DYNASONICS

Series TFXP

Transit Time Ultrasonic Flow Meter

Operations & Maintenance
Manual

REV 4/01

BEFORE OPERATING THE TFXP

Important Notice!

UPSTREAM TRANSDUCER — 4 - 20 mA OUTPUT
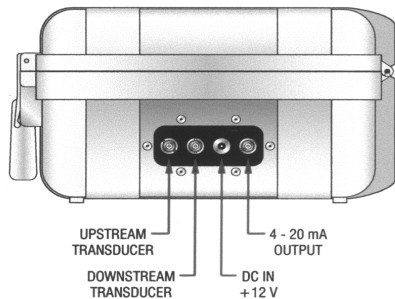DOWNSTREAM TRANSDUCER — DC IN +12 V

Figure 1.1

The TFXP flow meter is equipped with a Lead Acid Gel Cell battery. This battery will require charging before initial operation.

Apply power, utilizing the enclosed 12 Volt DC output line power converter or cigarette-style power cord, to the TFXP for a period of 16-24 hours prior to using the product for the first time. The power converter connects to the socket connection located on the side of the enclosure. See **Figure 1.1**. A fully charged battery will provide up to 24 hours of continuous operation before recharging will be necessary.

When the battery level has decreased to a point where recharging is required, the LOW BATTERY indicator will illuminate on the front panel. At that point, the meter will only operate a short time more until it automatically turns itself off—preventing excessive battery discharge that can damage the Gel Cell battery. The TFXP has an integral charging circuit that prevents overcharging. The instrument can be permanently connected to AC line power without damaging the flow meter or the battery. Page 1.10 of this manual contains additional recommendations to preserve and maximize the power in the TFXP battery.

If the TFXP is to be used for extended periods of operation, the AC power converter or the 12 volt cigarette converter can remain connected indefinitely.

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QUICK-START OPERATING INSTRUCTIONS

This manual contains detailed operating instructions for all aspects of the TFXP instrument. The following condensed instructions are provided to assist the operator in getting the instrument configured and measuring 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 times the pipe inside diameter) of straight pipe upstream and 5 straight diameters downsteam. See Table 2.1 for detailed piping configurations and recommended lengths of straight pipe.

B. Select a mounting method for the transducers based on pipe size and liquid characteristics. See **Figure 1.2**. Select **W-Mount** for plastic pipes flowing clean, non-aerated liquids in the 1-3 inch [25-75 mm] internal diameter range. Select **V-Mount** for pipes of all materials and most liquids in pipe sizes from 1-10 inches [25-250 mm]. Select **Z-Mount** for pipes larger than 10 inches.
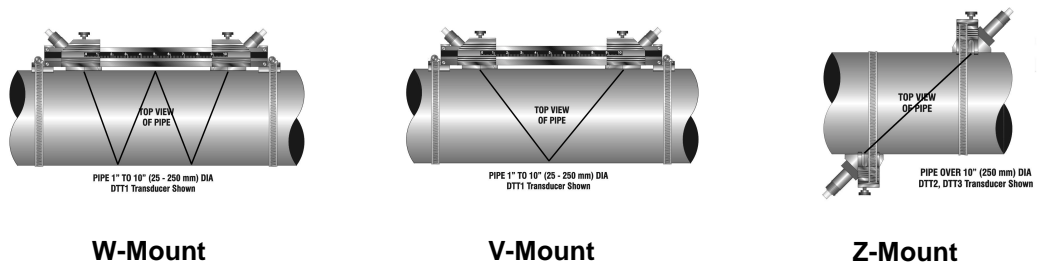

W-Mount   **V-Mount**   **Z-Mount**

Figure 1.2

C. Enter the following data into the TFXP transmitter via the integral keypad or UltraLink software utility.

QUICK-START OPERATING INSTRUCTIONS

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

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

UPSTREAM TRANSDUCER
DOWNSTREAM TRANSDUCER
4 - 20 mA OUTPUT
DC IN +12 V
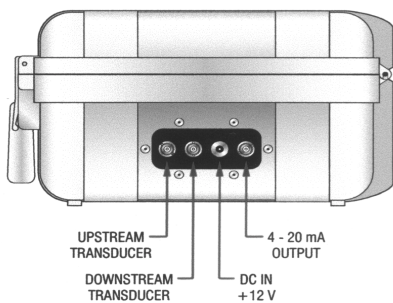
Figure 1.3

Connections

Startup

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

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. Attach the transducer mounting rail or saddles to the pipe at the location(s) determined in Step 1. Refer to Figure 1.1 for proper orientation.

C. Apply a liberal amount of couplant grease onto the transducer faces. Place each transducer into the rail/saddle ensuring proper linear and radial placement.

3. TRANSDUCER/POWER CONNECTIONS

A. Do not attempt to add additional cable to the transducers.

B. Refer to the WIRING DIAGRAM located on the inner door of the TFXP transmitter and **Figure 1.3** for proper power and transducer connections.

4. INITIAL SETTINGS AND POWER UP

A. Press the ON button on the flow meter keypad.

B. From the Service Menu, verify that signal strength is greater than 2.0%.

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

PART 1 - INTRODUCTION

General

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

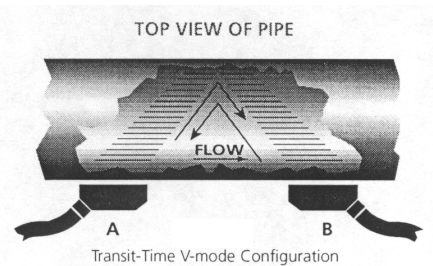TFXP transit time flow meters utilize two transducers that function as both ultrasonic transmitters and receivers. The transducers are clamped on the outside of a closed pipe <u>at a specific distance from each other</u>.

TOP VIEW OF PIPE

FLOW

A   B

Transit-Time V-mode Configuration

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 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 TFXP 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 1 - 100 inch [25 - 2540 mm] internal diameters. 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 transducers are rated to 300°F [150°C]. Higher temperatures can be accommodated. Please consult the Dynasonics factory for assistance.

PART 1 - INTRODUCTION

User Safety

The TFXP employs modular construction and provides electrical safety for the operator. The display face contains voltages no greater than 10 Vdc. All user connections are made through sealed bulk-head plugs located on the side of the TFXP enclosure.

Data Integrity

Non-volatile flash memory retains all user-entered configuration values in memory for several years, even if power is lost or the unit is turned off. Data Logger values are stored in flash memory in the logger. 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 TFXP is located on the inside of the transmitter's front cover. Should technical assistance be required, please provide the Dynasonics Customer Service Department with this information.

Product Matrix

T F X P - ☐ ☐ ☐ A - ☐ ☐

Power Supply
A) 115 VAC
B) 230 VAC
(two round terminals)
G) 230 VAC
(three rectangular
terminals)

Output 2*
1) 4-20mA

Output 1*
6) 200,000 event datalogger

Approvals
N) Class 1, Div 2 (pending)

Options
N) None
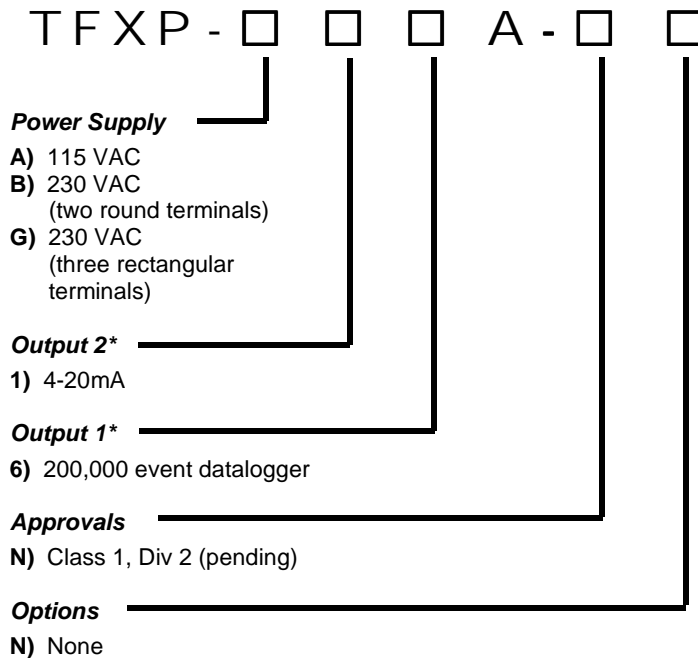
Replacement Parts	*Part Number*
TFXP Flow meter	D040-0110-001
Data Logger, 200,000-event	D020-1045-104
Padded carrying case	D003-1012-002
Transducers, set of two	D071-0105-000
Transducer Cable, 20 ft. [6m]	D005-2112-020
Acoustic Grease, temporary mount	D002-2011-001
Mounting Track, w/measuring scale	D010-2102-010
Mounting Clamp, single	D003-0139-002
36 inch SS hose clamp	D002-2007-001
Power converter, 115V U.S.	D005-2502-001
Power converter, 230V European	D005-2502-002
Power converter, 230V U.K.	D005-2503-003
Power cord, 12V cigarette-style	D005-2116-002
4-20mA interconnect cable	D005-2116-001
Infrared communicator and UltraLink	D005-2115-100
Infrared communicator	D005-2115-001
Manual, TFXP flow meter	DTFXP O&M

