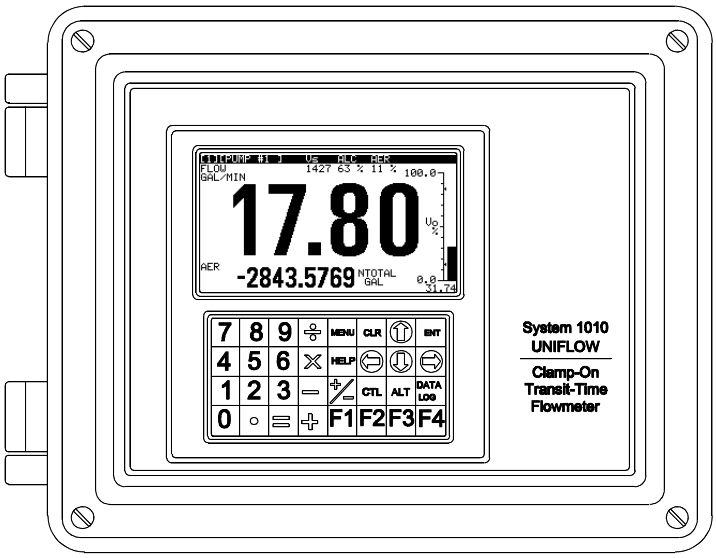
1010PVNFM-3A

CONTROLOTRON

FIELD MANUAL

SYSTEM 1010PVN/PVDN
NEMA CLAMP-ON
MULTI-FUNCTION FLOWMETER



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Made in the USA

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CONTROLOTRON CORPORATION (the Company) warrants to the original purchaser of this equipment that should this equipment or any part thereof (except the items indicated below), under normal use and conditions, be proven defective in material or workmanship within two (2) years from the date of original purchase, such defect(s) will be repaired or replaced (at the Company's option) without charge for standard parts and repair labor.

High temperature transducers and system batteries are not warranted.

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System 1010 material returned for Certification, Validation, Repair, or Replacement may result in the loss of memorized pipe site data in equipment computer memory. Controlotron can save and then restore this data for some NEMA type systems and all Portable systems, if requested at the time of equipment return. A fee may be imposed for this service.

This Warranty does not extend to costs incurred for removal or reinstallation of the equipment, or to damage to equipment, accessories or components caused by such removal or reinstallation.

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ERRATA

Digital Pgen Function and Wiring Procedure Update

NOTE: The following applies to System 1010DVN, 1010PVN, and 1010SN Liquid Flowmeter installation manuals.

Replace the PGEN menu cell description and set up procedure in the Data Span/Set/Cal menu Span Data option list including any related menu graphics and text throughout the manual with the following:

PGEN

The [PGEN P/*Unit Volume*] menu cell entry controls a digital output pulse function and is available in Custody Transfer units only (designated by a "C" in their part number). It allows the assigning of PGEN digital signal pulses per unit of volume. For example, 1000 output pulses per unit of liquid.

The default PGEN value is configured to provide a 5000 Hz output frequency at a flow velocity of 100 ft/sec (30 meters/sec).

NOTE: The unit of volume is determined by the Volume Units initially selected from the [Total Volume Units] menu cell option list.

1010DVCDN,1010PVCDN, 1010SCDN
(Expanded 1010N-7 I/O Module)
Installation Drawing 1010N-7-7 (Sheet 3 of 3)
(Ultra Performance Flowmeters)

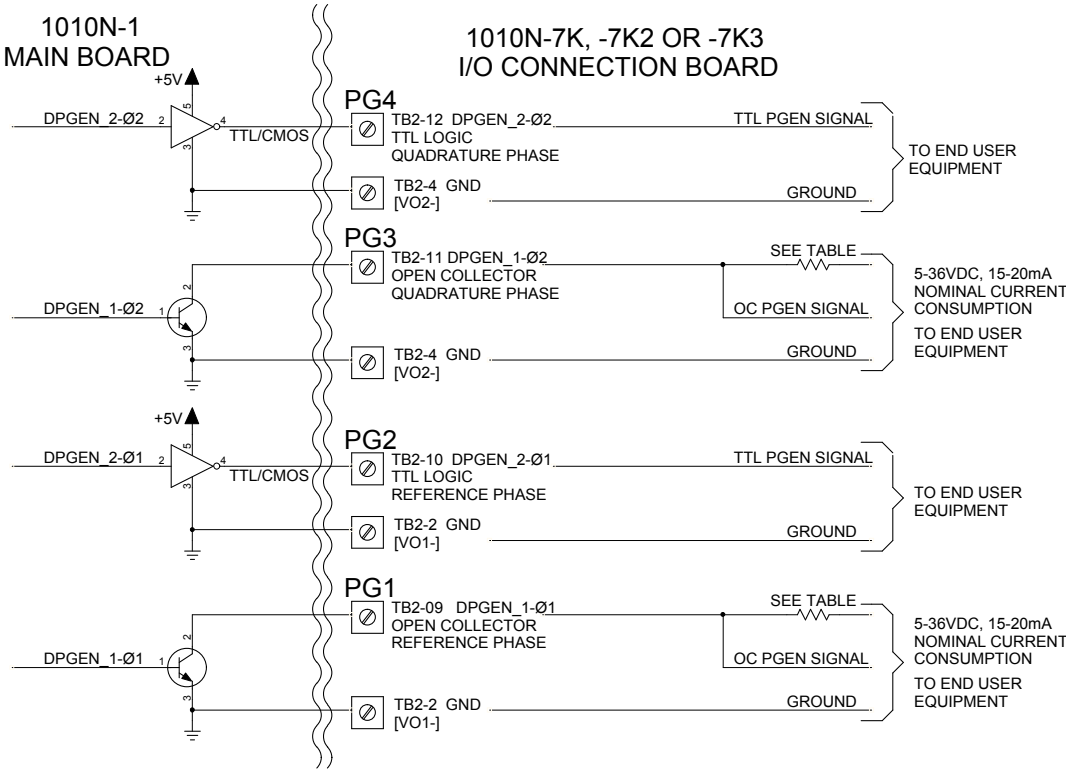
TB2

PIN#	SIGNAL	FUNCTION	NOTES
9	PG1	PRIMARY FREQUENCY OUTPUT / OPEN COLLECTOR	Digitally Synthesized Pulse Waveform
10	PG2	PRIMARY FREQUENCY OUTPUT / TTL	
11	PG3	QUADRATURE FREQUENCY OUTPUT / OPEN COLLECTOR	
12	PG4	QUADRATURE FREQUENCY OUTPUT / TTL	

(continued on next page)

PGEN Wiring Diagram

The unit must be wired as shown below before assigning PGEN output pulses.



NOTES

1. TB2-9 & TB2-11 are Open Collector Outputs that require external pull up resistors for operation. See table on next page for External Supply Voltage and suggested resistor value and ratings. Maximum current into the transistor is 100mA. Maximum Voltage is +36Vdc.

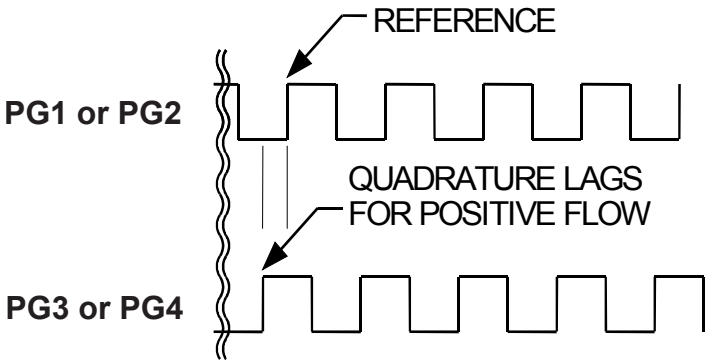
CAUTION: Negative voltages with respect ground will permanently damage the transistors.

2: TB2-10 & TB2-12 are TTL/CMOS compatible outputs. No pullup resistor is required. CAUTION: Application of any external voltage, even via a resistor, could permanently damage this circuit.

1010N-7K, -7K2 or 7K3 I/O MODULES WITH ULTRA PRECISION FLOWMETERS OPEN COLLECTOR USER RESISTOR RECOMMENDATIONS			
USER SUPPLY VOLTAGE [Vdc]	EXTERNAL R1 OR R2 [Ohms]	EXPECTED CURRENT DRAW [mA]	RECOMMENDED RESISTOR WATTAGE [WATTS]
5	270	18.5	1/2
9	510	17.6	1/2
12	680	17.6	1/2
18	1000	18	3/4
24	1500	16	1
28	1800	15.5	1-1/4
36	2400	15	1-1/4

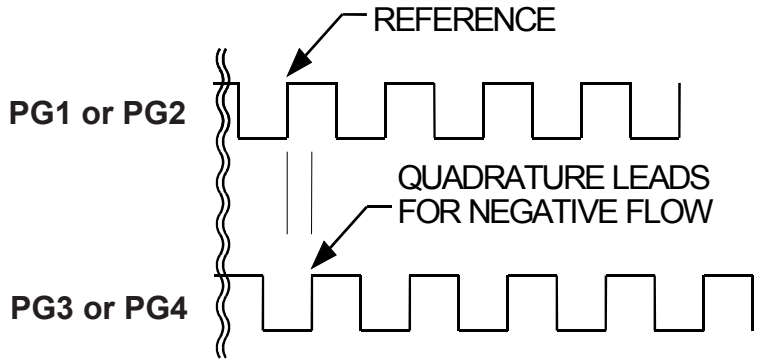
FOR POSITIVE FLOW

PG3 and PG4 LAGS PG1 and PG2 by 90º



FOR NEGATIVE FLOW

PG3 and PG4 LEADS PG1 and PG2 by 90º



To change the default PGEN settings:

From the [Span Data] menu press 

From the [PGEN P/*Unit Volume*] menu cell, press  to activate the numeric entry.

Use the numeric keys to enter the desired number of PGEN pulses per unit volume.

NOTE: Ensure that the number entered will provide sufficient resolution while remaining within the 20 Hz to 5000 Hz pulse frequency range. Note that the PGEN output will stop sending pulses at flow rates corresponding to frequencies less than 20 Hz. In this case the PGEN value must be increased.

To store the data press 

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FIELD MANUAL

SYSTEM 1010PVN/PVDN NEMA CLAMP-ON MULTI-FUNCTION FLOWMETER

This equipment contains components that are susceptible to electrostatic discharge (ESD). Please observe ESD control measures during the handling and connection process.

Field Manual 1010PVNFM-3A
August 2005

For use with Operating System
Software Version 3.01.04 or later

Prepared By _____ Date 8/22/05

Engineering _____ Date 8/22/05

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Made in the USA

Printed August 2005

Manual Changes

NOTE: For the latest updates and revisions to this field manual go to *www.controlotron.com/downloads.htm* and check the Product Manual listing.

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MANUAL ADDENDUM

SETUP PROCEDURE FOR WET-FLOW CALIBRATED 1010 SYSTEMS

System 1010 Uniflow Portable & NEMA Flowmeter Systems

Manual Addendum

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SETUP PROCEDURE FOR "WET-FLOW CALIBRATED" 1010 SYSTEM

Caution: DO NOT use the field manual installation procedure to startup a wet-flow calibrated system. Doing so could void the calibration by corrupting essential data. This addendum contains the only authorized instructions to be used when commissioning a wet-flow calibrated 1010 system.

1. INTRODUCTION

When the system 1010 is wet-flow calibrated, the flow computer stores the installation parameters in its storage memory. Each flow calibration is assigned a unique site name. Usually, the site name corresponds to the pipe size. For example, a 3-inch carbon steel, schedule 40 pipe would be given the name "3CS40."

The flow calibration report issued with each wet-flow calibration, includes a flow calibration "Diagnostic Data Sheet." This data sheet lists the site name and other necessary information (such as transducer serial number and spacing information), for setting-up the flowmeter. A wet-flow calibration applies to a specific flowmeter and set of transducers; identified by serial numbers on the diagnostic data sheet.

NOTE: In order for the flow calibration to be valid, the flow computer and transducers being used must have the same serial numbers as those listed for the site on the Calibration Diagnostic Data Sheet.

2. SETUP PROCEDURE

2.1 Transducer Installation

2.1.1 Refer to the diagnostic data sheet to find the mounting mode (Direct or Reflect) used during the wet-flow calibration. Review the transducer installation guidelines in your 1010 field manual.

2.1.2 Refer to the diagnostic data sheet for the transducer spacing index utilized during the flow calibration. Using the mounting configuration employed during the flow calibration, install the transducers on the pipe at the above noted spacing positions in accordance with the instructions provided on the transducer installation drawings.

2.1.3 Attach the transducer cables noting that the cable marked "UP" attaches to the transducer closest to the source of flow.

NOTE: Before proceeding further, ensure that the pipe is full of liquid. It is not important at this point that it be flowing.

2.2 Flowmeter Setup

NOTE: The following instructions require the use of the keypad and the menu. The installer should become familiar with their use before proceeding further.

2.2.1 Switch the flowmeter on. Press the <MENU> key.

2.2.2 On multi-channel flowmeters, use the arrow keys to select [Dual Channel Flow] or [Dual Beam Flow] depending on the mode utilized for the wet-flow calibration.

2.2.3 Use the arrow keys to select either [Clamp-on], [Flow Tube] or [Clamp-on Spool].

2.2.4 Select [Full Site Setup] and use the <Right Arrow> to select [Channel Setup]; then select [Recall Site Setup].

2.2.5 Use the <Down Arrow> to scroll to the site name indicated on the Calibration Diagnostic Data Sheet. Then press <ENT>.

2.2.6 The meter will perform a momentary "Makeup" routine that will take a few seconds and then begin operation.

2.2.7 Refer to your 1010 field manual for instructions on setting zero flow.

NOTE: Setting zero flow must be performed each time the transducers are installed. The zero adjustment has no effect on the wet-flow calibration data or the calibration (Kc) factor.

2.2.8 Using the arrow keys, scroll to the Data Span/Set/Cal menu location. Verify that the [Kc] (calibration) factor matches the value indicated on the diagnostic data sheet.

2.2.9 If you are measuring a liquid other than ambient water, select the [Liquid Class] menu cell and <Down Arrow> from there to [Viscosity]. Enter the correct viscosity for the liquid you will be monitoring.

2.2.10 Setup is now complete. Press the <MENU> key twice to view the flow rate display. DO NOT utilize the [Save Site] command when it appears.

2.2.11 When measurements are completed, simply turn off the meter. DO NOT save the site. This might contaminate the wet-flow calibration data already stored.

NOTE: Contact Controlotron's Technical Services Department if any flow calibration data is accidentally removed or overwritten.

3. TRANSFER INSTALL FUNCTION

All 1010 flowmeter operating systems (version 3.00.20 and greater) include the installation facility called "Transfer Install." This function permits the transducers to be repositioned while maintaining all calibration parameters and operation established during the water calibration. The Transfer Install function allows the transducers to be optimally positioned for a different fluid, without the need for a new Initial Makeup procedure.

NOTE: Prior to performing Transfer Install make sure that the water calibration procedure was performed and a saved active site exists.

3.1 Transfer Install Procedure

To initiate the Transfer Install function, proceed as follows:

3.1.1 In the Application Menu press the <Right Arrow> to select the [Liquid Class] menu cell. Scroll and highlight [Estimated Vs m/s] from the option list.

3.1.2 Use the numeric keys to change the Estimated Vs to the Estimated Vs value of the customer selected liquid.

3.1.3 To enter new Estimated Vs value press <ENT>.

3.1.4 Proceed to the Pick/Install Xdcr menu and select the same transducer, mounting mode and spacing offset that was selected for the water calibration.

3.1.5 Re-space the transducers to the index position indicated by the flowmeter.

3.1.6 Scroll to the [Install Completed?] menu cell and select [Transfer Install] from the option list.

NOTE: If [Transfer Install] does not appear in the option list then either the Estimated Vs or the transducer size was improperly entered. In this case, recall the water calibration site and start the procedure again at Step 3.1.1 above.

3.1.7 For MultiPath systems repeat Step 3.1.6 above for the remaining paths.

3.1.8 The flowmeter should now be operational at the new spacing location.

NOTE: Depending on the size of the pipeline, the change in the estimated sonic velocity (Vs) and the repositioning of transducers, the flowmeter may not operate out of Fault even if the spool or pipe is filled with liquid. This can be expected when performing a Transfer Install for liquified gases or for clamp-on natural gas flowmeters.

3.2 Saving New Transfer Install Site

3.2.1 To save the Transfer Installed site, scroll to the Channel Setup menu and press the <Right Arrow>. Press the <Right Arrow> again to select the [Save/Rename] menu cell.

3.2.2 Use the numeric keys to rename the Transfer Installed site with the same site name used in Step 3.1.2 above, but with a "T" appended to the end of the site name (e.g., 3CS40T).

3.2.3 Press <ENT> to store data.

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MANUAL ADDENDUM

SYSTEM 1010 EXPANDED I/O OPTION

(For Systems Equipped With 1010N-7 Modules)

Manual Addendum

EXPANDED I/O OPTION

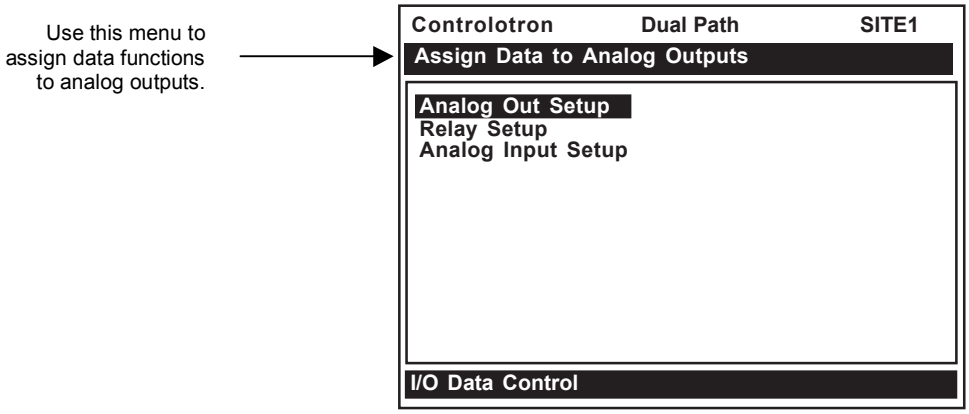
(For Systems Equipped With 1010N-7 Modules)

INTRODUCTION

The 1010N-2 I/O Module and 1010N-7 Expanded I/O Module both provide current (Io1, Io2), voltage (V01 and Vo2) and pulse rate (Pgen 1 and Pgen 2) analog outputs. The Expanded I/O Module Option allows users to drive as many as four additional 4-20 mA loop-powered instrumentation outputs. The following information is intended to be used with the I/O Data Control and Span Data sections and Analog Output Trim Menu in the field manual.

The System 1010 flowmeter provides an Analog Output Setup menu (see below) that allows the user to assign data functions for these output signals (refer to Analog Output Setup in the appropriate 1010 field manual). In addition, refer to Installation Drawings 1010N-2-7 and 1010N-7-7 in the field manual appendices for additional connection information and terminal block numerical designators.

NOTE: All meters in the System 1010N and DN product family can accept the Expanded I/O Module Option except 4- Channel meters.



EXPANDED I/O MODULE OPTION

The Expanded I/O Module Option provides expanded Io analog outputs. It is implemented through the use of a 1010N-7 Expanded I/O Module occupying the same position as the 1010N-2 I/O Module. This option allows users to drive up to four additional 4-20mA loop-powered instrumentation outputs. *Note that the meter menu does not indicate that these supplementary outputs are present and available.* The outputs, in addition to being loop-powered, are isolated from one another as well as the meter.

Expanded I/O Module Option Identification

To verify that your meter has the Expanded I/O Module Option installed check the following:

The designation **A1** should be part of the flowmeter part number.

For example: 1010ENRE-T1**A1**KGS

1010N-2 I/O Module

The conventional 1010N-2 I/O module provides the following:

- Two self-powered, isolated 4-20 mA current loops (signals Io1 and Io2) that are assignable and spannable by the user to many flowmeter variables such as flow, sonic velocity, signal strength, etc. These self-powered outputs also provide an industry-standard fault indication by dropping to 2 mA if assigned to flow rate and under fault conditions. *Note that these outputs, though isolated from the system, are NOT isolated from each other.*

- Two 0-10 Vdc outputs (signals Vo1 and Vo2) that are also assignable and spannable by the user as above. These are also self-powered, but are not isolated from the system.

- Two 0-5000 Hz Pgen signals (Pgen1 and Pgen2) also assignable and spannable by the user. These are TTL level pulses.

The 1010N/DN class of meters has a total of six analog outputs as indicated above. In addition (refer to Installation Drawings 1010N-2-7 and 1010N-7-7):

- Alarms/Status/Totalizer pulses are generally presented as relay closures as either Mercury Wetted Form 1A or Dry Reed Form C relays.

- Analog inputs, when provided, are in the form of 4-20 mA non-isolated inputs.

- The meter also has four non-isolated totalizer command lines providing Totalizer Clear and Totalizer Hold (NoTot) functionality.

1010N-7 Expanded I/O Module Option

The Expanded I/O Module Option provides all of the above plus the following outputs:

- The four signals that drive the pulse generator outputs (Pgen 1 and Pgen2) and voltage outputs (Vo1 and Vo2) of the meter create four current outputs: Aux Io1, Aux Io2, Aux Io3 and Aux Io4 (see diagram on next page).

- By spanning and assigning a system variable to 0-10 volt (Vo1 and Vo2) or 0-5000 Hz pulse output (Pgen1 and Pgen2) the module simultaneously outputs these signals to the Expanded I/O Module Option Aux outputs. For a 2-Channel meter the programming assignments are as follows:

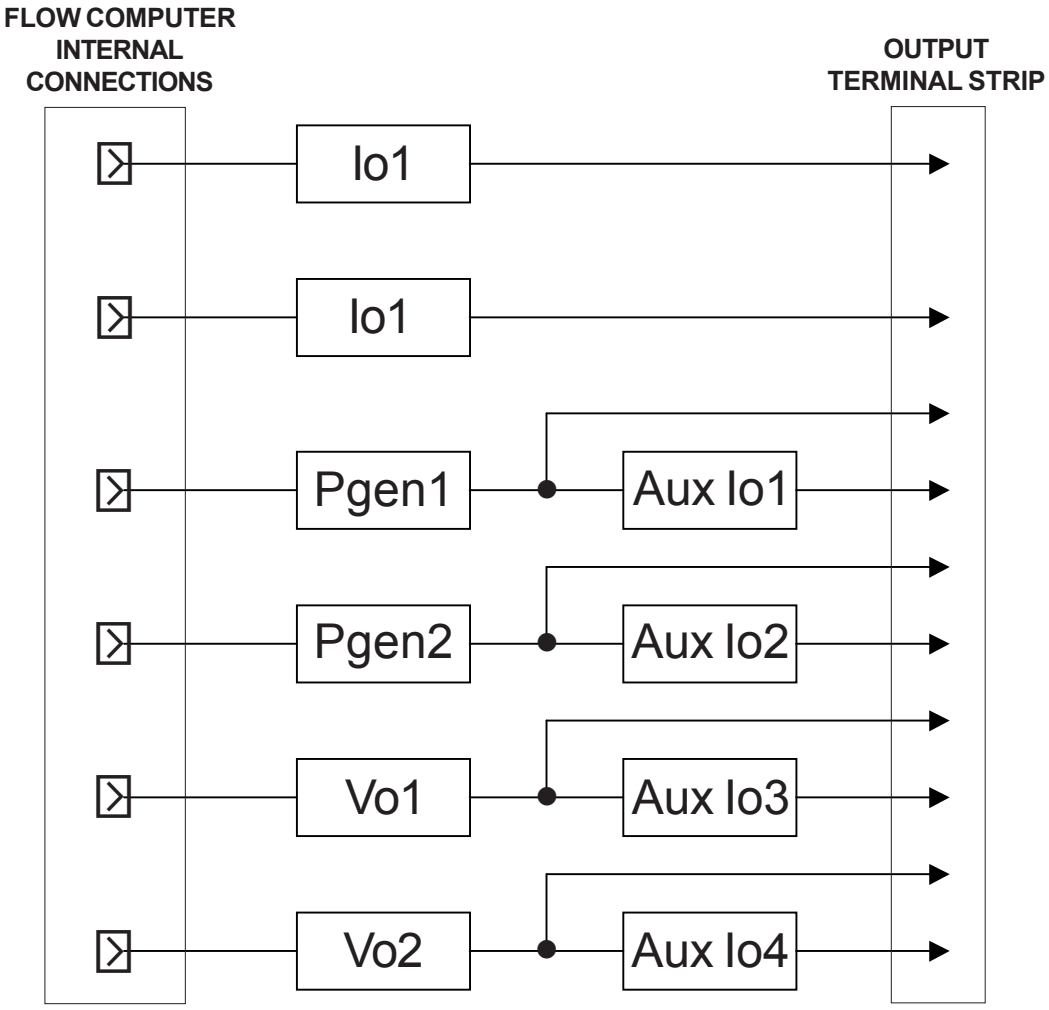
TYPICAL 2-CHANNEL METER EXPANDED I/O OPTION CONNECTIONS

CHANNEL	SIGNAL	AUX Io	METER MENU DISPLAY
CH1	Pgen1 Vo1	Io1 Io3	Vo1 Pgen1
CH2	Pgen2 Vo2	Io2 Io4	Vo1 Pgen1

- Note that the four Aux Io outputs are externally powered.

