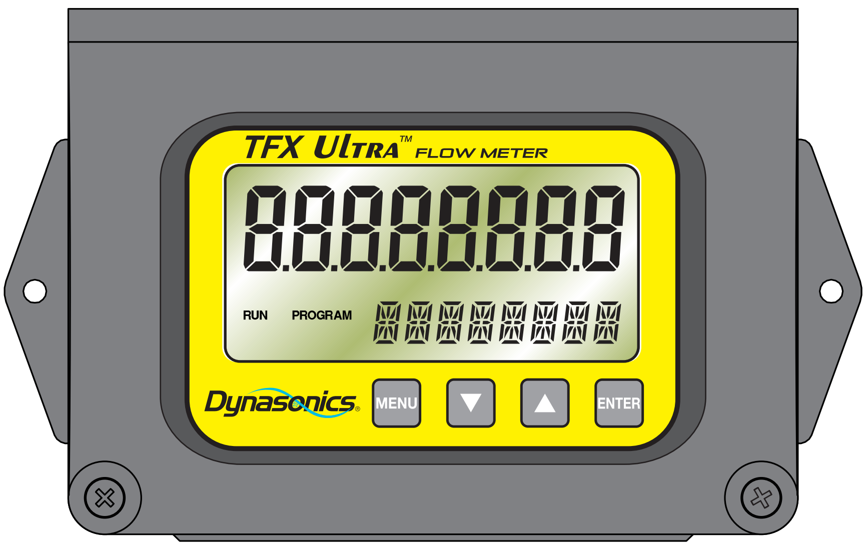
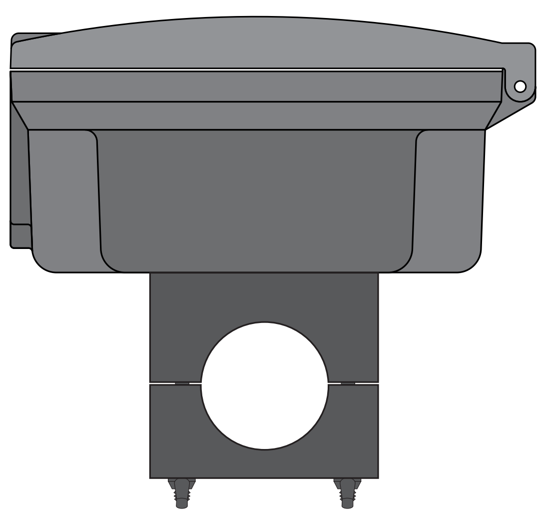
Operator's Manual

Ultra

Transit Time Flow Meter





Tel: 262-639-6770

Toll Free: 800-535-3569

TABLE OF CONTENTS

PART 4 - STARTUP AND CONFIGURATION..39

PART 5 - ULTRALINK™ SOFTWARE UTILITY 64

APPENDIX 84

FIGURES

TABLES

QUICK-START OPERATING INSTRUCTIONS

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

NOTE: *The following steps require information supplied by the Ultra meter itself so it will be necessary to supply power to the unit, at least temporarily, to obtain setup information.*

1 - TRANSDUCER LOCATION

1) In general, select a mounting location on the piping system with a minimum of **10** pipe diameters (10 × the pipe inside diameter) of straight pipe upstream and **5** straight diameters downstream. See ***Table 2.1*** for additional configurations.
2) If the application requires DTN, DTL or DTH transducers select a mounting method for the transducers based on pipe size and liquid characteristics. See ***Table 2.2***. Transducer configurations are illustrated in ***Figure Q.1*** below.

NOTE: *All DTS and DTC transducers use **V-**Mount configuration.*

3) Enter the following data into the Ultra transmitter via the integral keypad or the software utility:

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

**** NOMINAL VALUES FOR THESE PARAMETERS ARE INCLUDED WITHIN THE ULTRA OPERATING SYSTEM. THE NOMINAL VALUES MAY BE USED AS THEY APPEAR OR MAY BE MODIFIED IF THE EXACT SYSTEM VALUES ARE KNOWN.***

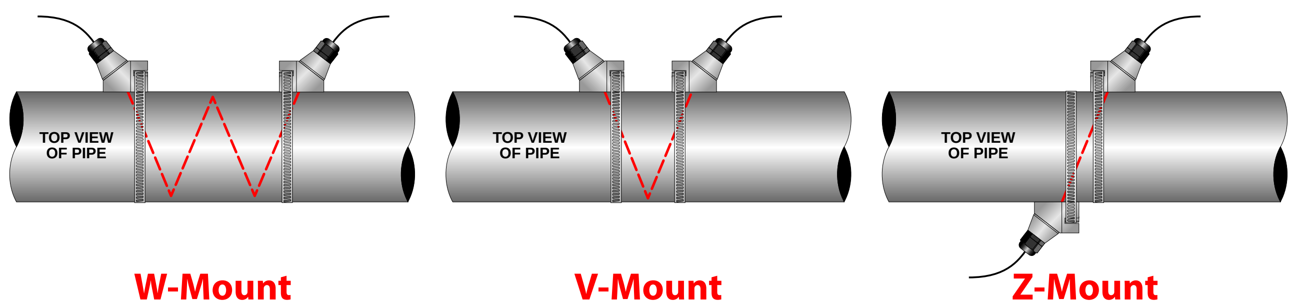


FIGURE Q.1 - TRANSDUCER MOUNTING CONFIGURATIONS

4) Record the value calculated and displayed as Transducer Spacing (**XDC SPAC**).

2 - ELECTRICAL CONNECTIONS

TRANSDUCER/POWER CONNECTIONS

1) Route the transducer cables from the transducer mounting location back to the Ultra enclosure. Connect the transducer wires to the terminal block in the Ultra enclosure.

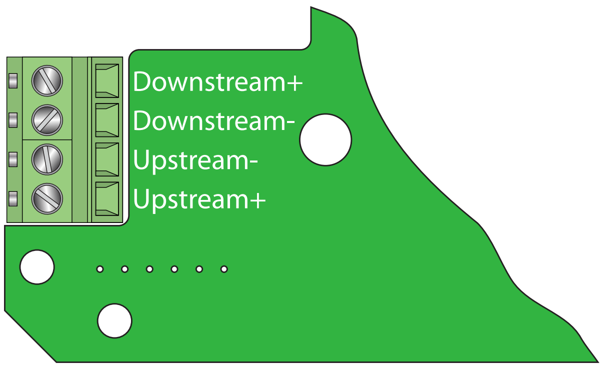


FIGURE Q.2 - TRANSDUCER CONNECTIONS

2) Verify that power supply is correct for the meters power option.

Line voltage AC units require 95 to 265 VAC 47 to 63 Hz @ 17 VA maximum.

Low voltage AC units require 20 to 28 VAC 47 to 63 Hz @ 0.35 A maximum.

DC units require 10 to 28 VDC @ 5 Watts maximum.

3) Connect power to the Ultra flow meter.

3 - PIPE PREPARATION AND TRANSDUCER MOUNTING

(DTN, DTL, and DTH Transducers)

1) Place the flow meter in signal strength measuring mode. This value is available on the Ultra display (Service Menu) or in the data display of the 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.
3) Apply a single ½" (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 ***Step 1***.
5) Space the transducers according to the recommended values found during programming or from the software utility. Secure the transducers with the mounting straps at these locations.

(DTS and DTC Transducers)

1) Place the flow meter in signal strength measuring mode. This value is available on the Ultra display (Service Menu) or in the data display of the 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.
3) Apply a single ½” (12 mm) bead of acoustic couplant grease to the top half of the transducer and secure it to the pipe with bottom half or U-bolts.
4) Tighten the nuts so that the acoustic coupling grease begins to flow out from the edges of the transducer and from the gap between the transducer and the pipe. **Do not over tighten**.

4 - STARTUP

INITIAL SETTINGS AND POWER UP

1) Apply power to the transmitter.
2) Verify that **SIG STR** is greater than 5.0.
3) Input proper units of measure and I/O data.

INTRODUCTION

GENERAL

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

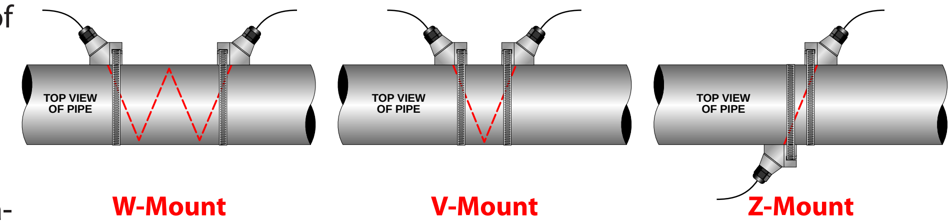


FIGURE 1.1 - ULTRASOUND TRANSMISSION

The Ultra family of transit time flow meters utilize two transducers that function as both ultrasonic transmitters and receivers. The transducers are clamped on the outside of a closed pipe **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 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 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 Ultra flow meter can be successfully applied on a wide range of metering applications. The simple-to-program transmitter allows the standard product to be used on pipe sizes ranging from ½ inch to 100 inches (12 mm to 2540 mm)*. A variety of liquid applications can be accommodated:

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

Because the transducers are non-contacting and have no moving parts, the flow meter is not affected by system pressure, fouling or wear. Standard transducers, DTN and DTL are rated to a pipe surface temperature of -40 to +250 °F (-40 to +121 °C). DTS small pipe transducers are rated from -40 to +185 °F (-40 to +85 °C). The DTH high temperature transducers can operate to a pipe surface temperature of -40 to +350 °F (-40 to +176 °C) and the DTC small pipe high temperature transducer will withstand temperature of -40 to +250 °F (-40 to +121 °C).

****ALL ½" TO 1½" SMALL PIPE TRANSDUCERS AND 2" SMALL PIPE TUBING TRANSDUCER SETS REQUIRE THE TRANSMITTER BE CONFIGURED FOR 2 MHz AND USE DEDICATED PIPE TRANSDUCERS. DTL TRANSDUCERS REQUIRE THE USE OF THE 500 KHz TRANSMISSION FREQUENCY. THE TRANSMISSION FREQUENCY IS SELECTABLE USING EITHER THE SOFTWARE UTILITY OR THE TRANSMITTER'S KEYPAD.***

CE COMPLIANCE

The Ultra transmitter can be installed in conformance to CISPR 11 (EN 55011) standards. See the CE Compliance drawings in the ***Appendix*** of this manual.

USER SAFETY

TheUltra employs modular construction and provides electrical safety for the operator. The display face contains voltages no greater than 28 VDC. The display face swings open to allow access to user connections.

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 for several years at 77 °F (25 °C), even if power is lost or turned off. Password protection is provided as part of the Security menu (**SEC MENU**) and prevents inadvertent configuration changes or totalizer resets.

PRODUCT IDENTIFICATION

The serial number and complete model number of the transmitter are located on the top outside surface of the transmitter's body. Should technical assistance be required, please provide the Customer Service Department with this information.

PART 1 - TRANSMITTER INSTALLATION

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

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

1) Locate the transmitter within the length of transducer cables supplied. If this is not possible, it is recommended that the cable be exchanged for one that is of proper length. To add cable length to a transducer, the cable must be the same type as utilized on the transducer. Twinaxial cables can be lengthened with like cable to a maximum overall length of 100 feet (30 meters). Coaxial cables can be lengthened with RG59 75 Ohm cable and BNC connectors to 990 feet (300 meters).

2) Mount the Ultra transmitter in a location:

   ~ Where little vibration exists.

   ~ That is protected from corrosive fluids.

   ~ That is within the transmitters ambient temperature limits -40 to +185 °F (-40 to +85 °C).

   ~ That is out of direct sunlight. Direct sunlight may increase transmitter temperature to above the maximum limit.

3) Mounting - Refer to ***Figure 1.2*** for enclosure and mounting dimension details. Ensure that enough room is available to allow for door swing, maintenance and conduit entrances. Secure the enclosure to a flat surface with two appropriate fasteners.

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

   An optional cable gland kit is available for inserting transducer and power cables. The part number for this kit is D010-1100-000 and can be ordered directly from the manufacturer.

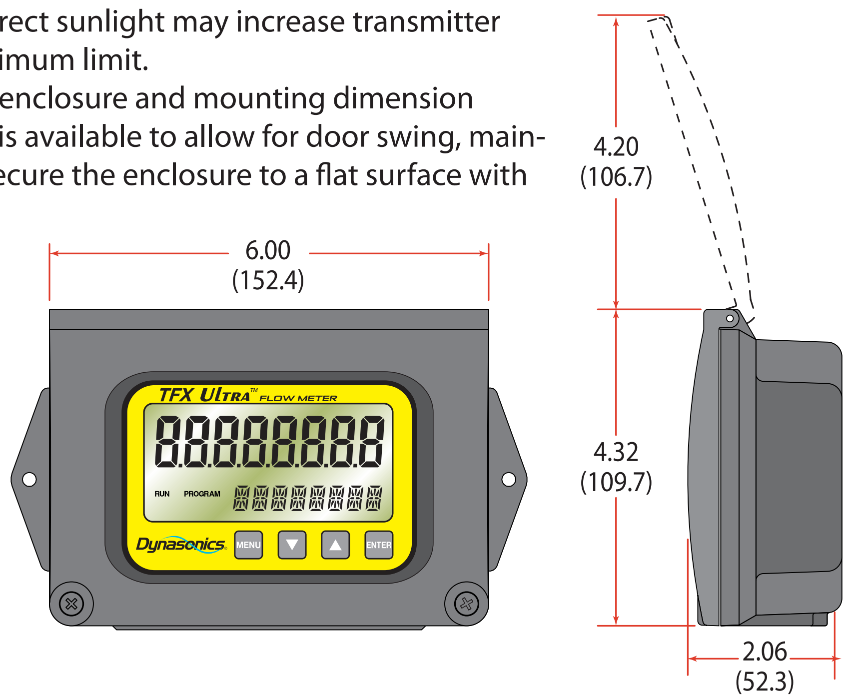


FIGURE 1.2 - ULTRA TRANSMITTER DIMENSIONS

NOTE: *Use NEMA 4 [IP-65] rated fittings/plugs to maintain the watertight integrity of the enclosure. Generally, the right conduit hole (viewed from front) is used for power, the left conduit hole for transducer connections, and the center hole is utilized for I/O wiring.*

TRANSDUCER CONNECTIONS

To access terminal strips for wiring, loosen the two screws in the enclosure door and open.

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).

The terminals within Ultra are of a screw-down barrier terminal type. Connect the appropriate wires at the corresponding screw terminals in the transmitter. Observe upstream and downstream orientation and wire polarity. See ***Figure 1.3***.

__NOTE:__ Transducer cables have two possible wire colors. For the blue and white combination the blue wire is positive (+) and the white wire is negative (-). 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 DYNASONICS factory to arrange an exchange for a transducer with the appropriate length of cable. Cables 100 to 990 feet (30 to 300 meters) are available with RG59 75 Ohm coaxial cable. If additional cable is added, ensure that it is the same type as utilized on the transducer. Twinaxial (blue and white conductor) cables can be lengthened with like cable to a __maximum overall length of 100 feet (30 meters)__. Coaxial cables can be lengthened with RG59 75 Ohm cable and BNC connectors to 990 feet (300 meters).

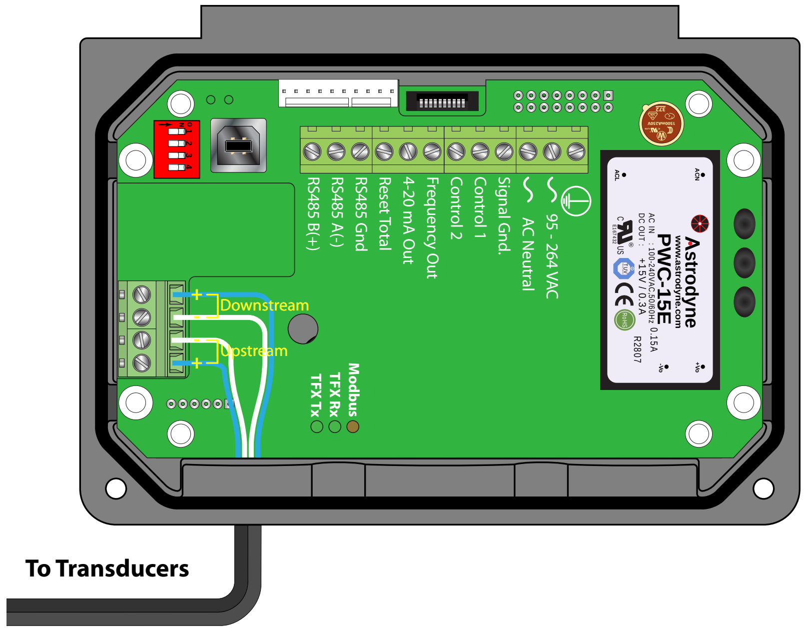


FIGURE 1.3 - TRANSDUCER CONNECTIONS

Connect power to the screw terminal block in the Ultra transmitter. See ***Figure 1.4*** and ***Figure 1.5***. Utilize the conduit hole on the right side of the enclosure for this purpose. Use wiring practices that conform to local and national codes (e.g., The National Electrical Code® Handbook in the U.S.)

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

__NOTE:__ This instrument requires clean electrical line power. Do not operate this unit on circuits with noisy components (i.e., fluorescent lights, relays, compressors, or variable frequency drives). The use of step down transformers from high voltage, high amperage sources is also not recommended. Do not to run signal wires with line power within the same wiring tray or conduit.

LINE VOLTAGE AC POWER CONNECTIONS

Connect 90 to 265 VAC, AC Neutral and Chassis Ground to the terminals referenced in ***Figure 1.4***. Do not operate without an earth (chassis) ground connection.

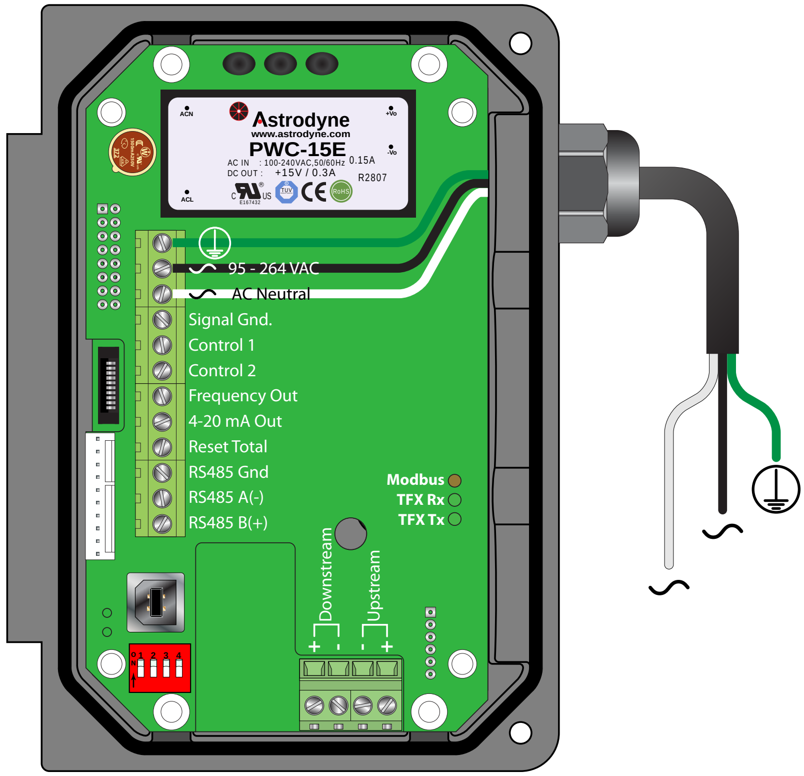


FIGURE 1.4 - AC POWER CONNECTIONS

LOW VOLTAGE AC POWER CONNECTIONS

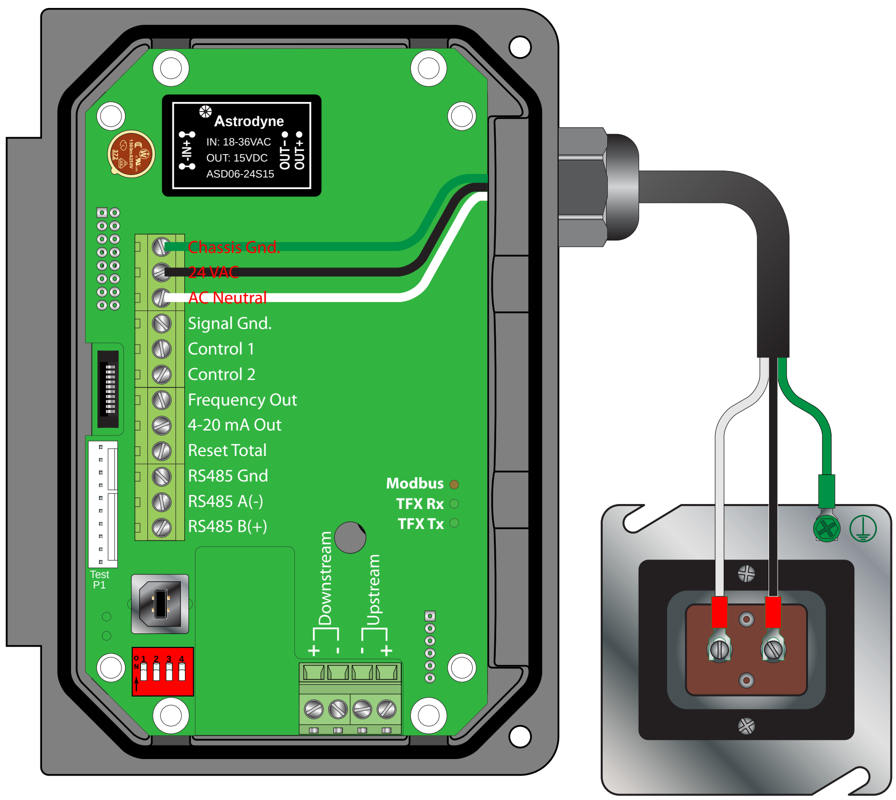
Connect 20 to 28 VAC, AC Neutral and Chassis Ground to the terminals referenced in ***Figure 1.5***. Do not operate without an earth (chassis) ground connection.

The 24 VAC power supply option for the Ultra is intended for a typical HVAC and <u>B</u>uilding <u>C</u>ontrol <u>S</u>ystems (BCS) powered by a 24 VAC, nominal, power source. This power source is provided by AC line power to 24 VAC drop down transformer and is installed by the installation electricians.

NOTE: *In electrically noisy applications, grounding the meter to the pipe where the transducers are mounted may provide additional noise suppression. This approach is only effective with conductive metal pipes. The earth (chassis) ground derived from the line voltage power supply should be removed at the meter and a new earth ground connected between the meter and the pipe being measured.*

NOTE: *Wire gauges up to 14 AWG can be accommodated in the Ultra terminal blocks.*

NOTE: *AC powered versions are protected by a field replaceable fuse, P.N. D005-1301-012. This fuse is equivalent to Wickmann P.N. 3720500041 or 37405000410.*



24 VAC Transformer

FIGURE 1.5 - 24 VAC POWER CONNECTIONS

DC POWER CONNECTIONS

The Ultra may be operated from a 10 to 28 VDC source, as long as the source is capable of supplying a minimum of 5 Watts of power.

Connect the DC power to 10 to 28 VDC In, Power Gnd., and Chassis Gnd., as in ***Figure 1.6***.

> ***NOTE:*** *DC powered versions are protected by an automatically resetting fuse. This fuse does not require replacement.*

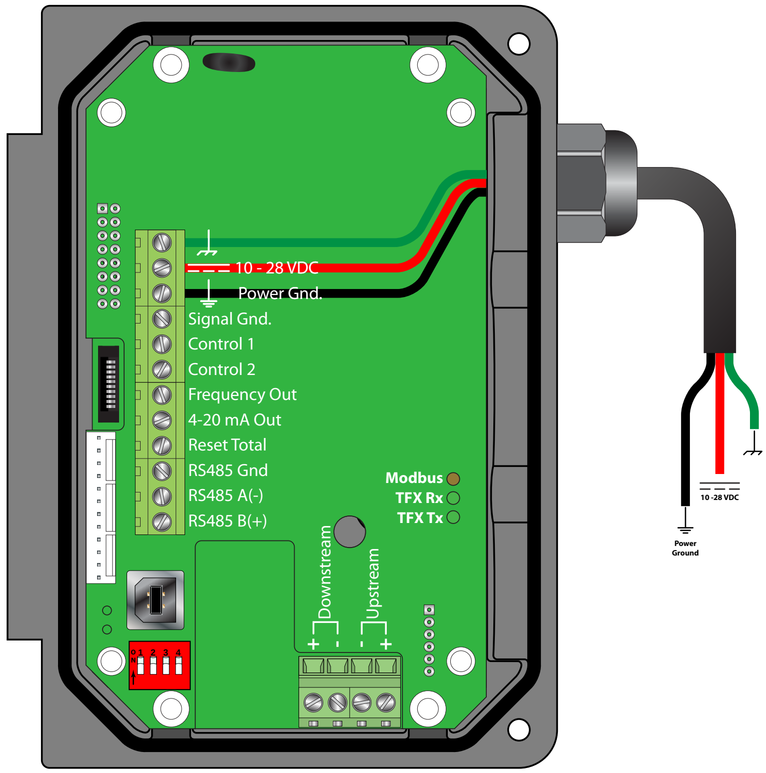


FIGURE 1.6 - DC POWER CONNECTIONS

PART 2 – TRANSDUCER INSTALLATION

GENERAL

The transducers that are utilized by the Ultra contain piezoelectric crystals for transmitting and receiving ultrasonic signals through walls of liquid piping systems. DTN, DTL and DTH transducers are relatively simple and straightforward to install, but spacing and alignment of the transducers is critical to the system's accuracy and performance. Extra care should be taken to ensure that these instructions are carefully executed. DTS and DTC, small pipe transducers, have integrated transmitter and receiver elements that eliminate the requirement for spacing measurement and alignment.

Mounting of the DTN, DTL, and DTH clamp-on ultrasonic transit time transducers is comprised of three steps:

1) Selection of the optimum location on a piping system.
2) Entering the pipe and liquid parameters into either the software utility or keying the parameters into transmitter using the keypad. The software utility or the transmitters firmware will calculate proper transducer spacing based on these entries.
3) Pipe preparation and transducer mounting.

Ultra Energy transmitters require two RTDs to measure heat usage. The flow meter utilizes 1,000 Ohm, three-wire, platinum RTDs in two mounting styles. Surface mount RTDs are available for use on well insulated pipes. If the area where the RTD will be located is not insulated, inconsistent temperature readings will result and insertion (wetted) RTDs should be utilized.

STEP 1 - MOUNTING LOCATION

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

An optimum location is defined as:

~ A piping system that is completely full of liquid when measurements are being taken. The pipe may become completely empty during a process cycle – which will result in the error code 0010 (Low Signal Strength) being displayed on the flow meter while the pipe is empty. This error code will clear automatically once the pipe refills with liquid. It is not recommended to mount the transducers in an area where the pipe may become partially filled. Partially filled pipes will cause erroneous and unpredictable operation of the meter.

~ A piping system that contains lengths of straight pipe such as those described in ***Table 2.1***. The optimum straight pipe diameter recommendations apply to pipes in both horizontal and vertical orientation. The straight runs in ***Table 2.1*** 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.

~ Mount the transducers in an area where they will not be inadvertently bumped or disturbed during normal operation.

~ Avoid installations on downward flowing pipes unless adequate downstream head pressure is present to overcome partial filling of or cavitation in the pipe.

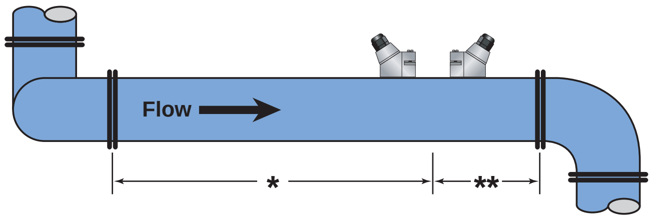
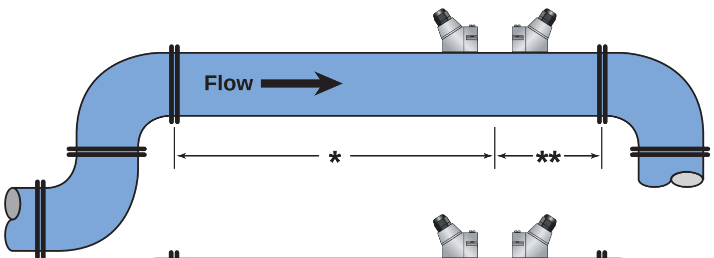
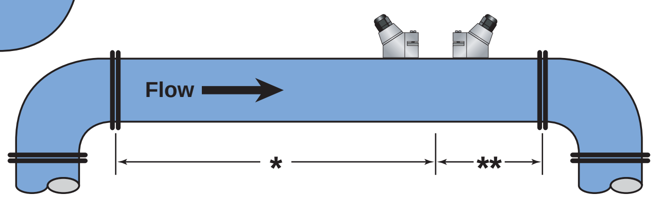
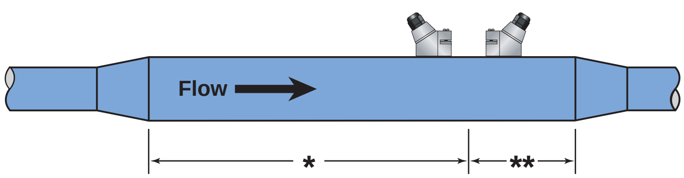
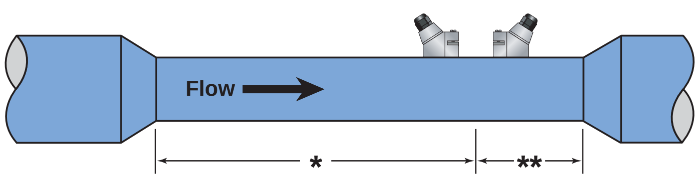
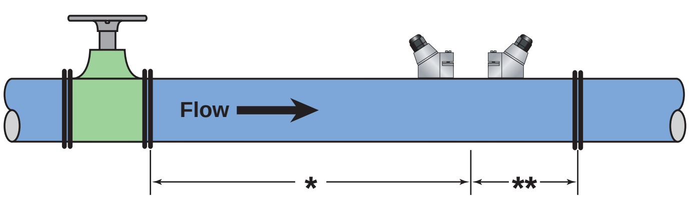
Piping Configuration and Transducer Positioning	Upstream Pipe Diameters	Downstream Pipe Diameters
	*	**
	24	5
	14	5
	10	5
	10	5
	10	5
	24	5

TABLE 2.1 - PIPING CONFIGURATION AND TRANSDUCER POSITIONING

The flow meter system will provide repeatable measurements on piping systems that do not meet these requirements, but accuracy of these readings may be influenced to various degrees.

STEP 2 - TRANSDUCER SPACING

Ultra transit time flow meters can be used with five different transducer types: DTN, DTL, DTH, DTS and DTC. Meters that utilize the DTN, DTL, or DTH transducer sets consist of two separate sensors that function as both ultrasonic transmitters and receivers. DTS and DTC transducers integrate both the transmitter and receiver into one assembly that fixes the separation of the piezoelectric crystals. DTN, DTL, and DTH transducers are clamped on the outside of a closed pipe at a specific distance from each other.

The DTN, DTL, and DTH 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 Mount Mode	Pipe Material	Pipe Size	Liquid Composition
W-Mount	Plastic (all types)	2-4 in. (50-100 mm)	Low TSS; 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		
TSS = Total Suspended Solids			

TABLE 2.2 - TRANSDUCER MOUNTING MODES — DTN, DTL, AND DTH

For further details, reference ***Figure 2.1***. The appropriate mounting configuration is based on pipe and liquid characteristics. Selection of the proper transducer mounting method is not entirely predictable and many times is an iterative process. ***Table 2.2*** 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. Use of the Ultra diagnostics in determining the optimum transducer mounting is covered later in this section.

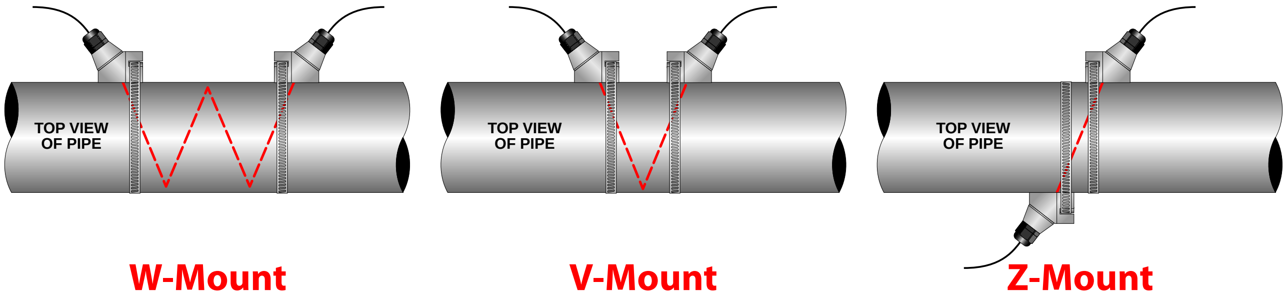


FIGURE 2.1- TRANSDUCER MOUNTING MODES — DTN, DTL, AND DTH

Size	Frequency Setting	Transducer	Mounting Mode
½	**2 MHz**	DTSnP	**V**
		DTSnC	
		DTSnT	
¾	**2 MHz**	DTSnP	
		DTSnC	
		DTSnT	
1	**2 MHz**	DTSnP	
		DTSnC	
		DTSnT	
1¼	**2 MHz**	DTSnP	
		DTSnC	
		DTSnT	
1½	**2 MHz**	DTSnP	
		DTSnC	
		DTSnT	
2	**1 MHz**	DTSnP	
		DTSnC	
	2 MHz	DTSnT	
NOTE: *DTS transducer designation refers to both DTS and DTC transducer types.*			

TABLE 2.3 - TRANSDUCER MOUNTING MODES — DTS / DTC

For pipes 24" (600 mm) and larger the DTL transducers using a transmission frequency of 500 KHz are recommended.

DTL transducers may also be advantageous on pipes between 4" and 24" if there are less quantifiable complicating aspects such as – sludge, tuberculation, scale, rubber liners, plastic liners, thick mortar, gas bubbles, suspended solids, emulsions, or pipes that are perhaps partially buried where a **V**-mount is required/desired, etc.

STEP 3 - ENTERING PIPE AND LIQUID DATA

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

The best accuracy is achieved when transducer spacing is exactly what the Ultra calculates, so the calculated spacing should be used if 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. If that is the case, the transducers should be placed at the highest signal level observed by moving the transducers slowly around the mount area.

NOTE: *Transducer spacing is calculated on "ideal" pipe. Ideal pipe is almost never found so the transducer spacing distances may need to be altered. 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 Ultra before mounting transducers.

The following information is required before programming the instrument:

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

NOTE: *Much of the data relating to material sound speed, viscosity and specific gravity is pre-programmed into the Ultra flow meter. This data only needs to be modified if it is known that a particular application's data varies from the reference values. Refer to* ***Part 4*** *of this manual for instructions on entering configuration data into the Ultra flow meter via the transmitter's keypad. Refer to* ***Part 5*** *for data entry via the software.*

[1]NOMINAL VALUES FOR THESE PARAMETERS ARE INCLUDED WITHIN THE ULTRA OPERATING SYSTEM. THE NOMINAL VALUES MAY BE USED AS THEY APPEAR OR MAY BE MODIFIED IF EXACT SYSTEM VALUES ARE KNOWN.

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

STEP 4 - TRANSDUCER MOUNTING

Pipe Preparation

After selecting an optimal mounting location (**Step 1**) and successfully determining the proper transducer spacing (**Step 2 & 3**), the transducers may now be mounted onto the pipe (**Step 4**).

Before the transducers are mounted onto the pipe surface, an area slightly larger than the flat surface of each transducer must be cleaned of all rust, scale and moisture. For pipes with rough surfaces, such as ductile iron pipe, it is recommended that the pipe surface be wire brushed to a shiny finish. 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.

The DTN, DTL, and DTH transducers must be properly oriented and spaced on the pipe to provide optimum reliability and performance. On horizontal pipes, when **Z**-Mount is required, the transducers should be mounted 180 radial degrees from one another and at least 45 degrees from the top-dead-center and bottom-dead-center of the pipe. See ***Figure 2.2***. Also see **Z**-Mount Transducer Installation. 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" (19 mm) back from the nose of the DTN and DTH transducers, and 1.2" (30 mm) back from the nose of the DTL transducers. See ***Figure 2.3***.

DTS and DTC transducers should be mounted with the cable exiting within ±45 degrees of the side of a horizontal pipe. See ***Figure 2.2***. On vertical pipes the orientation does not apply.