Transmitter

Description	Specification
Power Requirements	Internal 12V lead-acid gelcell battery provides 24 hrs of continuous operation @ 20°C. Charging: Wall mount power converter 115 or 230 Vac 50/60 Hz ± 15% @ 5 VA max; 12-15 Vdc @ 2.5 VA max.
Velocity	-40 to +40 fps [-12 to +12 mps]
Outputs	All output modules are optically isolated from earth and system grounds. A maximum of two outputs may be installed.
Standard	**Data Logger:** 200,000-event, 16-bit, integral DB-9 RS232C connection, can be removed and installed without disconnecting system power; data rates to 57.6k
Optional (consult factory)	**4-20 mA:** 800 ohms max.; 12-bit resolution; passive or active
	Pulse Output: MOSFET, 0.21 Ohms, 100V max., 0-10,000 Hz
	Relay: Two separate Form C relays, 200 VAC max. @ 0.5 A resistive
	RS232C: data rate to 57.6k
	RS485: supports up to 119 drops
	Heatflow: supports two 1,000 Ω RTDs, multiplexed, 12-bit resolution
Display	128x64 pixel graphics LCD, LED back lit. Two user selectable font sizes 0.35" [8.9mm] or 0.2" [5.0mm] 8 digit rate, 8 digit totalizer (resettable)
Units:	User configured
Rate	feet, gallons, ft^3, mil-gal, barrels, acre-feet, lbs., meters, liters, m^3, mil-liters, Kg (with Heatflow option: BTUs, calories, tons, Watts)
	[rate time: sec, min, hr, day]
Totalizer	Net total (difference between forward and reverse flow) gallons, ft^3, barrels, acre-feet, lbs., liters, m^3, kg (with Heatflow option: BTUs, calories, tons, Watts)
Ambient Conditions	-40 to 185° F [- 40 to 85 ° C], 0-95% relative humidity, non-condensing.
Enclosure	NEMA 4X [IP-65] ABS with SS hardware. Electronic enclosure: 14.00 [355.6] W x 6.06 [153.9] H x 10.56 [268.2] D inches [mm]; 14.8 [6.7] lbs. [Kg]
Accuracy Flow Rate	±0.5% of reading at rates > 1 fps for field calibrated systems; ±1% of reading at rates > |1 fps [0.3 mps]| uncalibrated; ±0.01 fps [0.003 mps] at rates < |1 fps [0.3 mps]|
Sensitivity	0.001 fps [0.0003 mps]
Repeatability	±0.01% of reading
Response Time	Flow: 0.3-30 seconds, user configured, to 100% of value, step change in flow
Security	Keypad lockout, access code enable
Approvals	CE EN50081-1 EMC/EN50082-1 EMI (pending); Hazardous Area Class I Div. 2 Groups C&D, Class II Div. 2 Groups E-G (pending)
ULTRALINK **Software Utility**	IBM compatible, Windows® 95/98/NT operating system

Transducer

Description	Specification
Liquid Types Supported	Virtually all liquids
Transducer to Transmitter Distance	(Std) 20 feet [6.09 meters], (Opt) lengths to 999 feet [300 meters]
Pipe Sizes	(Std.) 1 - 100 inches [25 - 2540 mm] pipe I.D.
Environment	(Std) - 40° to 300° F [-40° to 150° C]; consult factory for higher temperatures. (Std) NEMA 1, optional NEMA 4X and NEMA 6
Housing Material	(Std) Aluminum, Ultem™ and ss w/epoxy encapsulation
Mounting	(Std) Aluminum, plastic and SS
Approvals	Hazardous Area Class I Div. 2 Groups A-D, Class II Div. 2 Groups E-G (pending); optional Class 1 Div. 1 Groups A-D (pending)

Transmitter Location Considerations

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.

When the TFXP is to be utilized for extended periods of time in one location, the enclosure should be placed 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 TFXP system. If this is not possible, do not attempt to add additional cable to the transducer. 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. Place the TFXP 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 maximum limit.

3. If the transmitter will be subjected to a wet environment, it is recommended that the cover remain closed and the latches secured after configuration is completed. The faceplate/keypad of the TFXP is watertight, but avoid letting water collect on the keypad area.
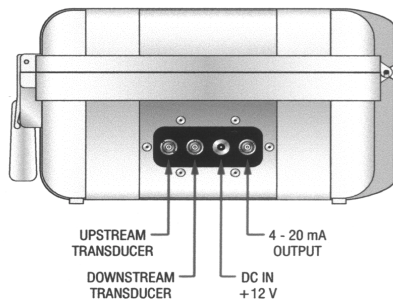
Electrical Connections

It is highly recommended that the internal battery in the TFXP be fully charged before using the meter for the first time. Details covering this procedure are located on Page 1.1 of this manual.

1. The connectors located on the side of the TFXP consist of three 1/4 turn BNC-type and one 5.5mm power plug. These connectors are environmentally sealed, but it is recommended not to allow water or other liquids to collect in the electrical connections pocket.

2. Connect the appropriate wires to the corresponding connections on the transmitter. The transducer cable has markings of UPSTREAM and DOWNSTREAM to assist in the installation process. The UPSTREAM transducer is the one located closer to the direction from which fluid flow normally comes from (The fluid normally passes the UPSTREAM transducer before passing the DOWNSTREAM transducer.) If the transducer wires are connected backwards, a negative flow indication will be observed on the flow meter display. See **Figure 1.4** or the Wiring Diagram located on the inner door of the transmitter.

Figure 1.4

NOTE: The transducer cables carry low level signals. Do not attempt to add additional cable to the factory supplied transducer cable. If additional cable is required, contact the Dynasonics factory to arrange for an exchange transducer with the appropriate length of cable. Cables to 990 feet [300 meters] are available.

Battery Charging and External Power Sources

The 12 Volt DC power converter and 12 Volt cigarette-style power cord connect to the socket connection located on the side of the enclosure. See **Figure 1.4**. A fully charged battery will provide up to 24 hours of continuous operation before recharging will be necessary. When the battery level has decreased to a point where recharging is required, the LOW BATTERY indicator will illuminate on the front panel. At that point, the meter will only operate a short time more until it automatically turns itself off—preventing excessive battery discharge that can damage

the Gel Cell battery.

If the TFXP is to be used for extended periods of operation, the 12 Vdc line power converter or the 12 V cigarette converter can remain connected indefinitely.

To charge the internal Gel Cell battery, apply power, utilizing the enclosed 12 Vdc line power converter or cigarette-style power cord, to the TFXP for a period of 16-24 hours. The TFXP has an integral charging circuit that prevents overcharging. The instrument can be permanently connected to AC line power without damaging the flow meter or the battery.

The Gel Cell battery is "maintenance free", but it still requires a certain amount of attention to prolong its useful life. To obtain the greatest capacity and longevity from the battery, the following practices are recommended:

- Do not allow the battery to completely discharge. (Discharging the battery to the point where the LOW BATTERY indicator illuminates will not damage the battery. Allowing the battery to remain discharged for long periods of time can degrade the storage capacity of the battery.) When not in use, continually charge the battery by keeping the 12 Vdc line power converter plugged in and connected to the flow meter. The TFXP battery management circuitry will not allow the battery to become "over-charged".

NOTE: The TFXP will automatically enter a low power consumption mode approximately 1-1/2 minutes after the LOW BATTERY indicator illuminates. This circuit prevents excessive discharge of the internal battery.

- If the TFXP is stored for prolonged periods of time, monthly charging is recommended.

- If the TFXP is stored for prolonged periods of time, store at a temperature below 70ºF [21ºC].

Use wiring practices that conform to local codes (National Electric Code Handbook in the USA). Use only the power converters that have been supplied with the TFXP flow meter. The ground terminal, if present on the converter, is mandatory for safe operation.

PART 1 - TFXP TRANSMITTER CONNECTIONS

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.).

The TFXP can be operated from a 11-15 Vdc source, using the included cigarette-style power cord, as long as it is capable of supplying at least 3 Watts—observe proper polarity.

General Information Regarding Input/ Output: ISO-MODs

The TFXP flow meter contains two *Isolated Input/output Modules* (ISO-MODs); one located inside of the flow meter enclosure and one that is user accessible, located under the access door on the keyboard. The standard configuration of these modules is to have the internal module configured as an actively powered 4-20 mA module and the user accessible one as a Data Logger.

ISO-MODs are epoxy encapsulated electronic input/output modules that are simple to install and replace in the field. All modules are 2,500 volt optically isolated from TFXP power and Earth grounds -- eliminating the potential for ground loops and reducing the chance of severe damage in the event of an electrical surge.

Seven ISO-MOD options are available including: 4-20 mA, dual-relay, rate pulse, RS232C, RS485, 200k event datalogger and RTD heat-delivered option. TFXP supports any two ISO-MOD input/output modules. All modules are field configurable by utilizing the keyboard or *ULTRALINK* interface.   Field wiring connections to ISO-MODs are quick and easy using pluggable terminals. Features of the various ISO-MODs are described below. See the Series TFXH addendum for details regarding the RTD **Heatflow Module** option.

Standard 4-20 mA Output

UPSTREAM TRANSDUCER — — 4 - 20 mA OUTPUT
DOWNSTREAM TRANSDUCER — — DC IN +12 V
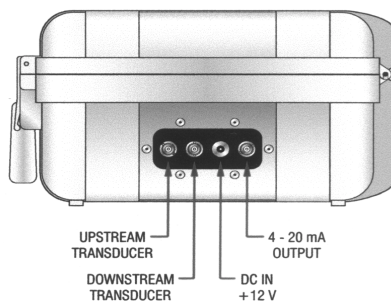
Figure 1.5

The 4-20 mA Output Module interfaces with virtually all recording and logging systems by transmitting an analog current signal that is proportional to system flow rate. Independent 4 mA and 20 mA span settings are established in software using the FL 4MA and FL 20MA settings in the OUTPUT2 configuration menu. 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 (4,096 discrete points). The module can drive more than 800 ohms of load with its internally generated 24 volt power source.

A 4-20 mA output interface cable has been included with the TFXP package. Connect the 1/4-turn BNC connection to the jack located on the side of the flow meter. **See Figure 1.5**. The red clip on the cable provides the positive

leg of the output and the black clip provides the negative side. Verify that the sum of the resistances in the loop do not exceed 800 Ohms.

Refer to Section 3 of this manual for detailed information regarding the configuration, calibration and testing of the 4-20 mA output.

Standard
Data Logger

Figure 1.6

A 200,000-event data logger/electronic stripchart recorder is located within the weather-tight pocket on the face plate of the flow meter. See **Figure 1.6**. Loosen the three thumbscrews located in the corners of the pocket cover and rotate the cover to expose the Data Logger module. The logger stores time-stamped, high resolution (16-bit) data at user selected intervals ranging from 1 to 30,000 (8.33 hours) seconds. Configuration of and data retrieval from the logger can be accomplished in one of two ways:

- The module is *hot-swappable* -- that is, it can be installed, removed from or replaced within the flow meter without disconnecting power. The module can be carried in a shirt pocket back to the office and plugged into a PC serial port via the module's integral DB9 connector.