EXPANDED I/O MODULE OPTION PROGRAMMING

The diagram below illustrates the Expanded I/O Module Option programming for a Single Channel meter with a 1010N-7 Expanded I/O Module.



NOTE: The 1010N-7 Expanded I/O Module auxiliary output signals (Aux Io1 - Aux Io4) generated from Pgen1, Pgen2, Vo1 and Vo2 are "mirrored" output currents. For example, if Vo1 is a 5 Vdc signal then Aux Io3 will be 12 mA.

NOTE: The method used to create auxiliary current loops makes it impractical to generate the 2 mA fault current produced by the primary 4-20 mA outputs of the meter.

TABLE OF CONTENTS

1. GETTING STARTED

1.1 INTRODUCTION

Congratulations on your purchase of the System 1010PVN Permanent Flowmeter. Intended for dedicated applications, this versatile transit-time meter is easy to set up and operate. The 1010 meter represents the state-of-the-art in computerized instrumentation. We are confident that in a very short time, you will appreciate its unrivaled performance and features; especially Controlotron's ground breaking enhanced transit-time Digitally Coded MultiPulse™ technology and the on-line automatic and interactive site setup help facility. This manual covers single channel and dual channel/path meter types.

This section shows how to install the System 1010PVN Permanent flowmeter with a minimum of effort. It will show how to use the Installation Menu to set up the system for transit-time and Clamp-on operation. It also shows the basic connections to and from the meter. For additional information on connections, see the drawings at the end of manual.

1.2 IMPORTANT SAFETY CONSIDERATIONS

The System 1010PVN Permanent meter operates from either an external AC or DC power source. Please observe all the electrical safety codes, etc., that apply to your application. We recommend that only experienced personnel with knowledge of local electrical codes and safety operating procedures perform the installation and wiring. It is solely the user's responsibility to operate this equipment safely. Controlotron cannot accept responsibility for any damage that may occur due to failure to observe any local safety rules.

If this equipment is used for a hazardous application (high line pressure, hostile liquid characteristics, perilous atmosphere, etc.), the end-user must ensure that only properly trained personnel are involved in its installation and operation.

Please do not let the size of the Installation Menu intimidate you. Almost all menu cells already contain default parameters. To begin operation, you only need to access the menu cells that control a required parameter, such as the pipe outer diameter. You will see that by accepting most defaults, you can set up the meter in about five minutes.

1.3 FLOWMETER INSTALLATION STEPS

Typical steps to complete the installation procedure.

- Collect the site data (pipe and liquid data, part numbers, etc.)
- Choose a mounting location for the flow computer and transducers.
- Mount the flow computer at the selected location.
- Prepare pipe for transducer mounting.
- Access the Installation Menu and create a site (see paragraph 1.7.3).
- Enter pipe parameters (see paragraph 2.2).
- Invoke transducer install procedure (see paragraph 2.4).
- Mount transducers on pipe and connect to flow computer (see Section 3).
- Complete transducer install menu operation (see paragraph 2.4).

1.4 THE KEYPAD ENABLE SWITCH

All System 1010PVN models provide a keypad enable/disable switch to prevent unauthorized access to the Installation Menu. In addition, a password entry option is available (see Channel Setup). The keypad enable/disable switch is located inside the lockable enclosure just above the I/O wiring terminal. Please switch to the enable position before proceeding further. If necessary, see Drawings 1010N-7 and 1010DN-7 for location details.

1.5 THE 1010PVN KEYPAD

The 1010PVN integral keypad provides 32 numeric and function keys (see table below). Use these keys to enter, review or edit the site data. Certain keys control the graphics display, Datalogger and Totalizer. "Blind Models", having no keypad or display, must be setup by using their serial data port (see Appendix B).

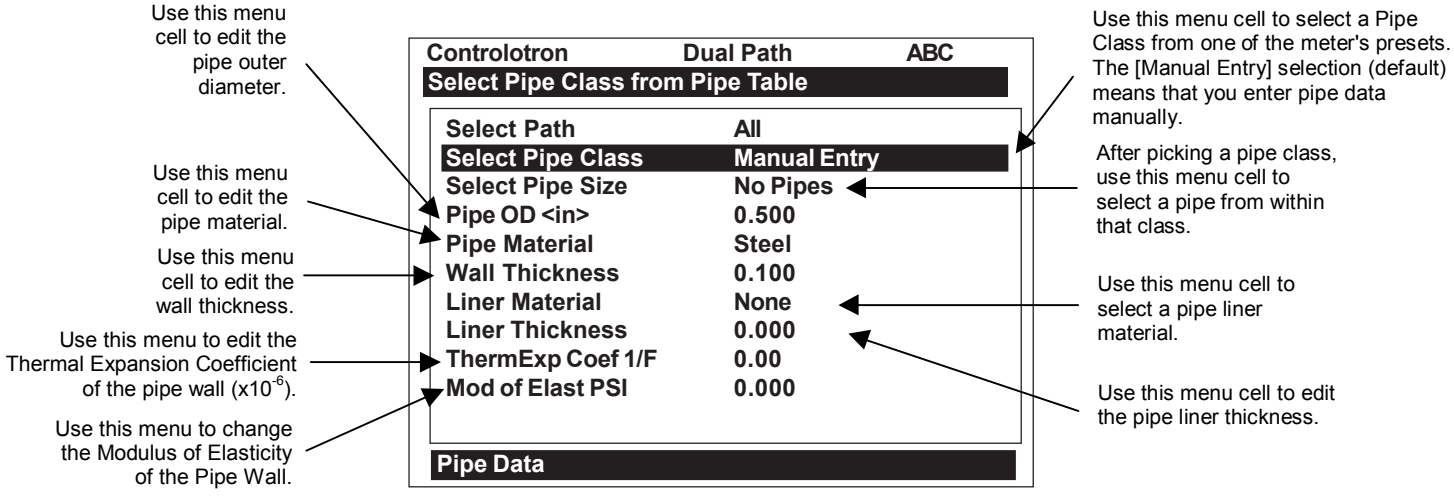
KEYPAD FUNCTION CHART

KEY	USAGE
MENU	Press to activate the Installation Menu.
ENT	Press <ENT> to store numeric data, select from option lists, etc.
LEFT, RIGHT ARROWS	Menu navigation keys move cursor in respective directions.
UP, DOWN ARROWS	Same as <Left> and <Right>. Also scrolls option list and graphic display screen.
CLR	Clear Key for erasing data, or selecting list options.
NUMBERS 0-9	Use to type numeric data.
DECIMAL POINT	Use for decimal points in numeric data.
MATH OPERATORS	Allows 4-function math operations in numeric entry cells.
"F" KEYS 1-3	Totalizer control and special function keys.
"F4" KEY	CAUTION: SYSTEM RESET KEY (during power up)
CTL & ALT	Used as shift keys for alternate key functions.
DATALOG	Triggers immediate Datalogger report.
PLUS/MINUS [+/-]	Changes the sign of numeric data.

NOTE: The keypad does not have alphabetic keys. Scrolling lists provide alpha-numeric characters as needed.

1.6 INTRODUCTION TO THE 1010PVN MENU SCREENS

The figure below shows a typical 1010PVN menu screen (in this case, the Pipe Data Menu).

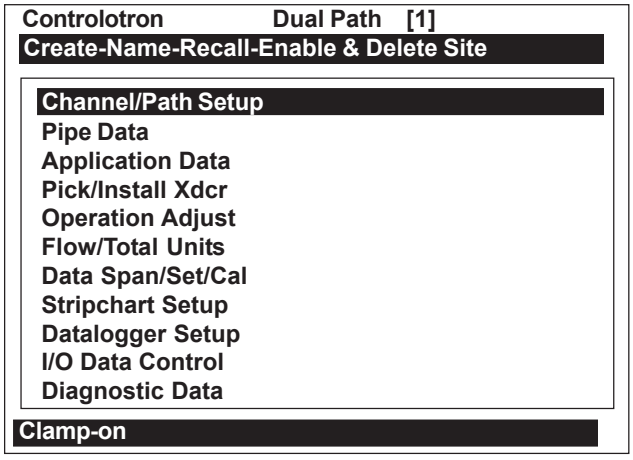


EXPLANATION OF THE CALL-OUTS

Menu Prompt Line	When you select a menu cell, a highlighted text prompt appears on the top of the screen to explain the function of the cell.
Current Selected Meter Type	Indicates Dual Path meter operating mode selected.
Selected Channel	The [1] indicates that measurement Path 1 is currently selected.
Highlighted Menu Cell	The menu cursor (highlight bar) shows where you are currently working by reversing the display colors for that cell (white type on black).
Highlighted Data	The right-hand column shows the current value highlighted. Pressing the <Right Arrow> provides access to an option list or numeric field where you can change the current value as required.
Menu Cell	A menu cell is an individual location within a menu (e.g., Pipe Data) that stores a parameter (either a numeric entry or an option list selection.
Menu Cell Data	The right-hand column shows the current value stored by left-hand column menu cell. The Pipe Data menu includes option list items and numeric entries.
Current Selected Menu	The highlighted bar at the bottom of the screen shows the name of the menu that you are accessing (e.g., Pipe Data).

1.7 HOW TO USE THE INSTALLATION MENU

This section introduces the System 1010 Installation Menu. It explains how to access and leave the Installation Menu and how to enter site data. The Installation Menu consists of sub-menus, each providing individual menu locations (*menu cells*) that store site data. For convenience, this manual refers to sub-menus simply as menus (e.g., the Pipe Data Menu). Shown below is the Clamp-on, Full Site Setup screen for Channel 1 of a Dual Path meter.

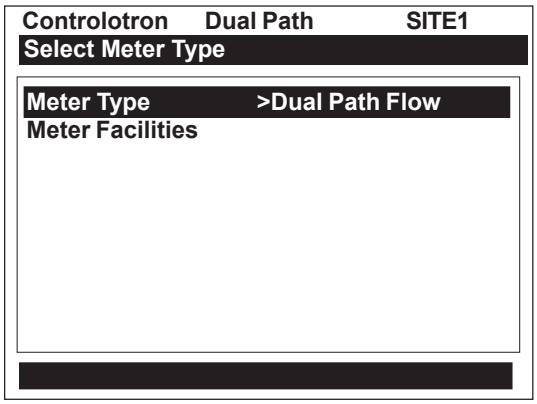


1.7.1 ACCESSING AND LEAVING THE MENU

Upon first turning the meter on you see a graphic of Controlotron's main facility. This means that there is no active site setup currently stored in memory. Note that this screen identifies the software version of the meter on the upper right-hand corner of the display.

Make sure the keypad enable switch is in the correct position then press the <MENU> key to select the menu. The first time you access the Installation Menu, you can leave it only by saving a site or by turning the meter off. After installing and activating a site, use the <MENU> key to toggle between a graphic display screen and the last accessed menu location.

When you press the <MENU> key, the cursor arrives at the first level of the installation menu. Refer to the sample Dual Path screen below. Note that two columns, one on the left-hand side and the other on right-hand side, divide the screen. The first left-hand item, [Meter Type], is highlighted (white type on black). The next left-hand selection is [Meter Facilities]. Use the [Meter Facilities] menu to set global meter options and controls.



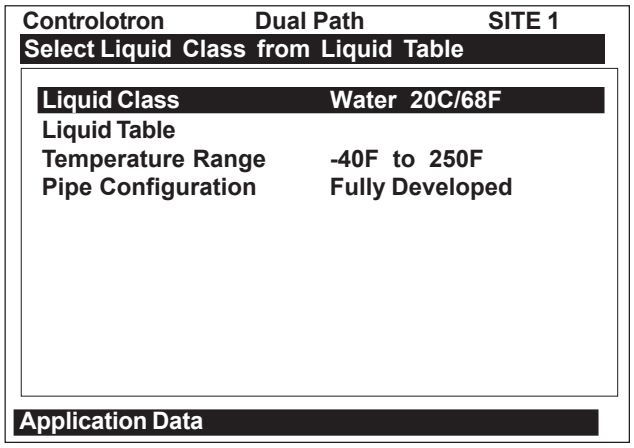
1.7.2 HOW TO ENTER DATA

The left-hand column shows the menu cells (described previously). Another way to think about left-hand column items is to consider them menu questions. Then you can see that the right-hand column answers these questions. Right-hand column answers can be:

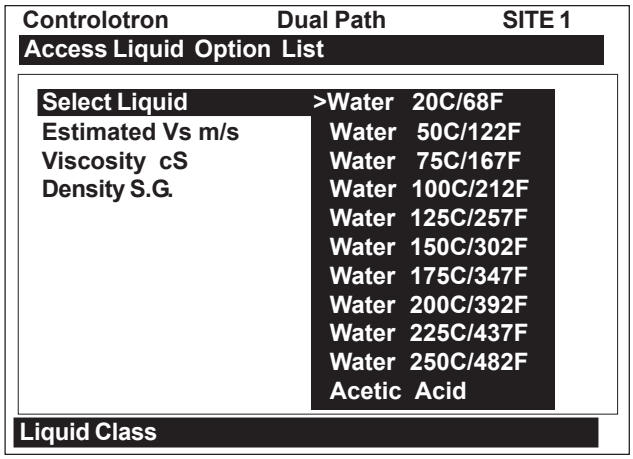
- Another series of menu cells (may become left column items when selected).
- An item from a scrollable option list (e.g., a class of liquids).
- A numeric entry (e.g., a pipe outer diameter).
- An alphanumeric string (e.g., a site name).

Selecting Items from an Option List

Examine the screen below. It shows how to use an option list to select a liquid for your application. How to access this menu will be explained later. Note that the menu name [Application Data] appears highlighted on lower left of the screen. Note also that the menu cell [Liquid Class] is highlighted - the right-hand column shows the answer [Water 20C/68F].

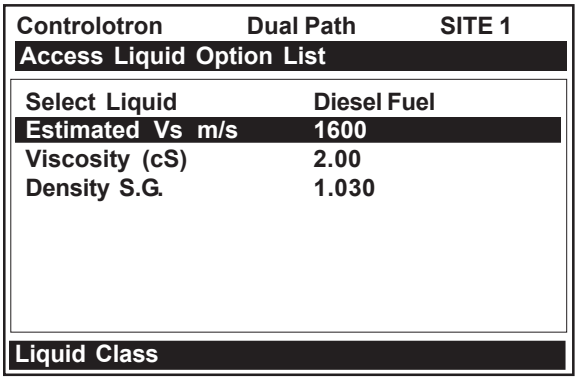


Pressing the <Right Arrow> changes the left-hand column to [Select Liquid]. Pressing the <Right Arrow> again accesses the option list. This expands the highlighted area to show the list contents. Note that a cursor (arrow) points to the top item on the list.



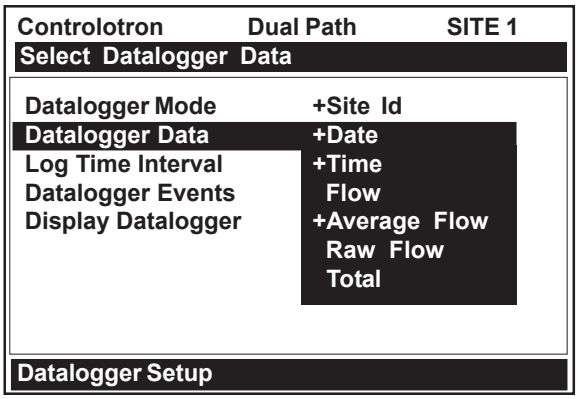
The <Up and Down Arrows> scroll the option lists. Every press moves the cursor to the next item in sequence. Due to the size of display screen, some option lists include more items than the display can show. For example, on the screen above the last option shown is [Acetic Acid]. However, this option list has more listings. Continue to press the <Down Arrow> to see more liquid selections. When you arrive at the last item on a list, the next <Down Arrow> press brings you back to the top of the list; because the option lists are of the "wrap-around" type.

To select an option list item, move the cursor to the item and then press the <ENT> key. This places your selection at the top of the list and moves you out of the option list to the next menu cell. Examine screen on next page. The option list item: [Diesel Fuel] has been selected. Note that this appears on the right-hand column and that the highlighted area moves to the next menu cell in sequence: [Estimated Vs m/s].



Multiple Select Option Lists

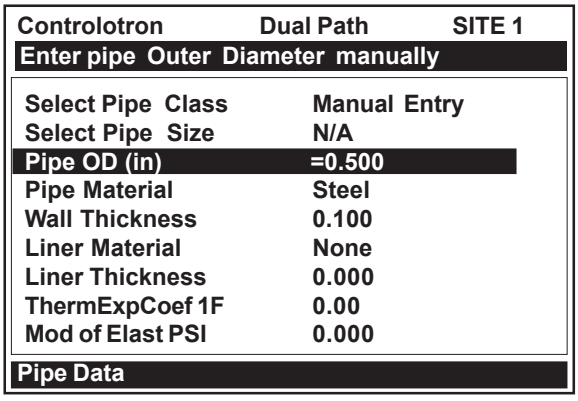
Certain option lists allow you to make more than one selection. For instance, the [Datalogger Data] option list in the Datalogger Setup menu allows you to select any or all of the available data items for your reports. You can use the <Up and Down Arrows> to move the cursor through the list. If you press <ENT> to select an item, a plus sign (+) appears next to that item. The cursor remains so that you can make other selections. To deselect a previously selected item, move cursor next to that item and press <CLR>. Use <Left Arrow> to leave a multiple select option list.



Entering Numeric Data

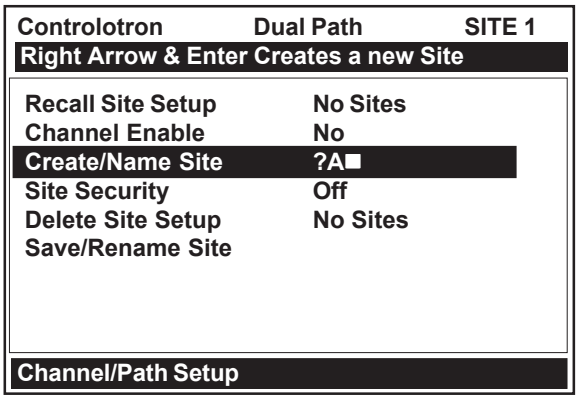
When a menu cell requires a numeric answer, press the <Right Arrow> to access a number entry field; an equal sign (=) appears before current entry. You can now use the number keys and the decimal point key to type a new value. If applicable, you can use <+/-> keys to change the mathematical sign of the number. Press <ENT> to store the numeric data.

NOTE: All Numeric Data cells provide a four-function calculator via the keypad's arithmetic function keys.



Entering Alphanumeric Strings

An alphanumeric string is a series of numbers and letters; and also the Quotation Mark and the Pound Sign symbol. You can also use a space. The meter uses these to identify a specific site setup or user-modified table. The 1010PVN keypad does not provide letter keys. However, when you access a menu cell that requires an alphanumeric string answer, the menu cell right-hand column provides an eight-character entry field. Press the <Right Arrow> to access the field. This selects the first character position. Note that the prompt changes to a question mark (?). With the cursor at the first character position, use the <Up or Down Arrow> to scroll through a single-character list. For example, as shown below, an <Up Arrow> at the first character position produces the letter: upper-case [A]. Pressing the <Right Arrow> moves the cursor to the second position.



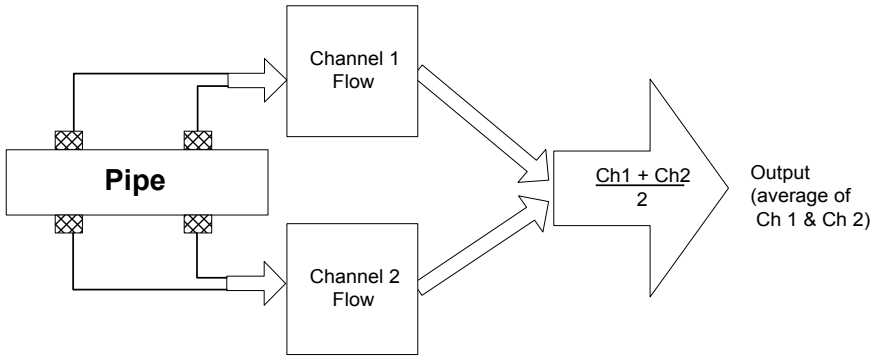
Use the <Right and Left Arrows> to move through the character positions. If you wish to use numbers in your string, you can type them directly from the keypad. After you finish selecting your string, press <ENT> to register it.

1.7.3 THE METER TYPE MENU

This is the first list presented upon entering the Installation Menu. Select the type of meter required for your application. The meter automatically conditions Installation Menu choices to suit the selected meter type.

Dual Path

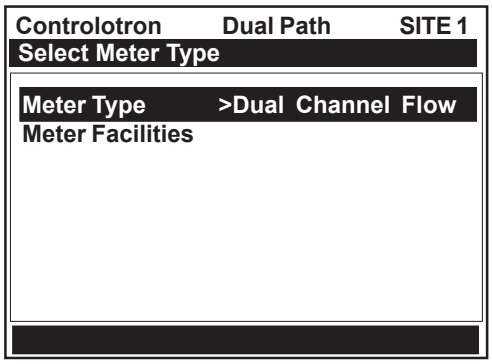
Dual Path uses two measurement channels to achieve a single output via a "virtual" third channel. The resultant data is the average of the two channels. Benefits include highest available precision and enhanced immunity to distorted flow profile conditions.



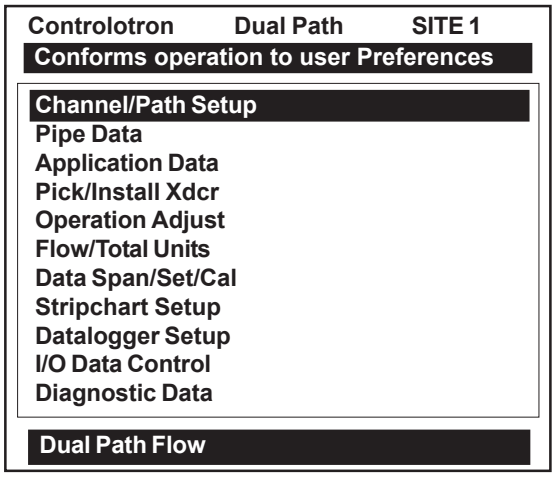
As shown in the steps below, selecting this mode only requires <Right Arrow> presses. This is because dual-channel clamp-on is the default configuration for this instrument. To select a different configuration, move the cursor to the desired Meter Type and then press <ENT> to select it.

1. Make sure that the keypad enable switch is in the [Enable-Up] position. Turn on power and press <MENU> to access the [Meter Type] screen. Refer to the figure below.

   Note that on the left-hand column, [Meter Type] is highlighted as is all the available meter types on the right-hand column. Press the <Right Arrow>. This places a cursor next to [Dual Path Flow].



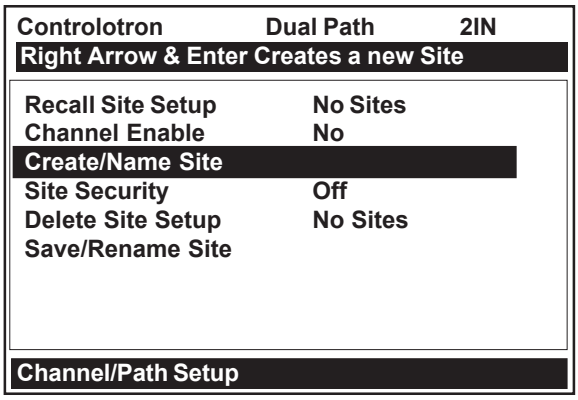
2. Press the <Right Arrow> again. This selects [Dual Path Flow]. Pressing <ENT> will also access the [Dual Path Flow] menu.



