1, 0xB981, 0x7940, 0xBB01, 0x7BC0, 0x7A80, 0xBA41,
    0xBE01, 0x7EC0, 0x7F80, 0xBF41, 0x7D00, 0xBDC1, 0xBC81, 0x7C40,
    0xB401, 0x74C0, 0x7580, 0xB541, 0x7700, 0xB7C1, 0xB681, 0x7640,
    0x7200, 0xB2C1, 0xB381, 0x7340, 0xB101, 0x71C0, 0x7080, 0xB041,
    0x5000, 0x90C1, 0x9181, 0x5140, 0x9301, 0x53C0, 0x5280, 0x9241,
    0x9601, 0x56C0, 0x5780, 0x9741, 0x5500, 0x95C1, 0x9481, 0x5440,
    0x9C01, 0x5CC0, 0x5D80, 0x9D41, 0x5F00, 0x9FC1, 0x9E81, 0x5E40,
    0x5A00, 0x9AC1, 0x9B81, 0x5B40, 0x9901, 0x59C0, 0x5880, 0x9841,
    0x8801, 0x48C0, 0x4980, 0x8941, 0x4B00, 0x8BC1, 0x8A81, 0x4A40,
    0x4E00, 0x8EC1, 0x8F81, 0x4F40, 0x8D01, 0x4DC0, 0x4C80, 0x8C41,
    0x4400, 0x84C1, 0x8581, 0x4540, 0x8701, 0x47C0, 0x4680, 0x8641,
    0x8201, 0x42C0, 0x4380, 0x8341, 0x4100, 0x81C1, 0x8081, 0x4040,
};

unsigned short    calculate_crc(const unsigned char *pv, int size)
{
      unsigned short crc = 0xFFFF;

      for ( ;size-- ; pv++)
      {
            crc = (crc >> 8) ^ crc_table[(crc ^ *pv) & 0xFF];
      }

      return crc;
}
```

CAST IRON PIPE
STANDARD CLASSES
(INSIDE DIAMETERS)

	CLASS A		CLASS B		CLASS C		CLASS D		CLASS E		CLASS F		CLASS G		CLASS H	
NOMINAL PIPE SIZE INCHES	O.D INCH	I.D. INCH	O.D. INCH	I.D. INCH	O.D. INCH	I.D. INCH	O.D. INCH	I.D. INCH	O.D INCH	I.D. INCH	O.D. INCH	I.D. INCH	O.D. INCH	I.D. INCH	O.D. INCH	I.D. INCH
3	3.80	3.02	3.96	3.12	3.96	3.06	3.96	3.00								
4	4.80	3.96	5.00	4.10	5.00	4.04	5.00	3.96								
6	6.90	6.02	7.10	6.14	7.10	6.08	7.10	6.00	7.22	6.06	7.22	6.00	7.38	6.08	7.38	6.00
8	9.05	8.13	9.05	8.03	9.30	8.18	9.30	8.10	9.42	8.10	9.42	8.10	9.60	8.10	9.60	8.00
10	11.10	10.10	11.10	9.96	11.40	10.16	11.40	10.04	11.60	10.12	11.60	10.00	11.84	10.12	11.84	10.00
12	13.20	12.12	13.20	11.96	13.50	12.14	13.50	12.00	13.78	12.14	13.78	12.00	14.08	12.14	14.08	12.00
14	15.30	14.16	15.30	13.98	15.65	14.17	15.65	14.01	15.98	14.18	15.98	14.00	16.32	14.18	16.32	14.00
16	17.40	16.20	17.40	16.00	17.80	16.20	17.80	16.02	18.16	16.20	18.16	16.00	18.54	16.18	18.54	16.00
18	19.50	18.22	19.50	18.00	19.92	18.18	19.92	18.00	20.34	18.20	20.34	18.00	20.78	18.22	20.78	18.00
20	21.60	20.26	21.60	20.00	22.06	20.22	22.06	20.00	22.54	20.24	22.54	20.00	23.02	20.24	23.02	20.00
24	25.80	24.28	25.80	24.02	26.32	24.22	26.32	24.00	26.90	24.28	26.90	24.00	27.76	24.26	27.76	24.00
30	31.74	29.98	32.00	29.94	32.40	30.00	32.74	30.00	33.10	30.00	33.46	30.00				
36	37.96	35.98	38.30	36.00	38.70	35.98	39.16	36.00	39.60	36.00	40.04	36.00				
42	44.20	42.00	44.50	41.94	45.10	42.02	45.58	42.02								
48	50.50	47.98	50.80	47.96	51.40	47.98	51.98	48.00								
54	56.66	53.96	57.10	54.00	57.80	54.00	58.40	53.94								
60	62.80	60.02	63.40	60.06	64.20	60.20	64.82	60.06								
72	75.34	72.10	76.00	72.10	76.88	72.10										
84	87.54	84.10	88.54	84.10												

STEEL, STAINLESS STEEL, P.V.C.