- Via the *DataLink* software utility and the serial DB9 interface cable included with the logger. Data can be accessed by connecting the cable to the logger, which is located in the pocket on the front faceplate of the instrument. See **Figure 1.6.**

Refer to Section 3 of this manual for detailed information regarding the configuration and operation of the Data Logger Module.

Optional
Control Relay

Two independent SPDT (single-pole, double-throw, Form C) relays are contained in this module. The relay operations are user configured via software to act in either a

flow rate alarm, signal strength alarm or totalizer/batching mode. 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 Relay ISO-MOD is used to control inductive loads such as solenoids and motors.

**Optional
0-10 kHz Output**

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. This module does not source voltage at its output, it must be connected in an "open-collector" fashion with an external power source and pull-up resistor. 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 (4,096 discrete points) and the maximum output frequency setting is 10,000 Hz. The MOSFET can support loads of 100V @ 9A.

**Optional
RS232C I/O**

The RS232 Module can be interfaced with the serial communication ports of PCs, PLCs and SCADA systems 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 19.2k are supported.

**Optional
RS485 I/O**

The RS485 Module allows up to 126 TFXP systems to be placed on a single three-wire cable bus. All meters are assigned a unique one byte serial number that allows all of the meters on the cable network to be independently accessed. Baud rates up to 19.2k and cable lengths to 1,000 feet [300 meters] are supported.

**Optional
RTD-BTU**

See the Appendix of this manual for information regarding connection and operation of the optional RTD-BTU option.

PART 2 - TRANSDUCER POSITIONING

General

The transducers that are utilized by the Series TFXP contain piezoelectric crystals for transmitting and receiving ultrasound signals through walls of liquid piping systems. The 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 clamp-on ultrasonic transit time transducers is comprised of three 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 TFXP keypad. The software embedded in UltraLink and TFXP 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.

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

Table 2.1[1]

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

PART 2 - TRANSDUCER POSITIONING

2. Transducer Spacing

TFXP 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. 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 transducers.

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 TFXP system.

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

The following information will be required before programming the instrument:

1. Transducer mounting configuration. Use the following guide to determine the optimum mounting method for a particular installation:

V-Mount Configuration

Figure 2.1 V-Mount. Reflective type (transducers mounted on one side of the pipe) of installation used primarily on pipe sizes in the 3-10 inch [75-250 mm] internal diameter range.

TOP VIEW
OF PIPE

PIPE 1" TO 10" (25 - 250 mm) DIA
DTT1 Transducer Shown
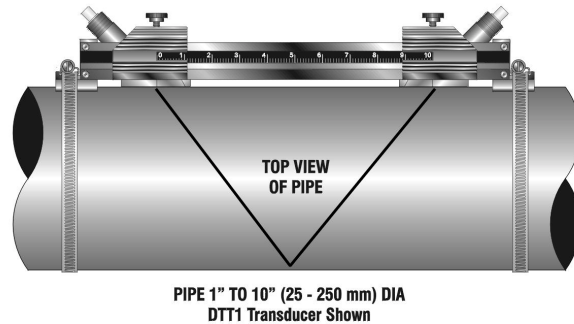
Figure 2.1 - Transducer V-Mount

W-Mount Configuration

Figure 2.2 W-Mount. Reflective type (transducers mounted on one side of the pipe) of installation used primarily on plastic pipe sizes in the 1-3 inch [25-75 mm] internal diameter range. Metal pipes will typically require the V-Mount for proper operation.

TOP VIEW
OF PIPE

PIPE 1" TO 10" (25 - 250 mm) DIA
DTT1 Transducer Shown
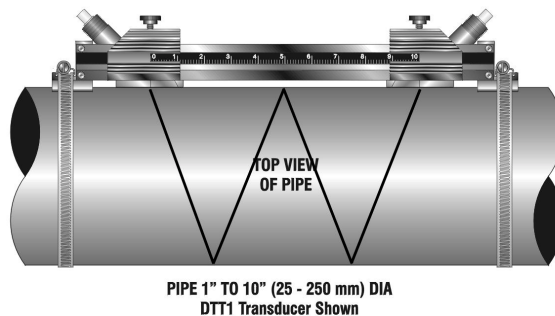
Figure 2.2 - Transducer W-Mount

**Z-Mount
Configuration**

Figure 2.3 Z-Mount. Direct type (transducers mounted on opposite sides of the pipe) of installation used primarily on pipe sizes in the 10-100 inch [250-2540 mm] internal diameter range.

TOP VIEW
OF PIPE

PIPE OVER 10" (250 mm) DIA
DTT2, DTT3 Transducer Shown
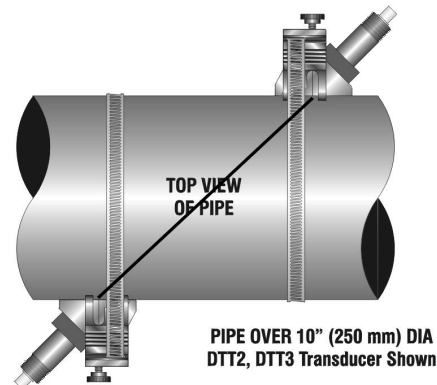
Figure 2.3 - Transducer Z-Mount

In addition, the following information is required before mounting the transducers on the pipe.

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 (if present)
8. Pipe liner material (if present)
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 TFXP operating system. The nominal values may be used as they appear or may be modified if exact system values are known.

Keypad Entry

The TFXP contains a tactile feedback keypad interface that allows the user to configure parameters used by the TFXP operating system.
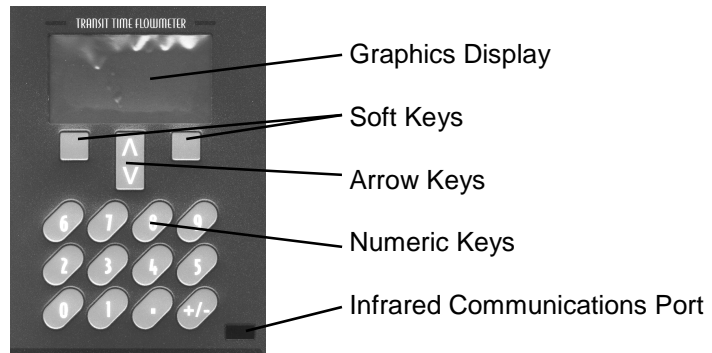
The TFXP system can be configured using UltraLink and a laptop computer. Please refer to page 2.13 for details regarding data entry in UltraLink.

The following "Soft Key" menu items will be displayed immediately above the two keys located in the lower corners of the Graphics Display.

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 for to SAVE.

2. 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.

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

4. The (soft)EDIT key is used to

- access the configuration parameters in the various menus.

- initiate changes in configuration parameters.

5. The (soft)ACCEPT key is used to

- accept configuration parameter changes.

6. The (soft)SELECT key is used to

Graphics Display Configuration

- 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

- From Menu 7, Display Menu, the number of graphics display lines can be toggled between two and four lines.

Menu 1, 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 TFXP to display sound speeds in pipe materials and liquids as either feet per second or meters per second respectively.

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** 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 [75-250 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 1-3 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 [250-2540 mm] internal diameter range.

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 DTFXP 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.

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

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 to be entered.

Liner Material Entry

LINER T -- Pipe Liner Thickness Entry
ENGLSH (Inches)
METRIC (Millimeters)

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

Liner Thickness 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.

PART 2 - TRANSDUCER POSITIONING

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 the Appendix located 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 the Appendix located 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 the Appendix located 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 from the line which is scribed into the side of the transducer block.

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 2.21 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 TFXP installation site (provided that UltraLink and TFXP communications are not enabled at the time of data entry) or it can be downloaded immediately to the TFXP meter (provided that UltraLink and TFXP communications are enabled during data entry).

To install UltraLink and establish communications with a PC, please follow the instructions enclosed with the UltraLink software package or in the Appendix 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 2.3-2.5.

After initializing UltraLink, click on the button labeled

Transducer spacing appears here.
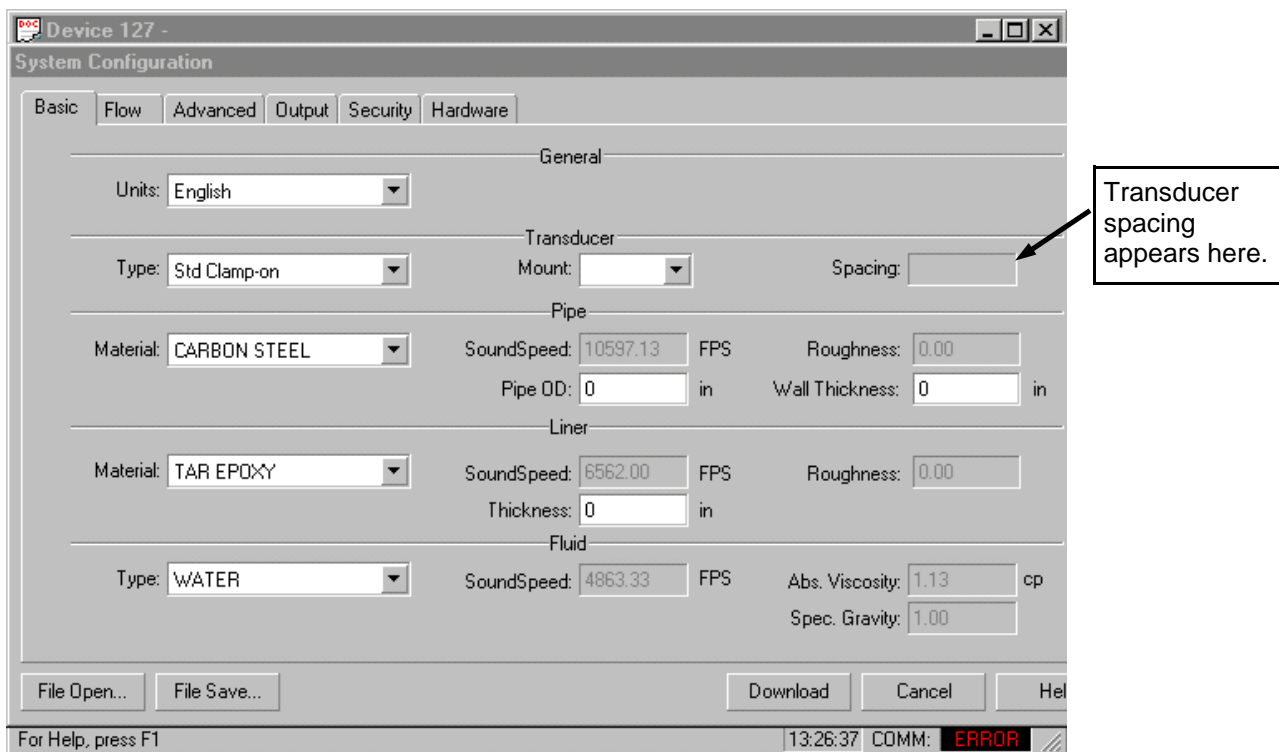
Figure 2.4 UltraLink Windows-based software utility configuration screen.

