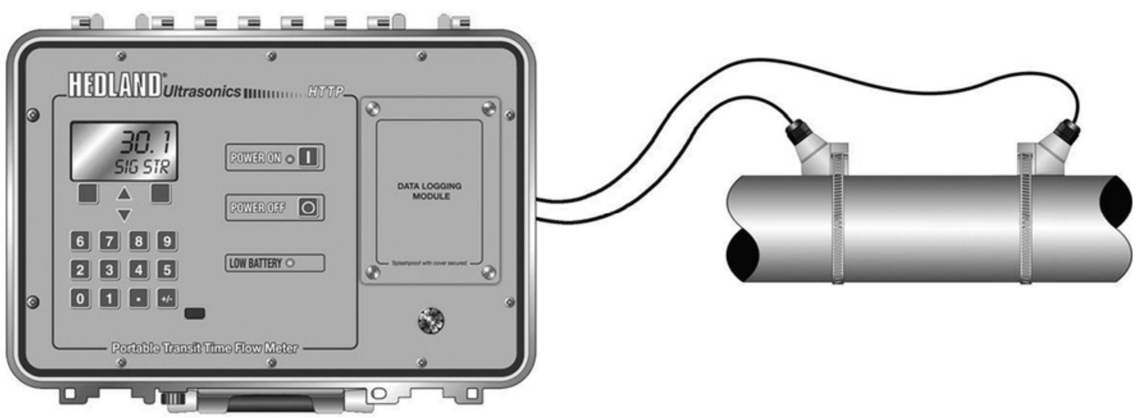
HEDLAND®

Series HTTP

Portable Transit Time Ultrasonic Flow Meter



Operations & Maintenance
Manual

Rev 01/06

BEFORE OPERATING THE HTTP

Important Notice!

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

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

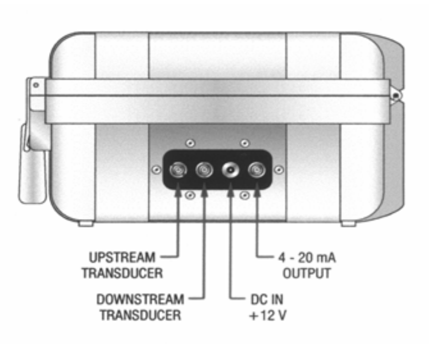


Figure 1.1

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

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

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Part 3 - Operation

Part 4 - Software

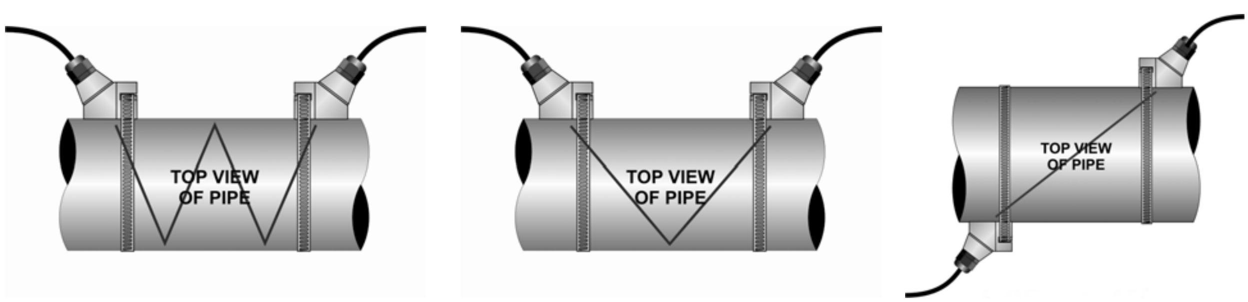
This manual contains detailed operating instructions for all aspects of the HTTP instrument. The following condensed instructions are provided to assist the operator in getting the instrument configured and measuring as quickly as possible. This pertains to basic operation only. If specific instrument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

Transducer Location

1. TRANSDUCER LOCATION

A. In general, select a mounting location on the piping system with a minimum of 10 pipe diameters (10 times the pipe inside diameter) of straight pipe upstream and 5 straight diameters downsteam. See Table 2.1 for detailed piping configurations and recommended lengths of straight pipe.

B. Select a mounting method for the transducers based on pipe size and liquid characteristics. See **Figure 1.2**. Select **W-Mount** for plastic pipes flowing clean, non-aerated liquids in the 2-3 inch (50-75 mm) internal diameter range. Select **V-Mount** for pipes of all materials and most liquids in pipe sizes from 2-10 inches (50-250 mm). Select **Z-Mount** for pipes 10-100 inches (250-2540 mm) inches.



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

Figure 1.2

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

C. Enter the following data into the HTTP transmitter via the integral keypad or *UltraLink*™ software utility.

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

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

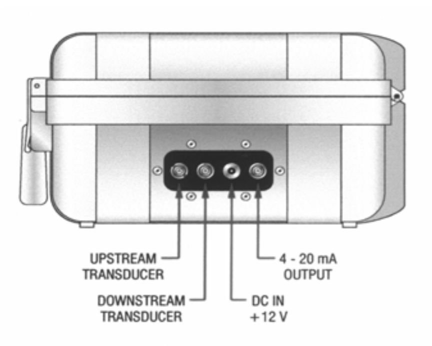


Figure 1.3

2. PIPE PREPARATION AND TRANSDUCER MOUNTING

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

B. Apply a liberal amount of couplant grease onto the transducer faces.

C. Attach the transducers to the pipe at the location(s) determined in Step 1. Refer to Figure 1.2 for proper orientation.

Connections

3. TRANSDUCER/POWER CONNECTIONS

A. If additional transducer cable is required, utilize RG59 coaxial wire with 75 Ohm terminations.

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

Startup

4. INITIAL SETTINGS AND POWER UP

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

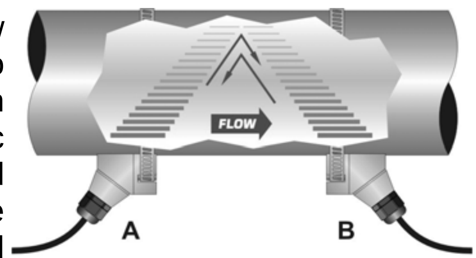
B. From the Service Menu, verify that signal strength is greater than 2.0%.

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

PART 1 - INTRODUCTION

General

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



HTTP 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-mode where the sound transverses the pipe two times, W-mode where the sound transverses the pipe four times, or in Z-mode where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once. This selection is based on pipe and liquid characteristics. The 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 HTTP flow meter can be successfully applied on a wide range of metering applications. The simple to program transmitter allows the standard product to be used on pipe sizes ranging from 2 - 100 inch (50 - 2540 mm) internal diameters. A variety of liquid applications can be accommodated: ultrapure liquids, potable water, chemicals, raw sewage, reclaimed water, cooling water, river water, plant effluent, etc. Because the transducers are non-contacting and have no moving parts, the flow meter is not affected by system pressure, fouling or wear. Standard transducers are rated to 300 °F (150 °C). Higher temperatures can be accommodated. Please consult the Hedland factory for assistance.

PART 1 - INTRODUCTION

User Safety

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

Data Integrity

Non-volatile flash memory retains all user-entered configuration values in memory for several years, even if power is lost or the unit is turned off. Data Logger values are stored in flash memory in the logger. Password protection is provided as part of the Security menu and prevents inadvertent configuration changes or totalizer resets.

Product Identification

The serial number and complete model number of your HTTP is located on the inside of the transmitter's front cover. Should technical assistance be required, please provide the Hedland Customer Service Department with this information.

Product Matrix

HTTP - □ □ □ A - □ □

Power Supply

A - 115 VAC
B - 230 VAC (two round terminals)
C - 100 VAC
G - 230 VAC (three rectangular terminals)

Output 2

1 - 4-20 mA

Output 1

N - None (Std)
6 - 200,000 event data logger [1]

Approvals

N - Ordinary Area
F - Class I Div 1, Groups C & D

Options

N - HTTN Transducer Package
H - HTTH High Temperature Transducer Package
2 - HTTS Small Pipe Transducer Package
-pipe sizes less than 2" (refer to Form No. 312 for part number matrix for HTTS transducers)

[1] The data logger records up to 30,000 points per file, with a maximum of 16 files. The total number of points that can be recorded on the logger is 200,000.

Replacement Parts	***Part Number***
HTTP Flow meter	HTTP-001
Data Logger, 200,000-event	HTTP-004
Padded carrying case	HTTP-008
Standard Transducer Set	HTTP-012
High Temp Transducer Set	HTTP-016
Transducer Cable set, 20 ft. (6m)	HTTP-COAX-20
Acoustic Grease, temporary mount	HTTF-CPLNT2
Mounting Track, w/measuring scale	HTTF-MTRK
36 inch SS hose clamp	HTTF-HCLP
Power converter, 115 V U.S.	HTTP-044
Power converter, 230 V European	HTTP-048
Power converter, 230 V U.K.	HTTP-052
Power cord, 12 V cigarette-style	HTTP-060
4-20 mA interconnect cable	HTTP-064
Infrared serial adapter	HTTP-072
USB to DB-9 adapter	HTTP-076
ULTRA*Link* software CD	HTTP-086
Manual, HTTP flow meter	HTTP-MANUAL

PART 1 - SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Liquid Types	Virtually all non-aerated liquids
Power	Internal 12 V lead-acid Gel Cell battery provides 24 hours of continuous operation @ 20 °C Charging: Wall mount power converter 115 or 230 VAC 50/60 Hz 15% @ 5 VA maximum; 12-15 VDC @ 2.5 VA maximum
Velocity	-40 to +40 FPS (-12 to +12 MPS)
Inputs/Outputs	All output modules are optically isolated from earth and system grounds One module and one data logger may be installed
Standard Options	**4-20 mA:** 800 Ohms maximum, 12-bit resolution, passive or active **Data Logger:** 200,000 event, 16-bit, integral DB-9 RS232C connection, can be removed and installed without disconnecting system power, data transfer rates to 57.6K
Other Options	**Rate Pulse:** MOFSET, 0.21 Ohms, 100 V maximum, 0-2,500 Hz **Dual Relay:** Two separate Form C relays, 200 VAC maximum @ 0.5 A resistive **RS232C:** Data rate to 57.6K **RS485:** Supports up to 126 drops
Display	128 x 64 pixel graphics LCD, LED back-lit Two user selectable font sizes: 0.35" (8.9 mm) or 0.2" (5 mm) 8 digit rate, 8 digit totalizer (resettable)
Units	User configured: Feet, gallons, ft^3, Mil-gal, barrels, acre-feet, lbs, meters, liters, m^3, Mil-liters, kg Rate: Sec, min, hr, day Totalizer: (NET, FWD, REV or BATCH) gallons, ft^3, barrels, acre-feet, lbs, liters, m^3, kg
Ambient Conditions	-40 °F to +185 °F (-40 °C to +85 °C), 0-95% relative humidity, non-condensing
Temperature (Pipe Surface)	HTTN: -40 °F to +300 °F (-40 °C to +121 °C) HTTH: -40 °F to +400 °F (-40 °C to +200 °C) HTTS: -40 °F to +185 °F (-40 °C to +85 °C)
Enclosure	NEMA 4X (IP 66) while open, NEMA 6 (IP 68) while closed ABS with SS hardware; 14.8 lbs (6.7 kg) 14.00W x 6.06H x 10.56D inches (355.6W x 153.9H x 268.2D mm)
Transducers	HTTN: CPVC, Ultem® and Nylon - NEMA 6 (IP 68) HTTH: PTFE, Vespel® and Nickel-plated Brass - NEMA 6 (IP 68) HTTS: PVC, Ultem®, SS, Zinc-plated Steel and Nylon - NEMA 4X (IP 66)
Line Sizes	2 inches (50 mm) and higher Optional: Small line sizes of less than 2" (50 mm), requires HTTS transducer
Transducer to Transmitter Distance	20 feet (6.09 meters) Optional: Lengths to 990 feet (300 meters), consult factory
Accuracy	±0.5% of reading at rates > 1 FPS (0.3 MPS) for field calibrated systems ±1% of reading rates > 1 FPS (0.3 MPS) uncalibrated 0.1 FPS (0.03 MPS) at rates < 1 FPS (0.3 MPS)
Sensitivity	Flow: 0.001 FPS (0.0003 MPS)
Repeatability	±0.01% of reading
Response Time	Flow: 0.3-30 seconds, user configures, to 100% of value, step change in flow
Security	Keypad lockout, four digit user selected access code
Transducer Installation	General Purpose Optional: Class I Division 1, Groups C and D
Approvals	Ordinary Area
***ULTRA**LINK*™ **Utility**	IBM Compatible, Windows® 95/98/2000/XP operating system

PART 1 - HTTP TRANSMITTER CONNECTIONS

Transmitter Location Considerations

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

When the HTTP is to be utilized for extended periods of time in one location, the enclosure should be placed in an area that is convenient for servicing, calibration or for observation of the LCD readout.

1. Locate the transmitter within the length of transducer cable that was supplied with the HTTP system. If this is not possible, additional cable should be RG59 co-axial cable and terminations should be 75 Ohm. Longer cables are also available by contacting the Hedland factory.

2. Place the HTTP transmitter in a location that is:

- Where little vibration exists.
- Protected from falling corrosive fluids.
- Within ambient temperature limits -40 to 185 °F (-40 to 85 °C).
- Out of direct sunlight. Direct sunlight may increase transmitter temperatures above maximum limit.

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

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

Electrical Connections

1. The connectors located on the side of the HTTP consist of three 1/4 turn BNC-type and one 5.5mm power plug. These connectors are environmentally sealed, but it is recommended not to allow water or other liquids to collect in the electrical connections pocket.
2. Connect the appropriate wires to the corresponding connections on the transmitter. The transducer cable has markings of UPSTREAM and DOWNSTREAM to assist in the installation process. The UPSTREAM transducer is the one located closer to the direction from which fluid flow normally comes from (The fluid normally passes the UPSTREAM transducer before passing the DOWNSTREAM transducer). If the transducer wires are connected backwards, a negative flow indication will be observed on the flow meter display. See **Figure 1.4** or the Wiring Diagram located on the inner door of the transmitter.

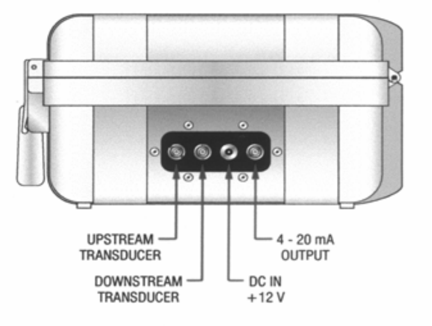


Figure 1.4

NOTE: The transducer cables carry low level signals. If additional cable is required, it must be RG59 coaxial cable with 75 Ohm terminations. Longer cables are also available from the Hedland factory.

Battery Charging and External Power Sources

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

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

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

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

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

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

- If the HTTP is stored for prolonged periods of time, monthly charging is recommended.
- If the HTTP is stored for prolonged periods of time, store at a temperature below 70 ºF (21 ºC).

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

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

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

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

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

General Information Regarding Input/ Output: ISO-MODs

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

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

The standard 4-20 mA output may be replaced with one of the following four ISO-MODs: dual-relay, rate pulse, RS232C, and RS485. HTTP supports one ISO-MOD input/output module in addition to the optional data logger. All modules are field configurable by utilizing the keyboard or ***ULTRA****LINK*™ interface. Field wiring connections to ISO-MODs are quick and easy using pluggable terminals.

Standard 4-20 mA Output

The 4-20 mA Output Module interfaces with virtually all recording and logging systems by transmitting an analog current signal that is proportional to system flow rate. Independent 4 mA and 20 mA span settings are established in software using the FL 4MA and FL 20MA settings in the OUTPUT2 configuration menu. These entries can be set anywhere in the –40 to +40 fps (-12 to +12 mps) measuring range of the instrument. Output resolution of the module is 12-bits (4,096 discrete points). The module can drive more than 800 Ohms of load with its internally generated 24 volt power source.