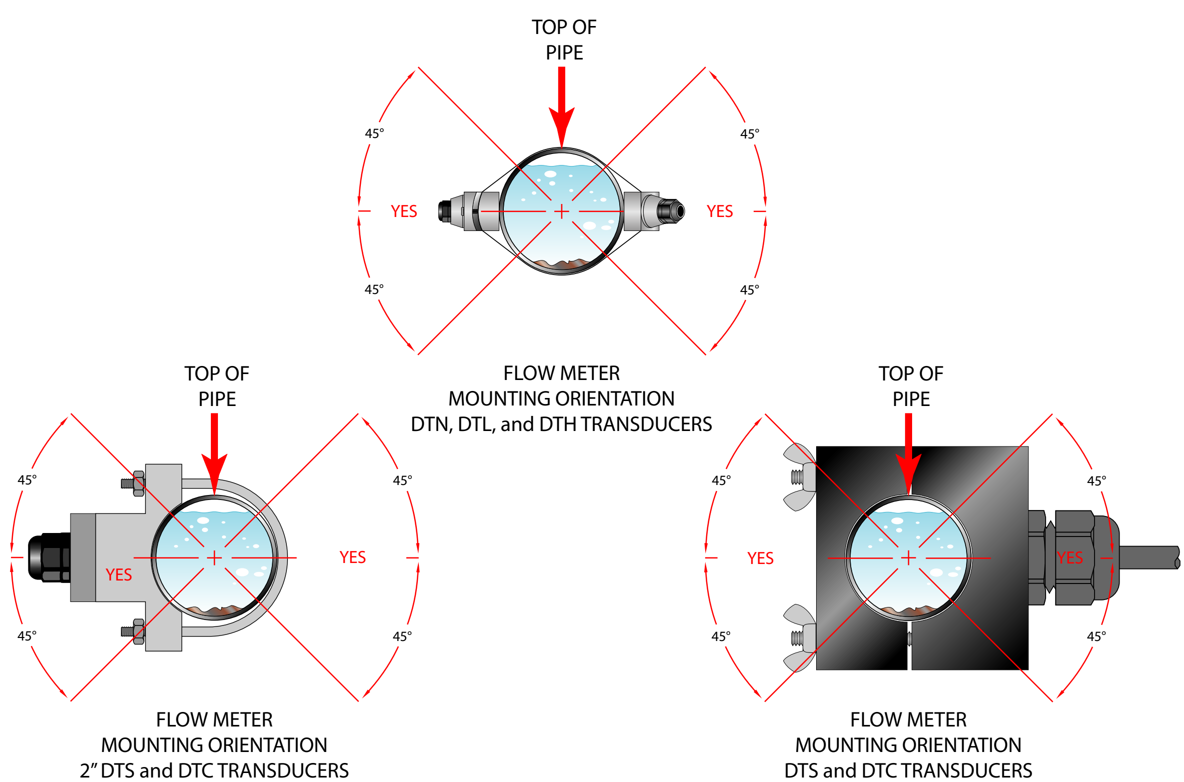


FIGURE 2.2 - TRANSDUCER ORIENTATION — HORIZONTAL PIPES

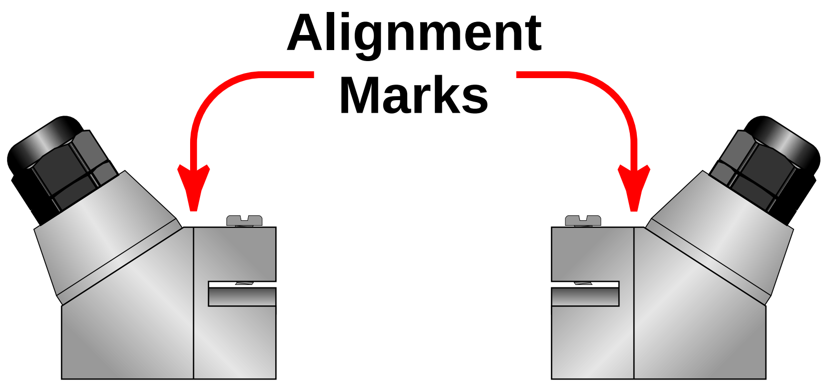


FIGURE 2.3 - TRANSDUCER ALIGNMENT MARKS

V-MOUNT AND W-MOUNT INSTALLATION

Application of Couplant

For DTN, DTL, and DTH transducers, place a single bead of couplant, approximately ½ inch (12 mm) thick, on the flat face of the transducer. See ***Figure 2.4***. Generally, a silicone-based grease is used as an acoustic couplant, but any grease-like substance that is rated not to "flow" at the temperature that the pipe may operate at will be acceptable. For pipe surface temperature over 130 °F (55 °C), Sonotemp® (P.N. D002-2011-010) is recommended.

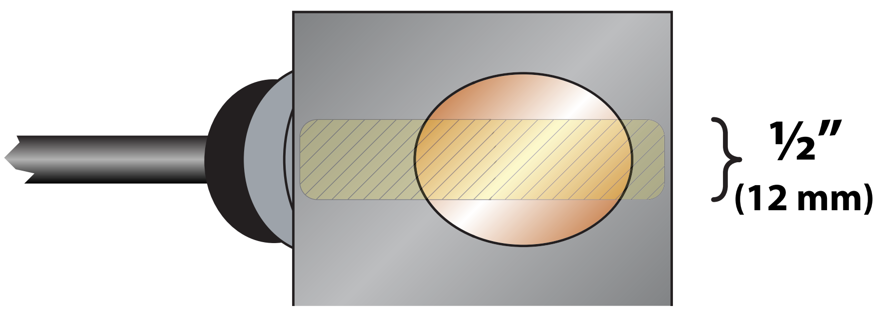


FIGURE 2.4 - APPLICATION OF COUPLANT

Transducer Positioning

1) Place the upstream transducer in position and secure with a mounting strap. 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 and adjust as necessary. Tighten the transducer strap securely.
2) Place the downstream transducer on the pipe at the calculated transducer spacing. See ***Figure 2.5***. Apply firm hand pressure. If signal strength is greater than 5, secure the transducer at this location. If the signal strength is not 5 or greater, using firm hand pressure slowly move the transducer both towards and away from the upstream transducer while observing signal strength.

NOTE: *Signal strength readings update only every few seconds, so it is advisable to move the transducer ⅛", wait, see if signal is increasing or decreasing and then repeat until the highest level is achieved.*

Signal strength can be displayed on the Ultra display or on the main data screen in the software utility. See ***Part 5*** of this manual for details regarding the software utility. Clamp the transducer at the position where the highest signal strength is observed. The factory default signal strength setting is 5, however there are many application specific conditions that may prevent the signal strength from attaining this level. For the Ultra, signal levels much less than 5 will probably not be acceptable for reliable readings.

3) If after adjustment of the transducers the signal strength does not rise to above 5, then an alternate transducer mounting method should be selected. If the mounting method was **W**-Mount, then re-configure the transmitter for **V**-Mount, move the downstream transducer to the new spacing distance and repeat ***Step 4***.

NOTE: *Mounting of high temperature transducers is similar to mounting the DTN/DTL transducers. High temperature installations require acoustic couplant that is rated not to "flow" at the temperature that will be present on the pipe surface.*

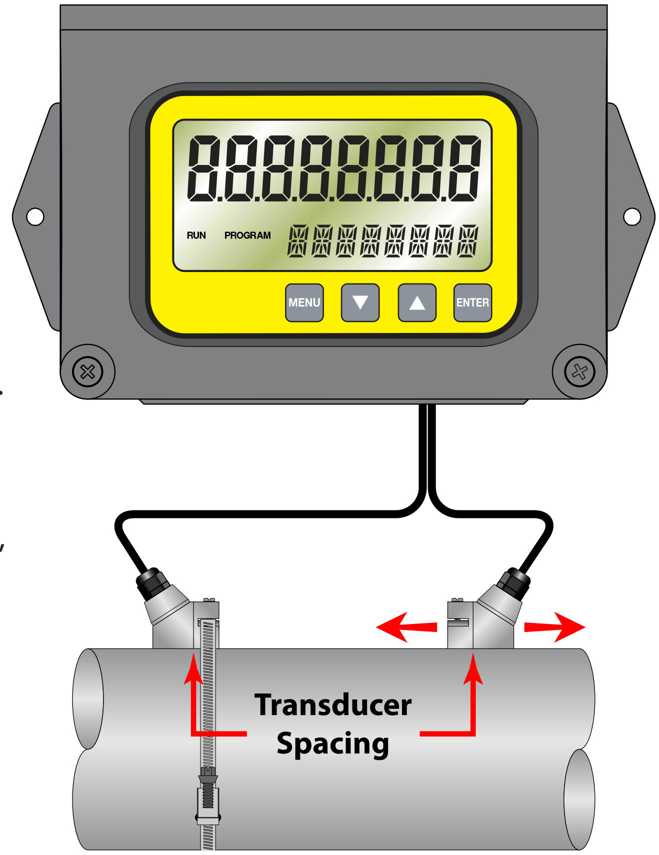


FIGURE 2.5 - TRANSDUCER POSITIONING

NOTE: *As a rule, the DTL should be used on pipes 24" and larger and not used for application on a pipe smaller than 4". Consider application of the DTL transducers on pipes smaller than 24" if there are less quantifiable aspects such as - sludge, tuberculation, scale, rubber liners, plastic liners, thick mortar liners, gas bubbles, suspended solids, emulsions, and smaller pipes that are perhaps partially buried where a* ***V****-Mount is required/desired, etc.*

DTS/DTC SMALL PIPE TRANSDUCER INSTALLATION

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

DTS/DTC installation consists of the following steps:

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 2.6***.
2) On horizontal pipes, mount the transducer in an orientation such that 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. See ***Figure 2.2***.
3) Tighten the wing nuts or "U" bolts so that the acoustic coupling grease begins to flow out from the edges of the transducer or from the gap between the transducer halves. **Do not over tighten**.
4) If signal strength is less than 5, remount the transducer at another location on the piping system.

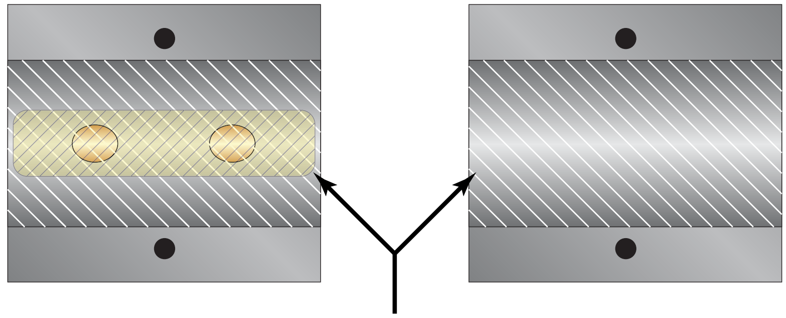


FIGURE 2.6 - APPLICATION OF ACOUSTIC COUPLANT — DTS/DTC TRANSDUCERS

NOTE: *If a DTS/DTC small pipe transducer was purchased separately from the Ultra meter, the following configuration procedure is required.*

DTS/DTC Small Pipe Transducer Configuration Procedure

1) Establish communications with the transit time meter. See ***Part 5 - Software Utility***.
2) From the Tool Bar select Calibration. See ***Figure 2.7***.

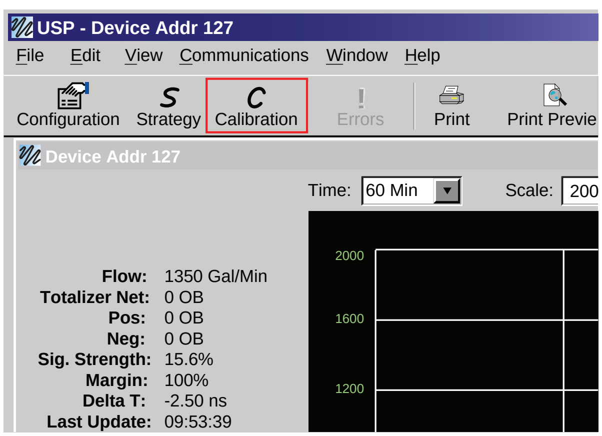


FIGURE 2.7 - DATA DISPLAY SCREEN

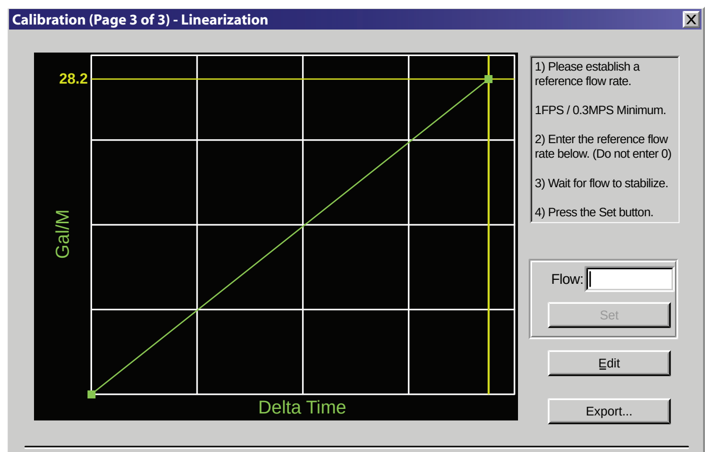


FIGURE 2.8 - CALIBRATION PAGE 3 OF 3

3) On the pop-up screen, click **Next** button twice to get to Page 3 of 3. See ***Figure 2.8***.
4) Click **Edit**.
5) If calibration point is displayed in Calibration Points Editor screen, record the information, highlight and click **Remove**. See ***Figure 2.9***.
6) Click **ADD...**

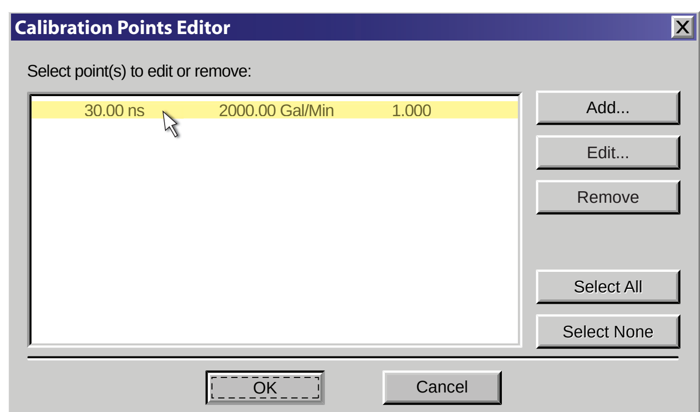


FIGURE 2.9 - CALIBRATION POINTS EDITOR

7) Enter Delta T, Un-calibrated Flow, and Calibrated Flow values from the DTS/DTC calibration label, the click **OK**. See ***Figure 2.10***.
8) Click **OK** in the Edit Calibration Points screen.
9) Process will return to Page 3 of 3. Click **Finish**. See ***Figure 2.8***.
10) After "Writing Configuration File" is complete, turn power off. Turn on again to activate new settings.

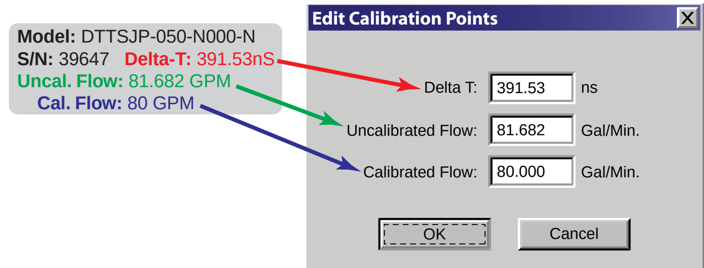


FIGURE 2.10 - EDIT CALIBRATION POINTS

MOUNTING TRANSDUCERS IN Z-MOUNT CONFIGURATION

Installation on larger pipes requires careful measurements of the linear and radial placement of the DTN, DTL, and DTH 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 2.11***. Align the paper ends to within ¼ 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 2.12***.
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 2.2*** 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 ***Step 2***, Transducer Spacing. 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 ½ the circumference of the pipe and lay it over the top of the pipe. The length of ½ the circumference can be found by:

½ Circumference = Pipe O.D. × 1.57

The transducer spacing is the same as found in the Transducer Positioning section.

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

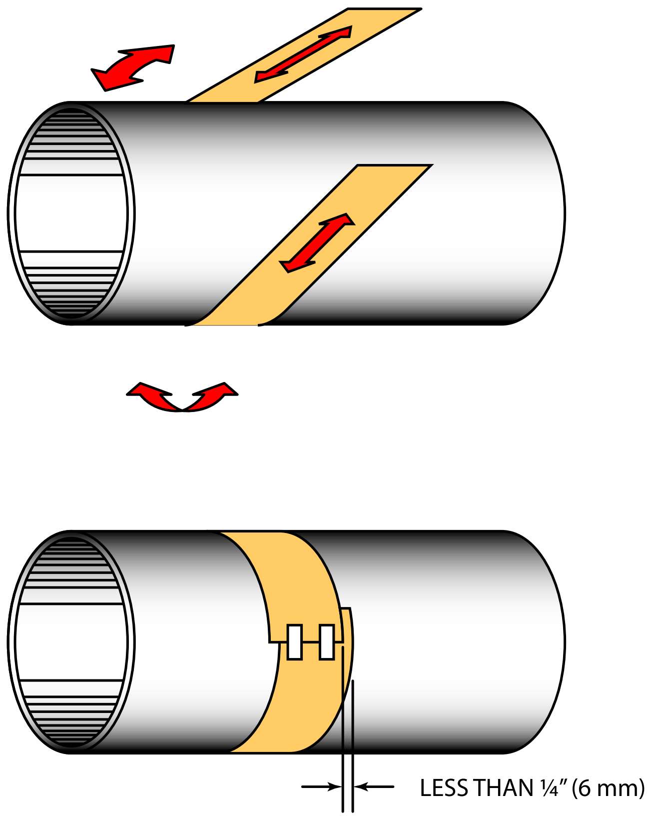


FIGURE 2.11 - PAPER TEMPLATE ALIGNMENT

5) For DTN, DTL, and DTH transducers, place a single bead of couplant, approximately ½ inch (12 mm) thick, on the flat face of the transducer. See ***Figure 2.4***. 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 temperature that the pipe may operate at will be 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.
7) Place the downstream transducer on the pipe at the calculated transducer spacing. See ***Figure 2.13***. 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. Signal strength of between 5 and 98 is acceptable. The factory default signal strength setting is 5, however there are many application specific conditions that may prevent the signal strength from attaining this level.

A minimum signal strength of 5 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.

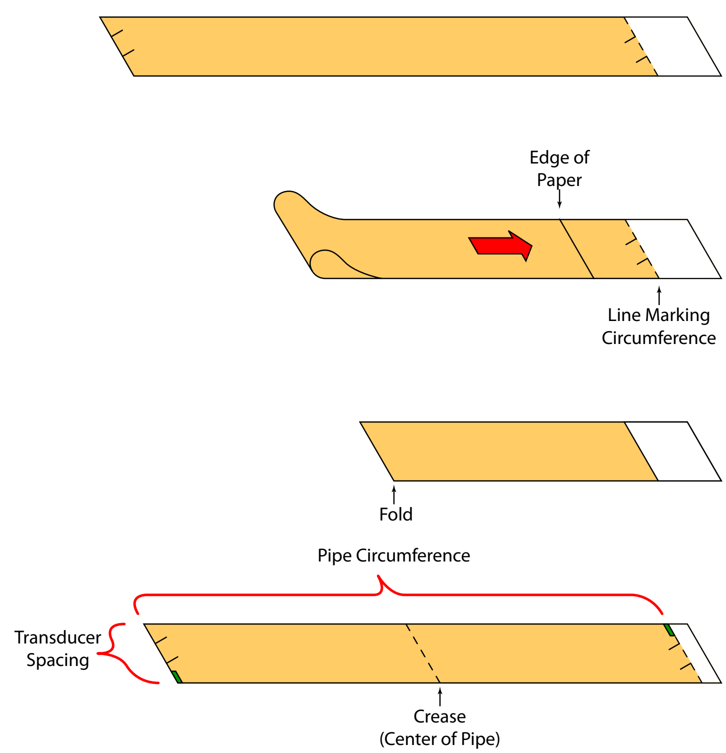


FIGURE 2.12 - BISECTING THE PIPE CIRCUMFERENCE

8) Certain pipe and liquid characteristics may cause signal strength to rise to greater than 98. The problem with operating a Ultra 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.
9) Secure the transducer with a stainless steel strap or other fastener.

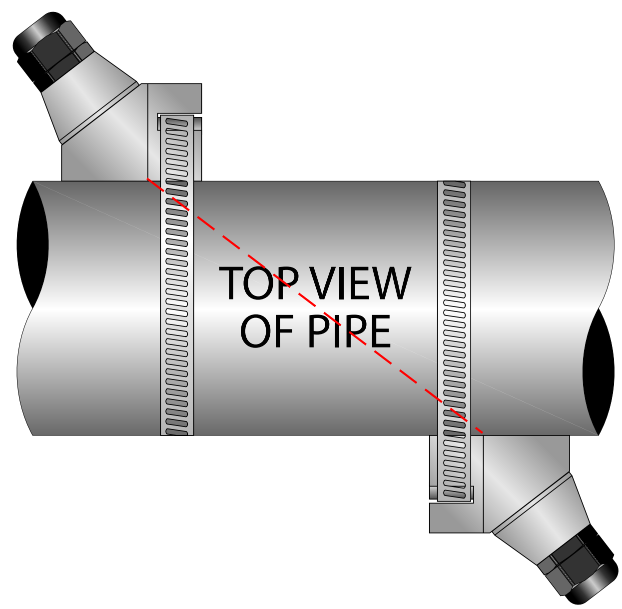


FIGURE 2.13 - Z-MOUNT TRANSDUCER PLACEMENT

MOUNTING TRACK INSTALLATION

1) A convenient transducer mounting track can be used for pipes that have outside diameters between 2 and 10 inches (50 and 250 mm). If the pipe is outside of that range, select a **V**-Mount or **Z**-Mount mounting method.
2) 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. Orientation on vertical pipe is not critical. Ensure that the track is parallel to the pipe and that all four mounting feet are touching the pipe.
3) Slide the two transducer clamp brackets towards the center mark on the mounting rail.
4) Place a single bead of couplant, approximately ½ inch (12 mm) thick, on the flat face of the transducer. See ***Figure 2.4***.
5) 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/transducer such that the notch in the clamp aligns with zero on the scale. See ***Figure 2.14***.
6) Secure with the thumb screw. Ensure that the screw rests in the counter bore on the top of the transducer. (Excessive pressure is not required. Apply just enough pressure so that the couplant fills the gap between the pipe and transducer.)
7) 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.

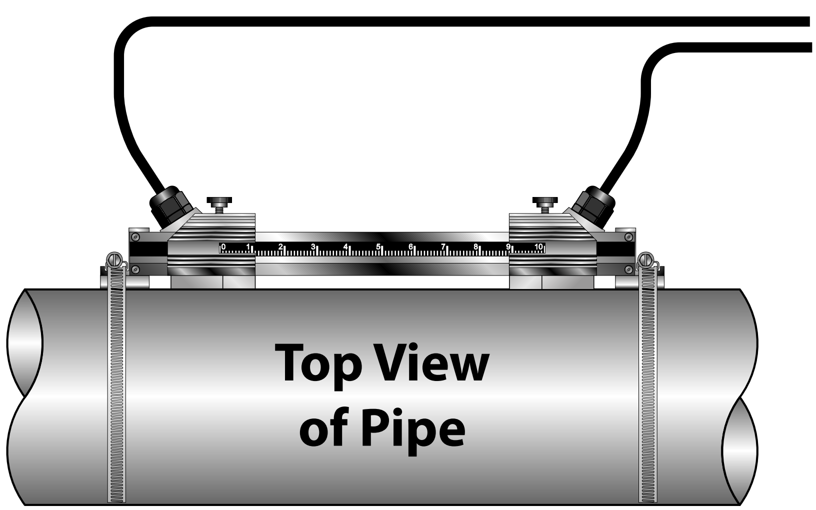


FIGURE 2.14 - MOUNTING TRACK INSTALLATION

PART 3 - INPUTS/OUTPUTS

GENERAL

The Ultra is available in two general configurations. There is the standard Ultra Flow flow model that is equipped with a 4-20 mA output, two open collector outputs, a rate frequency output, and RS485 communications using the Modbus RTU command set.

The energy version of the Ultra Energy has inputs for two 1,000 Ohm RTD sensors in place of the rate frequency and alarm outputs. This version allows the measurement of pipe input and output temperatures so energy usage calculations can be performed.

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.

For AC powered units, the 4-20 mA output is driven from a +15 VDC source located within the meter. The source is isolated from earth ground connections within the Ultra. The AC powered model can accommodate loop loads up to **400 Ohms**. DC powered meters utilize the DC power supply voltage to drive the current loop. The current loop is not isolated from DC ground or power. ***Figure 3.1*** shows graphically the allowable loads for various input voltages. The combination of input voltage and loop load must stay within the shaded area of ***Figure 3.1***.

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

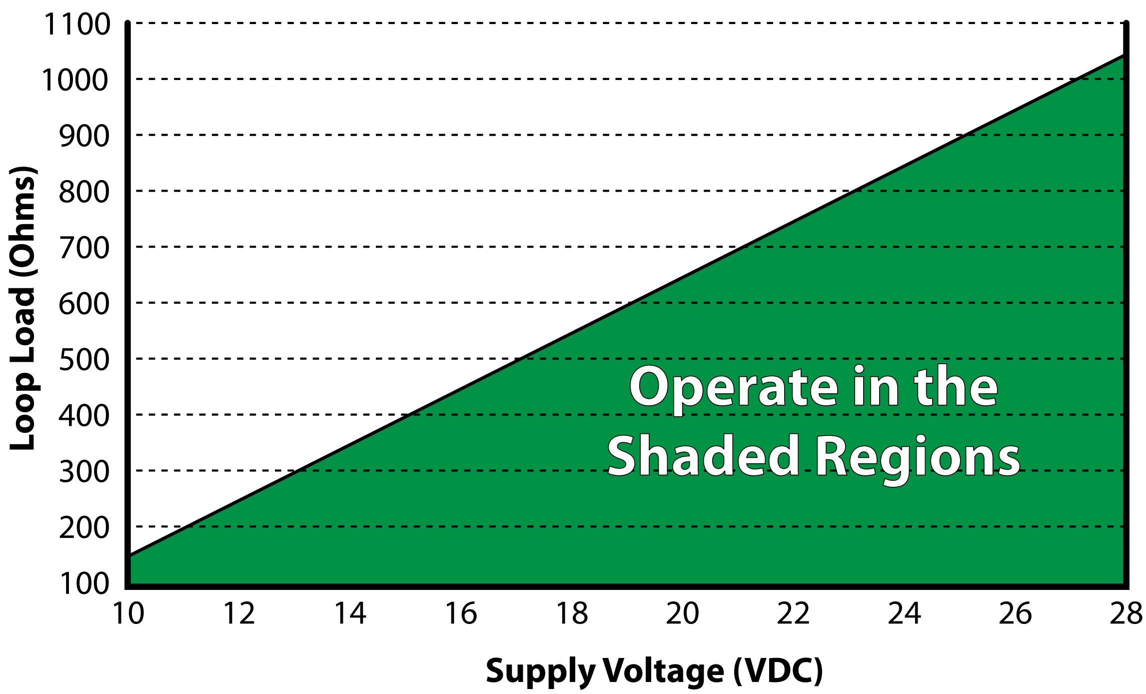


FIGURE 3.1 - ALLOWABLE LOOP RESISTANCE (DC POWERED UNITS)

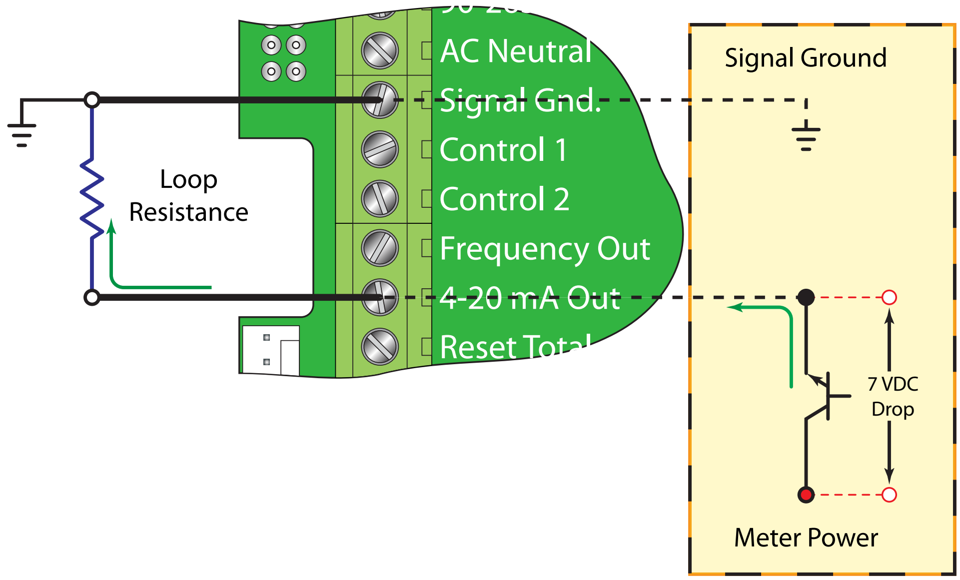


FIGURE 3.2 - 4-20 MA OUTPUT

The 4-20 mA output signal is available between the 4-20 mA Out and Signal Gnd terminals as shown in ***Figure 3.2***.

CONTROL OUTPUTS [ULTRA FLOW ONLY]

Two independent open collector transistor outputs are included with the Ultra Flow model. Each output can be configured for one of the following four functions:

Rate Alarm
Signal Strength Alarm
Totalizing/Totalizing Pulse
Errors
None

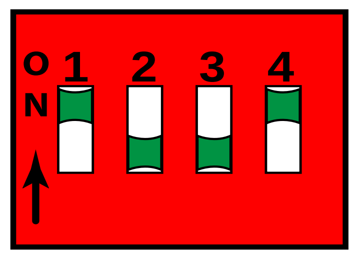


FIGURE 3.3 - SWITCH SETTINGS

Both control outputs are rated for a maximum of 100 mA and 10 to 28 VDC. A pull-up resistor can be added externally or an internal 10K Ohm pull-up resistor can be selected using DIP switches on the power supply board.

Switch	S1	S2	S3	S4
On	*Control 1 Pull-Up Resistor **IN** circuit*	*Control 2 Pull-Up Resistor **IN** circuit*	*Frequency output Pull-Up Resistor **IN** circuit*	*Square Wave Output*
Off	*Control 1 Pull-Up Resistor **OUT** of circuit*	*Control 2 Pull-Up Resistor **OUT** of circuit*	*Frequency Output Pull-Up Resistor **OUT** of circuit*	*Simulated Turbine Output*

TABLE 3.1 - DIP SWITCH FUNCTIONS

NOTE: *All control outputs are disabled when USB cable is connected.*

For the **Rate Alarm** and **Signal Strength Alarm** the on/off values are set using either the keypad or the software utility.

Typical control connections are illustrated in ***Figure 3.3***. Please note that only the **Control 1** output is shown. **Control 2** is identical except the pull-up resistor is governed by SW2.

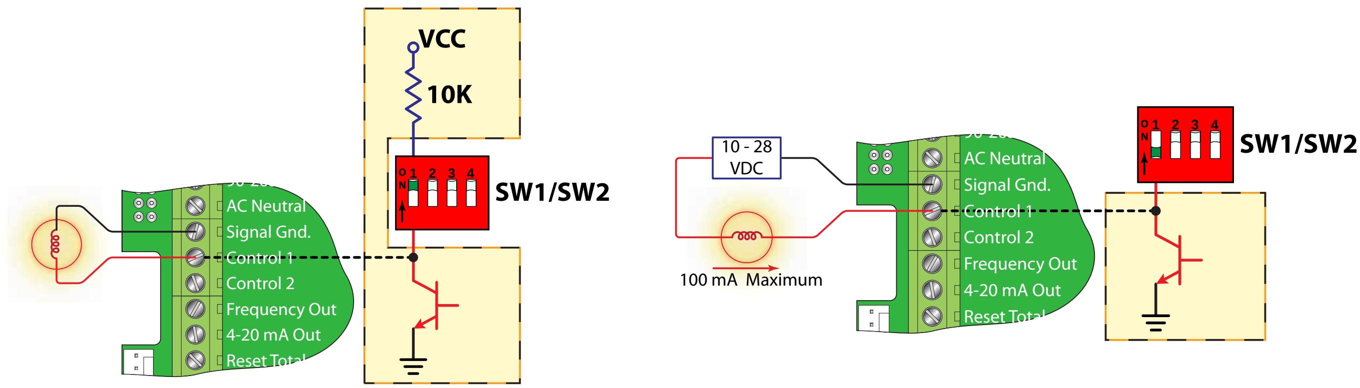


FIGURE 3.4 - TYPICAL CONTROL CONNECTIONS

Alarm Output

The flow rate output permits output changeover at two separate flow rates allowing operation with an adjustable switch deadband. ***Figure 3.5*** illustrates how the setting of the two set points influences rate alarm operation.

A single-point flow rate alarm would place the **ON** setting slightly higher than the **OFF** setting allowing a switch deadband to be established. If a deadband is not established, switch chatter (rapid switching) may result if the flow rate is very close to the switch point.

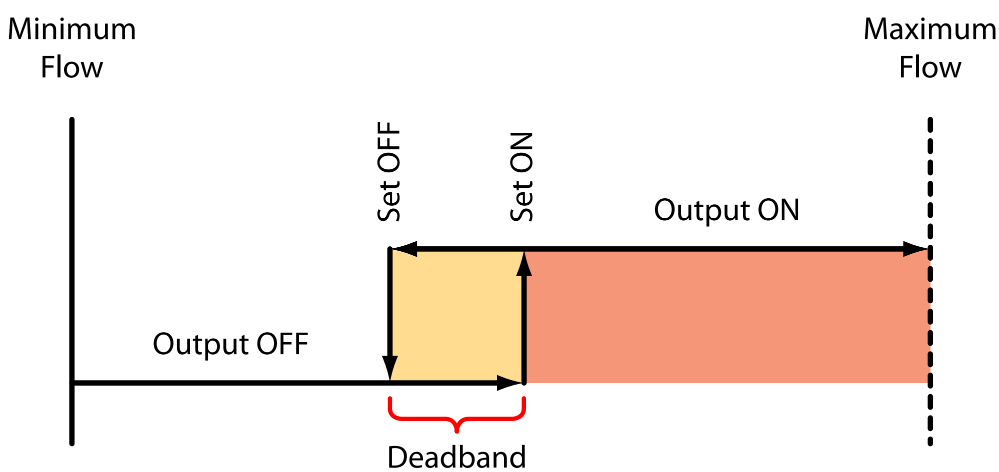


FIGURE 3.5 - SINGLE POINT ALARM OPERATION

NOTE: *All control outputs are disabled when USB cable is connected.*

Batch/Totalizer Output for Ultra Flow

Totalizer mode configures the output to send a 33 mSec pulse each time the display totalizer increments divided by the **TOT MULT.** The **TOT MULT** value must be a whole, positive, numerical value.

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 for Ultra Energy

Ultra Energy units can be ordered with a totalizer pulse output option. This option is installed in the position where the Ethernet option would normally be installed.

OPTIONAL TOTALIZING PULSE SPECIFICATIONS	
Optional Ultra Energy Totalizing Pulse Output	
Signal	1 pulse for each increment of the totalizers least significant digit.
Type	Opto-isolated, open collector transistor
Pulse Width	30 mSec, maximum pulse rate 16 Hz.
Voltage	28 VDC maximum.
Current	100 mA maximum (current sink).
Pull-up Resistor	2.8 K Ohms to 10 K Ohms

NOTE: *The totalizer pulse output option and the Ethernet communications output can not be installed in the same Ultra Energy unit at the same time.*

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

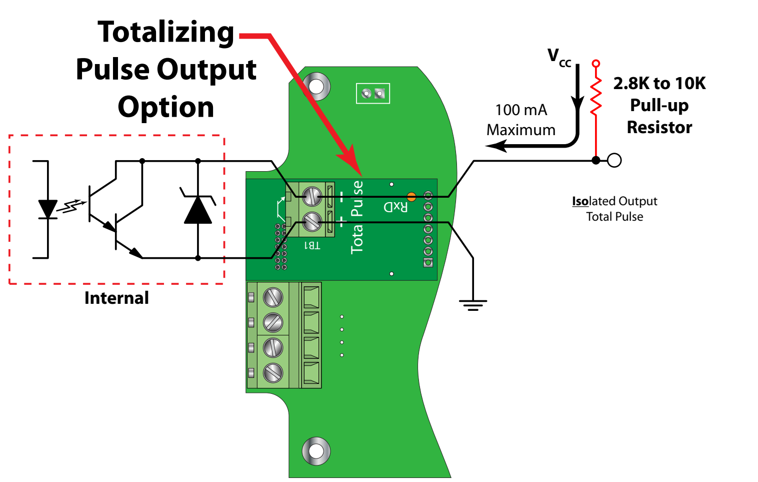


FIGURE 3.6 - ULTRA ENERGY TOTALIZER OUTPUT OPTION

Signal Strength Alarm

The **SIG STR** alarm will provide an indication that the signal level reported by the transducers has fallen to a point where flow measurements may not be possible. It can also be used to indicate that the pipe has emptied. Like the rate alarm described previously, the signal strength alarm requires that two points be entered, establishing an alarm deadband. A valid switch point exists when the **ON** value is lower than the **OFF** value. If a deadband is not established and the signal strength decreases to approximately the value of the switch point, the output may "chatter".