STANDARD SCHEDULES
(INSIDE DIAMETERS)

NOMINAL PIPE SIZE INCHES	SCH. 5	SCH. 10 (LTWALL)	SCH. 20	SCH. 30	STD.	SCH. 40	SCH. 60	X STG.	SCH. 80	SCH. 100	SCH. 120	SCH. 140	SCH. 180	OUTSIDE DIAMETER
1	1.185	1.097			1.049	1.049		0.957	0.957				0.815	1.315
1.25	1.53	1.442			1.380	1.380		1.278	1.278				1.160	1.660
1.5	1.77	1.682			1.610	1.610		1.500	1.500				1.338	1.900
2	2.245	2.157			2.067	2.067		1.939	1.939				1.687	2.375
2.5	2.709	2.635			2.469	2.469		2.323	2.323				2.125	2.875
3	3.334	3.260			3.068	3.068		2.900	2.900				2.624	3.500
3.5	3.834	3.760			3.548	3.548		3.364	3.364					4.000
4	4.334	4.260			4.026	4.026		3.826	3.826		3.624	3.624	3.438	4.500
5	5.345	5.295			5.047	5.047		4.813	4.813		4.563	4.563	4.313	5.563
6	6.407	6.357			6.065	6.065		5.761	5.761		5.501	5.501	5.187	6.625
8	8.407	8.329	8.125	8.071	7.981	7.981	7.813	7.625	7.625	7.437	7.187	7.187	6.183	8.625
10	10.482	10.42	10.25	10.13	10.02	10.02	9.750	9.750	9.562	9.312	9.062	9.062	8.500	10.75
12	12.42	12.39	12.25	12.09	12.00	11.938	11.626	11.75	11.37	11.06	10.75	10.75	10.12	12.75
14		13.50	13.37	13.25	13.25	13.124	12.814	13.00	12.50	12.31	11.81	11.81	11.18	14.00
16		15.50	15.37	15.25	15.25	15.000	14.688	15.00	14.31	13.93	13.56	13.56	12.81	16.00
18		17.50	17.37	17.12	17.25	16.876	16.564	17.00	16.12	15.68	15.25	15.25	14.43	18.00
20		19.50	19.25	19.25	19.25	18.814	18.376	19.00	17.93	17.43	17.00	17.00	16.06	20.00
24		23.50	23.25	23.25	23.25	22.626	22.126	23.00	21.56	20.93	20.93	20.93	19.31	24.00
30		29.37	29.00	29.00	29.25	29.250		29.00						30.00
36		35.37	35.00	35.00	35.25	35.25		35.00						36.00
42					41.25	41.25		41.00						42.00
48					47.25	47.25		47.00						48.00

DUCTILE IRON
Standard Schedule, O.D. and Wall Thicknesses.