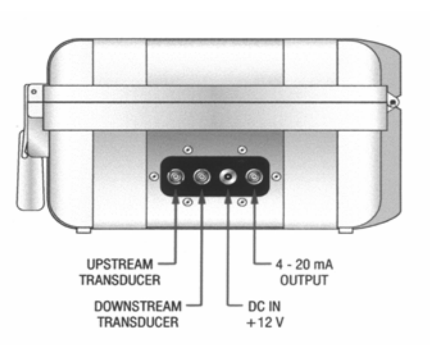


Figure 1.5

A 4-20 mA output interface cable has been included with the HTTP package. Connect the 1/4-turn BNC connection to the jack located on the side of the flow meter. **See Figure 1.5**. The red clip on the cable provides the positive leg of the output and the black clip provides the negative side. Verify that the sum of the resistances in the loop do not exceed 800 Ohms. The HTTP output is configured to source current.

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

Optional Data Logger

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

- The module is removable. The module can be carried in a shirt pocket back to the office and plugged into a PC serial port via the module's integral DB9 connector.
- Via the ***Data Logger*** software utility and the serial DB9 interface cable included with the logger. Data can be accessed by connecting the cable to the logger, which is located in the pocket on the front faceplate of the instrument. See **Figure 1.6.**

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

*****The 200,000 points can be divided into 16 unique files that each may contain up to 30,000 events.

Other *Optional* ISO-Mods

There are four additional optional ISO-Mods available in replacement of the standard 4-20 mA output. If interested in one of these optional ISO-Mods, please contact Hedland sales at 800-433-5263 or 262-639-6770 for detailed information.

PART 2 - TRANSDUCER POSITIONING

General

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

Mounting of the clamp-on ultrasonic transit time transducers is comprised of three steps:

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

1. Mounting Location

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

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

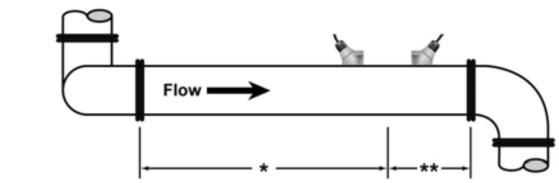
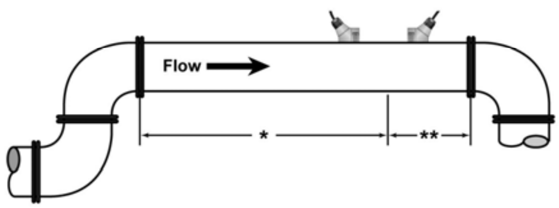
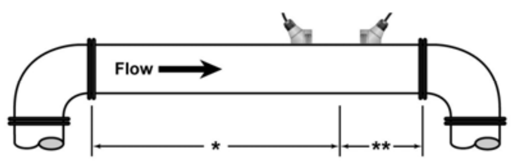
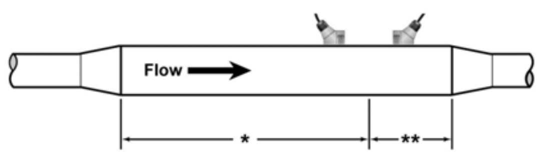
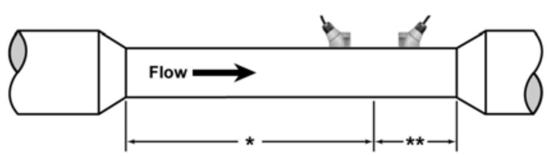
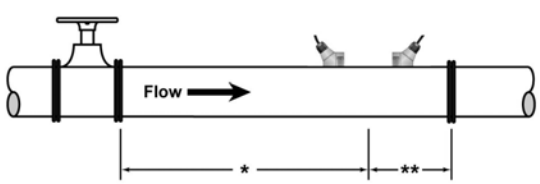
Piping Configuration and Transducer Position	Upstream Pipe Diameters *	Downstream Pipe Diameters **
	24	4
	14	3
	9	3
	8	3
	8	3
	24	4

Table 2.1[1]

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

2. Transducer Spacing

HTTP 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-mode where the sound transverses the pipe two times, W-mode where the sound transverses the pipe four times, or in Z-mode where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once. For further details, reference pictures located under **Table 2.2**. 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 or poor piping conditions are present. W-mode provides the longest sound path length between the transducers—but the weakest signal strength. Z-mode provides the strongest signal strength—but has the shortest sound path length. On pipes smaller than 3 inches (75 mm), it is desirable to have a longer sound path length, so that the differential time can be measured more accurately. Use of the HTTP diagnostics in determining the optimum transducer mounting is covered later in this section.

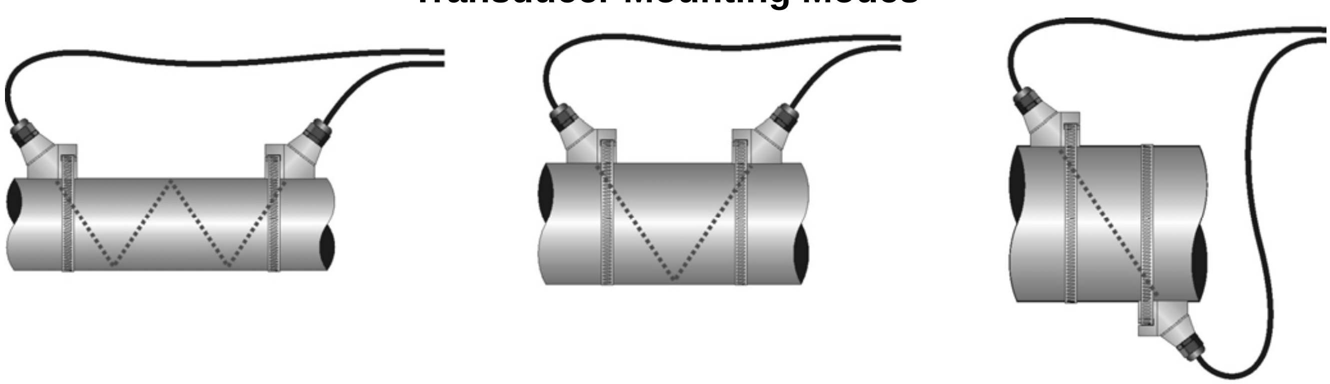
IMPORTANT: Since the time interval being measured is influenced by the transducer spacing, it is critical that the transducer spacing be measured on the pipe accurately to assure optimum performance from the HTTP system.

Table 2.2
Transducer Mounting Modes

Transducer Mount Mode	Pipe Material	Pipe Size	Liquid Composition
W-Mode	Plastic (all types)	1-6 in. (25-150 mm)	Low TSS; non-aerated
	Carbon Steel	1-4 in. (25-100 mm)	Low TSS; non-aerated
	Stainless Steel	1-6 in. (25-150 mm)	Low TSS; non-aerated
	Copper	1-6 in. (25-150 mm)	Low TSS; non-aerated
	Ductile Iron	Not recommended	
	Cast Iron	Not recommended	
V-Mode	Plastic (all types)	6-30 in. (150-750 mm)	Low TSS; non-aerated
	Carbon Steel	4-24 in. (100-600 mm)	Low TSS; non-aerated
	Stainless Steel	6-30 in. (150-750 mm)	Low TSS; non-aerated
	Copper	6-30 in. (150-750 mm)	Low TSS; non-aerated
	Ductile Iron	3-12 in. (75-300 mm)	Low TSS; non-aerated
	Cast Iron	3-12 in. (75-300 mm)	Low TSS; non-aerated
Z-Mode	Plastic (all types)	> 30 in. (> 750 mm)	Low TSS; non-aerated
	Carbon Steel	> 24 in. (> 600 mm)	Low TSS; non-aerated
	Stainless Steel	> 30 in. (> 750 mm)	Low TSS; non-aerated
	Copper	> 30 in. (> 750 mm)	Low TSS; non-aerated
	Ductile Iron	> 12 in. (> 300 mm)	Low TSS; non-aerated
	Cast Iron	> 12 in. (> 300 mm)	Low TSS; non-aerated

TSS = Total Suspended Solids

Transducer Mounting Modes



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

PART 2 - TRANSDUCER POSITIONING

Entering the Pipe and Liquid Data

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

In addition, the following information is required before mounting the transducers on the pipe. Note that much of the data relating to material, sound speed, viscosity and specific gravity are preprogrammed into the meter. This data only needs to be modified if it is known that a particular liquid data varies from the reference value.

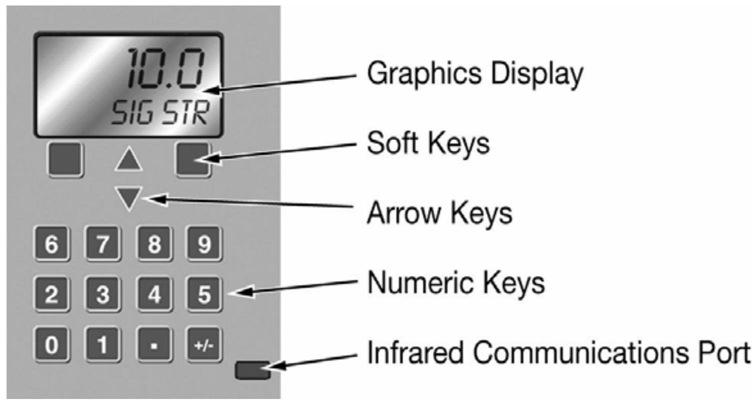
1. Transducer mounting configuration (Table 2.2)
2. Pipe O.D. (Outside Diameter)
3. Pipe wall thickness
4. Pipe material
5. Pipe sound speed[1]
6. Pipe relative roughness[1]
7. Pipe liner thickness (if present)
8. Pipe liner material (if present)
9. Fluid type
10. Fluid sound speed[1]
11. Fluid viscosity[1]
12. Fluid specific gravity[1]

[1] Nominal values for these parameters are included within the HTTP 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 HTTP will calculate proper transducer spacing for the particular data set. This distance will be in inches if the HTTP is configured in English units, or millimeters if configured in metric units.

Keypad Entry

The HTTP contains a tactile feedback keypad interface that allows the user to configure parameters used by the HTTP operating system.



Graphics Display Configuration

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

1. The (soft)MENU key is pressed from RUN mode to enter PROGRAM mode. The (soft)EXIT key is pressed in PROGRAM mode to exit configuration parameters and menus. If any configuration changes are made, the user will be prompted with a SAVE? (soft)YES or (soft)NO when returning to RUN mode. If no changes are made, the user will not be prompted to SAVE.
2. The UP/DOWN ARROW keys are used to scroll through menus and configuration parameters. The ARROW keys can also be used to adjust parameter numerical values. In RUN mode the UP/ DOWN ARROW keys are used to adjust the display contrast level.
3. The Numerical Keypad is used for entering numerical values.
4. The (soft)EDIT key is used to
   - access the configuration parameters in the various menus.
   - initiate changes in configuration parameters.

5. The (soft)ACCEPT key is used to
   - accept configuration parameter changes.
6. The (soft)SELECT key is used to
   - configure the engineering units on the graphics display. Press the (soft)SELECT key from RUN mode to highlight the engineering unit presently being displayed on the graphics display (pressing the SELECT key multiple times will toggle the highlighted unit from line to line). Use the UP/DOWN ARROW keys to select display units of:
     - RATE
     - TOTALizer
     - VELocity
     - SIGNAL STRength

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

UNITS Entry

Menu 1, the **BASIC** menu contains all of the configuration parameters necessary to make the transducer spacing calculation.

UNITS

ENGLSH
METRIC

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

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

Transducer Mount Configuration

XDCR MNT -- Transducer Mounting Method

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

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

W -- Mount. A reflective type (transducers mounted on one side of the pipe) of installation used primarily on pipe sizes in the 2-3 inch (50-75 mm) internal diameter range.

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

Pipe O.D. Entry

PIPE OD -- Pipe Outside Diameter Entry

ENGLSH (Inches)
METRIC (Millimeters)

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

Pipe Wall Entry

PIPE WT -- Pipe Wall Thickness Entry

ENGLSH (Inches)
METRIC (Millimeters)

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

Pipe Material Entry

PIPE MAT -- Pipe Material Selection

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

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

Pipe Sound Speed Entry

PIPE SS -- Speed of Sound in the Pipe Material

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

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

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

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

Pipe Roughness Entry

PIPE R -- Pipe Material Relative Roughness

UNITLESS VALUE

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

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

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

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

Liner Thickness Entry

LINER T -- Pipe Liner Thickness Entry

ENGLSH (Inches)
METRIC (Millimeters)

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

Liner Material Entry

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

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

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

Liner Sound Speed Entry

LINER SS -- Speed of Sound in the Liner

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

Allows adjustments to be made to the speed of sound in the liner. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second). If a liner was chosen from the LINER MAT list, a nominal value for speed of sound in that media will be automatically loaded. If the actual sound speed rate is known for the pipe liner and that value varies from the automatically loaded value, the value can be revised.

Fluid Type Entry

FL TYPE - Fluid/Media Type

TAP *WATER*
SEWAGE-RAW
ALCOHOL
SEA WATER
KEROSENE
GASOLINE
FUEL OIL
CRUDE OI
PROPANE
BUTANE
OTHER

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

Fluid Sound Speed Entry

FLUID SS -- Speed of Sound in the Fluid

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

Allows adjustments to be made to the speed of sound in the liquid. If the UNITS value was set to ENGLSH, the entry is in FPS (feet per second). METRIC entries are made in MPS (meters per second). If a fluid was chosen from the FL TYPE list, a nominal value for speed of sound in that media will be automatically loaded. If the actual sound speed rate is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

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

Fluid Viscosity Entry

FLUID VI -- Absolute Viscosity of the Fluid
cps

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

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

Fluid Specific Gravity Entry

SP GRVTY -- Fluid Specific Gravity Entry
unitless

Allows adjustments to be made to the specific gravity (density) of the liquid. If a fluid was chosen from the FL TYPE list, a nominal value for specific gravity in that media will be automatically loaded. If the actual specific gravity is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

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

Transducer Spacing Calculation

XDCR SPAC -- Transducer Spacing Calculation

ENGLSH (Inches)
METRIC (Millimeters)

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

IMPORTANT: Pipe sizes under 2 inches (50 mm) require optional transducers and a modified HTTP system that can be purchased separately. See Page 2.22 for additional details or consult the Hedland factory for information.

UltraLink™ Entry

***UltraLink*™ Data Entry**

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

PART 2 - TRANSDUCER POSITIONING

To install *UltraLink*™ and establish communications with a PC, please follow the instructions enclosed with the *UltraLink*™ software package or in the Appendix of this manual.

The system information required for entry into the *UltraLink*™ package is identical to that required for Keypad Entry covered in the previous section. See pages 2.3-2.5.

After initializing *UltraLink*™, click on the button labeled **Config**. The window shown in Figure 2.1 will appear. Enter the pipe and liquid parameters into the appropriate data fields in the **Basic** window. The correct transducer spacing will appear in the **Transducer - Spacing** data field.