Error Alarm Outputs

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

FREQUENCY OUTPUT [*ULTRA FLOW FLOW ONLY*]

The frequency output is an open-collector transistor circuit that outputs a pulse waveform that varies proportionally with flow rate. This type of frequency output is also know as a "Rate Pulse" output. The output spans from 0 Hz, normally at zero flow rate to 1,000 Hz at full flow rate (configuration of the **MAX RATE** parameter is described in detail in the flow meter configuration section of this manual).

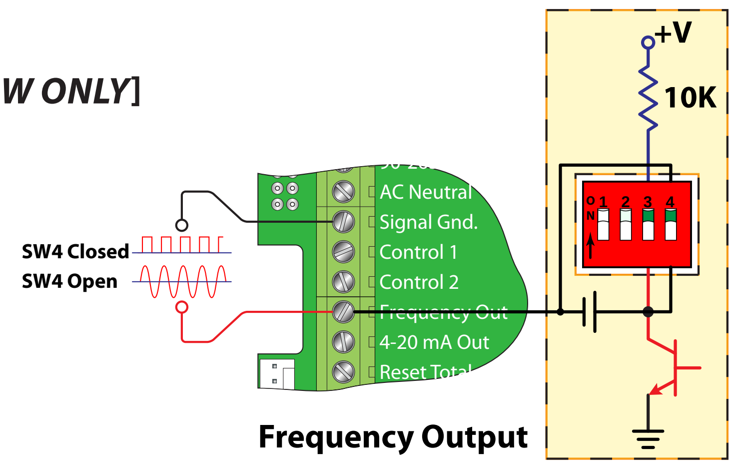


FIGURE 3.7 - FREQUENCY OUTPUT SWITCH SETTINGS

The frequency output is proportional to the maximum flow rate entered into the meter. The maximum output frequency is 1,000 Hz.

NOTE: *When USB programming cable is connected, the RS485 and frequency outputs are disabled.*

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 the Ultra this 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.

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

EQUATION 3.1 - K-FACTOR CALCULATION

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 1 Gallon) would be:

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

If the frequency output is to be used as a totalizing output, the Ultra 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 flow meters such as turbines, gear or nutating disk meters, the K-factor can be changed by modifying the **MAX RATE** flow rate value.

***NOTE:** For a full treatment of K-factors please see the **Appendix** of this manual.*

There are two frequency output types available:

Turbine meter simulation - This option is utilized when a receiving instrument is capable of interfacing directly with a turbine flow meter'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. To activate the turbine output circuit, turn SW4 **OFF**.

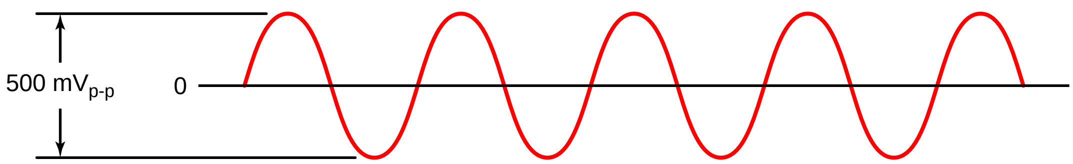


FIGURE 3.8 - FREQUENCY OUTPUT WAVEFORM (SIMULATED TURBINE)

Square-wave frequency - This option is utilized 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 square-wave with a peak voltage equaling the instrument supply voltage when the SW3 is **ON**. If desired, an external pull-up resistor and power source can be utilized by leaving SW3 **OFF**. Set SW4 to **ON** for a square-wave output.

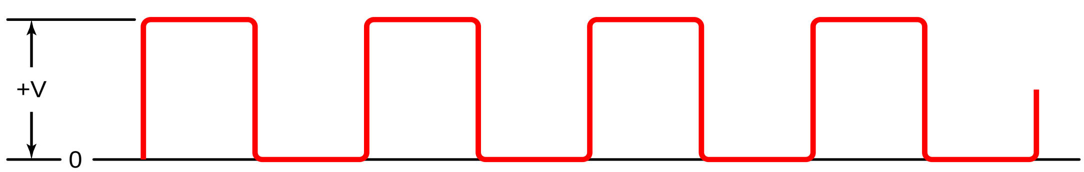


FIGURE 3.9 - FREQUENCY OUTPUT WAVEFORM (SQUARE WAVE)

RS485

The RS485 feature allows up to 126 Ultra systems to be placed on a single three-wire cable bus. All meters are assigned a unique numeric address that allows all of the meters on the cable network to be independently accessed. A Modbus RTU command protocol is used to interrogate the meters. An explanation of the command structure is detailed in the ***Appendix*** of this manual. Flow rate, total, signal strength and temperature (if so equipped) can be monitored over the digital communications bus. Baud rates up to 9600 and cable lengths to 5,000 feet (1,500 meters) are supported without repeaters or "end of line" resistors.

To interconnect meters, utilize three-wire shielded cable such as Belden® 9939 or equal. In noisy environments the shield should be connected on one end to a good earth ground connection. A USB to RS485 converter such as the B & B Electronics P/N 485USBTB-2W can be used to communicate with a PC running Windows 98, Windows ME, Windows 2000, Windows NT, Windows XP, Windows Vista®, and Windows® 7. For computers with RS232C serial ports, an RS232C to RS485 converter, such as B&B Electronics P/N 485SD9TB (illustrated in ***Figure 3.10***), is required to interconnect the RS485 network to a communication port on a PC. If more than 126 meters must be monitored, an additional converter and communication port are required.

NOTE: *When USB programming cable is connected, the RS485 and frequency outputs are disabled.*

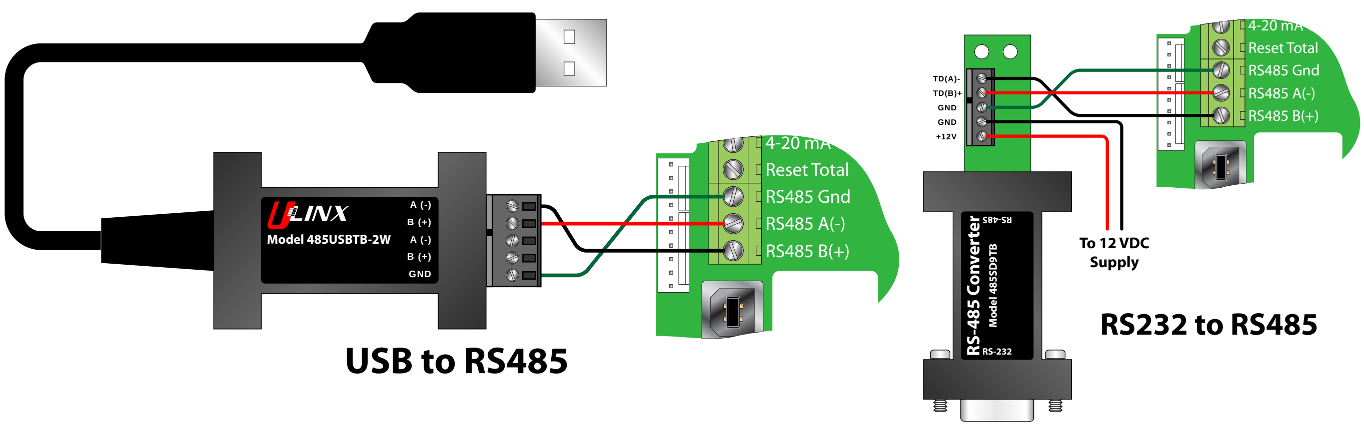


FIGURE 3.10 - RS485 NETWORK CONNECTIONS

HEAT FLOW [ULTRA ENERGY ONLY]

The Ultra Energy allows the integration of two 1000 Ohm, platinum RTDs with the flow meter, effectively providing instrument for measuring energy consumed in liquid heating and cooling systems. If RTDs were ordered with the Ultra Energy flow meter, they have been factory calibrated and are shipped with the meter.

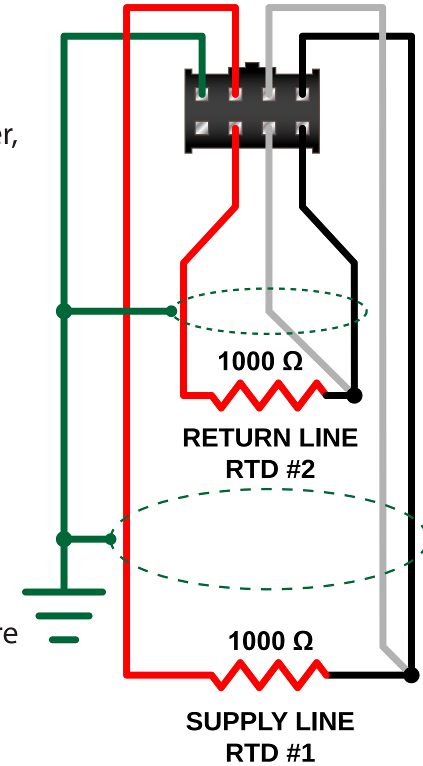


FIGURE 3.11 - RTD SCHEMATIC

The energy meter has multiple heat ranges to choose from. For best resolution use the temperature range that encompasses the temperature range of the application.

The three-wire surface mount RTDs are attached at the factory to a simple plug-in connector eliminating the possibility of mis-wiring. Simply install the RTDs on or in the pipe as recommended, and then plug the RTDs into the Ultra Energy.

Four ranges of surface mount RTDs and two lengths of wetted insertion probes are offered. Other cable lengths for surface mount RTDs are available. Contact the manufacturer for additional offerings.

All RTDs are 1,000 Ohm platinum, three-wire devices. The surface mount versions are available in standard lengths of 20 feet (6 meters), 50 feet (15 meters) and 100 feet (30 meters) of attached shielded cable.

Installation of Surface Mount RTDs

Surface mount RTDs should only be utilized on well insulated pipe. If the area where the RTD is located is not insulated, inconsistent temperature readings will result. Insertion (wetted) RTDs should be used on pipes that are not insulated.

Select areas on the supply and return pipes where the RTDs will be mounted. Remove or peel back the insulation all the way around the pipe in the installation area. Clean an area slightly larger than the RTD down to bare metal on the pipe.

Place a small amount of heat sink compound on the pipe in the RTD installation location. See ***Figure 3.12***. Press the RTD firmly into the compound. Fasten the RTD to the pipe with the included stretch tape.

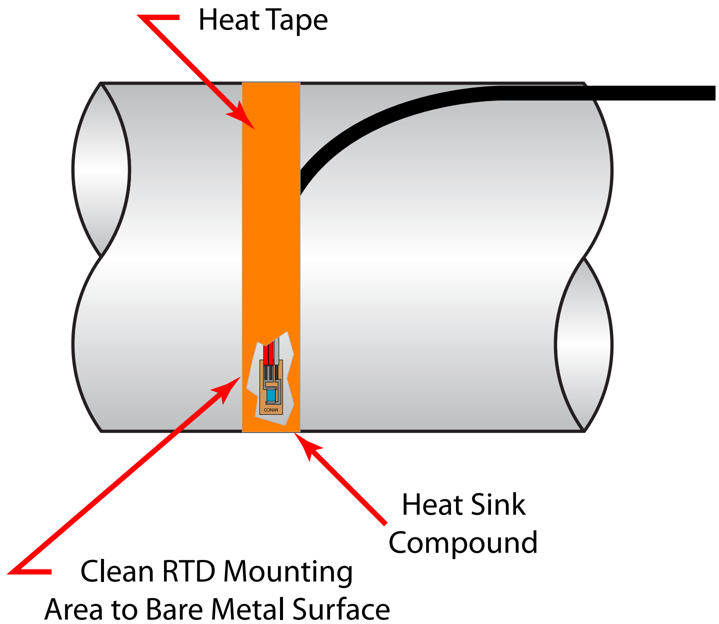


FIGURE 3.12 - SURFACE MOUNT RTD INSTALLATION

Route the RTD cables back to the Ultra Energy flow meter and secure the cable so that it will not be pulled on or abraded inadvertently. Replace the insulation on the pipe, ensuring that the RTDs are not exposed to air currents.

Installation of Insertion RTDs

Insertion RTDs are typically installed through ¼ inch (6 mm) compression fittings and isolation ball valves. Insert the RTD sufficiently into the flow stream such that a minimum of ¼ inch (6 mm) of the probe tip extends into the pipe diameter.

RTDs should be mounted within ±45 degrees of the side of a horizontal pipe. On vertical pipes the orientation is not critical. Route the RTD cables back to the Ultra Energy flow meter and secure the cable so that it will not be pulled on or abraded inadvertently.

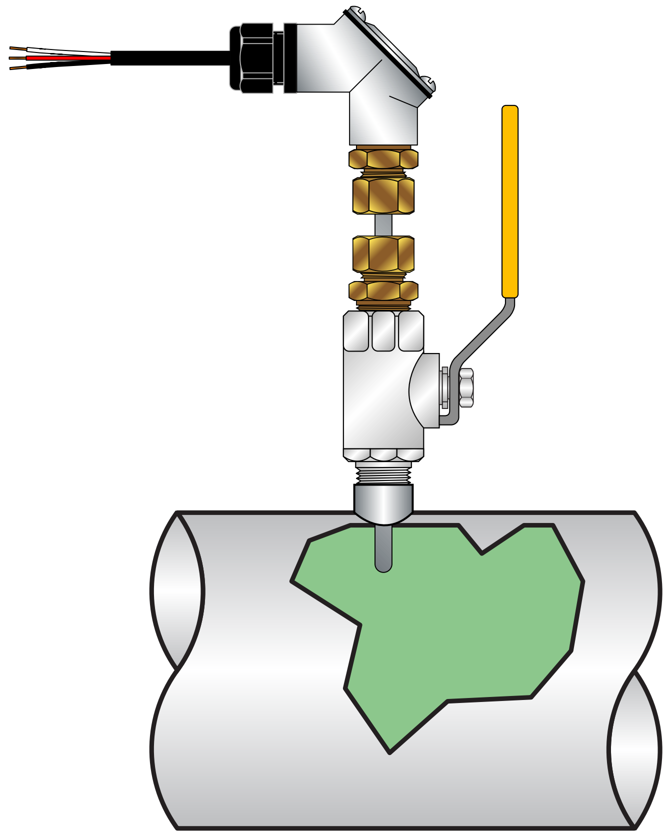


FIGURE 3.13 - INSERTION STYLE RTD INSTALLATION

If the cables are not long enough to reach the Ultra Energy, route the cables to an electrical junction box and add additional cable from that point. Use three-wire shielded cable, such as Belden® 9939 or equal, for this purpose.

__NOTE:__ Adding cable adds to the resistance the meter reads and may have an effect on absolute accuracy. If cable is added, ensure that the same length is added to both RTDs to minimize errors due to changes in cable resistance.

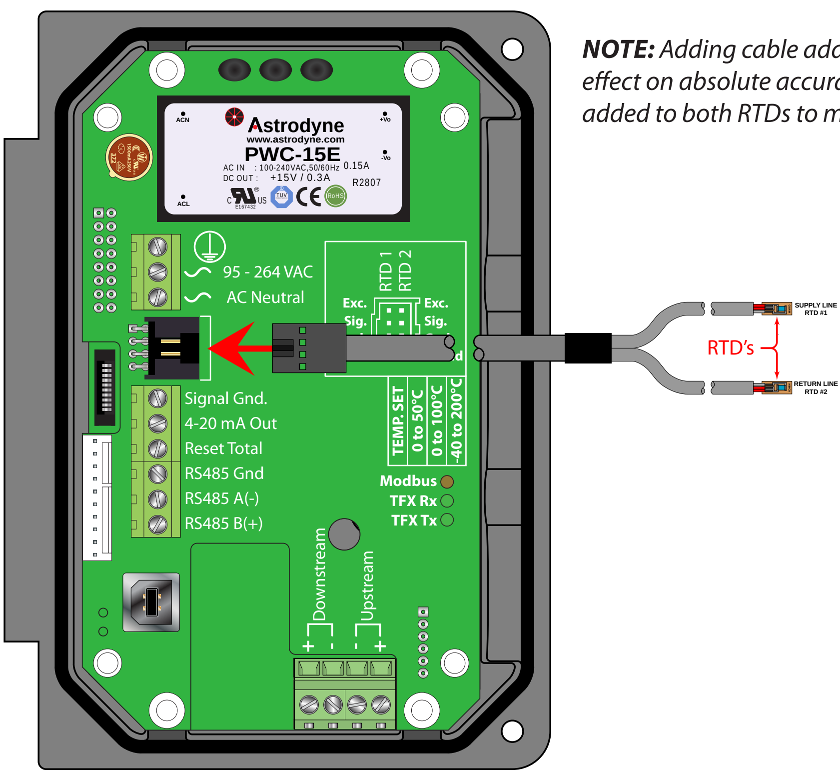


FIGURE 3.14 - CONNECTING RTDS

Wiring to Meter

After the RTDs have been mounted to the pipe, route the cable back to the Ultra Energy through the middle hole in the enclosure. Connection to the meter is accomplished by inserting the RTD connector into the mating connector on the circuit board. Be sure that the alignment tab on the RTD cable is up.

Replacement RTDs

If it is necessary to replace RTDs, complete RTD kits including the energy meter's plug-in connector and calibration values for the replacements are available from the manufacturer.

It is also possible to use other manufacturer's RTDs. The RTDs must be 1,000 Ohm platinum RTDs suitable for a three-wire connection. A connection adapter, P.N. D005-0350-300, is available to facilitate connection to the Ultra Energy. See ***Figure 3.15***.

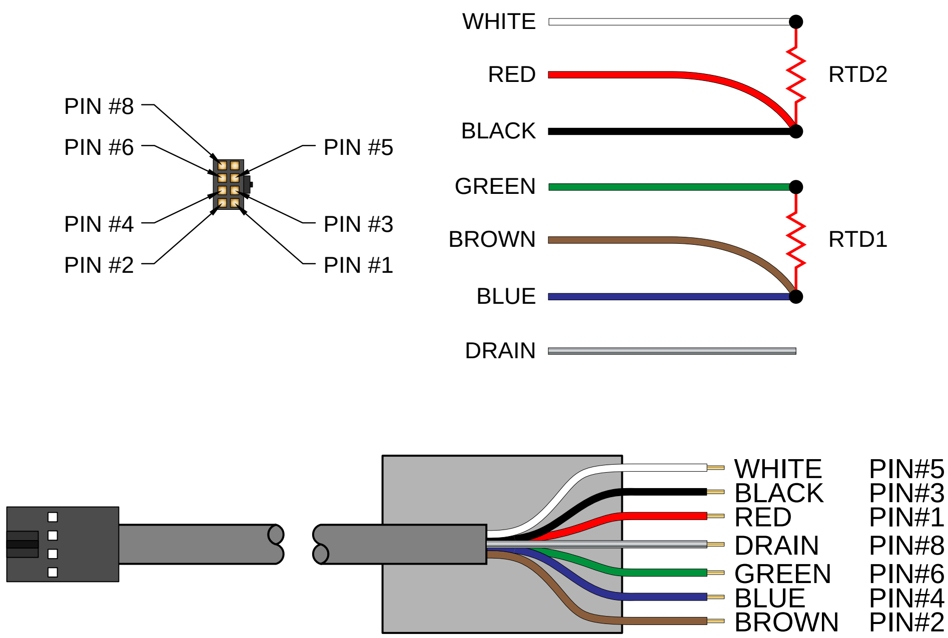


FIGURE 3.15 - ULTRA ENERGY - RTD ADAPTER CONNECTIONS

NOTE: *It will be necessary to calibrate third party RTDs to the Ultra Energy for proper operation. See the **Appendix** of this manual for the calibration procedure.*

PART 4 - STARTUP AND CONFIGURATION

BEFORE STARTING THE INSTRUMENT

NOTE: *The Ultra flow meter system requires a full pipe of liquid before a successful start-up can be completed. Do not attempt to make adjustments or change configurations until a full pipe is verified.*

NOTE: *If Dow 732 RTV was utilized to couple the transducers to the pipe, the adhesive must be fully cured before readings are attempted. Dow 732 requires 24 hours to cure satisfactorily. If Sonotemp® acoustic coupling grease was utilized as a couplant, curing is not required.*

INSTRUMENT STARTUP

Procedure:

1) Verify that all wiring is properly connected and routed, as described in **Part 1** of this manual.
2) Verify that the transducers are properly mounted, as described in **Part 2** of this manual.
3) Apply power. The display of a Ultra will briefly show a software version number and then all of the segments will illuminate in succession.

IMPORTANT!!: *In order to complete the installation of the Ultra flow meter, the pipe must be full of liquid.*

To verify proper installation and flow measurement operation:

1) Go to the **SER MENU** and confirm that signal strength (**SIG STR**) is between 5 and 98. If the signal strength is lower than 5, verify that proper transducer mounting methods and liquid/pipe characteristics have been entered. To increase signal strength, if a **W**-Mount transducer installation was selected, re-configure for a **V**-Mount installation; if **V**-Mount was selected, re-configure for **Z**-Mount.

NOTE: *Mounting configuration changes apply only to DTN, DTL and DTH transducer sets.*

2) Verify that the actual measured liquid sound speed is very close to the expected value. The measured liquid sound speed (**SSPD FPS** and **SSPD MPS**) is displayed in the **SER MENU**. Verify that the measured sound speed is within 2% of the value entered as **FLUID SS** in the **BSC MENU**. The pipe must be full of liquid in order to make this measurement.

Once the meter is operating properly, refer to the **Keypad Programming** section of this manual for additional programming features.

KEYPAD PROGRAMMING

The Ultra units ordered with keypads can be configured through the keypad interface or by using the Windows® compatible software utility. Units without a keypad can only be configured using the software utility. *See* ***Part 5*** of this manual for software details. Of the two methods of configuration, the software utility provides more advanced features and offers the ability to store and transfer meter configurations between Ultra meters. All entries are saved in non-volatile FLASH memory and will be retained indefinitely in the event of power loss.

NOTE: *When USB programming cable is connected, the RS485 and frequency outputs are disabled.*

The Ultra (keypad version) contains a four-key tactile feedback keypad interface that allows the user to view and change configuration parameters used by the operating system.

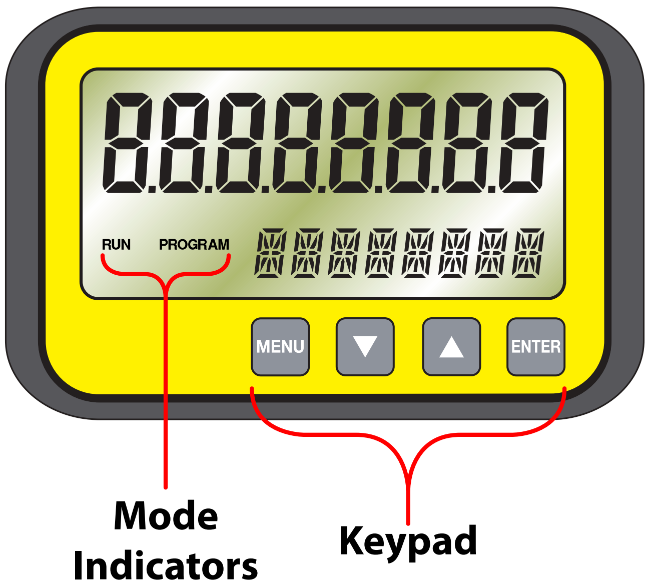


FIGURE 4.1 - KEYPAD INTERFACE

1) The **MENU** key is pressed from **RUN** mode to enter **PROGRAM** mode. The **MENU** key is pressed in **PROGRAM** mode to exit from configuration parameter selection and menus. If changes to any configuration parameters are made, the user will be prompted with a **SAVE?** when returning to **RUN** mode. If **YES** is chosen the new parameters will be saved in program memory.
2) The arrow ▲▼keys are used to scroll through menus and configuration parameters. The arrow keys are also used to adjust parameter numerical values.
3) The **ENTER** key functions are:

~ Pressed from the **RUN** mode to view the current software version operating in the instrument.

~ Used to access the configuration parameters in the various menus.

~ Used to initiate changes in configuration parameters.

~ Used to accept configuration parameter changes.

MENU STRUCTURE

The Ultra firmware uses a hierarchical menu structure. A map of the user interface is included in the ***Appendix*** of this manual. The map provides a visual path to the configuration parameters that users can access. This tool should be employed each time configuration parameters are accessed or revised.

The seven menus used in the Ultra firmware are as follows:

BSC MENU	**BASIC** -- This menu contains all of the configuration parameters necessary to initially program the meter to measure flow.
CH1 MENU	**CHANNEL 1** -- Configures the 4-20 mA output. Applies to both the Ultra Flow and Ultra Energy models.
CH2 MENU	**CHANNEL 2** -- Configures the type and operating parameters for channel 2 output options. Channel 2 parameters are specific to the model of Ultra Flow used.
SEN MENU	**SENSOR** -- This menu is used to select the sensor type (i.e. DTN, DTS, etc.)
SEC MENU	**SECURITY** -- This menu is utilized for resetting totalizers, returning filtering to factory settings, and revising security the password.
SER MENU	**SERVICE** -- The service menu contains system settings that are used for advanced configuration and zeroing the meter on the pipe.
DSP MENU	**DISPLAY** -- The display menu is used to configure meter display functions.

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

BSC MENU -- BASIC MENU

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

Units Selection

UNITS -- Programming Unit Selection (Choice)
ENGLSH (Inches)
METRIC (Millimeters)

Installs a global measurement standard into the memory of the instrument. The choices are either **English** or **Metric** units.

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

The **ENGLSH/METRIC** selection will also configure the Ultra 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 **ENGLSH** to **METRIC** or from **METRIC** to **ENGLSH**, the entry must be* *saved and the instrument reset (power cycled or System Reset* **SYS RSET** *entered) in order for the Ultra 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.*

Address

ADDRESS -- Modbus Address (Value)
1-126

NOTE: *This is for the RS485 connection only. The Modbus TCP/IP address is set via the integrated HTML application in the Ethernet port.*

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

Transducer Mount

XDCR MNT -- Transducer Mounting Method (Choice)
V
W
Z

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

Flow Direction

FLOW DIR -- Transducer Flow Direction Control (Choice)
FORWARD
REVERSE

Allows the change of the direction the meter assumes is forward. When mounting Ultra meters with integral transducers this feature allows upstream and downstream transducers to be "electronically" reversed making upside down mounting of the display unnecessary.

Transducer Frequency

XDCR HZ -- Transducer Transmission Frequency (Choice)
500 KHZ (500 Kilohertz)
1 MHZ (1 Megahertz)
2 MHZ (2 Megahertz)

Transducer transmission frequencies are specific to the type of transducer and the size of pipe. In general the DTL 500 KHz transducers are used for pipes greater than 24 inches (600 mm). DTN and DTH, 1 MHz transducers, are for intermediate sized pipes between 2 inches (50 mm) and 24 inches (600 mm). The DTS and DTC, 2 MHz transducers, are for pipe sizes between ½ inch (13 mm) and 2 inches (50 mm).

Pipe Outside Diameter

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

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

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

Pipe Wall Thickness

PIPE WT -- Pipe Wall Thickness Entry (Value)
ENGLSH (Inches)
METRIC (Millimeters)

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

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

Pipe Material

PIPE MAT -- Pipe Material Selection (Choice)

Acrylic	(ACRYLIC)	Glass Pyrex	(PYREX)	St Steel 304/316	(SS 316)
Aluminum	(ALUMINUM)	Nylon	(NYLON)	St Steel 410	(SS 410)
Brass (Naval)	(BRASS)	HD Polyethylene	(HDPE)	St Steel 430	(SS 430)
Carbon Steel	(CARB ST)	LD Polyethylene	(LDPE)	PFA	(PFA)
Cast Iron	(CAST IRN)	Polypropylene	(POLYPRO)	Titanium	(TITANIUM)
Copper	(COPPER)	PVC CPVC	(PVC/CPVC)	Asbestos	(ASBESTOS)
Ductile Iron	(DCTL IRN)	PVDF	(PVDF)	Other	(OTHER)
Fiberglass-Epoxy	(FBRGLASS)	St Steel 302/303	(SS 303)		

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

Pipe Sound Speed

PIPE SS -- Speed of Sound in the Pipe Material (Value)
ENGLSH (Feet per Second)
METRIC (Meters per Second)

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 **ENGLSH**, the entry is in **FPS** (feet per second). **METRIC** entries are made in **MPS** (meters per second).

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

If **OTHER** was chosen as **PIPE MAT**, then a **PIPE SS** must also be entered.

Pipe Roughness

PIPE R -- Pipe Material Relative Roughness (Value)
Unitless Value

The Ultra 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:

$$Pipe\ R = \frac{Linear\ RMS\ Measurement\ of\ the\ Pipes\ Internal\ Wall\ Surface}{Inside\ Diameter\ of\ the\ Pipe}$$

If a pipe material was chosen from the **PIPE MAT** 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.

Liner Thickness

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

If the pipe has a liner, enter the pipe liner thickness. Enter this value in inches if **ENGLSH** was selected as **UNITS**; in millimeters if **METRIC** was selected.

Liner Material

LINER MA - Pipe Liner Material (Choice)
Liner Type - (If a LINER Thickness was selected)

Tar Epoxy	(TAR EPXY)	HD Polyethylene	(HDPE)
Rubber	(RUBBER)	LD Polyethylene	(LDPE)
Mortar	(MORTAR)	Teflon (PFA)	(TEFLON)
Polypropylene	(POLYPRO)	Ebonite	(EBONITE)
Polystyrene	(POLYSTY)	Other	(OTHER)

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

Liner Sound Speed

LINER SS -- Speed of Sound in the Liner (Value)
ENGLSH (Feet per Second)
METRIC (Meters per Second)

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 **ENGLSH**, the entry is in **FPS** (feet per second). **METRIC** entries are made in **MPS** (meters per second).

If a liner was chosen from the **LINER MA** 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.

Liner Roughness

LINER R -- Liner Material Relative Roughness (Value)
Unitless Value

The Ultra 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:

$$Liner\ R = \frac{Linear\ RMS\ Measurement\ of\ the\ Liners\ Internal\ Wall\ Surface}{Inside\ Diameter\ of\ the\ Liner}$$

If a liner material was chosen from the **LINER MA** 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.

Fluid Type

FL TYPE -- Fluid/Media Type (Choice)

Water Tap	(WATER)	Ethanol	(ETHANOL)	Oil Diesel	(DIESEL)
Sewage-Raw	(SEWAGE)	Ethylene Glycol	(ETH-GLYC)	Oil Hydraulic [Petro-based]	(HYD OIL)
Acetone	(ACETONE)	Gasoline	(GASOLINE)	Oil Lubricating	(LUBE OIL)
Alcohol	(ALCOHOL)	Glycerin	(GLYCERIN)	Oil Motor [SAE 20/30]	(MTR OIL)
Ammonia	(AMMONIA)	Isopropyl Alcohol	(ISO-ALC)	Water Distilled	(WATR-DST)
Benzene	(BENZENE)	Kerosene	(KEROSENE)	Water Sea	(WATR-SEA)
Brine	(BRINE)	Methanol	(METHANOL)	Other	(OTHER)

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

Fluid Sound Speed

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

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

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

If **OTHER** was chosen as **FL TYPE**, a **FLUID SS** will need to be entered. A list of alternate fluids and their associated sound speeds 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 software utility. *See **Part 5***.

Fluid Viscosity

FLUID VI -- Absolute Viscosity of the Fluid (Value - cP)

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

Ultra flow meters utilize pipe size, viscosity and specific gravity to calculate Reynolds numbers. Since the Reynolds number influences flow profile, the Ultra has to compensate for the relatively high velocities at the pipe center during transitional or laminar flow conditions. The entry of **FLUID VI** is utilized in the calculation of Reynolds and the resultant compensation values.

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

If **OTHER** was chosen as **FL TYPE**, then a **FLUID VI** must also be entered. A list of alternate fluids and their associated viscosities is located in the ***Appendix*** of this manual.

Fluid Specific Gravity

SP GRAVTY -- Fluid Specific Gravity Entry (Value)
Unitless Value

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

As stated previously in the **FLUID VI** section, specific gravity is utilized in the Reynolds correction algorithm. It is also utilized if mass flow measurement units are selected for rate or total.

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

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

Fluid Specific Heat Capacity

SP HEAT -- Fluid Specific Heat Capacity (Value)
BTU/lb

Allows adjustments to be made to the specific heat capacity of the liquid.

If a fluid was chosen from the **FL TYPE** list, a default specific heat will be automatically loaded. This default value is displayed as **SP HEAT** in the **BSC MENU**. If the actual specific heat of the liquid is known or it differs from the default value, the value can be revised. See ***Tables 4.1, 4.2,*** and ***4.3*** for specific values. Enter a value that is the mean of both pipes.

Specific Heat Capacity for Water		
Temperature		Specific Heat BTU/lb °F
°F	°C	
32-212	0-100	1.00
250	121	1.02
300	149	1.03
350	177	1.05

TABLE 4.1 - SPECIFIC HEAT CAPACITY VALUES FOR WATER

Specific Heat Capacity Values for Common Fluids			
Fluid	Temperature		Specific Heat BTU/lb °F
	°F	°C	
Ethanol	32	0	0.65
Methanol	54	12	0.60
Brine	32	0	0.71
Brine	60	15	0.72
Sea Water	63	17	0.94

TABLE 4.2 - SPECIFIC HEAT CAPACITY VALUES FOR OTHER COMMON FLUIDS

Specific Heat Capacity BTU/lb °F								
Temperature		Ethylene Glycol Solution (% by Volume)						
°F	°C	25	30	40	50	60	65	100
-40	-40	n/a	n/a	n/a	n/a	0.68	0.70	n/a
0	-17.8	n/a	n/a	0.83	0.78	0.72	0.70	0.54
40	4.4	0.91	0.89	0.845	0.80	0.75	0.72	0.56
80	26.7	0.92	0.90	0.86	0.82	0.77	0.74	0.59
120	84.9	0.93	0.92	0.88	0.83	0.79	0.77	0.61
160	71.1	0.94	0.93	0.89	0.85	0.81	0.79	0.64
200	93.3	0.95	0.94	0.91	0.87	0.83	0.81	0.66
240	115.6	n/a	n/a	n/a	n/a	n/a	0.83	0.69

TABLE 4.3 - SPECIFIC HEAT CAPACITY VALUES FOR ETHYLENE GLYCOL/WATER

Transducer Spacing

XDC SPAC -- Transducer Spacing Calculation (Value)
ENGLSH (Inches)
METRIC (Millimeters)

NOTE: *This value is calculated by the firmware after all pipe parameters have been entered. The spacing value only pertains to DTN, DTL, and DTH transducer sets.*

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

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

Rate Units

RATE UNT -- Engineering Units for Flow Rate (Choice)

Gallons	(Gallons)	Pounds	(LB)
Liters	(Liters)	Kilograms	(KG)
Millions of Gallons	(MGal)	British Thermal Units	(BTU)
Cubic Feet	(Cubic Ft)	Thousands of BTUs	(MBTU)
Cubic Meters	(Cubic Me)	Millions of BTUs	(MMBTU)
Acre Feet	(Acre Ft)	Tons	(TON)
Oil Barrels	(Oil Barr) [42 Gallons]	Kilojoule	(kJ)
Liquid Barrels	(Liq Barr) [31.5 Gallons]	Kilowatt	(kW)
Feet	(Feet)	Megawatt	(MW)
Meters	(Meters)		

Select a desired engineering unit for flow rate measurements.

Rate Interval

RATE INT -- Time Interval for Flow Rate (Choice)
SEC Seconds
MIN Minutes
HOUR Hours
DAY Days

Select a desired engineering unit for flow rate measurements.

Totalizer Units

TOTL UNT -- Totalizer Units

Gallons	(Gallons)	Pounds	(LB)
Liters	(Liters)	Kilograms	(KG)
Millions of Gallons	(MGal)	British Thermal Units	(BTU)
Cubic Feet	(Cubic Ft)	Thousands of BTUs	(MBTU)
Cubic Meters	(Cubic Me)	Millions of BTUs	(MMBTU)
Acre Feet	(Acre Ft)	Tons	(TON)
Oil Barrels	(Oil Barr) [42 Gallons]	Kilojoule	(kJ)
Liquid Barrels	(Liq Barr) [31.5 Gallons]	Kilowatt	(kW)
Feet	(Feet)	Megawatt	(MW)
Meters	(Meters)		

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

Totalizer Exponent

TOTL E -- Flow Totalizer Exponent Value (Choice)
E(-1) to E6

Utilized for setting the flow totalizer exponent. This feature is useful for accommodating a very large accumulated flow or to increase totalizer resolution when flows are small (displaying fractions of whole barrels, gallons, etc.) The exponent is a $\times 10^n$ multiplier, where "n" can be from –1 (× 0.1) to +6 (× 1,000,000). ***Table 4.4*** should be referenced for valid entries and their influence on the display. Selection of **E-1** and **E0** adjusts the decimal point on the display. Selection of **E1, E2** and **E3** causes an icon of × 10, × 100 or × 1000 respectively to appear to the right of the total flow display value.