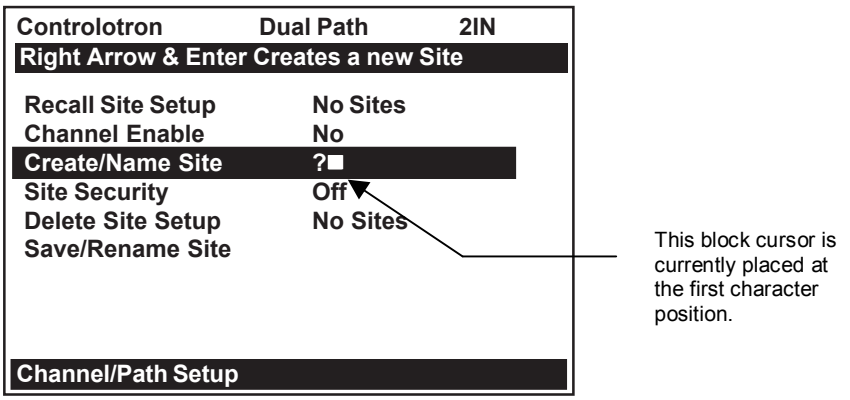
Creating a New Site Setup (See paragraph 2.1.1)

The Channel/Path Setup section of this manual provides detailed instructions on how to use all the Channel/Path Setup menu commands. This section provides an example of how to use the [Create/Rename Site] command to create a new site setup. *Always begin a new installation by issuing the [Create/Name Site] command.* Although you do not need to enter a site name to create a new site setup, you have to provide one to save the site setup or to identify the source of logged data. In this example, we will use [SITE1] for the site name.

1. To access the [Channel/Path Setup] menu, press the <Right Arrow> then move the highlight down to [Create/Name Site].

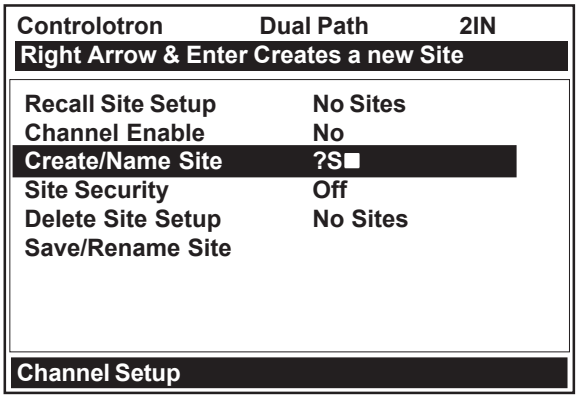


2. Press the <Right Arrow>. Note that the cursor changes to a block, which appears after a question mark (?). This indicates that you have accessed the first character position of an eight-character (max.) alphanumeric entry field.



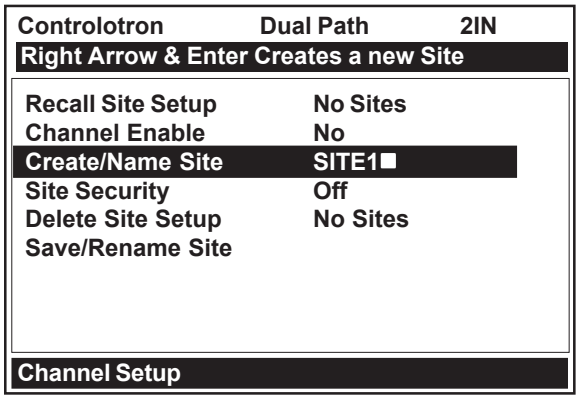
3. Press and hold the <Up Arrow>. Note that the character position begins to scroll upward through the alphabet of capital letters. Continue to scroll until block cursor shows [S]. Press the <Right Arrow>.

NOTE: The character [S] remains at the first character position and the block cursor moves to the second character position.

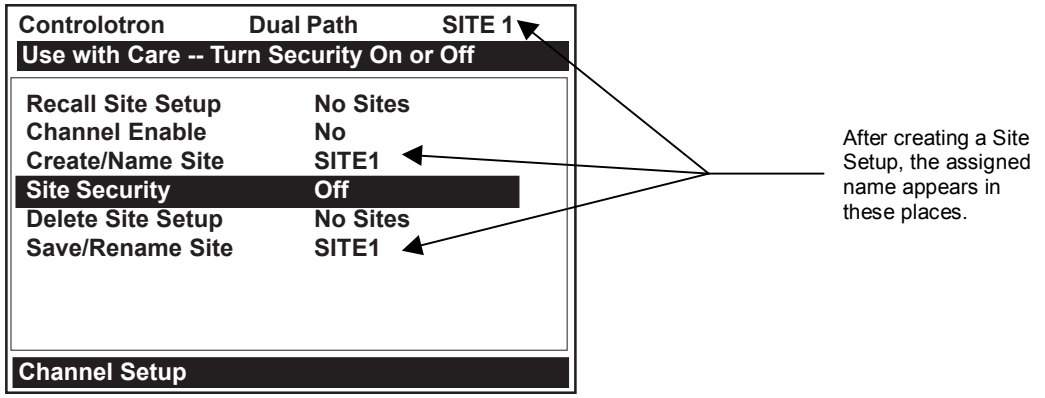


4. Press and hold the <Down Arrow>. Note that the capitalized alphabet list begins to scroll downward through the alphabet from [S]. Stop scrolling at letter [I]. Press the <Right Arrow> to move the block cursor to the third character position.

5. Scroll back up to letter [T]. Move the cursor to the fourth character position. Scroll down to letter [E]. Move the cursor to the fifth character position. Type [1] on the numeric keypad to complete the site name.



6. Press <ENT> to create the site setup named [SITE1]. Note that the name now appears in the [Save/Rename Site] menu cell and on the upper right corner of the graphic screen.



2. THE 1010PVN INSTALLATION MENU

Programming System 1010PVN requires no special experience or training. This field manual contains all the necessary information. If you intend to connect this instrument to an external device, then please have the instruction manual for the device available for reference. The following paragraphs present a generic menu reference that applies to all configurations of 1010 NEMA meters.

This section contains a general description of how to enter site setup data via the 1010PVN Installation Menu. It assumes that you have already selected a meter type as described in the Getting Started section. For convenience, it presents the Installation Menu in the same sequence as it appears on the menu screen. Please note, however, that it is not necessary to program the meter sequentially.

The conventions used with these instructions are:

- When the text refers to a keypad key, it will be enclosed in "less than" (<) and "greater than" (>) symbols: e.g., <MENU>, <ENT>, <Up Arrow>, etc. Where a visual of the key is shown; this means press this key.

- When the text refers to a menu or menu cell name, it will be enclosed with square brackets: e.g., [Pipe Data], [Channel Enable], etc.

- Each menu includes an image of its main screen and a diagram of its structure. The rightmost column of the structure diagram lists the option list choices of the menu cell, if applicable.

General Installation Menu Notes:

- If a power failure occurs while you are entering or editing data, the entered data may not be retained in Active Memory.

- Although you can operate the meter immediately after completion of the site setup, we recommend that you preserve your settings by saving them under a site name. Site data can be saved at any time before invoking either the [Recall Site Setup] or the [Create/Rename Site] commands. When issued, these commands overwrite all data present in Active Memory.

- We do not recommend that you attempt to operate the flowmeter at a new site by recalling and then editing an existing site setup. Each site must have its own set of transducer install parameters, even if the data from the recalled site setup is identical. Always issue the [Create/Rename Site] to begin a new site setup. This will fill all the menu cells with defaults to eliminate the possibility of retaining unwanted parameters.

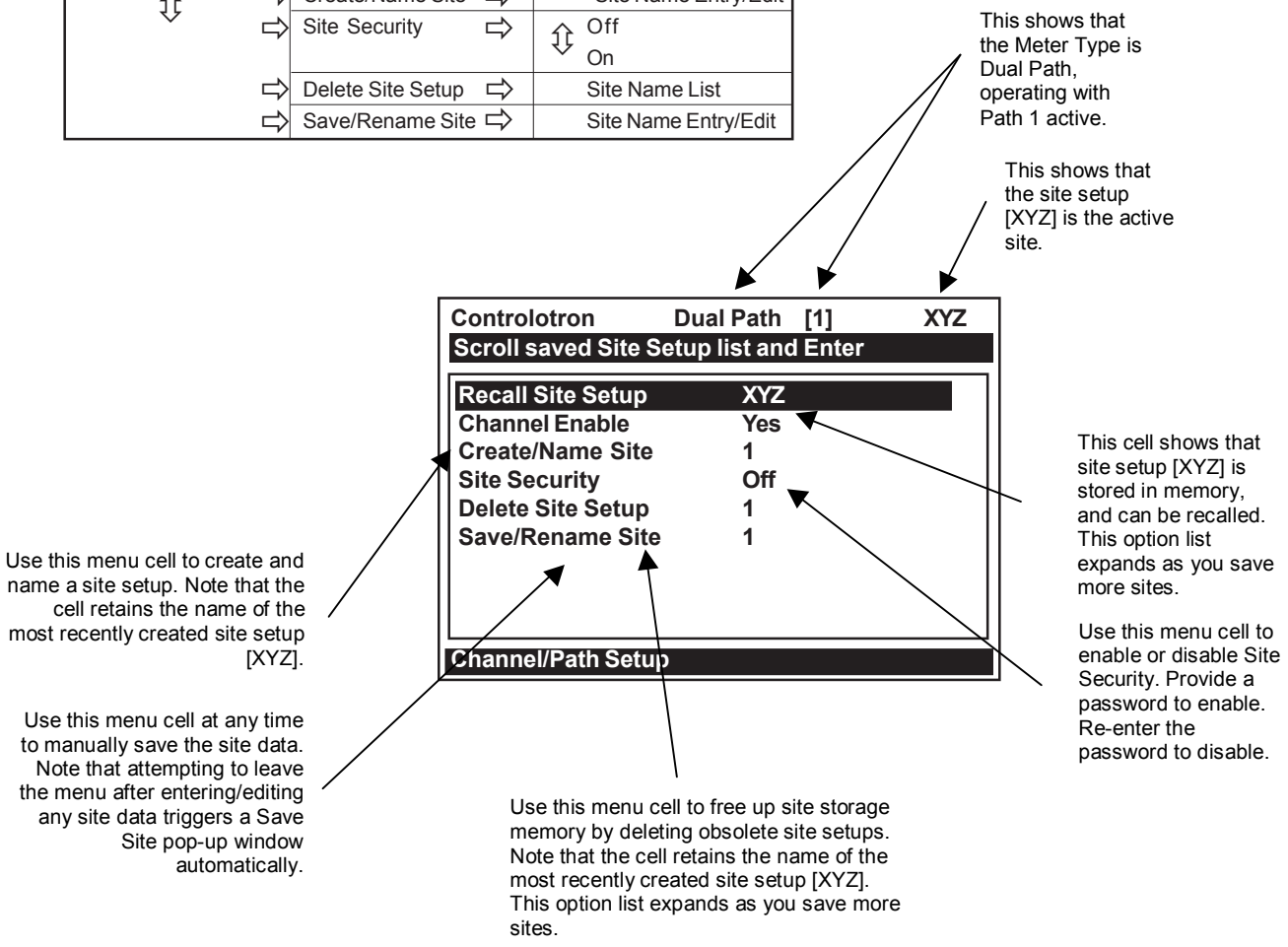
- The meter allows you to create your own personal site setup defaults. After creating a site setup and editing default parameters as desired, save the site using the name [FASTSTRT]. The next time you issue the Create/Name Site command, your custom parameters will become the system's defaults.

2.1 THE CHANNEL/PATH SETUP MENU

The Channel/Path Setup Menu is available after picking a meter type and a measurement technology. Use this menu to manage site setups. You can create, recall, delete and save entire site setups. You can apply Site Security, which permits read-only access to the Installation Menu unless you enter a password. The Channel Enable switch allows you to disable and enable a measurement channel. Be aware that site name option lists only show sites that are consistent with the currently selected meter type.

CHANNEL/PATH SETUP MENU STRUCTURE

Channel/Path Setup ⇨	Recall Site Setup ⇨	*Site Name List
⇨	Channel Enable ⇨	⇳ Yes / No
⇳ ⇨	Create/Name Site ⇨	*Site Name Entry/Edit
⇨	Site Security ⇨	⇳ Off / On
⇨	Delete Site Setup ⇨	Site Name List
⇨	Save/Rename Site ⇨	Site Name Entry/Edit



2.1.1 HOW TO RECALL A SITE SETUP

The [Recall Site] command allows you to reinstall the system at a former site. For an original installation, see [Create/Name Site] for instructions on how to create a new Site Setup. This menu cell provides a list of saved site names. Scrolling to a site name and pressing <ENT> moves all the parameters associated with that name into Active Memory.

If there are no site setups present in site storage memory, the menu cell reports [No Sites] in the right-hand column. Saving a site setup with a site name adds the name to this option list.

The first selection on the list is the currently active Site Setup. The system will be ready for operation after you install the transducers and make the required hardware connections. Note that the installed transducers must comply with the recalled site parameters.

To recall a Saved Site Setup: (*Where a visual of the keys is shown; this means press this key)*

To access the list of saved site names press 

To move the cursor to the Site Name press 

Pressing  triggers a pop-up window that asks if you intend to use the original transducer position (recommended). This means that you have to remount the transducers exactly as they were in the previous install.

If you cannot recreate the original transducer installation, then press  to change the pop-up list from [Original] to [New].

Pressing  disables the measurement channel until you repeat the Pick/Install Transducer routine.

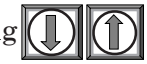
2.1.2 HOW TO ENABLE AND DISABLE A SENSING PATH

The flow computer disables a sensing path until the completion of the required Site Setup entries and the transducer installation procedure. The meter enables the measurement channel automatically after it receives all required site data and completes the transducer install routine. (The Site Enable menu cell allows you to disable or enable a measurement channel after there has been a successful transducer install).

The system does not require your presence for routine operation. If a fault condition (e.g., an empty pipe) disrupts operation, the system will recover automatically after the fault clears. Use Channel Enable [No] to turn off a channel that is currently unused but active; for example, if the transducers have been removed for servicing.

To disable a channel that is operating:

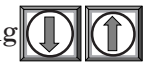
To access the [Channel Enable] option list press 

Move the cursor to [No] by pressing 

To disable the measurement channel press 

To enable a channel:

To access the [Channel Enable] option list press 

Move the cursor to [Yes] by pressing 

To enable the measurement channel press 

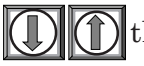
2.1.3 HOW TO CREATE/NAME A SITE SETUP

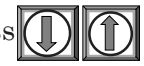
Use this command to create a new Site Setup. This is the first action required for an original installation. Create/Name Site inserts system defaults in all the appropriate menu cells. You can edit these defaults as necessary to suit your needs.

You do not have to provide a site name in order to create a new Site Setup. You can create a site simply by pressing the <Right Arrow> to access the menu cell entry field and then pressing <ENT>. This creates a "nameless" Site Setup. However, if you intend to use the meter's multi-site storage facility, you must enter a unique site name for each site setup you want to retain in site storage memory.

To Create and Name a new Site Setup:

To access the first character position press 

To select a character press  then  to highlight to next character position.

To select the second character press 

Repeat this process to select all the characters (8 max.) you want to use to identify the new Site Setup.

To create the new Site Setup press 

NOTE: If you decide to use numbers or a decimal point in the site name, you can type these characters directly from the keypad.

2.1.4 HOW TO ENABLE/DISABLE SITE SECURITY

With Site Security enabled, the meter will require a password before it allows any activity that could interrupt or affect system operation. You can still access the Installation Menu. However, Site Security limits access to the viewing of parameters only. In other words, you will still be able to review site data, but you will not be able to make any changes. The flowmeter will allow a <F4> Reset Sequence when Security is active, however, it also contains a Menu Enable switch that allows you to inhibit this function (see drawing 1010N-7).

Activate Site Security with care. Once activated, the only way to deactivate it is via the Site Security [Off] command. However, the cursor will not move to the Site Security option list until you enter the correct password. Therefore, it is essential that you never forget or misplace the password. The only way to deactivate Site Security without knowing the password is to return the unit to Controlotron. However, the process the factory uses to remove Site Security will eliminate any existing Site Data as well. Remember, your meter contains a menu enable switch which also provides this function.

CAUTION: MAKE CERTAIN THAT YOU RETAIN A COPY OF THE PASSWORD IN A SECURE LOCATION.

To activate Site Security:

To access the [Site Security] option list press 

To scroll the option list to [On] press ⇩ ⇧ then ENT. [Enter Code?] appears at the top of the display screen.

To select the first character, use the numeric keys or press ⇩ ⇧. To move the cursor to the first character position ⇨.

To move the cursor to the second character position press ⇨

Repeat the selection process for the second character. Continue this process until all the required characters (8 max.) appear in the field.

To store code press ENT. [Confirm Code ?] appears at top of the Display screen. Re-type code exactly as described above.

Pressing ENT moves the cursor to the Site Security option list.

To scroll the option list to [Site Security: On] by pressing ⇩ ⇧. Once you turn on Site Security, you must enter the correct code to turn it off.

To activate Site Security press ENT.

2.1.5 HOW TO DELETE A SITE SETUP

If you attempt to save a Site Setup when memory is full, the screen will show [Memory Full]. If you get this message after issuing a Save/Rename Site command, you'll have to delete an unneeded Site Setup to clear memory space. The Datalogger and Site Storage share a common memory pool, so a large amount of logged data could also trigger the [Memory Full] message. For how to clear Datalogger memory, see [Meter Facilities/Datalogger Control]. The Defragment Command may also secure more memory (see Meter Facilities/Memory Control Menu).

To delete a stored Site Setup:

To highlight [Delete Site] press ⇩.

To access the [Delete Site] option list press ⇨.

Move the cursor to the site name of the site setup you want to delete.

To delete the obsolete site setup press ENT.

2.1.6 HOW TO SAVE/RENAME A SITE SETUP

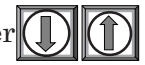
The Save/Rename Site command copies data from Active Memory to the Site Storage Memory. Saved Site Setups can be recalled for future use. This menu cell allows you to save a Site Setup at any time during the programming process. However, you must recall and complete the Site Setup in order to achieve operation.

When you access the Save/Rename Site menu cell, the name of the most recently created Site Setup (see Create/Name Site) appears automatically. If this name is acceptable, you can press <ENT> to save the Site Setup. You can change the listed site name by following the procedure

below. You may select up to eight characters. If you decide to use numbers or a decimal point in the site name, you can type these characters directly from the keypad.

To Save or Rename a Site Setup:

To access the first character position 

To select a character  then  to highlight to next character position.

To select the second character  . Repeat this process to select all the characters (8 max.). To save the site data present in Active Memory  .

2.2 THE PIPE DATA MENU

This menu becomes available after picking a Meter Type, Measurement Channel and Measurement Technology. We recommend that you edit the Pipe Data immediately after creating a new Site Setup.

The Pipe Data menu allows you to define the application's pipe parameters. Select a pipe from one of the meter's stored pipe tables (see menu structure below); or input the pipe size and description manually. Manual entries include Pipe Material, Outer Diameter (OD) and pipe Wall Thickness. Liner Material and Liner Thickness entries are included to support pipes with liners. The meter requires the pipe outer diameter (OD) and wall thickness to operate. You must define these parameters to complete the installation.

The pipe table includes descriptions for over sixty standard pipes plus any user-entered pipes (see Meter Facilities). To use these presets, first pick a Pipe Class (e.g., ASA Stainless Steel), then pick a pipe size within that class (e.g., 4SS10). When you select a particular pipe class/size, the relevant pipe parameters appear in the Pipe Data menu cells. If a given pipe class/size does not match your application exactly you can still edit each individual parameter to fine-tune your selection. In addition, the Meter Facilities section of the Installation Menu provides a pipe table editor that allows you to customize any or all of the stored pipe tables.

NOTE: If you edit the pipe parameters after the system is operating, you will have to repeat the transducer install procedure.

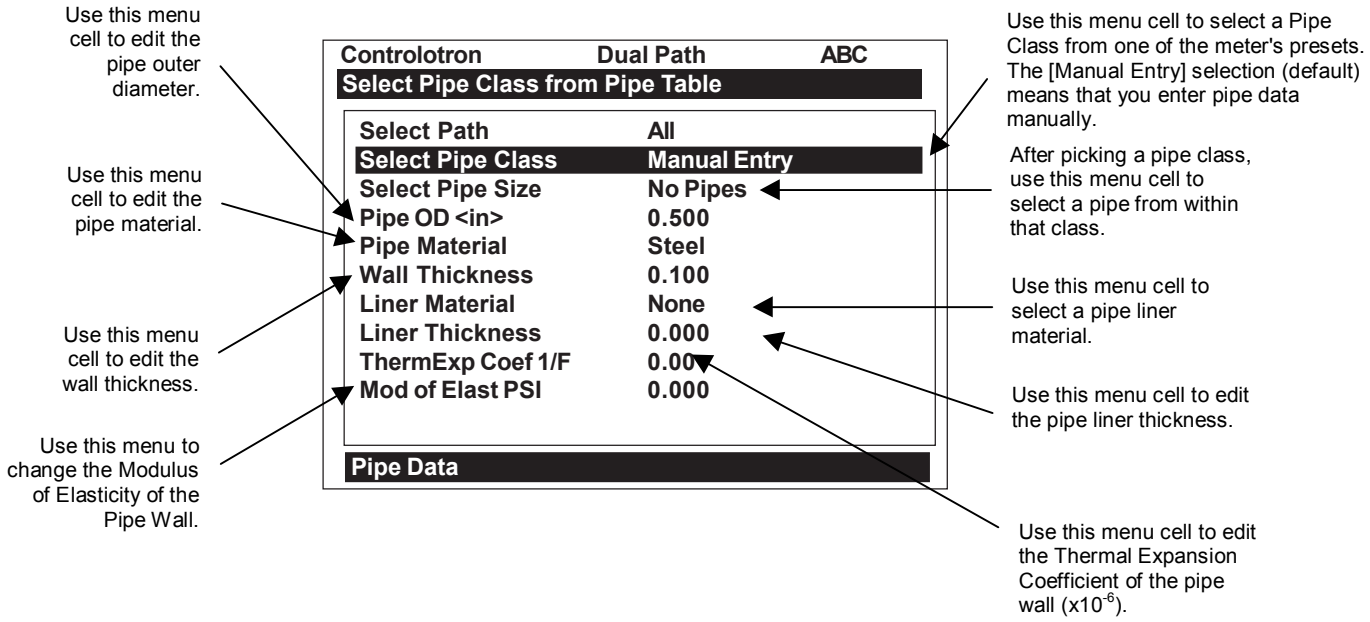
This 1010 operating system includes routines that will compensate the measured raw flow rate for dynamic changes in the pipe dimensions, caused by variations in line temperature and pressure supplied to the flow meter. To account for variations in pipe material, two data entry items (Thermal Expansion Coefficient and Modulus of Elasticity) are provided in the 1010 Pipe Data menu screen (see sample menu screen on next page).

The equation used to automatically compute the change in pipe inside diameter is:

$$d_1 = d_0(1 + \alpha(T_1 - T_0)) \cdot \left(1 + d_0 \frac{(P_1 - P_0)}{E\ w}\right)$$

Where:

d_0 = inside diameter of pipe at STP
d_1 = inside diameter of pipe after temperature and pressure change.
w = pipe wall thickness
T_0 and P_0 = Standard temperature and Pressure
T_1 and P_1 = Operating temperature and Pressure
α = Coefficient of Thermal Expansion of Pipe material
E = Modulus of Elasticity of pipe material



The default value for each of these new parameters is 0.0. A value of zero effectively disables the pressure and temperature pipe volume compensation routine. When entering a value for the thermal expansion coefficient and modulus of elasticity, keep in mind that the numeric entry already includes an exponent multiplier. For the Thermal Expansion Coefficient the multiplier is 10^{-6} and for the Modulus of Elasticity the multiplier is 10^{6}.

Typical values for each parameter are shown below:

Pipe Material	Thermal Expansion Coef	Modulus of Elasticity
Mild Carbon Steel	6.20 x 10^{-6} F^{-1} (11.16 x 10^{-6} C^{-1})	30 x10^{6} psi 2.07 x 10^{6} bar
304 Stainless	9.60 x 10^{-6} F^{-1} (17.28 x 10^{-6} C^{-1})	28 x10^{6} psi 1.93 x 10^{6} bar
316 Stainless	8.83 x 10^{-6} F^{-1} (15.89 x 10^{-6} C^{-1})	28 x10^{6} psi 1.93 x 10^{6} bar

NOTE: Do not enter exponents of above values.