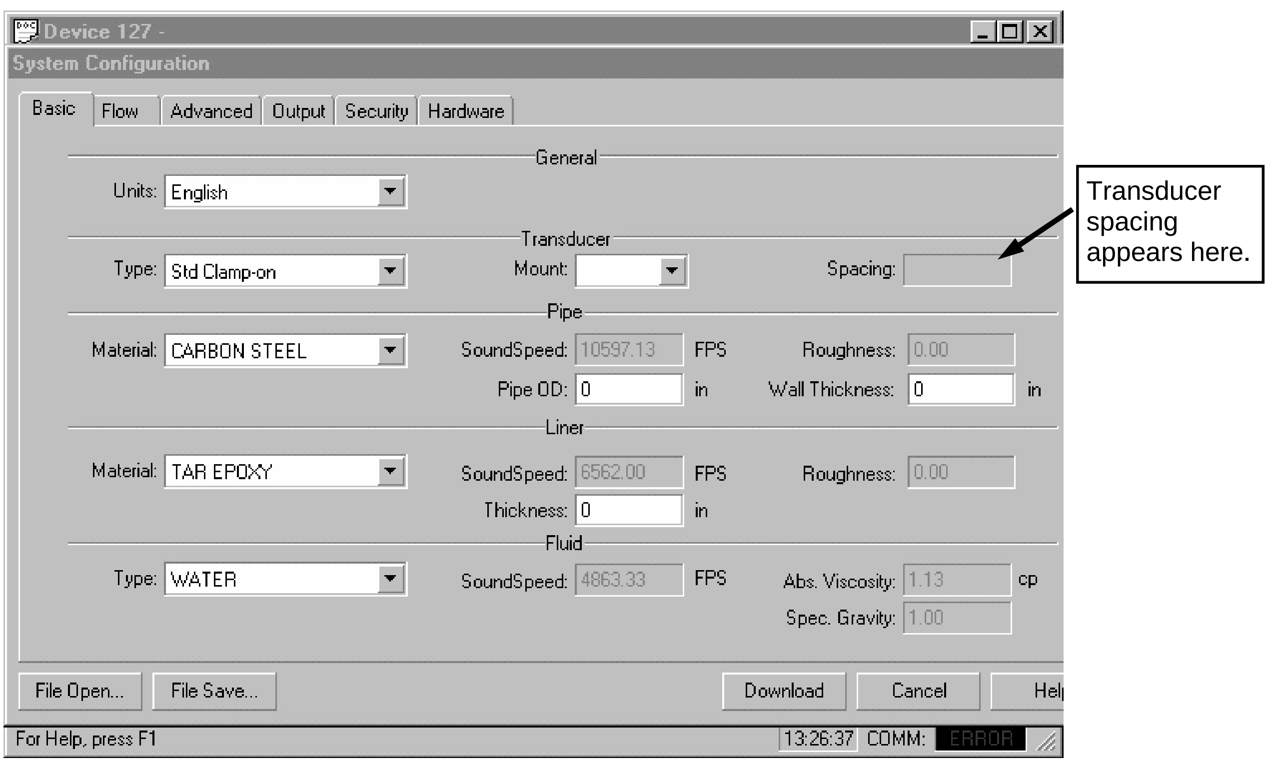


Figure 2.1 *UltraLink*™ Windows®-based software utility configuration screen.

After all data fields have been entered, **Download** to the HTTP or **File Save** to a disk by clicking on the appropriate button in the **Config** window. **Download** is not possible unless communications are enabled between the HTTP and *UltraLink*™. Communications are enabled when a green OK is indicated in the lower right-hand **COMM:** status box. If communications are not enabled, please review the documentation that details the installation and initialization of *UltraLink*™. Refer to Part 4, page 4.1.

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

3. Transducer Mounting

The HTT transducers need to be properly oriented on the pipe to provide optimum reliability and performance. On horizontal pipes, the transducers should be mounted 180 radial degrees from one another and at least 45 degrees from the top-dead-center and bottom-dead-center of the pipe. See **Figure 2.2**. Figure 2.2 does not apply to vertically oriented pipes.

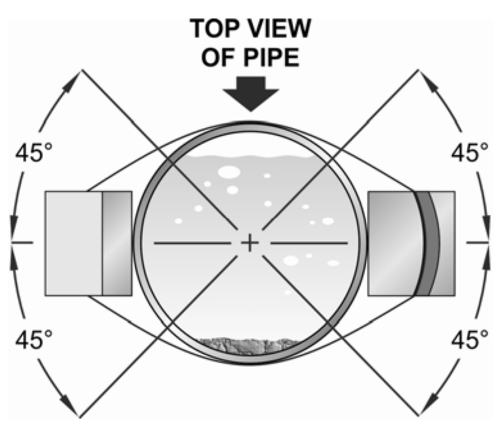


Figure 2.2 Horizontal pipe transducer mounting

Pipe Preparation

Before the transducers are bonded to the pipe surface, two areas slightly larger than the flat surface of the transducer heads must be cleaned of all rust, scale and moisture. For pipes with rough surfaces, such as ductile iron pipe, it is recommended that the pipe surface be ground flat. 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.

V-Mount and W-mount Transducer Installation

Transducer Mounting - V-mount and W-mount

1. Place a single bead of couplant, approximately 0.50 inch (12mm) thick, on the flat face of the transducer (**Figure 2.3)**. 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.

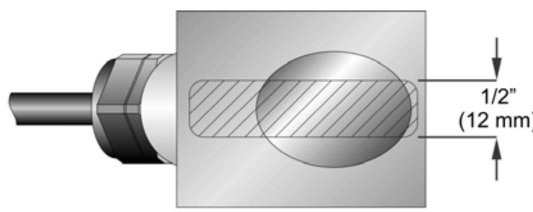


Figure 2.3 Transducer Couplant Application

2. Place the upstream transducer in position and secure with a mounting strap. The strap should be place 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 strap securely.
3. Place the downstream transducer on pipe at the calculated transducer spacing. See **Figure 2.4**. Using firm hand pressure, slowly move the transducer towards and away from the upstream transducer while observing Signal Strength. Clamp the transducer at the position where the highest Signal Strength is observed. A Signal Strength between 3.0 and 95.0 percent is acceptable.

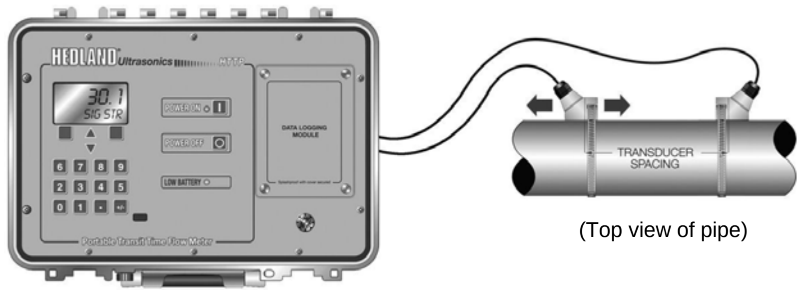


Figure 2.4 Transducer Position

4. If after adjustment of the transducers the Signal Strength does not rise to above 5 percent, then an alternate transducer mounting method should be selected. If the mounting method was W-mode, then reconfigure the HTT for V-mode, reset the HTTP, move the downstream transducer to the new location and repeat step 3.

5. Certain pipe and liquid characteristics may cause Signal Strength to rise to greater than 95%. The problem with operating a HTT with very high Signal Strength is that the signals may saturate the input amplifiers and cause erratic readings. To decrease the Signal Strength, move one transducer a small distance radially around the pipe, as shown in **Figure 2.5**.

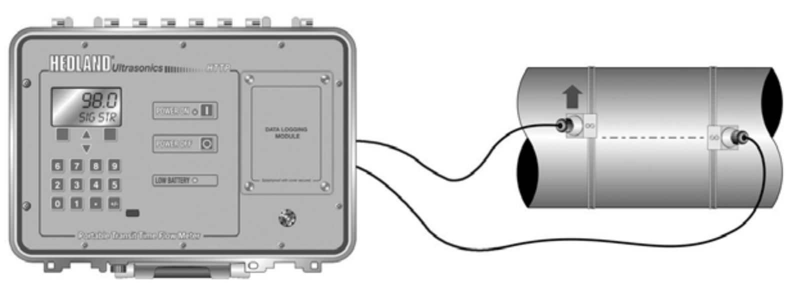


Figure 2.5 High Signal Strength Condition

Z-Mount Transducer Installation

HTT Mounting in Z-Mount Configuration

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

1. Wrap paper around pipe as shown in **Figure 2.6**. Align the paper ends to within 0.25 inches (6mm).

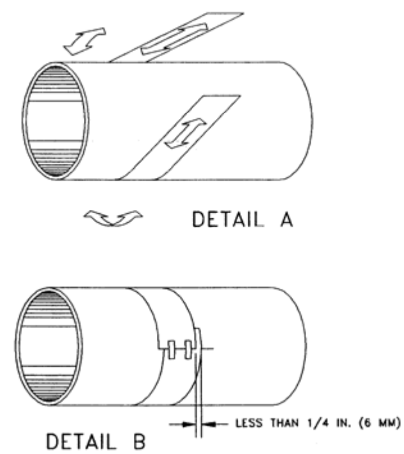


Figure 2.6 Paper Template Alignment

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

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 corner in the location of the mark. Move to the other side of the pipe and mark the ends of the crease. Measure from the end of the crease (directly across the pipe from the first transducer

location) the dimension derived in Step 2, Transducer Spacing. Mark this location on the pipe.

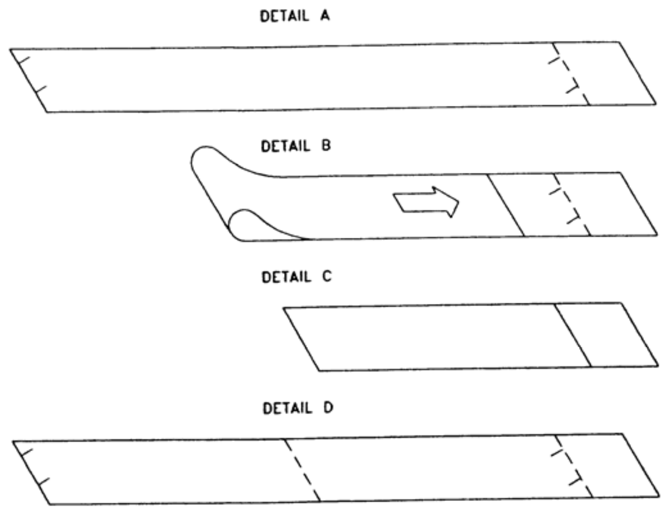


Figure 2.7 Bisecting the pipe circumference

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 to these dimensions and lay it over the top of the pipe.

   Length = Pipe O.D. x 1.57

   Width = Spacing determined on 2.12 or 2.14

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

5. Place a single bead of couplant, approximately 0.50 inch (12 mm) thick, on the flat face of the transducer. See **Figure 2.3**. 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.

6. Place the upstream transducer in position and secure with a stainless steel 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—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 2.8**. 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 95 percent is acceptable. On certain pipes, a slight twist to the transducer may cause signal strength to rise to acceptable levels.

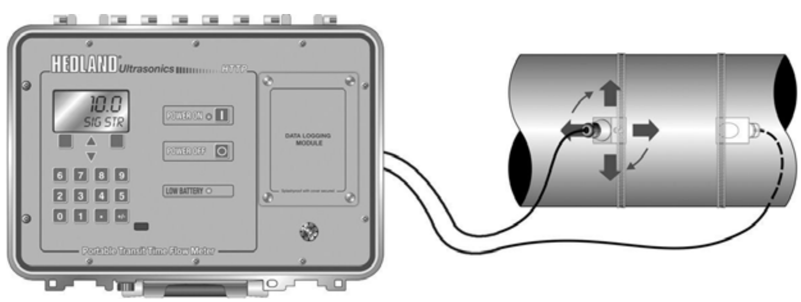


Figure 2.8
Z-Mode Transducer Placement

8. Certain pipe and liquid characteristics may cause Signal Strength to rise to greater than 95%. The problem with operating a HTT with very high Signal Strength is that the signals may saturate the input amplifiers and cause erratic readings. To decrease the Signal Strength one transducer can

be offset radially, as illustrated in **Figure 2.5**, or a V-Mode mounting method may be chosen.

9. Secure the transducer with a stainless steel strap.

Mounting Track Installation

Transducer Mounting - Mounting Track

1. The transducer mounting track is used for pipes that have outside diameters between 2 and 10 inches (50-250mm). If the pipe is outside of that range, then select a standard V-mode or W-mode mounting method.

2. Install the mounting rail on the side of the pipe with the stainless steel bands provided. Do not mount 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 clamps towards the center, 5 inch (125 mm) mark, on the mounting rail.

4. Place a single bead of couplant, approximately 0.25 inch (6 mm) thick, on the flat face of the transducer. See **Figure 2.3**.

5. Place the first transducer in between the mounting rails near the zero point on the mounting rail scale. Slide clamp over the transducer. Adjust the clamp/ transducer so the notch in the clamp aligns with zero on the scale. See **Figure 2.9**.

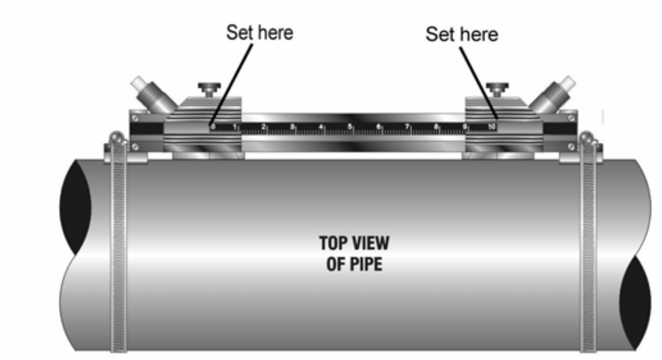


Figure 2.9 Transducer Space Measurement

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.

Transducer Mounting - HTTS Small pipe

Important note for pipe sizes under 2 inches (50 mm). If the transducer spacing that is calculated is lower than 2.65 inches (67 mm), a set of HTTS small pipe transducers are required. Please contact the Hedland factory or sales representative for information regarding the HTTS small pipe transducer.

The small pipe transducers offered by Hedland are designed for specific pipe outside diameters. Do not attempt to mount a HTTS transducer onto a pipe that is either too large or too small for the transducer - contact the Hedland factory to arrange for a replacement transducer that is the correct size.

HTTS installation consists of the following steps:

1. Apply a thin coating of silicone grease to both halves of the transducer housing where the housing will contact the pipe. See **Figure 2.10**.

2. On horizontal pipes, mount the transducer in an orientation such that the cable exits at ±45° from the side of the pipe. Do not mount with the cable exiting on either the top or bottom of the pipe. On vertical pipes the orientation does not matter.

3. Tighten the wing nuts so that the grease begins to flow out from the edges of the transducer and 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.

5. If Signal Strength is greater than 95%, contact the Hedland factory to obtain a lower power Strategy to load into the HTT flow meter.

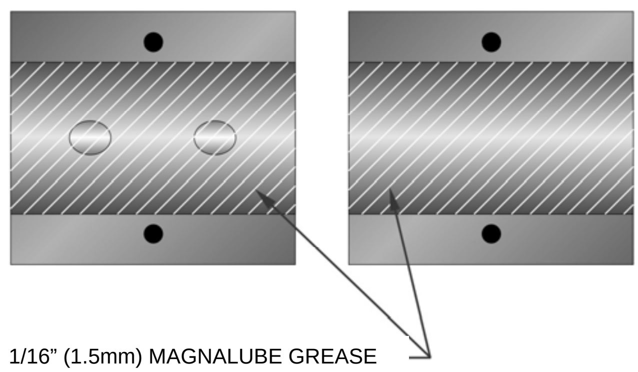


Figure 2.10 Application of Grease HTTS Transducer

PART 3 - STARTUP AND CONFIGURATION

Before Starting the Instrument

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

Note: If Dow 111 silicone grease was utilized as a couplant, a curing time is not required. However, if Dow 732 or another permanent RTV was used, the adhesive must fully cure before power is applied to the instrument.

Instrument Startup

<u>Procedure:</u>

1. Verify that all wiring is properly connected and routed as described previously in this manual.
2. Verify that the transducers are properly mounted as described in Part 2 of this manual.
3. Press the ON button on the flow meter keypad. The HTTP display backlighting will illuminate and the software version number will appear on the display.

> The display backlighting illuminates for approximately 20 seconds and automatically extinguishes to preserve battery power. To re-illuminate the display, press any key on the keyboard. Adjustments to the backlighting duration can be made in the Display Menu. Refer to page 3.29 for details.

