Dynasonics®
Ultrasonic Flow Meters

Transit Time Ultrasonic Flow Meters

TFXL Meter

Badger Meter

TTM-UM-00369-EN-04 (July 2016)

User Manual

CONTENTS

SCOPE OF THIS MANUAL

This manual is divided into two main sections:

- *"Quick-Start Operating Overview" on page 6* is intended to help you get the TFXL meter up and running quickly. Refer to the detailed instructions if you require additional information.
- The remaining chapters provide a detailed description of all software settings and hardware installation guidance.

Read this manual carefully before attempting any installation or operation. Keep the manual accessible for future reference.

UNPACKING AND INSPECTION

Upon opening the shipping container, visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts, or any other sign of damage that may have occurred during shipment.

NOTE: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the purchaser.

SAFETY

Terminology and Symbols

⚠ DANGER	Indicates a hazardous situation, which, if not avoided, is estimated to be capable of causing death or serious personal injury.
⚠ WARNING	Indicates a hazardous situation, which, if not avoided, could result in severe personal injury or death.
⚠ CAUTION	Indicates a hazardous situation, which, if not avoided, is estimated to be capable of causing minor or moderate personal injury or damage to property.

Considerations

The installation of the TFXL meter must comply with all applicable federal, state, and local rules, regulations, and codes.

⚠ WARNING

EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

⚠ AVERTISSMENT

RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CEMATÉRIEL INACCCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2.

⚠ WARNING

DO NOT CONNECT OR DISCONNECT EITHER POWER OR OUTPUTS UNLESS THE AREA IS KNOWN TO BE NON-HAZARDOUS.

⚠ AVERTISSMENT

RISQUE D'EXPLOSION. NE PAS DÉBRANCHER TANT QUE LE CIRCUIT EST SOUSTENSION, À MOINS QU'LL NE S'AGISSE D'UN EMPLACEMENT NON DANGEREUX.

IMPORTANT

Not following instructions properly may impair safety of equipment and/or personnel.

IMPORTANT

Must be operated by a Class 2 supply suitable for the location.

QUICK-START OPERATING OVERVIEW

Items Required for Basic Installation and Configuration

- TFXL meter
- Transducers (remote-mount versions sold separately)
- Mounting straps (for remote-mount versions)
- Acoustic couplant
- Power source
- UltraLink Software
- Configuration cable kit P/N D010-0204-001
- USB-to-DB9 converter P/N D005-2116-004 (required if PC does not have a serial port)
- Phillips screwdriver
- Flathead screwdrivers (large and small)
- 5/16 in. nut driver (optional, for remote-mount versions)

Follow these instructions to get the system up and running quickly. Refer to the detailed instructions if you require additional information.

NOTE: The following steps require information supplied by the transmitter itself so it will be necessary to supply power to the transmitter, at least temporarily, and connect to a computer using the UltraLink® software utility to obtain setup information.

Transducer Location

1. Select a mounting location on the piping system with a minimum of ten pipe diameters (10 × the pipe inside diameter) of straight pipe upstream and five straight diameters downstream. See *Table 1 on page 16* for additional configurations.
2. If the application requires DTTR, DTTN or DTTH transducers, select a mounting method for the transducers based on pipe size and liquid characteristics. See *Table 2 on page 17*. The three transducer mounting configurations are shown in *Figure 4*. See *"Transducer Mounting Configurations" on page 20* for mounting procedures.

NOTE: All DTTS and DTTC transducers use V–Mount configuration.

Power Connections

Power for the TFXL meter flow meter is obtained from a direct current (DC) power source.

1. Verify that the power source is capable of supplying 12…28V DC at a minimum of 250 milliamps.
2. With the power from the DC power source disabled or disconnected, connect the positive supply wire and ground to the appropriate field wiring terminals in the flow meter. See *Figure 1*. A wiring diagram decal is on the inside cover of the flow meter enclosure.

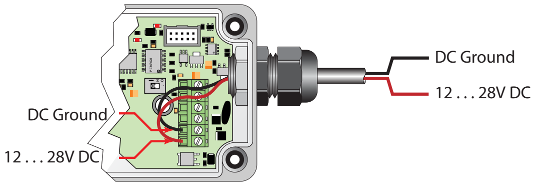


Figure 1: Power connections

Transducer Connections for Remote Mount Transducers

1. Guide the transducer terminations through the transmitter conduit hole on the bottom-left of the enclosure using a sealed cord grip or NEMA 4 conduit connection. Secure the transducer cable with the supplied conduit nut (if flexible conduit was ordered with the transducer).
2. The remote mount transducers use an add-in connection board on the left side of the meter below the LCD (TFXL meter 2 version). The terminals within the TFXL meter are of a screw-down barrier terminal type. Connect the wires at the corresponding screw terminals in the transmitter. Observe upstream and downstream orientation and wire polarity. See *Figure 2 on page 7*.

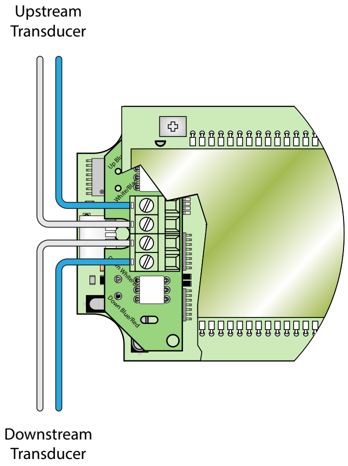


Figure 2: Remote mount connections

Initial Settings and Powerup

1. Apply power to the transmitter.
2. Enter the following data into the TFXL meter via the UltraLink software utility.

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
8 Pipe liner material
9 Fluid type
10 Fluid sound speed*
11 Fluid viscosity*
12 Fluid specific gravity*

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

3. Record the value calculated and displayed as transducer spacing.

Pipe Preparation and Transducer Mounting

DTTR, DTTN and DTTH Transducers

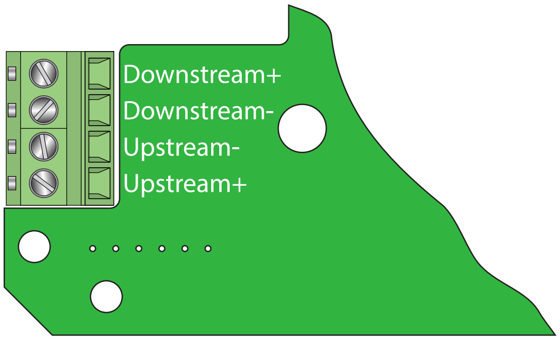


Figure 3: Transducer connections

1. Place the transmitter in signal strength measuring mode. This value is available on the data display of the UltraLink software utility.
2. The pipe surface, where the transducers are to be mounted, must be clean and dry. Remove scale, rust or loose paint to ensure satisfactory acoustic conduction. Wire brushing the rough surfaces of pipes to smooth bare metal may also be useful. Plastic pipes do not require preparation other than cleaning. On horizontal pipe, choose a mounting location within approximately 45 degrees of the side of the pipe.
   See *Figure 5 on page 9*. Locate the flow meter so that the pipe will be completely full of liquid when flow is occurring in the pipe. Avoid mounting on vertical pipes where the flow is moving in a downward direction.
3. Apply a single 1/2 inch (12 mm) bead of acoustic couplant grease to the upstream transducer and secure it to the pipe with a mounting strap.
4. Apply acoustic couplant grease to the downstream transducer and press it onto the pipe using hand pressure at the lineal distance calculated in *"Transducer Location" on page 6*.
5. Space the transducers according to the recommended values from the UltraLink software utility. Secure the transducers with the mounting straps at these locations.

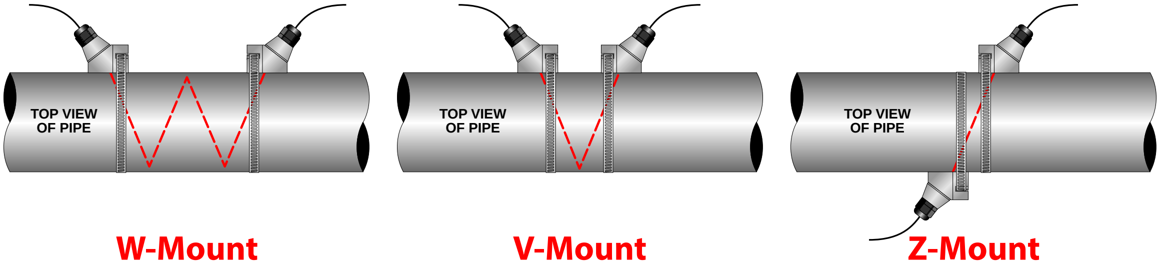
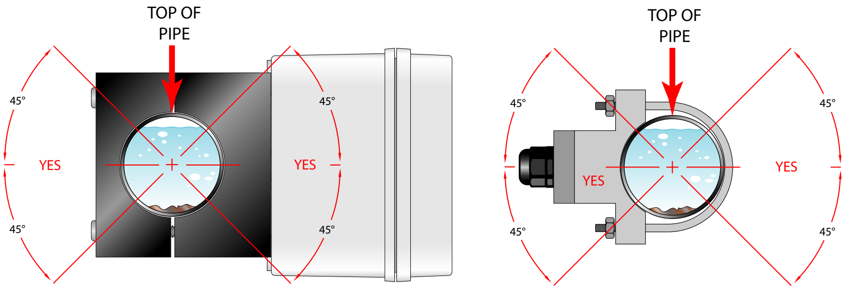
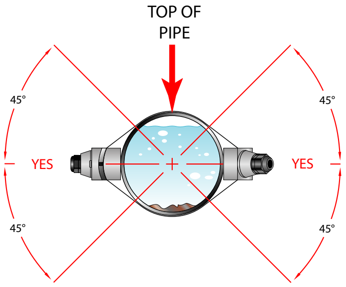


Figure 4: Transducer mounting configurations



FLOW METER
MOUNTING ORIENTATION
DTTS and DTTC TRANSDUCERS

FLOW METER
MOUNTING ORIENTATION
2" DTTS and DTTC TRANSDUCERS



FLOW METER
MOUNTING ORIENTATION
DTTR, DTTN and DTTH TRANSDUCERS

Figure 5: Transducer mounting orientations

DTTS and DTTC Transducers

1. Place the transmitter in signal strength measuring mode. This value is available on the transmitter's display *Service Menu* or in the data display of the UltraLink software utility.
2. The pipe surface, where the transducers are to be mounted, must be clean and dry. Remove scale, rust or loose paint to provide satisfactory acoustic conduction. Wire brushing the rough surfaces of pipes to smooth bare metal may also be useful. Plastic pipes do not require preparation other than cleaning. On horizontal pipe, choose a mounting location within approximately 45 degrees of the side of the pipe. See *Figure 5*. Locate the flow meter so that the pipe will be completely full of liquid when flow is occurring in the pipe. Avoid mounting on vertical pipes where the flow is moving in a downward direction.
3. Apply a single 1/2 inch (12 mm) bead of acoustic couplant grease to the top half of the transducer and secure it to the pipe with the bottom half or with U-bolts.
4. Tighten the nuts so the acoustic coupling grease begins to flow out from the edges of the transducer and from the gap between the transducer and the pipe.

IMPORTANT

Do not overtighten. Overtightening will not improve performance and may damage the transducer.

5. Verify that signal strength is greater than 5.0.
6. Input the units of measure and the I/O data.

INTRODUCTION

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

The TFXL meter family of transit time transmitters uses two transducers that function as both ultrasonic transmitters and receivers. The transducers are clamped on the outside of a closed pipe at a specific distance from each other.

The transducers can be mounted in **V-Mount** where the sound transverses the pipe two times, **W-Mount** where the sound transverses the pipe four times, or in **Z-Mount** where the sound crosses the pipe once. The selection of how transducers are mounted on opposite sides of the pipe and method is based on pipe and liquid characteristics, which both have an effect on how much signal is generated. The flow meter 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 TFXL 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 1/2 …100 inches (12…2540 mm). A variety of liquid applications can be accommodated:

ultrapure liquids
plant effluent
cooling water
sewage
potable water
reclaimed water
river water
others
chemicals

Because the transducers are non-contacting and have no moving parts, the transmitter is not affected by system pressure, fouling or wear.

Temperature Ratings for Transducers

Because the transducers are non-contacting and have no moving parts, the flow meter is not affected by system pressure, fouling or wear. Temperature ratings for each transducer are listed below.

Transducer	Temperature Rating
DTTR	–40…250° F (–40…121° C)
DTTC	–40…194° F (–40…90° C)
DTTN	–40…194° F (–40…90° C)
DTTH	–40…350° F (–40…177° C)
DTTS	–40…140° F (–40…60° C)

User Safety

The TFXL meter uses a low voltage DC power source that provides electrical safety for the user. Remove the cover to access to the meter connections and the computer interface connection.

⚠DANGER

THE POWER SUPPLY BOARD CAN HAVE LINE VOLTAGES APPLIED TO IT, SO DISCONNECT ELECTRICAL POWER BEFORE OPENING THE INSTRUMENT ENCLOSURE. WIRING SHOULD ALWAYS CONFORM TO LOCAL CODES AND THE NATIONAL ELECTRICAL CODE.

Data Integrity

Non-volatile flash memory retains all user-entered configuration values in memory indefinitely, even if power is lost or turned off.

Product Identification

The serial number and complete model number of the transmitter are located on the top outside surface of the transmitter body. Should technical assistance be required, please provide our customer service department with this information.

TRANSMITTER INSTALLATION

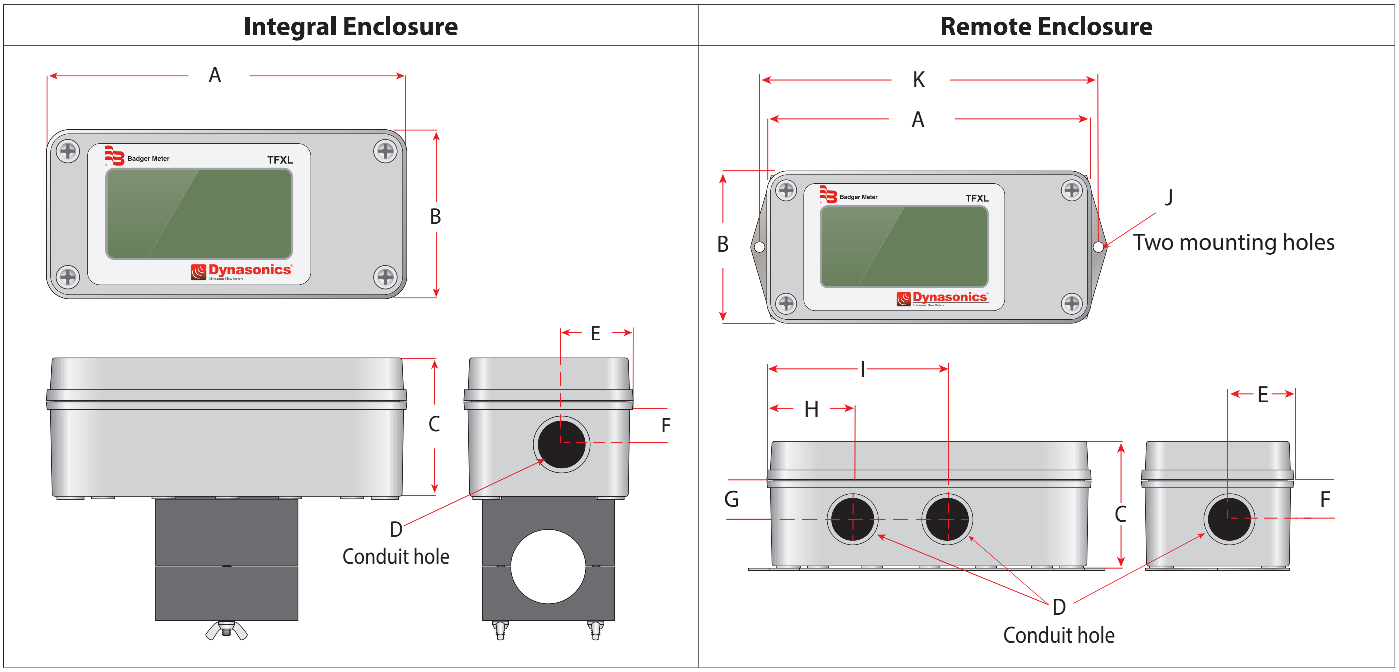
Transmitter Location

Mount the enclosure in an area that is convenient for servicing, calibration and observation of the LCD readout (if equipped).

1. Locate the transmitter within the length of transducer cables supplied. If this is not possible, exchange the cable for one that is of proper length.
2. Mount the transmitter in a location:
    - ◊ Where little vibration exists.
    - ◊ That is protected from corrosive fluids.
    - ◊ That is within the transmitters ambient temperature limits –40…185° F (–40…85° C).
    - ◊ That is out of direct sunlight. Direct sunlight may increase transmitter temperature to above the maximum limit.
3. See *Figure 6* for enclosure and mounting dimension details. Allow enough room for door swing, maintenance and conduit entrances.
4. Secure the enclosure to a flat surface with two fasteners.
5. Feed the cables through the conduit holes in the enclosure. Use plugs to seal any unused holes.

NOTE: Use NEMA 4 (IP-65) rated fittings/plugs to maintain the watertight integrity of the enclosure. Generally, the right side conduit hole (viewed from front) is used for power, the bottom conduit hole(s) for transducer connections.

Enclosures



Integral Enclosure

Remote Enclosure

A	B	C	D DIA	E	F	G	H	I	J DIA	K
in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)
6.72 (170.7)	3.17 (80.5)	2.57 (65.3)	0.87 (22.2)	1.33 (33.8)	0.85 (21.6)	0.77 (19.6)	1.78 (45.2)	3.74 (95)	0.22 (5.6)	7.01 (178)

Figure 6: Transmitter enclosure dimensions

The remote mount transmitter has three conduit holes in the flow meter enclosure that should be suitable for most installations. Use a sealed cord grip or NEMA 4 conduit connection to retain the NEMA 3 integrity of the flow meter enclosure. Failure to do so will void the manufacturer's warranty and can lead to product failure.

The TFXL meter is housed in an insulating plastic enclosure that does not provide continuity of bonding between field wiring conduit and the TFXL meter chassis or other conduits connected to the enclosure.

Wiring methods and practices are to be made in accordance with the NEC (National Electrical Code®) and/or other local ordinances that may be in effect. Consult the local electrical inspector for information regarding wiring regulations.