THE PIPE DATA MENU STRUCTURE

Pipe Data ⇨	Select Pipe Class ⇨ ⇳	Manual Entry **ASA Stainless Steel*** ASA Carbon Steel ASA Plastic Metric DN Steel Metric SGP Steel Cast Iron Table Ductile Iron Table Copper Tube Table		
	Select Pipe Size ⇳	Manual Entry	*Set pipe parameters manually*	
		ASA Stainless Steel*	ASA Carbon Steel	ASA Plastic
		⇳ **1SS10**	1CS40	1P40
		2SS10	1CS80	1P80
		3SS10	2CS40	2P40
		4SS10	2CS80	2P80
		6SS10	3CS40	3P40
		8SS10	3CS80	3P80
		Metric DN Steel	4CS40	4CS40
		⇳ 50 DN	4CS80	4P80
		100 DN	6CS40	6P40
		200 DN	6CS80	6P80
		400 DN	8CS40	8P40
		800 DN	8CS80	8P80
		Metric SGP Steel	10CS XS	10P XS
		⇳ 20A-SGP	10CS40	10P40
		25A-SGP	12CS STD	12P STD
		32A-SGP	12CS XS	12P XS
		40A-SGP	16CS STD	16P STD
		50A-SGP	16CS XS	16P XS
		65A-SGP	18CS STD	18P STD
		80A-SGP	18CS XS	18P XS
		90A-SGP	20CS STD	20P STD
		100A-SGP	20CS XS	20P XS
		125A-SGP	24CS STD	24P STD
		150A-SGP	24CS XS	24P XS
		175A-SGP	30CS STD	30P STD
		200A-SGP	30CS XS	30P XS
		225A-SGP	36CS STD	36P STD
		250A-SGP	36CS XS	36P XS
		300A-SGP	Cast Iron Table	Ductile Iron Table
		350A-SGP	6” cls C	6” cls 52
		400A-SGP	10” cls C	8” cls 52
		450A-SGP	12” cls C	10” cls 52
		500A-SGP	16” cls C	12” cls 52
		Copper Tube Table	20” cls C	16” cls 52
		⇳ 1” type M		24” cls 52
		1” type K		
		1” type L		
		2” type M		
		2” type K		
		2” type L		
		4” type M		
		4” type K		
		4” type L		
		6” type M		
		6” type K		
		6” type L		
	Pipe OD (in / mm)	*xx.xx (numeric entry).*	*Auto if specific pipe is selected)*	

*NOTE: The highlighted selection in the above table illustrates how to choose the ***ASA Stainless Steel*** **Pipe Class** and all its available Pipe Size selections. All other Pipe Classes (e.g., ASA Carbon Steel) listed can be selected in the same manner.

THE PIPE DATA MENU STRUCTURE *(continued)*

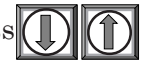
Pipe Data (cont.) ⇨	Pipe Material ⇨	⇳ Steel ABS Aluminum Black Iron Brass Cast Iron CuNi (70/30) CuNi (90/10) Copper Ductile Iron FRP Glass Hastelloy Inconel Kynar (PVDF) monel Nickel Polyethylene PVC (Plastic) Teflon Titanium
⇨	Wall Thickness ⇨	x.xxx *(numeric entry)*
⇨	Liner Material ⇨	⇳ None Cement Coal Tar Enamel Glass Plastic HDPE Teflon Rubber
⇨	Liner Thickness ⇨	x.xxx *(numeric entry)*
⇨	ThermExpCoef ⇨	0.000
⇨	Mod Elast PSI ⇨	0.000

2.2.1 HOW TO SELECT A PIPE CLASS

The 1010PVN pipe tables are arranged by classes of common type and material. The default selection is [Manual Entry]. As its name infers, you would use this selection to manually enter individual pipe parameters.

To select a Pipe Class:

To access the [Pipe Class] option list press 

To scroll through the available classes press 

To select the class that fits your application press ENT

When you pick a Pipe Class, the Select Pipe Size menu cell (see below) presents the pipe size option list associated with the selected class. By using the pipe class and pipe size option lists, you automatically load all the required pipe information. You can also select a pipe class/size, then edit any of the associated defaults to fine-tune the pipe data.

NOTE: Create custom pipe data via the Pipe Table editor in the Meter Facilities menu.

2.2.2 HOW TO SELECT A PIPE SIZE

Selecting a Pipe Size installs the selected pipe parameters into the balance of the Pipe Data

menu cells and prepares the 1010 for Transducer selection and Installation. This option is not applicable if the Pipe Class is [Manual Entry].

After selecting a pipe class:

To access the [Pipe Size] option list press 

To scroll to the required pipe press 

To register selection press 

2.2.3 HOW TO ENTER THE PIPE OD (in. or mm)

Use this menu cell to edit the pipe outer diameter. Be aware that you will not be able to complete the transducer installation successfully unless this information is accurate. In addition, if you change this parameter on a previously installed site, you will have to repeat the transducer installation. *Note: Use actual pipe dimensions, not ASA code or any other standard.* The English/Metric selection in the Meter Facilities menu determines whether these dimensions are in inches or millimeters.

To enter the Pipe OD:

To enable numeric entry press 

Use the keypad's numeric keys to type the exact outer diameter of the pipe in inches or millimeters.

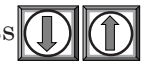
To register the Pipe OD press 

2.2.4 HOW TO SELECT A PIPE MATERIAL

The pipe material selection affects flow calibration to a small degree. It also influences the meter-generated transducer size and spacing recommendations. Select a substitute material if you do not find the material of your pipe in the pipe table. You can edit each pipe parameter to achieve a closer match. If you change any pipe parameters, after running the Transducer Install procedure, you may have to re-space the transducers. The [Pipe Material] option list provides a selection of common pipe materials. The default pipe material is [Steel]. Press the <Down Arrow> to accept the default setting for this menu cell.

To select a Pipe Material:

To access the [Pipe Material] option list press 

To scroll to the required pipe material press 

To register selection press 

2.2.5 HOW TO ENTER THE WALL THICKNESS

The wall thickness of the pipe is one of the required parameters. The flow computer needs this data to generate accurate transducer size and spacing data recommendations. Selecting a pipe class/size inserts a wall thickness value. If this data is inaccurate, then use this menu cell to set the pipe's wall thickness (in English or Metric data units).

NOTE: Do not use ASA schedule code to specify the wall thickness. You must enter actual dimensions.

To enter the Pipe Wall Thickness:

To enable numeric entry press 

Use the keypad's numeric keys to type exact wall thickness (use in/mm).

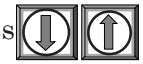
To register the pipe wall thickness press 

2.2.6 LINER MATERIAL

For lined pipes, select a pipe liner from the material option list. If the pipe liner material does not appear on the list then select the closest type available. If necessary, call Controlotron Customer Service for additional help. The system default Liner Material is [None]. If the pipe does not have a liner, press the <Down Arrow> twice to bypass to the next two menu cells. The [Liner Material] option list offers a selection of common liner materials.

To select a Liner Material:

To access the [Liner Material] option list press 

To scroll to the required Liner material press 

To register selection press 

2.2.7 LINER THICKNESS

If you specified a pipe liner in the [Liner Material] menu cell, then use this menu cell to set its exact thickness in appropriate units (English or Metric).

To enter a Liner Thickness:

To enable numeric entry press 

Use the number keys to type the exact line thickness value.

To register the data press 

2.2.8 ThermExp Coef

Use this menu cell to set the Thermal Expansion Coefficient.

To enter the Thermal Expansion Coefficient value:

To enable numeric entry press 

Use the number keys to type the Thermal Coeffiecient value.

To register the data press 

2.2.9 Mod of Elast PSI

Use this menu cell to set the Modular Elasticity.

To enter the value of Modulus of Elasticity:

To enable numeric entry press 

Use the number keys to type the Modular Elasticity PSI value.

To register the data press 

2.3 THE APPLICATION DATA MENU

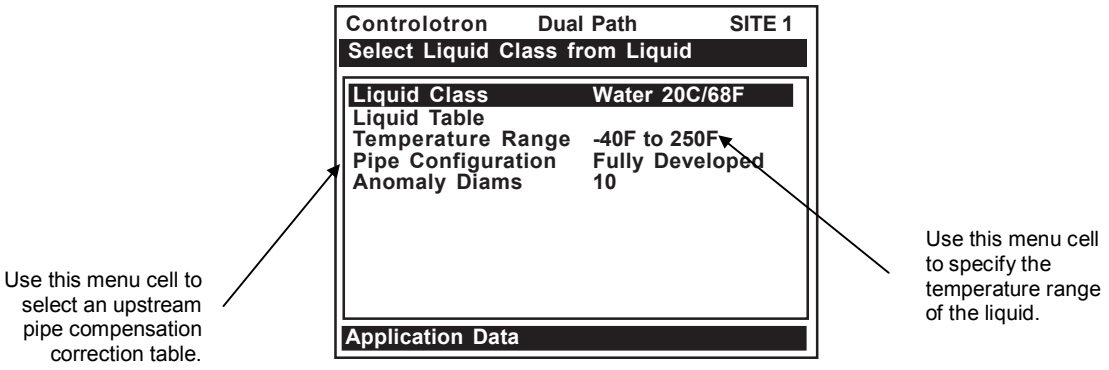
Use of the Application Data menu is optional.

CAUTION: An erroneous Viscosity entry could affect the meter's intrinsic calibration. Do not alter the default viscosity value of your liquid unless you are sure of your data.

Use the [Application Data] menu to edit default settings to match your application. When you specify a Liquid Class, the meter will adjust its operation to accommodate the liquid's estimated sonic velocity, viscosity and specific gravity. If necessary, you can edit each liquid class parameter individually to obtain a closer match with the liquid. The default liquid is Water at 68°F (20°C).

The [Temperature Range] menu cell allows you to specify the expected temperature range at the transducer mounting location. The default setting: [-40^{0}F to 250^{0}F], matches the standard 991 and 1011 series of transducers but not the 1011H. For higher pipe temperatures, selecting the proper temperature range allows the flow computer to recommend the appropriate transducers.

The default pipe configuration (Fully Developed) wll cause the flowmeter to use the conventional Reynolds Compensation Table when compensating for liquid flow profile behavior. The number of diameters between the upstream configurations and the transducer installation can be numerically entered via the [Anomaly Diams] menu cell.



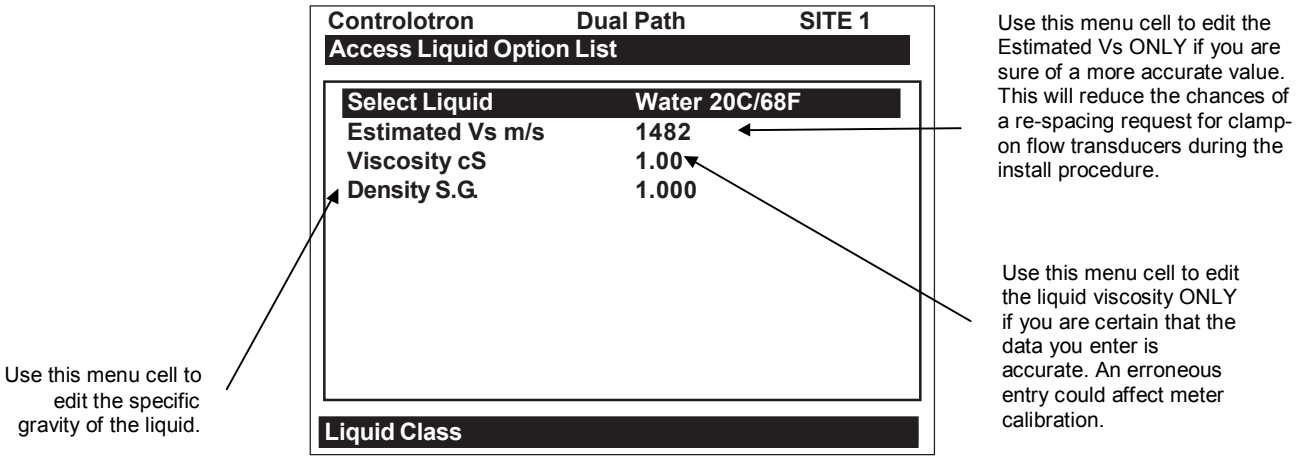
APPLICATION DATA MENU STRUCTURE

Application Data ⇨	Liquid Class ⇨	Select Liquid ⇨	⇳ Water 13C/55F Water 20C/68F Water 50C/122F Water 75C/167F Water 100C/212F Water 125C/257F Water 150C/302F Water 175C/347F Water 200C/392F Water 225C/437F Water 250C/482F Acetic Acid Alcohol Bromine Carbon Tet Chlorine Diesel Fuel Gasoline Glycerine Kerosene MEK Oil (SAE 20) Sea Water Toluene Trichloroethyl Other		
	⇳	⇳			
	⇨	Estimated Vs m/s ⇨	xxxx *(numeric entry)*		
	⇨	Viscosity cS ⇨	x.xx *(numeric entry)*		
	⇨	Density S.G. ⇨	x.xxx *(numeric entry)*		
⇨	Liquid Table ⇨	Table Active ⇨	⇳ No Yes		
	⇨	LiquIdent Slope	x.xxx *(numeric entry)*		
	⇨	Pressure Slope	x.xxx *(numeric entry)*		
	⇳ ⇨	LiquIdent Index ⇨	Add Index	⇳ Index Value Viscosity @ 400 Visc Slope @ 400 Kill Index @ 400	x.xxxx x.xxxx x.xxxx ⇳ No Yes
⇨	Temperature Range ⇨ ⇳	⇳ -40F to 450F -40F to 250F -40F to 375F			
⇨	Pipe Configuration ⇨ (Change to Upstream Piping) ⇳	⇳ Fully Developed* 1 Elbow Dbl Elbow + Dbl Elbow - Value Expander Reducer Norm Entry Header Inlet Intrusions			
⇨	Anomaly Diams	10			

*Default

2.3.1 HOW TO SELECT A LIQUID CLASS

The liquids listed in the Liquid Class option list are representative samples of the class of liquids to which they belong. Selecting a named liquid fills in the Estimated Vs (m/s), Viscosity (cS), and Density (SG) parameters automatically. However, you have the option of editing these parameters individually to fine tune the liquid settings. If you do not find a liquid that matches your application, then you can select [Other]. This selection will not provide a liquid name or automatic parameter entry.



To select a Liquid Class:

To access the option list press 

Scroll through the list to find the closest match to the application's liquid.

To register selection press ENT

How to Edit the Estimated Vs (liquid sonic velocity)

During transducer installation, the flow computer bases its initial transducer spacing recommendation on the value stored in this menu cell. Estimated Vs m/s allows you to review and modify (if necessary) the Vs value for the liquid class you selected.

After you install the transducers, the computer will measure Vs directly. If the displayed (or edited) Vs stored in this menu cell is accurate, the transducers will be spaced correctly. This will eliminate the need to re-space the transducers after their initial installation. However, if the estimated Vs is substantially different from the measured value, the computer will request you to re-space the transducers during the transducer install procedure.

NOTE: During the Xdcr install procedure (see paragraph 2.4), you can ignore a respacing request by pressing the <Down Arrow> instead of <ENT>. If this triggers a Spacing Alarm, check [Diagnostic Data/Site Setup Data] to make sure the measured Vs value does not exceed the Vs max or Vs min items.

To edit the Estimated Vs m/s:

To activate numeric entry press 

Type the sonic velocity value using meters-per-second.

To register the data press ENT

How to Edit the Viscosity (cS) Setting

The [Viscosity cS] menu cell shows the kinematic viscosity of the selected liquid (in centistokes). The viscosity value is particularly important for high viscosity liquids. The meter requires an accurate liquid viscosity to compute the flow profile compensation. If the displayed viscosity is correct, bypass this menu cell by pressing the <Down Arrow>.

To edit the Viscosity setting:

To activate numeric entry press 

Use the numeric keys to type the Viscosity value, which must be in centistokes.

To register the data press 

How to Edit the Density (SG) Setting

Use the Density (SG) menu cell to edit the nominal specific gravity of the selected liquid. This mode suits applications where the density is not only known, but also fixed, due to well-controlled liquid temperature and chemistry.

The default specific gravity setting is 1.000. Density (SG) (as it applies to this system) is defined as the ratio of the mass of this liquid to the mass of an equal volume of water at 20°C or 68°F.

To edit the Density SG setting:

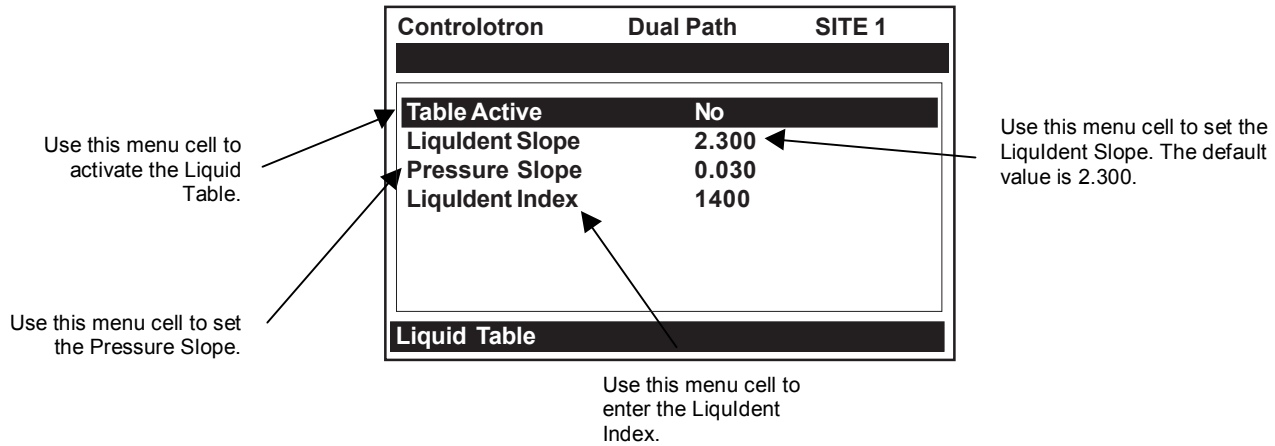
To activate numeric entry press 

Use the numeric keys to type the Density SG value.

To register the data press 

2.3.2 ACTIVATING THE LIQUID TABLE

The liquid table is used to associate the measured LiquIdent™ variable (temperature compensated sonic velocity) with user supplied Viscosity. By selecting the Liquid Table you can set the LiquIdent™ Slope, Pressure Slope, and the LiquIdent™ Index.



To activate the Liquid Table menu:

Press  to move the cursor to the [Liquid Table] menu cell.

Use  to select [No] or [Yes].

To register the selection press  .

Setting The LiquIdent™ Slope

The 1010PVN measures and reports the flowing liquid's sonic velocity (Vs) and its temperature (T). These components create the liquid's "Vs/T" signature. This signature is a fundamental component of the LiquIdent™ routine that identifies positively any liquid monitored by the 1010PVN system. Since a temperature change will affect the sonic velocity of the liquid, a method to balance the measured sonic velocity to a fixed reference temperature (60ºF/15.6ºC) is provided. The LiquIdent™ Slope Factor must be configured to represent the linear change in the liquid's sonic velocity per degree Fahrenheit. The LiquIdent™ routine uses this slope factor to maintain an accurate liquid identification as the liquid temperature varies.

NOTE: The LiquIdent™ Slope Factor for all liquids within a liquid class should be essentially identical, even though their individual sonic velocities may be very different.

This menu cell allows the LiquIdent™ Slope Factor to be edited for optimal operation. The LiquIdent™ Slope Factor default is 2.300. This default factor applies to hydrocarbon liquids at the reference temperature of 60ºF/15.6ºC (default).

To calculate a liquid's LiquIdent™ Slope Factor:

- Establish the maximum (Tmax) and minimum (Tmin) operating temperatures for all liquids within the Liquid Class. For each liquid, note the measured sonic velocity (located in the Diagnostic Menu) at *Tmax* and the sonic velocity at *Tmin* (in-meters-per-second).

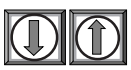
- Use the following formula to calculate the LiquIdent™ Slope Factors with the Liquid Class:

$$\text{LiquIdent™ Slope Factor} = \frac{(\text{Vs @Tmin}) - (\text{Vs @Tmax})}{(\text{Tmin} - \text{Tmax})}$$

NOTE: If the Centigrade scale is used for Tmax and Tmin, multiply the result by 0.56 to obtain the liquid's LiquIdent™ Slope Factor.

- Calculate the average of all the LiquIdent™ Slope Factors with the Liquid Class.

To enter the LiquIdent™ Slope Factor:

From the [Liquid Table] menu cell, press  to scroll down to LiquIdent™ Slope.

Press  to enable numeric entry.

Use the keypad numeric keys to enter desired LiquIdent™ Slope Factor.

To enter the LiquIdent™ Slope Factor press  .

Setting The Pressure Slope

The 1010PVN measures and reports the flowing liquid's sonic velocity (Vs) and its related pressure (P). Since a pressure change will affect the sonic velocity of the liquid, a method to balance the measured sonic velocity to a fixed reference pressure (4.7 PSIA/1.013 Bara) is provided. The Pressure Slope Factor default is 0.030 (m/s per PSI). This pressure slope factor helps maintain an accurate liquid identification as the LiquIdent™ factor and liquid temperature vary.

The 1010PVN has the ability to accept a 4-20 mA input for pressure. If used, the 1010PVN will process pressure data based on the analog input. This is recommended for pipelines that have wide pressure variances.

To calculate a liquid's Pressure Slope Factor:

- Establish the maximum (Pmax) and minimum (Pmin) pressures for all liquids within the Liquid Class. For each liquid, note the measured sonic velocity at *Pmax* and the sonic velocity at *Pmin* (in-meters-per-second).

- Use the following formula to calculate the Pressure Slope Factors with the Liquid Class:

$$\text{Pressure Slope Factor} = \frac{(\text{Vs @Pmin}) - (\text{Vs @Pmax})}{(\text{Pmin} - \text{Pmax})}$$

- Calculate the average of all the Pressure Slope Factors within the Liquid Class.

To enter the Pressure Slope Factor:

From the [Liquid Table] menu cell, press  to scroll down to *Pressure Slope*.

Press  to enable numeric entry.

Use the keypad numeric keys to enter the desired Pressure Slope Factor.

To enter the Pressure Slope Factor press  .

This moves the highlight down to [Liquid Index].

The Reference Base Temperature

The 1010PVN uses a reference Base Temperature of 60ºF (15.6ºC) for the LiquIdent™ Slope, 14.7 PISA (1.013 Bara) Pressure Slope and other settings.

Setting the LiquIdent™ Index

A Liquid Class must have an associated LiquIdent™ Index Scale. The 1010PVN uses this scale to compensate its outputs for variations in liquid type.

A LiquIdent™ Index is the sonic velocity for the liquid at the Base Temperature, generally 60ºF (15ºC). When a LiquIdent™ Index is entered for a particular liquid within the Liquid Class, the liquid's viscosity must also be entered at the LiquIdent™ Index.

To create a LiquIdent™ Index Scale for the Liquid Class, a minimum of two LiquIdent™ Indices are required to be entered. If desired, up to thirty-two LiquIdent™ indices can be entered. However, the computer only needs two to establish a scale of all the possible LiquIdent™ indices for the Liquid Class.

After the computer interpolates the LiquIdent™ Index Scale, its projections can be checked by entering a meaningful LiquIdent™ Index and examining the reported viscosity values. The scale can be fine-tuned by manually adjusting the factors at up to thirty-two separate points.

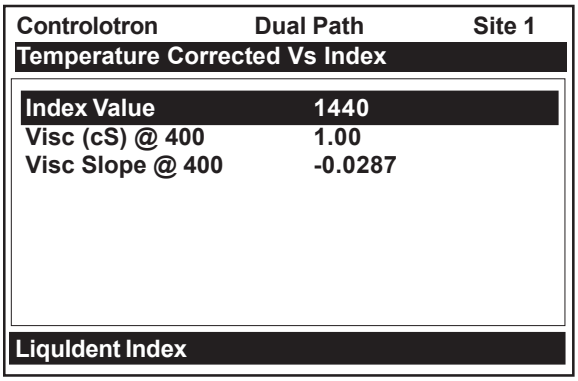
To enter the LiquIdent™ Index:

From the [Liquid Table] menu cell, press  to scroll down to [LiquIdent Index].

Press  to enable numeric entry.

Use the keypad numeric keys to enter the desired LiquIdent™ Index.

To enter the LiquIdent™ Index press ENT.



Each of the data points of a Site Liquid Table (maximum of 32) may be filled in by the user as indicated in the menu screen shown above.

Index Value - The temperature-corrected sonic velocity (LiquIdent) which points to the output variables forming the balance of the table entry. Below this you may enter the values associated with that LiquIdent value.

Viscosity - The kinematic viscosity of the liquid at system Base Temperature (units: centistokes).

Visc Slope - The exponent of the logarithmic expression used to project the liquid viscosity at measured temperature. The default value (-0.0287) has been found to be adequate for many hydrocarbons.

$$\gamma_n = e^{\left(V_{SLP} \times \Delta t + \ln(\gamma_b)\right)}$$

where:

γ_n = Kinematic viscosity at current measured temperature (cS)

e = Base of natural logarithms

V_{SLP} = Viscosity Slope (i.e., -0.0287)

Δt = Current Measured Temperature minus Base Temperture (degrees F)

γ_b= Visc @ Base Temperature (cS)

2.3.3 HOW TO SELECT A PIPE TEMPERATURE RANGE

This menu cell informs the flow computer about the expected temperatures that the transducers will be subjected to during operation. The default setting, -30^{0}F to 225^{0}F corresponds with the rated temperature range of our standard 991 or 1011 series transducers. The other selections provide higher upper limits of 375^{0}F and 450^{0}F respectively.