4. Confirm that Signal Strength is greater than 2%. If it is not, verify that proper transducer mounting methods and liquid/pipe characteristics have been entered. **<u>The pipe must be full of liquid in order to make this measurement.</u>**
5. Once the meter is properly operating (proper signal strength has been achieved), refer to the later portions of this manual section for additional programming features.

PART 3 - KEYPAD CONFIGURATION

General

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

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

Keypad Operation

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

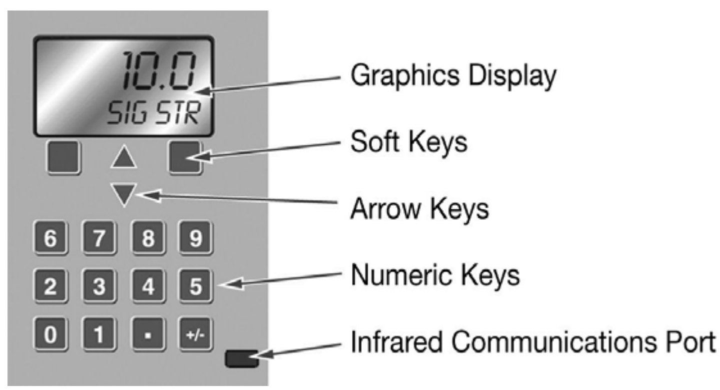


Figure 3.1

1. The MENU key is pressed from RUN mode to enter PROGRAM mode. The EXIT key is pressed in PROGRAM mode to exit configuration parameters and menus. If changes to any configuration parameters have been made, the user will be prompted with a SAVE? YES or NO when returning to RUN mode. If no changes have been made, the user will not be prompted to SAVE.
2. The UP/DOWN ARROW keys are used to scroll through menus and configuration parameters.

Display Contrast

The ARROW keys can also be used to adjust parameter numerical values or to adjust the display contrast level in RUN mode.

3. The Numerical Keypad is used for entering numerical values.
4. The ACCEPT key is used to
    - accept configuration parameter changes.

Graphics Display Configuration

5. The SELECT key is used to
    - configure the engineering units on the graphics display. Press the SELECT key from RUN mode to highlight the engineering unit presently being displayed on the graphics display (pressing the SELECT key multiple times will toggle the highlighted unit from line to line). Use the UP/DOWN ARROW keys to select display units of
        - N — Total (Net Totalizer)
        - + — Total (Positive Totalizer)
        - - — Total (Negative Totalizer)
        - Rate
        - Sound Speed FPS
        - Sound Speed MPS
        - SIGNAL STR.
        - Temp 1
        - Temp 2
        - Temp DIFF

    From Menu 8, Display Menu, the number of graphics display lines can be toggled between two and four lines.
    - access the configuration parameters in the various menus.
    - initiate changes in configuration parameters.

PART 3 - KEYPAD CONFIGURATION

Menu Structure

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

1. **BSC MENU** -- BASIC operations menu. Contains all of the configuration parameters necessary to program the meter to measure flow.
2. **Datalog operation** -- Configures the data logging location, logger interval and logging duration.
3. **Datalog maintenance** -- Existing data logger files can be erased from the logger.
4. **OUT2 MEN** -- Configures the type and operating parameters of the 4-20 mA or other ISO-MOD located internally in the HTTP flow meter.
5. **SEN MENU** -- Selects the transducer type (i.e. HTTN, HTTH, etc.).
6. **SEC MENU** -- Resets totalizers, resets the operating system and revises security passwords.
7. **SER MENU** -- SERVICE MENU contains system measurements that are used by service personnel for troubleshooting.
8. **DSP MENU** -- Configures meter display functions.

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

1. BSC MENU -- BASIC MENU

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

UNITS Selection

UNITS

ENGLSH
METRIC

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

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

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

Transducer Mount

XDCR MNT -- Transducer Mounting Method

V
W
Z

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

Pipe Diameter

PIPE OD -- Pipe Outside Diameter Entry

ENGLSH (Inches)
METRIC (Millimeters)

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

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

Pipe Wall Thickness

PIPE WT -- Pipe Wall Thickness Entry

ENGLSH (Inches)
METRIC (Millimeters)

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

Pipe Material

PIPE MAT -- Pipe Material Selection

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

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

Pipe Sound Speed

PIPE SS -- Speed of Sound in the Pipe Material

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

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

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

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

Pipe Roughness

PIPE R -- Pipe Material Relative Roughness
UNITLESS VALUE

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

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

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

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

Liner Thickness

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

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

Liner Material

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

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

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

Liner Sound Speed

LINER SS -- Speed of Sound in the Liner

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

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

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

Fluid Type

FL TYPE - Fluid/Media Type

TAP *WATER*
SEWAGE-RAW
ALCOHOL
SEA WATER
KEROSENE
GASOLINE
FUEL OIL
CRUDE OIL
PROPANE
BUTANE
OTHER

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

Fluid Sound Speed

FLUID SS -- Speed of Sound in the Fluid

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

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

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

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

Fluid Viscosity

FLUID VI -- Absolute Viscosity of the Fluid

cps

Allows adjustments to be made to the absolute viscosity of the liquid. If a fluid was chosen from the FL TYPE list, a nominal value for viscosity in that media will be automatically loaded. If the actual viscosity is known for the application fluid and it varies from the automatically loaded value, the value can be revised.

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

Fluid Specific Gravity

SP GRVTY -- Fluid Specific Gravity Entry

unitless

Allows adjustments to be made to the specific gravity (density) of the liquid. If a fluid was chosen from the FL TYPE list, a nominal value for specific gravity in that media will be automatically loaded. If the actual specific gravity is known for the application fluid and that value varies from the automatically loaded value, the value can be revised.

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

Transducer Spacing

XDCR SPAC -- Transducer Spacing Calculation

ENGLSH (Inches)
METRIC (Millimeters)

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

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

Engineering Units RATE

RATE UNT - Engineering Units for Flow Rate

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

Select a desired engineering unit for flow rate measurements.

Engineering Units RATE INTERVAL

RATE INT - Time Interval for Flow Rate

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

Select a desired engineering unit for flow rate measurements.

Engineering Units TOTALIZER

TOTL UNT - Engineering Units for Flow Totalizer

GALLONS - U.S. Gallons
LITERS - Metric Liter
MGAL - Millions of U.S. Gallons
CUBIC FT - Cubic Feet

CUBIC ME - Cubic Meters
ACRE FT - Acre Feet
OIL BARR - Oil Barrels (42 U.S. Gallons)
LIQ BARR - Liquor Barrels (31.5 U.S. Gallons)
FEET - Linear Feet
METERS - Linear Meters

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

Engineering Units TOTAL Exponent

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

Utilized for setting the flow totalizer exponent. This feature is useful for accommodating a very large accumulated flow. The exponent is a $x10^n$ multiplier, where "n" can be from -1 (x0.1) to +6 (x1,000,000). Table 3.1 should be referenced for valid entries and their influence on the HTTP display.

TABLE 3.1—Totalizer Exponent Values

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

Minimum Flow Rate

MIN RATE - Minimum Flow Rate Settings

Rate Unit/Rate Interval

A minimum volumetric flow rate setting is entered to establish filter software settings. Volumetric entries will be in the Engineering Rate Units and Interval selected on pages 3.10-3.11 of this manual. For uni-directional measurements, set MIN RATE to zero. For bi-directional measurements, set to the highest negative (reverse) flow rate expected in the piping system.

Maximum Flow Rate

MAX RATE - Maximum Flow Rate Settings

Rate Unit/Rate Interval

A maximum volumetric flow rate setting is entered to establish filter software settings. Volumetric entries will be in the Engineering Rate Units and Interval selected on pages 3.10-3.11 of this manual. For uni-directional or bi-directional 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

Percent of the range between MIN RATE and MAX RATE

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

System Damping

DAMP PER - System Damping

Relative Percent Entry: 0-100%

Flow Filter Damping establishes a maximum adaptive filter value. Under the 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 and allows the meter to react faster. Increasing this value tends to provide smoother steady-state flow readings and outputs. If erratic flow conditions are present or expected, more advanced filters are available for use in the *UltraLink*™ software utility. See Part 4 for further information.

2. DATALOG OPERATION MENU

ISO-MOD Data Logger

File Number/Location ID 1-30,000
[16 total location IDs]
INTERVAL 1-30,000 seconds
DURATION 1-30,000 hours

The Series HTTP has an optional 200,000-point data logger/electronic stripchart recorder. The logger can be configured in a couple of different ways to match user applications. The logger stores time-stamped, high resolution (16-bit) data at user-selected intervals ranging from 1 to 30,000 (8.33 hours) seconds. Configuration and data retrieval from the logger can be accomplished in one of two ways:

- The module is *hot-swappable* -- it can be installed, removed or replaced within the flow meter without disconnecting power. The module can be carried in a pocket and plugged into a PC serial port via the module's integral DB9 connector. This feature eliminates the need for a laptop computer to be at the flow meter site.
- Via the *Data Logger* software utility and the serial DB9 interface cable included with the logger. Data can be accessed by connecting the cable to the logger, which is located in the pocket on the front faceplate of the instrument. See **Figure 3.2.** e

Figure 3.2

See Section 4 for details regarding operation of the *Data Logger* and *UltraLink*™ software utilities.

Data Logger Configuration

There are three configuration parameters to enter for data logger operation:

- FILE NUMBER/LOCATION ID
- INTERVAL
- DURATION

File Number or Location

The HTTP and the data logger module can be used to monitor and store data on up to 16 different locations. These locations are identified by the FILE NUMBER/ LOCATION ID that is assigned. The data logger will not write over an existing file. Existing data files will need to be uploaded and then erased from the logger before new data can be written into the space. The data logger will stop logging once it has reached 30,000 location IDs. Uploading and storing of files is completed using the *Data Logger* software utility. See Section 4 of this manual for details regarding the *Data Logger* and *UltraLink*™ utilities.

NOTE: There is a maximum of 30,000 location IDs (samples) per location. The logger will stop logging once it reaches this point, and a new data file will need to be entered.

Logging Interval

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

For reference there are:

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

Table 3.2 describes some typical configurations of the INTERVAL and DURATION times with what the expected data samples collected count will be.

Table 3.2

Example No.	INTERVAL Seconds	DURATION Hours Operated	Samples Collected
1	1	6	21,600
2	10	72 (3 days)	25,920
3	60 (1min)	480 (20 days)	28,800
4	300 (5 min)	2,016 (12 wks)	24,192
5	1,800 (30 min)	8,760 (1 yr)	17,520
6	3,600 (1 hr)	8,760 (1 yr)	8,760
7	18,000 (5 hr)	26,280 (3 yr)	17,520

NOTE: There is a maximum of 30,000 location IDs (samples) per location.

Logging Duration

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

3. DATALOG MAINTENANCE

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

4. OUTPUT 2 MENU

Standard 4-20 mA

ISO-MOD 4-20 mA

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

Configured via jumper selections for either a passive or active transmission mode, the 4-20 mA Output Module interfaces with virtually all recording and logging systems by transmitting an analog current signal that is proportional to system flow rate. Independent 4 mA and 20 mA span settings are established in software using the Flow Measuring Range entries. These entries can be set anywhere in the –40 to +40 FPS (-12 to +12 MPS) measuring range of the instrument. Output resolution of the module is 12-bits (4096 discrete points) and the module can drive up to 800 Ohms of load with its internal 24V isolated power source.

4-20 mA Span

The FL 4MA and FL 20MA entries are used to set the span of the 4-20 mA analog output. These entries are volumetric rate units that are equal to the volumetric units configured as Engineering Rate Units and Engineering Units Time Interval entered on page 3.10.

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

For example, 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

4-20 mA Calibration

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

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

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.

Procedure:

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

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

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

Procedure:

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

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

4-20 mA Test

4-20 TST - 4-20 mA Output Test

4-20

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

Optional Modules

The Series HTTP allows other input/output modules to be used in place of the 4-20 mA output. Please contact the Hedland factory regarding these options:

Optional Rate Pulse

ISO-MOD RATE PULSE

FL 0H
FL 25KH

The Rate Pulse Output Module is utilized to transmit information to external counters and PID systems via a frequency output that is proportional to system flow rate. Independent Zero and Span settings are established in software using the Flow Measuring Range entries. Output resolution of the module is 12-bits (4096 discrete points) and the maximum output frequency setting is 2,500Hz. The module has two output modes, turbine meter simulation and "open collector". The turbine meter simulation sources a non-ground referenced saw-tooth waveform with a maximum peak amplitude of approximately 500mVpp. The open-collector output utilizes a 0.21-Ohm FET output that is rated to operate at 100 V and 1 A maximum. If the open-collector output type is utilized, an external voltage source and limit resistor must be present.

Rate Pulse Span

The FL 0H and FL 25KH entries are used to set the span of the 0-2.5KHz frequency output. These entries are volumetric rate units that are equal to the volumetric units configured as Engineering Rate Units and Engineering Units Time Interval entered on page 3.11.

In a bi-directional system, to span the 0-2.5kHz output from -100 GPM to +100 GPM, with 1.25kHz being 0 GPM, set the FL 100H and FL 10KH inputs as follows:

FL 0H = 100.0
FL 25KH = 100.0

To span the 0-2.5 kHz output from 0 GPM to +100 GPM, with 1.25 kHz being 50 GPM, set the FL 0H and FL 25KH inputs as follows:

FL 0H = 0
FL 25KH = 100.0

Optional Dual Relay

ISO-MOD Dual Relay

RELAY 1 AND RELAY 2
- *NONE*
- *TOTALIZE*
  - *TOT MULT*
- *FLOW*
  - *ON*
  - *OFF*
- *SIG STR*
- *ERRORS*

Two independent SPDT (single-pole, double-throw, Form C) relays are contained in this module. The relay operations are user configured via software to act in either a flow rate alarm, signal strength alarm, error alarm or totalizer/batching mode. The relays are rated for 200 VAC max. and a have current rating of 0.5A resistive load (175 VDC @ 0.25A resistive). It is highly recommended that a secondary relay be utilized whenever the Control Relay ISO-MOD is used to control inductive loads such as solenoids and motors.

Batch/Totalizer Relay

TOTALIZE mode configures the relay to output a 50 mSec pulse (contact changeover) each time the display totalizer increments—divided by the TOT MULT. The TOT MULT value must be a whole, positive, numerical value.

- If the Totalizer Exponent is set to E0 (x1) and the Relay Multiplier is set to 1, then the relay will pulse each time the totalizer increments one count, or each single, whole measurement unit totalized.
- If the Totalizer Exponent is set to E2 (x100) and the Relay Multiplier is set to 1, then the relay will pulse each time the display totalizer increments or once per 100 measurement units totalized.
- If the Totalizer Exponent is set to E0 (x1) and the Relay Multiplier is set to 2, the relay will pulse once for every two counts that the totalizer increments.

Flow Rate Relay

Flow rate relay configuration permits relay changeover at two separate flow rates, allowing operation with an adjustable switch deadband. **Figure 3.3** 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 when flow rate is too close to the switch point.

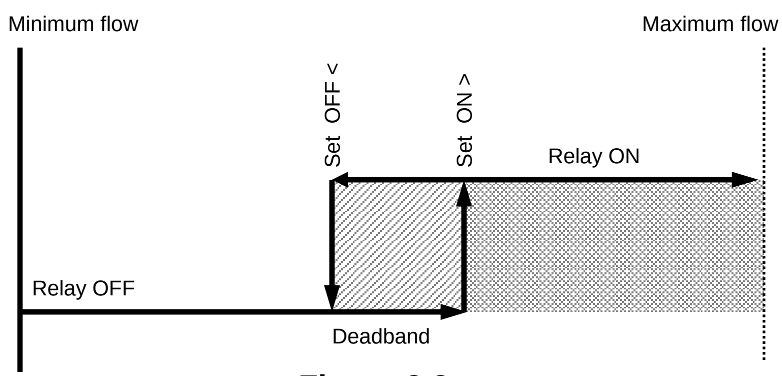


Figure 3.3
Single Point Alarm Operation

Signal Strength Alarm

The SIG STR alarm will provide an indication that the flow meter signals between the transducers have fallen to a point where flow measurements may not be possible. It can also be used to indicate the pipe has emptied. Like the Flow 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> is a value lower than OFF<. If a deadband is not established and the signal strength decreases to approximately the value of the switch point, the relay may chatter.