When making connections to the field wiring terminals inside the flow meter, strip back the wire insulation approximately 0.25 inch (6 mm). Stripping back too little may cause the terminals to clamp on the insulation and not make good contact. Stripping back too much insulation may lead to a situation where the wires could short together between adjacent terminals. Wires should be secured in the field wiring terminals using a screw torque of 0.5…0.6 Nm.

If using the DC ground terminal as a protective conductor terminal, apply the protective conductor first and secure it independently of other connections. Connect the protective conductor so it is unlikely to be removed by servicing that does not involve the protective conductor or post a warning requiring the replacement of the protective conductor after removal.

Power the TFXL meter with a Class 2 direct current (DC) power source. The power source should be capable of supplying 12…28V DC at a minimum of 250 milliamps. With the power from the DC power source disabled or disconnected, connect the positive supply wire and ground to the field wiring terminals in the flow meter. See *Figure 8 on page 14*. A wiring diagram is on the inside cover of the meter enclosure.

IMPORTANT

- ***FOLLOW INSTRUCTIONS TO PROVIDE SAFETY OF EQUIPMENT AND/OR PERSONNEL.***
- ***MUST BE OPERATED BY A POWER SUPPLY SUITABLE FOR THE LOCATION.***
- ***DO NOT CONNECT OR DISCONNECT EITHER POWER OR OUTPUTS UNLESS THE AREA IS KNOWN TO BE NONHAZARDOUS.***
- ***DO NOT CONNECT THE INTERFACE CABLE BETWEEN A TFXL METER AND A PERSONAL COMPUTER UNLESS THE AREA IS KNOWN TO BE NONHAZARDOUS.***

TRANSDUCER CONNECTIONS

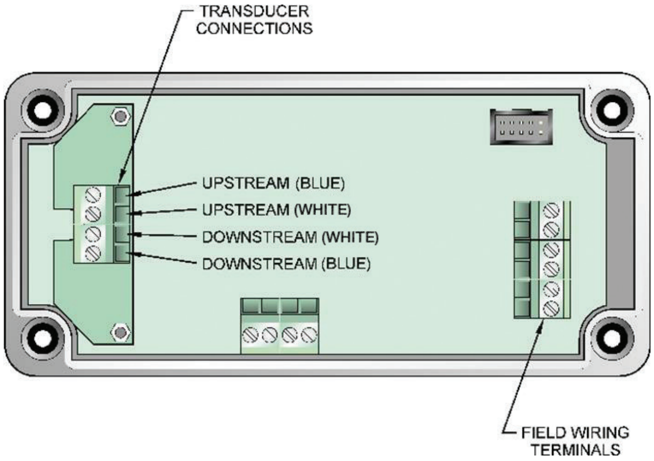


Figure 7: Transducer connections

To access terminal strips for wiring, first loosen the four screws holding the top of the case to the bottom.

NOTE: The four screws are "captive" screws and cannot be removed from the top of the case.

If the unit has a display, remove the four Phillips head screws that hold the display to the main circuit board and carefully move it out of the way. Do not over stress the ribbon cable located between the display and the microprocessor circuit boards.

Guide the transducer terminations through the transmitter conduit hole located in the bottom-left of the enclosure. Secure the transducer cable with the supplied conduit nut (if flexible conduit was ordered with the transducer).

NOTE: TFXL meter with integral transducers have the transducers connected at the factory and the transducer connections section can be skipped.

The terminals within the TFXL meter are of a screw-down barrier terminal type. Depending on the type of transducers being used there are two terminal strip arrangements possible.

Remote mount small pipe transducers are connected to the terminals on the main circuit board.

Remote mount transducers are connected to a daughter board on the left side of the meter.

Connect the appropriate wires at the corresponding screw terminals in the transmitter. Observe upstream and downstream orientation and wire polarity. See *Figure 7*.

NOTE: High temperature transducer cables come with red and black wire colors. For the red and black combination, the red wire is positive (+) and the black wire is negative (–).

NOTE: The transducer cable carries low level, high frequency signals. In general, it is not recommended to add additional length to the cable supplied with the transducers. If additional cable is required, contact the factory to arrange an exchange for a transducer with the appropriate length of cable. Cables 100…990 feet (30…300 meters) are available with RG59 75 Ohm coaxial cable.

DC POWER CONNECTIONS

The TFXL meter should be operated from an 12…28V DC Class 2 power source capable of supplying a minimum of 250 mA of current.

1. Feed the power source through the conduit hole on the right side of the enclosure. Connect power to the screw terminal block in the TFXL meter. Use wiring practices that conform to local and national codes.
2. Connect the DC power to 12…28V DC In and DC Gnd, as in *Figure 8*.

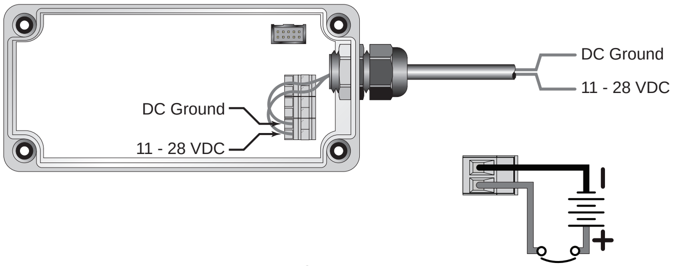


Figure 8: DC power connections

3. Connect an 12…28V DC Class 2 power source as illustrated in *Figure 8*. TFXL meter terminal blocks can accommodate wire up to 14 AWG.
4. Connect a switch or circuit breaker in close proximity of the TFXL meter and within easy reach of the operator.
5. Mark the switch or circuit breaker as the disconnect device for the TFXL meter.

TRANSDUCER INSTALLATION

The transducers for the TFXL meter contain piezoelectric crystals that transmit and receive ultrasonic signals through the walls of liquid piping systems.

DTTR, DTTN and DTTH transducers are relatively simple and straightforward to install, but spacing and alignment of the transducers is critical to the system's accuracy and performance. *CAREFULLY EXECUTE THESE INSTRUCTIONS*.

DTTS and DTTC small pipe transducers have integrated transmitter and receiver elements that eliminate the requirement for spacing measurement and alignment.

Mounting the DTTR, DTTN and DTTH clamp-on ultrasonic transit time transducers takes four steps:

1. Select the optimum location on a piping system.
2. Select a mounting configuration.
3. Enter the pipe and liquid parameters into the UltraLink software utility or key them into the transmitter. The UltraLink software utility or the transmitter's firmware calculates proper transducer spacing based on these entries.
4. Prepare the pipe and mount the transducers.

Mounting Location

Select a 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 is defined as:

- A piping system that is completely full of liquid when measurements are being taken. If the pipe may become completely empty during a process cycle an error code *0010* (Low Signal Strength) will be displayed on the transmitter while the pipe is empty. This error code will clear automatically once the pipe refills with liquid. Do not mount the transducers in an area where the pipe may become partially filled, such as the highest point in a flow loop. Partially filled pipes will cause erroneous and unpredictable operation of the transmitter.
- A piping system that contains lengths of straight pipe such as those described in *Table 1 on page 16*. The optimum straight pipe diameter recommendations apply to pipes in both horizontal and vertical orientation. The straight runs in *Table 1* apply to liquid velocities that are nominally 7 fps (2.2 mps). As liquid velocity increases above this nominal rate, the requirement for straight pipe increases proportionally.
- An area where the transducers will not be inadvertently bumped or disturbed during normal operation.
- NOT on downward flowing pipes unless adequate downstream head pressure is present to overcome partial filling of or cavitation in the pipe.

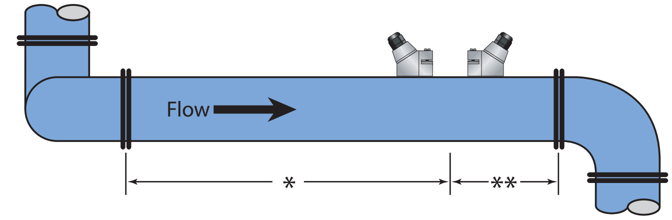
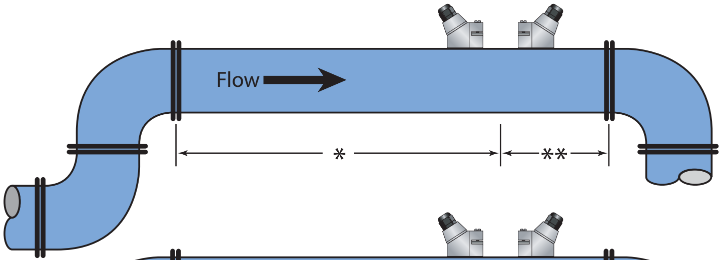
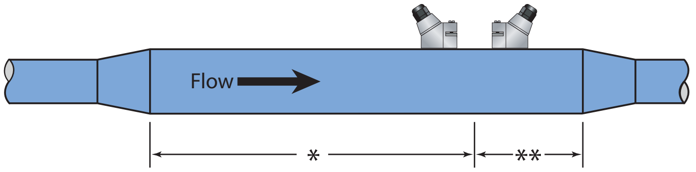
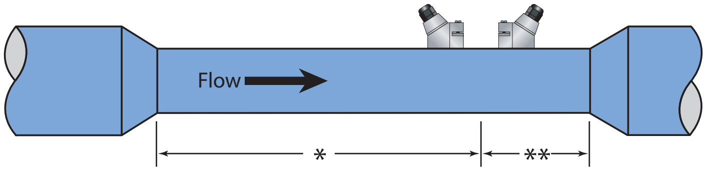
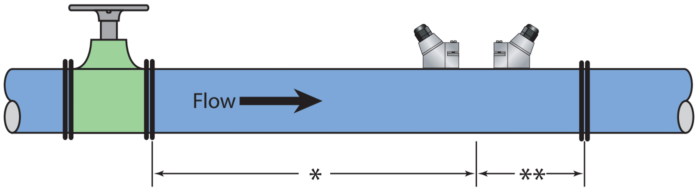
Piping Configuration and Transducer Positioning	Upstream Pipe Diameters	Downstream Pipe Diameters
	*	**
	24	5
	14	5
	10	5
	10	5
	10	5
	24	5

Table 1: Piping configuration and transducer positioning

The TFXL meter will provide repeatable measurements on piping systems that do *not* meet these pipe diameter requirements, but the accuracy of the readings may be influenced.

Select a Mounting Configuration

The transmitter can be used with five transducer types: DTTR, DTTN, DTTH, DTTS and DTTC. Meters that use the DTTR, DTTN or DTTH transducer sets consist of two separate sensors that function as both ultrasonic transmitters and receivers. These transducers are clamped on the outside of a closed pipe at a specific distance from each other. DTTS and DTTC transducers integrate both the transmitter and receiver into one assembly that fixes the separation of the piezoelectric crystals.

The DTTR, DTTN and DTTH transducers can be mounted in:

- **W**-Mount where the sound traverses the pipe four times. This mounting method produces the best relative travel time values but the weakest signal strength.
- **V**-Mount where the sound traverses the pipe twice. **V**-Mount is a compromise between travel time and signal strength.
- **Z**-Mount where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once. **Z**-Mount will yield the best signal strength but the smallest relative travel time.

Transducer Mounting Configuration	Pipe Material	Pipe Size	Liquid Composition
W-Mount	Plastic (all types)	2…4 in. (50…100 mm)	Low TSS (Total Suspended Solids); non-aerated
	Carbon Steel		
	Stainless Steel		
	Copper		
	Ductile Iron	Not recommended	
	Cast Iron		
V-Mount	Plastic (all types)	4…12 in. (100…300 mm)	
	Carbon Steel		
	Stainless Steel		
	Copper	4…30 in. (100…750 mm)	
	Ductile Iron	2…12 in. (50…300 mm)	
	Cast Iron		
Z-Mount	Plastic (all types)	> 30 in. (> 750 mm)	
	Carbon Steel	> 12 in. (> 300 mm)	
	Stainless Steel		
	Copper	> 30 in. (> 750 mm)	
	Ductile Iron	> 12 in. (> 300 mm)	
	Cast Iron		

Table 2: Transducer mounting modes for DTTR, DTTN and DTTH

The transducers can be mounted in V-Mount where the sound transverses the pipe two times, W-Mount where the sound transverses the pipe four times, or in Z-Mount where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once. The selection of mounting method is based on pipe and liquid characteristics which both have an effect on how much signal is generated. The transmitter 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.

The appropriate mounting configuration is based on pipe and liquid characteristics. Selecting the proper transducer mounting method is an iterative process. *Table 2* contains recommended mounting configurations for common applications. These recommended configurations may need to be modified for specific applications if such things as aeration, suspended solids, out-of-round piping or poor piping conditions are present.

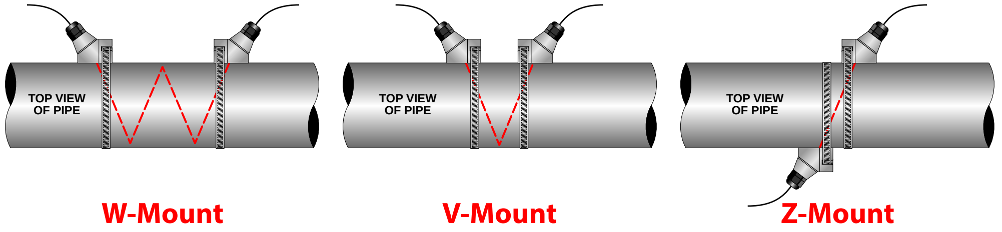
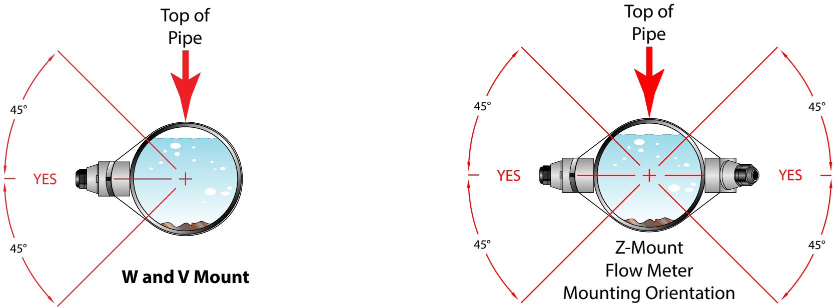
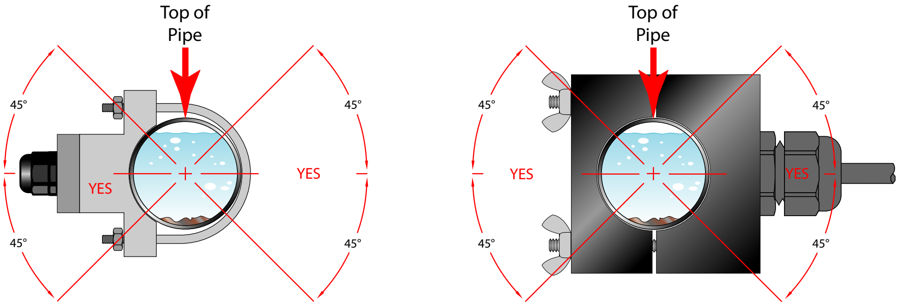


Figure 9: Transducer mounting modes for DTTR, DTTN and DTTH



W and V Mount

Z-Mount
Flow Meter
Mounting Orientation
DTTR, DTTN and DTTH Transducers



Flow Meter
Mounting Orientation
2" DTTS and DTTC Transducers

Flow Meter
Mounting Orientation
DTTS and DTTC Transducers

Figure 10: Transducer orientation for horizontal pipes

For DTTS and DTTC transducers, the transducers are V-mount. The frequency setting depends on the pipe material.

Pipe Size	Frequency Setting	Transducer	Pipe	Mounting Configuration
1/2 in.	2 MHz	DTTSnP	ANSI	V
		DTTSnC	Copper	
		DTTSnT	Stainless Steel	
3/4 in.	2 MHz	DTTSnP	ANSI	
		DTTSnC	Copper	
		DTTSnT	Stainless Steel	
1 in.	2 MHz	DTTSnP	ANSI	
		DTTSnC	Copper	
		DTTSnT	Stainless Steel	
1-1/4 in.	2 MHz	DTTSnP	ANSI	
		DTTSnC	Copper	
		DTTSnT	Stainless Steel	
1-1/2 in.	2 MHz	DTTSnP	ANSI	
		DTTSnC	Copper	
		DTTSnT	Stainless Steel	
2 in.	1 MHz	DTTSnP	ANSI	
		DTTSnC	Copper	
	2 MHz	DTTSnT	Stainless Steel	
DTTS transducer designation refers to both DTTS and DTTC transducer types.				

Table 3: Transducer mounting modes for DTTS / DTTC

Enter the Pipe and Liquid Parameters

The TFXL meter calculates proper transducer spacing based on the piping and liquid information you enter into the transmitter via the UltraLink software utility. See *"Parameter Configuration Using UltraLink Software" on page 29*.

The most accuracy is achieved when the transducer spacing is exactly what the transmitter calculates, so use the calculated spacing if the signal strength is satisfactory. If the pipe is not round, the wall thickness not correct or the actual liquid being measured has a different sound speed than the liquid programmed into the transmitter, the spacing can vary from the calculated value. In that case, place the transducers at the highest signal level observed when moving the transducers slowly around the mount area.

NOTE: Transducer spacing is calculated on "ideal" pipe. Ideal pipe almost never exists, so you may need to alter the transducer spacing. An effective way to maximize signal strength is to configure the display to show signal strength, fix one transducer on the pipe and then—starting at the calculated spacing—move the remaining transducer small distances forward and back to find the maximum signal strength point.

IMPORTANT

Enter all of the data on this list, save the data and reset the transmitter before mounting the transducers.

The following information is required before programming the instrument:

Transducer mounting configuration	Pipe liner thickness (if present)	Pipe O.D. (outside diameter)	Pipe liner material (if present)
Pipe wall thickness	Fluid type	Pipe material	Fluid sound speed[1]
Pipe sound speed[1]	Fluid viscosity[1]	Pipe relative roughness[1]	Fluid specific gravity[1]

Table 4: Parameters required

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

NOTE: Much of the data relating to material sound speed, viscosity and specific gravity is pre-programmed into the transmitter. You need to modify this data only if you know that a particular application's data varies from the reference values. See *"Parameter Configuration Using UltraLink Software" on page 29* for instructions on entering configuration data into the transmitter via the software utility.

After entering the data listed above, the transmitter will calculate proper transducer spacing for the particular data set. The distance will be in inches if the transmitter is configured in English units, or millimeters if configured in metric units.

Mount the Transducer

After selecting an optimal mounting location and determining the proper transducer spacing, mount the transducers onto the pipe.