If you know that the pipe temperature will exceed 250^{0}F at the transducer mounting location, please use this menu cell to select the appropriate range. This will allow the flow computer to restrict its transducer recommendations to the appropriate environmentally rated types.

To select a Temperature Range:

To access the [Temperature Range] option list press 

To highlight the desired range press 

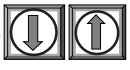
To register your selection press 

2.3.4 PIPE CONFIGURATION

The [Pipe Configuration] menu cell in the Application Data menu presents a list of descriptions of piping configurations that could affect the flow profile characteristics (such as “Single Elbow”). Examine the option list. Selecting a piping configuration that closely approximates conditions at or near your mounting location allows the flow computer to compensate for the effect of upstream piping on flow profile. The number of diameters between the upstream configurations and the transducer installation can be numerically entered via the [Anomaly Diams] menu cell.

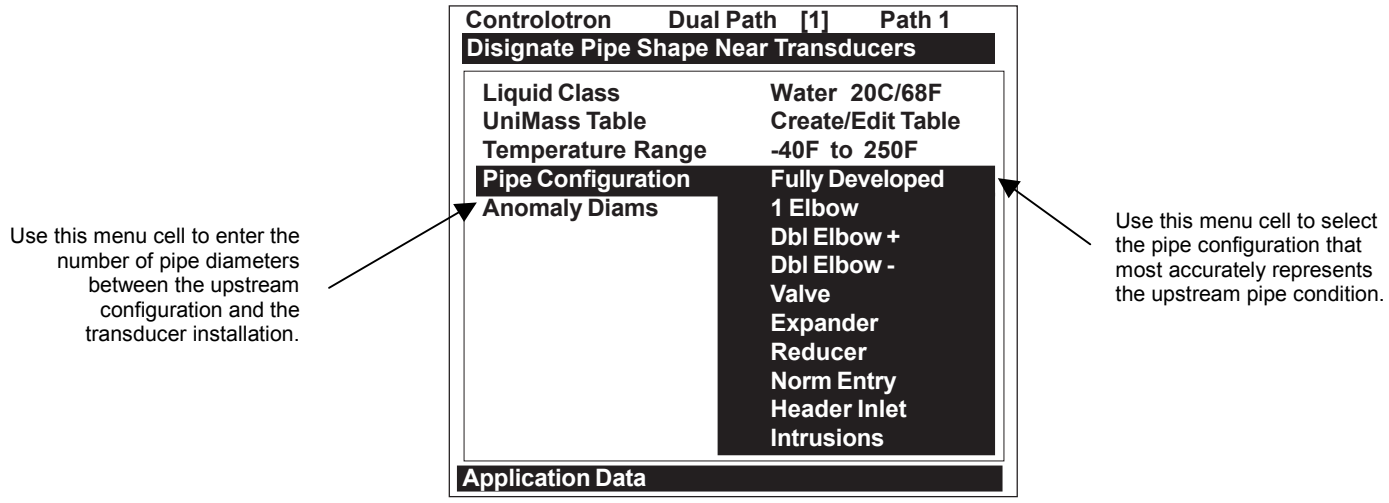
To select a Piping Configuration:

To access the option list press 

To highlight the desired piping configuration press 

To register selection press 

The default pipe configuration (Fully Developed) wll cause the flowmeter to use the conventional Reynolds Compensation Table when compensating for liquid flow profile behavior.



Pipe Configuration Menu Structure

Application Data ⇨ ⇳	Pipe Configuration ⇨ (Change to Upstream Piping) ⇳	⇳ Fully Developed* 1 Elbow Dbl Elbow + Dbl Elbow - Valve Expander Reducer Norm Entry Header Inlet Intrusions
⇨	Anomaly Diams	xxxx (numeric entry)

* Default

PIPE CONFIGURATION OPTION LIST DEFINITIONS

Fully Developed Fully Developed flow, as would be expected for very long straight pipe runs or installation downstream of a flow condition.

1 Elbow Single 90 degree Elbow upstream of transducer installation.

Dbl Elbow + Double out-of-plane Elbows upstream of transducer installation.

Dble Elbow - Double in-plane Elbows upstream of transducer installation.

Valve To Be Determined.

Expander Pipe expansion upstream of transducer installation.

Reducer Pipe reduction upstream of transducer installation.

Norm Entry To Be Determined.

Header Inlet Header or pipe manifold upstream of transducer installation.

Intrusions To Be Determined.

2.4 THE PICK/INSTALL XDCR (Transducer) MENU

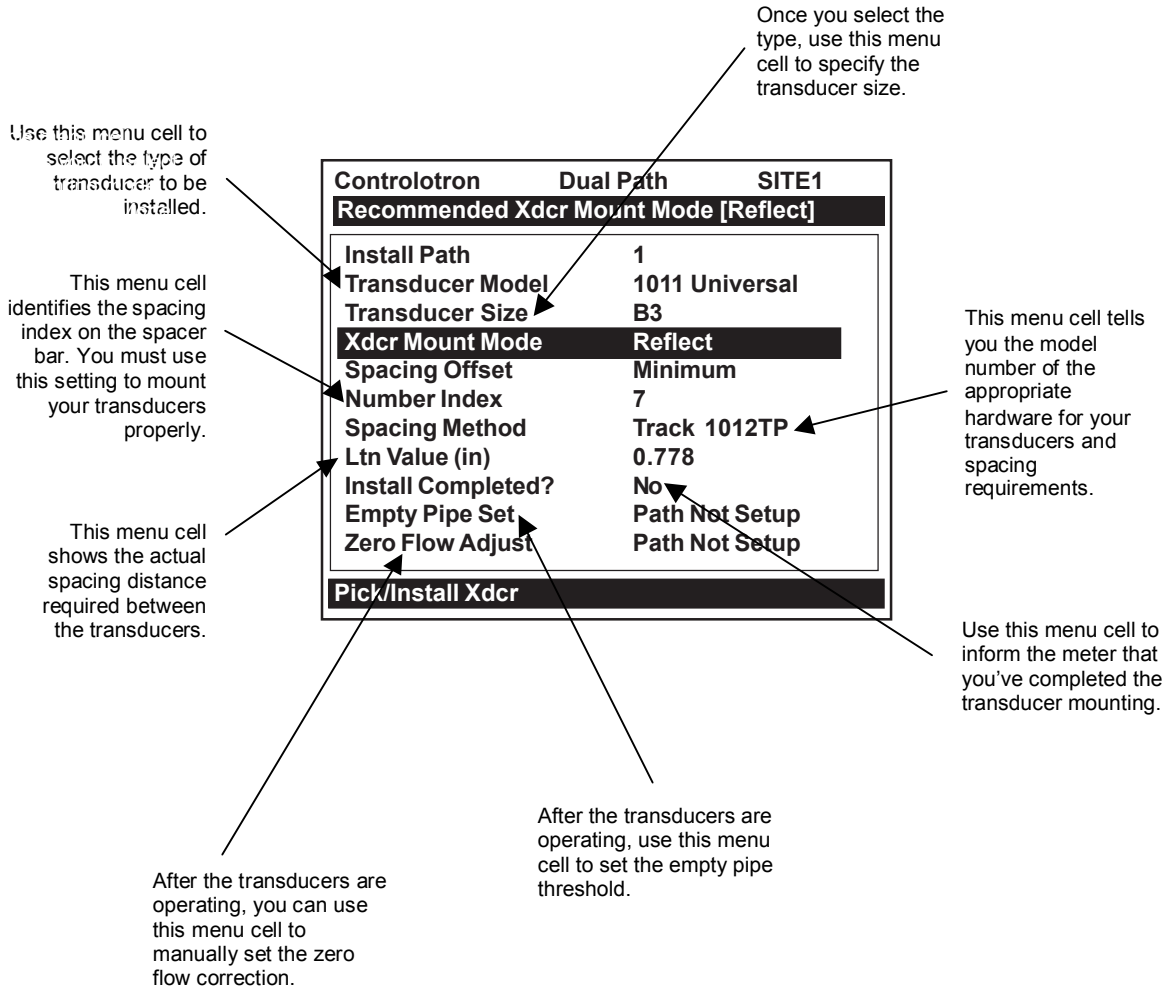
Use this menu after creating a new site setup in the Channel Setup menu, and defining the pipe parameters in the Pipe Data menu.

Based on pipe data (and optionally application data) entries, the Pick/Install Xdcr menu automatically identifies the most suitable transducers for the application. It recommends the appropriate mounting mode (direct or reflect) and lists the Spacer Bar or Mounting Track part number and spacing index. Ideally, you will be able to use the primary recommendations. However, you can edit the menu entries as required to accommodate different transducers or mounting configurations.

The 1010PVN will adjust its parameters to optimize performance based on your selections. The Ltn menu cell shows the required spacing distance (in inches or millimeters) between the upstream and downstream transducers. Use the [Install Completed?] menu cell to inform the flow computer that you completed the physical mounting of the transducers. You can define the empty pipe and zero flow values once the transducers are operational.

NOTE: It would probably be most beneficial to you at this point to read Section 3 before proceeding to mount transducers.

NOTE: When installing transducers do not key in the V/M (Version/Modification) label number as the Transducer Size.



NOTE: Menu cell [Install Path] appears when the Dual Path Flow meter is selected from the [Select Meter Type] menu. The Path [1] or Path [2] menu cell can be selected by pressing the <Right Arrow>.

PICK/INSTALL XDCR MENU STRUCTURE

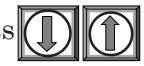
Pick/Install Xdcr ⇨	Transducer Model ⇨ ⇳	991 Universal 1011 Universal 1011 Hi Precision		
	Transducer Size ⇨	*1011 Universal*	*991 Universal*	*1011H High Precision*
	⇳	⇳ A1 A2 B1 B2 B3 C1 C2 C3 D1 D2 D3 E1 E2 E3	⇳ 0A 0 1 2A 2 3A 3 4A 4 5A 5	⇳ A1H A2H A3H B1H B2H B3H C1H C2H D1H D2H D3H D4H
⇳	Xdcr Mount Mode ⇨ ⇳	⇳ Direct Reflect		
	Spacing Offset ⇨ ⇳	⇳ Minimum Nominal Maximum		
	Number Index ⇨	4 *(generated)*		
	Spacing Method ⇨	Spacer Bar [P/N]	⇨ *auto P/N generation	
	Ltn Value (in) ⇨	2.00 (generated)		
	Install Completed ⇨	⇳ No [Yes] Install	**[Yes] indicates successful install*	
	Empty Pipe Set ⇨ ⇳	⇳ MTYmatic Set Empty Actual MTY		
	Zero Flow Adjust ⇨ ⇳	⇳ AutoZero ZeroClr Reversamatic Actual Zero ZeroMatic	**Reflect mount only*	

2.4.1 HOW TO SELECT A TRANSDUCER MODEL

Use the [Transducer Model] menu cell to define the type of transducer for use with your application. This allows the flow computer to adjust its transmit/receive functions accordingly. You can choose from either the [1011 Universal] or [1011H High Precision] transducer lists, or from a list of [991 Universal] models. You should consider using high precision transducers for extremely critical applications. We usually recommend these transducers for custody transfer, leak detection or nuclear power applications. The system default is [1011 Universal]. If this suits the application, bypass this menu cell by pressing the <Down Arrow>.

To select a Transducer Model:

To access the [Transducer Model] option list press 

To move the cursor to the required transducer model press 

To store your selection press 

2.4.2 HOW TO SELECT A TRANSDUCER SIZE

When you move the cursor to [Transducer Size], the highlighted prompt at the top of the display screen shows a list of recommended transducer sizes. For example **[Recommended Xdcrs: D3, D2, D1, C1, C3].** The flow computer generates this list automatically based on your pipe and your application data entries. The left-most transducer size (e.g., D3) is the primary (most appropriate) choice. The right-most transducer (e.g., C3) is still acceptable (but the least desirable) choice. Since these are simply recommendations not requirements, you can override the flow computer and use any size, as long as the mounting method accommodates the pipe's diameter. The flow computer shows that your selection is acceptable if it is able to calculate transducer spacing (Ltn).

To select a Transducer Size:

To access the [Transducer Size] option list press 

To move the cursor to the desired transducer size press 

To select the transducer press 

2.4.3 HOW TO SELECT A XDCR MOUNT MODE

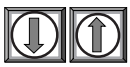
The flow computer recommends the transducer mounting mode [Direct or Reflect]. In almost all cases it will be Reflect, since this is the most desirable configuration. Reflect mode allows you to mount the transducers on pipes that do not permit back or side access. Reflect mode provides inherent compensation for flow profile distortion (crossflow) that could be the result of unfavorable application conditions such as an insufficient upstream straight run. In addition, Reflect mode supports the AutoZero™ function, which sets the zero flow velocity automatically.

Direct mounting may produce a stronger transducer signal and requires less mounting length than Reflect mounting. This can be important if the liquid or pipe material exhibits high sonic attenuation, thereby preventing operation in the Reflect configuration.

NOTE: We recommend using Direct Mount with Plastic pipes.

To select a Xdcr Mounting Mode:

To access the [Xdcr Mount Mode] option list press 

To move the cursor to the required mounting type press 

To store selection press 

2.4.4 HOW TO USE THE SPACING OFFSET

After you select the mounting method, the flow computer checks your entries for pipe size, transducer type etc. and then recommends a spacing offset. This is the first step in establishing the correct distance between the transducers. Spacer bars and mounting tracks utilize

number indices (labels) to simplify transducer placement. One transducer is located at the Reference position, while the other one is located at the Number Index position. The Number Index cannot be directly edited. However, the Spacing Offset can be changed via its option list. Changing the Spacing Offset will alter the reported Number Index. Maximum spacing offset provides moderately greater signal levels but, in some cases, slightly decreased zero flow stability. (NOTE: This mounting method is different for the System 991 Flowmeter.)

If the flow-computer reports "Use Ltn," you have to measure the distance between the upstream and downstream transducers. The flow computer issues the actual distance between the transducers in inches or millimeters (See Ltn paragraph 2.4.7). Please consult Section 3 for details on how to use the Ltn measurement. Note that, even though using Ltn does not call for the physical use of the Number Index, you can still change the Spacing Offset to influence the strength of the transmit signal.

The 1010PVN uses a pair of precisely matched transducers. Therefore, you can select either one for the Reference position. You must connect the Up transducer cable to the transducer mounted on the upstream side of the mounting track. This lets the meter display the flow direction correctly.

It is important that you note each transducer's serial number and its Index position during the original installation because to reinstall the flowmeter successfully, you must remount each transducer in its original position. Transducer pairs have matching serial numbers except for the appended letters "A" and "B." This helps you to identify each transducer.

To select a different Spacing Offset

To access to [Spacing Offset] option list press 

To move the cursor to the desired offset press 

To store selection press 

2.4.5 THE NUMBER INDEX MENU CELL

Selecting the Spacing Offset allows the flow computer to calculate the Number Index. The Number Index establishes the spacing between a pair of transducers. You cannot override this recommendation. To complete the transducer installation, you must accept the Number Index by mounting the transducer at that point on your spacer bar or mounting track. Initially, the flow computer bases its Number Index selection on the pipe diameter and estimated liquid sonic velocity (Vs) you entered in the Applcation Data menu. When you invoke the [Install Completed?] routine, the flow computer actually measures the liquid sonic velocity (Vs). In some cases, it may prompt you to re-space the transducers to another number index.

2.4.6 REVIEWING THE SPACING METHOD

The flow computer analyzes your transducer selection, mounting mode and pipe size to determine the best way to install your transducers. It will recommend the use of either a mounting track, a spacer bar, or independent mounting. The flow computer will list the part number of a mounting track or spacer bar. If it decides upon independent mounting, it will report the distance required between the two transducers. In this case, you have to make sure that when you mount the transducers, the space between them equals the length specified in the Ltn menu cell. See Section 3 for details on how to accomplish this.

2.4.7 THE Ltn VALUE MENU CELL

This view only menu cell shows the distance in inches or millimeters between the front faces of the transducers along the axis of the pipe. If you are mounting the transducers without a track or spacer bar, you have to space them according to this value (see Section 3 for details). Note that Ltn may be a negative number for direct mount on very small pipes where the transducer spacing overlaps.

2.4.8 HOW TO USE [INSTALL COMPLETED?]

Use the [Install Completed?] menu cell to inform the flow computer that you have mounted the transducers according to the selected mode and spacing requirements and are ready to start operation.

To start the [Install Completed?] routine for an original installation:

Select [Dual Path Flow]and press the <Right Arrow>.

Press <Down Arrow>. Scroll to the [Pick/Install Xdcr] menu cell. Press <Right Arrow>.

Install transducers as required (refer to appropriate 1010 Field Manual for procedures).

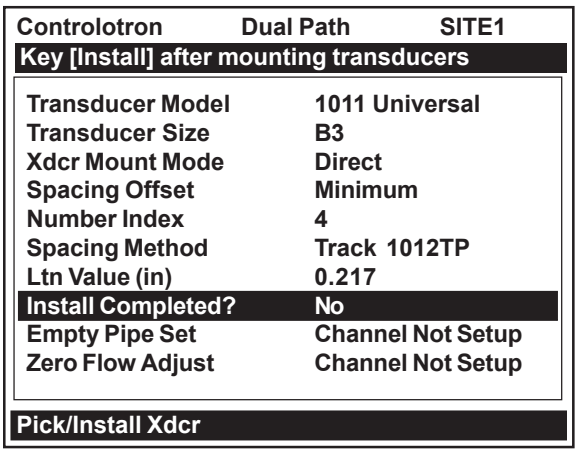
NOTES

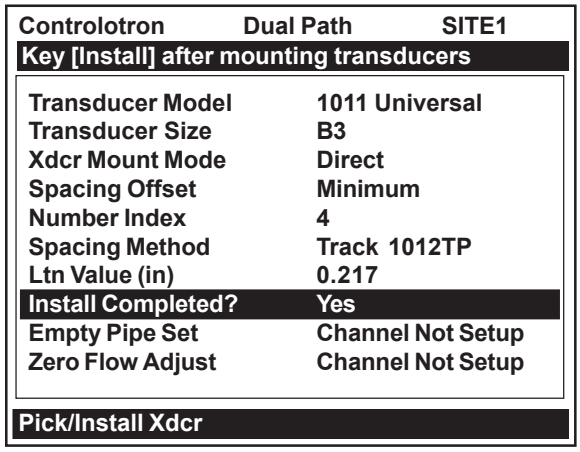
- *Mount the transducers using the selected mode (direct or reflect). Please refer to the transducer mounting procedures detailed in Section 3.*
- *When using a mounting track or a spacer bar in reflect mode, locate the first transducer at the Reference Index and the second transducer at the recommended Number Index.*
- *If you are mounting the transducers independently, you must use the recommended distance; Ltn to space the transducers.*
- *You must use the proper sonic coupling compound. See "Recommended Sonic Coupling Compounds" in Section 5 for appropriate type and part number.*
- *The pipe must be completely filled with a liquid, which can be either flowing or at zero flow.*

After transducers are properly mounted, the flow computer completes its Initial Makeup command and the [Install Completed?] menu cell appears.

To access the [Install Completed?] option list, press the <Right Arrow>.

Press <Down Arrow> and scroll to the [Install] menu cell and then press <ENT> (unless otherwise directed to do so by Controlotron's Technical Service Department).





Press <ENT>. The [Install Completed?] menu cell will indicate [Yes] after the 1010PVN is successfully installed.

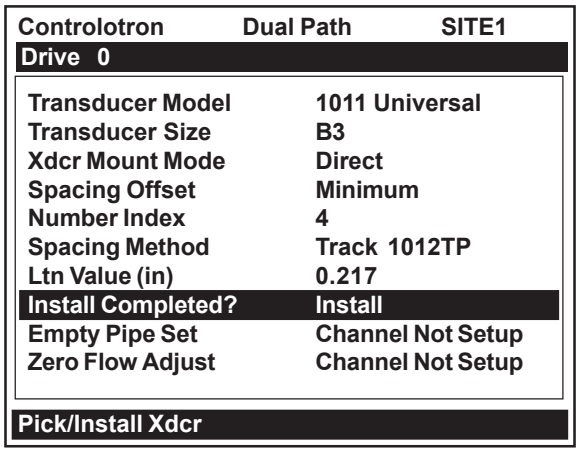
To complete the Install process disregard the following paragraphs explaining the Force Transmit and Force Frequency diagnostic software routines. Proceed to the Install process completion steps immediately following the Force Transmit procedures.

NOTE: If the transducers have been installed successfully but the Estimated Vs (sonic velocity) has been changed, the Pick/Install Xdcr menu cell [Install Completed?] option list will also display the [Transfer Install] function selection. The Transfer Install function allows the transducers to be optimally positioned for a different fluid, without the need for a new Initial Makeup procedure (see the Water Calibration addendum in this manual for details).

Force Transmit Procedure

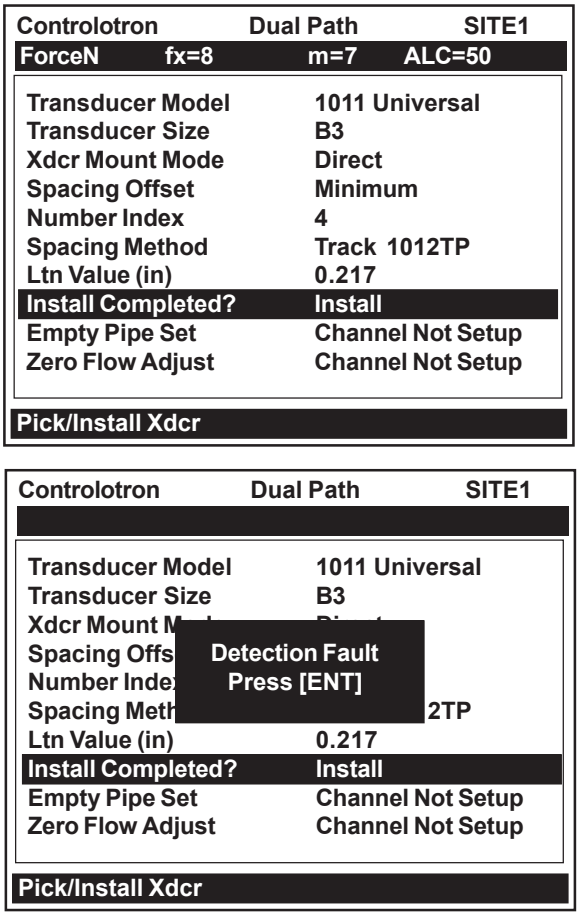
This diagnostic software routine allows the user to "force" a transmitting condition that can be use to search for an amplitude level (ALC) when Detection Fault or Low Signal alarms are present. The routine forces the flowmeter to generate constant transmit bursts while reporting current receive signal strength for the user.To initiate the Force Transmit function, refer to example below.

1. After [Install Completed?] is selected press <ENT>. While the meter is going through the drives (see menu screen below), press the <ALT> and <MENU> keys simultaneously.



NOTE: The <ALT> and <MENU> keys must be pressed before the flowmeter scans through all the drives, or the selection of the detection mode and the Force Transmit function must be initiated again.

2. A typical menu screen will appear as shown below and indicate the current ALC (e.g., 50). This ALC number indicates the current receive signal strength and can be used for further diagnostic purposes.



3. To exit Force Transmit, press the <Left Arrow> and a Detection Fault prompt will appear (see above).

4. Press the <Left Arrow> again and the meter will return to the Pick/Install Xdcr menu and highlight the [Empty Pipe Set] menu cell.

5. *To force a frequency*, repeat steps 1 and 2 above, but press <Right Arrow>. The following typical display line will appear: **Drive =0**

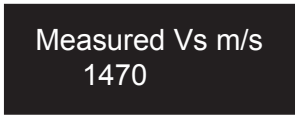
Using numeric keys enter the frequency and press <ENT>.

To complete the Install process after mounting the transducers press <ENT>.

6. *If the Force Transmit diagnostic procedure is not used*, the normal [Install Completed?] function occurs as follows:

Immediately after you press <ENT>, the computer starts an internal process called an Initial Makeup. The current Initial Makeup activity, for example: **Drive 14 m 10 [——]** appears at the top of display screen. During the Initial Makeup, the flow computer verifies the site data,

verifies your site data, records the sonic characteristics of the pipe and liquid and then adjusts internal parameters to optimize flow measurement. Please remain patient. This process can take several seconds or several minutes to complete. There is no relationship between the length of an Initial Makeup and the meter's subsequent performance. An Initial Makeup for larger pipes (and more demanding application conditions) simply takes a little longer. Upon successful completion of the initial makeup, the 1010 will show you a pop-up window with the measured Vs as shown in the example below.