PIPE SIZE	O.D	CLASS 50	CLASS 51	CLASS 52	CLASS 53	CLASS 54	CLASS 55	CLASS 56	STD. LINER	DOUBLE LINER
3	3.96	1.98	0.25	0.28	0.31	0.34	0.37	0.4	0.125	0.25
4	4.8	2.4	0.26	0.29	0.32	0.35	0.38	0.41		
6	6.9	0.25	0.28	0.31	0.34	0.37	0.4	0.43		
8	9.05	0.27	0.3	0.33	0.36	0.39	0.42	0.45		
10	11.1	0.29	0.32	0.35	0.38	0.41	0.44	0.47		
12	13.2	0.31	0.34	0.37	0.4	0.43	0.46	0.49		
14	15.3	0.33	0.36	0.39	0.42	0.45	0.48	0.51	0.1875	0.375
16	17.4	0.34	0.37	0.4	0.43	0.46	0.49	0.52		
18	19.5	0.35	0.38	0.41	0.44	0.47	0.5	0.53		
20	21.6	0.36	0.39	0.42	0.45	0.48	0.51	0.54		
24	25.8	0.38	0.41	0.44	0.47	0.5	0.53	0.56		
30	32	0.39	0.43	0.47	0.51	0.55	0.59	0.63	0.25	0.5
36	38.3	0.43	0.48	0.62	0.58	0.63	0.68	0.73		
42	44.5	0.47	0.53	0.59	0.65	0.71	0.77	0.83		
48	50.8	0.51	0.58	0.65	0.72	0.79	0.86	0.93		
54	57.1	0.57	0.65	0.73	0.81	0.89	0.97	1.05		

DYNASONICS

FPS TO GPM CROSS - REFERENCE (Schedule 40)

Nominal Pipe (Inches)	I.D. INCH	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
1	1.05	2.6989	4.0484	5.3978	6.7473	8.097	9.4462	10.796	12.145	13.490	14.844	16.190	17.540	18.890	20.240	21.590	22.941	24.290
1.25	1.38	4.6620	6.9929	9.3239	11.655	13.99	16.317	18.648	20.979	23.310	25.641	27.970	30.300	32.630	34.960	37.300	39.627	41.958
1.5	1.61	6.3454	9.5182	12.691	15.864	19.04	22.209	25.382	28.555	31.730	34.900	38.070	41.250	44.420	47.590	50.760	53.936	57.109
2	2.07	10.489	15.734	20.979	26.224	31.47	36.713	41.958	47.202	52.450	57.692	62.940	68.180	73.430	78.670	83.920	89.160	94.405
2.5	2.47	14.935	22.402	29.870	37.337	44.80	52.272	59.740	67.207	74.670	82.142	89.610	97.080	104.50	112.00	119.50	126.95	134.41
3	3.07	23.072	34.608	46.144	57.680	69.22	80.752	92.288	103.82	115.40	126.90	138.40	150.00	161.50	173.00	184.60	196.11	207.65
3.5	3.55	30.851	46.276	61.702	77.127	92.55	107.98	123.40	138.83	154.30	169.68	185.10	200.50	216.00	231.40	246.80	262.23	277.66
4	4.03	39.758	59.636	79.515	99.394	119.3	139.15	159.03	178.91	198.80	218.67	238.50	258.40	278.30	298.20	318.10	337.94	357.82
5	5.05	62.430	93.645	124.86	156.07	187.3	218.50	249.72	280.93	312.10	343.36	374.60	405.80	437.00	468.20	499.40	530.65	561.87
6	6.06	89.899	134.85	179.80	224.75	269.7	314.65	359.60	404.55	449.50	494.45	539.40	584.30	629.30	674.20	719.20	764.14	809.09
8	7.98	155.89	233.83	311.78	389.72	467.7	545.61	623.56	701.50	779.40	857.39	935.30	1013.0	1091.0	1169.0	1247.0	1325.1	1403.0
10	10.02	245.78	368.67	491.56	614.45	737.3	860.23	983.12	1106.0	1229.0	1351.8	1475.0	1598.0	1720.0	1843.0	1966.0	2089.1	2212.0
12	11.94	348.99	523.49	697.99	872.49	1047.0	1221.5	1396.0	1570.5	1745.0	1919.5	2094.0	2268.0	2443.0	2617.0	2792.0	2966.5	3141.0
14	13.13	422.03	633.04	844.05	1055.1	1266.0	1477.1	1688.1	1899.1	2110.0	2321.1	2532.0	2743.0	2954.0	3165.0	3376.0	3587.2	3798.2
16	15.00	550.80	826.20	1101.6	1377.0	1652.0	1927.8	2203.2	2478.6	2754.0	3029.4	3305.0	3580.0	3856.0	4131.0	4406.0	4681.8	4957.2

FPS TO GPM: GPM = $(\text{PIPE ID})^2$ X VELOCITY IN FPS X 2.45

GPM TO FPS: FPS = $\frac{\text{GPM}}{(\text{ID})^2 \times 2.45}$

FPS X .3048 = MPS

GPM X .0007 = GPD

GPM X 3.7878 = LPM

DYNASONICS

FPS TO GPM CROSS - REFERENCE (Schedule 40)