Exponent	Display Multiplier
E-1	× 0.1 (÷10)
E0	× 1 (no multiplier)
E1	× 10
E2	× 100
E3	× 1,000
E4	× 10,000
E5	× 100,000
E6	× 1,000,000

TABLE 4.4 - EXPONENT VALUES

Minimum Flow Rate

MIN RATE -- Minimum Flow Rate Settings (Value)

A minimum rate setting is entered to establish filter software settings and the lowest rate value that will be displayed. Volumetric entries will be in the Rate Units and Interval selected on ***Page 48*** of this manual. For unidirectional measurements, set **MIN RATE** to zero. For bidirectional measurements, set **MIN RATE** to the highest negative (reverse) flow rate expected in the piping system.

NOTE: *The flow meter will not display a flow rate at flows less than the **MIN RATE** value. As a result, if the **MIN RATE** is set to a value greater than zero, the flow meter will display the **MIN RATE** value, even if the actual flow/energy rate is less than the **MIN RATE**.*

*For example, if the **MIN RATE** is set to 25 and actual rate is 0, the meter display will indicate 25. Another example, if the **MIN RATE** is set to -100 and the actual flow is -200, the meter will indicate -100. This can be a problem if the meter **MIN RATE** is set to a value greater than zero because at flows below the **MIN RATE** <u>**the rate display will show zero flow, but the totalizer which is not affected by the MIN RATE setting will keep totalizing**</u>.*

Maximum Flow Rate

MAX RATE -- Maximum Flow Rate Settings (Value)

A maximum volumetric flow rate setting is entered to establish filter software settings. Volumetric entries will be in the Rate Units and Interval selected on ***Page 48*** of this manual. For unidirectional measurements, set **MAX RATE** to the highest (positive) flow rate expected in the piping system. For bidirectional measurements, set **MAX RATE** to the highest (positive) flow rate expected in the piping system.

Low Flow Cut-off

FL C-OFF -- Low Flow Cut-off (Value)
0-100%

A low flow cut-off entry is provided to allow very low flow rates (that can be present when pumps are off and valves are closed) to be displayed as zero flow. Typical values that should be entered are between 1.0% and 5.0% of the flow range between **MIN RATE** and **MAX RATE**.

Damping Percentage

DAMP PER -- System Damping (Value)
0-100%

Flow filter damping establishes a maximum adaptive filter value. Under stable flow conditions (flow varies less than 10% of reading), 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 10% window, the flow filter adapts by decreasing the number of averaged readings which allows the meter to react faster. Increasing this value tends to provide smoother steady-state flow readings and outputs. If very erratic flow conditions are present or expected, other filters are available for use in the software utility. See ***Part 5*** of this manual for further information.

CH1 MENU -- CHANNEL 1 MENU

CH1 MENU -- 4-20 mA Output Menu [Applies to All Ultra Versions]

4-20 MA -- 4-20 mA Setup Options (Values)

FL 4MA	**Flow at 4 mA**
FL 20MA	**Flow at 20 mA**
CAL 4MA	**4 mA Calibration**
CAL 20MA	**20 mA Calibration**
4-20 TST	**4-20 mA Test**

The **CH1** menu controls how the 4-20 mA output is spanned for all Ultra models and how the frequency output is spanned for the Ultra Flow flow model.

The **FL 4MA** and **FL 20MA** settings are used to set the span for both the 4-20 mA output and the 0-1,000 Hz frequency output on the Ultra Flow meter versions.

The 4-20 mA output is internally powered (current sourcing) and can span negative to positive flow/energy 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 to + 40 FPS (-12 to +12 MPS) range of the instrument. Resolution of the output is 12-bits (4096 discrete points) and the can drive up to a 400 Ohm load when the meter is AC powered. When powered by a DC supply, the load is limited by the input voltage supplied to the instrument. *See **Figure 3.1*** for allowable loop loads.

FL 4MA -- Flow at 4 mA
FL 20MA -- Flow at 20 mA

The **FL 4MA** and **FL 20MA** entries are used to set the span of the 4-20 mA analog output and the frequency output on Ultra Flow versions. These entries are volumetric rate units that are equal to the volumetric units configured as **RATE UNT** and **RATE INT** discussed on ***Page 48*****.**

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

FL 4MA = -100.0
FL 20MA = 100.0

If the meter were a Ultra Flow, this setting would also set the span for the frequency output. At -100 GPM, the output frequency would be 0 Hz. At the maximum flow of 100 GPM, the output frequency would be 1,000 Hz, and in this instance a flow of zero would be represented by an output frequency of 500 Hz.

Example 2 - To span the 4-20 mA output from 0 GPM to +100 GPM, with 12 mA being 50 GPM, set the **FL 4MA** and **FL 20MA** inputs as follows:

FL 4MA = 0.0
FL 20MA = 100.0

For the Ultra Flow, in this instance zero flow would be represented by 0 Hz and 4 mA. The full scale flow or 100 GPM would be 1,000 Hz and 20 mA, and a midrange flow of 50 GPM would be expressed as 500 Hz and 12 mA.

The 4-20 mA output is factory calibrated and should not require adjustment. If small adjustments to the DAC (**D**igital to **A**nalog **C**onverter) are needed, for instance if adjustment due to the accumulation of line losses from long output cable lengths are required, the **CAL 4mA** and **CAL 20 MA** can be used.

CAL 4 MA -- 4 mA DAC Calibration Entry (Value)
CAL 20 MA-- 20 mA DAC Calibration Entry (Value)

The **CAL 4MA** and **CAL 20 MA** entries allow fine adjustments to be made to the "zero" and full scale of the 4-20 mA output. To adjust the outputs, an ammeter or reliable reference connection to the 4-20 mA output must be present.

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

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

4 mA Calibration Procedure:

1) Disconnect one side of the current loop and connect the ammeter in series (disconnect either wire at the terminals labeled 4-20 mA Out or Signal Gnd).
2) Using the arrow keys, increase the numerical value to increase the current in the loop to 4 mA. Decrease the value to decrease the current in the loop to 4 mA. Typical values range between 40-80 counts.
3) Reconnect the 4-20 mA output circuitry as required.

20 mA Calibration Procedure:

1) Disconnect one side of the current loop and connect the ammeter in series (disconnect either wire at the terminals labeled 4-20 mA Out or Signal Gnd).
2) Using the arrow keys, increase the numerical value to increase the current in the loop to 20 mA. Decrease the value to decrease the current in the loop to 20 mA. Typical values range between 3700-3900 counts.
3) Reconnect the 4-20 mA output circuitry as required.

4-20 TST -- 4-20 mA Output Test (Value)

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.

CH2 MENU -- CHANNEL 2 MENU

The **CH2** menu is used to configure model specific I/O options. The Ultra Flow presents a different set of parameters than the Ultra Energy meter.

Caution: It is possible to choose options pertaining only to the **Ultra Flow** when a **Ultra Energy** meter is present. The opposite is also true. The proper menu type must be chosen for the actual meter. If this caution isn't followed, the outputs or meter readings will be unpredictable.

Channel 2 Options

CH2 Menu -- Channel 2 I/O Options (Choice)
RTD -- Input Values for Ultra Energy Meters (Values)
CONTROL/HZ -- Output Options for Ultra Flow Meters

Ultra Energy Options

RTD -- Calibration Values (Value)
RTD1 A **Calibration Value for RTD1 A**
RTD1 B **Calibration Value for RTD1 B**
RTD2 A **Calibration Value for RTD2 A**
RTD2 B **Calibration Value for RTD2 B**

Inputs from two 1,000 Ohm platinum RTD temperature sensors allow measurements of heating or cooling usage.

The values used to calibrate the RTD temperature sensors are derived in the laboratory and are specific to the RTD and to the electronic circuit it is connected to. The RTDs on new units come with the calibration values already entered into the Ultra Energy and should not need to be changed.

Field replacement of RTDs is possible thru the use of the keypad or the software utility. If the RTDs were ordered from the manufacturer, they will come with calibration values that need to be loaded into the Ultra Energy.

New, non-calibrated RTDs will need to be field calibrated using an ice bath and boiling water to derive calibration values. This procedure is outlined in the ***Appendix*** of this manual.

SURFACE MOUNT RTDs	
D010-3000-301	set of two, 200 °C Maximum Temperature (20 feet of cable)
INSERTION RTDs	
D010-3000-200	single, 3 inch (75 mm), 0.25 inch OD
D010-3000-203	single, 6 inch (150 mm), 0.25 inch OD

TABLE 4.5 - RTDs

Ultra Flow Options

Two independent open collector transistor outputs are included with the Ultra Flow model. Each output can be configured independently for one of the following:

CONTROL/HZ -- Control Options (Choice)

Select either Control 1 or Control 2 to program.

TOTALIZE -- Totalizer Output Options

TOT MULT --Totalizer Multiplier (Value)

Sets the multiplier value applied to the totalizing pulse output.

FLOW -- Flow Alarm Output Options

FLOW -- Flow Alarm Values

ON (Value)

Sets value at which the alarm output will turn ON.

OFF (Value)

Sets value at which the alarm output will turn OFF.

SIG STR -- Signal Strength Alarm Options

SIG STR -- Signal Strength Alarm Values

ON (Value)

Sets value at which the alarm output will turn ON.

OFF (Value)

Sets value at which the alarm output will turn OFF.

ERRORS

Alarm outputs on any error condition. See ***Error Table*** in the ***Appendix*** of this manual.

NONE

Alarm outputs disabled.

NOTE: *The setup options for both* ***CONTROL 1*** *and* ***CONTROL 2*** *follow the same menu path. For a complete view of the menu options, see the* ***Menu Map*** *in the* ***Appendix*** *of this manual.*

SEN MENU -- SENSOR MENU

The **SEN MENU** allows access to the various types of transducers the Ultra can work with. Selecting the proper transducers in conjunction with the transducer mount (**XDCR MNT**) and transducer frequency (**XDCR HZ**) is critical to accurate operation of the meter.

SEN MENU -- Transducer Selection Menu (Choice)

DTN

Used on pipes 2 inches (51 mm) and larger.

(250 °F/121 °C maximum)

DTH

High temperature version of DTN.

(350 °F/177 °C maximum)

DTL

Used on pipes 24 inches (600 mm) and larger.

(250 °F/121 °C maximum)

For pipes 24" (600 mm) and larger the DTL transducers using a transmission frequency of 500 KHz are recommended.

DTL transducers may also be advantageous on pipes between 4" and 24" if there are less quantifiable complicating aspects such as, sludge, tuberculation, scale, rubber liners, plastic liners, thick mortar, gas bubbles, suspended solids, emulsions, or pipes that are perhaps partially buried where a **V**-mount is required/desired, etc.

DT1500

Used with the M5-1500 and D1500 legacy flow meters.

COPPER PIPE

Used with DTS and DTC small pipe transducers.

DTS (185 °F/85 °C maximum), DTC (250 °F/121 °C maximum)

ANSI PIPE

Used with DTS and DTC small pipe transducers.

DTS (185 °F/85 °C maximum), DTC (250 °F/121 °C maximum)

TUBING

Used with DTS and DTC small pipe transducers.

DTS (185 °F/85 °C maximum), DTC (250 °F/121 °C maximum)

SEC MENU -- SECURITY MENU

The **SEC MENU** menu allows access to meter functions that may need to be protected from changes.

SEC MENU -- Security Function Selection Menu

TOT RES -- Totalizer Reset (Choice)

YES

NO

Resets the totalizing displayed on the LCD to zero.

SYS RES -- System Reset (Choice)

YES

NO

Restarts the flow meter's microprocessor. This is similar to power cycling the flow meter.

CH PSWD? -- Change Password (Value)

0 - 9999

The password comes from the factory set to 0000. When set to 0000 the password function is disabled. By changing the password from 0000 to some other value (any value between 0001-9999), configuration parameters will not be accessible without first entering the password value when prompted. If the value is left at 0000, no security is invoked and unauthorized changes can be made. Access to resetting of the totalizer is also protected by this password. If the password is lost or forgotten, contact the manufacturer for a universal password to unlock the meter.

SER MENU -- SERVICE MENU

The **SER MENU** menu allows access to meter set up values that may need revision due to application specific conditions and information valuable in troubleshooting.

SER MENU -- Service Menu

SSPD MPS -- Liquid Sound Speed (Meters per Second) (Reported by Firmware)
SSPD FPS -- Liquid Sound Speed (Feet per Second) (Reported by Firmware)

The Ultra performs an actual speed of sound calculation for the liquid it is measuring. This speed of sound calculation will vary with temperature, pressure and fluid composition.

The Ultra will compensate for fluid sound speeds that vary within a window of ± 10% of the liquid specified in the **BSC MENU**. If this range is exceeded, error code 0011 will appear on the display and the sound speed entry must be corrected.

The value indicated in **SSPD** measurement should be within 10% of the value entered/indicated in the **BSC MENU** item **FLUID SS**. (The SSPD value itself cannot be edited.) If the actual measured value is significantly different (> ± 10%) than the **BSC MENU**'s **FLUID SS** value, it typically indicates a problem with the instrument setup. An entry such as **FL TYPE**, **PIPE OD** or **PIPE WT** may be in error, the pipe may not be round or the transducer spacing is not correct.

Table 4.6 lists sound speed values for water at varying temperatures. If the Ultra is measuring sound speed within 2% of the table values, then the installation and setup of the instrument is correct.

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

TABLE 4.6 - SOUND SPEED OF WATER

SIG STR -- Signal Strength (Reported by Firmware)

The **SIG STR** value is a relative indication of the amount of ultrasound making it from the transmitting transducer to the receiving transducer. The signal strength is a blending of esoteric transit time measurements distilled into a usable overall reference.

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

Signal strength below the Low Signal Cutoff (**SIG C-OF)** value will generate a 0010 error (Low Signal Strength) and require either a change in the **SIG C-OF** value or transducer mounting changes.

NOTE: *If the unit is configured to display totalizer values, the display will alternate between ERROR 0010 and the totalizer value.*

Signal strength readings in excess of 98 may indicate that a mounting method with a longer path length may be required. For example, if transducers mounted on a 3 inch PVC pipe in **V**-Mount cause the measured signal strength value to exceed 98, change the mounting method to **W**-Mount for greater stability in readings.

Because signal strength is not an "absolute" indication of how well a Ultra meter is functioning, there is no real advantage to a signal strength of 50 over a signal strength of 10.

TEMP 1 -- Temperature of RTD 1 (Reported by Firmware in °C)

When **RTD** is selected from the **CH2** menu and RTDs are connected to the Ultra Energy meter, the firmware will display the temperature measured by RTD 1 in °C.

TEMP 2 -- Temperature of RTD 2 (Reported by Firmware in °C)

When **RTD** is selected from the **CH2** menu and RTDs are connected to the Ultra Energy meter, the firmware will display the temperature measured by RTD 2 in °C.

TEMPDIFF -- Temperature difference (Reported by Firmware in °C)

When **RTD** is selected from the **CH2** menu and RTDs are connected to the Ultra Energy meter, the firmware will display the difference in temperature measured between RTD 1 and RTD 2 in °C.

SIG C-OF -- Low Signal Cutoff (Value)
0.0 - 100.0

The **SIG C-OF** is used to drive the flow meter and its outputs to the **SUB FLOW** (Substitute Flow described below) state if conditions occur that cause low signal strength. A signal strength indication below 5 is generally inadequate for measuring flow reliably, so the minimum setting for **SIG C-OF** is 5. A good practice is to set the **SIG C-OF** at approximately 60-70% of actual measured maximum signal strength.

NOTE: *The factory default "Signal Strength Cutoff" is 5.*

If the measured signal strength is lower than the **SIG C-OF** setting, an error 0010 will be displayed on the Ultra display until the measured signal strength becomes greater than the cutoff value.

A 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 will also cause low signal strength conditions.

SUB FLOW -- Substitute Flow (Value)
0.0 - 100.0

Substitute Flow (**SUB FLOW**) is a value that the analog outputs and the flow rate display will indicate when an error condition in the flow meter 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:

$$\text{Substitute Flow} = 100 - \frac{100 \times \text{Maximum Flow}}{\text{Maximum Flow} - \text{Minimum Flow}}$$

TABLE 4.7 lists some typical settings to achieve "Zero" with respect to **MIN RATE** and **MAX RATE** settings.

****THE SOFTWARE UTILITY IS REQUIRED TO SET VALUES OUTSIDE OF 0.0-100.0.***

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

TABLE 4.7 - SAMPLE SUBSTITUTE FLOW READINGS

SET ZERO -- Set Zero Flow Point (Choice)
NO
YES

Because every flow meter installation is slightly different and sound waves can travel in slightly different ways through these various installations, it is important to remove the zero offset at zero flow to maintain the meter's accuracy. A provision is made using this entry to establish "Zero" flow and eliminate the offset.

Procedure:

1) The pipe must be full of liquid.
2) Flow must be absolute zero - securely close any valves and allow time for any settling to occur.
3) Press **ENTER**, use the arrow ▲▼ keys to make the display read **YES**.
4) Press **ENTER**.

D-FLT 0 -- Set Default Zero Point (Choice)
NO
YES

If the flow in a piping system cannot be shut off, allowing the **SET ZERO** procedure described above to be performed or if an erroneous "zero" flow was captured - like can happen if **SET ZERO** is conducted with flowing fluid, then the factory default zero should be utilized. To utilize the **D-FLT 0** function, simply press **ENTER**, then press an arrow ▲▼key to display **YES** on the display and then press **ENTER**.

The default zero places an entry of zero (0) into the firmware instead of the actual zero offset entered by using the **SET ZERO** procedure.

COR FTR -- Correction Factor (Value)
0.500 - 1.500

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

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

2) An out-of-round pipe, carrying water, causes the Ultra to indicate a measured sound speed that is 7.4% lower than the ***Table 4.5*** value. This pipe condition will cause the flow meter to indicate flow rates that are 7.4% lower than actual flow. To correct the flow readings, enter 1.074.

DSP MENU -- DISPLAY MENU

The **DISPLAY** menu parameters control what is shown on the display and the rate at which displayed items alternate (dwell time).

Display Submenu -- Display Options

DISPLAY -- Display (Choice)
FLOW
TOTAL
BOTH

The Ultra will only display the flow rate with the **DISPLAY** set to **FLOW** - it will not display the total flow. The meter will only display the total flow with the **DISPLAY** set to **TOTAL** - it will not display the flow rate. By selecting **BOTH**, the display will alternate between **FLOW** and **TOTAL** at the interval selected in **SCN DWL** (see below).

Total Submenu -- Totalizer Choices

TOTAL -- Totalizer Options (Choice)
POS - Positive Flow Only
NEG - Negative Flow Only
NET - Net Flow
BATCH - Batch Mode

Select **POS** to view the positive direction total only. Select **NEG** to view the negative direction total only. Select **NET** to display the net difference between the positive direction and negative direction totals. Select the **BATCH** to configure the totalizer to count up to a value that is entered as **BTCH MUL**. After reaching the **BTCH MUL** value, the display will return to zero and will repeat counting to the **BTCH MUL** value.

Display Dwell Time

SCN DWL -- Dwell Time (Value)
1 to 10 (in Seconds)

Adjustment of **SCN DWL** sets the time interval that the display will dwell at **FLOW** and then alternately **TOTAL** values when **BOTH** is chosen from the display submenu. This adjustment range is from 1 second to 10 seconds.

Totalizer Batch Quantity

BTCH MUL -- Batch Multiplier (Value)

If **BATCH** was chosen for the totalizer mode, a value for batch accumulation must be entered. This is the value to which the totalizer will accumulate before resetting to zero and repeating the accumulation. This value includes any exponents that were entered in the **BSC MENU** as **TOTAL E**.

For example:

1) If **BTCH MUL** is set to 1,000, **RATE UNT** to **LITERS** and **TOTL E** to **E0** (liters × 1), then the batch totalizer will accumulate to 1,000 liters, return to zero and repeat indefinitely. The totalizer will increment 1 count for every 1 liter that has passed.

2) If **BTCH MUL** is set to 1,000, **RATE UNT** to **LITERS** and **TOTL E** to **E2** (liters × 100), then the batch totalizer will accumulate to 100,000 liters, return to zero and repeat indefinitely. The totalizer will only increment 1 count for every 100 liters that has passed.

PART 5 - ULTRALINK™ SOFTWARE UTILITY

INTRODUCTION

In addition to, or as a replacement for, the keypad entry programming, the Ultra flow meter can be used with the ULTRALINK™ software utility. The ULTRALINK™ utility is used for configuring, calibrating and communicating with the Ultra family of flow meters. Additionally, it has numerous troubleshooting tools to make diagnosing and correcting installation problems easier.

ULTRALINK™ has been designed to provide the Ultra user with a powerful and convenient way to configure calibrate and troubleshoot all Ultra family flow meters. A PC can be hard-wired to an Ultra flow meter through a standard USB connection found on most current computers.

SYSTEM REQUIREMENTS

ULTRALINK™ requires a PC-type computer, running Windows 98, Windows ME, Windows 2000, Windows NT, Windows XP, Windows Vista® or Windows® 7 operating systems and a USB communications port.

INSTALLATION

1) From the Windows "Start" button, choose the Run command. From the "Run" dialog box, use the Browse button 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, if desired.

NOTE: *If a previous version of* ULTRALINK™ *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) Connect the B end of the USB A/B communications cable (P.N. D005-2117-003) to the Ultra USB communication port and the A end to a convenient USB port on the computer.

NOTE: *It is advisable to have the Ultra meter powered up prior to running this software.*
NOTE: *While the USB cable is connected, the RS485 and frequency outputs are disabled.*

2) Double-click on theULTRALINK™ icon. The first screen is the "RUN" mode screen (see ***Figure 5.1***), which contains real-time information regarding flow rate, totals, signal strength, communications status, and the flow meter's serial number. The **COMM** indicator in the lower right-hand corner indicates that the serial connection is active. If the **COMM** box contains a red **ERROR,** click on the **Communications** button 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-hand 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.

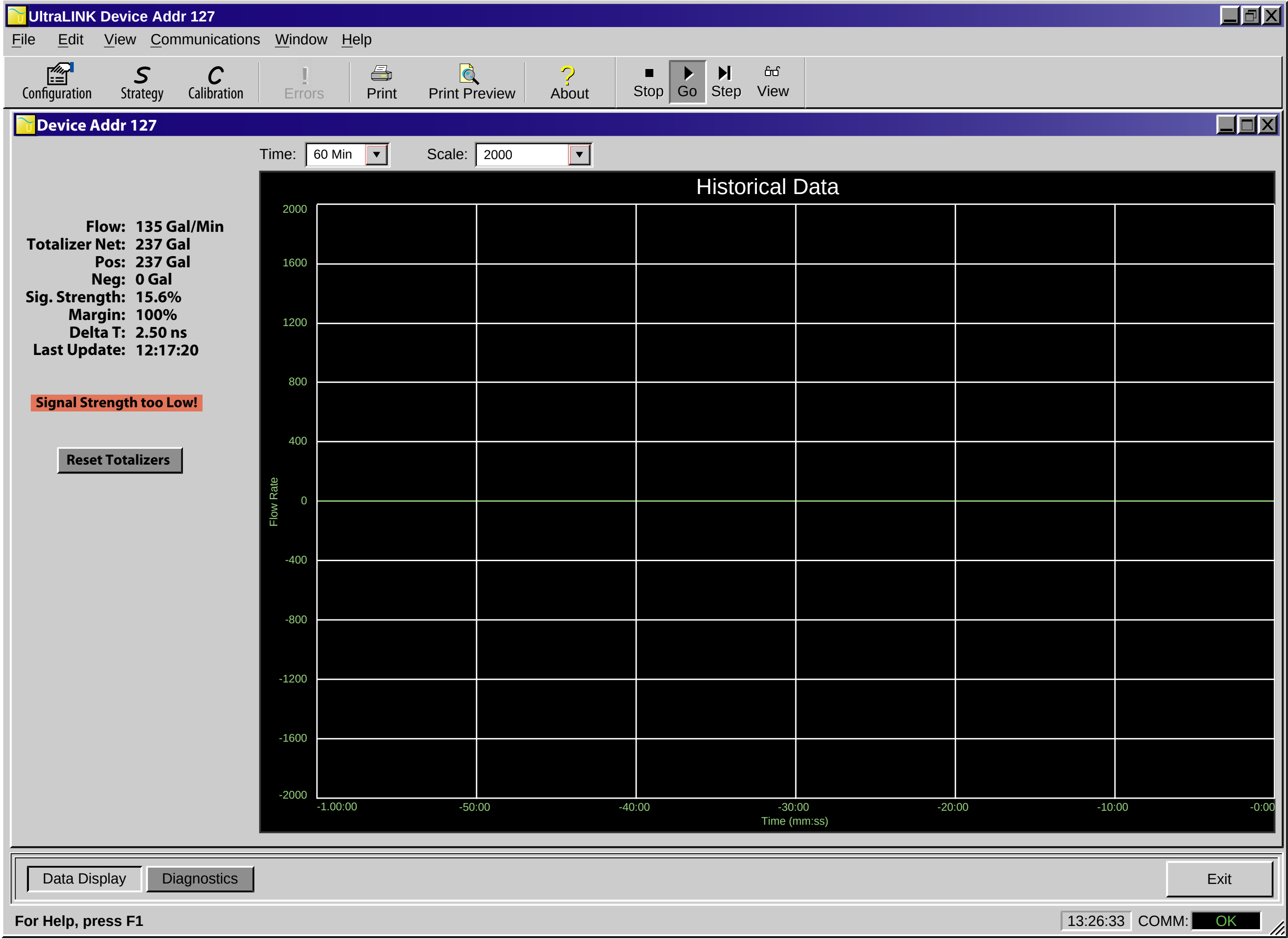
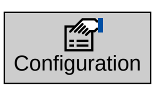


FIGURE 5.1 - DATA DISPLAY SCREEN



The Configuration drop-down houses six screens used to control how the Ultra is set up and responds to varying flow conditions. The first screen that appears after clicking the **Configuration** button is the **Basic** screen. See ***Figure 5.2***.

BASIC TAB

General

The general heading allows users to select the measurement system for meter setup, either **English** or **Metric** and choose from a number of pre-programmed small pipe configurations in the **Standard Configurations** drop-down. If pipe measurements are to be entered in inches, select **English**. If pipe measurements are to be entered in millimeters, select **Metric**. If the **General** entries are altered from those at instrument start-up, then click on the **Download** button in the lower right-hand portion of the screen and cycle power to the Ultra.

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, MODBUS Address, Standard Configurations, Frequency, Flow Direction**, and **Specific Heat Capacity** will be unavailable behind a "grayed out" entry box.
2) Go back to the **Standard Configurations** drop-down menu and select **Custom**. As soon as **Custom** is chosen, the previously grayed out selections will become available for editing.
3) Make any changes to the **Basic** configuration deemed necessary and press **Download**.
4) To ensure that the configuration changes take effect, turn the power off and then back on again to the transmitter.

Also under the ***General*** heading is a field for entering a **MODBUS Address**. If the Ultra is to be used on a multi-drop RS485 network, it must be assigned a unique numerical address. This box allows that unique address to be chosen.

NOTE: *This address does not set the Modbus TCP/IP, EtherNet/IP™, BACnet® address. That is set via the web page interface that is integrated into the Ethernet port.*

NOTE: *Do not confuse the **MODBUS Address** with the "**Device Address**" as seen in the upper left-hand corner of the display. The **Device Addr** is included for purposes of backward compatibility of first generation Ultra products. The **Device Addr** has no function and will not change when used with an Ultra.*

Transducer

***Transducer* Type** selects the transducer that will be connected to the Ultra flow meter. Select the appropriate transducer type from the drop-down list. This selection influences transducer spacing and flow meter performance, so it must be correct. If you are unsure about the type of transducer to which the Ultra will be connected, consult the shipment packing list or call the manufacturer for assistance.

NOTE: *A change of **Transducer Type** will cause a System Configuration Error (1002: Sys Config Changed) to occur. This error will clear when the microprocessor is reset or power is cycled on the flow meter.*

Transducer* Mount** selects the orientation of the transducers on the piping system. See ***Part 2 of this manual and ***Table 2.2*** for detailed information regarding transducer mounting modes for particular pipe and liquid characteristics. Whenever ***Transducer* Mount** is changed, a download command and subsequent microprocessor reset or flow meter power cycle must be conducted.

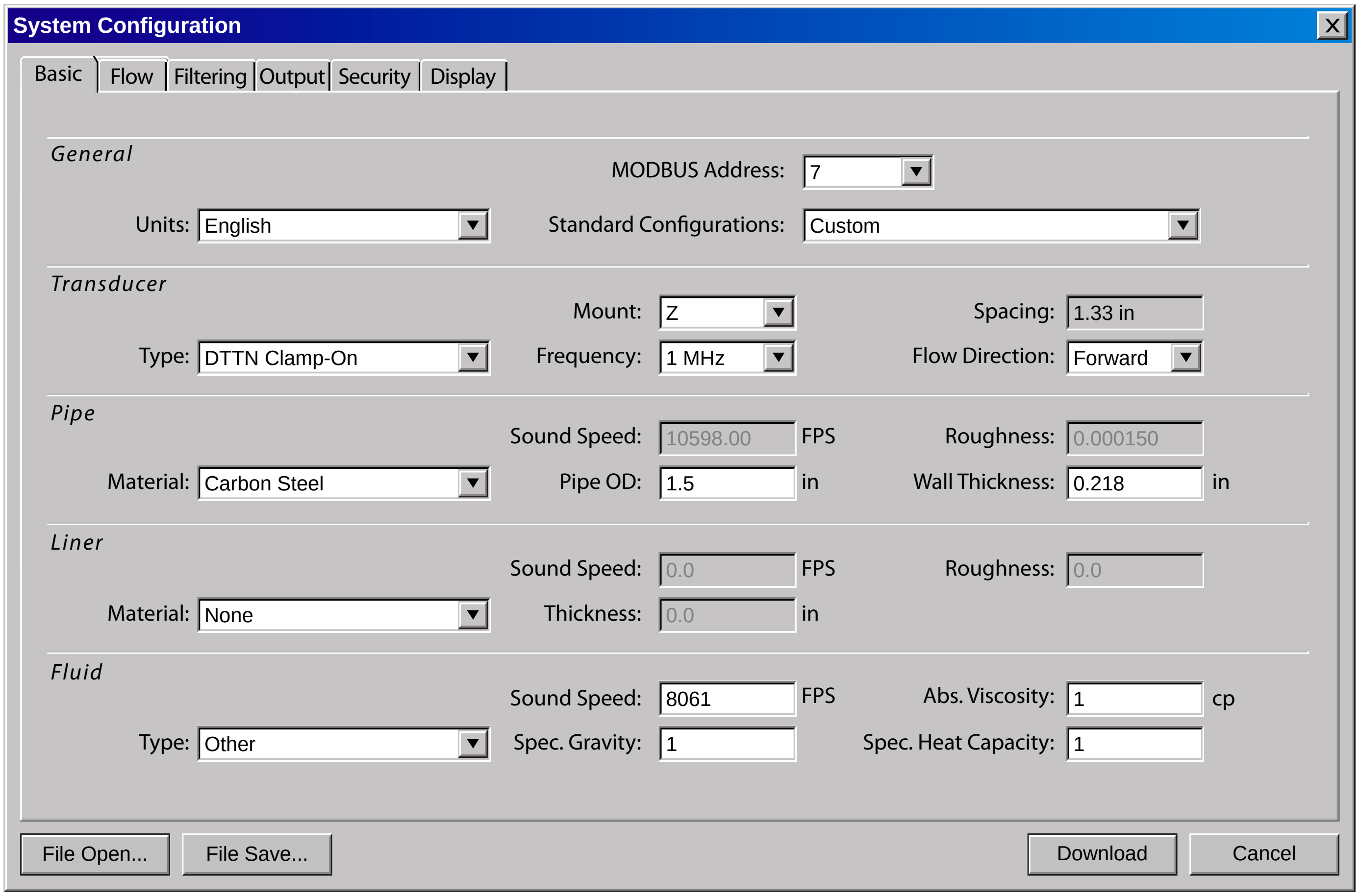


FIGURE 5.2 - BASIC TAB

***Transducer* Frequency** permits the meter to select a transmission frequency for the various types of transducers that can be utilized. In general, the larger the pipe the slower the transmission frequency needs to be to attain a good signal.

Frequency	Transducers	Transmission Modes	Pipe Size and Type
2 MHz	All ½″ thru 1½″ Small Pipe and Tube 2″ Tubing	Selected by Firmware	Specific to Transducer
1 MHz	2″ ANSI Pipe and Copper Tube	Selected by Firmware	Specific to Transducer
	Standard and High Temp	W, V, and Z	2″ and Greater
500 KHz	Large Pipe	W, V, and Z	24″ and Greater

TABLE 5.1 - TRANSDUCER FREQUENCIES

***Transducer* Spacing** is a value calculated by the Ultra firmware that takes into account pipe, liquid, transducer and mounting information. This spacing will adapt as these parameters are modified. The spacing is given in inches for **English** units selection and 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 DTN, DTL, and DTH transducers.*

***Transducer* Flow Direction** allows the change of the direction the meter assumes is forward. When mounting Ultra meters with integral transducers, this feature allows upstream and downstream transducers to be "electronically" reversed, making upside down mounting of the display unnecessary.

***Pipe* Material** is selected from the pull-down list. If the pipe material utilized 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.

***Pipe* O.D.** and **Wall Thickness** are based on the physical dimensions of the pipe on which the transducers will be mounted. Enter this value in inches for **English** units or millimeters for **Metric** units.

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

Liner* Material** is selected from the pull-down list. If the pipe liner material utilized 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). See ***Page 45 for pipe liner relative roughness calculations.

***Fluid* Type** is 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.

FLOW TAB

Flow Rate Units are selected from the drop-down lists. Select an appropriate rate unit and time from the two lists. This entry also includes the selection of **Flow Rate Interval** after the **/** sign.

Totalizer Units are selected from drop-down lists. Select an appropriate totalizer unit and totalizer exponent. The totalizer exponents are in scientific notation and permit the eight digit totalizer to accumulate very large values before the totalizer "rolls over" and starts again at zero. ***Table 4.4*** illustrates the scientific notation values and their respective decimal equivalents.

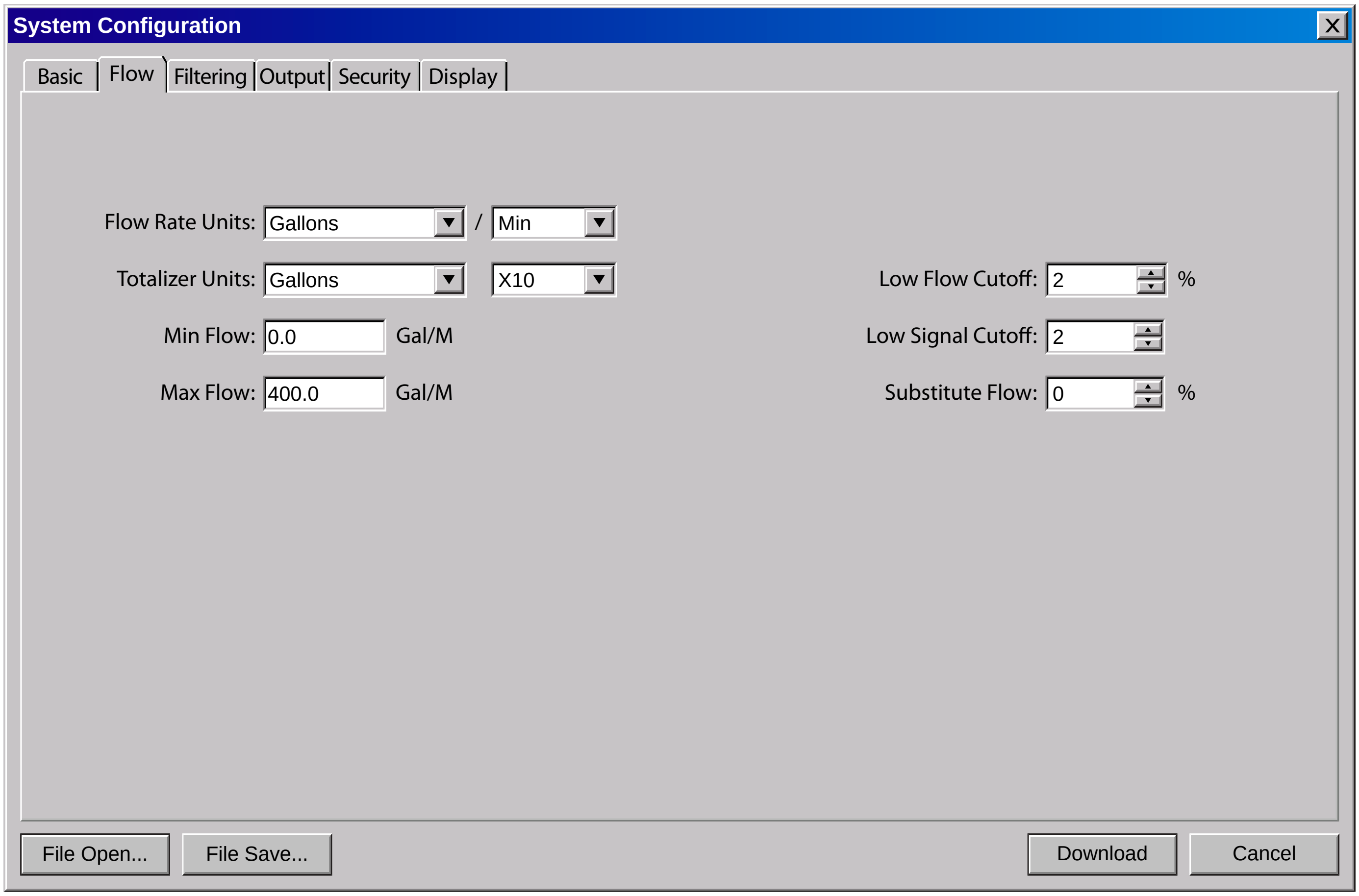


FIGURE 5.3 - FLOW TAB

Min Flow is the minimum volumetric flow rate setting entered to establish filtering parameters. Volumetric entries will be 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 is the maximum volumetric flow rate setting entered to establish filtering parameters. Volumetric entries will be 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 is provided to allow very low flow rates (that can be present when pumps are off and valves are closed) to be displayed as zero flow. Typical values that should be entered are between 1.0% and 5.0% of the flow range between **Min Flow** and **Max Flow**.