This means that the flow computer was able to complete the Initial Makeup and is now actively measuring flow. This pop-up window allows you to "fine-tune" the Measured Vs by pressing the <Right Arrow> to activate numeric entry. You can then use the numeric keys to type a different value. However, only edit the Measured Vs when you are certain of your liquids actual sonic velocity. If, however, there is a large discrepancy between the "measured" Vs and the "actual" Vs, then consider that an accurate Vs measurement depends on certain parameters that the flow computer cannot sense directly (e.g., pipe dimensions or transducer placement). In other words, entering incorrect pipe parameters or not using the recommended spacing could result in an erroneous Vs measurement.

The meter is now ready to report flow. Press the <Menu> key to display flow.

In cases where the actual Vs differs noticeably from the estimated Vs, the computer may issue a re-space command. This requires that you re-space the Number Index transducer at the new Number Index, then press <ENT> again. Repeat the initial makeup process. You can override a re-space command by simply keying the <Down Arrow>. However, after the meter completes begins operating, you must confirm that the sonic velocity (Vs) of the liquid falls between the [Vs max] and [Vs min] items in [Diagnostic Data/Site Setup Data].

Therefore, only consider editing the measured Vs after you remove all the primary causes for an inaccuracy. Check your pipe dimensions and pipe material entries. Re-check the transducer spacing and part numbers. Large Vs discrepancies are almost always due to erroneous pipe data or incorrect transducer placement.

To accept the Measured Vs:

Pressing  or  moves the cursor to the [Empty Pipe Set] menu cell.

If you decide to edit the Measured Vs:

To activate numeric entry press 

Use the numeric keys to type the new Vs value (in meters-per-second).

To store the corrected Vs press 

The flow computer may recommend a new Number Index and prompt you to press 

Remount the transducer at the new Number Index.

To repeat the Initial Makeup process press 

After the flow computer completes its Initial Makeup command, the [Install Completed?] option list changes to:

Install Completed?	Yes
	New Makeup

If you want to redo the Initial Makeup, move cursor to [New Makeup], then press <ENT>. This resets the option list. You can now repeat the install routine described previously.

2.4.9 THE EMPTY PIPE SET MENU

The flow computer performs the MTYmatic routine automatically during its Initial Make-up to establish a standard setting for the Empty Pipe alarm. The [Empty Pipe Set] option list allows you to re-invoke MTYmatic, use an Actual MTY routine (if application conditions allow you to empty and refill the pipe) or use the Set Empty routine to set the empty pipe threshold by direct numeric entry.

How to Use the Actual MTY Command

If application conditions allow you to empty and refill the pipe, then you should perform the Actual Empty procedure. This is the recommended way to define the empty pipe threshold.

NOTE: NEVER perform this procedure when the pipe is full.

To perform the Actual MTY Procedure:

To access the [Empty Pipe Set] option list press 

To move the cursor to [Actual MTY] press  then ENT

[Empty Pipe Press Enter] appears on the menu prompt line.

Empty the pipe completely, then press ENT. [Fill Pipe Press Enter] appears on the menu prompt line.

Refill the pipe completely, then press ENT

How to Use the MTYmatic Command

You can repeat MTYmatic (performed during the Initial Makeup) to correct an inaccurate Actual MTY setting if conditions do not allow you to repeat the Actual Empty procedure.

NOTE: Only use the MTYmatic procedure when the pipe is full.

To start MTYmatic:

To access the [Empty Pipe Set] option list press 

Move the cursor next to [MTYmatic] by pressing 

To invoke MTYmatic press ENT

How to Use the Set Empty Command

Use [Set Empty] to enter a number that represents the signal strength level consistent with an empty pipe. Set Empty uses non-linear scaling. There is no direct correlation between the number you enter and any standard amplitude unit. If you set the number too low, the meter may not detect a true empty pipe. If you set it too high, it could trigger the empty pipe alarm, suspending flow measurement, even though the liquid is flowing.

To enter an Empty Pipe Alarm Threshold:

To access the [Empty Pipe Set] option list press 

To move the cursor to [Set Empty] press 

Press ENT. The current empty threshold number appears in a pop-up window.

Use the numeric keys to type a new Set Empty number.

To store the Set Empty number press ENT

2.4.10 ZERO FLOW ADJUST MENU

Unlike turbine meters ultrasonic transit-time meters provide active flow measurement right down to zero flow, however, the measurement of the transit-time delta is dependent on the similarity or "match" of the electronics, cables and ultrasonic transducers. Consequently some flow offset (or zero offset) may be present in any installation. To eliminate this residual zero offset Controlotron has developed several different methods to insure proper zero flow compensation. The following paragraphs describe each method and when they should be used.

AutoZero

When the 1011 transducers are mounted in the Reflect Mode configuration (see paragraph 3.1.5) the AutoZero routine is automatically invoked at the end of the Initial Makeup. Flow does not have to be stopped to perform AutoZero since only the pipe wall signal is used in determining the zero offset and not the liquid component. The AutoZero routine performs a one-time analysis of the pipe wall component of the ultrasound signal to quantify any residual mismatch in the hardware. Once the AutoZero routine is complete, the system memorizes this measured zero offset and subtracts this value from the flow reading.

Actual Zero

The "Actual Zero" function simply averages the indicated "zero flow" readings (over a user defined time period) then stores this average value in memory. Under normal operation the indicated flow reading is zero compensated by simply subtracting this memorized value from the uncompensated flow reading. Actual Zero is the most positive method for zeroing the system, however, *flow must be stopped with the line blocked (if possible) before invoking this function.* If stopping flow is not possible then an alternate zeroing method should be selected.

ReversaMatic™

This routine involves swapping the UP and Down transducers on the pipe (while keeping the cables attached) such that the difference in the transit-time change represents the zero offset. The fixed zero offset value is stored in memory in the same manner as described in Actual Zero. This routine would generally be used whenever flow cannot be stopped and the transducers cannot be mounted in the Reflect Mode configuration. Flow must be stable during the entire process.

ZeroMatic™ *(not present in MultiPulse operation)*

When ZeroMatic™ is invoked the flowmeter first performs the same analysis as described above in the AutoZero routine. However, after this analysis is complete the flowmeter continues to interrogate the pipe wall signal and update the zero offset value under normal operation, such that the flowmeter dynamically compensates for changing conditions which would normally result in zero drift. ZeroMatic™ will only operate with the transducers mounted in the Reflect Mode configuration and is recommended for applications which experience large temperature extremes.

NOTE: Invoking ZeroMatic™ will clear any existing "fixed" or memorized zero offset. If any zero offset remains after flow is stopped, an Actual Zero can be performed without interrupting ZeroMatic™ operation. To disable ZeroMatic™, invoke it again, but then press <Left Arrow> to abort the installation.

NOTE: The ZeroClr command only resets the memorized zero offset registers not those set when the AutoZero routine is invoked.

Using Actual Zero

NOTE: Flow must be stopped with the line blocked (if possible) before invoking this function.

To invoke Actual Zero:

Access the [Zero Flow Adjust] option list by pressing 

Press  . A pop-up window prompts you to set the current flow rate (in selected rate units) to equal zero (0.000).

NOTE: If a flow offset is desired (i.e., to test analog outputs) then press <Right Arrow> to enable numeric entry.

Press  to start the Actual Zero process.

When you send the command, the flow computer analyzes the current flow rate for up to sixty seconds, integrating (averaging) the data for the best zero correlation. During this time, the menu prompt at the top of the display screen shows a timer that counts from zero to sixty. You can allow zero averaging for the entire period, or cancel the process at any time by pressing the <ENT> key. This controls the amount of data the meter averages to obtain a zero level.

Using ReversaMatic™

If site conditions do not permit stopping the flow rate at the mounting location, and you do not know the current flow rate, then you can use the ReversaMatic™ routine to establish the zero flow level. You should perform the ReversaMatic™ procedure as quickly as possible to ensure that the flow rate remains constant throughout the procedure.

To invoke ReversaMatic:

- To access the [Zero Flow Adjust] option list press 
- Move the cursor to [ReversaMatic]. Press  to invoke the routine.

- The meter begins to measure the positive flow rate. "Positive" flow refers to flow moving from upstream transducer location to the downstream transducer location. Note top prompt line shows: **Reversamatic Action**

- Upon completion, the meter beeps and the display screen shows:
  Reverse Xdcrs / Press ENT
- Now remove then remount the upstream and downstream transducers in their reversed positions. Mount the Up transducer (without removing its cable) in the Down transducer/ cable location. Mount Down transducer with its cable in the Up transducer/cable location. When remounting the transducers, couple them to the pipe properly. Press <ENT> (after re-installing the transducers).

- The flow computer measures the negative flow rate briefly, then beeps and repeats the prompt: **Reverse Xdcrs / Press ENT**

- Now remount the transducers for normal operation (in their original orientation). When remounting transducers, couple them to the pipe properly. Press <ENT> (after re-installing the transducers).

This completes the ReversaMatic™ procedure. The system's zero accuracy will be very close to that obtainable using the Actual Zero method, providing flow remained constant during this procedure.

Important Note: *A caution on the use of upper and lower flow limits (used to prevent flow misregistration) prior to using the Reversal Zero technique (ReversaMatic): If the negative flow rate that the meter reads in the step during which the transducers are reversed is more negative than the lower flow limit, the meter will re-register positive and the Reversal Zero cycle will thus be corrupted.*

Therefore, postpone the installation of upper and lower flow limits until the reversal zero procedure is executed successfully. For pipes that combine large diameters with very high flow velocities, it may be necessary to move the upper and lower flow limits out of the way until the reversal zero is completed. Moreover, pipes of this size frequently have excellent intrinsic zero performance and may not even need zeroing.

ZeroMatic™ (optional function)

NOTE: ZeroMatic™ is used in the Reflect Mode only. Invoking ZeroMatic™ clears any existing fixed zero offset.

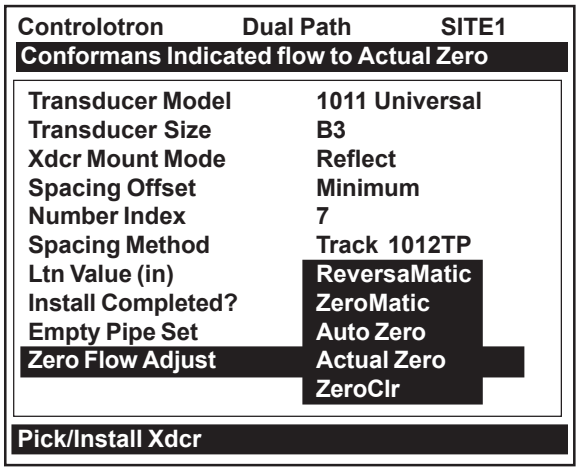
Use this menu cell to select the ZeroMatic™ option. If conditions permit the use of the Auto Zero function then the ZeroMatic™ option can be used as well.

To select and enable the ZeroMatic option:

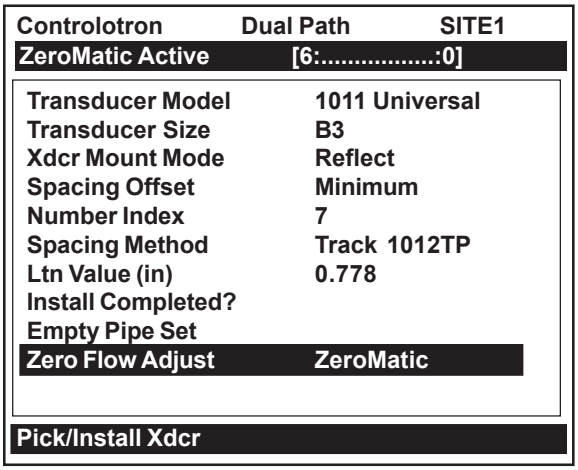
In the Pick/Install Xdcr menu, press  to scroll to the [Zero Flow Adjust] menu cell.

To access the [Zero Flow Adjust] option list press 

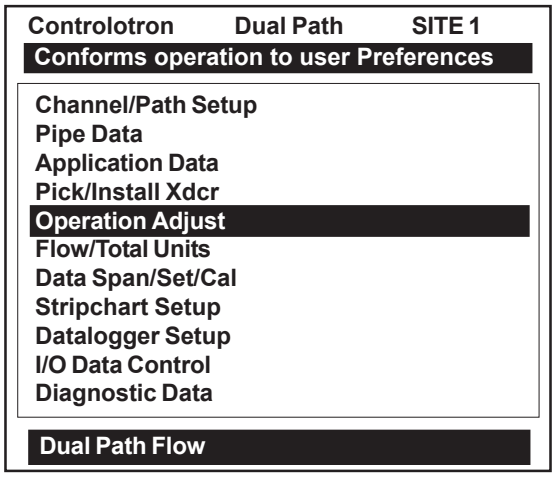
NOTE: If ZeroMatic™ is not running, the [Actual Zero] menu item will be displayed next to the [Zero Flow Adjust] menu cell.



Select the [ZeroMatic] menu cell by pressing ⇩ or ⇧ then press ENT

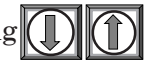


When the inital makeup of ZeroMatic™ is complete the screen will return to the Pick/Install Xdcr menu and automatically highlight [Operation Adjust], which is the next menu cell.



To disable the ZeroMatic function:

Select the [Pick/Install Xdcr] menu cell from the Dual Path Flow menu.

Scroll down to the [Zero Flow Adjust] menu cell by pressing 

NOTE: The highlighted [ZeroMatic] menu item is the only indication that ZeroMatic™ is functioning.

Invoke the ZeroMatic™ initial makeup procedure as previously described above.

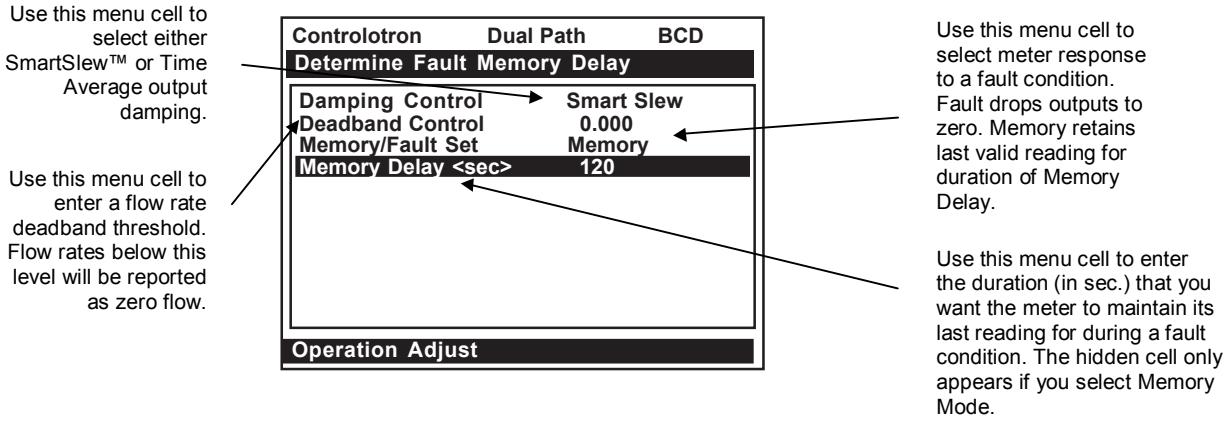
While ZeroMatic™ initial makeup is running, press  to abort the process thereby disabling the function.

The screen will return to the Dual Path Flow menu and highlight the [Operation Adjust] menu cell.

2.5 THE OPERATION ADJUST MENU

This menu becomes available after picking a meter type and measurement channel. We recommend that you use it after the transducers are installed and operating to "fine-tune" the meter's output characteristics.

Each application presents different data display and output requirements due to unique pipe and liquid conditions. Use the [Operation Adjust] menu to match meter operation to the site. You can set damping controls for the primary flow rate output. You can define a Deadband, (usually a very low flow rate), below which, the flow output will be forced to zero. You can also select the meter response to a continuous Fault condition.



Operation Adjust Menu Structure

Operation Adjust ⇨ ⇳	⇳ Damping Control ⇨	⇳ Smart Slew x *(numeric selection)* Time Average xx.x *(numeric entry)*
	⇳ Deadband Control ⇨	x.xx *(numeric entry)*
	⇳ Memory/Fault Set ⇨	⇳ Memory Fault
	⇳ Memory Delay (sec) ⇨	xxx *(numeric entry) (hidden in Fault Mode)*

2.5.1 DAMPING CONTROL

System 1010 provides two different data output filter types, Time Average and SmartSlew™. Time Average (recommended) integrates the instantaneous flow rate over a selectable time period. Use the Time Average function when stability in flow reading is essential. A value entered (in seconds) sets the time it takes the meter to respond to a rate change. The default is 10 seconds. Enter any amount of time up to 60 seconds maximum.

SmartSlew™ performs data scatter damping during steady flow periods while maintaining the ability to respond to changing flow rates. SmartSlew™ values range from [1 to 9]. Pick a higher number to slow meter response to a rate change.

To select Time Average (default):

To access the [Damping Control] option list press 

To move the cursor down to [Time Average] press 

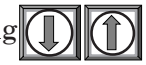
To enable Time Average entry press 

Use the numeric keys to type the new Time Average setting.

To register the new value press 

To edit the SmartSlew™ setting:

To access the [SmartSlew] option list press  three times.

Scroll the numeric list to the desired choice by pressing 

To register the new value press 

2.5.2 DEADBAND CONTROL

Use Deadband Control to instruct the meter to report zero flow if the flow rate falls below a specified level (usually a very low rate). It will prevent the possibility of data scatter (a natural result of digital computation) from causing false totalizer accumulation during long non-flowing periods. Inspect the actual data scatter during zero flow conditions to find the proper deadband setting for your application.

To edit the default setting (0.000):

To enable numeric entry press 

Use the numeric keys to type in the desired rate (using selected flow rate units).

To register the new value press 

2.5.3 MEMORY/FAULT SET

Certain situations (e.g., an empty pipe or excessive aeration) will interrupt data production. Use Memory/Fault Set to select the meter response to such an interruption. The Fault setting

(default) will zero the flow rate output and declare an alarm on a flow display screen, Datalogger report and an assigned relay output.

For some applications, occasional temporary Fault conditions may be a normal part of the process and would not require an alarm response. The system offers a Memory operating mode to support such an application. Memory Mode suspends the system's Fault response by preventing the flow outputs from dropping to zero for the interval specified in the Memory Delay menu cell. During the Memory duration, the meter will maintain the last valid flow reading measured before the onset of the fault condition. The default Memory Delay is 60 seconds. You may select any duration from 3 to 604,800 seconds (one week).

To select Memory Mode:

To access the [Memory/Fault Set] option list press 

Move the cursor down to [Memory] by pressing 

To make selection press 

This moves the highlight to [Memory Delay (sec)].

Memory Delay (sec)

Selecting [Memory] activates the suppressed [Memory Delay] menu cell. It allows you to specify the number of seconds that the meter maintains its last valid flow reading. When the memory delay expires, it triggers the fault alarm response described previously.

To specify the Memory delay:

To enable numeric entry press 

Use the number keys to type the delay in seconds.

To register the new value press 

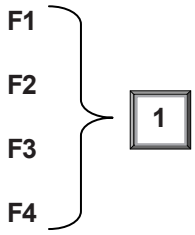
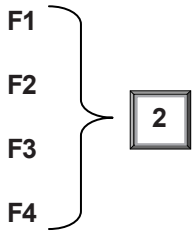
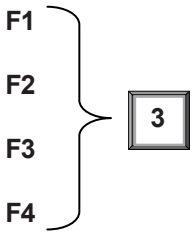
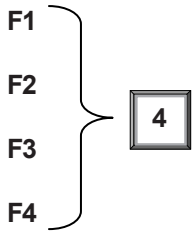
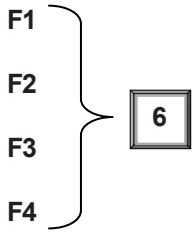
2.6 THE FLOW/TOTAL UNITS MENU

The Flow/Total Units menu is available after selecting a meter type and measurement channel. Use the Flow/Total Units menu to select energy and volumetric flow units and an associated time base for the energy and flow rate and total outputs. After making your selections, a view-only menu cell shows the resultant scaling. Another menu cell lets you adjust the output resolution by selecting a display range.

This system provides three totalizer display modes:

POSFLOW	*Positive (forward) energy/flow total only*
NEGFLOW	*Negative (reverse) energy/flow total only*
NETFLOW	*The net of the Positive and Negative energy/flow (default)*

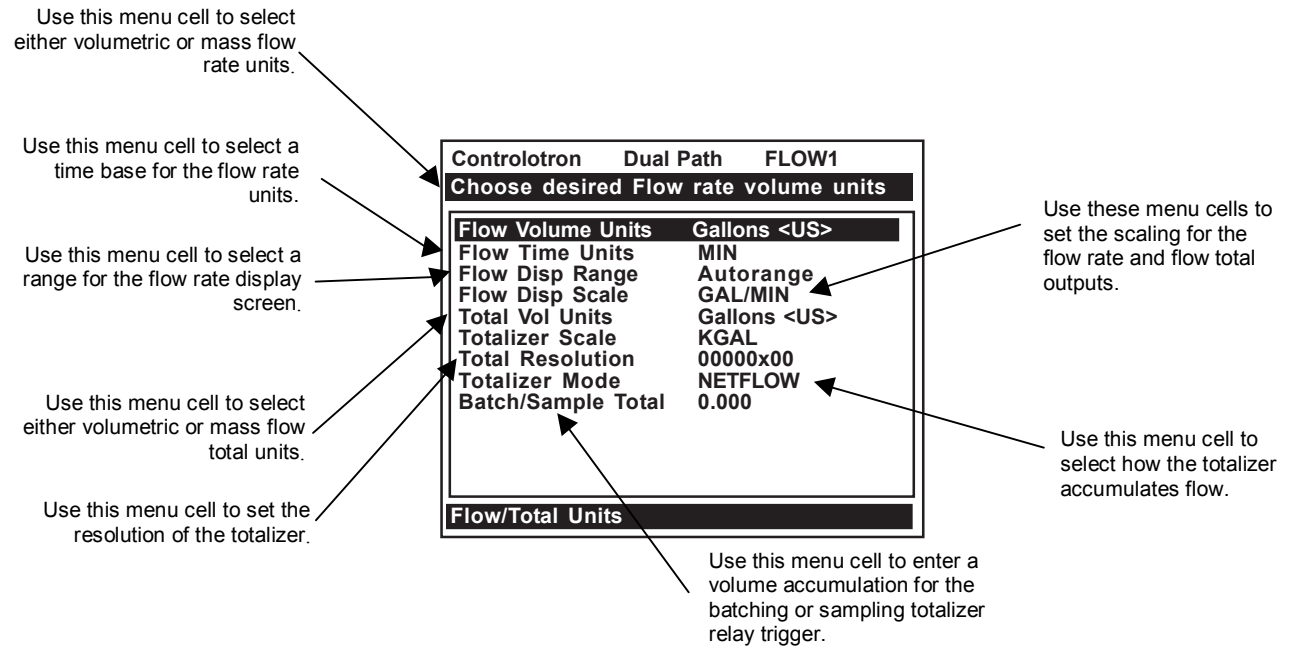
TOTALIZER CONTROLS *(the "n" in <Fn> = channel number)**

	CLEAR (also clears overflow)	Resetting the Totalizer registers clears all total data accumulated during operation. *Note: In Dual Path mode, the Totalizer operates only on the virtual system channel (Ch 3). Therefore in this case, the CLEAR trigger would be <F3> <1>.*
	NOTOT (Totalizer Freeze)	Invoking the NOTOT command disables the Totalizer. Totalization will not resume until you repeat the Fn and Numeric 2 key sequence. When you activate NOTOT, an N precedes the TOTAL symbol (i.e., [NTOTAL]) on the LCD Screen.
	LAPTOT (Totalizer snapshot)	The LAPTOT command freezes the Totalizer screen display. However, the flow computer will continue to update its internal registers. The flow computer will show the current total when you repeat the F1 - Numeric 3 key sequence. When you activate LAPTOT, an L precedes the TOTAL symbol (i.e., [LTOTAL]) on the LCD Screen.
	CLEAR (Batch/Tot Register)	Clears the Batch Sample totalizer register. See Batch/Sample Tot.
	CLEAR (Makeup Latch)	Clears the Makeup Latch. See paragraph 2.7 The Data Span/Set/CAL Menu and subparagraph 2.7.1 Span Data.

*Use the F1 key as the "Lead-in command" for 4-Path Totalizer operations.