Nominal Pipe (Inches)	I.D. INCH	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
18	16.88	697.52	1046.3	1395.0	1743.8	2093.0	2441.3	2790.1	3138.8	3488.0	3836.3	4185.0	4534.0	4883.0	5231.0	5580.0	5928.9	6277.7
20	18.81	866.14	1299.0	1732.0	2165.3	2598.4	3031.5	3464.6	3897.6	4330.7	4763.8	5196.8	5629.9	6063.0	6496.0	6929.1	7362.2	7795.3
24	22.63	1253.7	1880.0	2507.0	3134.1	3761.0	4387.8	5014.6	5641.5	6268.3	6895.1	7522.0	8148.8	8775.6	9402.4	10029	10656	11283
26	25.25	1560.7	2341.0	3121.0	3901.9	4682.2	5462.6	6243.0	7023.4	7803.7	8584.1	9364.5	10145	10925	11706	12486	13266	14047
28	27.25	1817.8	2727.0	3636.0	4544.5	5453.4	6362.3	7271.2	8180.0	9088.9	9997.8	10907	11816	12725	13633	14542	15451	16360
30	29.25	2094.4	3142.0	4189.0	5236.0	6283.2	7330.4	8377.6	9424.9	10472	11519	12566	13614	14661	15708	16755	17803	18850
32	31.25	2390.6	3586.0	4781.0	5976.5	7171.9	8367.2	9562.5	10758	11953	13148	14344	15539	16734	17930	19125	20320	21516
34	33.25	2706.4	4060.0	5413.0	6766.0	8119.2	9472.4	10826	12179	13532	14885	16238	17592	18945	20298	21651	23004	24358
36	35.25	3041.8	4563.0	6084.0	7604.5	9125.4	10646	12167	13688	15209	16730	18251	19772	21292	22813	24334	25855	27376
42	41.25	4165.4	6248.0	8331.0	10414	12496	14579	16662	18744	20827	22910	24992	27075	29158	31241	33323	35406	37489
48	47.99	5637.8	8457.0	11276	14095	16913	19732	22551	25370	28189	31008	33827	36646	39465	42284	45103	47922	50740
54	53.98	7133.1	10700	14266	17833	21399	24966	28532	32099	35665	39232	42798	46365	49931	53498	57065	60631	64198
60	60.09	8839.2	13259	17678	22098	26518	30937	35357	39777	44196	48616	53035	57455	61875	66294	70714	75134	79553
72	72.10	12726	19089	25451	31814	38177	44540	50903	57266	63628	69991	76354	82717	89080	95443	101805	108168	114531
84	84.10	17314	25971	34628	43285	51943	60600	69257	77914	86571	95228	103885	112542	121199	129856	138514	147171	155828

FPS TO GPM: GPM = (PIPE ID)^2 X VELOCITY IN FPS X 2.45

GPM TO FPS: $FPS = \dfrac{GPM}{(ID)^2 \times 2.45}$

FPS X .3048 = MPS

GPM X .0007 = GPD

GPM X 3.7878 = LPM

Addendum — Heat Flow
Dynasonics Series TFX Heat Flow

General

The TFX flowmeter with the optional heat flow module installed is designed to measure the rate and quantity of heat delivered to a given building, area or heat exchanger. The instrument measures the volumetric flow rate of the heat exchanger liquid (water, water/glycol mixture, brine, etc.), the temperature at the inlet pipe and the temperature at the outlet pipe. Heat delivery is calculated by the following equation:

Rate of heat delivery = Q*(Tin – Tout)*c

Where

Q	=	volumetric flow rate
Tin	=	temperature at the inlet
Tout	=	temperature at the outlet
c	=	specific heat of the liquid

The RTD module installed in the TFX measures the differential temperature of two 1000-ohm three-wire platinum RTDs. The three-wire configuration allows the temperature sensors to be located several hundred feet away from the TFX meter without influencing system accuracy or stability. The TFX transit time flow meter can also tolerate large distances between the flow measurement transducers and the electronic instrument.