Config. The window shown in Figure 2.4 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 TFXP 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 TFXP 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 details the installation and initialization of UltraLink. This document is part of Dynasonics Part Number D005-2115-100 infrared communications adapter package.

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.

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.
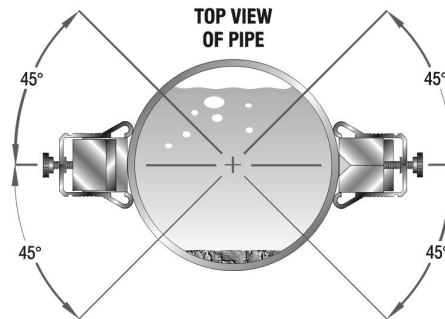
Figure 2.5 Transducer mounting locations on horizontal pipe.

Installations on Pipes Smaller than 10 Inches [250 mm] Go to Page 2.18

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].

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**.

DETAIL A

DETAIL B

LESS THAN 1/4 IN. (6 MM)
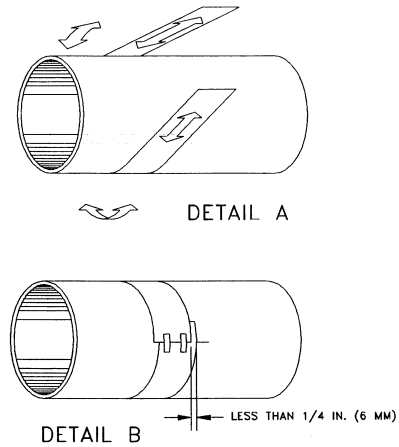
Figure 2.6 Paper Template Alignment

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

DETAIL A

DETAIL B

DETAIL C

DETAIL D
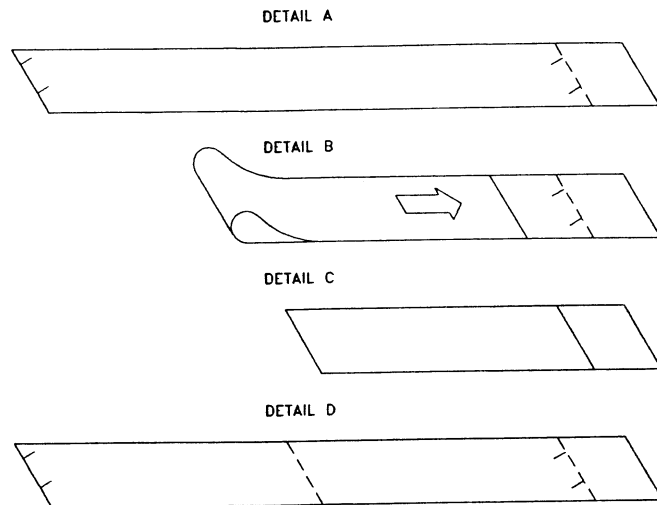
Figure 2.7 Bisecting the pipe circumference

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.

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 2.12 or 2.14

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

DTT1, DTT2 and DTT3 Installation

DTT1, DTT2 and DTT3 Mounting Saddle Installation

1. Install the first mounting saddle 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 located towards the "inside" and the thumbscrew will be mounted towards the outside. See **Figure 2.8**.

2. Place a single bead of couplant, approximately 0.25 inch [6 mm] thick, on the flat face of the transducer. See **Figure 2.9**. Use Dow 732 for permanent and Dow 44 for temporary (less that six months) installations.

3. Place the first transducer in between the saddle and pipe near the zero point on the mounting rail scale. Slide the transducer clamp over the transducer. Adjust the clamp/transducer such that the line on the transducer aligns with the mark on the pipe. **See Figure 2.8**.

4. Secure with the thumb screw. (Excessive
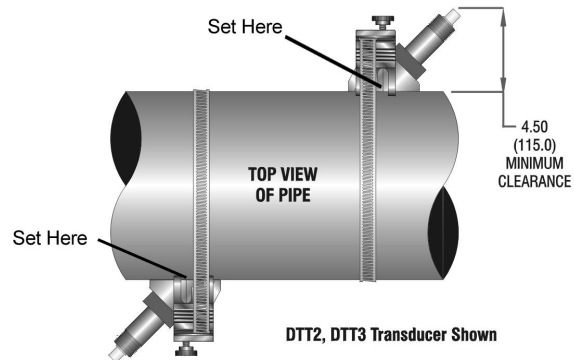
Figure 2.8 Z-Mount Alignment

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 111 or an alternate form of grease has been used as a couplant, setting time is not necessary.
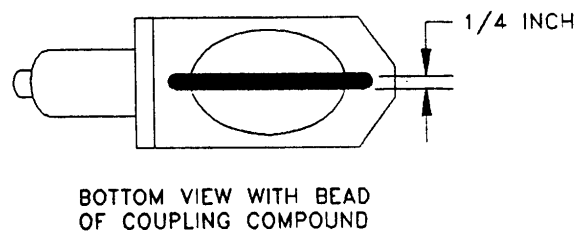
Figure 2.9 Transducer Couplant Application

5. Mount the second saddle 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 thumb screw. Refer to **Figure 2.8** for proper orientation.

DTTA Transducer Installation

DTTA Mounting Rail Installation

1. Install the single mounting rail on the pipe in a orientation suggested by **Figure 2.5** (using only a single rail, not the two opposing rails pictured) 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 0.25 inch [6 mm] thick, on the flat face of the transducer. See **Figure 2.10**. Use Dow 732 for permanent and Dow 111 for temporary (less that six months) installations.
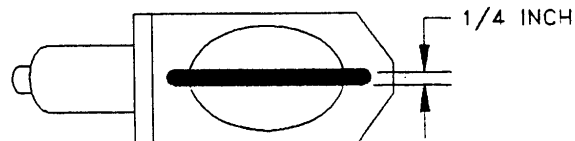
BOTTOM VIEW WITH BEAD
OF COUPLING COMPOUND

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**.

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 111 or an alternate form of grease has been used as a couplant, setting time is not necessary.
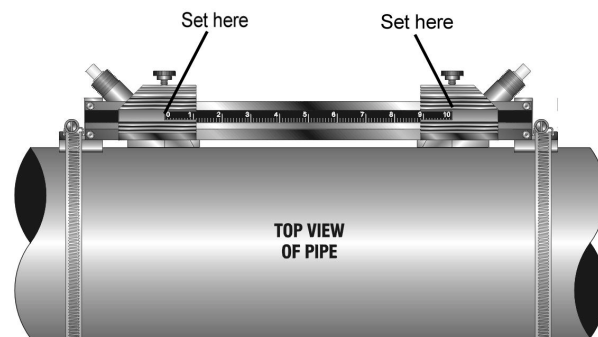
Figure 2.11 Transducer Space Measurement

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.

Pipes Smaller than 2 inches [50 mm]

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 as illustrated in **Figure 2.12**.
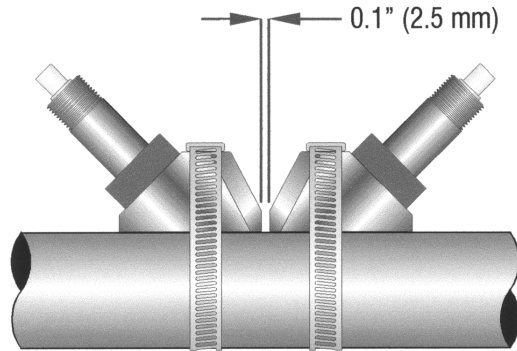
Figure 2.12 Pipes Smaller than
2 inches [50 mm]

PART 3 - STARTUP AND CONFIGURATION

Before Starting the Instrument

Note: The TFXP flow meter system requires a full pipe of liquid before a successful startup can be completed. 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.

Instrument Startup

Procedure:

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. Press the ON button on the flow meter keypad. The TFXP display backlighting will illuminate and the software version number and Dynasonics' logo will appear on the display.

The display backlighting illuminates for approximately 20 seconds and automatically extinguishes to preserve battery power. To re illuminate the display, press any key on the keyboard. Adjustments to the backlighting duration can be made in the Display Menu. Refer to page 3.27 for details.

4. Confirm that Signal Strength is greater than 2%. If it is not, verify that proper transducer mounting methods and liquid/pipe characteristics have been entered. **The pipe must be full of liquid in order to make this measurement.**

5. Once the meter is properly operating (proper signal strength has been achieved), refer to the later portions of this manual section for additional programming features.

PART 3 - KEYPAD CONFIGURATION

General

After a installation of the transducer track or cradle assembly and connection of appropriate power supplies to the TFXP, 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 TFXP 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 TFXP meters.