Low Signal Cutoff is used to drive the flow meter 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.

NOTE: *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 will become visible 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 will also cause low signal strength conditions.

Substitute Flow is a value that the analog outputs and the flow rate display will indicate when an error condition in the flow meter 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 Flow** and **Max Flow**. 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 an error condition. To calculate where to set the Substitute Flow value in a bidirectional system, perform the following operation:

$$\textit{Substitute Flow} = 100 - \frac{100 \times \textit{Maximum Flow}}{\textit{Maximum Flow} - \textit{Minimum Flow}}$$

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

FILTERING TAB

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

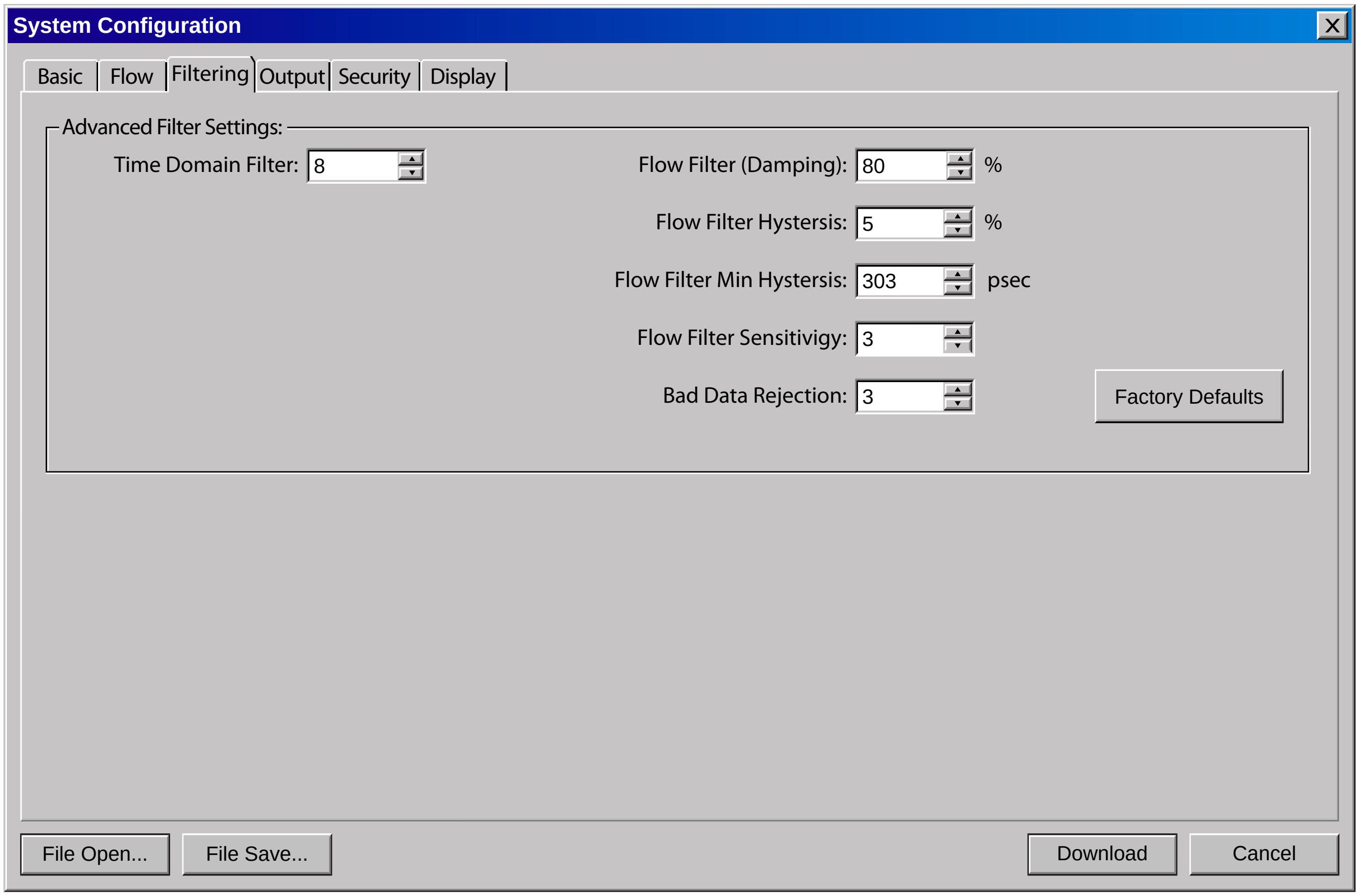


FIGURE 5.4 - FILTERING TAB

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 flow meter. Conversely, lowering this value will decrease the response time of the meter to changes in flow/energy rate. This filter is not adaptive, it is operational to the value set at all times.

NOTE: *The Ultra completes a measurement in approximately 350-400 mS. The exact time is pipe size dependent.*

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 meter to react faster.

The damping value is increased to increase stability of the flow rate readings. Damping values are decreased to allow the flow meter to react faster to changing flow rates. The factory settings are suitable for most installations. Increasing this value tends to provide smoother steady-state flow readings and outputs.

Flow Filter Hysteresis creates a window around the average flow measurement reading 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 (Damping)** 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 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 (ρ sec) 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 allows configuration of how fast the **Flow Filter Damping** will adapt in the positive direction. Increasing this value allows greater damping to occur faster than lower values. Adaptation in the negative direction is not user adjustable.

Bad Data Rejection is a value related to the number of successive readings that must be measured outside of the **Flow Filter Hysteresis** or **Flow Filter MinHysteresis** windows before the flow meter 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 flow meter 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 flow meter. Select the appropriate function from the pull-down menu and press the Download button. When a function is changed from the factory setting, a Configuration error (1002) will result. This error will be cleared by resetting the Ultra microprocessor from the Communications/Commands/Reset Target button or by cycling power on the Ultra flow meter. Once the proper output is selected and the microprocessor is reset, calibration and configuration of the modules can be completed.

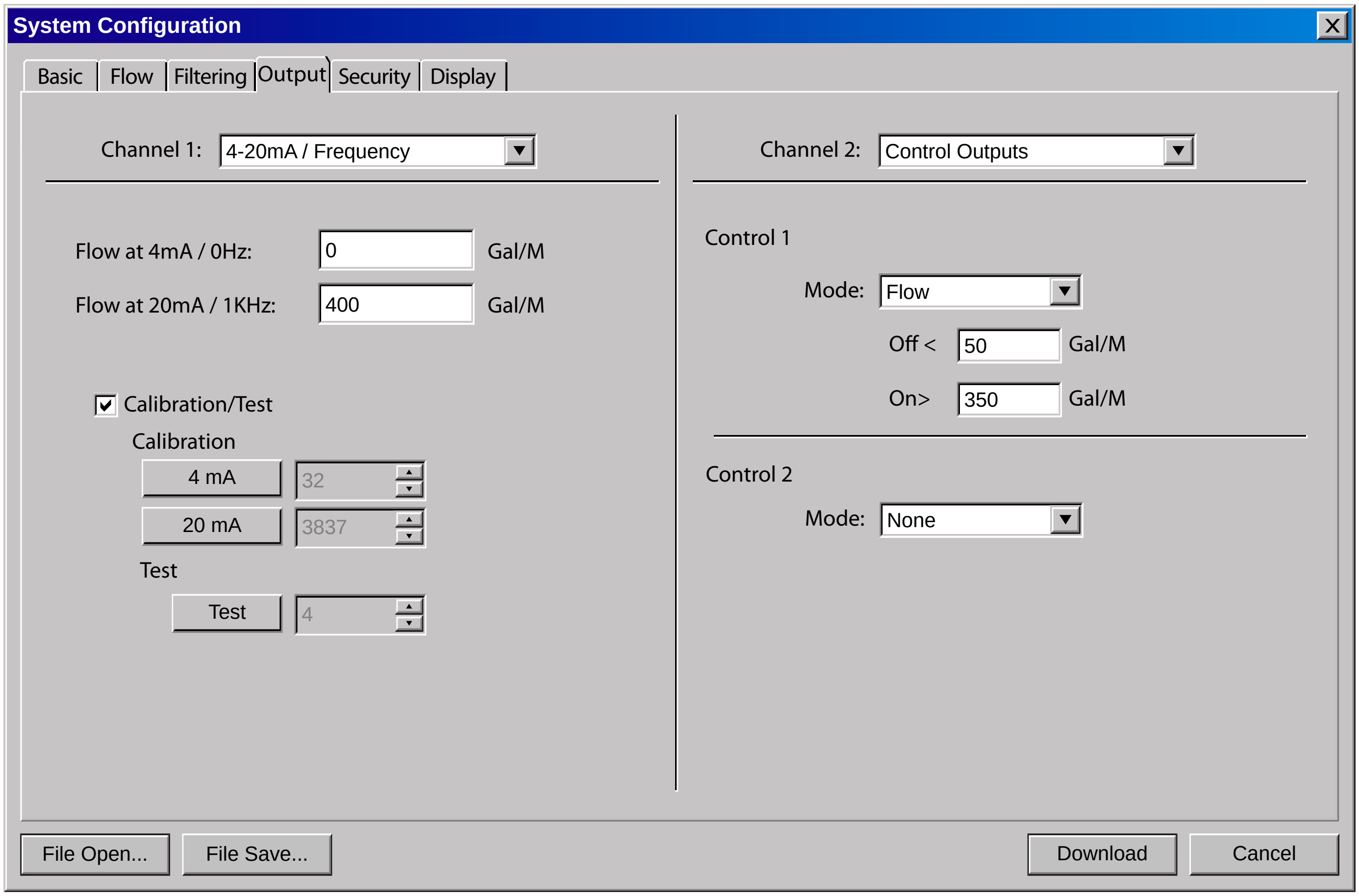


FIGURE 5.5 - OUTPUT TAB

CHANNEL 1 - 4-20 MA CONFIGURATION

NOTE: *The 4-20 mA Output Menu applies to all Ultra versions and is the only output choice for Channel 1.*

The **Channel 1** menu controls how the 4-20 mA output is spanned for all Ultra models and how the frequency output is spanned for the Ultra Flow model.

The Flow at 4 mA / 0 Hz and Flow at 20 mA / 1,000 Hz settings are used to set the span for both the 4-20 mA output and the 0-1,000 Hz frequency output on the Ultra meter versions.

The 4-20 mA output is internally powered (current sourcing) and can span negative to positive flow/energy 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 to + 40 FPS (-12 to +12 MPS) range of the instrument. Resolution of the output is 12-bits (4096 discrete points) and can drive up to a 400 Ohm load when the meter is AC powered. When powered by a DC supply, the load is limited by the input voltage supplied to the instrument. See ***Figure 3.1*** for allowable loop loads.

Flow at 4 mA / 0 Hz
Flow at 20 mA / 1,000 Hz

The Flow at 4 mA / 0 Hz and Flow at 20 mA / 1,000 Hz entries are used to set the span of the 4-20 mA analog output and the frequency output on Ultra Flow versions. These entries are volumetric rate units that are equal to the volumetric units configured as rate units and rate interval discussed on ***Page 49*.**

For example, to span the 4-20 mA output from -100 GPM to +100 GPM with 12 mA being 0 GPM, set the Flow at 4 mA / 0 Hz and Flow at 20 mA / 1,000 Hz inputs as follows:

Flow at 4 mA / 0 Hz = -100.0
Flow at 20 mA / 1,000 Hz = 100.0

If the meter were a Ultra Flow, this setting would also set the span for the frequency output. At -100 GPM, the output frequency would be 0 Hz. At the maximum flow of 100 GPM, the output frequency would be 1,000 Hz, and in this instance a flow of zero would be represented by an output frequency of 500 Hz.

Example 2 - To span the 4-20 mA output from 0 GPM to +100 GPM with 12 mA being 50 GPM, set the Flow at 4 mA / 0 Hz and Flow at 20 mA / 1,000 Hz inputs as follows:

Flow at 4 mA / 0 Hz = 0.0
Flow at 20 mA / 1,000 Hz = 100.0

For the Ultra Flow meter, in this instance, zero flow would be represented by 0 Hz and 4 mA. The full scale flow or 100 GPM would be 1,000 Hz and 20 mA and a midrange flow of 50 GPM would be expressed as 500 Hz and 12 mA.

The 4-20 mA output is factory calibrated and should not require adjustment. If small adjustments to the DAC (**D**igital to **A**nalog **C**onverter) are needed, for instance if adjustments due to the accumulation of line losses from long output cable lengths are required, the **Calibration 4 mA** and **Calibration 20 mA** can be used.

Calibration 4 mA -- 4 mA DAC Calibration Entry (Value)
Calibration 20 mA-- 20 mA DAC Calibration Entry (Value)

The **Calibration 4 mA** and **Calibration 20 mA** entries allows fine adjustments to be made to the "zero" and full scale of the 4-20 mA output. To adjust the outputs, an ammeter or reliable reference connection to the 4-20 mA output must be present.

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

NOTE: *The Calibration 4 mA and Calibration 20 mA entries should not be used in an attempt to set the 4-20 mA range. Utilize Flow at 4 mA / 0 Hz and Flow at 20 mA / 1,000 Hz detailed above for this purpose.*

4 mA Calibration Procedure:

1) Disconnect one side of the current loop and connect the ammeter in series (disconnect either wire at the terminals labeled 4-20 mA Out or Signal Gnd).
2) Using the arrow keys, increase the numerical value to increase the current in the loop to 4 mA. Decrease the value to decrease the current in the loop to 4 mA. Typical values range between 40-80 counts.
3) Reconnect the 4-20 mA output circuitry as required.

20 mA Calibration Procedure:

1) Disconnect one side of the current loop and connect the ammeter in series (disconnect either wire at the terminals labeled 4-20 mA Out or Signal Gnd).
2) Using the arrow keys, increase the numerical value to increase the current in the loop to 20 mA. Decrease the value to decrease the current in the loop to 20 mA. Typical values range between 3700-3900 counts.
3) Reconnect the 4-20 mA output circuitry as required.

4-20 Test -- 4-20 mA Output Test (Value)

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.

CHANNEL 2 - RTD CONFIGURATION [ULTRA ENERGY ONLY]

NOTE: *The Channel 2 Menu is used to configure model specific I/O options. The Ultra Flow presents a different set of parameters than the Ultra Energy meter.*

Caution: It is possible to choose options pertaining only to the Ultra Flow when an Ultra Energy meter is present. The opposite is also true. The proper menu type must be chosen for the actual meter. If this caution isn't followed, the outputs or meter readings will be unpredictable.

Inputs from two 1,000 Ohm platinum RTD temperature sensors allow the measurement of energy delivered in liquid heating and cooling systems.

The values used to calibrate the RTD temperature sensors are derived in the laboratory and are specific to a specific RTD. The RTDs on new units come with the calibration values already entered into the Ultra Energy and should not need to be changed.

Field replacement of RTDs is possible thru the use of the keypad or the software. If the RTDs were ordered from the manufacturer, they will come with calibration values that need to be loaded into the Ultra Energy.

RTD Calibration Procedure:

1) Enter the calibration values for **RTD #1 A** and **B** followed by **RTD #2 A** and **B**.
2) Double-click on the **Download** button to send the values to memory.
3) Turn the power off and then back on to the Ultra to enable the changes to take effect.

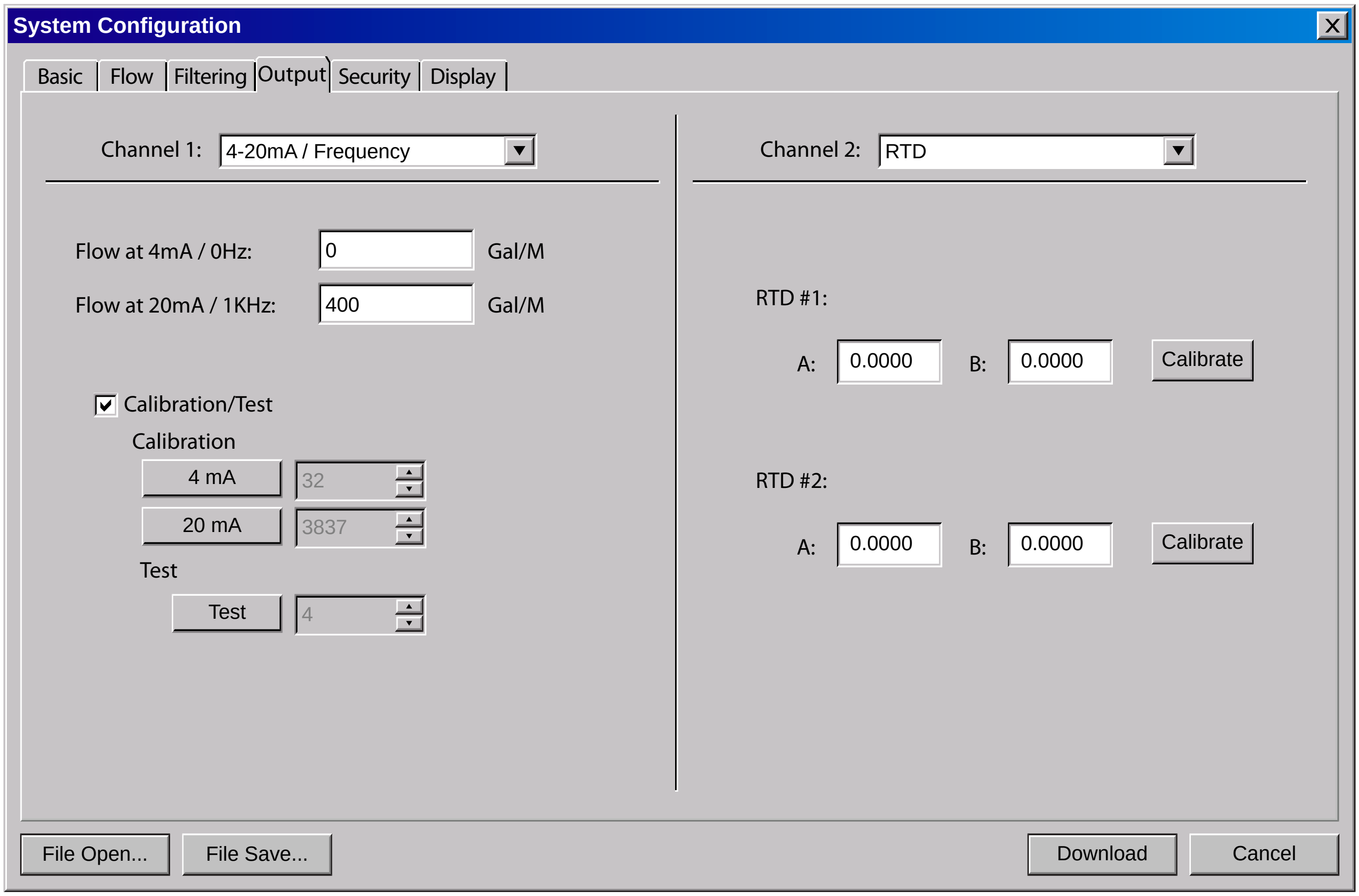


FIGURE 5.6 - CHANNEL 2 INPUT (RTD)

New, non-calibrated RTDs will need to be field calibrated using an ice bath and boiling water to derive calibration values. This procedure is outlined in the ***Appendix*** of this manual.

CHANNEL 2 - CONTROL OUTPUT CONFIGURATION [ULTRA FLOW ONLY]

Two independent open collector transistor outputs are included with the Ultra Flow meter model. Each output can be configured independently to "Alarm" for one of the following. See Alarm Output in ***Part 3*** for output details.

None
Batch / Total
Flow
Signal Strength
Errors

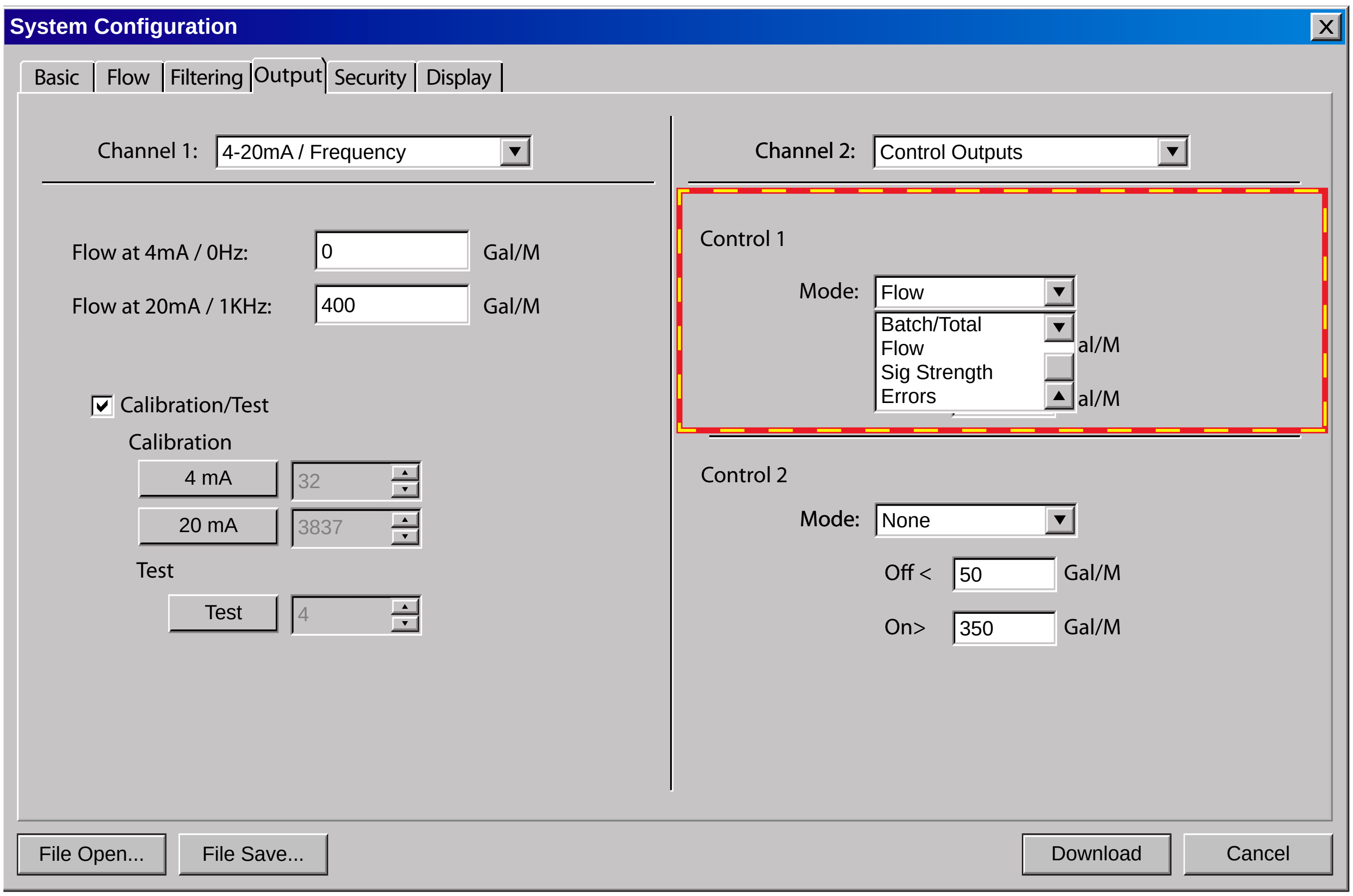


FIGURE 5.7 - CHANNEL 2 OUTPUT CHOICES

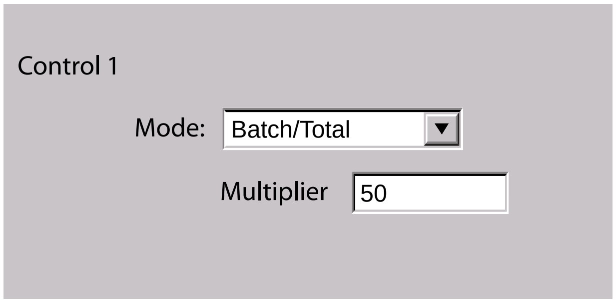
None

All alarm outputs are disabled.

Batch / Total

Multiplier (Value)

This is the value to which the totalizer will accumulate before resetting to zero and repeating the accumulation. This value includes any exponents that were entered in the **BSC MENU** as **TOTAL E**. See Alarm Output in ***Part 3***.



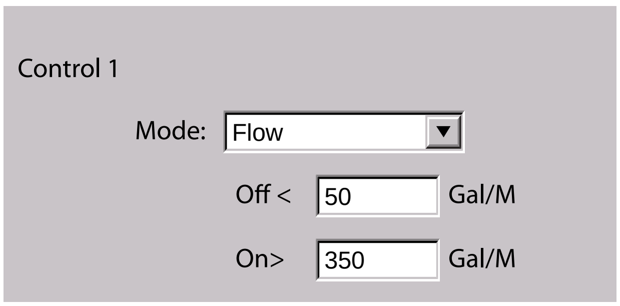
Flow

ON (Value)

Sets value at which the alarm output will switch from OFF to ON.

OFF (Value)

Sets value at which the alarm output will switch from ON to OFF.



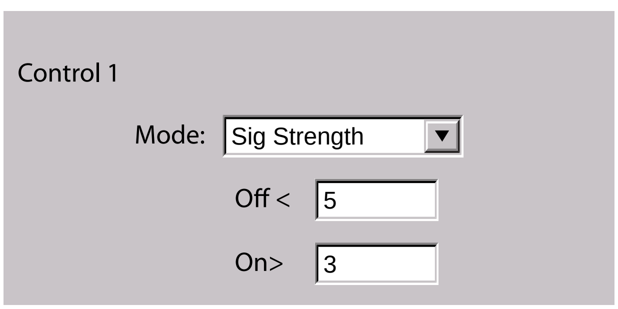
Signal Strength

ON (Value)

Sets value at which the alarm output will turn ON.

OFF (Value)

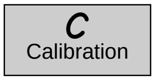
Sets value at which the alarm output will turn OFF.



Errors

Alarm outputs on any error condition. See ***Error Table*** in the ***Appendix*** of this manual.

SETTING ZERO AND CALIBRATION



The software utility contains a powerful multi-point calibration routine that can be used to calibrate the Ultra flow meter to a primary measuring standard in a particular installation. To initialize the three-step calibration routine, click on the ***Calibration*** button located on the top of the Data Screen. The display shown in ***Figure 5.8*** will appear.

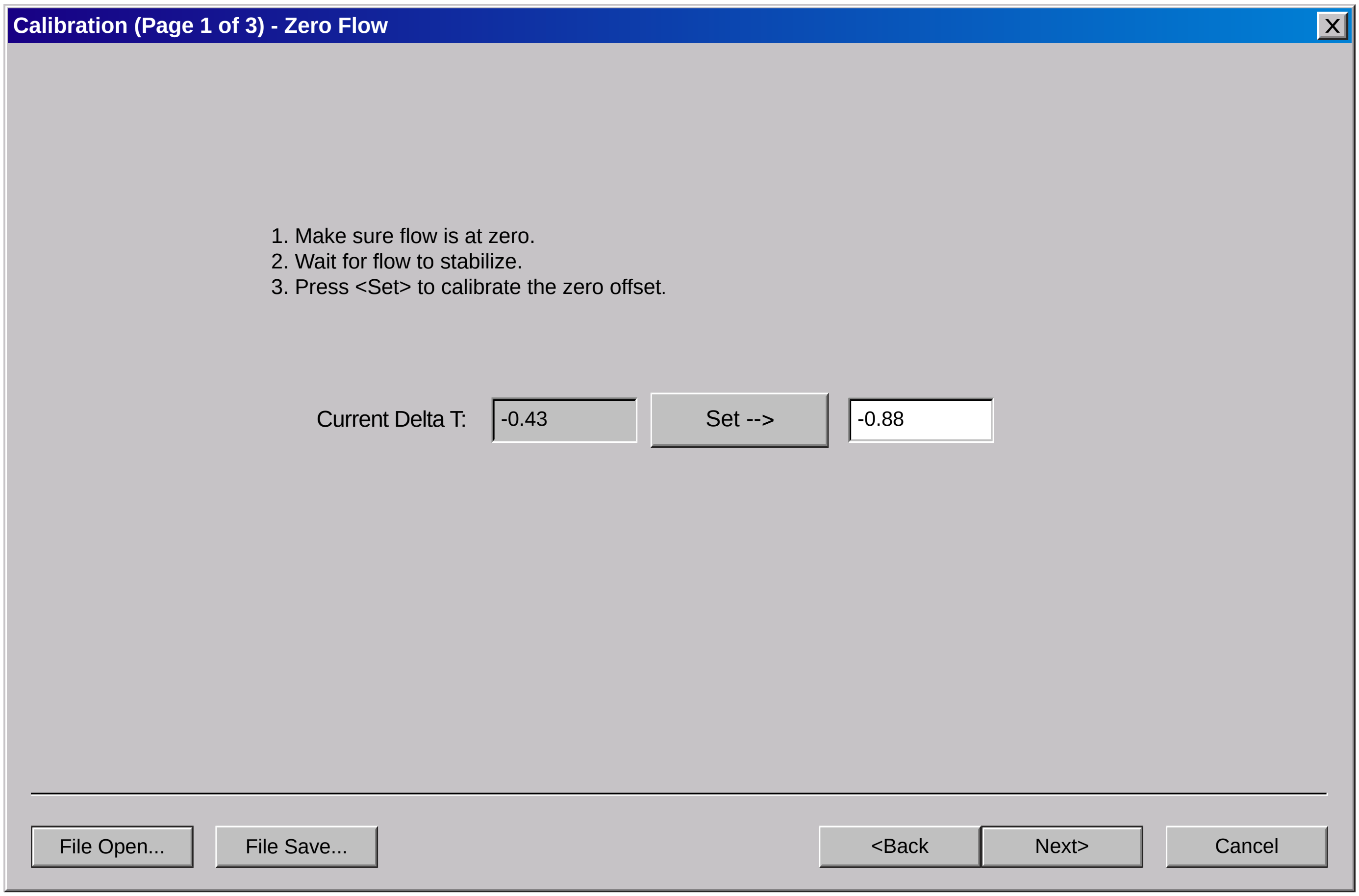


FIGURE 5.8 - CALIBRATION PAGE 1 OF 3

The first screen (Page 1 of 3) , establishes a baseline zero flow rate measurement for the instrument.

Because every flow meter installation is slightly different and sound waves can travel in slightly different ways through these various installations, it is important to remove the zero offset at zero flow to maintain the meters accuracy. A provision is made using this entry to establish "Zero" flow and eliminate the offset.

To zero the flow meter:

1) Establish zero flow in the pipe (ensure 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 the **Set** button.
3) Click the **Next** button when prompted, then click the **Finish** button on the calibration screen.

The zeroing process is essential in systems using the DTS and DTC transducer sets to ensure the best accuracy.

The second step (Page 2 of 3) in the calibration process is the selection of the engineering units with which the calibration will be performed. Select the **Flow Rate Units** and click the **Next** button at the bottom of the window.

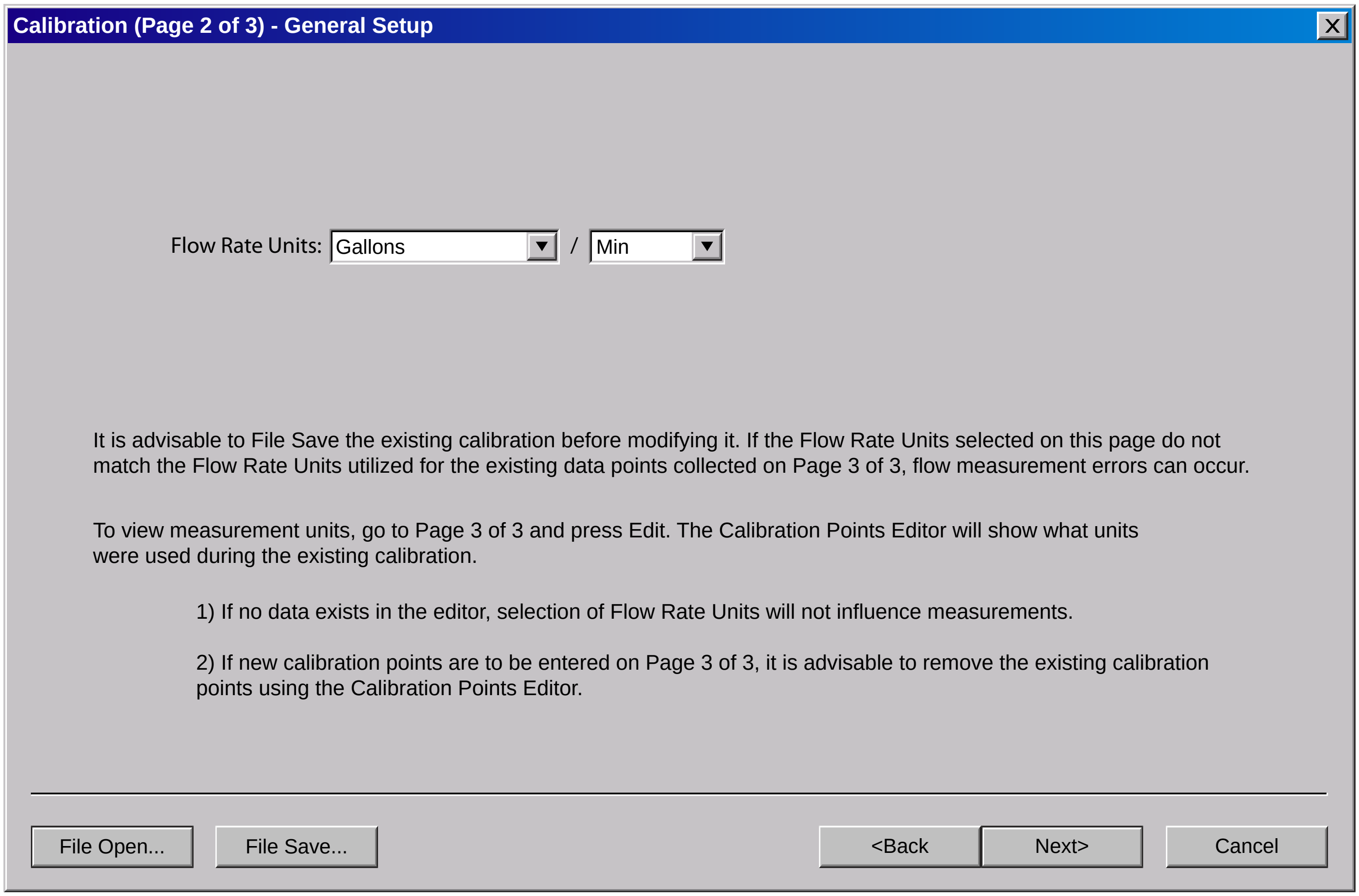


FIGURE 5.9 - CALIBRATION PAGE 2 OF 3

Page 3 of 3 as shown in ***Figure 5.10*** allows multiple actual flow rates to be recorded by the Ultra. To calibrate a point, establish a stable, known flow rate (verified by a real-time primary flow instrument), enter the actual flow rate in the ***Figure 5.10*** window and click the **Set** button. Repeat for as many points as desired.