The RTDs included with the TFX heat delivered flowmeter have been factory calibrated and are marked with an identification as to which terminal, #1 or #2, the RTD has been calibrated. The RTDs are 1000-ohm platinum and are designed to be mounted on the exterior surface of the pipe. The RTDs are rated for a temperature range of –50 to +130 C.

Installation

1. Follow the instructions outlined in the standard TFX manual for proper installation of the flow measurement transducers. After installation, verify that the Signal Strength is greater than 4-5% and, if possible, perform a Zero flow calibration on the pipe. Please note that all readings require a full pipe of liquid.
2. Select areas on the inlet and outlet pipes where the RTDs will be mounted. Remove or peel back the insulation all the way around the pipe in the installation area. Clean an area slightly larger than the RTD down to bare metal on the pipe.

3. Place a small amount of heat sink compound on the pipe in the RTD installation location. See Figure 1. Press the RTD firmly into the compound. Fasten the RTD to the pipe with the included heater tape.
4. Route the RTD wires to an electrical junction box in close proximity to the installation location. Secure the RTD wires such that they will not be pulled on or abraded inadvertently. Replace the insulation on the pipe.
5. Route a cable from the electrical junction box back to the TFX flowmeter. Connect the RTDs as illustrated in Figure 2. Note that the SNS1 and DRV1 wires originate from the same location on the RTD.

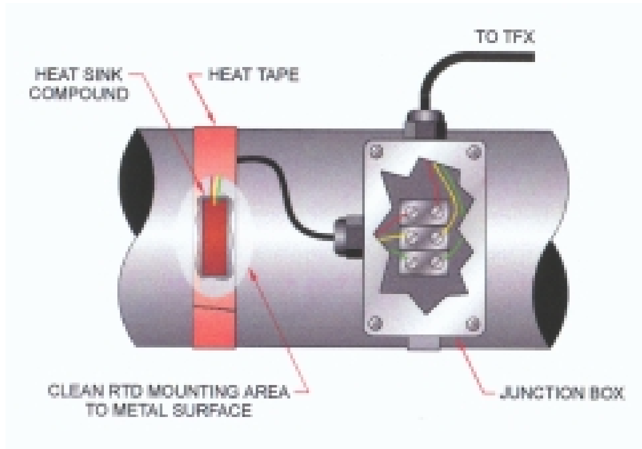


Figure 1

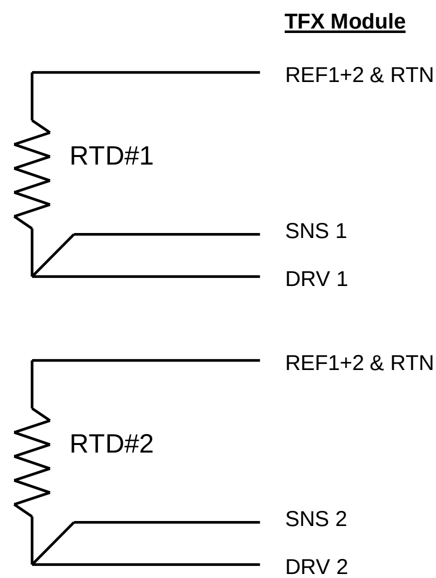


Figure 2

Transmitter Programming

1. The RTDs included with the TFX heat delivered flowmeter have been factory calibrated and are marked with an identification as to which terminal, #1 or #2, the RTD has been calibrated. If recalibration of the RTDs is required or RTDs other than those supplied with the TFX are being utilized, the UltraLink software utility will be required. UltraLink can also be used to configure all operating parameters of the heat flow instrument.