Keypad Operation

Graphics Display

Soft Keys

Arrow Keys

Numeric Keys

Infrared Communications Port
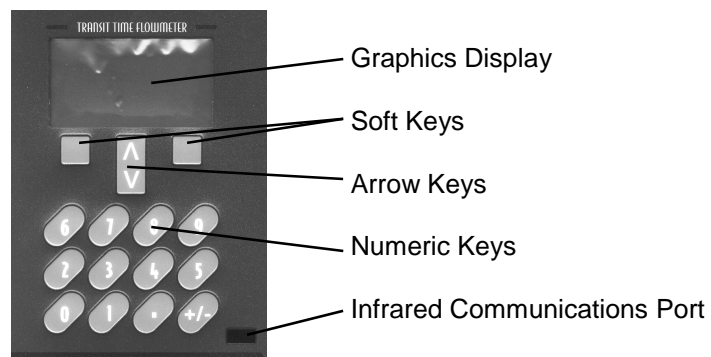
Figure 3.1

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**.

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 for to SAVE.

PART 3 - KEYPAD CONFIGURATION

Display Contrast

2. 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.

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

4. The (soft)ACCEPT key is used to

-   accept configuration parameter changes.

5. The (soft)SELECT key is used to

Graphics Display Configuration

-   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 keys to select display units of

    -   RATE
    -   TOTALizer
    -   VELocity
    -   SIGNAL STRength

    From Menu 8, Display Menu, the number of graphics display lines can be toggled between two and four lines.

-   access the configuration parameters in the various menus.

-   initiate changes in configuration parameters.

Menu Structure

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

1. BSC MENU -- BASIC operations menu. It contains all of the configuration parameters necessary to program the meter to measure flow.

2. **Datalog operation** -- Configures the datalogging location, logger interval and logging duration.

3. **Datalog maintenance** -- Existing datalogger files can be erased from the logger.

4. **OUT2 MEN** -- Configures the type and operating parameters of the ISO-MOD located internally in the TFXP flow meter.

5. **SEN MENU** -- SENSOR menu is for future use.

6. **SEC MENU** -- SECURITY MENU utilized for resetting totalizers, resetting the operating system and revising security passwords.

7. **SER MENU** -- 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. **DSP MENU** -- DISPLAY MENU used to configure meter display functions.

1. BSC MENU -- BASIC MENU

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

The BASIC menu contains all of the configuration parameters necessary to make the TFXP 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 TFXP to display sound speeds in pipe materials and liquids as either feet per second or meters per second, respectively.

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 3-8 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 1-3 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 8-100 inch [200-2540 mm] internal diameter range.

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.

PART 3 - KEYPAD CONFIGURATION

Pipe Diameter

PIPE OD -- Pipe Outside Diameter Entry
> *ENGLSH (Inches)*
> *METRIC (Millimeters)*

Enter the pipe <u>outside diameter</u> 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 <u>wall thickness</u> in inches if ENGLSH was selected as UNITS; in millimeters if METRIC was selected.

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 TFXP 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.

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

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 to be entered.

Liner Thickness

LINER T -- Pipe Liner Thickness Entry

> *ENGLSH (Inches)*
> *METRIC (Millimeters)*

Enter the pipe <u>liner thickness</u>. 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 the Appendix located 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 the Appendix located 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)
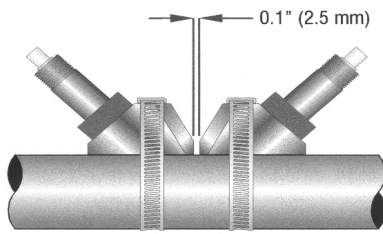
**MOUNTING ON PIPES
SMALLER THAN 2" (50 mm) DIA**

Figure 3.2

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 on 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**.

**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).

Minimum Velocity

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

A minimum volumetric flow rate setting is entered to establish filter software settings.

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 <u>negative</u> value.

PART 3 - KEYPAD CONFIGURATION

Maximum Velocity

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 <u>negative</u> 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.

System Damping

DAMP PER - System Damping
Relative Percent Entry

In installations where very turbulent or erratic flow is encountered, increasing the Damping setting can increase display and output stability. The DAMP PER setting increases and decreases the response time of the flow meter display and outputs. Set a value between 1 and 100 percent, a setting of 1 having the fastest response and 100 having the slowest response.

2. DATALOG OPERATION MENU

ISO-MOD DataLogger

> *Location Number 1-30,000 [16 total locations]*
> *INTERVAL 1-30,000 seconds*
> *DURATION 1-30,000 hours*

The standard configuration for the TFXP includes a powerful 200,000-event data logger/electronic strip-chart recorder. The logger can be configured in a couple of different ways to match user applications. The logger stores time-stamped, high resolution (16-bit) data at user selected intervals ranging from 1 to 30,000 (8.33 hours) seconds. Configuration of and data retrieval from the logger can be accomplished in one of two ways:

- The module is *hot-swappable* -- that is, it can be installed, removed from or replaced within the flow meter without disconnecting power. The module can be carried in a shirt pocket back to the office and plugged into a PC serial port via the module's integral DB9 connector. This feature eliminates the requirement to carry a laptop computer to the flowmeter site.

- Via the **DataLink** software utility and the serial DB9 interface cable included with the logger. Data can be accessed by connecting the cable to the logger, which is located in the pocket on the front faceplate of the instrument. See **Figure 3.3**

See Section 4 of this manual for details regarding operation of the **DataLink** and **UltraLink** software utilities.

Figure 3.3

Data Logger Configuration

There are three configuration parameters to enter for datalogger operation:

PART 3 - KEYPAD CONFIGURATION

- FILE NUMBER/LOCATION
- INTERVAL
- DURATION

File Number or Location

The TFXP and the datalogger module can be used to monitor and store data on up to 16 different locations. These locations are identified by the FILE NUMBER/ LOCATION that is assigned. The datalogger will not write over an existing file. Existing data files will need to be uploaded and then erased from the logger before new data can be written into the space. Uploading and storing of datalogger files is completed using the *DataLink* software utility. See Section 4 of this manual for details regarding operation of the *DataLink* and *UltraLink* software utilities.

Logging Interval

From the OUTPUT 1 menu, adjust the time INTERVAL between readings. INTERVAL values between 1 and 30,000 seconds are acceptable.

For reference there are:

> 60 seconds in 1 minute
> 300 seconds in 5 minutes
> 1,800 seconds in 30 minutes
> 3,600 seconds in 1 hour
> 30,000 seconds in 8.33 hours

Table 3.1 describes some typical configurations of the INTERVAL and DURATION times with what the expected data samples collected count will be.

Logging Duration

If the TFXP is going to be left unattended, logging flow data, for extended periods of time, the DURATION time can be configured to stop logging after the DURATION of time has passed. DURATION is configured in hours and values between 1 and 30,000 hours are acceptable.

Table 3.1

Example No.	INTERVAL Seconds	DURATION Hours Operated	Samples Collected
1	1	24 (1 day)	86,400
2	10	168 (7 days)	60,480
3	60 (1min.)	720 (30 days)	43,200
4	300 (5 min.)	8,760 (1 yr)	105,120
5	1,800 (30 min.)	8,760 (1 yr)	17,520
6	3,600 (1 hr.)	8,760 (1 yr)	8,760
7	18,000 (5 hr.)	26,280 (3 yr)	17,520

3. DATALOG MAINTENANCE

Datalog Maintenance permits files to be deleted from the data logger module. The Menu contains three options for deleting files: delete the last file that was generated, delete the first file that was generated or delete all of the files on the logger.

4. OUTPUT 2 MENU

Standard
4-20mA

ISO-MOD 4-20mA

> *FL   4MA*
> *FL   20MA*
> *CAL 4MA*
> *CAL 20MA*
> *4-20 TST*

The 4-20 mA Output Module interfaces with virtually all recording and logging systems by transmitting an analog current signal that is proportional to system flow rate. Independent 4 mA and 20 mA 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 module can drive up to 800 ohms of load with its internal 24V isolated power source.

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.

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.

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.

Procedure:

1.   Disconnect one side of the current loop and connect the ammeter in series (disconnect either wire at the terminals labeled +/- on the ISO-MOD 4-20mA module).

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 +/- on the ISO-MOD 4-20mA module).

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 on from the 4-20mA output. By incrementing this value, the 4-20mA output will transmit the indicated current value.

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 10,000 Hz. The 0.21-Ohm FET output is rated to operate at 100 V and 9 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 0-10KHz 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 3.10. 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 0-10KHz output from –100 GPM to +100 GPM, with 5KHz 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 5 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 0-10KHz output. To adjust the 100Hz setting, frequency counter or reliable reference connection to the 0-10KHz 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 0-10KHz range. Utilize FL 100H and FL 10KH, detailed above, for this purpose.

Procedure:

1. The module must be powered to perform this cali-bration. Connect the frequency counter at the terminals labeled +/- on the ISO-MOD 0-10KHz module). Set the counter to the appropriate measuring range for measuring 100 Hz.

2. Using the arrow keys, increase the numerical value to increase the output frequency to 100 Hz ±3 Hz. Decrease the value to decrease the output frequency to 100 Hz ±3 Hz. Typical values range between 40-80 counts.

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

Procedure:

1. The module must be powered to perform this cali-

bration. Connect the frequency counter at the terminals labeled +/- on the ISO-MOD 0-10KHz module). Set the counter to the appropriate measuring range for measuring 10 KHz.

2. Using the arrow keys, increase the numerical value to increase the output frequency to 10 KHz ±10 Hz. Decrease the value to decrease the output frequency to 10 KHz ±10 Hz. Typical values range between 3700-3900 counts.

Optional **Dual Relay**

ISO-MOD Dual Relay

> *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 contained in this module. The relay operations are user configured via software to act in either a flow rate alarm, signal strength alarm, error alarm or totalizer/batching mode. The relays are rated for 200 VAC max. and a have current rating of 0.5A resistive load [175 VDC @ 0.25A resistive]. It is highly recommended that a slave relay be utilized whenever the Control Relay ISO-MOD is 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 3.10.

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 3.10) 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 3.22. 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.

Error Alarm Relay

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

**Optional
RS-485 I/O**

running the UltraLink software utility. Baud rates up to 19.2 K are supported.

ISO-MOD RS-485

> *RS485 MO* — MODE
> > *SLAVE*
> > *MASTER*
> *RS485 BA* — BAUD RATE
> > *1200*
> > *2400*
> > *9600*
> > *19200*
> *ADDRESS* — Device Address
> > *1-127*

The RS485 Module allows up to 126 TFXP systems daisychained on a single three-wire cable network— communications are via Modbus protocol, detailed in the Appendix of this manual. All meters are assigned a unique one byte serial number that allows all of the meters on the cable network can be accessed independently. Baud rates up to 19.2K and cable lengths to 1,000 feet [300 meters] are supported.