1. Clean the surface of the pipe. If the pipe has external corrosion or dirt, wire brush, sand or grind the mounting location until it is smooth and clean. 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.
2. Orient and space the DTTR, DTTN and DTTH transducers on the pipe to provide optimum reliability and performance. On horizontal pipes, when Z-Mount is required, mount the transducers 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 10 on page 18*. On vertical pipes, the orientation is not critical.

The spacing between the transducers is measured between the two spacing marks on the sides of the transducers. These marks are approximately 0.75 inches (19 mm) back from the nose of the DTTR, DTTN and DTTH transducers. See *Figure 11*.

Mount DTTS and DTTC transducers with the cable exiting within ±45 degrees of the side of a horizontal pipe. On vertical pipes, the orientation does not apply.

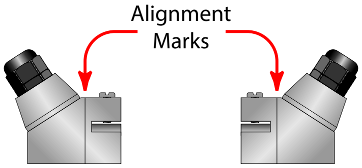


Figure 11: Transducer alignment marks

Transducer Mounting Configurations

V-Mount and W-Mount Configurations

Apply the Couplant
For DTTR, DTTN and DTTH transducers, place a single bead of couplant, approximately 1/2 inch (12 mm) thick, on the flat face of the transducer. See *Figure 12*. Generally, a silicone-based grease is used as an acoustic couplant, but any good quality grease-like substance that is rated to not flow at the operating temperature of the pipe is acceptable. For pipe surface temperature over 150° F (65° C), use Sonotemp® (P.N. D002-2011-011).

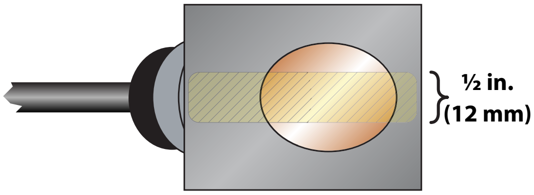


Figure 12: Application of couplant

Position and Secure the Transducer

1. Place the upstream transducer in position and secure with a mounting strap. Place the straps in the arched groove on the end of the transducer. Use the screw provided to help hold the transducer onto the strap. Verify that the transducer is true to the pipe and adjust as necessary. Tighten the transducer strap securely.
2. Place the downstream transducer on the pipe at the calculated transducer spacing. See *Figure 13 on page 20*. Apply firm hand pressure. If signal strength is greater than five, secure the transducer at this location. If the signal strength is not five or greater, using firm hand pressure slowly move the transducer both towards and away from the upstream transducer while observing signal strength.
   Signal strength can be displayed on the transmitter's display or on the main data screen in the UltraLink software utility. See *"Parameter Configuration Using UltraLink Software" on page 29*. Clamp the transducer at the position where the highest signal strength is observed. The factory default signal strength setting is five. However, there are many application-specific conditions that may prevent the signal strength from attaining this level. Signal levels less than five will probably not be acceptable for reliable readings.

NOTE: Signal strength readings update only every few second. Move the transducer 1/8 inch then wait to see if the signal is increasing or decreasing. Repeat until the highest level is achieved.

3. If, after adjusting the transducers, the signal strength does not rise to above five, use an alternate transducer mounting configuration. If the mounting configuration was **W**-Mount, re-configure the transmitter for **V**-Mount, move the downstream transducer to the new spacing distance and repeat the procedure *"Mount the Transducer" on page 19*.

NOTE: Mounting the high temperature transducers is similar to mounting the DTTR/DTTN transducers. High temperature installations require acoustic couplant that is rated not to flow at the operating temperature of the pipe surface.

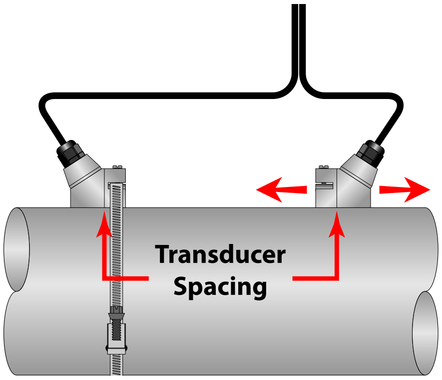


Figure 13: Transducer positioning

DTTS/DTTC Small Pipe Transducer Installation

The small pipe transducers are designed for specific pipe outside diameters. Do not attempt to mount a DTTS/DTTC transducer onto a pipe that is either too large or too small for the transducer. Instead, contact the manufacturer to arrange for a replacement transducer that is the correct size.

1. Apply a thin coating of acoustic coupling grease to both halves of the transducer housing where the housing will contact the pipe. See *Figure 14*.
2. On horizontal pipes, mount the transducer in an orientation so the cable exits at ±45 degrees from the side of the pipe. Do not mount with the cable exiting on either the top or bottom of the pipe. On vertical pipes, the orientation does not matter.
3. Tighten the wing nuts or U-bolts so the acoustic coupling grease begins to flow out from the edges of the transducer or from the gap between the transducer halves.

IMPORTANT

Do not overtighten. Overtightening will not improve performance and may damage the transducer.

4. If signal strength is less than five, remount the transducer at another location on the piping system.

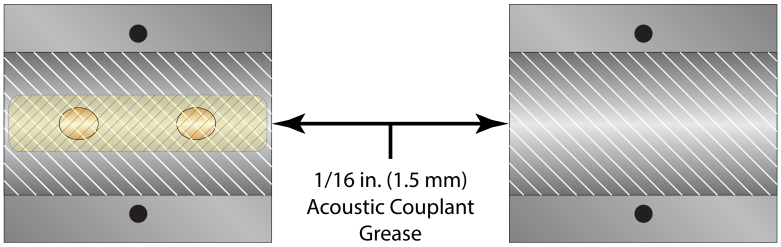
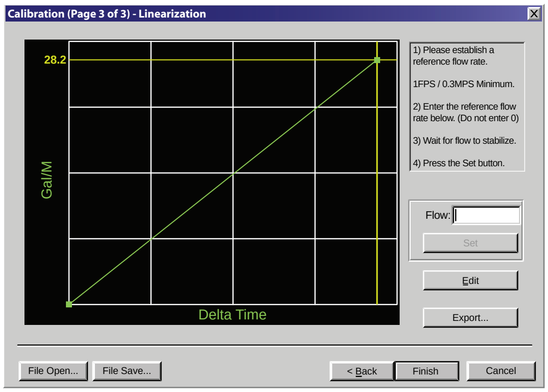


Figure 14: Application of acoustic couplant — DTTS/DTTC transducers

NOTE: If a DTTS/DTTC small pipe transducer was purchased separately from the transmitter, the following configuration procedure is required.

DTTS/DTTC Small Pipe Transducer Calibration Procedure

1. Establish communications with the transit time transmitter.
2. From the tool bar, select **Calibration**. See *Figure 17*.
3. On the pop-up screen, click **Next** twice to get to *Page 3 of 3*. See *Figure 15*.
4. Click **Edit**.
5. If a calibration point is displayed in *Calibration Points Editor*, record the information, then highlight and click **Remove**. See *Figure 16*.
6. Click **ADD...**
7. Enter Delta T, Un-calibrated Flow, and Calibrated Flow values from the DTTS/DTTC calibration label, then click **OK**. See *Figure 18*.
8. Click **OK** in the *Edit Calibration Points* screen.
9. The display will return to *Page 3 of 3*. Click **Finish**. See *Figure 15*.
10. After *Writing Configuration File* is complete, turn off the power. Turn on the power again to activate the new settings.



1) Please establish a reference flow rate.

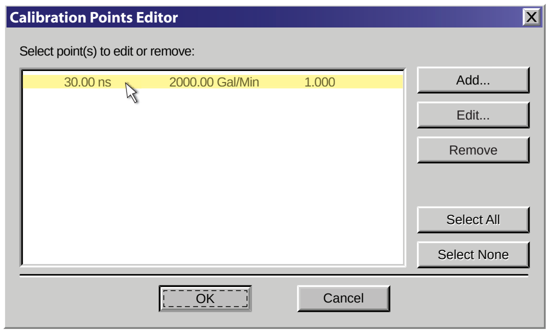
1FPS / 0.3MPS Minimum.

2) Enter the reference flow rate below. (Do not enter 0)

3) Wait for flow to stabilize.

4) Press the Set button.

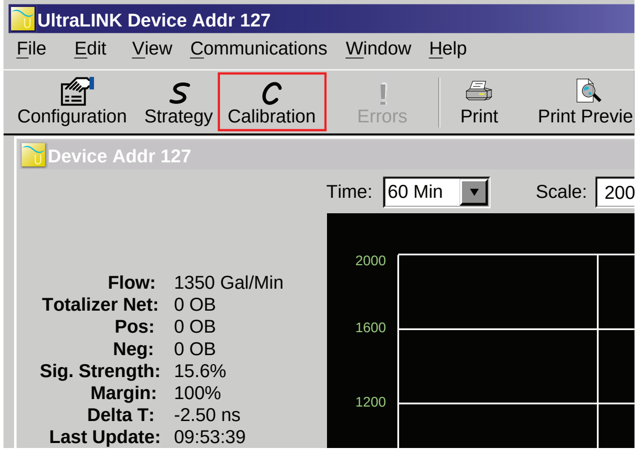
Figure 15: Calibration points editor



Select point(s) to edit or remove:

30.00 ns 2000.00 Gal/Min 1.000

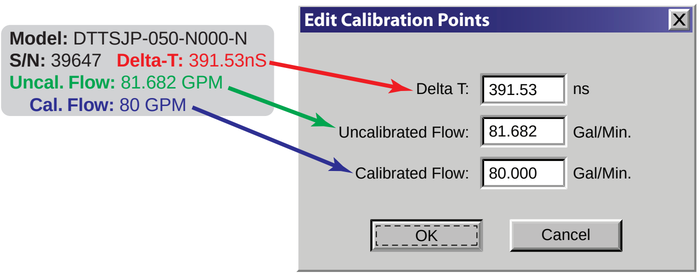
Figure 16: Calibration page 3 of 3



Time: 60 Min Scale: 200

Flow: 1350 Gal/Min
Totalizer Net: 0 OB
Pos: 0 OB
Neg: 0 OB
Sig. Strength: 15.6%
Margin: 100%
Delta T: -2.50 ns
Last Update: 09:53:39

Figure 17: Data display screen



Model: DTTSJP-050-N000-N
S/N: 39647 **Delta-T:** 391.53nS
Uncal. Flow: 81.682 GPM
Cal. Flow: 80 GPM

Delta T: 391.53 ns
Uncalibrated Flow: 81.682 Gal/Min.
Calibrated Flow: 80.000 Gal/Min.

Figure 18: Edit calibration points

Z-Mount Configuration

Installation on larger pipes requires careful measurements of the linear and radial placement of the DTTR, DTTN and DTTH transducers. Failure to properly orient and place the transducers on the pipe may lead to weak signal strength and/or inaccurate readings. This section 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.

1. Wrap the paper around the pipe in the manner shown in *Figure 19*. Align the paper ends to within 1/4 inch (6 mm).
2. Mark the intersection of the two ends of the 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 20*.
3. 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 10* for acceptable radial orientations. Wrap the template back around the pipe, placing the beginning of the paper and one corner in the location of the mark. Move to the other side of the pipe and mark the pipe at the ends of the crease. Measure from the end of the crease (directly across the pipe from the first transducer location) the dimension derived in *"Select a Mounting Configuration" on page 17*. Mark this location on the pipe.
4. 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 1/2 the circumference of the pipe and lay it over the top of the pipe. The equation for the length of 1/2 the circumference is: 1/2 Circumference = Pipe O.D. × 1.57

The transducer spacing is the same as found in *"Position and Secure the Transducer" on page 20*. Mark opposite corners of the paper on the pipe. Apply transducers to these two marks.

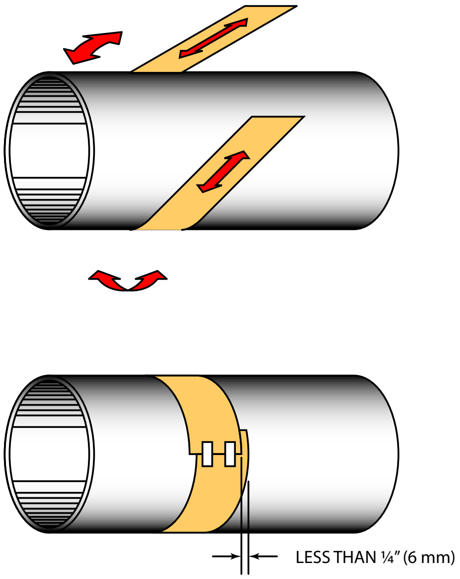


Figure 19: Paper template alignment

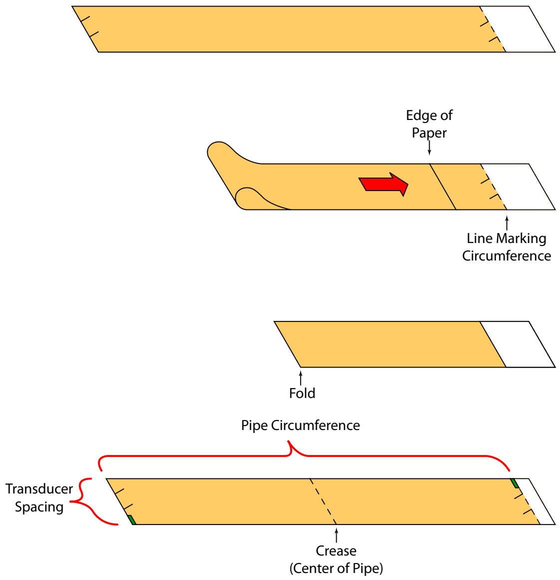


Figure 20: Bisecting the pipe circumference

5. For DTTR, DTTN and DTTH transducers, place a single bead of couplant, approximately 1/2 inch (12 mm) thick, on the flat face of the transducer. See *Figure 12*. Generally, a silicone-based grease is used as an acoustic couplant, but any good quality grease-like substance that is rated to not flow at the operating temperature of the pipe is acceptable.
6. Place the upstream transducer in position and secure with a stainless steel strap or other fastening device. Straps should be placed in the arched groove on the end of the transducer. A screw is provided to help hold the transducer onto the strap. Verify that the transducer is true to the pipe, adjust as necessary. Tighten transducer strap securely. Larger pipes may require more than one strap to reach the circumference of the pipe.

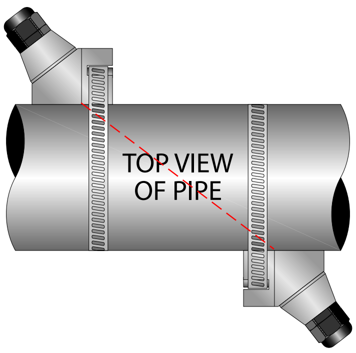


Figure 21: Z-Mount transducer placement

7. Place the downstream transducer on the pipe at the calculated transducer spacing. See *Figure 21*. Using firm hand pressure, slowly move the transducer both towards and away from the upstream transducer while observing signal strength. Clamp the transducer at the position where the highest signal strength is observed. A signal strength between 5…98 is acceptable.

   The factory default signal strength setting is five. However there are many application-specific conditions that may prevent the signal strength from attaining this level. A minimum signal strength of five is acceptable as long as this signal level is maintained under all flow conditions.

   On certain pipes, a slight twist to the transducer may cause signal strength to rise to acceptable levels. Certain pipe and liquid characteristics may cause signal strength to rise to greater than 98. The problem with operating this transmitter with very high signal strength is that the signals may saturate the input amplifiers and cause erratic readings. Strategies for lowering signal strength would be changing the transducer mounting method to the next longest transmission path. For example, if there is excessive signal strength and the transducers are mounted in a **Z**-Mount, try changing to **V**-Mount or **W**-Mount. Finally, you can also move one transducer slightly off-line with the other transducer to lower signal strength.
8. Secure the transducer with a stainless steel strap or other fastener.

Mounting Rail System Installation for DTTR

For remote flow DTTR transducers with outside diameters between 2…10 inches (50…250 mm) , the rail mounting kit aids in installation and positioning of the transducers. Transducers slide on the rails, which have measurement markings that are viewable through the sight opening.

1. Install the single mounting rail on the side of the pipe with the stainless steel bands provided. Do not mount it on the top or bottom of the pipe. On vertical pipe, orientation is not critical. Check 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 toward the center mark on the mounting rail.
3. Place a single bead of couplant, approximately 1/2 inch (12 mm) thick, on the flat face of the transducer. See *Figure 12 on page 20*.
4. Place the first transducer in between the mounting rails near the zero point on the scale. Slide the clamp over the transducer. Adjust the clamp and transducer so the notch in the clamp aligns with the zero on the scale. See *Figure 23*.
5. Secure with the thumb screw. Check 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.)
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.

Figure 22: Mounting rail system for DTTR

Mounting Track Installation for DTTN/DTTH

A convenient transducer mounting track can be used for pipes that have outside diameters between 2…10 inches (50…250 mm) and for DTTN/DTTH transducers. If the pipe is outside of that range, mount the transducers separately.

1. Install the single mounting rail on the side of the pipe with the stainless steel bands provided. Do not mount it on the top or bottom of the pipe. On vertical pipe, orientation is not critical. Check 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 toward the center mark on the mounting rail.
3. Place a single bead of couplant, approximately 1/2 inch (12 mm) thick, on the flat face of the transducer. See *Figure 12 on page 20*.
4. Place the first transducer in between the mounting rails near the zero point on the scale. Slide the clamp over the transducer. Adjust the clamp and transducer so the notch in the clamp aligns with the zero on the scale. See *Figure 23*.
5. Secure with the thumb screw. Check 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.)
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.

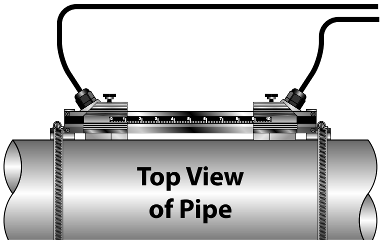


Figure 23: Mounting track installation

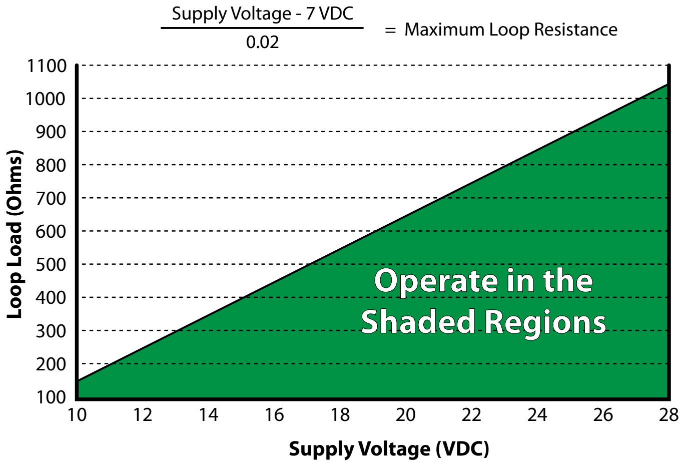
INPUTS/OUTPUTS

The TFXL meter is available in two general configurations:

- The standard TFXL meter is equipped with a 4…20 mA output and a rate frequency output.
- The TFXL meter is also available with a totalizing pulse output option.