2. To properly measure heat delivery, the specific heat capacity of the liquid must be entered. When a liquid is chosen from the FL TYPE list, a default specific heat will be loaded. This default value is displayed as SP HEAT in the BASIC MENU. If the actual specific heat of the liquid is known or if it differs from the default value, press the ENTER key and modify the value. Press the enter key to save the value. See the values listed in Tables 1 and 2 for specific values. Enter a value that is the mean of both pipes.

3. The RATE UNIT can be displayed as three different values; BTUs, CALs or Watts. Select the proper unit from the RATE UNIT list. Select the appropriate RATE INTERVAL from the list (seconds, minutes, hours, days). Be aware that the instrument can only display values as large as 99,999,999.
4. Select an appropriate TOTALIZER UNIT from the list; BTU, CAL, Watt.
5. In the SER MENU three values can be displayed that may aid in troubleshooting the heatflow instrument. In this menu, the temperature being read by RTD1 is indicated as TEMP1 (all values are degrees Celsius) , RTD2 as TEMP2 and the absolute difference as TEMPDIFF.

Table 1—Heat Capacity of Water

In the following table the unit is $J\ g^{-1}\ °C^{-1}$.

°C	0	1	2	3	4	5	6	7	8	9
0	4.2174	4.2138	4.2104	4.2074	4.2045	4.2019	4.1996	4.1974	4.1954	4.1936
10	4.1919	4.1904	4.1890	4.1877	4.1866	4.1855	4.1846	4.1837	4.1829	4.1822
20	4.1816	4.1810	4.1805	4.1801	4.1797	4.1793	4.1790	4.1787	4.1785	4.1783
30	4.1782	4.1781	4.1780	4.1780	4.1779	4.1779	4.1780	4.1780	4.1781	4.1782
40	4.1783	4.1784	4.1786	4.1788	4.1789	4.1792	4.1794	4.1796	4.1799	4.1801
50	4.1804	4.1807	4.1811	4.1814	4.1817	4.1821	4.1825	4.1829	4.1833	4.1837
60	4.1841	4.1846	4.1850	4.1855	4.1860	4.1865	4.1871	4.1876	4.1882	4.1887
70	4.1893	4.1899	4.1905	4.1912	4.1918	4.1925	4.1932	4.1939	4.1946	4.1954
80	4.1961	4.1969	4.1977	4.1985	4.1994	4.2002	4.2011	4.2020	4.2029	4.2039
90	4.2048	4.2058	4.2068	4.2078	4.2089	4.2100	4.2111	4.2122	4.2133	4.2145

Table 2—Heat Capacity of Liquids

Liquids	
Alcohol, amyl	18
,, ethyl	0
,, ,,	40
,, methyl	12
Aniline	15
Benzene	10
,,	40
Brine	−20
Brine‡	0
,,	15
Ether, ethyl	18
Glycerine	18–50
Oil, castor	20
Oil, linseed	20
,, olive	7
,, paraffin	20–60
,, rape	20
,, sperm	20
Sea-water	17
Toluene	18
Turpentine	18

Limited Warranty and Disclaimer

Dynasonics, div. of Racine Federated Inc. warrants to the end purchaser, for a period of one year from the date of shipment from our factory, that all new transmitters and transducers manufactured by it are free from defects in materials and workmanship. This warranty does not cover products that have been damaged due to normal use, misapplication, abuse, lack of maintenance, or improper installation. Dynasonics' obligation under this warranty is limited to the repair or replacement of a defective product, at no charge to the end purchaser, if the product is inspected by Dynasonics and found to be defective. Repair or replacement is at Dynasonics' discretion. An authorization number must be obtained from Dynasonics before any product may be returned for warranty repair or replacement. The product must be thoroughly cleaned and any process chemicals removed before it will be accepted for return.