RS485 MO

Select SLAVE for all of the TFXP meters.

RS485 BA

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

ADDRESS

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

4. SEN MENU -- SENSOR MENU

The SEN MENU is presently not utilized.

5. SEC MENU -- 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.

6. SEr MENU -- 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 TFXP 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 modified.

Signal Strength

SIG STR - Signal Strength

The measurement of Signal Strength assists service personnel with troubleshooting the TFXP 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 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 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.

Setting/Calibrating 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.

7. 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 keys to select display units of

- RATE
- TOTALizer
- VELocity
- SIGNAL STRength

BACK LIGHT TIMEOUT

The LED backlighting on the TFXP is used to assist the operator in viewing the display in poorly lit areas— the backlighting, when activated, doubles the power consumption of the flow meter. If left on continuously, the charge in the battery will be depleted much more rapidly than if the backlighting is only activated for short periods of time. If the instrument is being operated while powered from an external power

source, the back light may be left on permanently.

Adjust the Back Light Timeout to approximate the amount of seconds that the backlighting should remain active. The time out can be set anywhere between 10 and 30,000 seconds. If continuous backlighting is desired, set the Back Light Timeout to 0 seconds.

SOFTWARE UTILITIES

Important Notice!

The TFXP flow meter is shipped with two software utilities, *UltraLink* and *DataLink*. The UltraLink utility is used for configuration, calibration and communication with the TFXP flow meter. The DataLink utility is used for uploading and translating data accumulated in the data logger module located in the pocket on the front faceplate of the flow meter.

UltraLink has been designed to provide a TFX user a powerful and convenient way to configure and calibrate DTFXD1, DTFXD2 and TFXP flowmeters. UltraLink can be used in conjunction with an infrared communications adapter (Dynasonics P.N. D005-2115-001), ISO-MOD RS232 or ISO-MOD RS485.

System Requirements

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

Installation

1. Backup/Copy all files from the 3.5" diskette to a folder on the computer hard disk.

2. Remove the diskette from the computer and store.

3. From the "Start" command, RUN **UISetup.exe** from the hard disk folder.

4. **UISetup** 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 infra-red communications adapter (Dynasonics P.N. D005-2115-001), ISO-MOD RS232 or ISO-MOD RS485.

2. Double-click on the **UltraLink** icon. The opening screen, shown in **Figure 4.1** below, contains an option for starting the limited use evaluation copy of the "Professional" version of UltraLink or starting the "Standard" version. The Standard version is satisfactory for most users.

Figure 4.1

3. The first screen is the "RUN-mode" screen, See **Figure 4.2**, 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.

4. Click on the button labeled **Config** for updating flow

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.
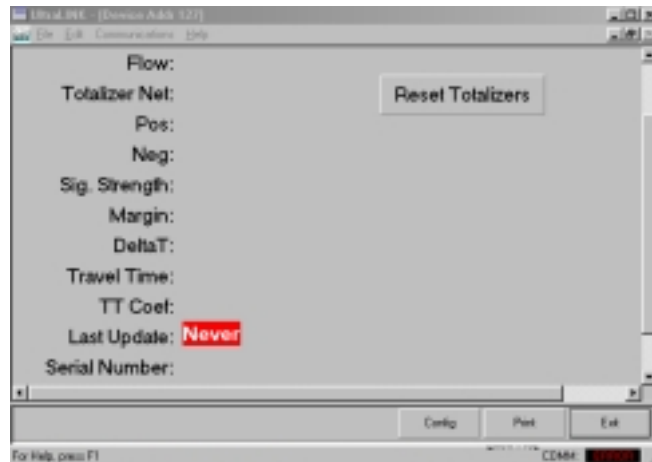
Figure 4.2

range, liquid, pipe and I/O operating information   The first screen that appears after clicking the **Config** button is the **BASIC** menu. See **Figure 4.3**. The BASIC menu allows selection of the transducer type (standard
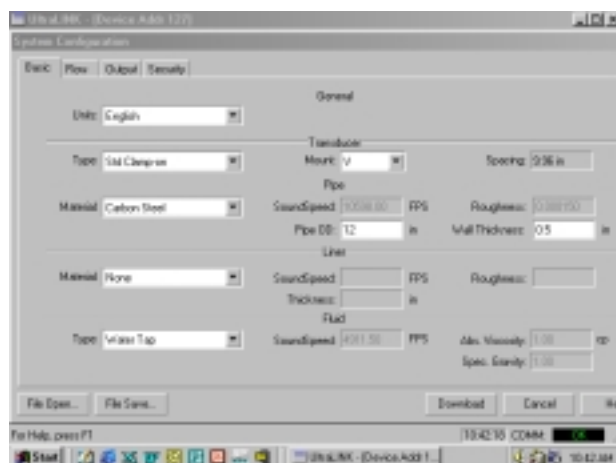
Figure 4.3

clamp-on in almost all cases), transducer mounting configuration (V-mode, W-mode, Z-mode—see section 2 of this manual for details), pipe size and materials and liquid type. Proper entry of these values is critical to proper operation and accuracy of the TFX instrument. When all data fields have been filled out, click on the **Flow** button to set up measuring units and other system features.

5. The **Flow** window, See **Figure 4.4**, requires selection of units of measure, totalizer exponents, flow measur-
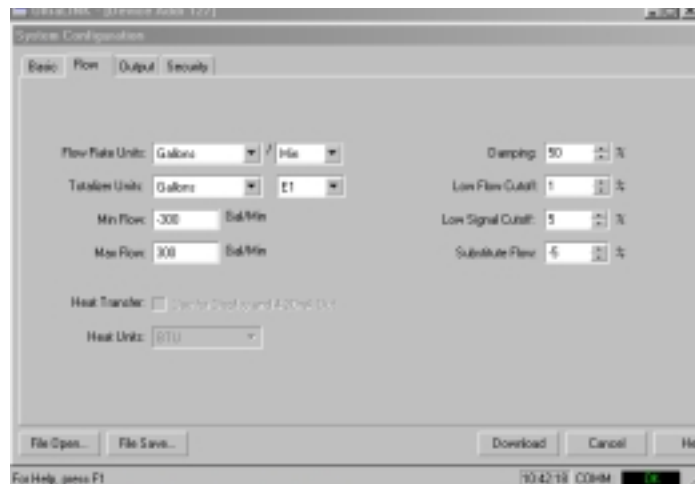
Figure 4.4

ing range, system damping, low flow cutoff, signal strength cutoff and substitute flow. Configuration of these values and their influence on flow meter operation is detailed in section 3 of this manual.

Entry of data in the **Basic** and **Flow** screens 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 or data logging, click on the **Download** button to transfer the configuration to the TFX instrument.

6. To configure the 4-20 mA output or data logger, click on the **Output** tab. The output menu allows selection, configuration, calibration and testing of various input/

output modules. Standard TFXP flow meters contain a single 4-20 mA output module located in Module #2 position and a data logger located in the Module #1 position. The window will appear as shown in **Figure 4.5**. (The 4-20 mA module is mounted internally in the flow meter and requires meter disassembly in order to replace the module. The data logger is located under the sealed front plate on the meter face. The logger is designed for repeated installation and removal.) Detailed information regarding all of the modules available and configuration options are available in section 3 of this manual. Select None for Module #1, and select 4-20 mA for Module #2 to enable datalogger.

Figure 4.5

7. 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.

SOFTWARE UTILITIES

Figure 4.6

Downloading Configurations

When Configuration of the flowmeter is complete, press the Download button to transfer the information to the TFXP flow meter. Note: Infrared communications must be established and maintained throughout the download of information. If transmission is interrupted, repress the Config button and setup the window tabs again.

Field Calibration

UltraLink contains a powerful multi-point calibration routine that can be used to calibrate the TFX flow meter to a primary measuring standard in a particular installation. To initialize the three step calibration routine, press the Edit menu located on the top task bar. Select the Calibration option. The display shown in **Figure 4.7** 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.
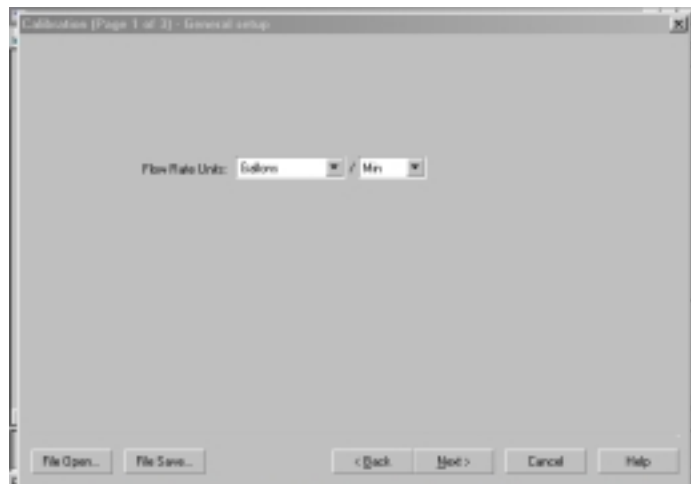
Figure 4.7

Establish Zero Flow Rate

The second screen, **Figure 4.8**, 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 4.8 is stable (and typically very close to zero). Press the Set button. Press the Next button when complete.