THE FLOW/TOTAL UNITS MENU STRUCTURE

Flow/Total Units ⇨	Flow Volume Units ⇨	⇳ Gallons (US) Liters Cubic Feet Cubic Meters Cubic Inches Cubic Cm Ounces (U.S.) Imperial Gal 31.0 GAL BBL 31.5 GAL BBL 42.0 GAL BBL 55 GAL Drum Acre-feet Pounds Kilograms Tons Metric Tons Ft/Sec (Vel) m/Sec (Vel)
⇳	Flow Time Units ⇨ ⇳	⇳ MIN HR DAY SEC
	Flow Display Range ⇨ ⇳	⇳ Autorange High
	Flow Display Scale ⇨ ⇳	⇳ mGAL/MIN GAL/MIN KGAL/MIN
	Total Volume Units ⇨ ⇳	⇳ *Same list as Flow Volume Units*
	Totalizer Scale ⇨ ⇳	⇳ GAL KGAL mGAL
	Total Resolution ⇨ ⇳	⇳ 0000000X 00000X00 000000X0
	Totalizer Mode ⇨ ⇳	⇳ NEGFLOW NETFLOW POSFLOW
	Batch/Sample Total ⇨	x.xxx *(numeric entry)*



2.6.1 FLOW VOLUME UNITS

The [Flow Volume Units] option list allows you to select the rate units the meter uses to report volumetric or mass flow. If you select mass units, the meter uses the specific gravity parameter (see Application Class section) to convert volumetric flow to mass flow. The default English Units is [Gallons].

To select a Volumetric or Mass Unit:

To access the [Flow Volume Unit] option list press 

To move the cursor to the required units press 

To store selection press 

2.6.2 FLOW TIME UNITS

The [Flow Time Units] option list allows you to select a flow display time base. The system default is [Minutes]. If this suits the application, press  to bypass this menu cell.

To select a Flow Time Unit:

To access the [Flow Time Units] option list press 

To move the cursor to the required time units press 

To store the time units press 

2.6.3 FLOW DISPLAY RANGE

The [Display Range] option list offers a choice of [Autorange] (default), or [High] range. The Autorange selection increases resolution automatically at low flow rates and reduces resolution at high flow rates as required to prevent data overflow. If you select [High] range, the meter controls its screen resolution to prevent data overflow at the highest possible flow.

To edit the Display Range:

To access the [Display Range] option list press 

To move the cursor to the required display range press 

To store selection press 

2.6.4 FLOW DISPLAY SCALE

After you select rate units, the meter automatically computes a prefix to provide the best combination of capacity and resolution (e.g., KGAL/MIN). The [Flow Display Scale] menu cell shows the results. If the displayed scaling is not suitable, you can edit it by accessing the option list. Note that this scaling applies to all flow rate data displayed on the flow display screen, even if the units do not appear next to the data (because there may not be room on the screen). Therefore, always keep this prefix in mind when you enter flow related data.

To select a different Flow Display Scale:

To access the [Flow Display Scale] option list press 

Move the cursor to the desired display scale by pressing 

To register selection press 

2.6.5 TOTAL VOLUME UNITS

This menu cell allows you to select which units the meter uses for the flow total output. If you select mass units, the meter uses the specific gravity parameter (see paragraph 2.4) to convert volumetric flow to mass flow. The default English Flow Total Units is [Gallons] US]. If this suits the application, press the <Down Arrow> to bypass this menu cell.

To change the default setting:

To access the [Total Volume Units] option list press 

To move the cursor to the desired Total volume units press 

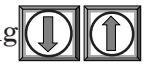
To store selection press 

2.6.6 TOTALIZER SCALE

After you select [Totalizer Volume Units], the meter automatically computes a prefix to provide the best combination of capacity and resolution (e.g., MGAL/MIN). The [Totalizer Scale] menu cell shows the results. If the displayed scaling is not suitable, you can edit it by accessing the option list. Note that this scaling applies to all flow total data displayed on the flow display screen, even if the units do not appear next to the data (because there may not be room on the screen). Always keep this prefix in mind when you enter totalizer-related data.

To select a different Totalizer Scale:

To access the [Totalizer Scale] option list press 

Move the cursor to the desired display scale by pressing 

To register selection press 

2.6.7 TOTAL RESOLUTION

The meter assigns multiplier prefixes for the flow total units you selected (e.g., MGPM). It provides three resolution (or capacity) levels. Therefore, actual Totalizer display units depend on the selected multiplier. Check the total units by accessing the Totalizer Scale menu cell.

If you use the totalizer (TOTCNT) relay output, take into account:

a) The TOTCNT relay output pulses at a maximum rate of 0.5 pulses per sec. (0.5 Hz).

b) The meter sends a totalizer output pulse for every advance of the rightmost visible totalizer digit.

It is possible for a high flow rate to persist long enough to exceed the relay output's 0.5 Hz rate. If this occurs, the meter will store excess pulses in an overflow buffer, and route them back to the relay when the flow rate drops enough to allow the TOTCNT output to catch-up. Exceeding the 0.5 Hz rate for long periods could cause an excessive accumulation of buffered pulses and continue to trip the relay after the flow rate lessens, or even stops. If this occurs, the meter will be unable to indicate the current flow total. Therefore, select a resolution to ensure that, even at the maximum expected flow rate, the TOTCNT pulse will not be activated more than 0.5 times per second for any appreciable length of time. Note that resetting the Totalizer also clears the overflow buffer.

To change the default resolution:

To access the [Total Resolution] option list press 

Move the cursor to the required resolution press 

To store selection press 

2.6.8 TOTALIZER MODE

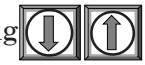
The Totalizer function operates in any of the modes listed below:

MODE	FLOW DIRECTION	NOTES
POSFLOW	positive flow	Accumulates flow in positive direction only
NEGFLOW	negative flow	Accumulates flow in reverse direction only
NETFLOW	positive or negative	Adds to positive total; subtracts from reverse total

NOTE: NETFLOW (default) is best for applications where there may be zero flow for long periods. It minimizes false Totalizer register increments due to data scatter. Press the <Down Arrow> to accept the default setting.

To select a Totalizer Mode:

To access the [Totalizer Mode] option list press 

Move the cursor to the required Totalizer mode by pressing 

To store selection press 

2.6.9 BATCH/SAMPLE TOTAL

The meter maintains a separate totalizer register for Batching or Sampling applications. Unlike the Flow Total registers, you cannot access this register directly. It is used for relay control only. If you assign the system relay to this function, a momentary (200 mS) relay pulse occurs whenever the BATCHTOT register accumulates a specified liquid quantity. You enter the total flow volume required to activate the relay, in the Batch/Sample Total menu cell. The numeric entry must reflect the selected flow total units. The Totalizer Display Scaling menu cell shows the applicable flow total units. The sign of the Batch/Sample Total determines positive or negative accumulations.

NOTE: The Batch/Sample total relay requires the same consideration for exceeding the maximum pulse rate as the TOTCNT relay (see Total Resolution).

To enter a Batch/Sample Volume:

To activate numeric entry press 

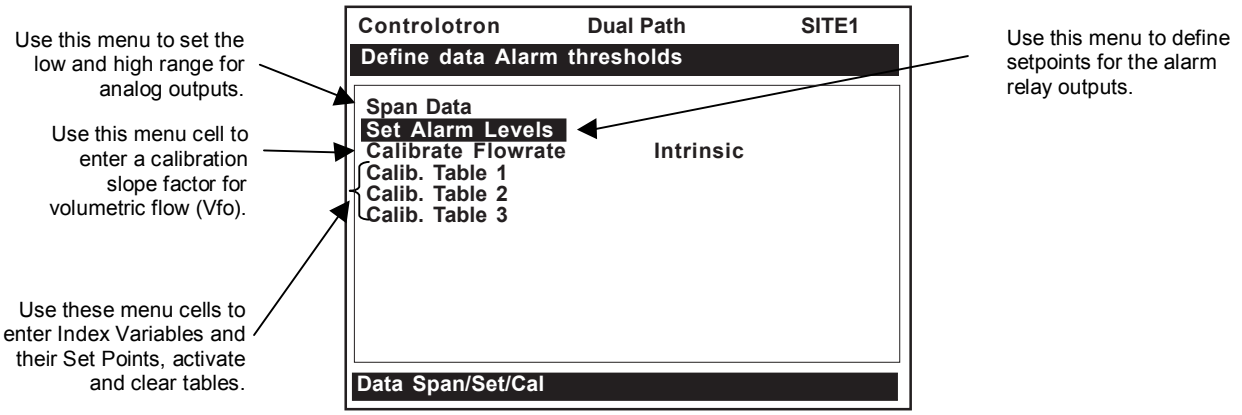
Use the numeric keys to type the desired Batch/Sample TOT accumulation.

To store data press 

2.7 THE DATA SPAN/SET/CAL MENU

This menu becomes available after picking a Meter Type and Measurement Channel. However, some functions will only be active after the transducers are installed and operating properly.

Use the [Data Span/Set/Cal] menu to set the range for analog outputs and setpoints for Alarm relay outputs. Additionally, the [Calibrate Flowrate] menu allows you to apply external adjustments to the meter's intrinsic primary outputs.



THE DATA SPAN/SET/CAL MENU STRUCTURE

Data Span/Set/Cal ⇨	Span Data ⇨	⇳ PGEN P/(Units)*	xxxx.xxx (numeric entry)	
		Max Flow (Units)	x.xxx (numeric entry)	
		Min Flow (Units)	x.xxx (numeric entry)	
		Max Liquident	x.xxx (numeric entry)	
		Min Liquident	x.xxx (numeric entry)	
	⇳	Max Vs m/s	x.xxx (numeric entry)	
		Min Vs m/s	x.xxx (numeric entry)	
		Max Viscosity cS	x.xxx (numeric entry)	
		Min Viscosity cS	x.xxx (numeric entry)	
		Max Temperature	x.xxx (numeric entry)	
		Min Temperature	x.xxx (numeric entry)	
⇳	Set Alarm Levels ⇨	⇳ High Flow	x.xxx (numeric entry)	
		Low Flow	x.xxx (numeric entry)	
		High Liquident	x.xxx (numeric entry)	
		Low Liquident	x.xxx (numeric entry)	
		High Viscosity cS	x.xxx (numeric entry)	
	⇳	Low Viscosity cS	x.xxx (numeric entry)	
		High Temperature	x.xxx (numeric entry)	
		Low Temperature	x.xxx (numeric entry)	
		Interface Vs m/s	x.xxx (numeric entry)	
		Aeration %	x.xxx (numeric entry)	
		Makeup Latch ⇨	⇳ OFF ON	
	Calibrate Flowrate ⇨	⇳ Intrinsic		
		Kc	x.xxx (numeric entry)	

*Present in Custody Transfer flowmeters only.

(continued)

THE DATA SPAN/SET/CAL MENU STRUCTURE *(continued)*

Data Span/Set/Cal ⇨	Calib. Table 1 ⇨	Index Variable 1 ⇨	⇳ Flow Vs Liquident Viscosity (cS) Valc Vaer Temp 1 Reynolds # Pressure Aux		
	⇳	⇨ Calib. Table 1 ⇨	New Point ⇨	⇳ Cal. Index Value PosFlow Corr NegFlow Corr Accept/Clear	x.xxx x.xxx x.xxx ⇳ Accept Pt. Clear Pt.
			⇳		
		Table Active 1 ⇨	No		
		Clear Table 1 ⇨	⇳ No Yes		
⇳	Calib. Table 2 ⇨	Index Variable 2 ⇨	Same List as Index Variable 1		
		Calib. Table 2 ⇨	New Point	⇳ Cal. Index Value PosFlow Corr NegFlow Corr Accept/Clear	x.xxx x.xxx x.xxx ⇳ Accept Pt. Clear Pt.
	⇳	⇳			
		Table Active 2 ⇨	No		
		Clear Table 2 ⇨	⇳ No Yes		
	Calib. Table 3 ⇨	Index Variable 3 ⇨	Same List as Index Variable 1		
		Calib. Table 3 ⇨	New Point	⇳ Cal. Index Value PosFlow Corr NegFlow Corr Accept/Clear	x.xxx x.xxx x.xxx ⇳ Accept Pt. Clear Pt.
	⇳	⇳			
		Table Active 3 ⇨	No		
		Clear Table 3 ⇨	⇳ No Yes		

2.7.1 SPAN DATA

The Span Data menu allows you to set 0% and 100% output limits for volumetric flow (Vfo), absolute flow (Vfab) and sonic velocity (Vs). Each menu cell shows appropriate rate units and time base. If you change flow rate units after spanning the system, the computer automatically updates the output data setup to reflect the change. Span limits apply to both the analog outputs and the on-screen stripchart. The flow outputs operate as follows:

Vfo *Spanned Volumetric*	The minimum and maximum flow rate entries establish the Vfo span. The Max Flow menu cell sets 100% of span. The Min Flow menu cell sets 0% of span. Use signed numbers for bi-directional spanning. Note that negative (reverse) flow always is lower than positive flow, whatever its absolute magnitude. For example, for a flow measurement range of -30 GPM to +10 GPM, the 4 mA span will be -30 GPM, and the 20 mA span will be +10 GPM.
Vfab *Spanned Absolute Volumetric Flow Rate:*	Vfab is the absolute magnitude of the volumetric flow rate (Vfo). There are no menu cells provided to span this output. Vfab shares the Vfo span entries. The Vfab minimum span is always zero. The maximum span for Vfab is the largest absolute value of either the min. or the max. flow rate (Vfo) entries. For example, a span between +10 GPM and -30 GPM, spans the Vfab output from 0 GPM to 30 GPM.
Vs *Spanned Liquid Sonic Velocity:*	Vs is the sonic velocity in meters-per-second (m/s) of the flowing liquid. The min. and max. Vs entries establish the Vs span. Max Vs (m/s) defines 100% of span. The Min Vs (m/s) defines 0% of span.

Maximum span values represent:
100% of span
Current output of 20 mA
Voltage output of 10 Vdc
Pulse output of 5000 Hz

Minimum span values represent:
0% of span
Current output of 4 mA
Voltage output of 0 Vdc
Pulse output of 0 Hz

PGEN

The [PGEN P/*Unit Volume*] menu cell entry controls a digital output pulse function and is available in Custody Transfer units only (designated by a "C" in their part number). It allows assigning of PGEN digital signal pulses per unit of volume. For example, 1000 output pulses per unit of liquid.

NOTE: The unit of volume is determined by the Volume Units initially selected from the [Total Volume Units] menu cell option list (refer to paragraph 4.6.6).

To assign PGEN output pulses:

From the [Span Data] menu press 

From the [PGEN P/*Unit Volume*] menu cell, press  to activate the numeric entry.

Use the numeric keys to enter the desired number of PGEN pulses per unit volume.

To store the data press 

1010PVCDN (Expanded 1010N-7 I/O Module)
Installation Drawing 1010N-7-7 (Sheet 3 of 3)
(Ultra Performance Flowmeters)

TB2

PIN#	SIGNAL	FUNCTION	NOTES
9	PG1	PRIMARY FREQUENCY OUTPUT / OPEN COLLECTOR	Digitally Synthesized Pulse Waveform
10	PG2	PRIMARY FREQUENCY OUTPUT / TTL	
11	PG3	QUADRATURE FREQUENCY OUTPUT / OPEN COLLECTOR	
12	PG4	QUADRATURE FREQUENCY OUTPUT / TTL	

Max Flow

The [Max Flow] menu cell stores the maximum range for the flow rate output (Vfo). It can be a positive or negative value. Enter the data using the flow rate units you selected. This entry also spans the unsigned flow variable (Vfab).

To enter the Max. Flow Range Setting:

To activate numeric entry press 

Use the numeric keys to type the maximum flow rate (100% of range).

To store the data press 

Min Flow

The [Min Flow] menu cell stores the minimum range for the flow rate output (Vfo). It can be a positive or negative value (to reflect bi-directional flow). However, the minimum span for the unsigned flow (Vfab) is always zero. Enter the data using the flow rate units you selected.

To set the Min. Flow Range:

To activate numeric entry press 

Use the numeric keys to type the minimum flow rate (0% of range).

To store data press 

The following Span Data items are set in the same way as the two previously shown examples by entering numeric values and storing the data.

Max LiquIdent

The [Max LiquIdent] menu cell stores the maximum range value for the LiquIdent function.

Min LiquIdent

The [Min Liquident] menu cell stores the minimum range value for the LiquIdent function.

Max Vs m/s

The [Max Vs m/s] menu cell stores the maximumrange value (in m/s) for the LiquIdent function.

Min Vs m/s

The [Min Vs m/s] menu cell stores the maximum range value (in m/s) for the LiquIdent function.

Max Viscosity cS

The [Max Viscosity cS] menu cell stores the maximum range for the analog span. The viscosity units are centistokes with no alternatives offered.

Min Viscosity cS

The [Min Viscosity cS] menu cell stores the minimum range for the analog span. The viscosity units are centistokes with no alternatives offered.

Max Temperature

The [Max Temperature] menu cell stores the maximum temperature range for the analog span. If metric preferences are selected *prior to site creation* the temperature units will be in Centigrade. If English preferences are selected *prior to site creation* the temperature units will be in Fahrenheit.

Min Temperature

The [Min Temperature] menu cell stores the minimum temperature range for the analog span. If metric preferences are selected *prior to site creation* the temperature units will be in Centigrade. If English preferences are selected *prior to site creation* the temperature units will be in Fahrenheit.

2.7.2 SET ALARM LEVELS

The Set Alarm Levels menu allows you to select system alarm functions. Alarms appear locally on the LCD digital display. In addition, you can use the Relay Setup menu to assign those functions to the system's relays. You may select from high or low energy or flow rate, liquid interface (Vs) and liquid aeration alarm functions. Entry of all alarm setpoints is accomplished using the selected rate units. You can enable or disable a Makeup Alarm Latch to keep the makeup alarm active until you reset it manually by an <Fn>6 simultaneous key press.

To access the Alarm Setpoints menu press 

High Flow

The [High Flow] menu cell stores the maximum range for the analog span.

To set the High Flow alarm value:

To activate numeric entry press  .

Use the numeric keys to type the High Flow value.

To store the data press  .

Low Flow

The [Low Flow] menu cell stores the maximum range for the analog span.

To set the Low Flow alarm value:

To activate numeric entry press  .

Use the numeric keys to type the Low Flow value.

To store the data press  .

The following Alarm Relay Setpoints are set in the same way as the two previously shown examples by entering numeric values and storing the data.

Max LiquIdent

The [Max LiquIdent] menu cell stores the maximum range value for the LiquIdent function.

Min LiquIdent

The [Min Liquident] menu cell stores the minimum range value for the LiquIdent function.

High Viscosity cS

The [High Viscosity cS] menu cell sets the high liquid viscosity alarm relay setpoint. The viscosity units are centistokes with no alternatives offered.

Low Viscosity cS

The [Low Viscosity cS] menu cell sets the low liquid viscosity alarm relay setpoint. The viscosity units are centistokes with no alternatives offered.

High Temperature

The [High Temperature] menu cell sets the high temperature alarm relay setpoint. If metric preferences are selected *prior to site creation* the temperature units will be in Centigrade. If English preferences are selected *prior to site creation* the temperature units will be in Fahrenheit.

Low Temperature

The [Low Temperature] menu cell sets the low temperature alarm relay setpoint If metric preferences are selected *prior to site creation* the temperature units will be in Centigrade. If English preferences are selected *prior to site creation* the temperature units will be in Fahrenheit.

Interface Vs m/s

The [Interface Vs m/s] menu cell sets the Interface Vs alarm relay setpoint. Relay changes state when variable exceeds users setpoint.

Aeration %

The 1010PVN surpasses all other transit-time systems in its ability to operate with substantial aeration (caused by entrained gases, mixing condition or cavitation). Some applications may require an alarm indication if aeration exceeds a particular level. The meter detects this aeration level and provides this data as an output. The aeration percentage triggers the alarm relay whenever it meets or exceeds the threshold you set in this menu cell. The aeration percentage (Vaer %) appears in the [Liquid Data] menu cell of the Diagnostic Data Menu. The digital display screen also shows the current aeration percentage.

NOTE: Severely aerated conditions may induce meter fault. The 50% default usually allows enough leeway for continued operation. For intermittent faults, see memory interval in the Output Control menu.

To set the Aeration % Alarm:

To move the cursor to activate numeric entry press 

Use the numeric keys to type the Aeration percentage setpoint.

To store data press ENT

Makeup Latch

A fault condition (caused by an empty pipe or a transient loss of power, etc.) could temporarily interrupt operation. After recovery from the fault, the meter executes an in-process makeup to restore operating parameters. During the makeup, the meter sets a Makeup Alarm flag, which clears upon completion. Therefore, unless you were monitoring the unit continuously, you could miss the fact that an In-process Makeup occurred. The Makeup Alarm Latch alerts you that the system implemented a Makeup by holding the Makeup Alarm active until you reset it manually by the simultaneous keystrokes: <Fn>6 (where "n" represents the measurement channel). In addition, if the Datalogger is active with Status Alarms selected, generating a Datalogger report will reset the Makeup Alarm Latch. This ensures that the Alarm does not appear on succeeding Datalogger reports. A Makeup Alarm appearing on a subsequent report indicates that an In-Process Makeup must have occurred since the last Datalogger report.

To enable or disable the Makeup Latch:

To access the [Makeup Latch] option list press →

Move the cursor to select either [On or Off] by pressing ↓ ↑

To turn Makeup Latch [On] or [Off] press ENT

2.7.3 CALIBRATE FLOWRATE AND CALIBRATION TABLES

System 1010PVN equipment provides three ways to condition the calibration performance of its flowrate output: Intrinsic (factory set), Kc, and Calibration Tables 1 through 3. Access to these calibration options is found in the [Calibrate Flowrate] menu cell and the three [Calib. Table] menu cells of the Data Span/Set/Cal menu (refer to Data Span/Set/Cal menu on next page).

The 1010's intrinsic calibration is excellent as confirmed by numerous laboratory and field trials under diverse application conditions. Controlotron can confidently say that in any given application, the majority of conventional flowmeters can not match the system's measurement range or its linearity.

Intrinsic

When selected, the meter uses no slope adjustment at all. Output data is still zeroed and corrected for Reynolds number, but no slope adjustment is imposed on the meter's flow register.

Some applications may require an output adjustment to match an official external reference. The [Calibrate Flowrate] menu allows you to select a calibration mode. The right-hand column shows the active calibration mode. You can select Intrinsic (factory) and Kc (Slope Correction) Calibration. Selecting either of the external calibration modes will not eliminate the Intrinsic (factory) calibration. You can use this menu cell to switch between Intrinsic and Kc at any time.

Kc Calibration

For most applications, the measured flow range produces a linear meter response. Therefore, the Kc (slope correction) calibration is the preferred method since it only requires a single correction factor for all the flow rates encountered.

Data Span/Set/Cal Menu (Calibration Section)

Data Span/Set/Cal ⇨ ⇳	Calibrate Flowrate ⇨ ⇳	⇳ Intrinsic Kc	x.xxx		
	Calib. Table 1 ⇨ ⇳	Index Variable ⇨ ⇳	⇳ Flow Vs Liquident Viscosity (cS) Valc Vaer Temp 1 Reynolds # Pressure Aux		
		Calib. Table 1 ⇨ ⇳	New Point ⇨	⇳ Cal. Index Value PosFlow Corr NegFlow Corr Accept/Clear	x.xxx x.xxx x.xxx ⇳ Accept Pt. Clear Pt.
		Table Active 1 ⇨	No		
		Clear Table 1 ⇨	⇳ No Yes		

NOTE: Changing the calibration can cause profound changes in a flowmeter's operating characteristics. Use only the most respected flow standard to obtain a correction factor. The percentage you enter must provide an accurate and consistent shift across the entire flow range anticipated for the application.

Kc Factor

To obtain the Kc factor, compare flow total data taken simultaneously from the 1010 and a reference meter whose accuracy meets the required standard. Allow both meters to accumulate flow total data long enough to average out any differences due to flow fluctuation between the two meter locations. Compare outputs of the two totalizers to determine percentage increase (+) or decrease (-) that is necessary to produce the best average correlation between System 1010 and the reference standard.

Selecting the Kc Factor

When the [Kc] menu cell is selected, the meter imposes this % slope adjustment of its rate output. Output data is zeroed and corrected for the Reynolds number (flow profile compensated), however, in addition, a percent change in the rate output is imposed based on the data entered in this cell. The number entered by the user is evaluated into a slope correction factor by dividing it by 100 and algebraically adding it to 1. The resulting factor is used as a multiplier on the rate register of the instrument. Thus an entry of -3% will multiply the rate register by 0.97, for example.

To calculate Kc: $$Kc = \left[\frac{\text{Actual Rate}}{\text{Indicated Rate}} - 1 \right] \times 100$$

To enter the Kc Factor:

To enable numeric entry press  .