Standard 4…20 mA Output

The 4…20 mA output interfaces with most recording and logging systems by transmitting an analog current signal that is proportional to system flow rate. The 4…20 mA output is internally powered (current sourcing) and can span negative to positive flow/energy rates.



$$\frac{\text{Supply Voltage - 7 VDC}}{0.02} = \text{Maximum Loop Resistance}$$

Figure 24: Allowable loop resistance

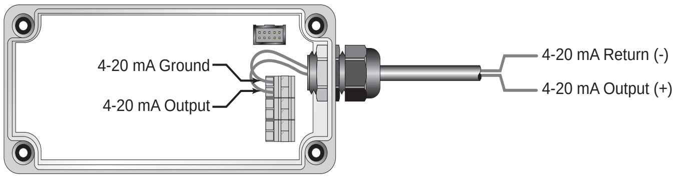


Figure 25: 4…20 mA output

The 4…20 mA output signal is available between the 4…20 mA Output and Signal Ground terminals as shown in *Figure 25*.

Batch/Totalizer Output

Totalizer mode configures the output to send a 100 mSec pulse each time the display totalizer increments divided by the *TOT MULT*. The *TOT MULT* value must be a whole, positive numerical value. This output is limited to 1 Hz maximum.

> For example, if the totalizer exponent *TOTL E* is set to *E0* ×1 and the totalizer multiplier *TOT MULT* is set to 1, then the output will pulse each time the totalizer increments one count, or each single, whole measurement unit totalized.
>
> If the totalizer exponent *TOTL E* is set to *E2* ×100 and the totalizer multiplier *TOT MULT* is set to 1, then the control output will pulse each time the display totalizer increments or once per 100 measurement units totalized.
>
> If the totalizer exponent *TOTL E* is set to *E0* ×1 and the totalizer multiplier *TOT MULT* is set to 2, the control output will pulse once for every two counts that the totalizer increments.

Totalizer Output Option

TFXL meters can be ordered with a totalizer pulse output option. This option is installed in the position where the rate pulse would normally be installed.

Totalizing Pulse Specifications

Parameter	Specification
Signal	One pulse for each increment of the totalizer's least significant digit
Operation	Normal state is high; pulses low with display total increments
Pulse Duration	30 mSec/minute
Source / Sink	2 mA maximum
Logic	5V DC

Table 5: Optional totalizing pulse output

Wiring and configuration of this option is similar to the totalizing pulse output for the TFXL meter variation. This option must use an external current-limiting resistor.

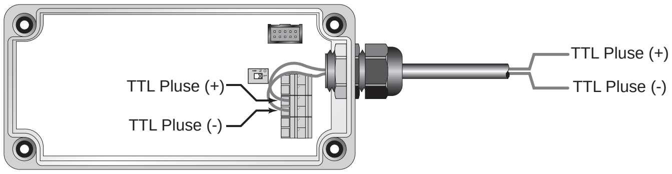


Figure 26: Totalizer output option

Frequency Output

The frequency output is a TTL circuit that outputs a pulse waveform that varies proportionally with flow rate. This type of frequency output is also known as a Rate Pulse output. The output spans from 0 Hz, normally at zero flow rate to 1000 Hz at full flow rate (see *"Flow Tab" on page 35*).

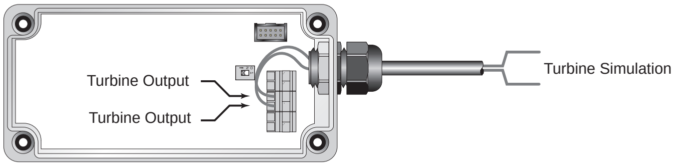


Figure 27: Frequency output switch settings

The frequency output is proportional to the maximum flow rate entered into the meter. The maximum output frequency is 1000 Hz. If, for example, the **MAX RATE** parameter was set to 400 GPM then an output frequency of 500 Hz (half of the full scale frequency of 1,000 Hz) would represent 200 GPM.

In addition to the control outputs, the frequency output can be used to provide total information by use of a "K-factor". A K-factor simply relates the number of pulses from the frequency output to the number of accumulated pulses that equates to a specific volume.

For this transmitter, the relationship is described by the following equation. The 60,000 relates to measurement units in volume/min. Measurement units in seconds, hours or days would require a different numerator.

$$\text{K factor} = \frac{60{,}000}{\text{Full Scale Units}}$$

A practical example would be if the *MAX RATE* for the application were 400 gpm, the K-factor (representing the number of pulses accumulated needed to equal one gallon) would be:

$$\text{K factor} = \frac{60{,}000}{400\ \text{gpm}} = 150\ \text{Pulses Per Gallon}$$

If the frequency output is to be used as a totalizing output, the transmitter and the receiving instrument must have identical K-factor values programmed into them to ensure that accurate readings are being recorded by the receiving instrument. Unlike standard mechanical transmitters such as turbines, gear or nutating disc meters, the K-factor can be changed by modifying the *MAX RATE* flow rate value. See *"K-Factors" on page 42*.

There are two frequency output options available:

The **Turbine Meter Simulation** option is used when a receiving instrument is capable of interfacing directly with a turbine transmitter's magnetic pickup. The output is a relatively low voltage AC signal whose amplitude swings above and below the signal ground reference. The minimum AC amplitude is approximately 500 mV peak-to-peak. The TFXL is configured for turbine simulation if the output option in the part number is a "1" (DTFXL*-**1-**). **SW1** must be OFF for the turbine output circuit.

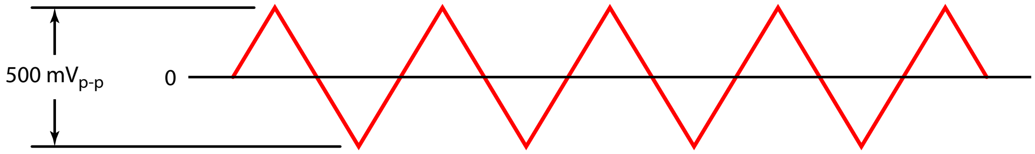


Figure 28: Frequency output waveform (simulated turbine)

The **Square-Wave Frequency** option is used when a receiving instrument requires that the pulse voltage level be either of a higher potential and/or referenced to DC ground. The output is a TTL (5V) square-wave. The TFXL is configured for TTL pulse frequency (and 4…20 mA output) if the output option in the part number is a "3" (DTFXL*-**3-**).

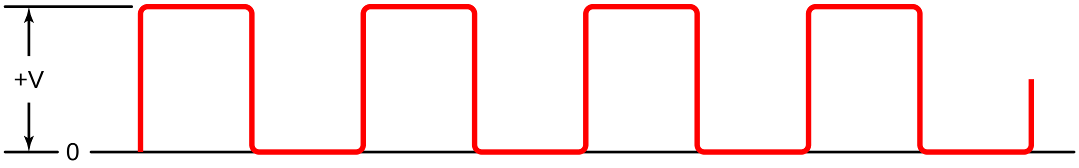


Figure 29: Frequency output waveform (square wave)

PARAMETER CONFIGURATION USING ULTRALINK SOFTWARE

The flow meter must be programmed with the UltraLink software utility. The software is used to configure, calibrate and communicate with TFXL flow meters. Additionally, it has numerous troubleshooting tools to make diagnosing and correcting installation problems easier.

System Requirements

The software requires a PC-type computer, running Windows 2000, Windows XP, Windows Vista or Windows 7 operating systems.

Additional Parts Required for Configuration

Part Number	Description
D010-0204-001	Configuration cable kit
D005-2116-004	USB-to-DB9 converter (required if PC does not have a serial port)

Installation

1. From the Windows *Start* button, choose the **Run** command. From the *Run* dialog box, use **Browse** to navigate to the *UltraLink_Setup.exe* file and double-click.
2. The UltraLink Setup will automatically extract and install on the hard disk. The UltraLink icon can then be copied to the desktop.

NOTE: If a previous version of this software is installed, it must be un-installed before a new version of the software can be installed. Newer versions will ask to remove the old version and perform the task automatically. Older versions must be removed using the Microsoft Windows Add/Remove Programs applet.

NOTE: Most PCs will require a restart after a successful installation.

Initialization

1. If the PC has a serial port, connect the PC to the TFXL meter with the D010-0204-001 cable kit.
   If the PC has no serial port, connect the PC to the TFXL meter with the D010-0204-001 cable kit and the D005-2116-004 USB converter connected in series.

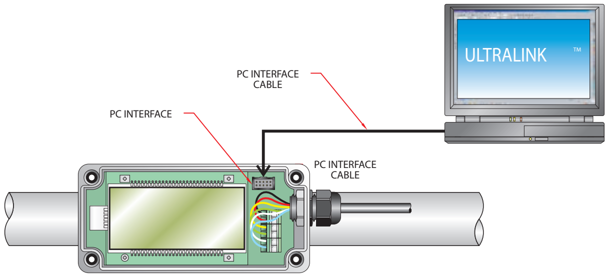


Figure 30: PC connections

NOTE: Power up the transmitter prior to running this software.

NOTE: While the serial cable is connected, the frequency outputs are disabled.

2. Double-click the UltraLink icon to start the software.

The UltraLink software will attempt to connect to the transmitter. If communications cannot be established, you will be prompted to select a Com Port and Com Port Type.

The first screen is the *RUN* mode screen, which contains real-time information regarding flow rate, totals, signal strength, communications status, and the transmitter's serial number. The *COMM* indicator in the lower right corner indicates that the serial connection is active. If the *COMM* box contains a red *ERROR* indication, select **Communications** on the Menu bar and select **Initialize**. Choose the appropriate COM port and the RS232 / USB Com Port Type. Proper communication is verified when a green *OK* is indicated in the lower right corner of the PC display and the *Last Update* indicator in the text area on the left side of the screen changes from red to an active clock indication.

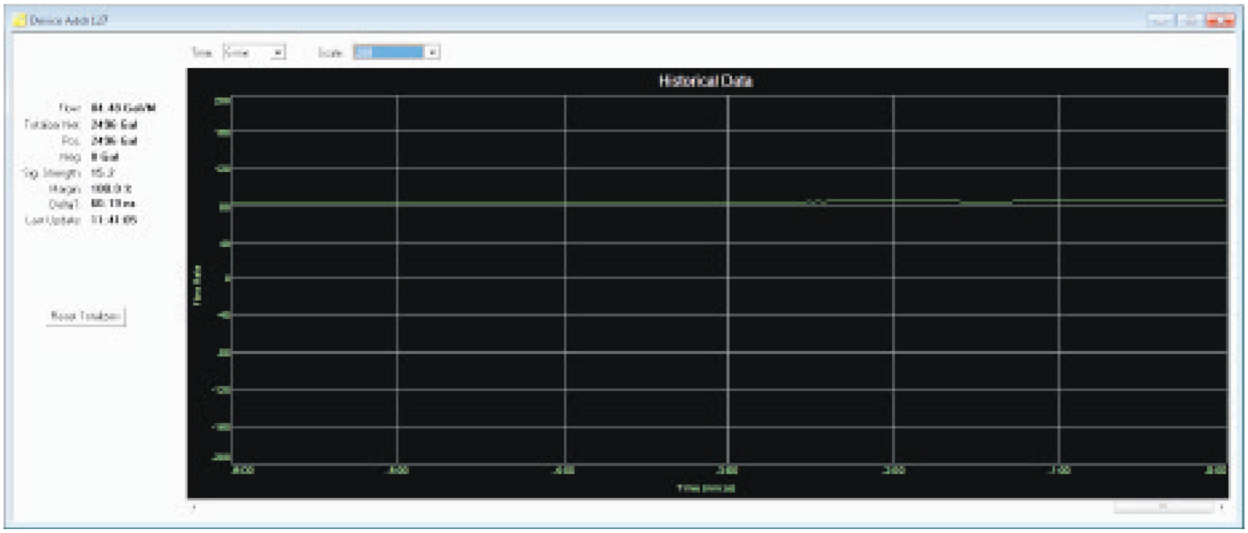


Figure 31: Data display screen

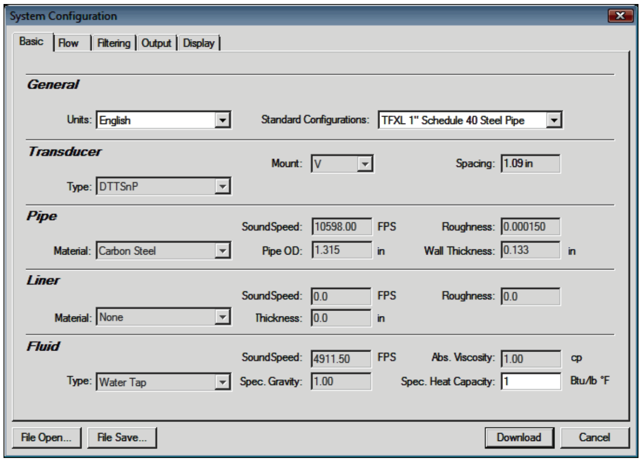
CONFIGURATION MENU

Configuration

The *Configuration* menu has six tabs used to control how the transmitter is set up and responds to varying flow conditions. The first screen that appears after clicking the Configuration button is the *Basic* tab.

Basic Tab

Entry of data in the *Basic* and *Flow* tabs is all that is required to provide flow measurement functions to the transmitter. If you are not going to use input/output functions, click **Download** to transfer the configuration to the transmitter. When the configuration has been completely downloaded, turn the power to the transmitter off and then on again to guarantee the changes take effect.



Units: English
Standard Configurations: TFXL 1" Schedule 40 Steel Pipe
Mount: V
Spacing: 1.09 in
Type: DTTSnP
SoundSpeed: 10598.00 FPS
Roughness: 0.000150
Material: Carbon Steel
Pipe OD: 1.315 in
Wall Thickness: 0.133 in
SoundSpeed: 0.0 FPS
Roughness: 0.0
Material: None
Thickness: 0.0 in
SoundSpeed: 4911.50 FPS
Abs. Viscosity: 1.00 cp
Type: Water Tap
Spec. Gravity: 1.00
Spec. Heat Capacity: 1 Btu/lb °F

Figure 32: Basic tab

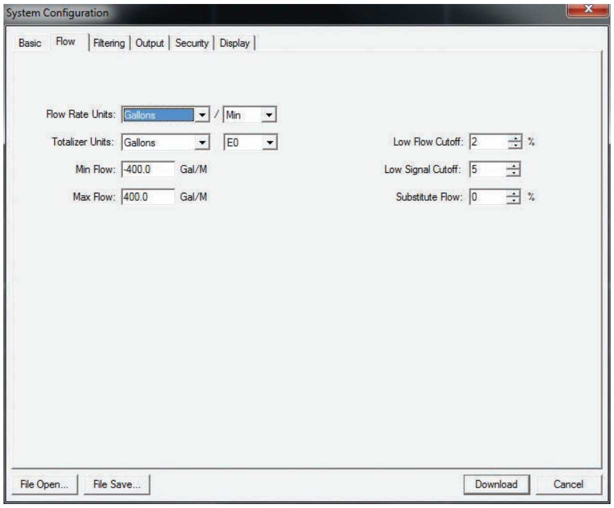
Category	Parameter	Meaning	Option	Description
General	Units	Measurement standard	ENGLISH (Inches) METRIC (Millimeters)	The English/metric selection will also configure the transmitter to display sound speeds in pipe materials and liquids as either feet per second (fps) or meters per second (mps), respectively. **IMPORTANT**: If the UNITS entry has been changed from ENGLISH to METRIC or from METRIC to ENGLISH, the entry must be saved and the instrument reset (power cycled)) in order for the transmitter to initiate the change in operating units. Failure to save and reset the instrument will lead to improper transducer spacing calculations and an instrument that may not measure properly.
	Standard Configuration	Pre-programmed pipe configurations	Menu selection	When using the *Standard Configurations* drop-down menu alternate, menu choices can be made by using the following guidelines: 1. Select the transducer type and pipe size for the transducer to be used. The firmware will automatically enter the appropriate values for that pipe size and type. Every entry parameter except for *Units*, *Standard Configurations* and *Specific Heat Capacity* are unavailable (grayed out). 2. From the *Standard Configurations* drop-down menu, select **Custom**. The previously unavailable selections are now available for editing. 3. Make any necessary changes to the basic configuration and click **Download**. 4. Cycle the transmitter power off and then back on again for the changes to take effect.