Calibrating with Actual Flow

The screen shown in **Figure 4.9** allows multiple actual flow rates to be run past the meter and the values recorded by the TFXP. 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 4.9**

Figure 4.8

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.
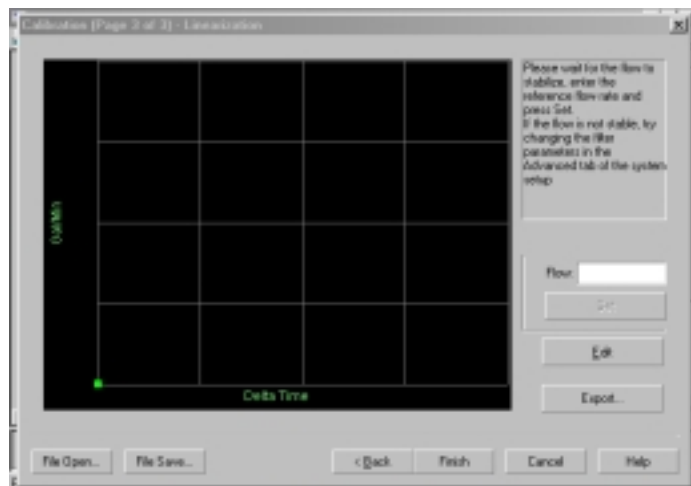
Figure 4.9

SOFTWARE UTILITIES

**Saving the
Configuration**

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.

Printing a 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 4.10** will appear as the computer is attempting to establish communications with the logger module.
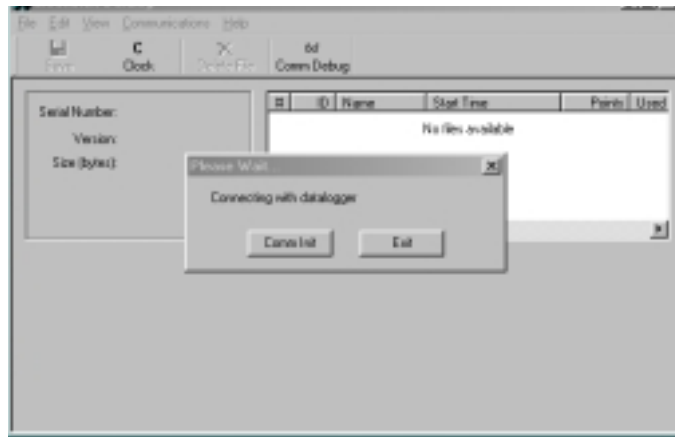
Figure 4.10

Connect the logger to the computers serial communications port with the enclosed DB9 cable. After a few moments, the Please Wait window will disappear and a green OK will appear in the lower right-hand corner of the win-
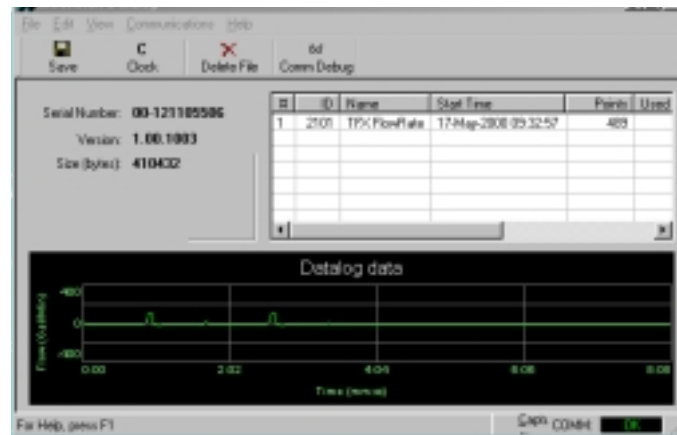
Figure 4.11

dow. After communications are established (and the OK is displayed) the utility will scan the logger for all existing files. The scanning of the logger module and the uploading of the file data can take up to several minutes. The files will appear on the table, See **Figure 4.11**, 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 4.12**. 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 pur-

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.
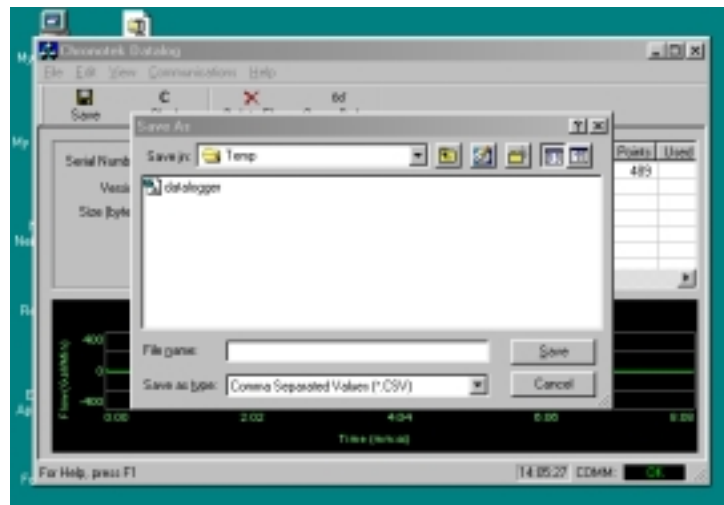
Figure 4.12

poses.

The datalogger module contains a real-time clock that can be set by pressing the Clock button on the top task bar. See **Figure 4.13**. Activating the window compares the datalogger clock to the clock located in the PC. Adjust-
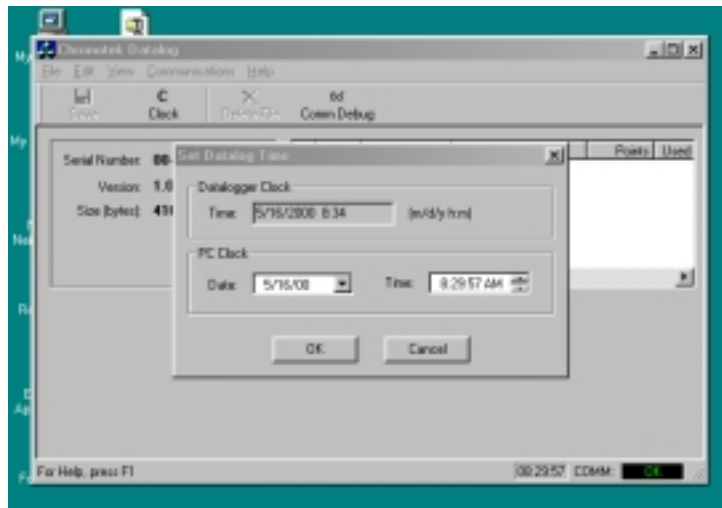
Figure 4.13

ments can be made and uploaded to the logger.

APPENDIX

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

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

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<data₁>...<dataₙ><crc-16>`

Reply: `<addr>65<size>00<data₁>...<dataₙ><crc-16>`

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

Size (Inches)	CLASS A O.D. Inch	CLASS A I.D. Inch	CLASS A Wall	CLASS B O.D. Inch	CLASS B I.D. Inch	CLASS B Wall	CLASS C O.D. Inch	CLASS C I.D. Inch	CLASS C Wall	CLASS D O.D. Inch	CLASS D I.D. Inch	CLASS D Wall	CLASS E O.D. Inch	CLASS E I.D. Inch	CLASS E Wall	CLASS F O.D. Inch	CLASS F I.D. Inch	CLASS F Wall	CLASS G O.D. Inch	CLASS G I.D. Inch	CLASS G Wall	CLASS H O.D. Inch	CLASS H I.D. Inch	CLASS H Wall
3	3.80	3.02	0.39	3.96	3.12	0.42	3.96	3.06	0.45	3.96	3.00	0.48												
4	4.80	3.96	0.42	5.00	4.10	0.45	5.00	4.04	0.48	5.00	3.96	0.52												
6	6.90	6.02	0.44	7.10	6.14	0.48	7.10	6.08	0.51	7.10	6.00	0.55	7.22	6.06	0.58	7.22	6.00	0.61	7.38	6.08	0.65	7.38	6.00	0.69
8	9.05	8.13	0.46	9.05	8.03	0.51	9.30	8.18	0.56	9.30	8.10	0.60	9.42	8.10	0.66	9.42	8.10	0.66	9.60	8.10	0.75	9.60	8.00	0.8
10	11.10	10.10	0.50	11.10	9.96	0.57	11.40	10.16	0.62	11.40	10.04	0.68	11.60	10.12	0.74	11.60	10.00	0.80	11.84	10.12	0.86	11.84	10.00	0.92
12	13.20	12.12	0.54	13.20	11.96	0.62	13.50	12.14	0.68	13.50	12.00	0.75	13.78	12.14	0.82	13.78	12.00	0.89	14.08	12.14	0.97	14.08	12.00	1.04
14	15.30	14.16	0.57	15.30	13.98	0.66	15.65	14.17	0.74	15.65	14.01	0.82	15.98	14.18	0.90	15.98	14.00	0.99	16.32	14.18	1.07	16.32	14.00	1.16
16	17.40	16.20	0.60	17.40	16.00	0.70	17.80	16.20	0.80	17.80	16.02	0.89	18.16	16.20	0.98	18.16	16.00	1.08	18.54	16.18	1.18	18.54	16.00	1.27
18	19.50	18.22	0.64	19.50	18.00	0.75	19.92	18.18	0.87	19.92	18.00	0.96	20.34	18.20	1.07	20.34	18.00	1.17	20.78	18.22	1.28	20.78	18.00	1.39
20	21.60	20.26	0.67	21.60	20.00	0.80	22.06	20.22	0.92	22.06	20.00	1.03	22.54	20.24	1.15	22.54	20.00	1.27	23.02	20.24	1.39	23.02	20.00	1.51
24	25.80	24.28	0.76	25.80	24.02	0.89	26.32	24.22	1.05	26.32	24.00	1.16	26.90	24.28	1.31	26.90	24.00	1.45	27.76	24.26	1.75	27.76	24.00	1.88
30	31.74	29.98	0.88	32.00	29.94	1.03	32.40	30.00	1.20	32.74	30.00	1.37	33.10	30.00	1.55	33.46	30.00	1.73						
36	37.96	35.98	0.99	38.30	36.00	1.15	38.70	35.98	1.36	39.16	36.00	1.58	39.60	36.00	1.80	40.04	36.00	2.02						
42	44.20	42.00	1.10	44.50	41.94	1.28	45.10	42.02	1.54	45.58	42.02	1.78												
48	50.50	47.98	1.26	50.80	47.96	1.42	51.40	47.98	1.71	51.98	48.00	1.99												
54	56.66	53.96	1.35	57.10	54.00	1.55	57.80	54.00	1.90	58.40	53.94	2.23												
60	62.80	60.02	1.39	63.40	60.06	1.67	64.20	60.20	2.00	64.82	60.06	2.38												
72	75.34	72.10	1.62	76.00	72.10	1.95	76.88	72.10	2.39															
84	87.54	84.10	1.72	88.54	84.10	2.22																		