Error Alarm Relay

If a relay is set to ERROR mode, the relay will activate when errors occur in the flow meter that has caused the meter to stop measuring reliably. See Appendix for a list of potential error codes.

Optional RS232C Module

ISO-MOD RS232C

RS232 MO — MODE
- *HOST*
- *UIF*

RS232 BA — BAUD RATE
- *1200*
- *2400*
- *9600*
- *19200*

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

Optional
RS485 Module

ISO-MOD RS485

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

The RS485 Module allows up to 126 HTTP systems to be daisy-chained on a single three-wire cable network. Communications are via a proprietary digital protocol, detailed in the Appendix. All meters are assigned a unique one byte serial number that allows all of the meters on the cable network to be accessed independently. Baud rates up to 19.2K and cable lengths to 5,000 feet (1,500 meters) are supported without the need for repeaters.

RS485 MO

Select SLAVE for all of the HTTP meters.

RS485 BA

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

ADDRESS

Each HTTP connected on the communications bus must have a unique address number assigned. Address 127 is a universal address that will result in all HTTP instruments on the network responding simultaneously—regardless of address—resulting in CRC errors. Only select address location 127 if one meter is on the network.

4. SEN MENU -- SENSOR MENU

The SEN MENU is utilized to select the type of transducer that will be interfaced with the HTTP meter. Select the appropriate transducer from the list and save the configuration. If the transducer selection is modified, a system reset is required.

5. SEC MENU -- SECURITY MENU

SEC MENU allows users to make password revisions, reset flow totalizer and reset transmitter microprocessor.

Totalizer RESET

TOT RES

NO
YES

Select YES to reset flow totalizer/accumulator to Zero.

System RESET

SYS RSET

NO
YES

Select YES to initiate a microprocessor reset. All configurations and totalizer values will be maintained.

Change Password

CH PSWD? -- Change the Security Password

0-9999

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

6. SER MENU -- SERVICE MENU

The SERVICE Menu makes available two different system measurements that are used for trouble-shooting and fine tuning of the instrument. Actual liquid sound speed and system signal strength readings can be accessed through this menu.

The SERVICE Menu also has features that allow adjustment of Signal Strength Cutoff, Error-Mode outputs, Zero Flow Rate Set and entry of a universal correction factor.

Liquid Sound Speed

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

The HTTP performs an actual speed of sound calculation for the liquid it measures. This calculation will vary with temperature, pressure and fluid composition. The value indicated should be within 2% of the value entered/indicated in the BASIC menu item FLUID SS. The value cannot be modified. If the actual measured value is significantly different than the BASIC MENU’s FLUID SS value, it typically indicates a problem with the instrument setup. Any entry such as PIPE OD or wall thickness may be in error, the pipe may not be round, or the transducer spacing is not correct. **Table 3.3 on page 3.26** lists sound speed values for water at varying temperatures. If the HTTP is measuring sound speed within 2% of the table values, then the installation and setup of the instrument is correct and accurate readings may be assured.

Table 3.3 Sound Speed in Liquid Water vs. Temperature

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

Signal Strength

SIG STR - Signal Strength

The measurement of Signal Strength assists service personnel in troubleshooting the HTTP system. In general, expect the signal strength readings to be greater than 4% on a full pipe with the transducers properly mounted. Signal strength readings that are less than 4% may indicate a need to chose an alternative mounting method for the transducers, or that an improper pipe size has been entered.

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

Signal Strength Cutoff

Signal Strength Cutoff SIG C-OF is used to drive the 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 of between 0.5 and 0.8 is inadequate for measuring flow reliably, so minimum settings for SIG C-OF are in the range of 1.0 to 2.0. A good practice is to set the SIG C-OF at approximately 60-70% of actual measured signal strength (described above).

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

Substitute Flow Entry

Substitute Flow or 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.

Table 3.4 below lists some typical settings to achieve “Zero” with respect to MIN and MAX FLOW settings.

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

**UltraLink*™ is required to set values outside of 0.0-100.0.

TABLE 3.4—Substitute Flow Entry

Setting/Calibrating Zero Flow

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

To zero the meter:

1. The pipe must be full of liquid.
2. Flow must be absolute zero—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.
5. The procedure is complete.

Factory Default Zero Calibration

If the flow in a piping system cannot be shut off, allowing the SET ZERO procedure described above to be performed, 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. This function can also be utilized to correct an inadvertently entered or erroneous SET ZERO entry.

Correction Factor

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

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

- An out-of-round pipe, carrying water, causes the HTTP to indicate a measured sound speed that is 7.4% lower than the **TABLE 3.3** 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.

7. DSP MENU -- DISPLAY MENU

Graphics Display Mode

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

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

Display Units

DISPLAY UNITS SELECTION

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

- RATE
- TOTALizer
- VELocity
- SIGNAL STRength

Back Light Timeout

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

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

PART 4 - SOFTWARE UTILITIES

Important Notice!

The HTTP flow meter can be used with two software utilities, ***UltraLink™*** and ***Data Logger***. The *UltraLink* utility is used for configuration, calibration and communication with the HTTP flow meter. The *Data Logger* utility is used for uploading and translating data accumulated in the data logger module located in the pocket on the front faceplate of the flow meter.

UltraLink has been designed to provide a HTT user a powerful and convenient way to configure and calibrate HTTP flow meters. *UltraLink* can be used in conjunction with the infrared communications adapter included in the HTTP case or the optional ISO-MOD RS232 and ISO-MOD RS485.

System Requirements

Computer type - PC, operating system - Windows® 95/98/2000/NT, a communications port for the infrared adapter, access to the Hedland web site.

Installation

1. Go to www.hedland.com
2. Go to Products/Transit Time Ultrasonic/Software
3. Click the *UltraLink™* icon.
4. Follow downloading instructions.
5. **UlSetup** will automatically extract and install on the hard disk and place a short-cut icon on the desktop.
6. Some PCs may require a restart after a successful installation.

A CD of the *UltraLink* software can also be purchased by contacting Hedland sales at 800-433-5263 or 262-639-6770. Please refer to part number HTTP-086.

Initialization

1. Connect the infrared communications adapter to a PC communication port and point the communicator at the HTTP infrared window, located in the lower right hand corner of the keypad. If meter is ordered with a ISO-MOD RS232 or ISO-MOD RS485,

connect the PC Communications port directly to the optionally installed RS232C or RS485 port located on side of HTTP meter.

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

2. The first screen is the “RUN-mode” screen, See **Figure 4.1**, which contains real-time information regarding flow rate, totalizer accumulation, system signal strength, diagnostic data and the flow meter’s serial number. The indicator in the lower right-hand corner will indicate communications status. If a red **ERROR** is indicated, click on the Communications button on the top bar. Click on Initialize. Choose the appropriate COM port and interface type. Proper communications are established when a green **OK** is indicated in the lower right-hand corner of the PC display.

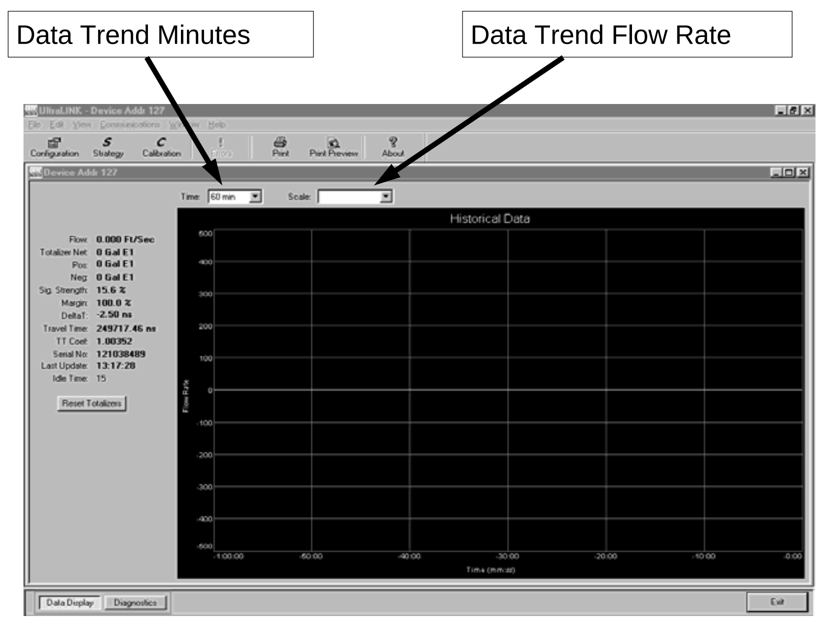


Figure 4.1
***UltraLink*™ Data Screen**

Configuration

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

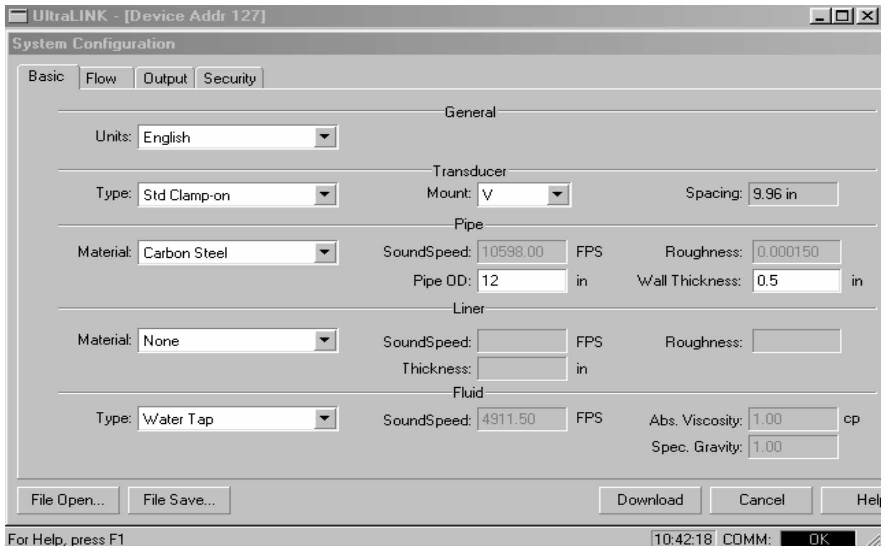


Figure 4.2
Basic Tab

BASIC TAB - see **Figure 4.2**

- **General Units** allows selection of either English (U.S.) or Metric units of measure. If measurements of the pipe are to be entered in inches, select English. If measurements are to be entered in millimeters, select Metric. If the General Units are altered from those at instrument startup, then click on the Download button on the lower right-hand portion of the screen and re-cycle power to the HTTP.
- **Transducer Type** selects the transducer that will be connected to the HTT flow meter. Select from HTTN, HTTH, or HTTS models. This selection will influence transducer spacing and flow meter performance. If you are unsure about the type of transducer to which the HTT will be connected, consult the shipment packing list or call the Hedland factory for assistance. A change of Transducer Type will cause a System Configuration Error (Error 1002) 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 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.
- **Transducer Spacing** is a value calculated by the HTT flow meter 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 mm for Metric. This value is the lineal distance that must be between the center lines on the transducer heads.
- **Pipe Material** is selected from the pull-down list. If the pipe material utilized is not located on the list, select Other and enter pipe material sound speed (much of this information is available via web sites such as www.ultrasonic.com) and relative roughness (rms internal surface regularities/the pipe internal diameter) of the pipe.
- **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.
- **Liner Material** is selected from the pull-down list. If the pipe liner material utilized is not located on the list, select Other and enter liner material sound speed (much of this information is available at web sites such as www.ultrasonic.com) and relative roughness (rms internal surface regularities/the pipe internal diameter) of the pipe liner.
- **Fluid Type** is selected from a pull-down list. If the liquid is not located on the list, select Other and enter the liquid sound speed and viscosity into the appropriate boxes. Liquid Specific Gravity is required if mass measurements are to be made.

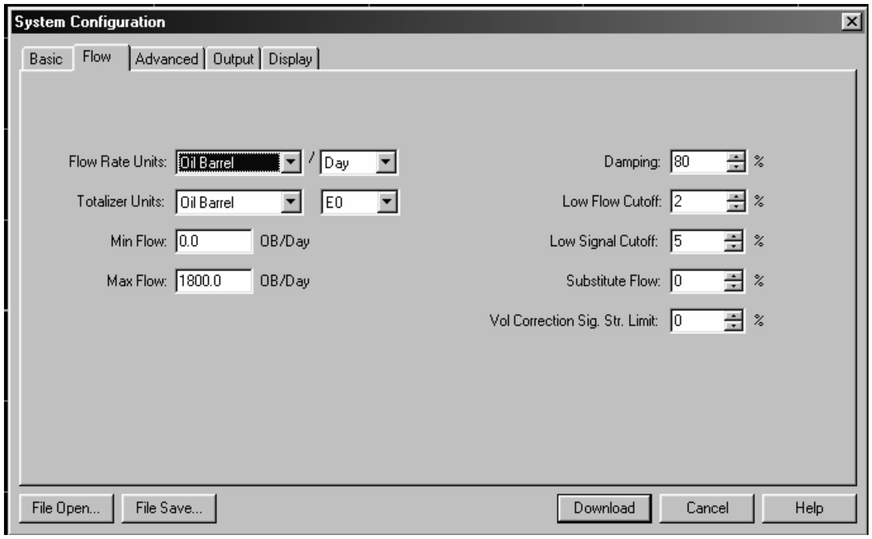


Figure 4.3
Flow Tab

Flow Units Configuration

FLOW Tab - see **Figure 4.3**

- **Flow Rate Units** are selected from the pull down lists. Select an appropriate rate unit and time from the two lists.
- **Totalizer Units** are selected from pull down lists. Select an appropriate totalizer unit and totalizer exponent. The totalizer exponents are in Scientific Notation and permit the eight digit totalizer to accumulate large values before the totalizer "rolls over" and starts again at zero. **Table 4.1** illustrates the Scientific Notation values and their respective decimal equivalents.

TABLE 4.1 - Totalizer Exponent Values

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

- **MIN Flow** is used by the HTT to establish filter settings in its operating system. Enter a flow rate that is the minimum flow rate anticipated within the system. For uni-directional systems, this value is typically zero. For bi-directional systems this value is set to a negative number that is equal to the maximum negative flow rate that is anticipated within the system.
- **MAX Flow** is used by the HTT to establish filter settings in its operating system. Enter a flow rate that is the maximum, positive flow rate anticipated within the system.
- The **Damping** value is increased to increase stability of the flow rate readings. Damping values are decreased to allow the flow meter to react faster to changing flow rates.
- **Low Flow Cutoff** is entered as a percentage between MAX and MIN Flow. It influences how the meter will act at flows close to zero. Typically, an entry of 1% provides a stable zero indication, while providing a 100:1 turndown ratio for measurements.
- **Low Signal Cutoff** is a relative value that should be entered after a successful startup. For an initial value, enter 5% (Signal Strength indications below 3% are considered to be below the noise ceiling and should not be indicative of a successful flow meter startup.) The entry has three purposes. It provides an error indication—Low Signal Strength (Error 0010 on display) when liquid conditions within the pipe have changed to the point where flow measurements may not be possible. It warns if the pipe's liquid level has fallen below the level of the transducers. It can signal that something with the flow meter installation or configuration may have changed. For example, the couplant used to mount the transducer has become compromised, a cable has been disconnected or a pipe size has been altered.
- **Substitute Flow** is used to provide an indication and output that signifies that an error exists with the flow meter or its setup. It is set as a percentage between MIN Flow and MAX Flow. In a uni-directional system, this value is typically set to zero to indicate zero flow while in an error condition. In a bi-directional system, the percentage can be set such that zero is displayed in a error condition. To calculate where to set the Substitute Flow value in a bi-directional system, perform the following operation:

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

Downloading the Configuration

- 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 HTT instrument.