<table>
<tr><th>Category</th><th>Parameter</th><th>Meaning</th><th>Option</th><th>Description</th></tr>
<tr><td rowspan="5">Transducer</td><td>Type</td><td>Transducer type</td><td>Menu selection</td><td>Selects the transducer that will be connected to the transmitter. Select the appropriate transducer type from the drop-down list. This selection influences transducer spacing and transmitter performance, so it must be correct. If you are unsure about the type of transducer to which the transmitter will be connected, consult the shipment packing list or call the manufacturer for assistance.
A change of transducer type will cause a system configuration <i>error 1002: Sys Config Changed</i> to occur. This error will clear when power to the transmitter is cycled.</td></tr>
<tr><td>Mount</td><td>Transducer mounting method</td><td>V
W
Z</td><td>Selects the orientation of the transducers on the piping system. See <i>"Transducer Installation" on page 15</i> and <i>Table 2 on page 17</i> for detailed information regarding transducer mounting modes for particular pipe and liquid characteristics. Whenever the transducer mounting mode is changed, power to the transmitter must be cycled.</td></tr>
<tr><td>Frequency</td><td>Transducer transmission frequency</td><td>1 MHZ
2 MHZ</td><td>Selects a transmission frequency for the various types of transducers. In general, the larger the pipe the slower the transmission frequency needs to be to attain a good signal.
<table>
<tr><th>Frequency</th><th>Transducers</th><th>Mounting Modes</th><th>Pipe Size and Type</th></tr>
<tr><td>2 MHz</td><td>All 1/2…1-1/2 in. Small Pipe and Tube
2 in. Tubing</td><td>Selected by Firmware</td><td>Specific to Transducer</td></tr>
<tr><td rowspan="2">1 MHz</td><td>2 in. ANSI Pipe and Copper Tube</td><td>Selected by Firmware</td><td>Specific to Transducer</td></tr>
<tr><td>Standard and High Temp</td><td>W, V, and Z</td><td>2 in. and Greater</td></tr>
</table></td></tr>
<tr><td>Spacing</td><td>Transducer spacing</td><td>ENGLISH (Inches)
METRIC (Millimeters)</td><td>A value calculated by the transmitter's firmware that takes into account pipe, liquid, transducer and mounting information. The spacing adapts as these parameters are modified. The spacing is given in inches for English units or millimeters for metric. This value is the lineal distance that must be between the transducer alignment marks. Selection of the proper transducer mounting method is not entirely predictable and many times is an iterative process.
NOTE: This setting only applies to DTTR, DTTN and DTTH transducers.</td></tr>
<tr><td>Flow Direction</td><td>Transducer flow direction</td><td>FORWARD
REVERSE</td><td>Allows the change of the direction the transmitter assumes is forward. When mounting transmitters with integral transducers, use this feature to reverse upstream and downstream transducers, making upside-down mounting of the display unnecessary.</td></tr>
</table>

Category	Parameter	Meaning	Option	Description
Pipe	Material	Pipe material	Select a material from the pull-down list. If the pipe material used is not found in the list, select **Other** and enter the actual pipe material *Sound Speed* and *Roughness* (much of this information is available at web sites such as www.ondacorp.com/tecref_acoustictable.html) for pipe relative roughness calculations.	
	Sound Speed	Pipe sound speed	ENGLISH (fps) METRIC (mps)	Specifies the speed of sound value, shear or transverse wave, for the pipe wall. If the *UNITS* value was set to *ENGLISH*, 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 MATERIAL* list, a nominal value for speed of sound in that material will be automatically loaded. If the actual sound speed 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 MATERIAL*, then a *PIPE SOUND SPEED* must also be entered.
	Pipe O.D.	Pipe outside diameter	ENGLISH (Inches) METRIC (Millimeters)	Enter the pipe outside diameter in inches if *ENGLISH* was selected as *UNITS*; in millimeters if *METRIC* was selected. See *"North American Pipe Schedules" on page 44* for charts listing popular pipe sizes. Correct entries for pipe O.D. and pipe wall thickness are critical to obtaining accurate flow measurement readings..
	Roughness	Pipe material relative roughness	(Enter a numeric value)	The transmitter provides flow profile 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 algorithm and is found by using the following formula: $\text{Pipe R} = \frac{\text{Linear RMS Measurement of the Pipes Internal Wall Surface}}{\text{Inside Diameter of the Pipe}}$ If a pipe material was chosen from the *PIPE MATERIAL* list, a nominal value for 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.
	Wall Thickness	Pipe wall thickness	ENGLISH (Inches) METRIC (Millimeters)	Enter the pipe wall thickness in inches if *ENGLISH* was selected as *UNITS*; in millimeters if *METRIC* was selected. See *"North American Pipe Schedules" on page 44* for charts listing popular pipe sizes. Correct entries for pipe O.D. and pipe wall thickness are critical to obtaining accurate flow measurement readings.
Liner	Material	Pipe liner material	Select a liner material. If the pipe liner material used is not included in the list, select **Other** and enter liner material *Sound Speed* and *Roughness* (much of this information is available at web sites such as www.ondacorp.com/tecref_acoustictable.html).	
	Sound Speed	Speed of sound in the liner	ENGLISH (fps) METRIC (mps)	Allows adjustments to be made to the speed of sound value, shear or transverse wave, for the pipe wall. If the *UNITS* value was set to *ENGLISH*, 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 MATERIAL* 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.
	Thickness	Pipe liner thickness	ENGLISH (Inches) METRIC (Millimeters)	If the pipe has a liner, enter the pipe liner thickness. Enter this value in inches if *ENGLISH* was selected as *UNITS*; in millimeters if *METRIC* was selected.
	Roughness	Liner material relative roughness	(Enter a numeric value)	The transmitter provides flow profile 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 and is found by using the following formula: $\text{Liner R} = \frac{\text{Linear RMS Measurement of the Liner's Internal Wall Surface}}{\text{Inside Diameter of the Liner}}$ If a liner material was chosen from the *LINER MATERIAL* list, a nominal value for relative roughness in that material will be automatically loaded. If the actual roughness is known for the application liner and that value varies from the automatically loaded value, the value can be revised. See *"Liner material relative roughness" on page 38* for pipe liner relative roughness calculations.

Category	Parameter	Meaning	Option	Description
Fluid	Type	Fluid/media type	Select a fluid type. selected from a pull-down list. If the liquid is not found in the list, select **Other** and enter the liquid *Sound Speed* and *Absolute Viscosity* into the appropriate boxes. The liquid's specific gravity is required if mass measurements are to be made, and the specific heat capacity is required for energy measurements.	
	Sound Speed	Speed of sound in the fluid	ENGLISH (fps) METRIC (mps)	Allows adjustments to be made to the speed of sound entry for the liquid. If the *UNITS* value was set to *ENGLISH*, the entry is in fps (feet per second). *METRIC* entries are made in mps (meters per second). If a fluid was chosen from the *FLUID TYPE* list, a nominal value for speed of sound in that media will be automatically loaded. If the actual sound speed 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 *FLUID TYPE*, a *FLUID SOUND SPEED* will need to be entered. A list of alternate fluids and their associated sound speeds is located in the Appendix located at the back of this manual. Fluid sound speed may also be found using the *Target DBg Data* screen available in the UltraLink software utility. See *"Target Dbg Data Screen Definitions" on page 40*.
	Specific Gravity	Fluid specific gravity	(Enter a numeric value)	Allows adjustments to be made to the specific gravity (density relative to water) of the liquid. As stated previously in the *FLUID ABSOLUTE VISCOSITY* section, specific gravity is used in the Reynolds correction algorithm. It is also used if mass flow measurement units are selected for rate or total. If a fluid was chosen from the *FLUID 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 *OTHE*R was chosen as *FLUID TYPE*, a *SPECIFIC GRAVITY* may need to be entered if mass flows are to be calculated. See *"Specifications" on page 54* for list of alternate fluids and their specific gravities.
Fluid	Absolute Viscosity	Absolute viscosity of the fluid	(Enter a numeric value in centipoise)	Allows adjustments to be made to the absolute viscosity of the liquid in centipoise. Ultrasonic transmitters use pipe size, viscosity and specific gravity to calculate Reynolds numbers. Since the Reynolds number influences flow profile, the transmitter has to compensate for the relatively high velocities at the pipe center during transitional or laminar flow conditions. The entry of *FLUID VI* is used in the calculation of Reynolds and the resultant compensation values. If a fluid was chosen from the *FLUID 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 *FLUID TYPE*, then a *FLUID ABSOLUTE VISCOSITY* must also be entered. See *"Fluid Properties" on page 49* for a list of alternate fluids and their associated viscosities.
	Specific Heat Capacity	Fluid specific heat capacity	BTU/lb	Allows adjustments to be made to the specific heat capacity of the liquid. If a fluid was chosen from the *FLUID TYPE* list, a default specific heat will be automatically loaded. This default value is displayed as *SPECIFIC HEAT*. If the actual specific heat of the liquid is known or it differs from the default value, the value can be revised. See *Table 5*, *Table 6* and *Table 7* for specific values. Enter a value that is the mean of both pipes.

Flow Tab



Flow Rate Units: Gallons / Min

Totalizer Units: Gallons E0

Min Flow: -400.0 Gal/M

Max Flow: 400.0 Gal/M

Low Flow Cutoff: 2 %

Low Signal Cutoff: 5

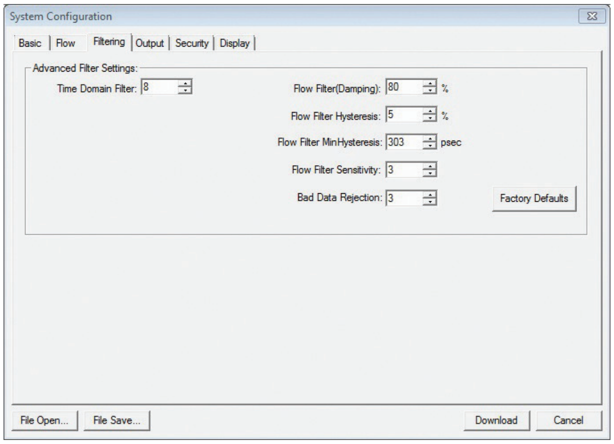
Substitute Flow: 0 %

Figure 33: Flow tab

Parameter	**Meaning**	**Option**	**Description**
Flow Rate Units	Engineering units for flow rate	Menu selection	Select an appropriate rate unit and time from the two lists. This entry also includes the selection of *Flow Rate Interval* after the virgule **(/)** sign.
Totalizer Units	Engineering units for totalizer	Menu selection	Select an appropriate totalizer unit and totalizer exponent. The totalizer exponents are in scientific notation and permit the eight digit totalizer to accumulate very large values before the totalizer "rolls over" and starts again at zero.
Min Flow	Minimum volumetric flow rate	(Enter a numeric value)	Enter the minimum volumetric flow rate setting to establish filtering parameters. Volumetric entries are in the flow rate units. For unidirectional measurements, set *Min Flow* to zero. For bidirectional measurements, set *Min Flow* to the highest negative (reverse) flow rate expected in the piping system.
Max Flow	Maximum volumetric flow rate	(Enter a numeric value)	Enter the maximum volumetric flow rate setting to establish filtering parameters. Volumetric entries are in the flow rate units. For unidirectional measurements, set *Max Flow* to the highest (positive) flow rate expected in the piping system. For bidirectional measurements, set *Max Flow* to the highest (positive) flow rate expected in the piping system.
Low Flow Cutoff	Flow cutoff value	(Enter a numeric value)	Allows very low flow rates (that can be present when pumps are off and valves are closed) to be displayed as zero flow. Enter values between 1.0…5.0% of the flow range between *Min Flow* and *Max Flow*.
Low Signal Cutoff	Low signal cutoff value	(Enter a numeric value)	Drives the transmitter and its outputs to the value specified in the *Substitute Flow* field when conditions occur that cause low signal strength. A signal strength indication below 5 is generally inadequate for measuring flow reliably, so generally the minimum setting for low signal cutoff is 5. A good practice is to set the low signal cutoff at approximately 60…70% of actual measured maximum signal strength. The factory default low signal cutoff is 5. If the measured signal strength is lower than the low signal cutoff setting, a *Signal Strength too Low* highlighted in red appears in the text area to the left in the *Data Display* screen until the measured signal strength becomes greater than the cutoff value. Signal strength indication below 2 is considered to be no signal at all. Verify that the pipe is full of liquid, the pipe size and liquid parameters are entered correctly, and that the transducers have been mounted accurately. Highly aerated liquids also cause low signal strength conditions.
Substitute Flow	Substitute flow value	0.0…100.0	A value that the analog outputs and the flow rate display to indicate when an error condition in the transmitter occurs. The typical setting for this entry is a value that will make the instrument display zero flow during an error condition. Substitute flow is set as a percentage between *MIN RATE* and *MAX RATE*. In a unidirectional system, this value is typically set to zero to indicate zero flow while in an error condition. In a bidirectional system, the percentage can be set such that zero is displayed in a error condition. To calculate where to set the substitute flow value in a bidirectional system, perform the following calculation: $\text{Substitute Flow} = 100 - \frac{100 \times \text{Maximum Flow}}{\text{Maximum Flow} - \text{Minimum Flow}}$ Some typical settings to achieve zero with respect to *MIN RATE* and *MAX RATE* settings are listed below. **NOTE:** *The UltraLink software utility is required to set values outside of 0.0…100.0.

Filtering Tab

The *Filtering* tab contains several filter settings for the transmitter. These filters can be adjusted to match response times and data "smoothing" performance to a particular application.



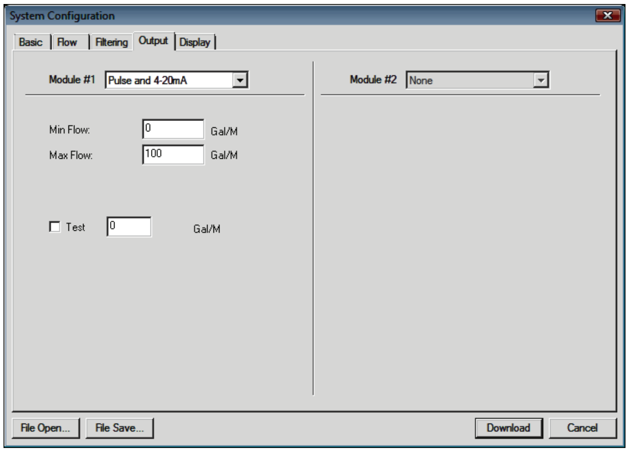
Advanced Filter Settings:
Time Domain Filter: 8
Flow Filter(Damping): 80 %
Flow Filter Hysteresis: 5 %
Flow Filter MinHysteresis: 303 psec
Flow Filter Sensitivity: 3
Bad Data Rejection: 3

Figure 34: Filtering tab

Parameter	Meaning	Option	Description
Time Domain Filter	Number of raw data sets averaged together	1…256	*Time Domain Filter* (range 1…256) adjusts the number of raw data sets (the wave forms viewed on the software *Diagnostics Screen*) that are averaged together. Increasing this value will provide greater damping of the data and slow the response time of the transmitter. Conversely, lowering this value will decrease the response time of the transmitter to changes in flow/energy rate. This filter is not adaptive, it is operational to the value set at all times. **NOTE:** The transmitter completes a measurement in approximately 350…400 mS. The exact time is pipe size dependent.
Flow Filter (Damping)	Maximum adaptive filter value	(Enter a numeric value)	*Flow Filter* (Damping) establishes a maximum adaptive filter value. Under stable flow conditions (flow that varies less than the *Flow Filter Hysteresis* entry), this adaptive filter will increase the number of successive flow readings that are averaged together up to this maximum value. If flow changes outside of the flow filter hysteresis window, the filter adapts by decreasing the number of averaged readings and allows the transmitter to react faster. The damping value is increased to increase stability of the flow rate readings. Damping values are decreased to allow the transmitter to react faster to changing flow rates. The factory settings are suitable for most installations. Increasing this value tends to provide smoother steady-state flow readings and outputs.
Flow Filter Hysteresis	Allows variations in flow	(Enter a numeric value)	*Flow Filter Hysteresis* creates a window around the average flow measurement reading allowing small variations in flow without changing the damping value. If the flow varies within that hysteresis window, greater display damping will occur up to the maximum values set by the flow filter entry. The filter also establishes a flow rate window where measurements outside of the window are examined by the *Bad Data Rejection* filter. The value is entered as a percentage of actual flow rate. For example, if the average flow rate is 100 gpm and the *Flow Filter Hysteresis* is set to 5%, a filter window of 95…105 gpm is established. Successive flow measurements that are measured within that window are recorded and averaged in accordance with the *Flow Filter Damping* setting. Flow readings outside of the window are held up in accordance with the *Bad Data Rejection* filter.
Flow Filter MinHysteresis	Minimum hysteresis window	(Enter a numeric value)	*Flow Filter MinHysteresis* sets a minimum hysteresis window that is invoked at sub 0.25 fps (0.08 mps) flow rates, where the "of rate" flow filter hysteresis is very small and ineffective. This value is entered in pico-seconds (ρsec) and is differential time. If very small fluid velocities are to be measured, increasing the flow filter minhysteresis value can increase reading stability.
Flow Filter Sensitivity	Sets damping speed	(Enter a numeric value)	*Flow Filter Sensitivity* allows configuration of how fast the *Flow Filter Damping* will adapt in the positive direction. Increasing this value allows greater damping to occur faster than lower values. Adaptation in the negative direction is not user adjustable.
Bad Data Rejection	Sets the number of readings to measure	(Enter a numeric value)	*Bad Data Rejection* is a value related to the number of successive readings that must be measured outside of the *Flow Filter Hysteresis* or *Flow Filter MinHysteresis* windows before the transmitter will use that flow value. Larger values are entered into *Bad Data Rejection* when measuring liquids that contain gas bubbles, as the gas bubbles tend to disturb the ultrasonic signals and cause more extraneous flow readings to occur. Larger *Bad Data Rejection* values tend to make the transmitter more sluggish to rapid changes in actual flow rate.

Output Tab

The entries made in the Output tab establish input and output parameters for the transmitter. Select the appropriate function from the pull-down menu and click **Download**. When a function is changed from the factory setting, a configuration error *1002* will result. This error will be cleared by resetting the transmitter microprocessor from the Communications/Commands/**Reset Target** button or by cycling power to the transmitter. Once the proper output is selected and the microprocessor is reset, calibration and configuration of the modules can be completed.



Module #1: Pulse and 4-20mA

Min Flow: 0 Gal/M

Max Flow: 100 Gal/M

☐ Test 0 Gal/M

Module #2: None

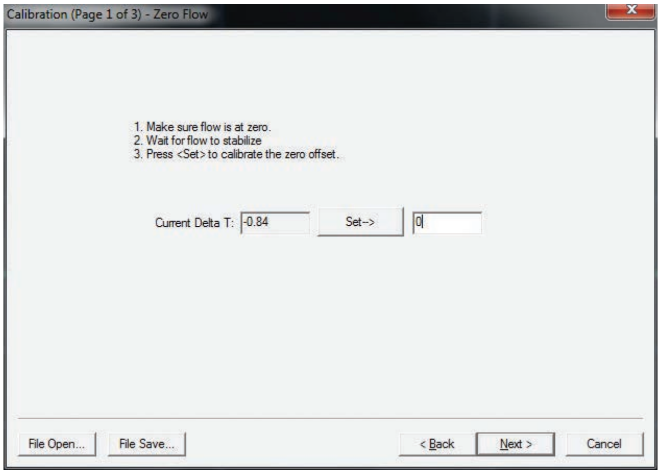
Figure 35: Output tab

Parameter	**Meaning**	**Description**
Min Flow	Controls how the 4-20 mA output is spanned	The *4-20 mA Output* menu applies to all transmitters and is the only output choice for *Channel 1*. The *Flow at 4 mA / 0 Hz* and *Flow at 20 mA / 1000 Hz* entries set the span for both the 4-20 mA output and the 0…1000 Hz frequency output. The 4-20 mA output is internally powered (current sourcing) and can span negative to positive flow rates. This output interfaces with virtually all recording and logging systems by transmitting an analog current that is proportional to system flow rate. Independent 4 mA and 20 mA span settings are established in firmware using the flow measuring range entries. These entries can be set anywhere in the – 40…40 fps (–12…12 mps) range. Resolution of the output is 12 bits (4096 discrete points) and can drive up to a 900 Ohm load. When powered by a DC supply, the load is limited by the input voltage supplied to the instrument. See *Figure 24 on page 26* for allowable loop loads. *Flow at 4 mA / 0 Hz* *Flow at 20 mA / 1000 Hz* The *Flow at 4 mA / 0 Hz* and *Flow at 20 mA / 1000 Hz* entries set the span of the 4-20 mA analog output and the frequency output. These entries are volumetric rate units that are equal to the volumetric units configured as rate units and rate interval. **Example 1**: To span the 4-20 mA output from –100…100 gpm with 12 mA being 0 gpm, enter these values: *Flow at 4 mA / 0 Hz* = ***–100.0*** *Flow at 20 mA / 1000 Hz* = ***100.0*** This setting also sets the span for the frequency output. At –100 gpm, the output frequency is 0 Hz. At the maximum flow of 100 gpm, the output frequency is 1000 Hz, and in this instance, a flow of zero is represented by an output frequency of 500 Hz. **Example 2**: To span the 4-20 mA output from 0…100 gpm with 12 mA being 50 gpm, enter these values: *Flow at 4 mA / 0 Hz* = ***0.0*** *Flow at 20 mA / 1000 Hz* = ***100.0*** In this instance, zero flow is represented by 0 Hz and 4 mA. The full scale flow or 100 gpm is 1000 Hz and 20 mA and a midrange flow of 50 gpm is 500 Hz and 12 mA.
Max Flow	Controls how the 20 mA output is spanned	
Test	Enables calibration adjustments	Allows a simulated flow value to be sent from the 4-20 mA output. By incrementing this value, the 4-20 mA output will transmit the indicated current value. Click **Test** to enable the *Calibration* and *Test* options.