March, 2000

Ductile Iron Pipe

DYNASONICS

Standard Classes

Pipe Size (inches)	Outside Diameter (inches)	Class 50		Class 51		Class 52		Class 53		Class 54		Class 55		Class 56		Cement Lining Std./Double Thickness
		ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	
3	3.96			3.46	0.25	3.40	0.28	3.34	0.31	3.28	0.34	3.22	0.37	3.14	0.41	
4	4.80			4.28	0.26	4.22	0.29	4.16	0.32	4.10	0.35	4.04	0.38	3.93	0.44	
6	6.90	6.40	0.25	6.34	0.28	6.28	0.31	6.22	0.34	6.16	0.37	6.10	0.40	6.04	0.43	.123/.250
8	9.05	8.51	0.27	8.45	0.30	8.39	0.33	8.33	0.36	8.27	0.39	8.21	0.42	8.15	0.45	
10	11.10	10.32	0.39	10.46	0.32	10.40	0.35	10.34	0.38	10.28	0.41	10.22	0.44	10.16	0.47	
12	13.20	12.58	0.31	12.52	0.34	12.46	0.37	12.40	0.40	12.34	0.43	12.28	0.46	12.22	0.49	
14	15.30	14.64	0.33	14.58	0.36	14.52	0.39	14.46	0.42	14.40	0.45	14.34	0.48	14.28	0.51	
16	17.40	16.72	0.34	16.66	0.37	16.60	0.40	16.54	0.43	16.48	0.46	16.42	0.49	16.36	0.52	
18	19.50	18.80	0.35	18.74	0.38	18.68	0.41	18.62	0.44	18.56	0.47	18.50	0.50	18.44	0.53	.1875/.375
20	21.60	20.88	0.36	20.82	0.39	20.76	0.42	20.70	0.45	20.64	0.48	20.58	0.51	20.52	0.54	
24	25.80	25.04	0.38	24.98	0.41	24.92	0.44	24.86	0.47	24.80	0.50	24.74	0.53	24.68	0.56	
30	32.00	31.22	0.39	31.14	0.43	31.06	0.47	30.98	0.51	30.90	0.55	30.82	0.59	30.74	0.63	
36	38.30	37.44	0.43	37.34	0.48	37.06	0.62	37.14	0.58	37.40	0.45	36.94	0.68	36.84	0.73	
42	44.50	43.56	0.47	43.44	0.53	43.32	0.59	43.20	0.65	43.08	0.71	42.96	0.77	42.84	0.83	.250/.500
48	50.80	49.78	0.51	49.64	0.58	49.50	0.65	49.36	0.72	49.22	0.79	49.08	0.86	48.94	0.93	
54	57.10	55.96	0.57	55.80	0.65	55.64	0.73	55.48	0.81	55.32	0.89	55.16	0.97	55.00	1.05	

March, 2000

Steel, Stainless Steel, P.V.C.

Standard Schedules

Nominal Pipe Size Inches	Outside Diameter	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	
		ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall
1	1.315	1.185	0.065	1.097	0.109					1.049		1.049	0.133			0.957	0.179	0.957	0.179							0.815	0.250
1.25	1.660	1.530	0.065	1.442	0.109					1.380		1.380	0.140			1.278	0.191	1.278	0.191							1.160	0.250
1.5	1.900	1.770	0.065	1.682	0.109					1.610		1.610	0.145			1.500	0.200	1.500	0.200							1.338	0.281
2	2.375	2.245	0.065	2.157	0.109					2.067		2.067	0.154			1.939	0.218	1.939	0.218							1.687	0.344
2.5	2.875	2.709	0.083	2.635	0.120					2.469		2.469	0.203			2.323	0.276	2.323	0.276							2.125	0.375
3	3.500	3.334	0.083	3.260	0.120					3.068		3.068	0.216			2.900	0.300	2.900	0.300							2.624	0.438
3.5	4.000	3.834	0.083	3.760	0.120					3.548		3.548	0.226			3.364	0.318	3.364	0.318								
4	4.500	4.334	0.083	4.260	0.120					4.026	0.237	4.026	0.237			3.826	0.337	3.826	0.337			3.624	0.438	3.624	0.438	3.438	0.531
5	5.563	5.345	0.109	5.295	0.134					5.047	0.258	5.047	0.258			4.813	0.375	4.813	0.375			4.563	0.500	4.563	0.500	4.313	0.625
6	6.625	6.407	0.109	6.357	0.134					6.065	0.280	6.065	0.280			5.761	0.432	5.761	0.432			5.501	0.562	5.501	0.562	5.187	0.719
8	8.625	8.407	0.109	8.329	0.148	8.125	0.250	8.071	0.277	7.981	0.322	7.981	0.322	7.813	0.406	7.625	0.500	7.625	0.500	7.437	0.594	7.187	0.719	7.187	0.719	6.183	1.221
10	10.750	10.482	0.134	10.42	0.165	10.25	0.250	10.13	0.310	10.02	0.365	10.020	0.365	9.750	0.500	9.750	0.500	9.562	0.594	9.312	0.719	9.062	0.844	9.062	0.844	8.500	1.125
12	12.750	12.420	0.165	12.39	0.180	12.25	0.250	12.09	0.330	12.00	0.375	11.938	0.406	11.626	0.562	11.750	0.500	11.370	0.690	11.060	0.845	10.750	1.000	10.750	1.000	10.120	1.315
14	14.000			13.50	0.250	13.37	0.315	13.25	0.375	13.25	0.375	13.124	0.438	12.814	0.593	13.000	0.500	12.500	0.750	12.310	0.845	11.810	1.095	11.810	1.095	11.180	1.410
16	16.000			15.50	0.250	15.37	0.315	15.25	0.375	15.25	0.375	15.000	0.500	14.688	0.656	15.000	0.500	14.310	0.845	13.930	1.035	13.560	1.220	13.560	1.220	12.810	1.595
18	18.000			17.50	0.250	17.37	0.315	17.12	0.440	17.25	0.375	16.876	0.562	16.564	0.718	17.000	0.500	16.120	0.940	15.680	1.160	15.250	1.375	15.250	1.375	14.430	1.785
20	20.000			19.50	0.250	19.25	0.375	19.25	0.375	19.25	0.375	18.814	0.593	18.376	0.812	19.000	0.500	17.930	1.035	17.430	1.285	17.000	1.500	17.000	1.500	16.060	1.970
24	24.000			23.50	0.250	23.25	0.375	23.25	0.375	23.25	0.375	22.626	0.687	22.126	0.937	23.000	0.500	21.560	1.220	20.930	1.535	20.930	1.535	20.930	1.535	19.310	2.345
30	30.000			29.37	0.315	29.00	0.500	29.00	0.500	29.25	0.375	29.250	0.375					29.000	0.500								
36	36.000			35.37	0.315	35.00	0.500	35.00	0.500	35.25	0.375	35.250	0.375					35.000	0.500								
42	42.000									41.25	0.375	41.250	0.375					41.000	0.500								
48	48.000									47.25	0.375	47.250	0.375					47.000	0.500								

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 = (PIPE ID)² X VELOCITY IN FPS X 2.45

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

FPS X .3048 = MPS

GPM X .0007 = GPD

GPM X 3.7878 = LPM

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

FPS X .3048 = MPS

GPM X .0007 = GPD

GPM X 3.7878 = LPM

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.
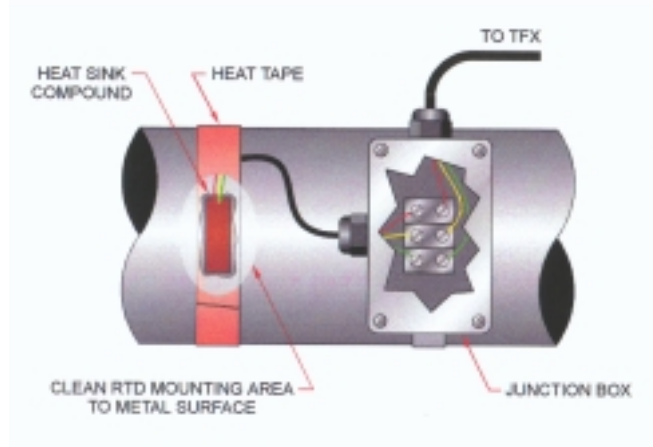

Figure 1

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.
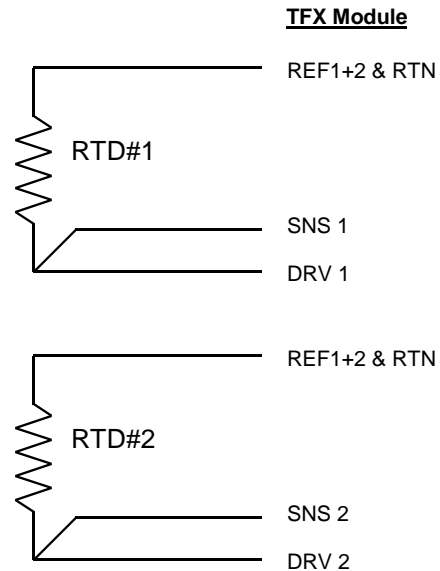

Figure 2

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 $J\ g^{-1}\ {}^{\circ}C^{-1}$.

°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.

DYNASONICS

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.

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.
8635 Washington Avenue
Racine, WI 53406
PHONE: (800)535-3569 or
(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.
8635 Washington Avenue
Racine, WI 53406
PHONE: (800)535-3569 or
(262)639-6770
FAX: (262)639-2267

Return Goods Authorization:

When returning equipment, it is necessary for you to contact our Service Department at (800)535-3569 or (262)639-6770 to obtain an RGA number for the authority and proper tracking of your material and its prompt inspection and return. The RGA number should be noted on the outside of the box. All returns of equipment go to the following address:

DYNASONICS
Division of Racine Federated, Inc.
8635 Washington Avenue
Racine, WI 53406
Attn: RGA #

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