Meter Filter Configuration

The Advanced TAB (see **Figure 4.4**) contains several filter settings for the HTT flow meter. These filters can be adjusted to match response times and data "smoothing" performance to a particular application. The factory settings are suitable for most installations.

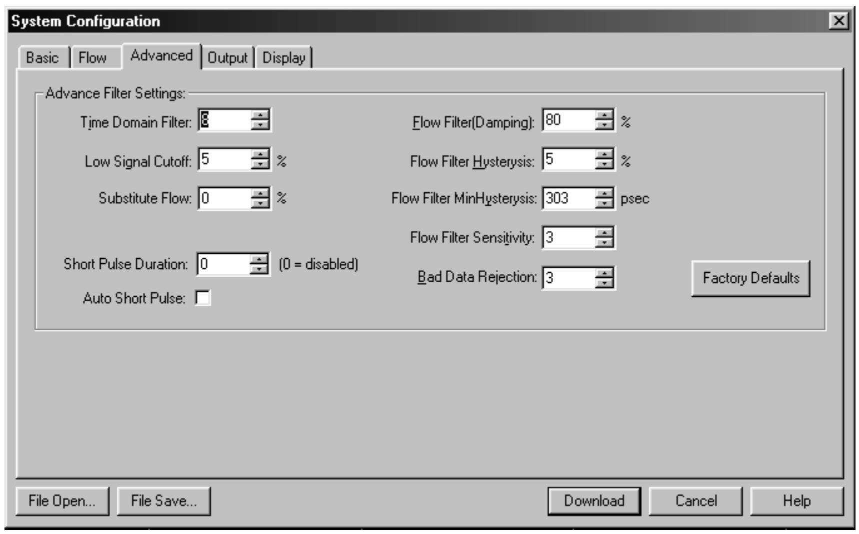


Figure 4.4
Advanced Tab

- **Time Domain Filter** adjusts the number of raw data sets (the wave forms viewed on the *UltraLink*™ Diagnostics Screen) that are averaged together. Increasing this value will provide greater damping of the data and slow the response time of the flow meter. This filter is not adaptive—it is operational to the value set at all times.
- **Low Signal Cutoff** is a duplicate entry from Page 4.6. Adjusting this value adjusts the value on the Flow TAB.
- **Substitute Flow** is a duplicate entry from Page 4.6. Adjusting this value adjusts the value on the Flow TAB.

- **Short Pulse Duration** is a function used on pipes larger than 2 inches (50 mm). If the pipe has an outer diameter of 8 inches or more, make sure that the Auto Short Pulse box is checked. Set this value to zero to disable the function.
- **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 Flow Filter adapts by decreasing and allows the meter to react faster. Increasing this value tends to provide smoother steady-state flow readings and outputs.
- **Flow Filter Hysteresis** creates a window around the average flow measurement reading whereby if the flow varies within that window, greater **Flow Filter Damping** will occur. The filter also establishes a flow rate window where measurements outside of the window are captured by the **Bad Data Rejection Filter**. The value is entered as a percentage of actual flow rate.

  Example:

  If the average flow rate is 100 GPM and the Flow Filter Hysteresis is set to 5%, a filter window of 95-105 GPM is established. Successive flow measurements that are measured within that window are recorded and averaged in accordance with the **Flow Filter Damping** setting. Flow readings outside of the window are held up in accordance with the **Bad Data Rejection Filter**.
- **Flow Filter MinHysteresis** sets a minimum hysteresis window that is invoked at sub 0.25 FPS (0.08 MPS) flow rates, where the “of rate” **Flow Filter Hysteresis** is very small and ineffective. This entry is entered in pico-seconds and is differential time. 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** and **Flow Filter MinHysteresis** windows before the flow meter will use that flow value. Larger values are entered into the Bad Data Rejection when measuring liquids that contain gas bubbles, as the gas bubbles tend to disturb the ultrasonic signals and cause more extraneous flow readings to occur. Larger Bad Data Rejection values tend to make the flow meter more sluggish to rapid changes in actual flow rate.

Output Configuration

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

The entries made in the Output TAB (See **Figure 4.5**) establish input and output calibration and ranges for ISO-MOD modules installed in the HTTP flow meter. If a module was ordered from and installed at the Hedland factory, then the Output TAB will contain information and configuration for that module. Select the appropriate module from the pull-down menu and press the Download button. If a module has been changed from the factory setting, a Configuration error will result. This error will be cleared by resetting the HTTP microprocessor from the Communications/

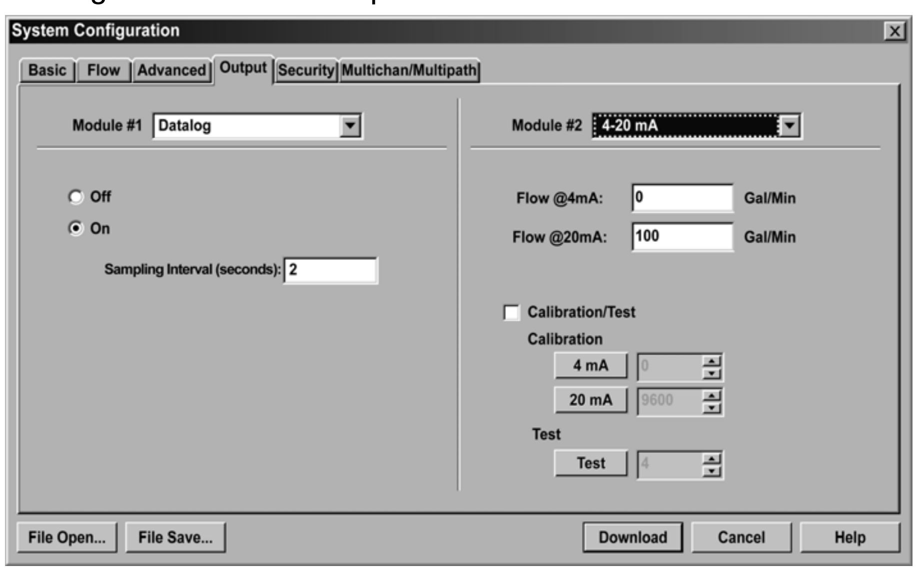


Figure 4.5
4-20mA Configuration

Commands/Reset Target button or by cycling power on the HTT flow meter. Once the proper output modules are selected and the microprocessor is reset, calibration and configuration of the modules can be completed. If a module slot is empty in the HTT enclosure, select NONE as the module type.

To configure the 4-20 mA output or data logger, click on the **Output** tab (See **Figure 4.5**). The output menu allows selection, configuration, calibration and testing of various input/output modules. Standard HTTP flow meters contain a single 4-20 mA output module located in Module #2 position and a data logger located in the Module #1 position. The window will appear as shown in **Figure 4.5**. (The 4-20 mA module is mounted internally in the flow meter and requires meter disassembly in order to replace the module. The data logger is located under the sealed front plate on the meter face. The logger is designed for repeated installation and removal.) Detailed information regarding all of the modules available and configuration options are available in section 3 of this manual. To disable the data logger, select None for Module #1, and select any other module for Module #2.

4-20 mA Module Configuration

If the 4-20 mA output has been installed, the screen shown in **Figure 4.5** will appear in *UltraLink*™ at the OUTPUT tab:

- **Flow @4mA** and **Flow @20mA** set the span of the 4-20 mA output. The entry is made in the same flow measurement units that were entered in the Flow Tab. The output can be set to span across zero (4 mA can be set to a negative flow value) so that the module will output bi-directional flow. For example, if a flow range spans from –100 to +100, the HTT will output 4 mA at –100 and 20 mA at +100 and output 12 mA (50% of the output) at 0.
- **Calibration/Test** is used to adjust the factory calibration span of the 4-20 mA output and to test the output. The 4-20 mA output is factory calibrated and should not require adjustment in the field. If the module is replaced or if recalibration is required, the following procedure is used to calibrate the span of the module:
    1. Connect a milliamp meter serially within the 4-20 mA module output.
    2. Check the Calibration/Test box.

3. Select the 4 mA Calibration box.
4. Adjust the count value to the right of the 4 mA button until the milliamp meter registers 4.00 mA.
5. Select the 20 mA Calibration box.
6. Adjust the count value to the right of the 20 mA button until the milliamp meter registers 20.00 mA.
7. Press the Test button.
8. Adjust the count value to 12.
9. Verify that the milliamp meter registers 12.00 mA.
10. Uncheck the Calibration/Test box.

Flow Meter Calibration

Setting Zero and Calibration

UltraLink™ contains a powerful multi-point calibration routine that can be used to calibrate the HTT 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 ***UltraLink*™ Data Screen**. The display shown in **Figure 4.6** will appear. The first step (Page 1 of 3) in the calibration process is the selection of the engineering units with which the calibration will be performed. Select the units and click the **Next** button at the bottom of the window.

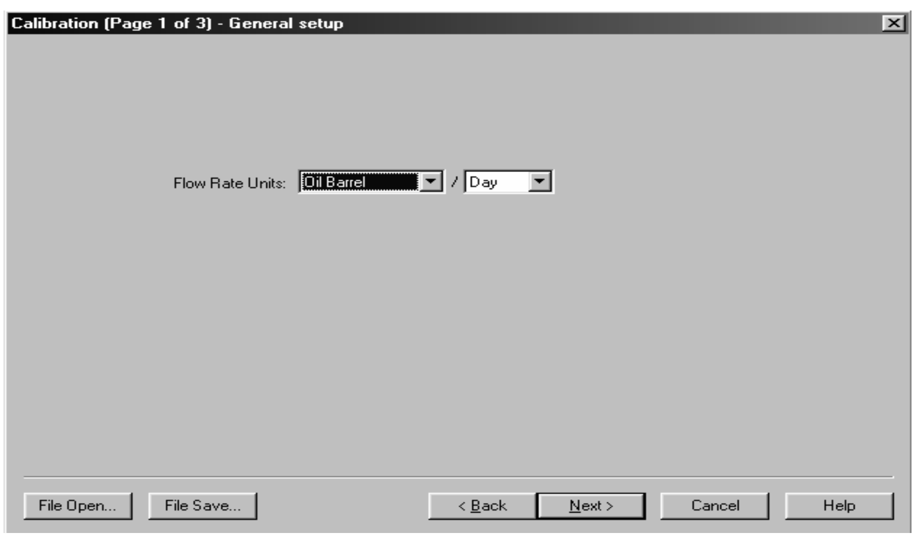


Figure 4.6
Calibration Units

The second screen (Page 2 of 3) **Figure 4.7**, establishes a baseline zero flow rate measurement for the instrument. To zero the flow meter, establish zero flow in the pipe (turn off all pumps and close a dead-heading valve). Wait until the delta-time interval shown in **Figure 4.7** is stable (and typically very close to zero). Click the **Set** button. Click the **Next** button when prompted, then click the **Finish** button on the Calibration Screen.

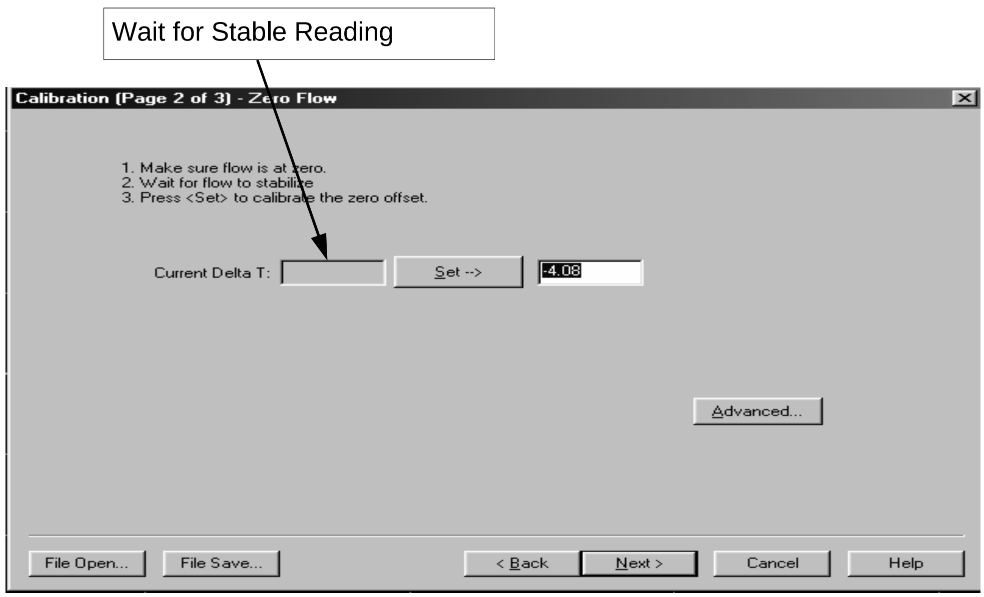


Figure 4.7
Setting Zero Flow

Important!

NOTE: *If the* ***Set*** *button was clicked, do not proceed with Flow Rate Calibration before clicking the* ***Finish*** *button to save the Zero setting.*

The screen shown in **Figure 4.8** (Page 3 of 3) allows multiple actual flow rates to be recorded by the HTT. To calibrate a point, establish a stable, known flow rate (verified by a real-time primary flow instrument), enter the actual flow rate in the **Figure 4.8** window and click the **Set** button. 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.

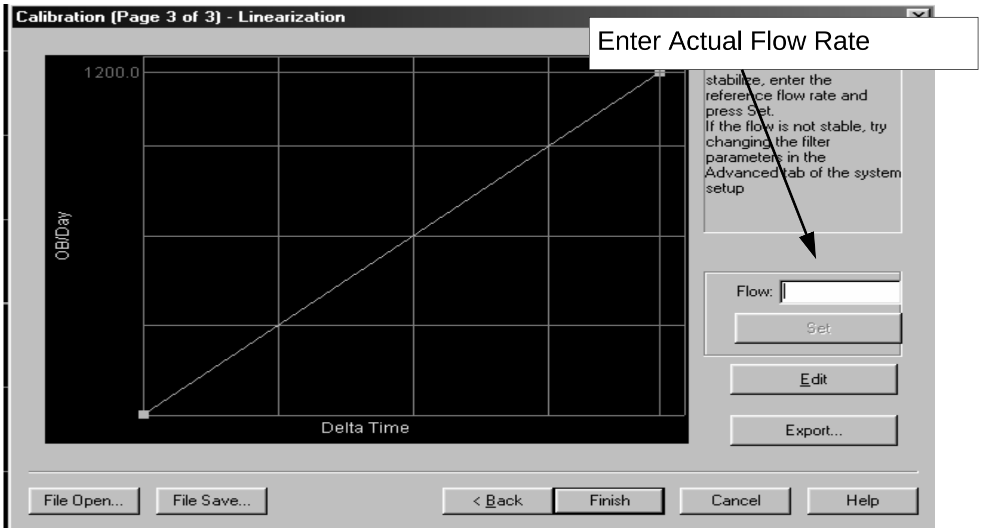


Figure 4.8
Flow Rate Calibration

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

Important!

NOTE: *Do not enter a zero flow rate under page 3 of 3 above.*
NOTE: *Hedland recommends only using one span point to achieve highest results.*

Saving the Configuration

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 Report

Printing Out a Flow Meter Configuration and Calibration Report

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

Using the Data Logger Software

During the installation of *UltraLink*™, a file called **Data Logger** was installed and its icon will appear on the Desktop of the computer. Double-click on the icon to start the utility. The screen shown in **Figure 4.9** will appear as the computer is attempting to establish communications with the logger module.