CALIBRATION MENU

C
Calibration

The *Calibration* menu contains a powerful multi-point routine for calibrating the transmitter to a primary measuring standard in a particular installation. To initialize the three-step calibration routine, click **Calibration**.



1. Make sure flow is at zero.
2. Wait for flow to stabilize
3. Press <Set> to calibrate the zero offset.

Current Delta T: -0.84 Set--> 0

Figure 36: Calibration Page 1 of 3

The first screen, *Page 1 of 3* establishes a baseline zero flow rate measurement for the transmitter.

Remove the Zero Offset

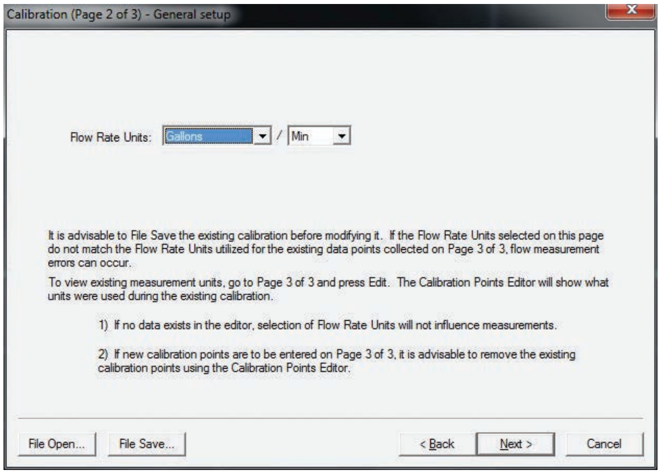
Because every transmitter installation is slightly different and sound waves can travel in slightly different ways through these installations, it is important to remove the zero offset at zero flow to maintain the transmitter's accuracy. The zeroing process is essential in systems using the DTTS and DTTC transducer sets for accuracy. To establish zero flow and eliminate the offset:

1. Establish zero flow in the pipe (verify that the pipe is full of fluid, turn off all pumps, and close a dead-heading valve). Wait until the delta time interval shown in *Current Delta T* is stable (and typically very close to zero).
2. Click **Set**.
3. Click **Next** when prompted, then click *Finish* to advance to *Page 2 of 3*.

Select Flow Rate Units

Use *Page 2 of 3* to select the engineering units for the calibration.

1. Select an engineering unit from the *Flow Rate Units* drop-down menu.
2. Click **Next** to advance to *Page 3 of 3*.



Flow Rate Units: Gallons / Min

It is advisable to File Save the existing calibration before modifying it. If the Flow Rate Units selected on this page do not match the Flow Rate Units utilized for the existing data points collected on Page 3 of 3, flow measurement errors can occur.

To view existing measurement units, go to Page 3 of 3 and press Edit. The Calibration Points Editor will show what units were used during the existing calibration.

1) If no data exists in the editor, selection of Flow Rate Units will not influence measurements.

2) If new calibration points are to be entered on Page 3 of 3, it is advisable to remove the existing calibration points using the Calibration Points Editor.

Figure 37: Calibration page 2 of 3

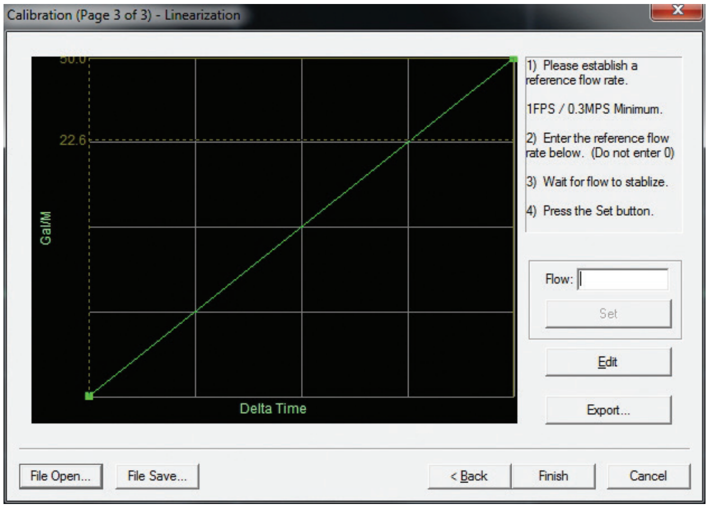
Set Multiple Flow Rates

Use *Page 3 of 3* to set multiple actual flow rates to be recorded by the transmitter.

To calibrate a point:

1. Establish a stable, known flow rate (verified by a real-time primary flow instrument).
2. Enter the actual flow rate in the *Flow* window and click **Set**.
3. Repeat for as many points as desired.
4. Click **Finish** when you have entered all points.

If you are using only two points (zero and span), use the highest flow rate anticipated in normal operation as the calibration point. If an erroneous data point is collected, remove it (click **Edit**, select the bad point, click **Remove**).



1) Please establish a reference flow rate.

1FPS / 0.3MPS Minimum.

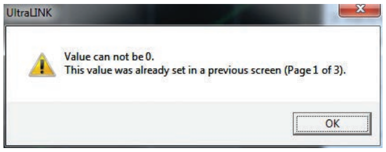
2) Enter the reference flow rate below. (Do not enter 0)

3) Wait for flow to stablize.

4) Press the Set button.

Figure 38: Calibration page 3 of 3

Zero values are not valid for linearization entries. Flow meter zero is entered on *Page 1 of 3*. If a zero calibration point is attempted, the following error message displays:

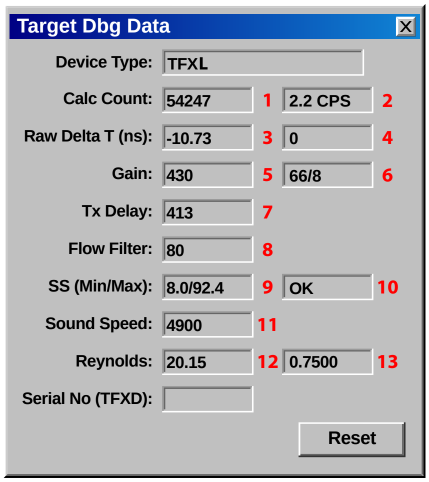


Value can not be 0.
This value was already set in a previous screen (Page 1 of 3).

Figure 39: Zero value error

Target Dbg Data Screen Definitions

Field	**Description**
Device Type	The flow meter type.
Calc Count	The number of flow calculations performed by the transmitter beginning at the time the power to the transmitter was last turned off and then on again.
Sample Count	The number of samples currently being taken in one second.
Raw Delta T (ηs)	The actual amount of time it takes for an ultrasonic pulse to cross the pipe.
Course Delta T	The transmitter series that uses two wave forms. The coarse to find the best delay and other timing measurements and a fine to do the flow measurement.
Gain	The amount of signal amplification applied to the reflected ultrasound pulse to make it readable by the digital signal processor.
Gain Setting/ Waveform Power	The first number The gain setting on the digital pot (automatically controlled by the AGC circuit). Valid numbers are from 1…100. The second number The power factor of the current waveform being used. For example, 8 indicates that a 1/8 power wave form is being used.
Tx Delay	The amount of time the transmitting transducer waits for the receiving transducer to recognize an ultrasound signal before the transmitter initiates another measurement cycle.
Flow Filter	The current value of the adaptive filter.
SS (Min/Max)	The minimum and maximum signal strength levels encountered by the transmitter beginning at the time the power to the transmitter was last turned off and then on again.
Signal Strength State	indicates if the present signal strength minimum and maximum are within a pre–programmed signal strength window.
Sound Speed	The actual sound speed being measured by the transducers at that moment.
Reynolds	is a number indicating how turbulent a fluid is. Reynolds numbers between 0 and 2000 are considered laminar flow. Numbers between 2000…4000 are in transition between laminar and turbulent flows and numbers greater than 4000 indicate turbulent flow.
Reynolds Factor	The value applied to the flow calculation to correct for variations in Reynolds numbers.



Device Type: TFXL
Calc Count: 54247 2.2 CPS
Raw Delta T (ns): -10.73 0
Gain: 430 66/8
Tx Delay: 413
Flow Filter: 80
SS (Min/Max): 8.0/92.4 OK
Sound Speed: 4900
Reynolds: 20.15 0.7500
Serial No (TFXD):

Figure 40: Target Dbg data screen

Saving the Configuration on a PC

The complete configuration of the transmitter can be saved from the Configuration screen. Select **File Save** button located in the lower left-hand corner of the screen and name the file. Files are saved as a *.dcf extension. This file may be transferred to other transmitters or may be recalled should the same pipe be surveyed again or multiple transmitters programmed with the same information.

Printing a Configuration Report

Select **File** > **Print** to print a calibration/configuration information sheet for the installation.

UltraLink Error Codes

Revised 04-06-2015

	Code	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 Removing the resistors from the transducer terminal block can boost the signal.
	0011	Measured speed of sound in the liquid is greater than ±10% of the value entered during transmitter setup	Verify that the correct liquid was selected in the BASIC menu. Verify that pipe size parameters are correct.
Class C Errors	**1001**	System tables have changed	Initiate a transmitter RESET by cycling power or by selecting SYSTEM RESET in the SEC MENU.
	1002	System configuration has changed	Initiate a transmitter 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	Re-calibrate the system.
	3005	Invalid speed-of-sound calibration data	Upload new data.
	3006	Bad system tables	Upload new table data.
Class A Errors	**4001**	Flash memory full	Return transmitter to factory for evaluation

Table 6: TFXL error codes

K-FACTORS

Description

The K-factor (with regards to flow) is the number of pulses that must be accumulated to equal a particular volume of fluid. You can think of each pulse as representing a small fraction of the totalizing unit.

An example might be a K-factor of 1000 (pulses per gallon). This means that if you were counting pulses, when the count total reached 1000, you would have accumulated one gallon of liquid. Using the same reasoning, each individual pulse represents an accumulation of 1/1000 of a gallon. This relationship is independent of the time it takes to accumulate the counts.

The frequency aspect of K-factors is a little more confusing because it also involves the flow rate. The same K-factor number, with a time frame added, can be converted into a flow rate. If you accumulated 1000 counts (one gallon) in one minute, then your flow rate would be one gpm. The output frequency, in Hz, is found simply by dividing the number of counts (1000) by the number of seconds in a minute (60) to get the output frequency.

1000 ÷ 60 = 16.6666 Hz. If you were looking at the pulse output on a frequency counter, an output frequency of 16.666 Hz would be equal to one gpm. If the frequency counter registered 33.333 Hz (2 × 16.666 Hz), then the flow rate would be two gpm.

Finally, if the flow rate is two gpm, then the accumulation of 1000 counts would take place in 30 seconds because the flow rate, and hence the speed that the 1000 counts is accumulated, is twice as great.

Calculating K-Factors

Many styles of transmitters are capable of measuring flow in a wide range of pipe sizes. Because the pipe size and volumetric units the transmitter will be used on vary, it may not possible to provide a discrete K-factor. In the event that a discrete K-factor is not supplied then the velocity range of the transmitter is usually provided along with a maximum frequency output.

The most basic K-factor calculation requires that an accurate flow rate and the output frequency associated with that flow rate be known.

Example 1

Known values are:

Frequency = 700 Hz
Flow Rate = 48 gpm

$$700 \text{ Hz} \times 60 \text{ sec} = 42{,}000 \text{ pulses per min}$$

$$\text{K factor} = \frac{42{,}000 \text{ pulses per min}}{48 \text{ gpm}} = 875 \text{ pulses per gallon}$$

Example 2

Known values are:

Full Scale Flow Rate = 85 gpm
Full Scale Output Frequency = 650 Hz

$$650 \text{ Hz} \times 60 \text{ sec} = 39{,}000 \text{ pulses per min}$$

$$\text{K factor} = \frac{39{,}000 \text{ pulses per min}}{85 \text{ gpm}} = 458.82 \text{ pulses per gallon}$$

The calculation is a little more complex if velocity is used because you first must convert the velocity into a volumetric flow rate to be able to compute a K-factor.

To convert a velocity into a volumetric flow, the velocity measurement and an accurate measurement of the inside diameter of the pipe must be known. Also needed is the fact that one US gallon of liquid is equal to 231 cubic inches.

Example 3

Known values are:

Velocity = 4.3 ft/sec
Inside Diameter of Pipe = 3.068 in.

Find the area of the pipe cross section.

$$\text{Area} = \pi r^2$$

$$\text{Area} = \pi \left(\frac{3.068}{2}\right)^2 = \pi \text{ x } 2.35 = 7.39 \text{ in}^2$$

Find the volume in one foot of travel.

$$7.39 \text{ in}^2 \text{ x } 12 \text{ in. (1 ft)} = \frac{88.71\text{in}^2}{\text{ft}}$$

What portion of a gallon does one foot of travel represent?

$$\frac{88.71 \text{ in}^3}{231 \text{ in}^3} = 0.384 \text{ gallons}$$

So for every foot of fluid travel 0.384 gallons will pass.

What is the flow rate in gpm at 4.3 ft/sec?

0.384 gallons × 4.3 FPS × 60 sec (1 min) = 99.1 gpm

Now that the volumetric flow rate is known, all that is needed is an output frequency to determine the K-factor.
Known values are:

Frequency = 700 Hz (By measurement)
Flow Rate = 99.1 gpm (By calculation)

700 Hz × 60 sec = 42,000 pulses per gallon

$$\text{K factor} = \frac{\text{42,000 pulses per min}}{\text{99.1 gpm}} = \text{423.9 pulses per gallon}$$

NORTH AMERICAN PIPE SCHEDULES

Steel, Stainless Steel, PVC Pipe, Standard Classes

NPS in.	OD in.	SCH 60		X STG.		SCH 80		SCH 100		SCH 120/140		SCH 180	
		ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.
1	1.315	—		0.957	0.179	0.957	0.179	—		—		0.815	0.250
1.25	1.660			1.278	0.191	1.278	0.191					1.160	0.250
1.5	1.900			1.500	0.200	1.500	0.200					1.338	0.281
2	2.375			1.939	0.218	1.939	0.218					1.687	0.344
2.5	2.875			2.323	0.276	2.323	0.276					2.125	0.375
3	3.500			2.900	0.300	2.900	0.300					2.624	0.438
3.5	4.000	—		3.364	0.318	3.364	0.318	—		—		—	
4	4.500			3.826	0.337	3.826	0.337			3.624	0.438	3.438	0.531
5	5.563			4.813	0.375	4.813	0.375			4.563	0.500	4.313	0.625
6	6.625			5.761	0.432	5.761	0.432			5.501	0.562	5.187	0.719
8	8.625	7.813	0.406	7.625	0.500	7.625	0.500	7.437	0.594	7.178	0.719	6.183	1.221
10	10.75	9.750	0.500	9.75	0.500	9.562	0.594	9.312	0.719	9.062	0.844	8.500	1.125
12	12.75	11.626	0.562	11.75	0.500	11.37	0.690	11.06	0.845	10.75	1.000	10.12	1.315
14	14.00	12.814	0.593	13.00	0.500	12.50	0.750	12.31	0.845	11.81	1.095	11.18	1.410
16	16.00	14.688	0.656	15.00	0.500	14.31	0.845	13.93	1.035	13.56	1.220	12.81	1.595
18	18.00	16.564	0.718	17.00	0.500	16.12	0.940	15.68	1.160	15.25	1.375	14.43	1.785
20	20.00	18.376	0.812	19.00	0.500	17.93	1.035	17.43	1.285	17.00	1.500	16.06	1.970
24	24.00	22.126	0.937	23.00	0.500	21.56	1.220	20.93	1.535	20.93	1.535	19.31	2.345
30	30.00	—		29.00	0.500	—		—		—		—	
36	36.00			35.00	0.500								
42	42.00			41.00	0.500								
48	48.00			47.00	0.500								

Table 7: Steel, stainless steel, PVC pipe, standard classes

Steel, Stainless Steel, PVC Pipe, Standard Classes (continued)