The purchaser must determine the applicability of the product for its desired use and assumes all risks in connection therewith. Dynasonics assumes no responsibility or liability for any omissions or errors in connection with the use of its products. Dynasonics will under no circumstances be liable for any incidental, consequential, contingent or special damages or loss to any person or property arising out of the failure of any product, component or accessory.

All expressed or implied warranties, including **the implied warranty of merchantability and the implied warranty of fitness for a particular purpose or application are expressly disclaimed** and shall not apply to any products sold or services rendered by Dynasonics.

The above warranty supersedes and is in lieu of all other warranties, either expressed or implied and all other obligations or liabilities. No agent or representative has any authority to alter the terms of this warranty in any way.

GENERAL TERMS AND CONDITIONS OF SALES

1. PAYMENT – Terms of payment are effective from the actual date of invoice. If, in the Seller's opinion, the financial condition of the Buyer at any time – or any other circumstances – do not justify the incurrence of production costs of shipment on the terms of payment specified, the Seller may require partial or full payment in advance. Payment terms are net 30 days unless otherwise stated on invoice.

2. F.O.B. – All shipments are from Racine, Wisconsin, USA, unless otherwise other stated, and title transfers to the buyer upon leaving factory.

3. QUOTATION AND PRICES – Quoted prices are firm for 30 days unless stated in the quotation and are subject to change without notice after expiration of this period.

4. TAXES – Any applicable sales, use, revenue, excise or other taxes not specifically stated in the quotation are to be remitted by the Buyer directly to the appropriate regulatory agency.

5. WARRANTY – Seller's standard published warranty in effect at the time of shipment shall apply. This warranty is exclusive and is in lieu of all other warranties, express, implied, or statutory, including the warranty of merchantability.

6. DELIVERY – The Seller shall not be liable for loss or damage of any kind resulting from delay or inability to deliver on account of flood, fire, labor trouble, riots, civil disturbances, accidents, acts or orders or regulations of civil or military authorities, shortages of material, or any other causes beyond Seller's control.

7. PRODUCT CHANGES – In keeping with our continuing policy of product improvement, we reserve the right to make changes in our products at any time, without incurring an obligation to change, replace or upgrade equipment previously shipped.

8. CANCELLATIONS – An order placed by Buyer and accepted by Seller may be cancelled only with the Seller's consent and upon terms that will indemnify the Seller against loss.

9. RESTOCKING CHARGE – On standard equipment, the charge is 25%, provided the equipment is returned within 30 days in acceptable condition with a RGA number. Restocking charges for special equipment may vary from standard equipment, and will be handled on a case-by-case basis. No returns will be taken after one year.

DIVISION OF RACINE FEDERATED INC.
2200 SOUTH STREET, RACINE, WI 53404

RETURN OF EQUIPMENT/SALES INFORMATION

CONTACTS AND PROCEDURES

Customer Service/Application Engineer:

If you have a question regarding order status, placing an order, reviewing applications for future purchases, or wish to purchase a new flowmeter, please contact our new National Sales and Marketing Headquarters:

DYNASONICS
Division of Racine Federated, Inc.
2200 South Street
Racine, WI 53404-1526
PHONE: (262)639-6770
FAX: (262)639-2267

Service/Repair Department:

If you already purchased equipment and have an operation problem, require service, or need to schedule field service, please contact our Service Department:

DYNASONICS
Division of Racine Federated, Inc.
2200 South Street
Racine, WI 53404-1526
PHONE: (262)639-6770
FAX: (262)639-2267

Return Goods Authorization:

When returning equipment, it is necessary for you to contact our Service Department at (262)639-6770 to obtain an RGA number for the authority and proper tracking of your material and its prompt inspection and return. All returns of equipment go to the following address:

DYNASONICS
Division of Racine Federated, Inc.
2200 South Street
Racine, WI 53404-1526
RGA #0000

DYNASONICS
2200 SOUTH STREET RACINE, WI 53404
TOLL-FREE IN THE U.S.: TEL: (800) 535-3569
TEL: (262) 639-6770 FAX: (262) 639-2267
URL: www.dynasonics.com

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