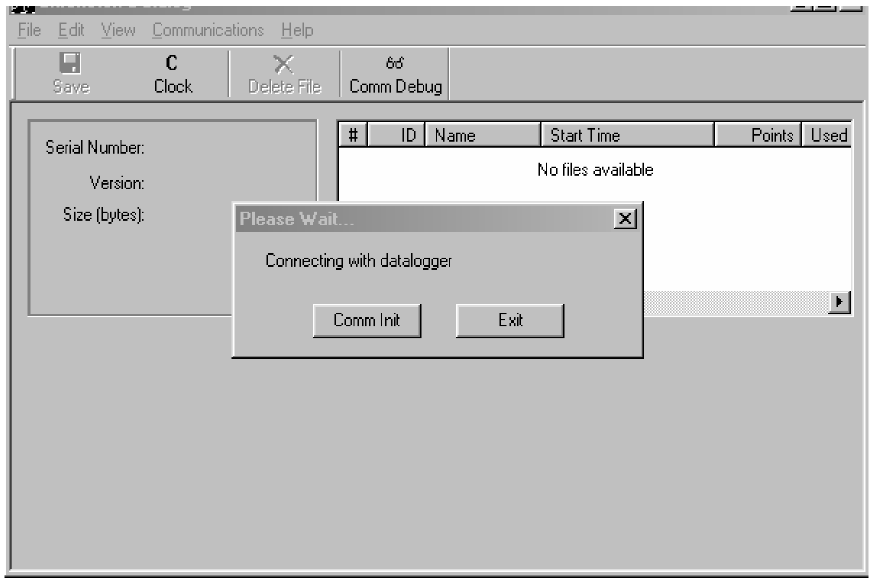


Figure 4.9

Connect the logger to the computer's serial communications port with the enclosed DB9 cable. After a few moments, the Please Wait window will disappear and a green OK will appear in the lower right-hand corner of the window. After communications are established (and the OK is displayed) the utility will scan the logger for all existing files. If the logger module is very full, uploading of the file data may take several minutes. A bar graph showing upload progress will provide status. The files will appear on the table (see **Figure 4.10**). Information regarding starting time, date and points collected will appear.

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

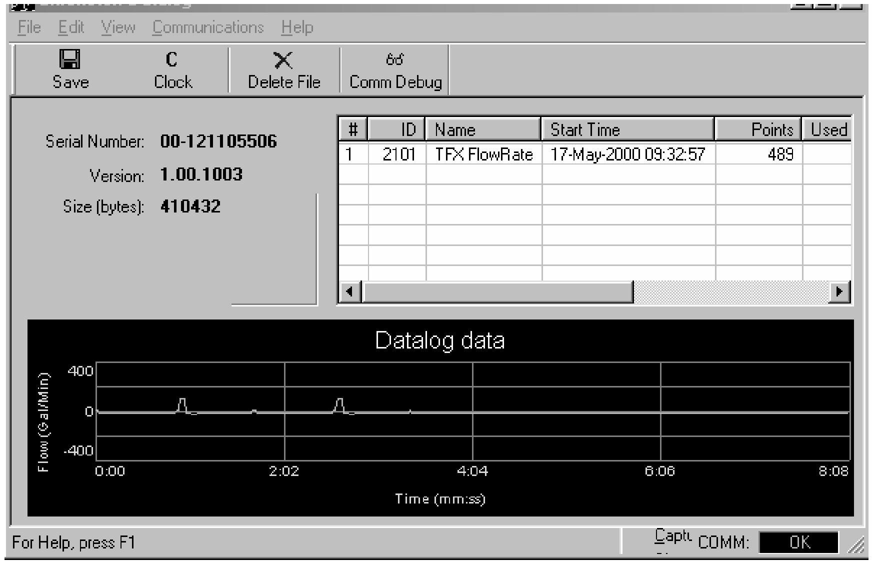


Figure 4.10

To save the file to a computer, select the file from the file table and click the Save button located on the top task bar (see **Figure 4.11**). Data Logger saves the files in .csv (comma separated value) format. For data manipulation or graphical purposes, these files can be opened using a spreadsheet application such as the Microsoft® Excel® program or the Corel® Quattro Pro® program.

Note: The spreadsheet programs listed above are limited to the number of lines of data that can be imported. Large files may need to open in Microsoft® WordPad and saved in two or more sections.

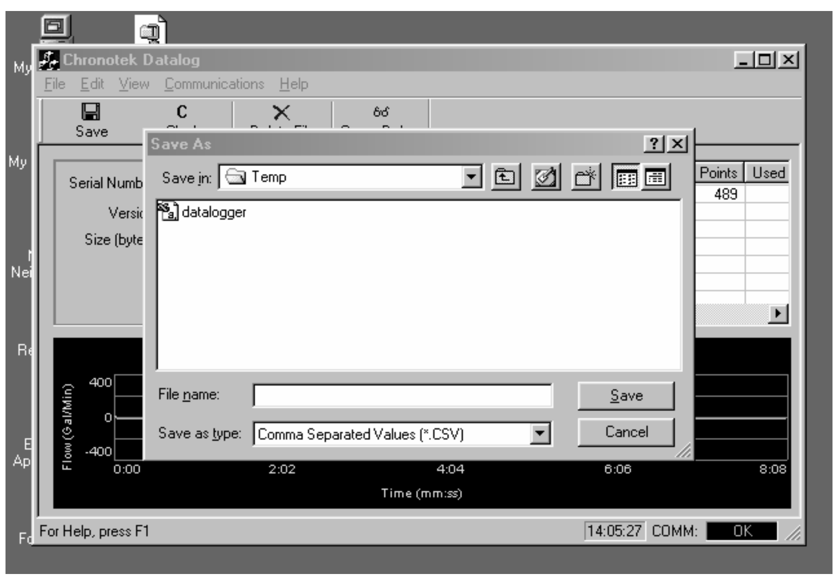


Figure 4.11

The data logger module contains a real-time clock that can be set by clicking the Clock button on the top task bar (see **Figure 4.12**). Activating the window compares the data logger clock to the clock located in the PC. Adjustments can be made and uploaded to the logger.

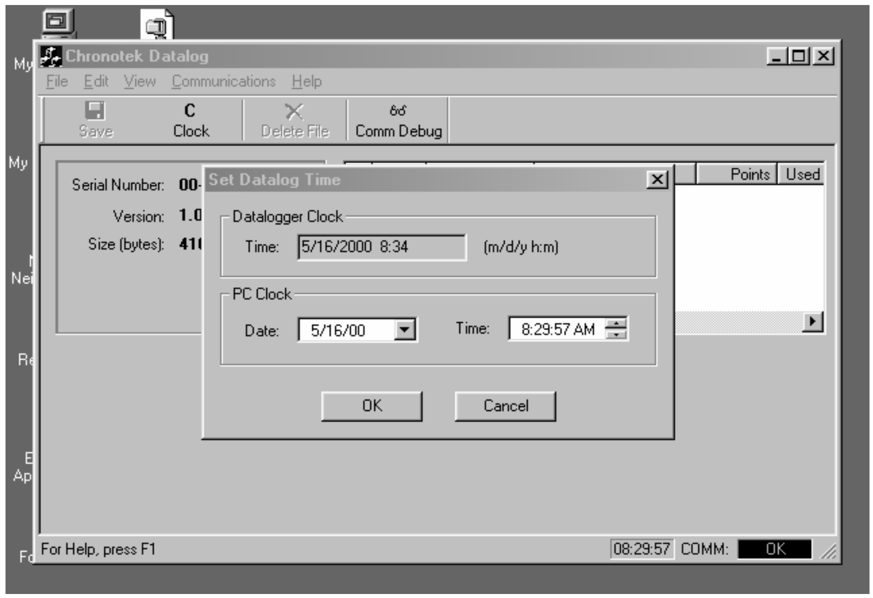


Figure 4.12

A P P E N D I X

HEDLAND®

HTT USER INTERFACE MAP

BSC MENU

- **UNITS**
  - *ENGLSH*
  - *METRIC*
- **XDCR MNT**
  - *V*
  - *W*
  - *Z*
- **PIPE OD**
  - *ENGLSH (INCHES)*
  - *METRIC (MM)*
- **PIPE WT**
  - *ENGLSH (INCHES)*
  - *METRIC (MM)*
- **PIPE MAT***
  - *CARBON S*
  - *STAINLES*
  - *CAST IRO*
  - *DUCTILE*
  - *COPPER*
  - *PVC*
  - *PVDF LOW*
  - *PVDF HI*
  - *ALUMINUM*
  - *ASBESTOS*
  - *FIBERGLASS*
  - *OTHER*
- **PIPE SS**
  - *ENGLSH (FPS)*
  - *METRIC (MPS)*
- **PIPE R**
  - (RELATIVE ROUGHNESS)
- **LINER T**
  - *ENGLSH (INCHES)*
  - *METRIC (MM)*
- **LINER TYPE***
  - *TAR EPOXY*
  - *RUBBER*
  - *MORTAR*
  - *POLYPROPYLENE*
  - *POLYSTYROL*
  - *POLYSTYRENE*
  - *POLYESTER*
  - *TEFLON*
  - *OTHER*
- **LINER SS**
  - *ENGLSH (FPS)*
  - *METRIC (MPS)*
- **FL TYPE***
  - TAP WATER
  - SEWAGE
  - KEROSENE
  - GASOLINE
  - FUEL OIL
  - CRUDE OI
  - PROPANE
  - BUTANE
  - OTHER
- **FLUID SS**
  - *ENGLSH (FPS)*
  - *METRIC (MPS)*
- **FLUID VI**
  - *CPS*
- **SP GRVTY**
  - *UNITLESS*
- **XDC SPAC**
  - *ENGLSH (INCHES)*
  - *METRIC (MM)*
- **RATE UNT**
  - *GALLONS*
  - *LITERS*
  - *MGAL*
  - *CUBIC FT*
  - *CUBIC ME*
  - *ACRE FT*
  - *OIL BARR*
  - *LIQ BARR*
  - *FEET*
  - *METERS*
- **RATE INT**
  - *MIN*
  - *HOUR*
  - *DAY*
  - *SEC*
- **TOTL UNT**
  - *GALLONS*
  - *LITERS*
  - *MGAL*
  - *CUBIC FT*
  - *CUBIC ME*
  - *ACRE FT*
  - *OIL BARR*
  - *LIQ BARR*
  - *FEET*
  - *METERS*
- **TOTL E**
  - *E-1 TO E6*
- **MIN RATE**
  - *RATE/INT*
- **MAX RATE**
  - *RATE/INT*
- **FL C-OFF**
  - *% of Full Scale*
- **DAMP PER**
  - *PERCENT*

DATALOG

- **DATALOG OPS**
  - ***DATALOG LOC***
    - *1-30,000*
  - ***DATALOG INT***
    - *1-30,000 sec.*
  - ***DATALOG DUR***
    - *1-30,000 hrs*
- **DATALOG MAINT**
  - ***DELETE FILES***
    - *1. All Files*
    - *2. First File*
    - *3. Last File*

OUT2 MEN

- **OUT2**
  - ***OPTIONS***
  - ***4-20MA***
    - *FL 4MA*
    - *FL 20MA*
    - *4-20 TST*
  - ***0-10KHz***
    - *FL 100H*
    - *FL 10KH*
  - ***RELAY***
    - *RELAY 1*
    - *RELAY 2*
  - ***RTD***
    - *CAL 1*
    - *CAL 2*
    - *A*
    - *B*
    - *C*
  - ***RS232***
    - *RS232 MO*
      - *HOST*
      - *UIF*
    - *RS232 BA*
      - *1200*
      - *2400*
      - *9600*
      - *19200*
  - ***RS485***
    - *RS485 MO*
      - *SLAVE*
      - *MASTER*
    - *RS485 BA*
      - *1200*
      - *2400*
      - *9600*
      - *19200*
    - *ADDRESS*
      - *1-127*
  - **NONE**

SEN MENU

- **NOT USED**

SEC MENU

- **TOT RES**
  - *NO*
  - *YES*
- **SYS RSET**
  - *NO*
  - *YES*
- **CH PSWD?**
  - *0-9999*

SER MENU

- **SSPD MPS**
- **SSPD FPS**
- **SIG STR**
- **SIG C-OFF**
- **SUB FLOW**
- **SET ZERO**

DSP MENU

- **DISPLAY LINES**
  - 1. 2 Lines
  - *2. 4 Lines*
- **BACK LIGHT TIME**
  - 0-30,000 *sec*
  - *(enter 0 for continuous backlight)*

Keypad Operations

1. The (soft)MENU key is pressed from RUN mode to enter PROGRAM mode. The (soft)EXIT key is pressed in PROGRAM mode to exit configuration parameters and menus. If changes to any configuration parameters have been made, the user will be prompted with a SAVE? (soft)YES or (soft) NO when returning to RUN mode. If no changes have been made, the user will not be prompted to SAVE. The UP/DOWN ARROW keys are used to scroll through menus and configuration parameters. The ARROW keys can also be used to adjust parameter numerical values. In RUN mode the UP/ DOWN ARROW keys are used to adjust the display contrast level.
2. The Numerical Keypad is used to entering numerical values.
3. The (soft)ACCEPT key is used to accept configuration parameter changes.
4. The (soft)SELECT key is used to
   - configure the engineering units on the graphics display—Press the (soft)SELECT key from RUN mode to highlight the engineering unit presently being displayed on the graphics display (pressing the SELECT key multiple times will toggle the highlighted unit from line to line). Use the UP/DOWN ARROW keys to select display units of
     - RATE
     - TOTALizer
     - VELocity
     - SIGNAL STRength

     From the Display Menu, the number of graphics display lines can be toggled between two and four lines.
   - access the configuration parameters in the various menus.
   - initiate changes in configuration parameters.

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

Date: 6/9/2000
Revision: none Revision Date: none
Software Version: 1.00.9512

HTT Error Codes

Revised 2-22-2002

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

Fluid Properties

Original Date: 7/30/1999
Revision: A
Revision Date: 9/10/2003
File: I:/dynasonics/dyna_code/tables/fluid_ss.xls

Fluid	Specific Gravity 20 degrees C	Sound Speed m/s	Sound Speed ft/s	delta-v/degree C m/s/degree C	Kinematic Viscosity Centistokes	Absolute Viscosity Centipoise
Acetate, Butyl		1270	4163.9			
Acetate, Ethyl	0.901	1085	3559.7	4.4	0.489	0.441
Acetate, Methyl	0.934	1211	3973.1		0.407	0.380
Acetate, Propyl		1280	4196.7			
Acetone	0.79	1174	3851.7	4.5	0.399	0.316
Alcohol	0.79	1207	3960.0	4.0	1.396	1.101
Alcohol, Butyl	0.83	1270	4163.9	3.3	3.239	2.688
Alcohol, Ethyl	0.83	1180	3868.9	4	1.396	1.159
Alcohol, Methyl	0.791	1120	3672.1	2.92	0.695	0.550
Alcohol, Propyl		1170	3836.1			
Alcohol, Propyl	0.78	1222	4009.2		2.549	1.988
Ammonia	0.77	1729	5672.6	6.7	0.292	0.225
Anlline	1.02	1639	5377.3	4.0	3.630	3.710
Benzene	0.88	1306	4284.8	4.7	0.711	0.625
Benzol, Ethyl	0.867	1338	4389.8		0.797	0.691
Bromine	2.93	889	2916.7	3.0	0.323	0.946
n-Butane	0.60	1085	3559.7	5.8		
Butyrate, Ethyl		1170	3836.1			
Carbon dioxide	1.10	839	2752.6	7.7	0.137	0.151
Carbon tetrachloride	1.60	926	3038.1	2.5	0.607	0.968
Chloro-benezene	1.11	1273	4176.5	3.6	0.722	0.799
Chloroform	1.49	979	3211.9	3.4	0.550	0.819
Diethyl ether	0.71	985	3231.6	4.9	0.311	0.222
Diethyl Ketone		1310	4295.1			
Diethylene glycol	1.12	1586	5203.4	2.4		
Ethanol	0.79	1207	3960.0	4.0	1.390	1.097
Ethyl alcohol	0.79	1207	3960.0	4.0	1.396	1.101
Ether	0.71	985	3231.6	4.9	0.311	0.222
Ethyl ether	0.71	985	3231.6	4.9	0.311	0.222
Ethylene glycol	1.11	1658	5439.6	2.1	17.208	19.153
Freon R12		774.2	2540			
Gasoline	0.7	1250	4098.4			
Glycerin	1.26	1904	6246.7	2.2	757.100	953.946
Glycol	1.11	1658	5439.6	2.1		
Isobutanol	0.81	1212	3976.4			
Iso-Butane		1219.8	4002			
Isopentane	0.62	980	3215.2	4.8	0.340	0.211
Isopropanol	0.79	1170	3838.6		2.718	2.134
Isopropyl alcohol	0.79	1170	3838.6		2.718	2.134
Kerosene	0.81	1324	4343.8	3.6		
Linalool		1400	4590.2			
Linseed Oil	.925-.939	1770	5803.3			
Methanol	0.79	1076	3530.2	2.92	0.695	0.550
Methyl alcohol	0.79	1076	3530.2	2.92	0.695	0.550
Methylene chloride	1.33	1070	3510.5	3.94	0.310	0.411
Methylethyl Ketone		1210	3967.2			
Motor Oil (SAE 20/30)	.88-.935	1487	4875.4			
Octane	0.70	1172	3845.1	4.14	0.730	0.513