NPS in.	OD in.	SCH 5		SCH 10 (Lt Wall)		SCH 20		SCH 30		STD		SCH 40	
		ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.
1	1.315	1.185	0.065	1.097	0.109	—		—		1.049	—	1.049	0.133
1.25	1.660	1.53	0.065	1.442	0.109					1.380		1.380	0.140
1.5	1.900	1.77	0.065	1.682	0.109					1.610		1.610	0.145
2	2.375	2.245	0.065	2.157	0.109					2.067		2.067	0.154
2.5	2.875	2.709	0.083	2.635	0.120					2.469		2.469	0.203
3	3.500	3.334	0.083	3.260	0.120					3.068		3.068	0.216
3.5	4.000	3.834	0.083	3.760	0.120	—		—		3.548	—	3.548	0.226
4	4.500	4.334	0.083	4.260	0.120					4.026	0.237	4.026	0.237
5	5.563	5.345	0.109	5.295	0.134					5.047	0.258	5.047	0.258
6	6.625	6.407	0.109	6.357	0.134					6.065	0.280	6.065	0.280
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
10	10.75	10.482	0.134	10.42	0.165	10.25	0.250	10.13	0.310	10.02	0.365	10.02	0.365
12	12.75	12.42	0.165	12.39	0.180	12.25	0.250	12.09	0.330	12.00	0.375	11.938	0.406
14	14.00	—		13.50	0.250	13.37	0.315	13.25	0.375	13.25	0.375	13.124	0.438
16	16.00			15.50	0.250	15.37	0.315	15.25	0.375	15.25	0.375	15.000	0.500
18	18.00			17.50	0.250	17.37	0.315	17.12	0.440	17.25	0.375	16.876	0.562
20	20.00			19.50	0.250	19.25	0.375	19.25	0.375	19.25	0.375	18.814	0.593
24	24.00			23.50	0.250	23.25	0.375	23.25	0.375	23.25	0.375	22.626	0.687
30	30.00	—		29.37	0.315	29.00	0.500	29.00	0.500	29.25	0.375	29.25	0.375
36	36.00			35.37	0.315	35.00	0.500	35.00	0.500	35.25	0.375	35.25	0.375
42	42.00			—		—		—		41.25	0.375	41.25	0.375
48	48.00									47.25	0.375	47.25	0.375

Table 7: Steel, stainless steel, PVC pipe, standard classes (continued)

Copper Tubing, Copper and Brass Pipe, Aluminum

Nominal Diameter in.		Copper Tubing in.			Copper & Brass Pipe in.	Alum. in.	Nominal Diameter in.		Copper Tubing in.			Copper & Brass Pipe in.	Alum. in.
		Type							Type				
		K	L	M					K	L	M		
0.5	OD	0.625	0.625	0.625	0.840	—	3-1/2 in.	OD	3.625	3.625	3.625	4.000	—
	Wall	0.049	0.040	0.028	0.108			Wall	0.120	0.100	0.083	0.250	
	ID	0.527	0.545	0.569	0.625			ID	3.385	3.425	3.459	3.500	
0.6250	OD	0.750	0.750	0.750	—	—	4 in.	OD	4.125	4.125	4.125	4.500	4.000
	Wall	0.049	0.042	0.030				Wall	0.134	0.110	0.095	0.095	0.250
	ID	0.652	0.666	0.690				ID	3 857	3.905	3.935	3.935	4.000
0.75	OD	0.875	0.875	0.875	1.050	—	4-1/2 in.	OD	—	—	—	—	5.000
	Wall	0.065	0.045	0.032	0.114			Wall					0.250
	ID	0.745	0.785	0.811	0.822			ID					4.500
1	OD	1.125	1.125	1.125	1.315	—	5 in.	OD	5.125	5.125	5.125	5.563	5.000
	Wall	0.065	0.050	0.035	0.127			Wall	0.160	0.125	0.109	0.250	0.063
	ID	0.995	1.025	1.055	1.062			ID	4.805	4.875	4.907	5.063	4.874
1.25	OD	1.375	1.375	1.375	1.660	—	6 in.	OD	6.125	6.125	6.125	6.625	6.000
	Wall	0.065	0.055	0.042	0.146			Wall	0.192	0.140	0.122	0.250	0.063
	ID	1.245	1.265	1.291	1.368			ID	5.741	5.845	5.881	6.125	5.874
1.5.	OD	1.625	1.625	1.625	1.900	—	7 in.	OD	—	—	—	7.625	7.000
	Wall	0.072	0.060	0.049	0.150			Wall				0.282	0.078
	ID	1.481	1.505	1.527	1.600			ID				7.062	6.844
2	OD	2.125	2.125	2.125	2.375	—	8 in.	OD	8.125	8.125	8.125	8.625	8 000
	Wall	0.083	0.070	0.058	0.157			Wall	0,271	0.200	0.170	0.313	0.094
	ID	1.959	1.985	2.009	2.062			ID	7.583	7.725	7.785	8.000	7.812
2.5	OD	2.625	2.625	2.625	2.875	2.500	10 in.	OD	10.125	10.125	10.125	10 000	—
	Wall	0.095	0.080	0.065	0.188	0.050		Wall	0.338	0.250	0.212	0.094	—
	ID	2.435	2.465	2.495	2.500	2.400		ID	9.449	9.625	9.701	9.812	—
3	OD	3.125	3.125	3.125	3.500	3.000	12 in.	OD	12.125	12.125	12.125	—	—
	Wall	0.109	0.090	0.072	0.219	0.050		Wall	0.405	0.280	0.254	—	—
	ID	2.907	2.945	2.981	3.062	2.900		ID	11.315	11.565	11.617	—	—

Table 8: Copper tubing, copper and brass pipe, aluminum

Cast Iron Pipe, Standard Classes, 3…20 inch

Size in.		**Class in.**							
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
3	OD	3.80	3.96	3.96	3.96	—	—	—	—
	Wall	0.39	0.42	0.45	0.48				
	ID	3.02	3.12	3.06	3.00				
4	OD	4.80	5.00	5.00	5.00	—	—	—	—
	Wall	0.42	0.45	0.48	0.52				
	ID	3.96	4.10	4.04	3.96				
6	OD	6.90	7.10	7.10	7.10	7.22	7.22	7.38	7.38
	Wall	0.44	0.48	0.51	0.55	0.58	0.61	0.65	0.69
	ID	6.02	6.14	6.08	6.00	6.06	6.00	6.08	6.00
8	OD	9.05	9.05	9.30	9.30	9.42	9.42	9.60	9.60
	Wall	0.46	0.51	0.56	0.60	0.66	0.66	0.75	0.80
	ID	8.13	8.03	8.18	8.10	8.10	8.10	8.10	8.00
10	OD	11.10	11.10	11.40	11.40	11.60	11.60	11.84	11.84
	Wail	0.50	0.57	0.62	0.68	0.74	0.80	0.86	0.92
	ID	10.10	9.96	10.16	10.04	10.12	10.00	10.12	10.00
12	OD	13.20	13.20	13.50	13.50	13.78	13.78	14.08	14.08
	Wall	0.54	0.62	0.68	0.75	0.82	0.89	0.97	1.04
	ID	12.12	11.96	12.14	12.00	12.14	12.00	12.14	12.00
14	OD	15.30	15.30	15.65	15.65	15.98	15.98	16.32	16.32
	Wall	0.57	0.66	0.74	0.82	0.90	0.99	1.07	1.16
	ID	14.16	13.98	14.17	14.01	14.18	14.00	14.18	14.00
16	OD	17.40	17.40	17.80	17.80	18.16	18.16	18.54	18.54
	Wall	0.60	0.70	0.80	0.89	0.98	1.08	1.18	1.27
	ID	16.20	16.00	16.20	16.02	16.20	16.00	16.18	16.00
18	OD	19.50	19.50	19.92	19.92	20.34	20.34	20.78	20.78
	Wall	0.64	0.75	0.87	0.96	1.07	1.17	1.28	1.39
	ID	18.22	18.00	18.18	18.00	18.20	18.00	18.22	18.00
20	OD	21.60	21.60	22.06	22.06	22.54	22.54	23.02	23.02
	Wall	0.67	0.80	0.92	1.03	1.15	1.27	1.39	1.51
	ID	20.26	20.00	20.22	20.00	20.24	20.00	20.24	20.00

Table 9: Cast iron pipe, standard classes, 3…20 inch

Cast Iron Pipe, Standard Classes, 24…84 inch

Size in.		Class in.							
		A	B	C	D	E	F	G	H
24	OD	25.80	25.80	26.32	26.32	26.90	26.90	27.76	27.76
	Wall	0.76	0.98	1.05	1.16	1.31	1.45	1.75	1.88
	ID	24.28	24.02	24.22	24.00	24.28	24.00	24.26	24.00
30	O D	31.74	32.00	32.40	32.74	33.10	33.46	—	
	Wall	0.88	1.03	1.20	1.37	1.55	1.73		
	ID	29.98	29.94	30.00	30.00	30.00	30.00		
36	OD	37.96	38.30	38.70	39.16	39.60	40.04	—	
	Wall	0.99	1.15	1.36	1.58	1.80	2.02		
	ID	35.98	36.00	35.98	36.00	36.00	36.00		
42	OD	44.20	44.50	45.10	45.58	—			
	Wall	1.10	1.28	1.54	1.78				
	ID	42.00	41.94	42.02	42.02				
48	OD	50.55	50.80	51.40	51.98	—			
	Wall	1.26	1.42	1.71	1.99				
	ID	47.98	47.96	47.98	48.00				
54	OD	56.66	57.10	57.80	58.40	—			
	Wall	1.35	1.55	1.90	2.23				
	ID	53.96	54.00	54.00	53.94				
60	OD	62.80	63.40	64.20	64.28	—			
	Wall	1.39	1.67	2.00	2.38				
	ID	60.02	60.06	60.20	60.06				
72	OD	75.34	76.00	76.88	—				
	Wall	1.62	1.95	2.39					
	ID	72.10	72.10	72.10					
84	OD	87.54	88.54	—					
	Wall	1.72	2.22						
	ID	84.10	84.10						

Table 10: Cast iron pipe, standard classes, 24…84 inch

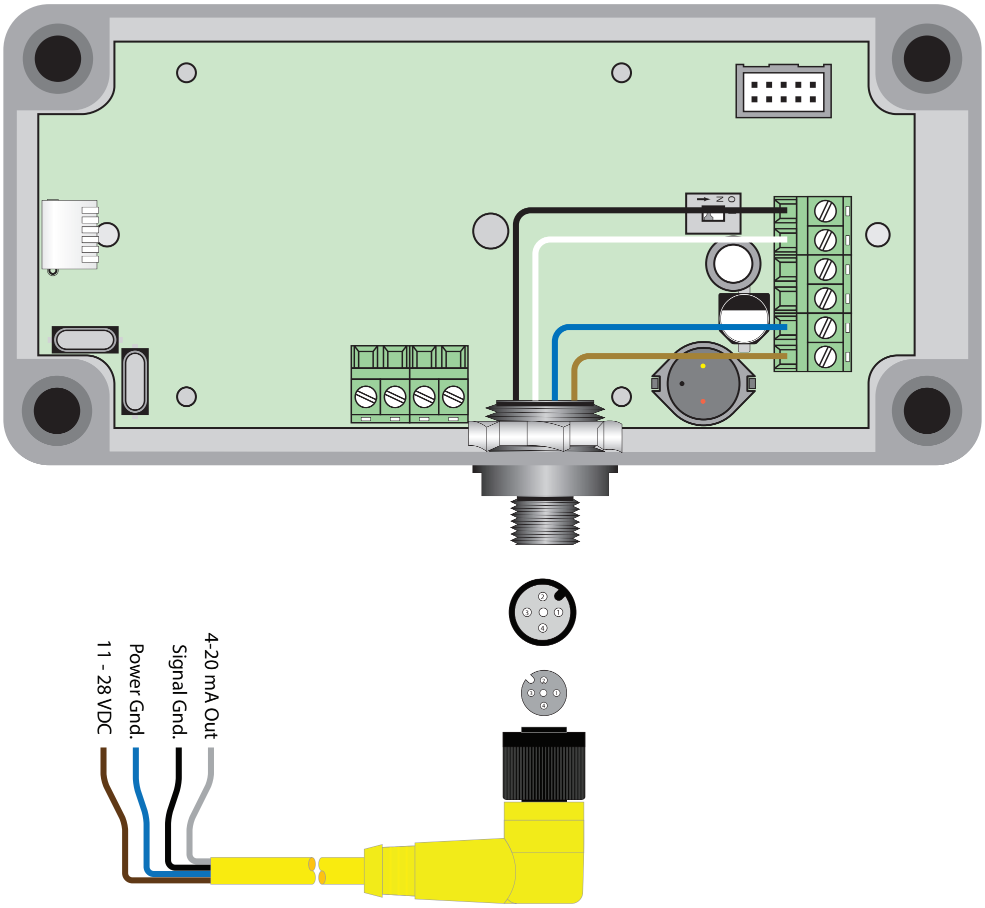
FLUID PROPERTIES

Fluid	Specific Gravity 20° C	Sound Speed		delta-v/° C m/s/° C	Kinematic Viscosity (cSt)	Absolute Viscosity (Cp)
		ft/s	m/s			
Acetate, Butyl	—	4163.9	1270	—	—	—
Acetate, Ethyl	0.901	3559.7	1085	4.4	0.489	0.441
Acetate, Methyl	0.934	3973.1	1211	—	0.407	0.380
Acetate, Propyl	—	4196.7	1280	—	—	—
Acetone	0.79	3851.7	1174	4.5	0.399	0.316
Alcohol	0.79	3960.0	1207	4.0	1.396	1.101
Alcohol, Butyl	0.83	4163.9	1270	3.3	3.239	2.688
Alcohol, Ethyl	0.83	3868.9	1180	4	1.396	1.159
Alcohol, Methyl	0.791	3672.1	1120	2.92	0.695	0.550
Alcohol, Propyl	—	3836.1	1170	—	—	—
Alcohol, Propyl	0.78	4009.2	1222	—	2.549	1.988
Ammonia	0.77	5672.6	1729	6.7	0.292	0.225
Aniline	1.02	5377.3	1639	4.0	3.630	3.710
Benzene	0.88	4284.8	1306	4.7	0.7 11	0.625
Benzol, Ethyl	0.867	4389.8	1338	—	0.797	0.691
Bromine	2.93	2916.7	889	3.0	0.323	0.946
n-Butane	0.60	3559.7	1085	5.8	—	—
Butyrate, Ethyl	—	3836.1	1170	—	—	—
Carbon dioxide	1.10	2752.6	839	7.7	0.137	0.151
Carbon tetrachloride	1.60	3038.1	926	2.5	0.607	0.968
Chloro-benezene	1.11	4176.5	1273	3.6	0.722	0.799
Chloroform	1.49	3211.9	979	3.4	0.550	0.819
Diethyl ether	0.71	3231.6	985	4.9	0.3 11	0.222
Diethyl Ketone	—	4295.1	1310	—	—	—
Diethylene glycol	1.12	5203.4	1586	2.4	—	—
Ethanol	0.79	3960.0	1207	4.0	1.390	1.097
Ethyl alcohol	0.79	3960.0	1207	4.0	1.396	1.101
Ether	0.71	3231.6	985	4.9	0.3 11	0.222
Ethyl ether	0.71	3231.6	985	4.9	0.3 11	0.222
Ethylene glycol	1.11	5439.6	1658	2.1	17.208	19.153
Freon R12	—	2540	774.2	—	—	—
Gasoline	0.7	4098.4	1250	—	—	—
Glycerin	1.26	6246.7	1904	2.2	757.100	953.946
Glycol	1.11	5439.6	1658	2.1	—	—
Isobutanol	0.81	3976.4	1212	—	—	—
Iso-Butane	—	4002	1219.8	—	—	—
Isopentane	0.62	3215.2	980	4.8	0.340	0.211
Isopropanol	0.79	3838.6	1170	—	2.718	2.134
Isopropyl Alcohol	0.79	3838.6	1170	—	2.718	2.134

Fluid	Specific Gravity 20° C	Sound Speed		delta-v/° C m/s/° C	Kinematic Viscosity (cSt)	Absolute Viscosity (Cp)
		ft/s	m/s			
Kerosene	0.81	4343.8	1324	3.6	—	—
Linalool	—	4590.2	1400	—	—	—
Linseed Oil	0.925…0.939	5803.3	1770	—	—	—
Methanol	0.79	3530.2	1076	2.92	0.695	0.550
Methyl Alcohol	0.79	3530.2	1076	2.92	0.695	0.550
Methylene Chloride	1.33	3510.5	1070	3.94	0.310	0.411
Methylethyl Ketone	—	3967.2	1210	—	—	—
Motor Oil (SAE 20/30)	0.88…0.935	4875.4	1487	—	—	—
Octane	0.70	3845.1	1172	4.14	0.730	0.513
Oil, Castor	0.97	4845.8	1477	3.6	0.670	0.649
Oil, Diesel	0.80	4101	1250	—	—	—
Oil (Lubricating X200)	—	5019.9	1530	—	—	—
Oil (Olive)	0.91	4694.9	1431	2.75	100.000	91 .200
Oil (Peanut)	0.94	4783.5	1458	—	—	—
Paraffin Oil	—	4655.7	1420	—	—	—
Pentane	0.626	3346.5	1020	—	0.363	0.227
Petroleum	0.876	4229.5	1290	—	—	—
1-Propanol	0.78	4009.2	1222	—	—	—
Refrigerant 11	1.49	2717.5	828.3	3.56	—	—
Refrigerant 12	1.52	2539.7	774.1	4.24	—	—
Refrigerant 14	1.75	2871.5	875.24	6.61	—	—
Refrigerant 21	1.43	2923.2	891	3.97	—	—
Refrigerant 22	1.49	2932.7	893.9	4.79	—	—
Refrigerant 113	1.56	2571.2	783.7	3.44	—	—
Refrigerant 114	1.46	2182.7	665.3	3.73	—	—
Refrigerant 115	—	2153.5	656.4	4.42	—	—
Refrigerant C318	1.62	1883.2	574	3.88	—	—
Silicone (30 cp)	0.99	3248	990	—	30.000	29.790
Toluene	0.87	4357	1328	4.27	0.644	0.558
Transformer Oil	—	4557.4	1390	—	—	—
Trichlorethylene	—	3442.6	1050	—	—	—
1,1,1 -Trichloroethane	1.33	3231.6	985	—	0.902	1.200
Turpentine	0.88	4117.5	1255	—	1.400	1.232
Water, distilled	0.996	4914.7	1498	–2.4	1.000	0.996
Water, heavy	1	4593	1400	—	—	—
Water, sea	1.025	5023	1531	–2.4	1.000	1.025
Wood Alcohol	0.791	3530.2	1076	2.92	0.695	0.550
m-Xylene	0.868	4406.2	1343	—	0.749	0.650
o-Xylene	0.897	4368.4	1331.5	4.1	0.903	0.810
p-Xylene	—	4376.8	1334	—	0.662	—