> ***NOTE:*** *If only two points are to be used (zero and span), it is preferable to use the highest flow rate anticipated in normal operation as the calibration point. If an erroneous data point is collected, the point can be removed by pressing the Edit button, selecting the bad point and then selecting Remove.*

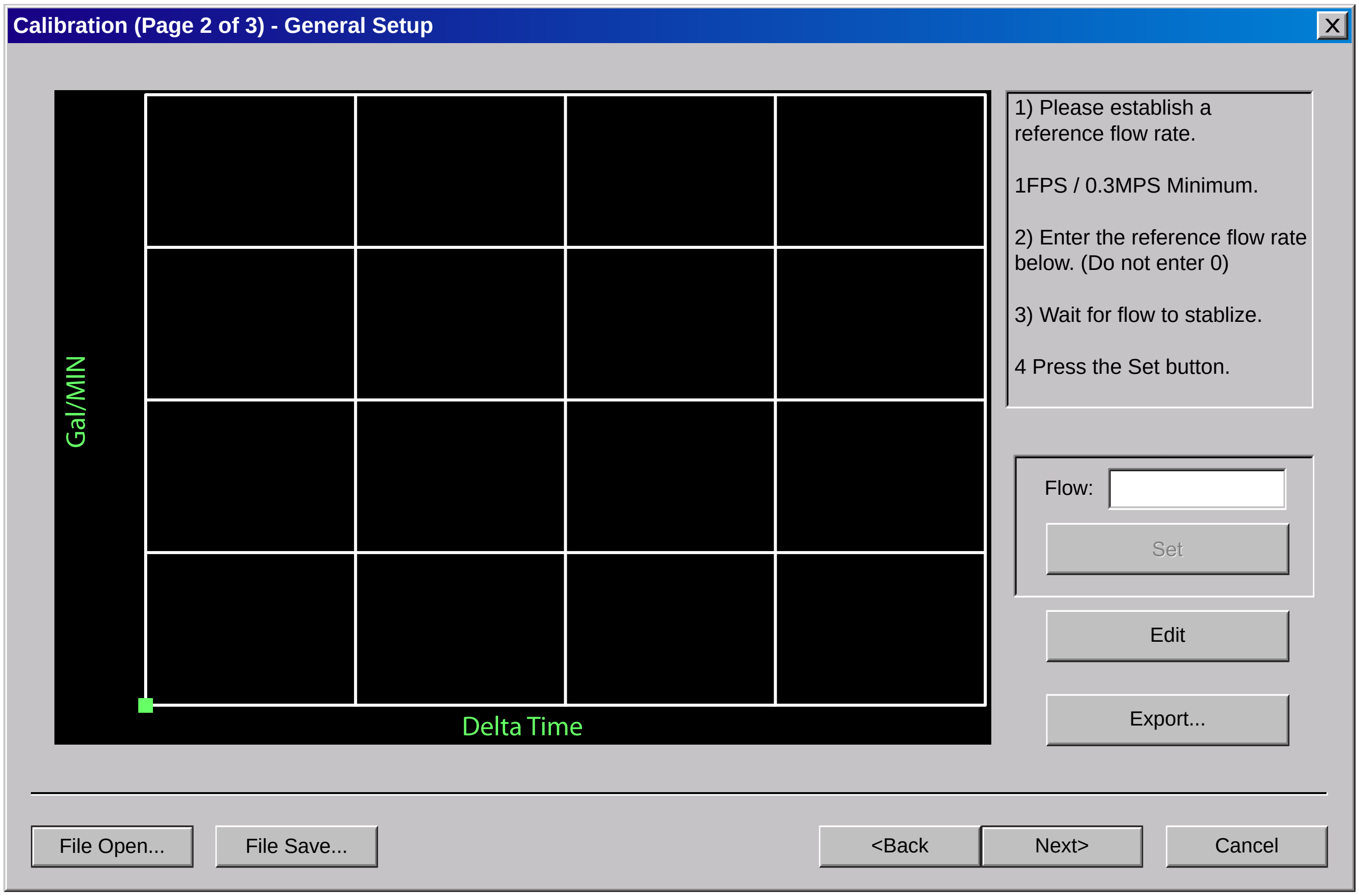
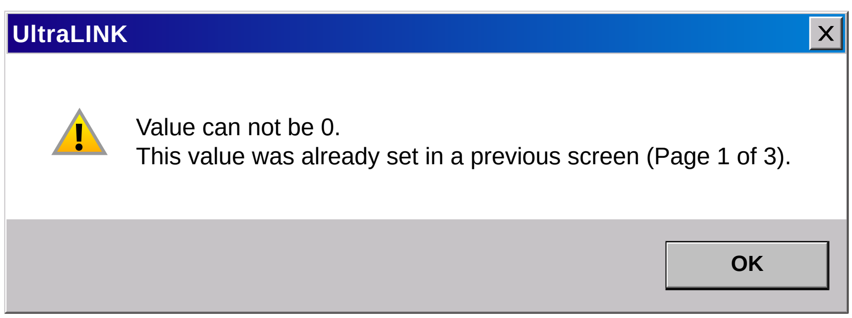


FIGURE 5.10 - CALIBRATION PAGE 3 OF 3

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 will be shown:



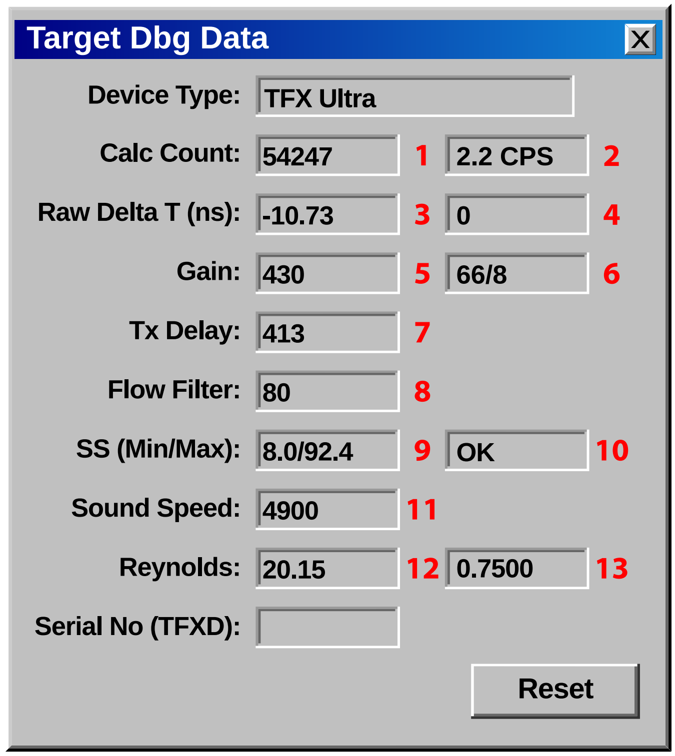
Press the **Finish** button when all points have been entered.

TARGET DBG DATA SCREEN - DEFINITIONS

1) Calc Count - The number of flow calculations performed by the meter beginning at the time the power to the meter was last turned off and then on again.

2) Sample Count - The number of samples currently being taken in one second.

3) Raw Delta T (ηs) - The actual amount of time it takes for an ultrasonic pulse to cross the pipe.



4) Course Delta T - The Ultra series uses two wave forms. The coarse to find the best delay and other timing measurements and a fine to do the flow measurement.

5) Gain - The amount of signal amplification applied to the reflected ultrasound pulse to make it readable by the digital signal processor.

6) Gain Setting/Waveform Power - The first number is the gain setting on the digital pot (automatically controlled by the AGC circuit). Valid numbers are from 1 to 100. The second number is the power factor of the current waveform being used. For example, "8" indicates that a ⅛ power wave form is being used.

7) 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.

8) Flow Filter - The current value of the adaptive filter.

9) SS (Min/Max) - The minimum and maximum signal strength levels encountered by the meter beginning at the time the power to the meter was last turned off and then on again.

10) Signal Strength State - Indicates if the present signal strength minimum and maximum are within a pre-programed signal strength window.

11) Sound Speed - The actual sound speed being measured by the transducers at that moment.

12) Reynolds - A number indicating how turbulent a fluid is. Reynolds numbers between 0 and 2000 are considered laminar flow. Numbers between 2000 and 4000 are in transition between laminar and turbulent flows and numbers greater than 4000 indicate turbulent flow.

13) Reynolds Factor - The value applied to the flow calculation to correct for variations in Reynolds numbers.

SAVING METER CONFIGURATION ON A PC

The complete configuration of the flow meter 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 flow meters or may be recalled should the same pipe be surveyed again or multiple meters programmed with the same information.

PRINTING A FLOW METER CONFIGURATION REPORT

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

APPENDIX

SPECIFICATIONS

System	
Liquid Types	Most clean liquids or liquids containing small amounts of suspended solids or gas bubbles.
Velocity Range	Bidirectional to greater than 40 FPS (12 MPS).
Flow Accuracy	**DTN/DTH/DTL:** 1% of reading at rates > 1 FPS (0.3 MPS); within 0.01 FPS (0.003 MPS) between 1 FPS (0.3 MPS) and within 0.01 FPS (0.003 MPS) at lower rates. **DTS/DTC:** 1” (25 mm) and larger units 1% of reading from 10 to 100% of measurement range; within 0.01 FPS (0.003 MPS) at lower rates. Smaller than 1” (25 mm) units are 1% of full scale.
Flow Repeatability	±0.01% of reading.
Flow Sensitivity	0.001 FPS (0.0003 MPS).
Temperature Accuracy (Energy Meters Only)	**Option A:** +32 to +122 °F (0 to +50 °C); Absolute 0.22 °F (0.12 °C) Difference 0.09 °F (0.05 °C). **Option B:** +32 to +212 °F (0 to +100 °C); Absolute 0.45 °F (0.25 °C) Difference 0.18 °F (0.1 °C). **Option C:** -40 to +350 °F (-40 to +177 °C); Absolute 1.1 °F (0.6 °C) Difference 0.45 °F (0.25 °C). **Option D:** -4 to to +86 °F (-20 to +30 °C); Absolute 0.22 °F (0.12 °C) Difference 0.09 °F (0.05 °C).
Temperature Sensitivity	**Option A:** 0.03 °F (0.012 °C). **Option B:** 0.05 °F (0.025 °C). **Option C:** 0.1 °F (0.06 °C). **Option D:** 0.03 °F (0.012 °C).
Temperature Repeatability	±0.5% of reading.

Transmitter	
Power Requirements	**AC:** 95-264 VAC 47-63 Hz at 17 VA Maximum. 20-28 VAC 47-63 Hz at 0.35 A Maximum. **DC:** 10-28 VDC at 5.0 W Maximum. **Protection:** Reverse polarity and transient suppression. **AC:** Field replaceable fuse. **DC:** Auto re-settable fuse.
Installation Compliance	**General Safety:** UL 61010-1, CSA C22.2 No. 61010-1 (all models) and EN 61010-1 (power supply options 95-264 VAC and 10-28 VDC only). **Hazardous Location (power supply options 95-264 VAC and 10-28 VDC only):** Class I Division 2 Groups C,D; Class II and III, Division 2, Groups C, D, F, and G for US/CAN; Class I, Zone 2, AEx nA IIB T6; ATEX II 2 G EEx nA II T6: UL 1604, CSA 22.2 No. 213, EN 60079-0 and EN 60079-15. **CE:** EN61326-1:2006 on integral flow transducers, remote transducers constructed with twinaxial cables 100 ft (30m) or shorter, or remote transducers with conduit.
Display	2 line LCD, LED backlight. **Top Row:** 7 segment, 0.7” (18 mm) high, numeric. **Bottom Row:** 14 segment, 0.35” (9 mm) high alpha-numeric. **Flow Rate Indication:** 8 digit positive, 7 digit negative max.; auto decimal, lead zero blanking. **Flow Totalizer:** 8 digit positive, 7 digit negative. Reset via software, keypad, contact closure.
Engineering Units	User configured.
Rate	Gal, liters, million gal, ft^3, m^3, acre-ft, oil barrels (42 gal), liquid barrels (31.5 gal), ft, m, lb, kg. Additional units for Energy version BTU, MBTU, MMBTU, Ton, kJ, kW, MW.
Time	Seconds, minutes, hours, days.
Totalizer	Gal, liters, million gal, ft^3, m^3, acre-ft, oil barrels (42 gal), liquid barrels (31.5 gal), lb, kg. Additional units for Energy version BTU, MBTU, MMBTU, Ton, kJ, kW, MW.
Mode	Forward, reverse, net, batch.

Input/Output (all transmitters)	All modules optically isolated from earth and system ground.
4-20 mA	12-bit resolution, internal power *(current source)*. Can span negative to positive flow/energy rates.
USB	2.0 for connection of a PC running *ULTRALINK*™ configuration utility. *(Requires USB A/B interface cable).*
10/100 Base-T	RJ45 communications via Modbus TCP/IP, EtherNet/IP™ and BACnet®/IP.
RS485	Modbus RTU command set.
Input/Output (Ultra Flow transmitter)	**Rate Pulse:** Open collector, 0 to 1,000 Hz maximum; 12 bit resolution,1.0 A max. Can span negative to positive rates. Square-wave or simulated turbine output.
	Alarm Outputs (2): Open collector, configure as Error alarm, Rate alarm, Signal Strength alarm, or Total/ Batch pulse.
Ambient Conditions	-40 °F to +185 °F (-40 °C to +85 °C), 0 to 95 % relative humidity *(non-condensing)*.
Enclosure	**Type:** Type 4 (IP 65). **Construction:** Powder-coated aluminum, polycarbonate, stainless steel, polyurethane.
Size	6.0" W x 4.4" H x 2.2" D *(152 mm W x 112 mm H x 56 mm D)*.
Transmitter Mounting	**Type:** **Wall:** Nickel-plated steel mounting brackets. **Pipe:** ½" Hose clamp mounting. **Integral Transducer:** Clamped around pipe. **Conduit holes:** ½" NPT Female **(2)**. ¾" NPT Female **(1)**.
Response Time (Flow)	0.3 to 30 seconds, user configured, for 10 % to 90 % step change in flow.
Security	Keypad lockout, user selected 4 digit password code.

Transducers	
Liquid Types	Most non-aerated, clean liquids.
Cable Length	Standard lengths 20, 50, 100 ft (6, 15, 30 meters) with twinaxial cable. Lengths of 100 to 990 ft (30 to 300 meters) utilize coaxial cable.
Pipe Sizes	**DTN/DTH:** 2 inch and larger. **DTL:** 24 inch and larger. **DTS/DTC:** (Small pipe) ½", ¾", 1", 1¼", 1½", 2" (ANSI Pipe, Copper Tube, Tube).
Environment	NEMA 6 (IP 67) standard units to a depth of 3 ft. (1 m) for 30 days maximum. Optional NEMA 6P (IP 68) units to a depth of 100 ft. (30 m), seawater equivalent density, maximum.
Pipe Surface Temperature	**DTN, DTL, and DTC:** -40 °F to +250°F (-40 °C to +121 °C). **DTS:** -40 °F to +185 °F (-40 °C to +85 °C). **DTH:** -40 °F to +350 °F (-40 °C to +177 °C).
Ambient Conditions	-40 °F to +185 °F (-40 °C to +85 °C), 0 to 95 % relative humidity (non-condensing).
Housing Material	**DTN, DTL, and DTC:** CPVC, Ultem®, and nylon cord grip, PVC cable jacket [polyethylene used in NEMA 6P (IP 68) versions]. **DTS:** PVC, Ultem®, and nylon cord grip, PVC cable jacket. **DTH:** PTFE, Vespel®, and nickel-plated brass cord grip, PFA cable jacket.
Approvals	**Standard:** General and Hazardous Location (see Installation Compliance under Transmitter specifications). Optional - DTN only: CSA Class 1, Div 1, Groups C & D; Requires intrinsically safe transducer kit with barrier. **UL 1604:** Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations. **CSA C22.2 No. 213:** Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations. **EN 60079-0:** Electrical Apparatus for Explosive Gas Atmospheres Part 0: General Requirements. **EN 60079-15:** Electrical Apparatus for Explosive Gas Atmospheres Part 15: Electrical Apparatus with Type of Protection "n".

Software Utilities	
ULTRALINK™	Utilized for configuration, calibration and troubleshooting. Compatible with Windows 95, Windows 98, Windows 2000, Windows XP, Windows Vista®, Windows® 7.
EnergyLink	Utilized to monitor a network of flow and energy meters. Compatible with Microsoft Excel® 2003 and Microsoft Excel® 2007.

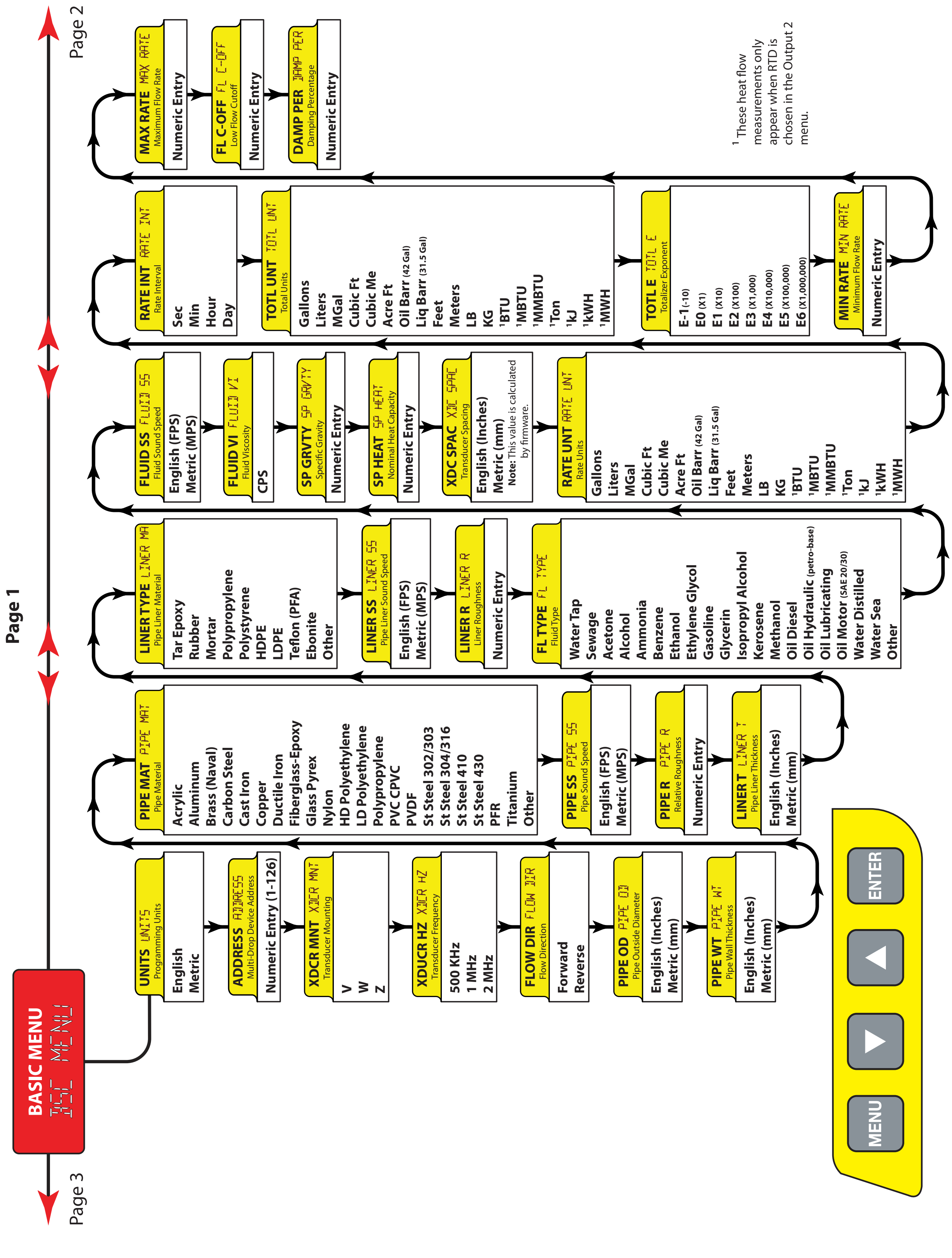


FIGURE A-2.1 - MENU MAP -- 1

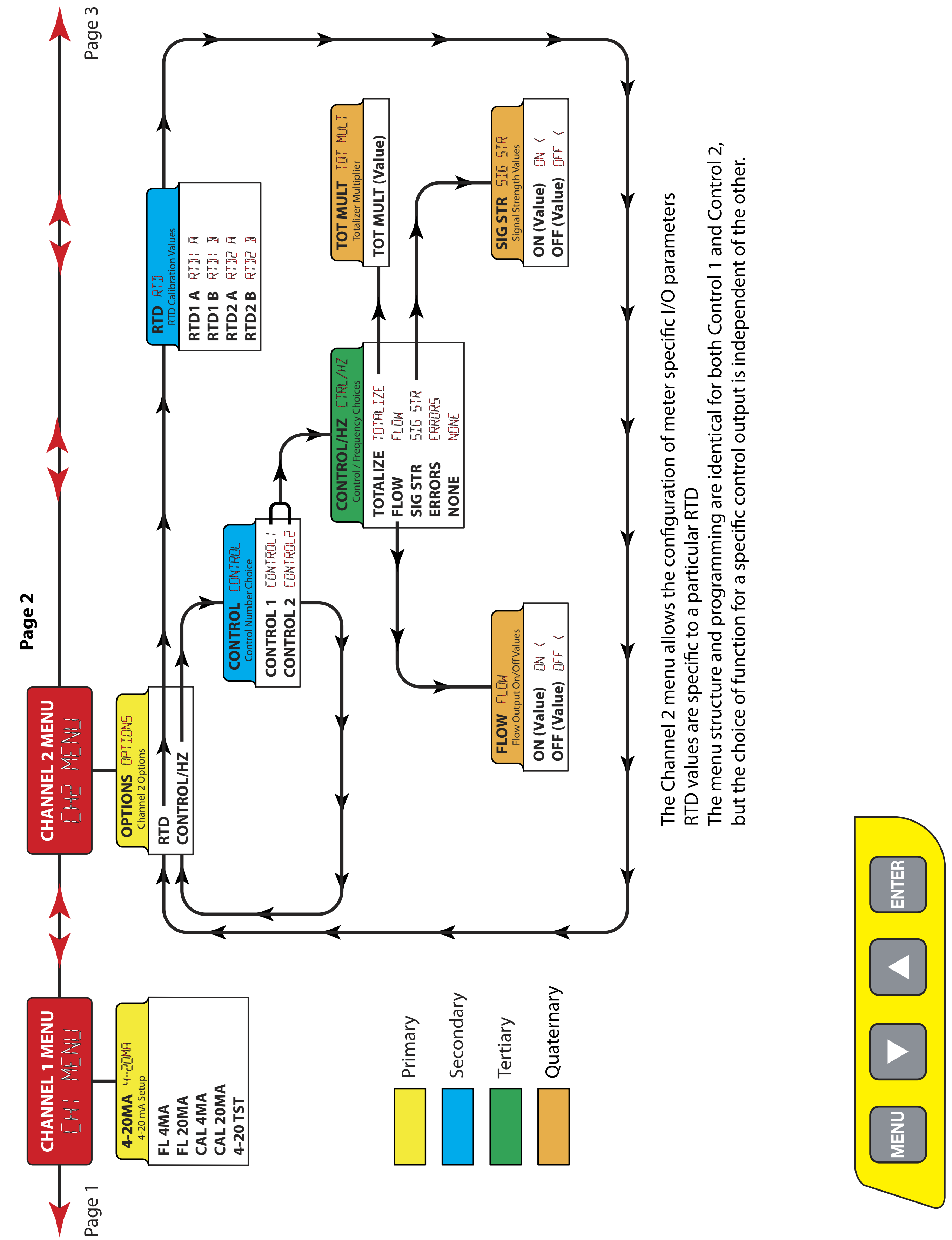


FIGURE A-2.2 - MENU MAP -- 2

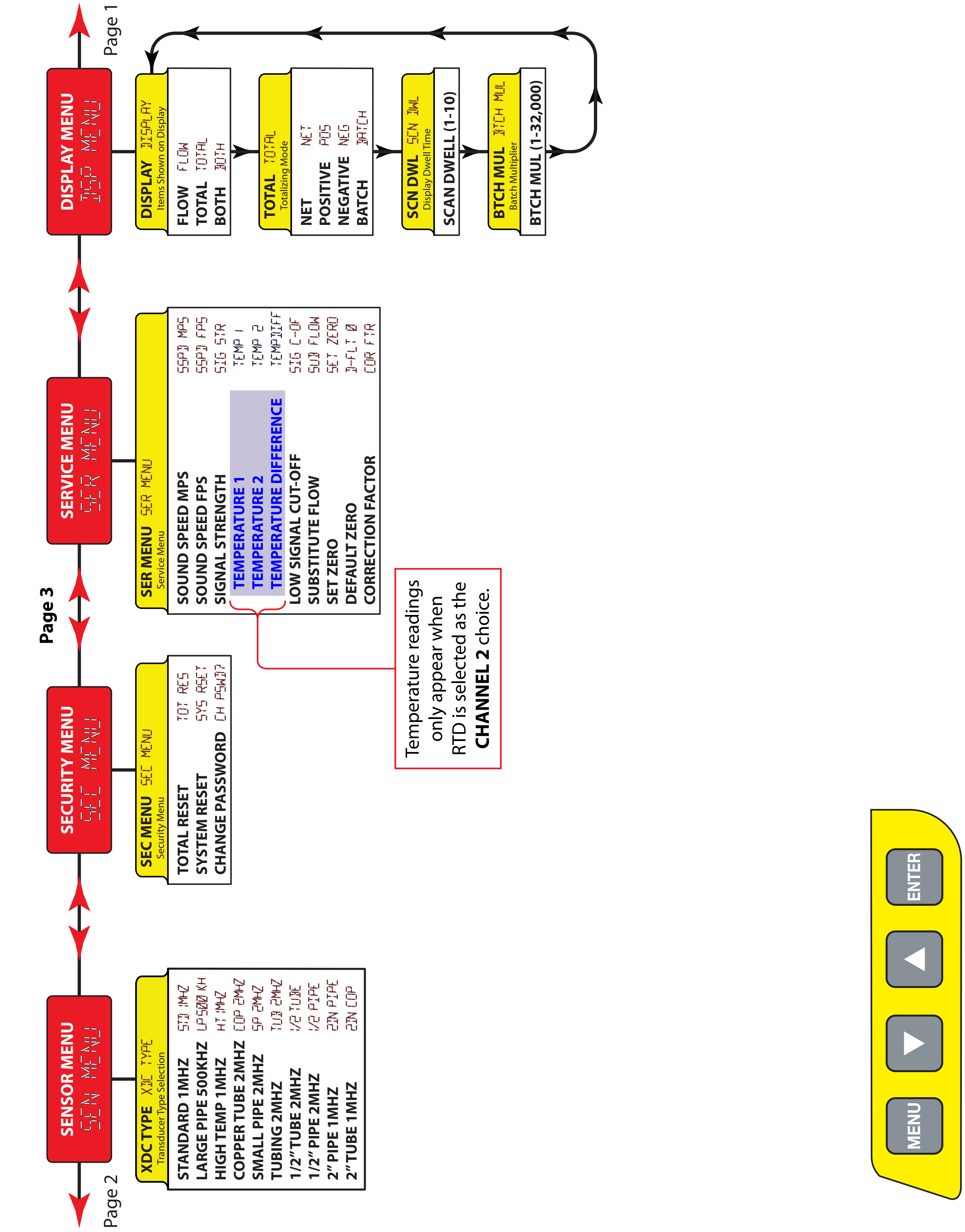


FIGURE A-2.3 - MENU MAP -- 3

Ultra MODBUS

Available Data Formats			
	Bits	Bytes	Modbus Registers
Long Integer	32	4	2
Single Precision IEEE754	32	4	2
Double Precision IEEE754	64	8	4

TABLE A-3.1 - AVAILABLE DATA FORMATS

Modbus Register / Word Ordering

Each Modbus Holding Register represents a 16-bit integer value (2 bytes). The official Modbus standard defines Modbus as a 'big-endian' protocol where the most significant byte of a 16-bit value is sent before the least significant byte. For example, the 16-bit hex value of '1234' is transferred as '12' '34'.

Beyond 16-bit values, the protocol itself does not specify how 32-bit (or larger) numbers that span over multiple registers should be handled. It is very common to transfer 32-bit values as pairs of two consecutive 16-bit registers in little-endian word order. For example, the 32-bit hex value of '12345678' is transferred as '56''78''12''34'. Notice the Register Bytes are still sent in big-endian order per the Modbus protocol, but the Registers are sent in little-endian order.

Other manufacturers, store and transfer the Modbus Registers in big-endian word order. For example, the 32-bit hex value of '12345678' is transferred as '12''34''56''78'. It doesn't matter which order the words are sent, as long as the receiving device knows which way to expect it. Since it's a common problem between devices regarding word order, many Modbus master devices have a configuration setting for interpreting data (over multiple registers) as 'little-endian' or 'big-endian' word order. This is also referred to as swapped or word swapped values and allows the master device to work with slave devices from different manufacturers.

If, however, the endianness is not a configurable option within the Modbus master device, it's important to make sure it matches the slave endianess for proper data interpretation. The Ultra actually provides two Modbus Register maps to accommodate both formats. This is useful in applications where the Modbus Master cannot be configured for endianness.

Communication Settings	
Baud Rate	9600
Parity	None
Data Bits	8
Stop Bits	1
Handshaking	None

Data Component Name	MODBUS Registers			Available Units
	Long Integer Format	Floating Point		
		Single Precision Format	Double Precision Format	
Signal Strength	40100 - 40101	40200 - 40201	40300 - 40303	
Flow Rate	40102 - 40103	40202 - 40203	40304 - 40307	Gallons, Liters, MGallons, Cubic Feet, Cubic Meters, Acre Feet, Oil Barrel, Liquid Barrel, Feet, Meters, Lb, Kg, BTU, MBTU, MMBTU, TON, kJ, kW, MW ***Per*** Second, Minute, Hour, Day
Net Totalizer	40104 - 40105	40204 - 40205	40308 - 40311	
Positive Totalizer	40106 - 40107	40206 - 40207	40312 - 40315	
Negative Totalizer	40108 - 40109	40208 - 40209	40316 - 40319	
Temperature 1	40110 - 40111	40210 - 40211	40320 - 40323	°C
Temperature 2	40112 - 40113	40212 - 40213	40324 - 40327	°C

TABLE A-3.2 - ULTRA MODBUS REGISTER MAP FOR 'LITTLE-ENDIAN' WORD ORDER MASTER DEVICES

For reference: If the Ultra Net Totalizer = 12345678 hex
Register 40102 would contain 5678 hex (Word Low)
Register 40103 would contain 1234 hex (Word High)

Data Component Name	MODBUS Registers			Available Units
	Long Integer Format	Floating Point		
		Single Precision Format	Double Precision Format	
Signal Strength	40600 - 40601	40700 - 40701	40800 - 40803	
Flow Rate	40602 - 40603	40702 - 40703	40804 - 40807	Gallons, Liters, MGallons, Cubic Feet, Cubic Meters, Acre Feet, Oil Barrel, Liquid Barrel, Feet, Meters, Lb, Kg, BTU, MBTU, MMBTU, TON, kJ, kW, MW ***Per*** Second, Minute, Hour, Day
Net Totalizer	40604 - 40605	40704 - 40705	40808 - 40811	
Positive Totalizer	40606 - 40607	40706 - 40707	40812 - 40815	
Negative Totalizer	40608 - 40609	40708 - 40709	40816 - 40819	
Temperature 1	40610 - 40611	40710 - 40711	40820 - 40823	°C
Temperature 2	40612 - 40613	40712 - 40713	40824 - 40827	°C

TABLE A-3.3 - ULTRA MODBUS REGISTER MAP FOR 'BIG-ENDIAN' WORD ORDER MASTER DEVICES

For reference: If theUltra Net Totalizer = 12345678 hex
Register 40602 would contain 1234 hex (Word High)
Register 40603 would contain 5678 hex (Word Low)

Modbus Coil Description	Modbus Coil	Notes
Reset Totalizers	1	Forcing this coil on will reset all totalizers. After reset, the coil automatically returns to the off state.

TABLE A-3.4 - MODBUS COIL MAP

Object Description	BACnet Object (Access Point)	Notes	Available Units
Signal Strength	AI1	Analog Input 1	
Flow Rate ***(Flow model)*** **Energy Rate** ***(BTU model)***	AI2	Analog Input 2	Gallons, Liters, MGallons, Cubic Feet, Cubic Meters, Acre Feet, Oil Barrel, Liquid Barrel, Feet, Meters, Lb, Kg, BTU, MBTU, MMBTU, TON, kJ, kW, MW ***Per*** Second, Minute, Hour, Day
Net Totalizer	AI3	Analog Input 3	
Positive Totalizer	AI4	Analog Input 4	
Negative Totalizer	AI5	Analog Input 5	
Temperature 1	AI6	Analog Input 6	°C
Temperature 2	AI7	Analog Input 7	°C
Reset Totalizers	BO1	Binary Output 1 Writing an (1) active state to this object will reset all totalizers. The Object will then automatically return to the (0) inactive state.	

TABLE A-3.5 - ULTRA BACnet® OBJECT MAPPINGS

Network Settings:

IP address, IP subnet, IP gateway, and Device Description are configured through the web interface. IP address and subnet defaults to 192.168.0.100 and 255.255.255.0. Connection to the web interface requires an Ethernet crossover cable, power to the flow meter, and a PC with a web browser. Typing http://192.168.0.100 in the address bar will allow connection to the flow meter's web interface for editing.

Access to the flow meter's data requires the entry of a username and password. The flow meter's default username is **admin** and the password is blank from the factory.

NOTE: *Changing the IP address will require use of the new number when trying to access the web page. Each meter must be setup with a unique IP address when trying to network multiple units.* ***Important!*** *When changes are made to the IP address, the new number must be retained by the user for future access.*

Main Page

The Main Page refreshes itself every 5 seconds and provides real time data from the meter.

MAIN PAGE

Enter location information here

Device Values	
Signal Strength	22.8
Flow Rate	100.4
Net Totalizer	1659.1
Positive Totalizer	1659.1
Negative Totalizer	0.0
Temp 1	26.5
Temp 2	48.7

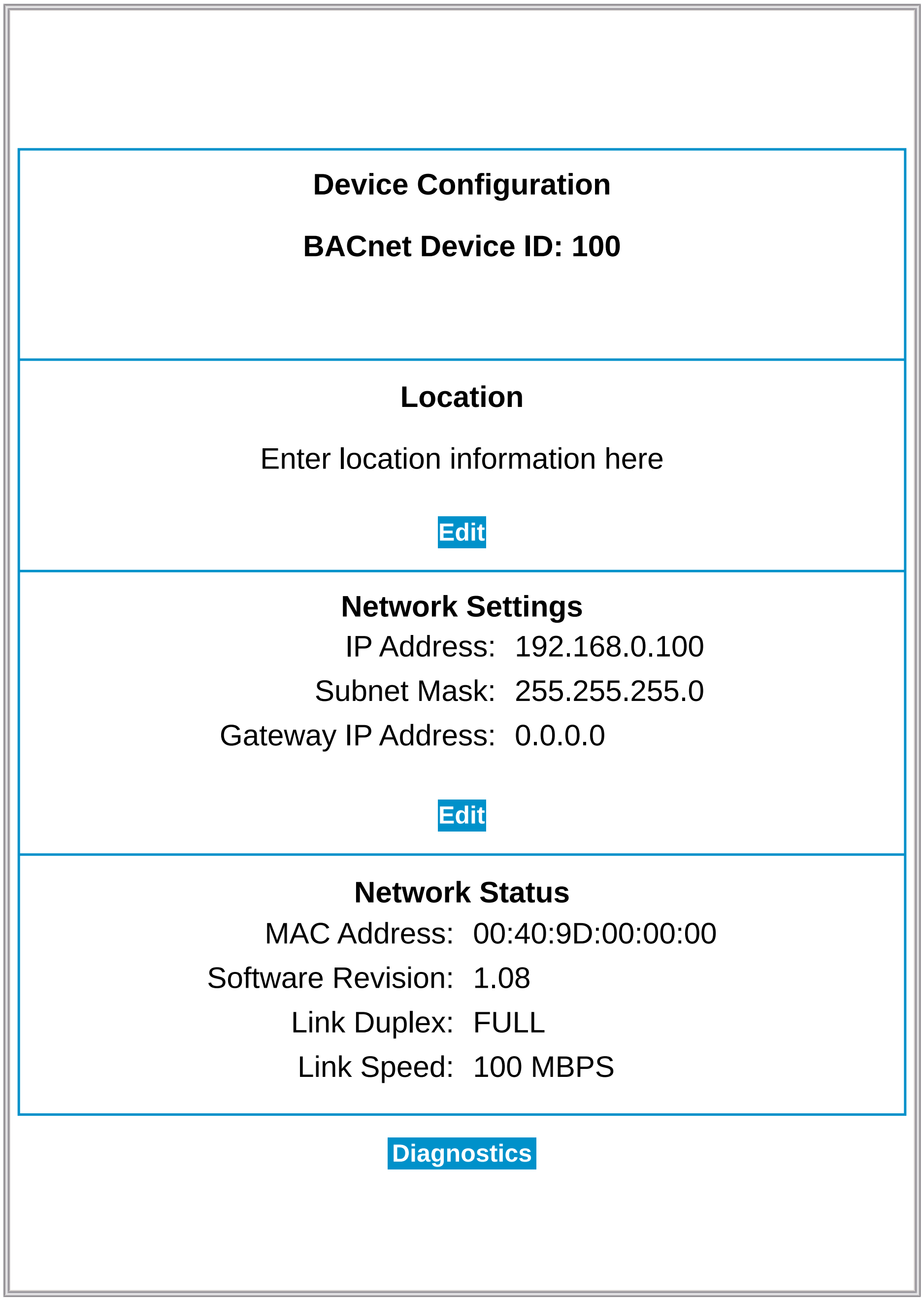
This page will automatically refresh every 5 seconds

Reset Totalizers

Configuration

Configuration Screen

To make changes to the settings for a category, click on EDIT to access the appropriate screen.