Oil, Castor	0.97	1477	4845.8	3.6	0.670	0.649
Oil, Diesel	0.80	1250	4101			
Oil (Lubricating X200)		1530	5019.9			
Oil (Olive)	0.91	1431	4694.9	2.75	100.000	91.200
Oil (Peanut)	0.94	1458	4783.5			
Paraffin Oil		1420	4655.7			
Pentane	0.626	1020	3346.5		0.363	0.227
Petroleum	0.876	1290	4229.5			
1-Propanol	0.78	1222	4009.2			
Refrigerant 11	1.49	828.3	2717.5	3.56		
Refrigerant 12	1.52	774.1	2539.7	4.24		
Refrigerant 14	1.75	875.24	2871.5	6.61		
Refrigerant 21	1.43	891	2923.2	3.97		
Refrigerant 22	1.49	893.9	2932.7	4.79		
Refrigerant 113	1.56	783.7	2571.2	3.44		
Refrigerant 114	1.46	665.3	2182.7	3.73		
Refrigerant 115		656.4	2153.5	4.42		
Refrigerant C318	1.62	574	1883.2	3.88		
Silicone (30 cp)	0.99	990	3248		30.000	29.790
Toluene	0.87	1328	4357	4.27	0.644	0.558
Transformer Oil		1390	4557.4			
Trichlorethylene		1050	3442.6			
1,1,1-Trichloro-ethane	1.33	985	3231.6		0.902	1.200
Turpentine	0.88	1255	4117.5		1.400	1.232
Water, distilled	0.996	1498	4914.7	-2.4	1.000	0.996
Water, heavy	1	1400	4593			
Water, sea	1.025	1531	5023	-2.4	1.000	1.025
Wood Alcohol	0.791	1076	3530.2	2.92	0.695	0.550
m-Xylene	0.868	1343	4406.2		0.749	0.650
o-Xylene	0.897	1331.5	4368.4	4.1	0.903	0.810
p-Xylene		1334	4376.8		0.662	

Digital Communications Protocol for HTT Flow Meters

Host protocol

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

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

<addr><command><data>…<data><crc-16>

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

The following special commands are defined:

Command	Description
65	Special “short” commands
66	Special “long” commands

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

Command 65:
<size><code><data$_1$>…<data$_{N-1}$>   N = <size>

Command 66:
<size_h><size_l><code><data$_1$>…<data$_{N-1}$>   N = <size_h>*256 + <size_l>

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

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

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

where:

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

The following error codes are defined:

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

Special codes

The following special 65 and 66 codes are supported.

Code	Description
00	Echo (for comm debugging)
0A	Read run time data (signal strength, flow rate and totalizers)
0B	Reset Totalizers

Code 00 – Echo

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

Code 0A – Read Flow data

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

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

Byte	Type	Description
0-1	2 byte integer	Signal Strength (0-1000)
2-9	8 byte floating point	Current flow rate in the units programmed
10-17	8 byte floating point	Net Totalizer in the units programmed
18-25	8 byte floating point	Positive Totalizer
26-33	8 byte floating point	Negative Totalizer

Code 0A Extension 1 - Read Extra Flow data

Command: <addr>65020A01<crc-16>
Reply: <addr>65220A01<data$_1$>…<data$_n$><crc-16>

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

Byte	Type	Description
0-1	2 byte integer	Signal Strength (0-1000)
2-9	8 byte floating point	Current flow rate in the units programmed
10-17	8 byte floating point	Net Totalizer in the units programmed
18-25	8 byte floating point	Positive Totalizer
26-33	8 byte floating point	Negative Totalizer
34-41	8 byte floating point	Temp 1 in deg C
42-49	8 byte floating point	Temp 2 in deg C

Code 0B – Reset Totalizers

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

C Source Code

Flow Data Definition

```
struct FLOWDATA
{
	short		sSignalStrength;
	double		dCurFlowRate;
	double		dNetTotalizer;
	double		dPositiveTotalizer;
	double		dNegativeTotalizer;
};
struct FLOWDATA_EX
{
	short		sSignalStrength;
	double		dCurFlowRate;
	double		dNetTotalizer;
	double		dPositiveTotalizer;
	double		dNegativeTotalizer;
	double		dTemp1;
	double		dTemp2;
};
```

CRC-16 Calculations

```
unsigned short crc_table[256] = {
   0x0000, 0xC0C1, 0xC181, 0x0140, 0xC301, 0x03C0, 0x0280, 0xC241,
   0xC601, 0x06C0, 0x0780, 0xC741, 0x0500, 0xC5C1, 0xC481, 0x0440,
   0xCC01, 0x0CC0, 0x0D80, 0xCD41, 0x0F00, 0xCFC1, 0xCE81, 0x0E40,
   0x0A00, 0xCAC1, 0xCB81, 0x0B40, 0xC901, 0x09C0, 0x0880, 0xC841,
   0xD801, 0x18C0, 0x1980, 0xD941, 0x1B00, 0xDBC1, 0xDA81, 0x1A40,
   0x1E00, 0xDEC1, 0xDF81, 0x1F40, 0xDD01, 0x1DC0, 0x1C80, 0xDC41,
   0x1400, 0xD4C1, 0xD581, 0x1540, 0xD701, 0x17C0, 0x1680, 0xD641,
   0xD201, 0x12C0, 0x1380, 0xD341, 0x1100, 0xD1C1, 0xD081, 0x1040,
   0xF001, 0x30C0, 0x3180, 0xF141, 0x3300, 0xF3C1, 0xF281, 0x3240,
   0x3600, 0xF6C1, 0xF781, 0x3740, 0xF501, 0x35C0, 0x3480, 0xF441,
   0x3C00, 0xFCC1, 0xFD81, 0x3D40, 0xFF01, 0x3FC0, 0x3E80, 0xFE41,
   0xFA01, 0x3AC0, 0x3B80, 0xFB41, 0x3900, 0xF9C1, 0xF881, 0x3840,
   0x2800, 0xE8C1, 0xE981, 0x2940, 0xEB01, 0x2BC0, 0x2A80, 0xEA41,
   0xEE01, 0x2EC0, 0x2F80, 0xEF41, 0x2D00, 0xEDC1, 0xEC81, 0x2C40,
   0xE401, 0x24C0, 0x2580, 0xE541, 0x2700, 0xE7C1, 0xE681, 0x2640,
   0x2200, 0xE2C1, 0xE381, 0x2340, 0xE101, 0x21C0, 0x2080, 0xE041,
   0xA001, 0x60C0, 0x6180, 0xA141, 0x6300, 0xA3C1, 0xA281, 0x6240,
   0x6600, 0xA6C1, 0xA781, 0x6740, 0xA501, 0x65C0, 0x6480, 0xA441,
   0x6C00, 0xACC1, 0xAD81, 0x6D40, 0xAF01, 0x6FC0, 0x6E80, 0xAE41,
   0xAA01, 0x6AC0, 0x6B80, 0xAB41, 0x6900, 0xA9C1, 0xA881, 0x6840,
   0x7800, 0xB8C1, 0xB981, 0x7940, 0xBB01, 0x7BC0, 0x7A80, 0xBA41,
   0xBE01, 0x7EC0, 0x7F80, 0xBF41, 0x7D00, 0xBDC1, 0xBC81, 0x7C40,
   0xB401, 0x74C0, 0x7580, 0xB541, 0x7700, 0xB7C1, 0xB681, 0x7640,
   0x7200, 0xB2C1, 0xB381, 0x7340, 0xB101, 0x71C0, 0x7080, 0xB041,
   0x5000, 0x90C1, 0x9181, 0x5140, 0x9301, 0x53C0, 0x5280, 0x9241,
   0x9601, 0x56C0, 0x5780, 0x9741, 0x5500, 0x95C1, 0x9481, 0x5440,
   0x9C01, 0x5CC0, 0x5D80, 0x9D41, 0x5F00, 0x9FC1, 0x9E81, 0x5E40,
   0x5A00, 0x9AC1, 0x9B81, 0x5B40, 0x9901, 0x59C0, 0x5880, 0x9841,
   0x8801, 0x48C0, 0x4980, 0x8941, 0x4B00, 0x8BC1, 0x8A81, 0x4A40,
   0x4E00, 0x8EC1, 0x8F81, 0x4F40, 0x8D01, 0x4DC0, 0x4C80, 0x8C41,
```

```
   0x4400, 0x84C1, 0x8581, 0x4540, 0x8701, 0x47C0, 0x4680, 0x8641,
   0x8201, 0x42C0, 0x4380, 0x8341, 0x4100, 0x81C1, 0x8081, 0x4040,
};

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

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

      return crc;
}
```

HEDLAND

Cast Iron Pipe

Standard Classes

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

HEDLAND

Ductile Iron Pipe

Standard Classes

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

March, 2000

HEDLAND

Steel, Stainless Steel, P.V.C.

Standard Schedules

Nominal Pipe Size Inches	OUTSIDE DIAMETER	SCH. 5		SCH. 10 (LTWALL)		SCH. 20		SCH. 30		STD.		SCH. 40		SCH. 60		X STG.		SCH. 80		SCH. 100		SCH. 120		SCH. 140		SCH. 180	
		ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall
1	1.315	1.185	0.065	1.097	0.109					1.049		1.049	0.133			0.957	0.179	0.957	0.179							0.815	0.250
1.25	1.660	1.530	0.065	1.442	0.109					1.380		1.380	0.140			1.278	0.191	1.278	0.191							1.160	0.250
1.5	1.900	1.770	0.065	1.682	0.109					1.610		1.610	0.145			1.500	0.200	1.500	0.200							1.338	0.281
2	2.375	2.245	0.065	2.157	0.109					2.067		2.067	0.154			1.939	0.218	1.939	0.218							1.687	0.344
2.5	2.875	2.709	0.083	2.635	0.120					2.469		2.469	0.203			2.323	0.276	2.323	0.276							2.125	0.375
3	3.500	3.334	0.083	3.260	0.120					3.068		3.068	0.216			2.900	0.300	2.900	0.300							2.624	0.438
3.5	4.000	3.834	0.083	3.760	0.120					3.548		3.548	0.226			3.364	0.318	3.364	0.318								
4	4.500	4.334	0.083	4.260	0.120					4.026	0.237	4.026	0.237			3.826	0.337	3.826	0.337			3.624	0.438	3.624	0.438	3.438	0.531
5	5.563	5.345	0.109	5.295	0.134					5.047	0.258	5.047	0.258			4.813	0.375	4.813	0.375			4.563	0.500	4.563	0.500	4.313	0.625
6	6.625	6.407	0.109	6.357	0.134					6.065	0.280	6.065	0.280			5.761	0.432	5.761	0.432			5.501	0.562	5.501	0.562	5.187	0.719
8	8.625	8.407	0.109	8.329	0.148	8.125	0.250	8.071	0.277	7.981	0.322	7.981	0.322	7.813	0.406	7.625	0.500	7.625	0.500	7.437	0.594	7.187	0.719	7.187	0.719	6.183	1.221
10	10.750	10.482	0.134	10.42	0.165	10.25	0.250	10.13	0.310	10.02	0.365	10.020	0.365	9.750	0.500	9.750	0.500	9.562	0.594	9.312	0.719	9.062	0.844	9.062	0.844	8.500	1.125
12	12.750	12.420	0.165	12.39	0.180	12.25	0.250	12.09	0.330	12.00	0.375	11.938	0.406	11.626	0.562	11.750	0.500	11.370	0.690	11.060	0.845	10.750	1.000	10.750	1.000	10.120	1.315
14	14.000			13.50	0.250	13.37	0.315	13.25	0.375	13.25	0.375	13.124	0.438	12.814	0.593	13.000	0.500	12.500	0.750	12.310	0.845	11.810	1.095	11.810	1.095	11.180	1.410
16	16.000			15.50	0.250	15.37	0.315	15.25	0.375	15.25	0.375	15.000	0.500	14.688	0.656	15.000	0.500	14.310	0.845	13.930	1.035	13.560	1.220	13.560	1.220	12.810	1.595
18	18.000			17.50	0.250	17.37	0.315	17.12	0.440	17.25	0.375	16.876	0.562	16.564	0.718	17.000	0.500	16.120	0.940	15.680	1.160	15.250	1.375	15.250	1.375	14.430	1.785
20	20.000			19.50	0.250	19.25	0.375	19.25	0.375	19.25	0.375	18.814	0.593	18.376	0.812	19.000	0.500	17.930	1.035	17.430	1.285	17.000	1.500	17.000	1.500	16.060	1.970
24	24.000			23.50	0.250	23.25	0.375	23.25	0.375	23.25	0.375	22.626	0.687	22.126	0.937	23.000	0.500	21.560	1.220	20.930	1.535	20.930	1.535	20.930	1.535	19.310	2.345
30	30.000			29.37	0.315	29.00	0.500	29.00	0.500	29.25	0.375	29.250	0.375			29.000	0.500										
36	36.000			35.37	0.315	35.00	0.500	35.00	0.500	35.25	0.375	35.250	0.375			35.000	0.500										
42	42.000									41.25	0.375	41.250	0.375			41.000	0.500										
48	48.000									47.25	0.375	47.250	0.375			47.000	0.500										

FPS TO GPM CROSS - REFERENCE (Schedule 40)

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

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

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

FPS X .3048 = MPS
GPM X .0007 = GPD
GPM X 3.7878 = LPM

HEDLAND

FPS TO GPM CROSS - REFERENCE (Schedule 40)

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

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

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

FPS X .3048 = MPS

GPM X .0007 = GPD

GPM X 3.7878 = LPM

RETURN OF EQUIPMENT/SALES INFORMATION

CONTACTS AND PROCEDURES

Customer Service/Application Engineer:

If you have a question regarding order status, placing an order, reviewing applications for future purchases, or wish to purchase a new flow meter, please contact us at:

HEDLAND
Division of Racine Federated, Inc.
8635 Washington Avenue
Racine, WI 53406-3738
PH: 800-433-5263 or 262-639-6770
FX: 800-245-3569 or 262-639-2267

Service/Repair Department:

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

HEDLAND
Division of Racine Federated, Inc.
8635 Washington Avenue
Racine, WI 53406-3738
PH: 800-433-5263 or 262-639-6770
FX: 800-245-3569 or 262-639-2267

Return Goods Authorization:

When returning equipment, it is necessary for you to contact our Service Department at 800-433-5263 or 262-639-6770 to obtain an RGA number for the authority and proper tracking of your material and its prompt inspection and return. All returns of equipment go to the following address:

HEDLAND
Division of Racine Federated, Inc.
8635 Washington Avenue
Racine, WI 53406-3738
RGA #0000

Hedland

Division of Racine Federated Inc.

Limited Warranty and Disclaimer

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

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

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

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

HEDLAND®

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