Table 11: Fluid properties

BRAD HARRISON® CONNECTOR OPTION

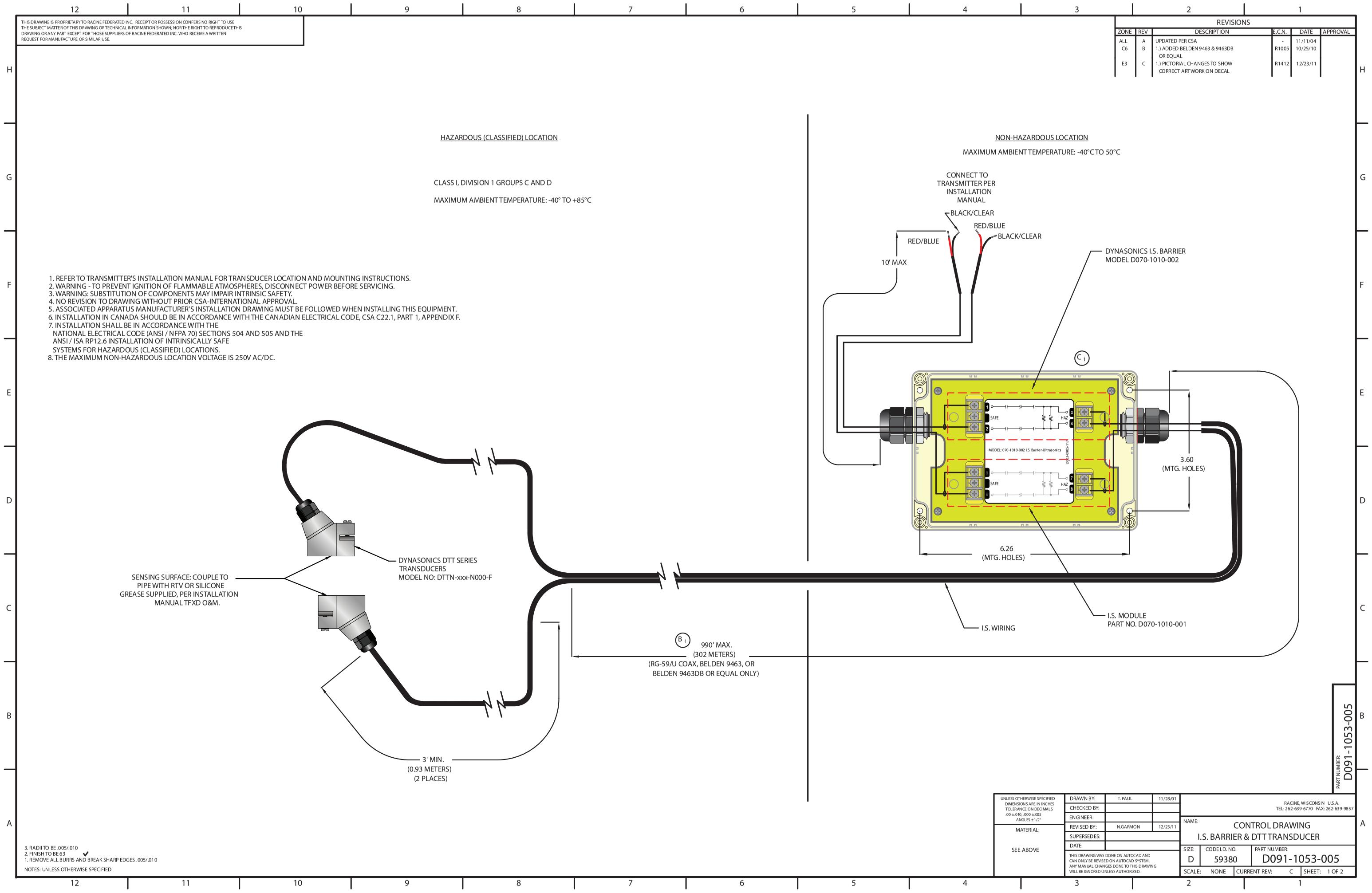


Cable
D005-0956-001 (Straight Connector)
D005-0956-002 (90° Connector)

Bulkhead Connector
D005-0954-001

Figure 41: Brad Harrison connection

CONTROL DRAWINGS



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REVISIONS					
ZONE	REV	DESCRIPTION	E.C.N.	DATE	APPROVAL
ALL	A	UPDATED PER CSA	-	11/11/04	
C6	B	1.) ADDED BELDEN 9463 & 9463DB OR EQUAL	R1005	10/25/10	
E3	C	1.) PICTORIAL CHANGES TO SHOW CORRECT ARTWORK ON DECAL	R1412	12/23/11	

1. REFER TO TRANSMITTER'S INSTALLATION MANUAL FOR TRANSDUCER LOCATION AND MOUNTING INSTRUCTIONS.
2. WARNING - TO PREVENT IGNITION OF FLAMMABLE ATMOSPHERES, DISCONNECT POWER BEFORE SERVICING.
3. WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.
4. NO REVISION TO DRAWING WITHOUT PRIOR CSA-INTERNATIONAL APPROVAL.
5. ASSOCIATED APPARATUS MANUFACTURER'S INSTALLATION DRAWING MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT.
6. INSTALLATION IN CANADA SHOULD BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, CSA C22.1, PART 1, APPENDIX F.
7. INSTALLATION SHALL BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (ANSI / NFPA 70) SECTIONS 504 AND 505 AND THE ANSI / ISA RP12.6 INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS.
8. THE MAXIMUM NON-HAZARDOUS LOCATION VOLTAGE IS 250V AC/DC.

3. RADII TO BE .005/.010
2. FINISH TO BE 63 ✓
1. REMOVE ALL BURRS AND BREAK SHARP EDGES .005/.010

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCE ON DECIMALS
.00 ±.010, .000 ±.005
ANGLES ±1/2°

MATERIAL:
SEE ABOVE

DRAWN BY:	T. PAUL	11/28/01
CHECKED BY:		
ENGINEER:		
REVISED BY:	N.GARMON	12/23/11
SUPERSEDES:		
DATE:		

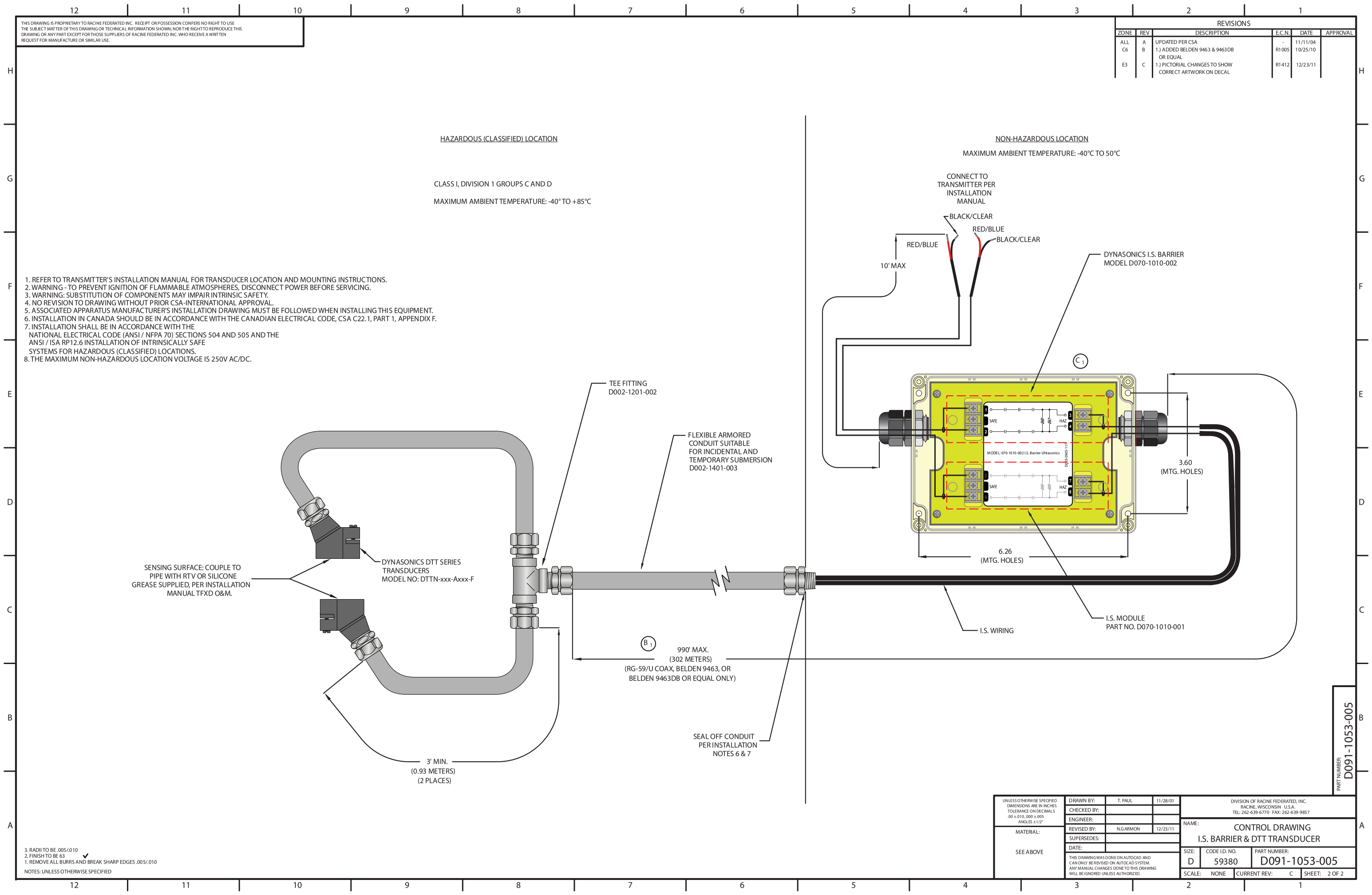
THIS DRAWING WAS DONE ON AUTOCAD AND CAN ONLY BE REVISED ON AUTOCAD SYSTEM. ANY MANUAL CHANGES DONE TO THIS DRAWING WILL BE IGNORED UNLESS AUTHORIZED.

RACINE, WISCONSIN U.S.A.
TEL: 262-639-6770 FAX: 262-639-9857

NAME: CONTROL DRAWING
I.S. BARRIER & DTT TRANSDUCER

SIZE: D
CODE I.D. NO. 59380
PART NUMBER: D091-1053-005
SCALE: NONE
CURRENT REV: C
SHEET: 1 OF 2

Figure 42: Control drawing, IS barrier DTT transducers



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REVISIONS

ZONE	REV	DESCRIPTION	E.C.N.	DATE	APPROVAL
ALL	A	UPDATED PER CSA	-	11/11/04	
C6	B	1.) ADDED BELDEN 9463 & 9463DB OR EQUAL	R1005	10/25/10	
E3	C	1.) PICTORIAL CHANGES TO SHOW CORRECT ARTWORK ON DECAL	R1412	12/23/11	

1. REFER TO TRANSMITTER'S INSTALLATION MANUAL FOR TRANSDUCER LOCATION AND MOUNTING INSTRUCTIONS.
2. WARNING - TO PREVENT IGNITION OF FLAMMABLE ATMOSPHERES, DISCONNECT POWER BEFORE SERVICING.
3. WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.
4. NO REVISION TO DRAWING WITHOUT PRIOR CSA-INTERNATIONAL APPROVAL.
5. ASSOCIATED APPARATUS MANUFACTURER'S INSTALLATION DRAWING MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT.
6. INSTALLATION IN CANADA SHOULD BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, CSA C22.1, PART 1, APPENDIX F.
7. INSTALLATION SHALL BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (ANSI / NFPA 70) SECTIONS 504 AND 505 AND THE ANSI / ISA RP12.6 INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS.
8. THE MAXIMUM NON-HAZARDOUS LOCATION VOLTAGE IS 250V AC/DC.

3. RADII TO BE .005/.010
2. FINISH TO BE 63 ✓
1. REMOVE ALL BURRS AND BREAK SHARP EDGES .005/.010

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON DECIMALS .00 ±.010, .000 ±.005 ANGLES ±1/2°

MATERIAL: SEE ABOVE

DRAWN BY:	T. PAUL	11/28/01
CHECKED BY:		
ENGINEER:		
REVISED BY:	N.GARMON	12/23/11
SUPERSEDES:		
DATE:		

THIS DRAWING WAS DONE ON AUTOCAD AND CAN ONLY BE REVISED ON AUTOCAD SYSTEM. ANY MANUAL CHANGES DONE TO THIS DRAWING WILL BE IGNORED UNLESS AUTHORIZED.

DIVISION OF RACINE FEDERATED, INC.
RACINE, WISCONSIN U.S.A.
TEL: 262-639-6770 FAX: 262-639-9857

NAME: CONTROL DRAWING
I.S. BARRIER & DTT TRANSDUCER

SIZE: D
CODE I.D. NO. 59380
PART NUMBER: D091-1053-005
SCALE: NONE
CURRENT REV: C
SHEET: 2 OF 2

PART NUMBER: D091-1053-005

Figure 43: Control drawing, IS barrier DTT transducers flexible conduit

SPECIFICATIONS

System

Liquid Types	Most clean liquids or liquids containing small amounts of suspended solids or gas bubbles	
Velocity Range	0.1…40 FPS (0.03…012, MPS)	
Flow Accuracy	DTTR/DTTN/DTTH	±1% of reading at rates > 1 FPS (0.3 MPS), ±0.01 FPS (±0.003 MPS) at rates lower than 1 FPS
	DTTS/DTTC	1 in. (25 mm) and larger – ±1% of reading from 10…100% of measuring range, or ±0.01 FPS (0.003 MPS) at rates lower than 10% of measuring range; 3/4 in. (19 mm) and smaller – ±1% of full scale
Ambient Temperature	General purpose	–40…185° F (–40…85° C)
	Hazardous locations integral mount	0…105° F (–17…40° C)
	Hazardous locations DTTN	–40…185° F (–40…85° C)
Repeatability	±0.5% of reading	
Transducer Type	Clamp-on, uses time-of-flight ultrasonics	
Protection	Reverse polarity, surge suppression	
Certifications	Remote mount transmitter and integral mount transmitter with transducers	General purpose standards: UL 61010-1 and CSA C22.2 No. 61010-1 Hazardous location designation and standards: Class I, Division 2, Groups C and D UL1604, CSA C22.2 No. 213
	Hazardous location transducers (DTTN with I.S. option)	Hazardous location designation and standards: Class I, Division 1, Groups C and D, T5 UL913:2002, UL916 CAN/CSA C22.2 No. 0-10, C22.2 No. 142-M1987, C22.2 No. 157-92 Install with I.S. barrier D070-1010-002

Table 12: System specifications

Transmitter

Power Requirements	12…28V DC @ 0.25A	
Display	Type	2 line x 8 character LCD
	Rate	8 maximum digits with lead zero blanking
	Total	8 maximum digits with exponential multipliers from –1…6
Enclosure Rating	NEMA Type 3 (Type 3) ABS, PVC and Ultem (integral system), brass or SS hardware	
Units of Measure	Engineering units	Feet, US gallons, cubic feet, million gallons, barrels (liquid and oil), acre-feet, lb, meters, cubic meters, liters, million liters, kilograms
	Rate	Second, minute, hour, day
Outputs	Analog and TTL Frequency (Output option 1)	4…20 mA: 900 ohms max, internally powered, 12-bit resolution
		Selectable turbine meter simulation or square wave 0…1000 Hz, duty cycle 50% +/- 10% Square wave: 5V DC Turbine meter simulation: 500 mVpp minimum
	Totalizer pulse (Output option 3)	Source or sink, 5V DC, 2 mA maximum, pulse duration 30 ms, external resistor Normal state high with pulses low

Table 13: Transmitter specifications

Transducers

Transducer Construction	DTTR	NEMA 6*/IP67	PBT glass filled, Ultem, Nylon cord grip PVC cable jacket; –40…250° F (–40…121° C)
	DTTC	NEMA 6*/IP67	CPVC, Ultem, Nylon cord grip Polyethylene cable jacket; –40…185° F (–40…85° C)
	DTTN I.S.	NEMA 6P*/IP68	CPVC, Ultem, Nylon cord grip Polyethylene cable jacket; –40…185° F (–40…85° C)
	DTTH	NEMA 6*/IP67	PTFE, Vespel, Nickel-plated brass cord grip PFA cable jacket; –40…350° F (–40…176° C)
	DTTS	NEMA 6*/IP67	PVC, Ultem, Nylon cord grip PVC cable jacket; –40…140° F (–40…60° C)
	*NEMA 6 units: to a depth of 3 ft (1 m) for 30 days max. NEMA 6P units: to a depth of 100 ft (30 m) seawater equivalent density indefinitely.		
Cable Length	990 ft (300 meter) max. in 10 ft (3 m) increments; Submersible Conduit limited to 100 ft (30 m)		
Pipe/Tubing Sizes	1/2 in. (12 mm) and larger		
Pipe/Tubing Materials	Carbon steel, stainless steel, copper and plastic		

Table 14: Transducer specifications

Software Utilities

ULTRALINK	Used to configure, calibrate and troubleshoot flow meter. Compatible with Windows 2000, Windows XP, Windows Vista and Windows 7

Table 15: Software specifications

PART NUMBER CONSTRUCTION

Dynasonics Ultrasonic Flow Meters

TFXL - Transit Time

DTFXL ☐ - ☐ ☐ ☐ - ☐ ☐

Model

Transit Time Ultrasonic Flow Transmitter	DTFXL

Display Options

ABS Enclosure - Blind (No Display) C/US	1
ABS Enclosure - With Rate and Total Display C/US	2

Pipe Size/Measurement Range

1/2 Inch ANSI Pipe	A
3/4 Inch ANSI Pipe	B
1 Inch ANSI Pipe	C
1-1/4 Inch ANSI Pipe	D
1-1/2 Inch ANSI Pipe	E
2 Inch ANSI Pipe	F
1/2 Inch Copper Tube	G
3/4 Inch Copper Tube	H
1 Inch Copper Tube	I
1-1/4 Inch Copper Tube	J
1-1/2 Inch Copper Tube	K
2 Inch Copper Tube	L
1/2 Inch O.D. Std Tube	M
3/4 Inch O.D. Std Tube	N
1 Inch O.D. Std Tube	P
1-1/4 Inch O.D. Std Tube	Q
1-1/2 Inch O.D. Std Tube	R
2 Inch O.D. Std Tube	S
Remote Mount | ***Use with DTTR/N/H***	X
Remote Mount | ***Use with DTTS/C***	Y

Connector Options

None - (Two) 1/2 inch Conduit Holes	N
(Two) Water Tight Cable Clamps	A
(Two) 1/2 Inch Flexible Conduit Connectors	D

Output Options

4 … 20 mA and TTL Pulse	1
Totalizer Pulse	3

Reserved

None (Reserved)	N

Options

None	N
CPVC Transducer Material | ***Integral Mount Options Only***	C
I.S. DTTN Transducer | ***Remote Option X Only***	F

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