BACnet® Object Support

Nine BACnet standard objects are supported, a Device object (DEx), a Binary Output object (BO1), and seven Analog Input objects (AI1 through AI7). The BACnet/IP UDP port defaults to 0xBAC0. The Object Identifier (BACnet Device ID) and Location can both be modified through the web page interface.

DEx	Object_Identifier	Defaults to DEx Can modify "x" through web page (1-9999)	W
	Object_Name	Up to 32 characters	W
	Object_Type	DEVICE (8)	R
	System_Status	OPERATIONAL or NON_OPERATIONAL	R
	Vendor_Name	"Racine Federated Inc."	R
	Vendor_Identifier	306	R
	Model_Name	"D(X)TFX"	R
	Application_Software_Version	"1.07"	R
	Location	"Sample Device Location" Up to 64 characters - can modify through web page	W
	Protocol_Version	1	R
	Protocol_Revision	2	R
	Protocol_Services_Supported	{ readProperty, writeProperty, readPropertyMultiple, writePropertyMultiple, deviceCommunicationControl, who-Has, who-Is }	R
	Protocol_Object_Types_Supported	{ AnalogInput, BinaryOutput, Device }	R
	Object_List	DEx, AI1, AI2, AI3, AI4, AI5, AI6, AI7, BO1	R
	Max_APDU_Length_Accepted	1476	R
	Segmentation_Supported	3 – NONE	R
	APDU_Timeout	3000 default	R
	Number_Of_APDU_Retries	1 default	R
	Device_Address_Binding	always empty	R
	Database_Revision	0	R

TABLE A-3.6 - BACnet® STANDARD OBJECTS

Protocol Implementation Conformance Statement (Normative)

BACnet Protocol Implementation Conformance Statement

Date: 03/22/2011
Vendor Name: Racine Federated Inc
Product Name: TFX Ultra Flow meter
Product Model Number: TFX
Application Software Version: 1.08 **Firmware Revision:** N/A **BACnet Protocol Revision:** 4

Product Description: Clamp-on ultrasonic flow and energy meters for liquids

BACnet Standardized Device Profile (Annex L):

- ☐ BACnet Operator Workstation (B-OWS)
- ☐ BACnet Building Controller (B-BC)
- ☐ BACnet Advanced Application Controller (B-AAC)
- ■ BACnet Application Specific Controller (B-ASC)
- ☐ BACnet Smart Sensor (B-SS)
- ☐ BACnet Smart Actuator (B-SA)

List all BACnet Interoperability Building Blocks Supported (Annex K):

- Data Sharing-ReadProperty-B (DS-RP-B)
- Data Sharing-WriteProperty-B (DS-WP-B)
- Data Sharing - ReadProperty Multiple - B (DS-RPM-B)
- Data Sharing - WriteProperty Multiple - B (DS-WPM-B)
- Device Management-Dynamic Device Binding-B (DM-DDB-B)
- Device Management-Dynamic Object Binding-B (DM-DOB-B)
- Device Management-DeviceCommunicationControl-B (DM-DCC-B)

Segmentation Capability:

- ☐ Segmented requests supported Window Size
- ☐ Segmented responses supported Window Size

Standard Object Types Supported:

- Device Object
- Analog Input Object
- Binary Output Object

Data Link Layer Options:

☐ BACnet IP, (Annex J)
☐ BACnet IP, (Annex J), Foreign Device
☐ SO 8802-3, Ethernet (Clause 7)
☐ ANSI/ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ ANSI/ATA 878.1, RS-485 ARCNET (Clause 8), baud rate(s) _____________
■ MS/TP master (Clause 9), baud rate(s): 9600
☐ MS/TP slave (Clause 9), baud rate(s):
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s):
☐ Point-To-Point, modem, (Clause 10), baud rate(s):
☐ LonTalk, (Clause 11), medium: ___________
☐ Other:

Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☐ Yes ■No

Networking Options:

☐ Router, Clause 6 - List all routing configurations, e.g., ARCNET-Ethernet, Ethernet-MS/TP, etc.
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)
Does the BBMD support registrations by Foreign Devices? ☐ Yes ■No

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

■ ANSI X3.4	☐ IBM™/Microsoft™ DBCS	☐ ISO 8859-1
☐ ISO 10646 (UCS-2)	☐ ISO 10646 (UCS-4)	☐ JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet equipment/ networks(s) that the gateway supports:

Not supported

HEATING AND COOLING MEASUREMENT

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

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

Where:

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

The RTD temperature measurement circuit in the Ultra Energy meter measures the differential temperature of two 1,000 Ohm, three-wire platinum RTDs. The three-wire configuration allows the temperature sensors to be located several hundred feet away from the meter without influencing system accuracy or stability.

The Ultra Energy meter allows integration of two 1,000 Ohm platinum RTDs with the Ultra Energy flow meter, effectively providing an instrument for measuring energy delivered in liquid cooling and heating systems. If RTDs were ordered with the Ultra Energy flow meter, they have been factory calibrated and are shipped connected to the module as they were calibrated.

Platinum RTD	
Type	1,000 Ohm
Accuracy	±0.3 °C 0.0385 curve
Temperature Response	Positive Temperature Coefficient

Field replacement of RTDs is possible thru the use of the keypad or the software utility. If the RTDs were ordered from the manufacturer of the Ultra Energy, they will come with calibration values that need to be loaded into the Ultra Energy.

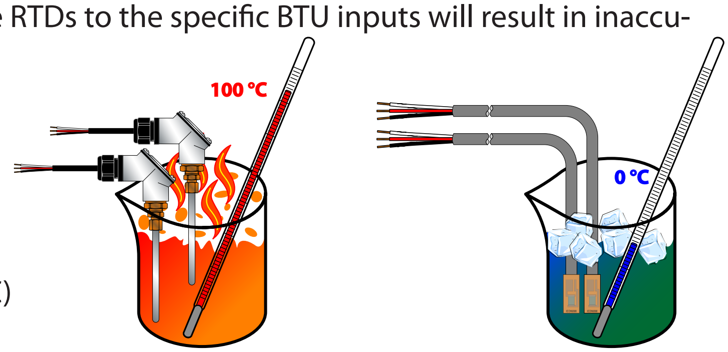
New, non-calibrated RTDs will need to be field calibrated using an ice bath and boiling water to derive calibration values. This procedure is outlined below.

In Field Calibration of RTD Temperature Sensors

Replacement RTD temperature sensors used in heat flow measurements must be calibrated in the field to ensure proper operation. Failure to calibrate the RTDs to the specific BTU inputs will result in inaccurate heat flow measurements.

Equipment Required:

Ice Bath
Boiling Water Bath
Laboratory Grade Thermometer (accurate to 0.1 °C)
Software Utility



Replacing or Re-calibrating RTDs

This procedure works with pairs of surface mount RTDs or pairs of insertion RTDs supplied by the manufacturer of the Ultra Energy.

1) Connect the RTDs.
2) Establish communications with the flow meter using the software utility.
3) Click on the "**Configuration**" tab in the menu bar and then select the "**Output**" tab.

The screen should now look something like the following:

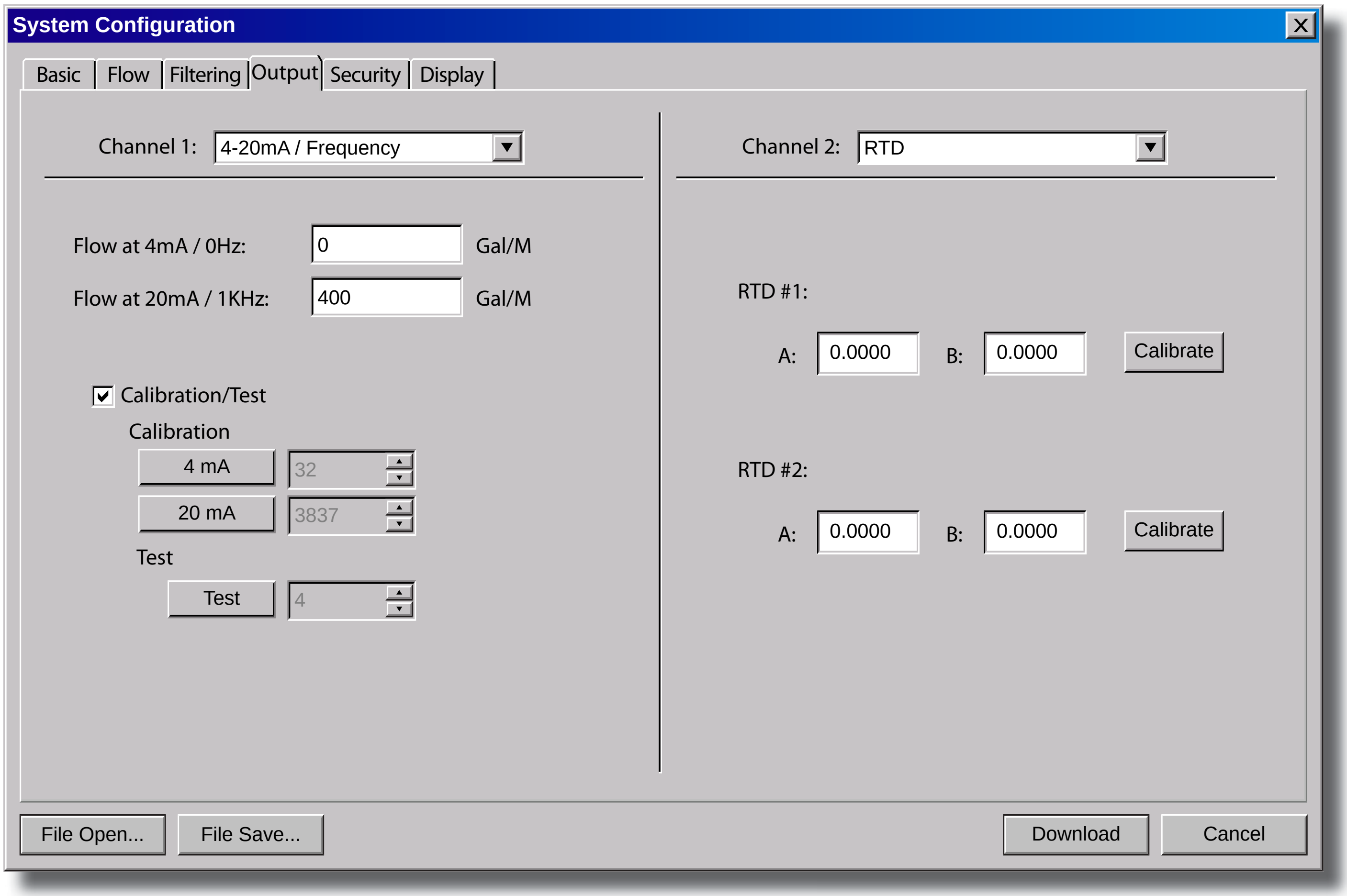


FIGURE A-4.1 - ULTRA OUTPUT CONFIGURATION SCREEN

4) If "RTD" is not selected in the Channel 2 drop-down list, select it now.
5) Insert both RTD temperature sensors and the laboratory grade thermometer into either the ice bath or the boiling water bath and allow about 20 minutes for the sensors to come up to the same temperature.

NOTE: *An ice bath and boiling water bath are used in these examples because their temperatures are easy to maintain and provide known temperature reference points. Other temperature references can be used as long as there is a minimum delta T of 40 °C between the two references.*

NOTE: *For maximum RTD temperature below 100 °C, the hot water bath should be heated to the maximum temperature for that RTD.*

6) Click on the "Calibrate" button and the following screen should now be visible. Make sure that the "**Calibrate Both RTDs at same temperature**" box is checked and then enter the temperature to the nearest 0.1 °C in the box labeled "Reference Temp (deg C)".
7) Press "Next".

The procedure for step 2 of 2 is similar to step 1 except the second water bath is used.

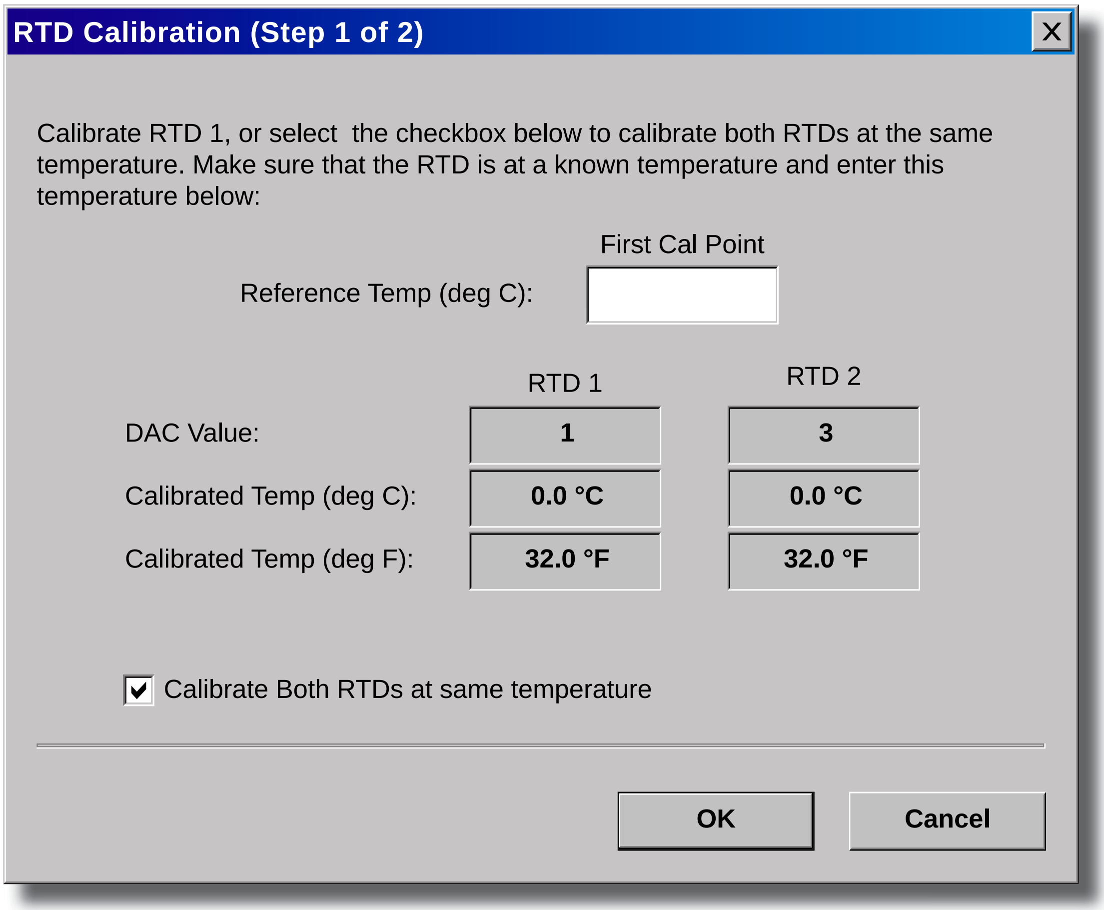


FIGURE A-4.2 - RTD CALIBRATION (STEP 1 OF 2)

8)) Insert both RTD temperature sensors and the laboratory grade thermometer into the second water bath and allow about 20 minutes for the sensors to come up to the same temperature.
9) Make sure that the "**Both RTDs at same temperature**" box is **checked** and then enter the temperature to the nearest 0.1 °C in the box labeled "Temp (deg C)".
10) Press "**OK**".
11) Press "**Download**" on the "**System Configuration**" screen to save the calibration values to the flow meter. After the download is complete, turn the power off and then on again to the meter to make the newly downloaded values take effect.

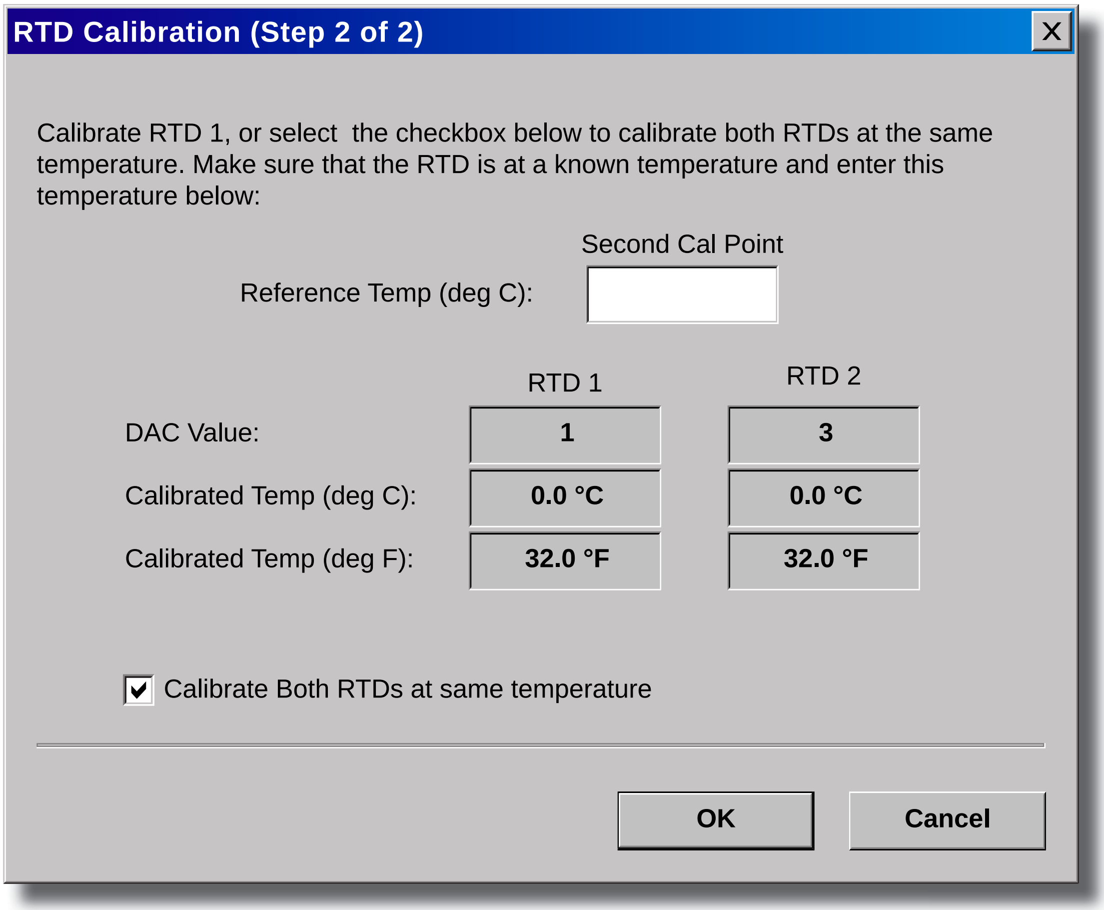
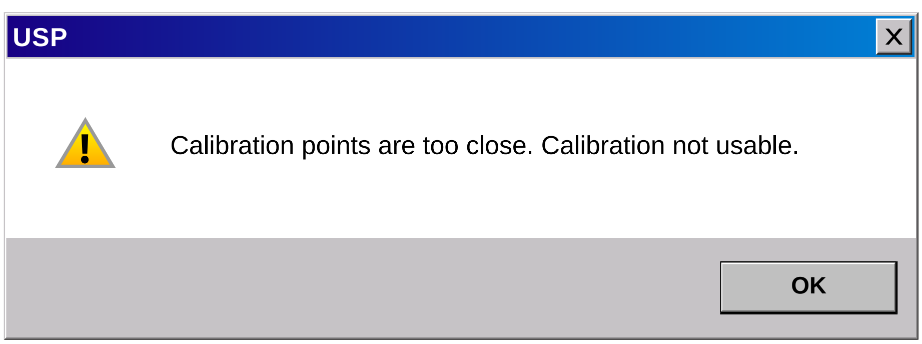


FIGURE A-4.3 - RTD CALIBRATION (STEP 2 OF 2)

If the calibration points are not separated by at least 40 °C or if either one or both of the RTDs are open, the following error message will be displayed:



Check the RTDs resistance values with an ohmmeter to make sure they are not "open" or "shorted". See ***Table A-4.2*** for typical RTD resistance values. Next check to ensure that incorrect "Cal Point" values were not entered inadvertently.

Heat Capacity of Water (J/g°C)										
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	4.2174	4.2138	4.2104	4.2074	4.2045	4.2019	4.1996	4.1974	4.1954	4.1936
10	4.1919	4.1904	4.1890	4.1877	4.1866	4.1855	4.1846	4.1837	4.1829	4.1822
20	4.1816	4.0310	4.1805	4.1801	4.1797	4.1793	4.1790	4.1787	4.1785	4.1783
30	4.1782	4.1781	4.1780	4.1780	4.1779	4.1779	4.1780	4.1780	4.1781	4.1782
40	4.1783	4.1784	4.1786	4.1788	4.1789	4.1792	4.1794	4.1796	4.1799	4.1801
50	4.1804	4.0307	4.1811	4.1814	4.1817	4.1821	4.1825	4.1829	4.1833	4.1837
60	4.1841	4.1846	4.1850	4.1855	4.1860	4.1865	4.1871	4.1876	4.1882	4.1887
70	4.1893	4.1899	4.1905	4.1912	4.1918	4.1925	4.1932	4.1939	4.1946	4.1954
80	4.1961	4.1969	4.1977	4.1985	4.1994	4.2002	4.2011	4.2020	4.2029	4.2039
90	4.2048	4.2058	4.2068	4.2078	4.2089	4.2100	4.2111	4.2122	4.2133	4.2145

TABLE A-4.1 - HEAT CAPACITY OF WATER

STANDARD RTD (Ohms)			
°C	**°F**	**100 Ohm**	**1000 Ohm**
-50	-58	80.306	803.06
-40	-40	84.271	842.71
-30	-22	88.222	882.22
-20	-4	92.160	921.60
-10	14	96.086	960.86
0	32	100.000	1000.00
10	50	103.903	1039.03
20	68	107.794	1077.94
25	77	109.735	1097.35
30	86	111.673	1116.73
40	104	115.541	1155.41
50	122	119.397	1193.97
60	140	123.242	1232.42
70	158	127.075	1270.75
80	176	130.897	1308.97
90	194	134.707	1347.07
100	212	138.506	1385.06
110	230	142.293	1422.93
120	248	146.068	1460.68
130	266	149.832	1498.32

TABLE A-4.2 - STANDARD RTD RESISTANCE VALUES

ULTRA ERROR CODES		
Revised 5-25-2009		
Code Number	Description	Correction
Warnings		
0001	Serial number not present	Hardware serial number has become inoperative – system performance will not be influenced.
0010	Signal Strength is below Signal Strength Cutoff entry	Low signal strength is typically caused by one of the following: » Empty pipe » Improper programming/incorrect values » Improper transducer spacing » Non-homogeneous pipe wall
0011	Measured Speed of Sound in the liquid is greater than ±10% different than the value entered during meter setup	Verify that the correct liquid was selected in the BASIC menu. Verify that pipe size parameters are correct.
Class C Errors		
1001	System tables have changed	Initiate a meter RESET by cycling power or by selecting SYSTEM RESET in the SEC MENU.
1002	System configuration has changed	Initiate a meter RESET by cycling power or by selecting SYSTEM RESET in the SEC MENU.
Class B Errors		
3001	Invalid hardware configuration	Upload corrected file.
3002	Invalid system configuration	Upload corrected file.
3003	Invalid strategy file	Upload corrected file.
3004	Invalid calibration data	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 unit to factory for evaluation

TABLE A-5.1 - ULTRA ERROR CODES

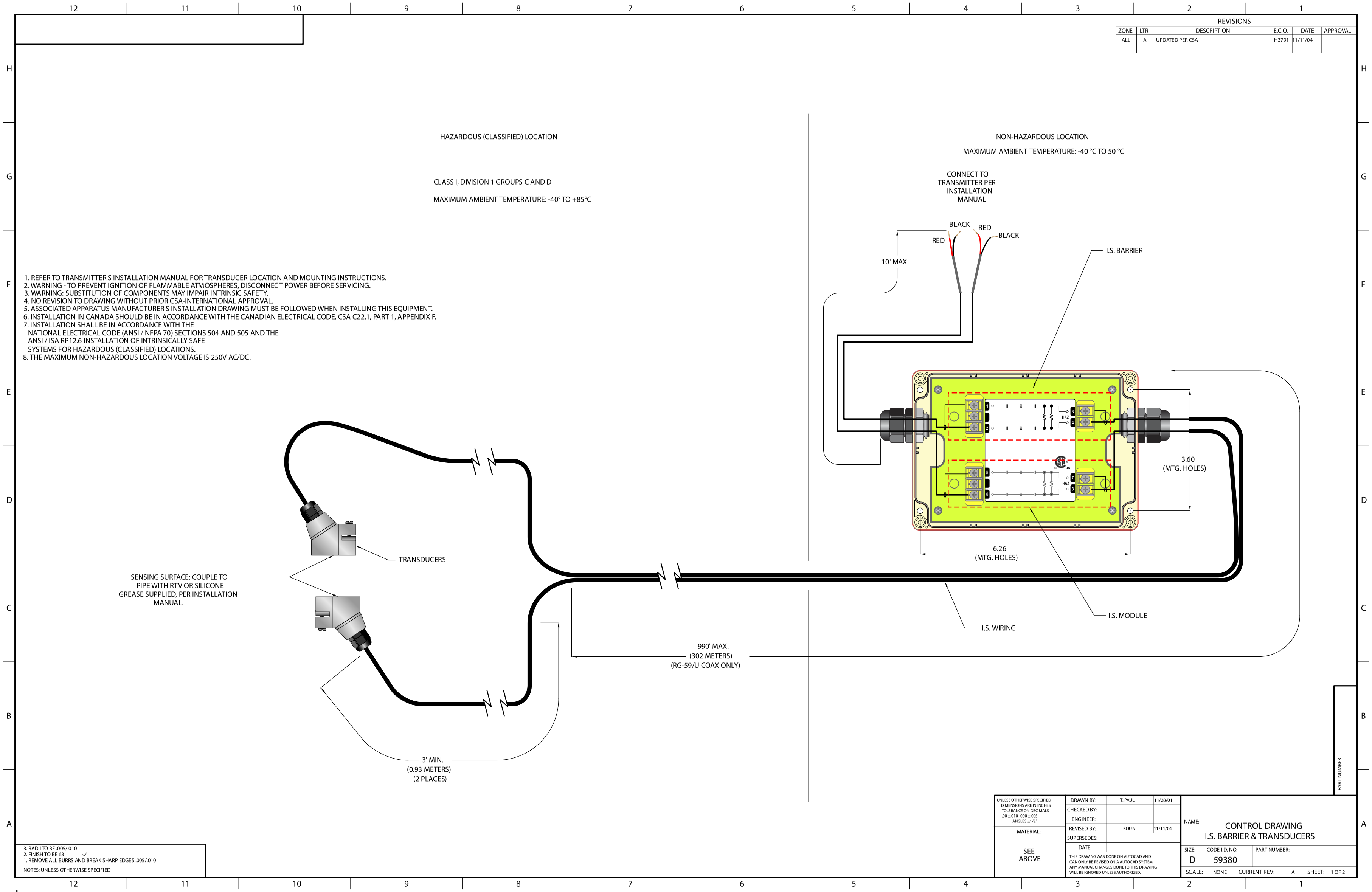


FIGURE A-6.1 - CONTROL DRAWING I.S. BARRIER DTT TRANSDUCERS

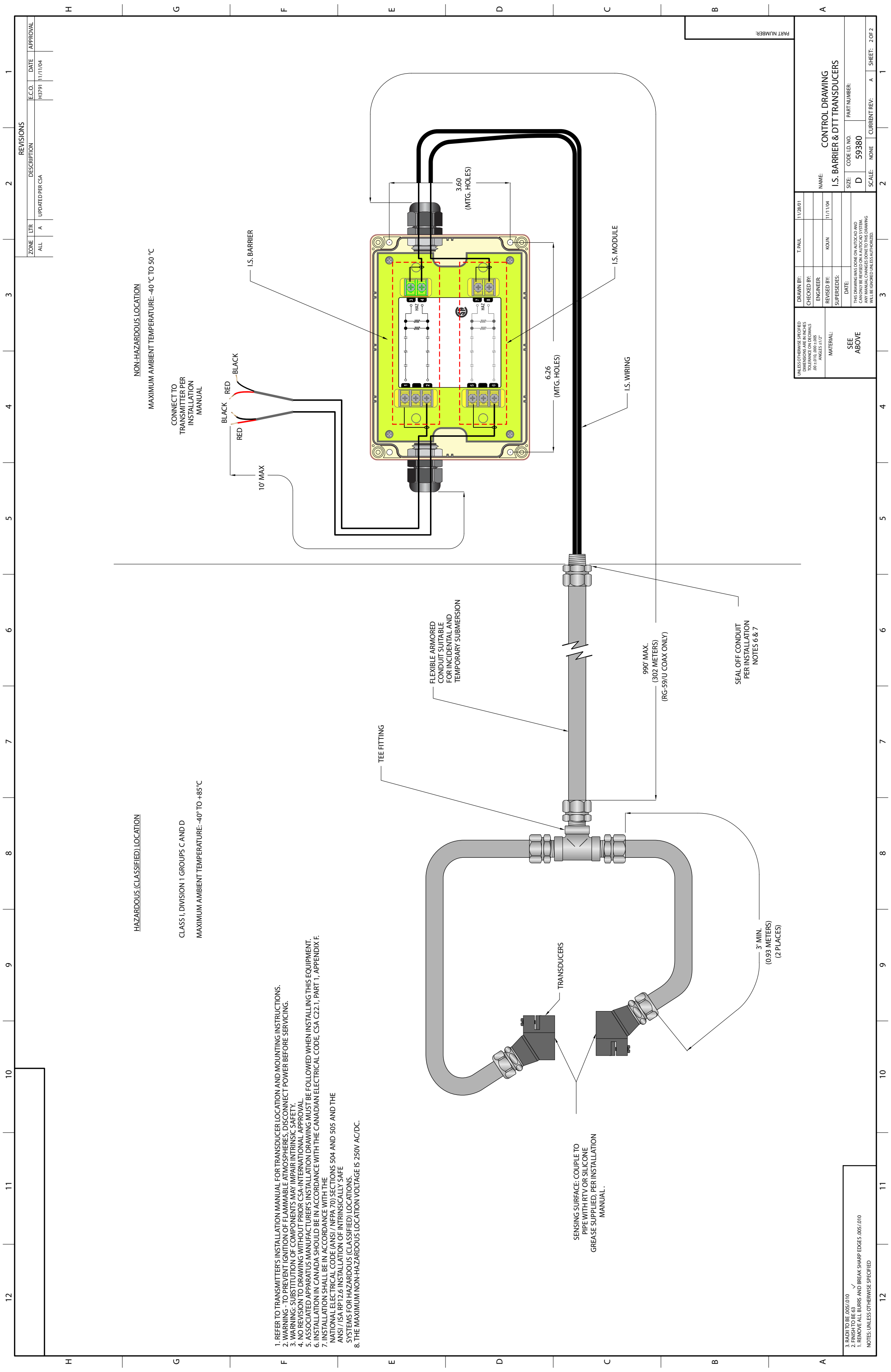
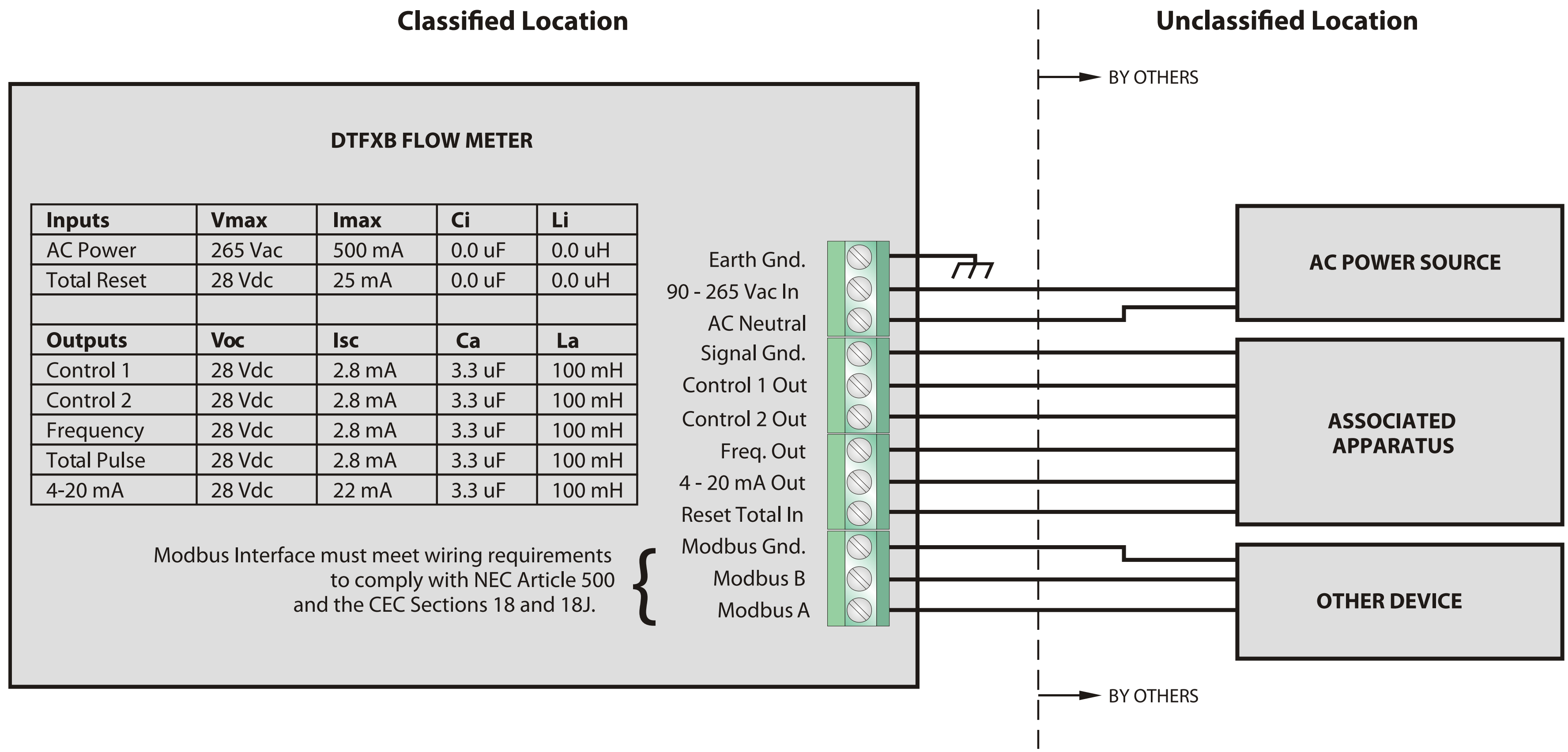


FIGURE A-6.2 - CONTROL DRAWING I.S. BARRIER DTT TRANSDUCERS FLEXIBLE CONDUIT



Inputs	Vmax	Imax	Ci	Li
AC Power	265 Vac	500 mA	0.0 uF	0.0 uH
Total Reset	28 Vdc	25 mA	0.0 uF	0.0 uH
Outputs	**Voc**	**Isc**	**Ca**	**La**
Control 1	28 Vdc	2.8 mA	3.3 uF	100 mH
Control 2	28 Vdc	2.8 mA	3.3 uF	100 mH
Frequency	28 Vdc	2.8 mA	3.3 uF	100 mH
Total Pulse	28 Vdc	2.8 mA	3.3 uF	100 mH
4-20 mA	28 Vdc	22 mA	3.3 uF	100 mH

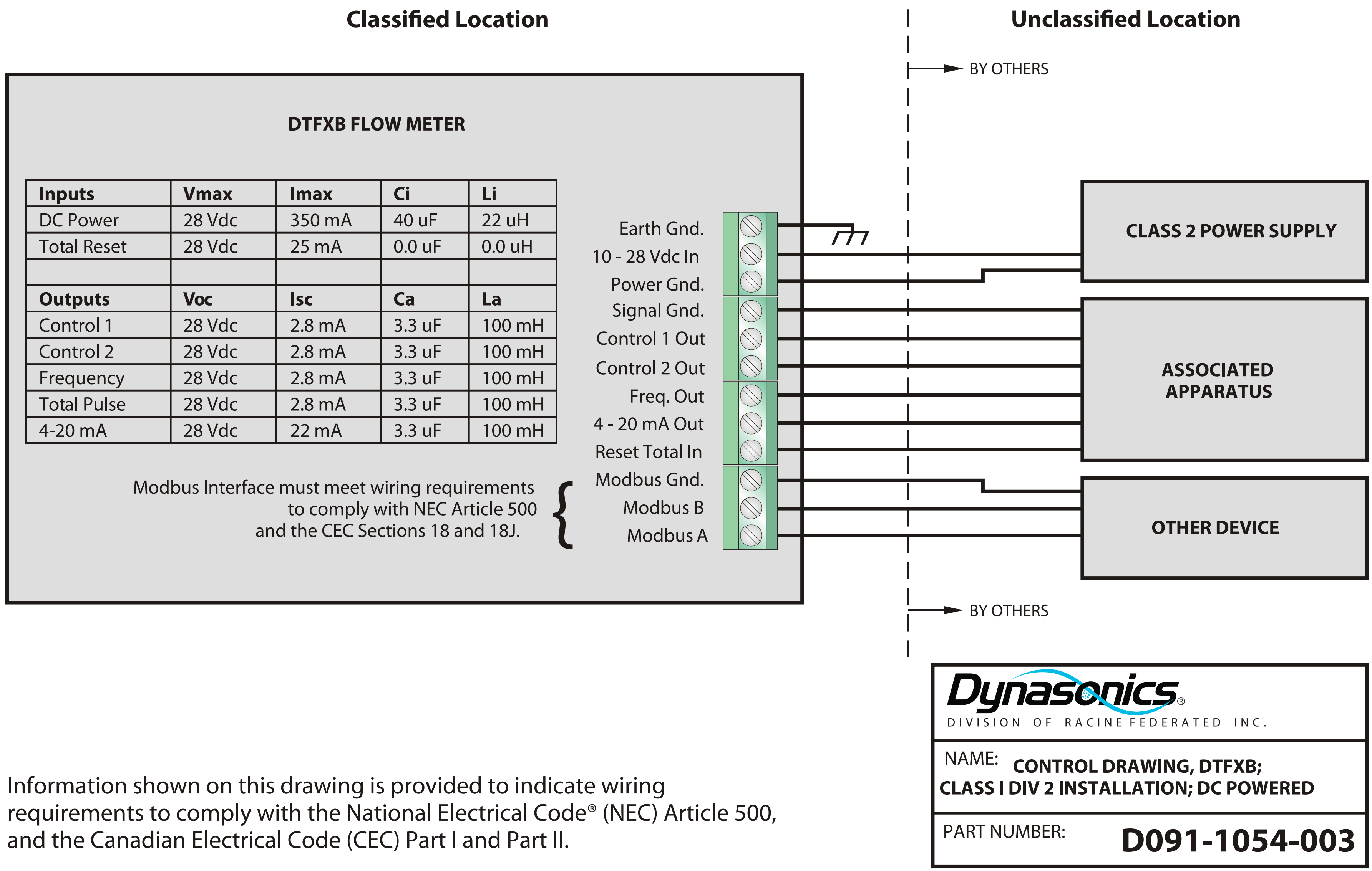
Dynasonics®
DIVISION OF RACINE FEDERATED INC.

NAME: **CONTROL DRAWING, DTFXB; CLASS I DIV 2 INSTALLATION; AC POWERED**

PART NUMBER: **D091-1054-004**

Information shown on this drawing is provided to indicate wiring requirements to comply with the National Electrical Code® (NEC) Article 500, and the Canadian Electrical Code (CEC) Part I and Part II.

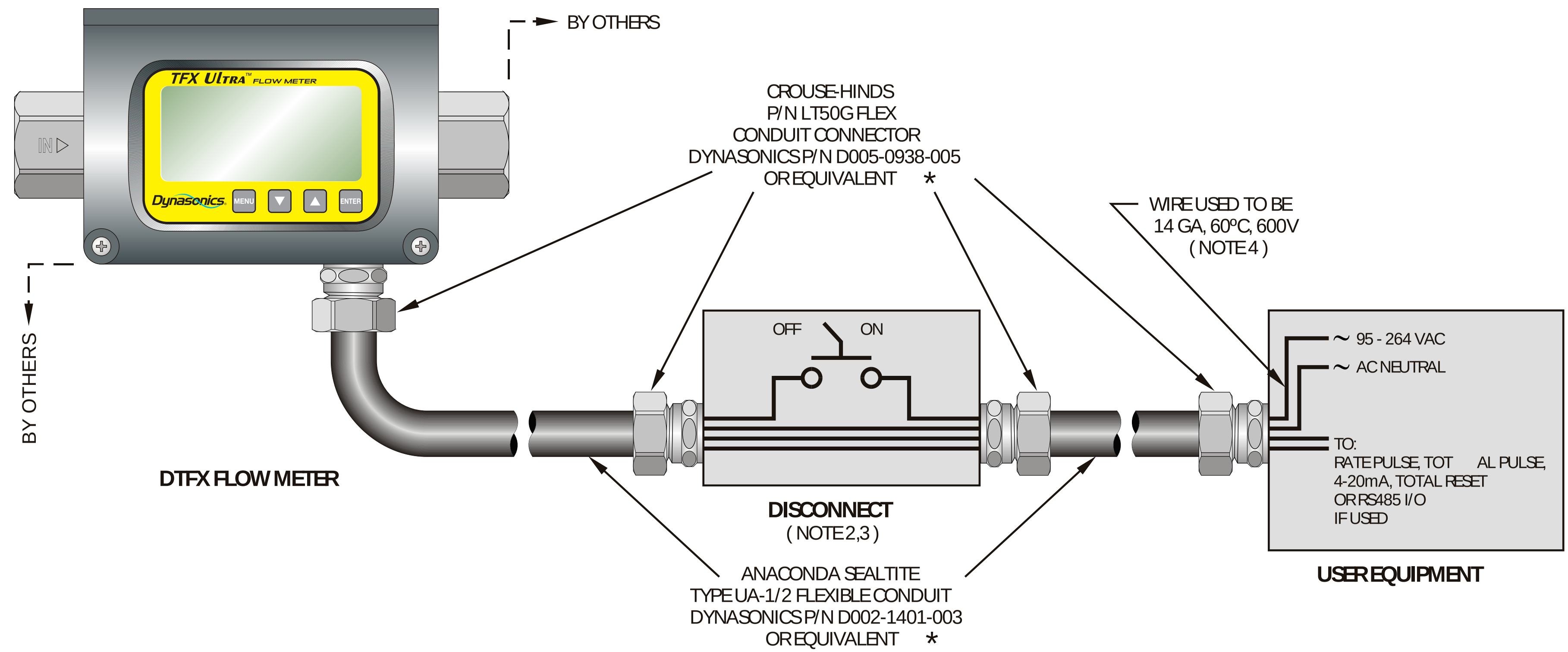
FIGURE A-6.3 - CONTROL DRAWING ULTRA FLOW (CLASS 1, DIV II)



Inputs	**Vmax**	**Imax**	**Ci**	**Li**
DC Power	28 Vdc	350 mA	40 uF	22 uH
Total Reset	28 Vdc	25 mA	0.0 uF	0.0 uH
Outputs	**Voc**	**Isc**	**Ca**	**La**
Control 1	28 Vdc	2.8 mA	3.3 uF	100 mH
Control 2	28 Vdc	2.8 mA	3.3 uF	100 mH
Frequency	28 Vdc	2.8 mA	3.3 uF	100 mH
Total Pulse	28 Vdc	2.8 mA	3.3 uF	100 mH
4-20 mA	28 Vdc	22 mA	3.3 uF	100 mH

Information shown on this drawing is provided to indicate wiring requirements to comply with the National Electrical Code® (NEC) Article 500, and the Canadian Electrical Code (CEC) Part I and Part II.

FIGURE A-6.4 - CONTROL DRAWING (CLASS 1, DIV II DC)



* Substitute part must be suitable for Class I, II, Div 2, Groups C, D.

1. Information shown on this drawing is provided to indicate wiring requirements to comply with National Electrical Code® (NEC) Article 500.

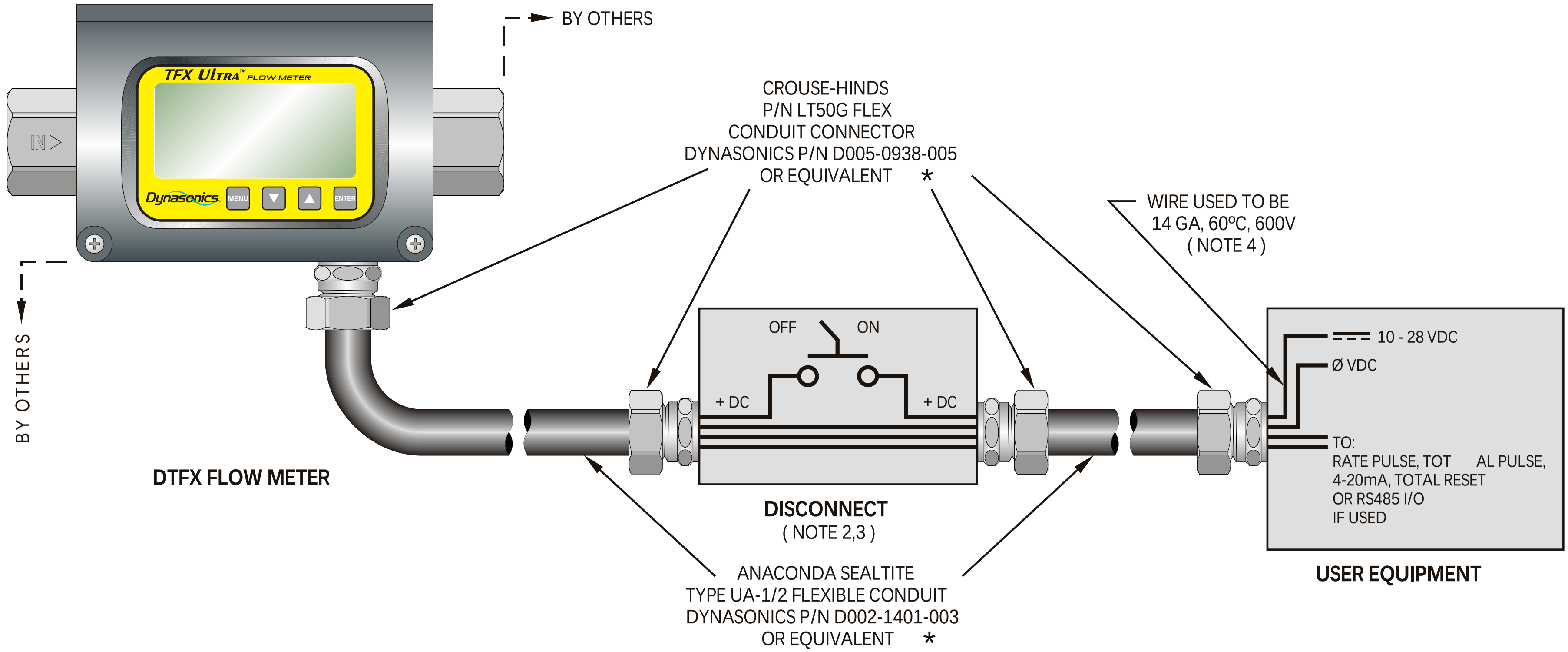
2. Disconnect to be located near the DTFX Flow meter. Do not position the Equipment so that it is di□cult to operate the disconnecting device.

Dynasonics®
DIVISION OF RACINE FEDERATED INC.

NAME: **DTFX AC POWERED HAZARDOUS AREA INSTALLATION**

PART NUMBER: **D091-1054-005**

FIGURE A-6.5 - ULTRA (AC) HAZARDOUS AREA INSTALLATION



1. Information shown on this drawing is provided to indicate wiring requirements to comply with National Electrical Code® (NEC) Article 500.
2. Disconnect to be located near the DTFX Flow meter. Do not position the Equipment so that it is di□cult to operate the disconnecting device.
3. Disconnect may not be required if DTFX Flow meter is powered from a class 2 Power Supply.
4. Smaller gauge wire may be acceptable if overall system meets NEC requirements per Article 725 Part III.

* Substitute part must be suitable for Class I, II, Div 2, Groups C, D.

Dynasonics® DIVISION OF RACINE FEDERATED INC.	
NAME:	DTFX DC POWERED HAZARDOUS AREA INSTALLATION
PART NUMBER:	D091-1054-006

FIGURE A-6.6 - ULTRA (DC) HAZARDOUS AREA INSTALLATION

BRAD HARRISON® CONNECTOR OPTION

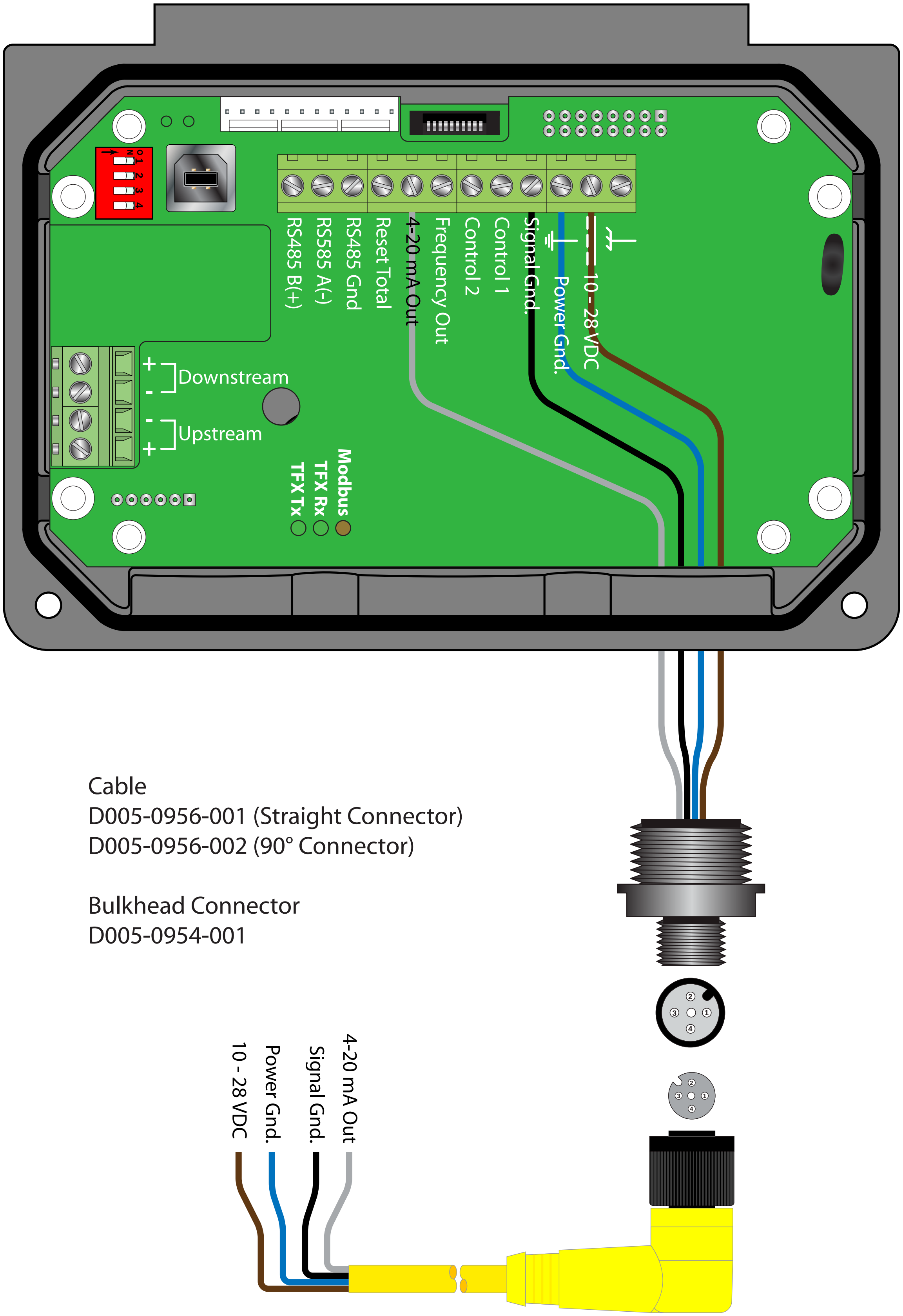


FIGURE A-7.1 - BRAD HARRISON® CONNECTIONS

K-FACTORS EXPLAINED

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 1 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 1 GPM. The output frequency, in Hz, is found simply by dividing the number of counts (1000) by the number of seconds (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 1 GPM. If the frequency counter registered 33.333...Hz (2 × 16.666...Hz), then the flow rate would be 2 GPM.

Finally, if the flow rate is 2 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 achieved, is twice as great.

Calculating K-factors for Ultrasonic meters

Many styles of ultrasonic flow meters are capable of measuring flow in a wide range of pipe sizes. Because the pipe size and volumetric units the meter will be used on vary, it is not possible to provide a discrete K-factor. Instead the velocity range of the meter 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

1) 700 Hz × 60 sec = 42,000 pulses per min

2) $$K - factor = \frac{42{,}000 \text{ pulses per min}}{48 \text{ GPM}} = 875 \text{ pulses per gallon}$$

Example 2:

Known values are:

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

1) 650 Hz x 60 sec = 39,000 pulses per min

2) $$K - factor = \frac{39{,}000\ pulses\ per\ min}{85\ GPM} = 458.82\ pulses\ per\ gallon$$

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 1 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

1) Find the area of the pipe cross section.

$$Area = \pi r^2$$

$$Area = \pi \left(\frac{3.068}{2}\right)^2 = \pi\ x\ 2.353 = 7.39\ in^2$$

2) Find the volume in 1 ft of travel.

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

3) What portion of a gallon does 1 ft of travel represent?

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

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)

1) 700 Hz $\times$ 60 sec = 42,000 pulses per gallon

2) $$K - factor = \frac{42{,}000 \; pulses \; per \; min}{99.1} = 423.9 \; pulses \; per \; gallon$$

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
Kerosene	0.81	4343.8	1324	3.6		
Linalool		4590.2	1400			
Linseed Oil	.925-.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)	.88-.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 A-8.1 - FLUID PROPERTIES

SYMBOL EXPLANATIONS

Caution—Refer to accompanying documents.

FLOW METER INSTALLATION

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

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

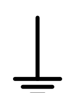
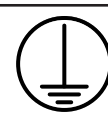
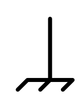
WARNING:
DO NOT CONNECT OR DISCONNECT EITHER POWER OR OUTPUTS UNLESS THE AREA IS KNOWN TO BE NON-HAZARDOUS.

AVERTISSMENT:
RISQUE D'EXPLOSION. NE PAS DÉBRANCHER TANT QUE LE CIRCUIT EST SOUS TENSION, À MOINS QU'IL NE S'AGISSE D'UN EMPLACEMENT NON DANGEREUX.

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

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

IMPORTANT NOTE:
Do not connect the interface cable between a Ultra flow meter and a personal computer unless the area is known to be non-hazardous.

ELECTRICAL SYMBOLS					
Function	Direct Current	Alternating Current	Earth (Ground)	Protective Ground	Chassis Ground
Symbol					

“STEEL, STAINLESS STEEL, P.V.C. PIPE” STANDARD CLASSES														
Nominal Pipe Size Inches	Outside Diameter	SCH 5		SCH 10 (Lt Wall)		SCH 20		SCH 30		STD		SCH 40	
		ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall
1	1.315	1.185	0.065	1.097	0.109					1.049		1.049	0.133
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 A-10.1 - ANSI PIPE DATA

"STEEL, STAINLESS STEEL, P.V.C. PIPE"
STANDARD CLASSES

Nominal Pipe Size Inches	Outside Diameter	SCH 60		X STG.		SCH 80		SCH 100		SCH 120/140		SCH 180	
		ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall
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 A-10.2 - ANSI PIPE DATA

Nominal Diameter		Copper Tubing Type K	Copper Tubing Type L	Copper Tubing Type M	Copper & Brass Pipe	ALUMINUM
½″	O. D.	0.625	0.625	0.625	0.840	
	Wall	0.049	0.040	0.028	0.108	
	I.D.	0.527	0.545	0.569	0.625	
⅝″	O. D.	0.750	0.750	0.750		
	Wall	0.049	0.042	0.030		
	I.D.	0.652	0.666	0.690		
¾″	O. D.	0.875	0.875	0.875	1.050	
	Wall	0.065	0.045	0.032	0.114	
	I.D.	0.745	0.785	0.811	0.822	
1″	O. D.	1.125	1.125	1.125	1.315	
	Wall	0.065	0.050	0.035	0.127	
	I.D.	0.995	1.025	1.055	1.062	
1¼″	O. D.	1.375	1.375	1.375	1.660	
	Wall	0.065	0.055	0.042	0.146	
	I.D.	1.245	1.265	1.291	1.368	
1½″	O. D.	1.625	1.625	1.625	1.900	
	Wall	0.072	0.060	0.049	0.150	
	I.D.	1.481	1.505	1.527	1.600	
2″	O. D.	2.125	2.125	2.125	2.375	
	Wall	0.083	0.070	0.058	0.157	
	I.D.	1.959	1.985	2.009	2.062	
2½″	O. D.	2.625	2.625	2.625	2.875	2.500
	Wall	0.095	0.080	0.065	0.188	0.050
	I.D.	2.435	2.465	2.495	2.500	2.400
3″	O. D.	3.125	3.125	3.125	3.500	3.000
	Wall	0.109	0.090	0.072	0.219	0.050
	I.D.	2.907	2.945	2.981	3.062	2.900

Nominal Diameter		Copper Tubing Type K	Copper Tubing Type L	Copper Tubing Type M	Copper & Brass Pipe	ALUMINUM
3½″	O. D.	3.625	3.625	3.625	4.000	
	Wall	0.120	0.100	0.083	0.250	
	I.D.	3.385	3.425	3.459	3.500	
4″	O. D.	4.125	4.125	4.125	4.500	4.000
	Wall	0.134	0.110	0.095	0.095	0.250
	I. D.	3 857	3.905	3.935	3.935	4.000
4½″	O D.					5.000
	Wall					0.250
	I. D.					4.500
5″	0. D.	5.125	5.125	5.125	5.563	5.000
	Wall	0.160	0.125	0.109	0.250	0.063
	I. D.	4.805	4.875	4.907	5.063	4.874
6″	0. D.	6.125	6.125	6.125	6.625	6.000
	Wall	0.192	0.140	0.122	0.250	0.063
	ID.	5.741	5.845	5.881	6.125	5.874
7″	O. D				7.625	7.000
	Wall				0.282	0.078
	I. D.				7.062	6.844
8″	O D	8.125	8.125	8.125	8.625	8 000
	Wall	0,271	0.200	0.170	0.313	0.094
	I. D.	7.583	7.725	7.785	8.000	7.812
10″	0. D.	10.125	10.125	10.125	10 000	
	Wall	0.338	0.250	0.212	0.094	
	I. D.	9.449	9.625	9.701	9.812	
12″	0. D.	12.125	12.125	12.125		
	Wall	0.405	0.280	0.254		
	I. D.	11.315	11.565	11.617		

TABLE A-10.3 - COPPER TUBE DATA

Ductile Iron Pipe (Standard Classes)

Size (Inches)		Class 50	51	52	53	54	55	56	Mortar Lining
3″	O.D.		3.96	3.96	3.96	3.96	3.96	3.96	Std. 0.123 Dbl. 0.250
	Wall		0.25	0.28	0.31	0.34	0.37	0.41	
	I.D.		3.46	3.40	3.34	3.28	3.22	3.14	
4″	O.D.		4.80	4.80	4.80	4.80	4.80	4.80	Std. 0.123 Dbl. 0.250
	Wall		0.26	0.29	0.32	0.35	0.38	0.42	
	I.D.		4.28	4.22	4.16	4.10	4.04	3.93	
6″	O.D.	6.90	6.90	6.90	6.90	6.90	6.90	6.90	Std. 0.123 Dbl. 0.250
	Wall	0.25	0.28	0.31	0.34	0.37	0.40	0.43	
	I.D.	6.40	6.34	6.28	6.22	6.16	6.10	6.04	
8″	O.D.	9.05	9.05	9.05	9.05	9.05	9.05	9.05	Std. 0.123 Dbl. 0.250
	Wall	0.27	0.30	0.33	0.36	0.39	0.42	0.45	
	I.D.	8.51	8.45	8.39	8.33	8.27	8.21	8.15	
10″	O.D.	11.10	11.10	11.10	11.10	11.10	11.10	11.10	Std. 0.123 Dbl. 0.250
	Wail	0.39	0.32	0.35	0.38	0.41	0.44	0.47	
	I.D.	10.32	10.46	10.40	10.34	10.28	10.22	10.16	
12″	O.D.	13.20	13.20	13.20	13.20	13.20	13.20	13.20	Std. 0.123 Dbl. 0.250
	Wall	0.31	0.34	0.37	0.40	0.43	0.46	0.49	
	I.D.	12.58	12.52	12.46	12.40	12.34	12.28	12.22	
14″	O.D.	15.30	15.30	15.30	15.30	15.30	15.30	15.30	Std . 0.1875 Dbl. 0.375
	Wall	0.33	0.36	0.39	0.42	0.45	0.48	0.51	
	I.D.	14.64	14.58	14.52	14.46	14.40	14.34	14.28	
16″	O.D.	17.40	17.40	17.40	17.40	17.40	17.40	17.40	Std . 0.1875 Dbl. 0.375
	Wall	0.34	0.37	0.40	0.43	0.46	0.49	0.52	
	I.D.	16.72	16.66	16.60	16.54	16.48	16.42	16.36	

Size (Inches)		Class 50	51	52	53	54	55	56	Mortar Lining
18″	O.D.	19.50	19.50	19.50	19.50	19.50	19.50	19.50	Std . 0.1875 Dbl. 0.375
	Wall	0.35	0.38	0.41	0.44	0.47	0.50	0.53	
	I.D.	18.80	18.74	18.68	18.62	18.56	18.50	18.44	
20″	O.D.	21.60	21.60	21.60	21.60	21.60	21.60	21.60	Std . 0.1875 Dbl. 0.375
	Wall	0.36	0.39	0.42	0.45	0.48	0.51	0.54	
	I.D.	20.88	20.82	20.76	20.70	20.64	20.58	20.52	
24″	O.D.	25.80	25.80	25.80	25.80	25.80	25.80	25.80	Std . 0.1875 Dbl. 0.375
	Wall	0.38	0.41	0.44	0.47	0.50	0.53	0.56	
	I.D.	25.04	24.98	24.92	24.86	24.80	24.74	24.68	
30″	O. D.	32.00	32.00	32.00	32.00	32.00	32.00	32.00	Std. 0.250 Dbl. 0.500
	Wall	0.39	0.43	0.47	0.51	0.55	0.59	0.63	
	I.D.	31.22	31.14	31.06	30.98	30.90	30.82	30.74	
36″	O.D.	38.30	38.30	38.30	38.30	38.30	38.30	38.30	Std. 0.250 Dbl. 0.500
	Wall	0.43	0.48	0.62	0.58	0.45	0.68	0.73	
	I.D.	37.44	37.34	37.06	37.14	37.40	36.94	36.48	
42″	O.D.	44.50	44.50	44.50	44.50	44.50	44.50	44.50	Std. 0.250 Dbl. 0.500
	Wall	0.47	0.53	0.59	0.65	0.71	0.77	0.83	
	I.D.	43.56	43.44	43.32	43.20	43.08	42.96	42.84	
48″	O.D.	50.80	50.80	50.80	50.80	50.80	50.80	50.80	Std. 0.250 Dbl. 0.500
	Wall	0.51	0.58	0.65	0.72	0.79	0.86	0.93	
	I.D.	49.78	49.64	49.50	49.36	49.22	49.08	48.94	
54″	O.D.	57.10	57.10	57.10	57.10	57.10	57.10	57.10	Std. 0.250 Dbl. 0.500
	Wall	0.57	0.65	0.73	0.81	0.89	0.97	1.05	
	I.D.	55.96	55.80	55.64	55.48	55.32	55.16	55.00	

TABLE A-10.4 - DUCTILE IRON PIPE DATA

Cast Iron Pipe (Standard Classes)

Size (Inches)		A	B	C	D	E	F	G	H
3″	O.D.	3.80	3.96	3.96	3.96				
	Wall	0.39	0.42	0.45	0.48				
	I.D.	3.02	3.12	3.06	3.00				
4″	O.D.	4.80	5.00	5.00	5.00				
	Wall	0.42	0.45	0.48	0.52				
	I.D.	3.96	4.10	4.04	3.96				
6″	O.D.	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
	I.D.	6.02	6.14	6.08	6.00	6.06	6.00	6.08	6.00
8″	O.D.	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
	I.D.	8.13	8.03	8.18	8.10	8.10	8.10	8.10	8.00
10″	O.D.	11.10	11.10	11.40	11.40	11.60	11.60	11.84	11.84
	Wall	0.50	0.57	0.62	0.68	0.74	0.80	0.86	0.92
	I.D.	10.10	9.96	10.16	10.04	10.12	10.00	10.12	10.00
12″	O.D.	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
	I.D.	12.12	11.96	12.14	12.00	12.14	12.00	12.14	12.00
14″	O.D.	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
	I.D.	14.16	13.98	14.17	14.01	14.18	14.00	14.18	14.00
16″	O.D.	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
	I.D.	16.20	16.00	16.20	16.02	16.20	16.00	16.18	16.00
18″	O.D.	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
	I.D.	18.22	18.00	18.18	18.00	18.20	18.00	18.22	18.00
20″	O.D.	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
	I.D.	20.26	20.00	20.22	20.00	20.24	20.00	20.24	20.00

Size (Inches)		A	B	C	D	E	F	G	H
24″	O.D.	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
	I.D.	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		
	I.D.	29.98	29.94	30.00	30.00	30.00	30.00		
36″	O.D.	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		
	I.D.	35.98	36.00	35.98	36.00	36.00	36.00		
42″	O.D.	44.20	44.50	45.10	45.58				
	Wall	1.10	1.28	1.54	1.78				
	I.D.	42.00	41.94	42.02	42.02				
48″	O.D.	50.55	50.80	51.40	51.98				
	Wall	1.26	1.42	1.71	1.99				
	I.D.	47.98	47.96	47.98	48.00				
54″	O.D.	56.66	57.10	57.80	58.40				
	Wall	1.35	1.55	1.90	2.23				
	I.D.	53.96	54.00	54.00	53.94				
60″	O.D.	62.80	63.40	64.20	64.28				
	Wall	1.39	1.67	2.00	2.38				
	I.D.	60.02	60.06	60.20	60.06				
72″	O.D.	75.34	76.00	76.88					
	Wall	1.62	1.95	2.39					
	I.D.	72.10	72.10	72.10					
84″	O.D.	87.54	88.54						
	Wall	1.72	2.22						
	I.D.	84.10	84.10						

TABLE A-10.5 - CAST IRON PIPE DATA

CE COMPLIANCE DRAWINGS

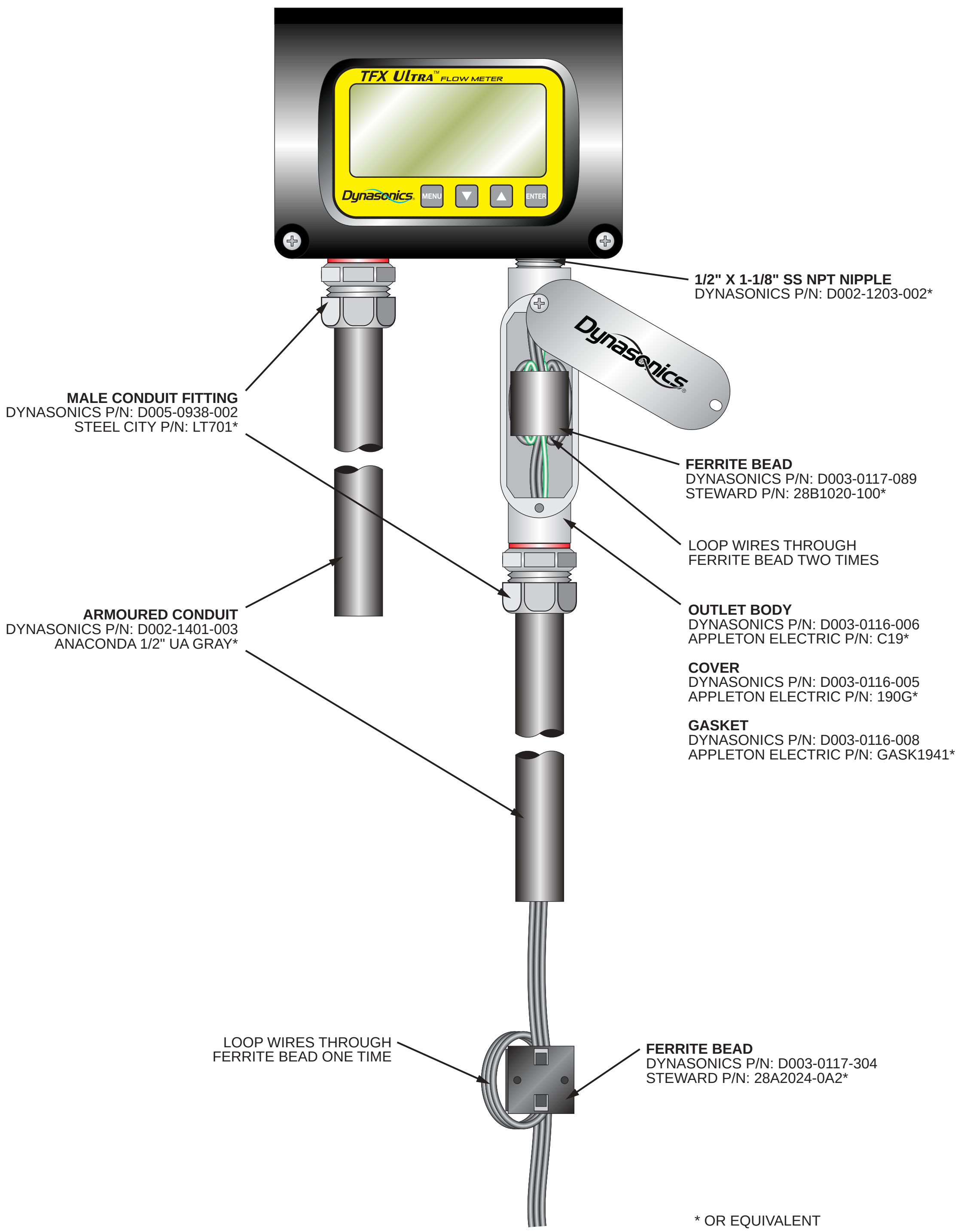


FIGURE A-11.1 - CE COMPLIANCE DRAWING FOR AC POWERED METERS

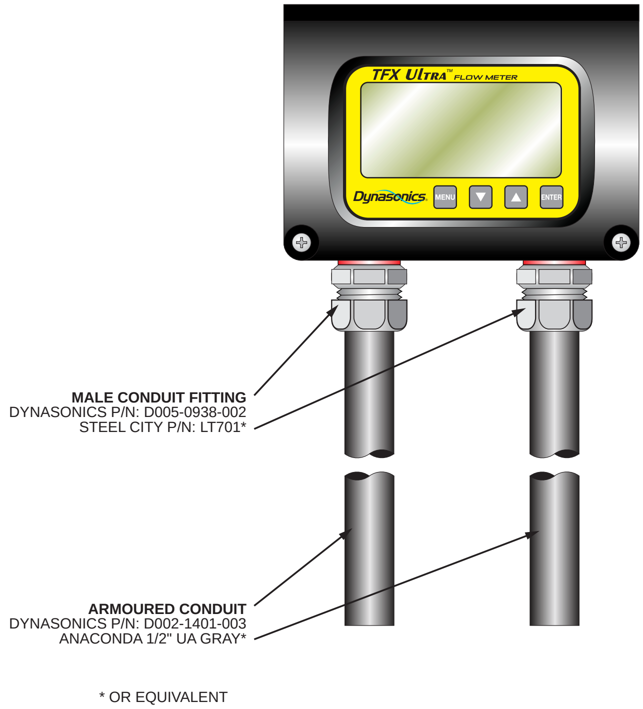


FIGURE A-11.2 - CE COMPLIANCE DRAWING FOR DC POWERED METERS

Division of Racine Federated Inc.
8635 Washington Avenue
Racine, WI 53406-3738
Toll-Free in U.S. and Canada
Tel: 800-535-3569 Fax: 800-732-8354
Tel: 262-639-6770 Fax: 262-639-2267
www.dynasonics.com

06-TTM-UM-00004 11/2011