Use the numeric keys to type the required Kc (as calculated above). Note that the Kc value can be negative or positive. Enter the - or + sign first, then type in the calibrated value.

To store the data press  . Note that Kc now appears in the right-hand column of the [Calibrate Flow Rate] menu cell with the new value. Also note that this can be viewed on the site printout.

Calibration Tables 1 through 3

System 1010PVN instruments offer a unique methodology by which a particular flow response of an instrument may be linearized or optimized by tabulating the results of a series of calibration exercises or collected batch data points. In essence, the meter allows the user to select any of a wide variety of system variables (flowrate, pressure, viscosity, etc.) as a pointer into a table of calibration factors (up to 32). As the system variable is updated, the value of the table's output factors (or positive and negative flow) is re-evaluated and used as a modifier for the current rate register. Note that the flow register is still zeroed and Reynolds number compensated normally and these slope corrections are in addition to these fundamentals.

NOTE: Kc is still active when this facility is being used.

To install a Calibration Table, proceed as follows:

1. The user selects a ***system variable*** that appears to correlate strongly with calibration shifts observed.

2. A table of values is formed comprised of the values that this index could assume over the range of system operation. Remember, the tables created do not extrapolate beyond their end points, they "clip."

3. A calibration factor, a number usually close to 1.00, is entered as a positive and a negative flowrate correction factor (termed *PosFlow Corr* and *NegFlow Corr*) for each of the desired index points.

The table may contain up to 32 pairs of these slope correction factors. Note that the **Kc factor, unlike these slope correction factors**, is entered as a signed percent change in rate, while these factors are simply rate multipliers. As points are entered, the point editor will provide list access to the already entered points plus access to the [New Point] menu cell, used to add a new point. The table may be created in its entirety and then activated by selecting [Yes] in the [Table Active] menu cell. The entire table may be cleared by selecting [Yes] in the [Clear Table] menu cell.

Note that the meter allows you to use [Aux] as an [Index Variable] input. Effectively you may slope modulate the meter's output based on the value of a 4 - 20 mA input signal. Also notable, the interaction between the Liquid Table, described elsewhere in this manual, and the calibration table(s) is extremely powerful.

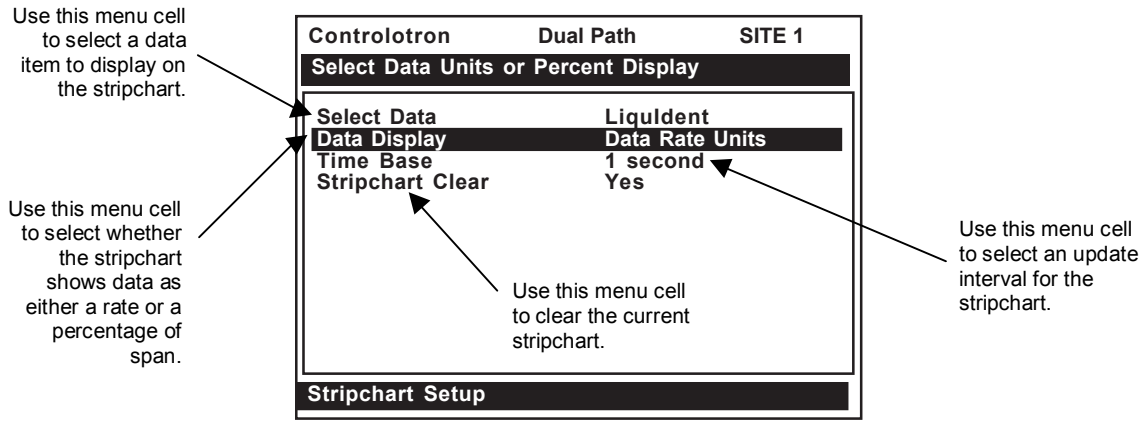
Since the table of slope correction coefficients resides between the meter's internal flow register(s) and the flow register, which actually provides reports to the user, poorly formed or defective Calibration Tables may severely impact the performance of the instrument. Take precautions before enabling these calibration tables. Although we recognize that it is unlikely that all three tables would ever be employed in a real installation, three tables are offered for maximum user flexibility. Since the tables can be disabled without being destroyed, 2 or 3 optimization strategies may be tested by this means in order to determine which approach is most effective.

2.8 THE STRIPCHART SETUP MENU

This menu becomes available after picking a Meter Type and Measurement Channel. Use the [Stripchart Setup] menu cell to select a data category, the type of scaling and the update interval for the on-screen stripchart display. You can also clear the stripchart screen.

THE STRIPCHART SETUP MENU STRUCTURE

⇨ Stripchart Setup ⇳	⇨ Select Data ⇳	⇨ ⇳ LiquIdent Visc Temp Vs Valc Vaer Vfo Vfab
	⇨ Data Display ⇳	⇨ ⇳ Data Rate Units Percent of Span
	⇨ Time Base ⇳	⇨ ⇳ 1 Second 3 seconds 6 seconds 12 seconds 24 seconds 1 minute 3 minutes 6 minutes 12 minutes 24 minutes 1.2 hours
	⇨ Stripchart Clear	⇨ ⇳ Yes No



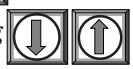
2.8.1 SELECT DATA

The [Select Data] option list allows you to select a data function for the on-screen stripchart display. The stripchart provides a data plot using the selected data units and time base. All data items except Valc and Vaer use the span settings from the [Data Span/Set/Cal] menu. The following data items are available for the Stripchart Display:

- LiquIdent ..... LiquIdent™ variable-temperature compensation sonic velocity.
- Visc ..... (viscosity)
- Temp ..... (temperature)
- Vs ..... (sonic velocity)
- Valc ..... (signal amplitude)
- Vaer ..... (aeration/cavitation)
- Vfo ..... (spanned flow) **default*
- Vfab ..... (spanned unsigned flow magnitude)

To select a data item for the stripchart:

To access the [Select Data] option list press 

Move the cursor to the desired item by pressing 

To store your selection press 

2.8.2 DATA DISPLAY

The [Data Display] option list allows you to select a format for the stripchart plot. It offers the choice of displaying data either in the current data rate units or as a percent of span defined in the [Data Span/Set/Cal menu]. [Data Rate Units] menu cell is the default selection.

To select a format for the data display:

To access the [Data Display] option list press 

To move the cursor to the required scale unit press 

To store your selection press 

2.8.3 TIME BASE

The [Time Base] option list defines the stripchart x-axis display interval. The stripchart plots an average of readings obtained during the elapsed time between reports. Stripchart resolution is 1 data point per pixel, of which there are approximately 100 on the short stripchart plot and approximately 200 on the full screen stripchart plot. Five pixel reports occur between major stripchart divisions.

NOTE: The stripchart display identifies the "real time" when the computer records the most recent graduation. You can time-stamp any graduation by counting back in graduation intervals. The default interval setting is 1 second.

To select a Time Base:

To access the [Time Interval] option list press 

Move the cursor to the desired interval by pressing 

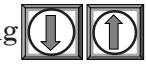
To store your selection press 

2.8.4 STRIPCHART CLEAR

Use this menu cell to clear the stripchart. Selecting [Yes] erases all current stripchart data.

To erase the Stripchart plot:

To access the [Stripchart Clear] option list press 

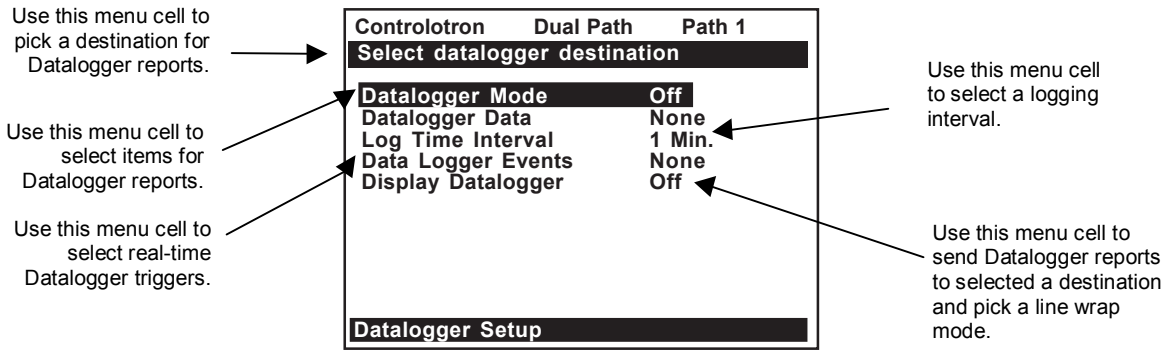
Move the cursor to [Yes] by pressing 

To clear the current Stripchart plot press 

2.9 THE DATALOGGER SETUP MENU

This menu becomes available after picking Meter Type and Measurement Channel. The integral Datalogger records data for eventual display on Graphics Screen, or for connection to an RS-232 compatible external device (printer, computer, network, etc.). Use Datalogger Setup to select data items and real-time events for datalogger reports. You can also set the logging interval, operating mode and screen format. The Datalogger Setup menu allows you to choose time interval-based data categories or event-based status alarms, and to specify the interval between data reports.

View Datalogger reports on the display screen or transmit them via the RS-232 Serial Port to external printers and computers. Note that a single-channel meter uses a compression algorithm to maximize data storage. This disables back scrolling of datalogger reports.



THE DATALOGGER SETUP MENU STRUCTURE

Datalogger Setup ⇨	Datalogger Mode ⇨ ⇳	⇳ Off Memory RS-232 Output
	Datalogger Data ⇨ ⇳	⇳ None Site Id Date Time *Path Flow Flow Average Flow Raw Flow Total *Path Vs Vs *Path Valc Valc Aeration LiquIdent Viscosity *Path Alarms Alarms Temperature Path Delta T Delta T Analog Inputs
⇳	Log Time Interval ⇨ ⇳	⇳ 5 Sec. 10 Sec. 15 Sec. 30 Sec. 1 Min. 5 Min. 15 Min. 30 Min. 1 Hr. 2 Hr. 4 Hr. 6 Hr. 12 Hr. 24 Hr. Demand
	Datalogger Events ⇨ ⇳	⇳ Fault Alarm Memory Relay 4 Relay 3 Relay 2 Relay 1 Makeup Spacing Empty Aeration Interface Flow Alarm
	Display Datalogger ⇨ ⇳	⇳ Off No Line Wrap Line Wrap

**NOTE: For Dual Path Flow.*

2.9.1 DATALOGGER MODE

The [Datalogger Mode] option list allows you to disable Datalogger, transmit reports to an external target via RS-232 port, or store selected data for later display. The default setting is [Off]. After enabling the Datalogger, select a data format before generating a report.

To select a Datalogger Mode:

To access the [Datalogger Mode] option list press 

Move the cursor to the desired mode by pressing 

To store the selection press 

2.9.2 DATALOGGER DATA

Set the Datalogger to record any or all of the data offered on the [Datalogger Data] option list shown on next page. However, recording unneeded data wastes valuable system RAM. We recommend that you always select [Site ID] (name) and [Time] to identify each line of data.

None	Default – Datalogging is disabled.
Site ID	You entered this site name when you created the site.
Date	The report date according to the meter's real time clock. (Format: MM.DD.YYYY)
Time	The report time according to the meter's real time clock. (Format: HH.MM)*
Path Flow	The instantaneous flow measured at the time of the report (for Dual Path Flow meters).
Flow	The instantaneous flow measured at the time of the report.
Average Flow	The average flow rate measured since the last report.
Raw Flow	The uncompensated flow rate in in/sec2 (only zeroed - no Reynolds number curve applied).
Total	The total flow accumulation measured at the time of the report.
Path Vs	The average liquid sonic velocity since the last report.
Vs	The average liquid sonic velocity since the last report.
Path Valc	The signal strength measured at the time of the report (for Dual Path Flow meters).
Valc	The signal strength measured at the time of the report.
Aeration	The aeration percentage recorded at the time of the report.
Liquident	Select Liquident function.
Viscosity	The liquid viscosity recorded at the time of report.
Path Alarms	The letter codes of any Path Alarms active at the time of the report (see next page).
Alarms	The letter codes of any alarms active at the time of the report (see next page).
Temperature	The instantaneous supply and return temperatures at the time for the report.
Path Delta T	The Up to Down transit-time difference measured at the time of the report (in u/s).
Analog Inputs	Any data appearing on an auxiliary input at the time of the report.

**The Time field expands to HH.MM.SS when a logging interval of more than once per minute is selected.*

If you select Alarms, the Datalogger logs the state of each alarm function upon generating a report. A dash [-] represents an inactive alarm. A letter code represents an active alarm (see next page).

Alarm Letter Codes and Descriptions

S ..... Spacing ..... Transducer spacing may need re-adjustment
E ..... Empty ..... Pipe is empty
R ..... Rate ..... Flow above High setting or below Low setting
F ..... Fault ..... Three continuous seconds without new data update
A ..... Aeration ..... Current aeration percentage exceeds the alarm setpoint
M ..... Memory ..... Last valid reading for a selected interval during Fault condition
K ..... Makeup ..... In-Process Makeup occurred
I ..... Interface ..... Liquid Vs exceeds interface alarm setpoint
P ..... Pig ..... Pig passage detected (optional)
Z ..... ZeroMatic ..... ZeroMatic signal fault

NOTE: The time interval-based Datalogger records the state of all the alarms at the selected report time only. Therefore, if an alarm condition resets before the report time, it would not appear on the report. Use Datalogger Events to log transient alarms. This mode generates a report upon the detection of an alarm event.

To select Datalogger Data items:

To access the [Datalogger Data] option list press  . Move the cursor to a desired data item by pressing  then  to select it. Note that a plus sign (+) appears before the item.

To de-select Datalogger Data:

Move the cursor to the data item then press  . Note that this removes the plus sign (+) from the item.

After selecting/deselecting all desired items press  to leave the Datalogger Data option list.

2.9.3 LOG TIME INTERVAL

The Datalogger records a "snapshot" of conditions at each log time interval. Datalogging uses a considerable amount of RAM, so only select short log intervals if it is fully justified.

NOTE: The meter maps the first Datalogger report time to an even division of its clock. Subsequent reports will conform to the selected interval.

To set the Log Time Interval:

To access the [Log Time Interval] option list press 

Move the cursor to desired interval press 

To store your selection press 

2.9.4 DATALOGGER EVENTS

The 1010PVN offers "event-based" data logging that operates concurrently with "time interval" based data logging. The event-based function generates a Datalogger report upon the triggering of any of the alarms. This is useful for recording transient alarms (e.g., a liquid interface, or a short aeration alert).

NOTE: An Alarm Event report will be generated immediately after the transition from a non-alarm to an alarm event. The reverse situation (alarm state to non-alarm state) does not trigger the event-based Datalogger.

Event-based Datalogger messages conserve memory. However, if you use this feature to monitor a level such as Flow Alarm, set the alarm threshold high enough to avoid repetitive triggering. You must select Site ID (Name) and Time to "time-stamp" the alarm events. Note that on the Datalogger report, a [-] represents a reserved letter code space (inactive alarm) and a letter code represents an active alarm.

To select Datalogger Event items:

To access the [Datalogger Events] option list press →. Move cursor to desired item by pressing ↓ ↑ then ENT to select it. Note that a plus sign(+) appears before the item.

To de-select Datalogger Events:

Move the cursor to the item by pressing ↓ ↑ then CLR . Note that this removes the plus sign (+) from the item.

After selecting all desired items press ← to leave the [Datalogger Events] option list.

2.9.5 DISPLAY DATALOGGER

Use this menu cell to enable and format the on-screen datalogger. You can allow the report to scroll on the screen with or without line wrapping. Selecting line wrap, forces a line feed after approximately 40 characters. This command is effective only after you select data items and the Datalogger has accumulated some data.

To enable the on-screen datalogger display:

To access the [Display Datalogger] option list press →

Move the cursor to the desired function.

To invoke the function press ENT

To scroll the on-screen datalogger display:

To display one line at a time press ↓

Use + key to scroll down one screen (10 lines) at a time.

Use = key to jump to 15 lines of the last screen.

In No-Line Wrap mode:

Use → or ← to scroll one column to the left or right. Use ALT + → or ALT + ← to scroll 8 columns to the right or the left. To get out of the display, press MENU

NOTE: In single channel 1010PVN meters the Datalogger uses a compression scheme that precludes backward scrolling.

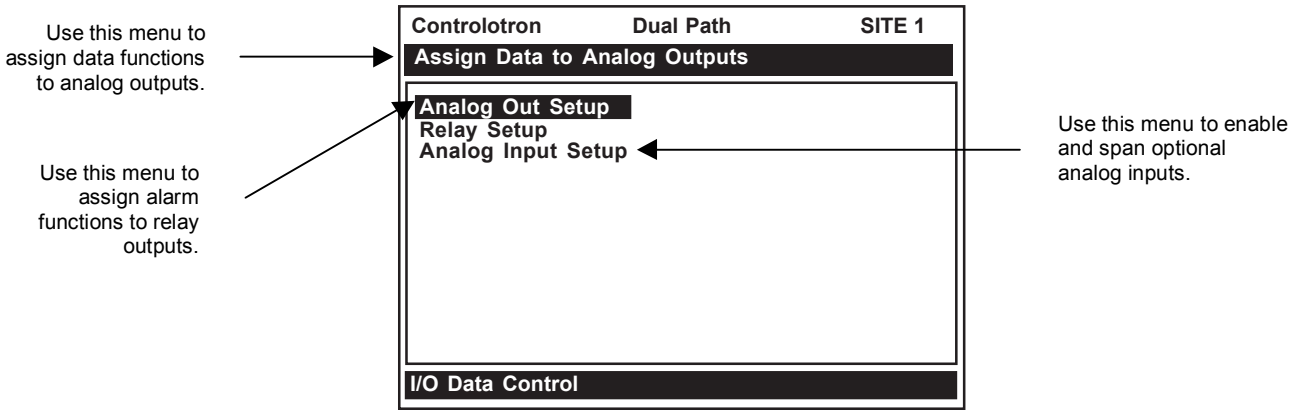
Important point about Datalogger resources and dual path systems.

When logging data on both measurement channels simultaneously, the Datalogger stores reports in a single common file. It is important that you select Site ID to appear on each line of data so that you can always identify which channel generated report.

2.10 THE I/O DATA CONTROL MENU

This menu becomes available after picking a Meter Type and Path.

Use this menu to assign functions for the meter's analog outputs and optional inputs. The [Analog Out Setup] menu cell assigns functions to the meter's current, voltage and pulse rate outputs. Each menu cell presents an option list of the available data items. In addition, you can set up the alarm relays, enable and span the analog input ports.



THE I/O DATA CONTROL MENU STRUCTURE

(Note: For Multi-Path flowmeters: "1" = Path 1, "2" = Path 2 and "S" represents the system or average channel. These characters appear to the left of the option list parameter.)

I/O Data Control ⇨	Analog Output Setup ⇨	Io1 ⇨	⇳ S Vfo S Vfab S Vs S Valc S Vaer S LiquIdent m/s S Viscosity S T1 Iin1 Iin2 Iin3* Iin4*
	⇨	Io2 ⇨	*See Io1 option list*
	⇨	Vo1 ⇨	*See Io1 option list*
	⇨	Vo2 ⇨	*See Io1 option list*
	⇨	Pgen 1 ⇨	*See Io1 option list*
	⇨	Pgen 2 ⇨	*See Io1 option list*
⇨	Relay Setup ⇨	Relay 1 ⇨	⇳ Off Power On S High Liquident S Low Liquident S High Viscosity (2-Path only) S Low Viscosity (2-Path only) S Hi Temperature S Low Temperature S High Flow S Low Flow S Flow Alarm S Fault Alarm S Spacing S Empty S Aeration S Interface S Reverse Flow S BatchTot S Pos Total S Neg Total S Fltwarn (2-Path only) S Soft Fault S Pig Detect
	⇨	Relay 2	See Relay 1 list
	⇨	Relay 3	See Relay 1 list
	⇨	Relay 4	See Relay 1 list

*For Multi-Beam and Arithmetic operating modes only.

(continued)

THE I/O DATA CONTROL MENU STRUCTURE *(continued)*

I/O Data Control ⇨ ⇳	Analog Input Setup ⇨ ⇳	lin1 ⇨ 4 mA 20 mA ⇳	Input ⇨ **numeric entry* **numeric entry*	⇳ Off Aux cS PSIA BARA T1 Deg F T1 Deg C T2 Deg F T2 Deg C
		lin2, lin3, lin4	See lin1 above	See lin1 above

2.10.1 ANALOG OUTPUT SETUP

The 1010PVN provides current, voltage and pulse-rate analog outputs. Analog Output Setup allows you to assign data functions for these signals. The flow computer's terminal strip contains the analog output terminals.

1010PVN Analog Outputs

Io (Isolated current)	4 to 20 mA varies in proportion to an assigned data function.
Vo (DC voltage)	0 to 10 Vdc varies in proportion to an assigned data function.
Pgen (TTL logic)	0 to 5000 Hz varies in proportion to an assigned data function.

Analog Out Setup Data Categories

S Vfo	System spanned volumetric flow (unsigned).
S Vfab	System spanned and signed absolute flow.
S Vs	System liquid sonic velocity.
S Valc	System signal amplitude.
S Vaer	System aeration number.
S Liquldent m/s	System sonic velocity compensated for temperature.
S Viscosity	System liquid viscosity.
S T1	Current liquid temperature.
lin1, lin2, lin3*, lin4*	Represents a re-transmit of the analog input signals (e.g., Pressure and Temp inputs can be transmitted on the 4/20 mA output).

NOTE 1: For Multi-Path flowmeters: "1" = Path 1, "2" = Path 2 and "S" represents the system or average path. These characters appear to the left of the option list parameter.

**NOTE: 2: Signals lin3 and lin4 are for Multi-beam and Arithmetic operation modes only.*

NOTE: For Expanded I/O modules, refer to drawing 1010N-7-7 and Addendum 1010FMA-14 for details.

Table To Determine Proper I/O Installation Drawings

Model Number and I/O Module	Installation Drawing and Page Number*
1010PVN	**1010N-2-7 (Sheet 2 of 2)**
1010PVN with 1010N-7 Expanded I/O Module	**1010N-7-7 (Sheet 2 of 3)**
1010PVDN	**1010N-2-7 (Sheet 2 of 2)**
1010PVDN with 1010N-7 Expanded I/O Module	**1010N-7-7 (Sheet 2 of 3)**

*Note: For Ultra Precsion transducers see 1010N-7-7 (sheet 3 of 3).

Assigning Io Output Functions

The Io analog output is a self-powered, isolated 4-20mADC signal that varies linearly in relation to a selected data function.

CAUTION: Do not connect to a powered loop.

To assign a function for the current output:

From Analog Out Setup, press  twice to access the [Io] option list.

Move the cursor to the desired data function by pressing 

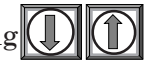
To store selection press 

Assigning Vo Output Functions

The Vo analog output is a 0-10 VDC signal that varies linearly in relation to a selected function. The output is mirrored in correct for flowmeter equipped with a 1010N-7 enhanced I/O module.

To assign a function to the voltage output:

To access the [Vo] option list press 

Move the cursor to the desired data function by pressing 

To store selection press 

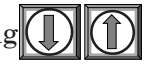
Assigning Pgen Output Functions

The Pgen analog output is a buffered TTL compliant pulse rate signal whose configuration is detailed in Installation Drawing 1010N-2-7. It varies linearly from 0-5000 Hz in relation to a selected data function.

NOTE: The analog Pgen function is not available in Custody Transfer flowmeters. See paragraph 2.7.1 for details.

To assign a function to the Pgen output:

To access the [Pgen] option list press 

Move the cursor to the desired data function by pressing 

To store selection press 

NOTE: If you have an Expanded I/O Module 1010N-7, refer to addendum 1010FMA-14 in this manual.

PULSE OUTPUT (Pgen Wiring)

1010PVN & 1010PVDN with 1010N-2 Modules
Installation Drawing 1010N-2-7 (Sheet 2 of 2)

TB2

PIN#	SIGNAL	FUNCTION	NOTES
11	PGEN 1+	FREQUENCY OUTPUT 1	0 - 5000 Hz, 5 Volt Logic, Square Waveform
12	PGEN 1-	REF. GROUND	
13	PGEN 2+	FREQUENCY OUTPUT 2	
14	PGEN 2-	REF. GROUND	

1010PVN & 1010PVDN with Expanded 1010N-7 I/O Modules
Installation Drawing 1010N-7-7 (Sheet 2 of 3)
(Standard, High Performance and Enhanced Performance Flowmeters)

TB2

PIN#	SIGNAL	FUNCTION	NOTES
9	PG1	FREQUENCY OUTPUT 1	0 - 5000 Hz, 5 Volt Logic, Square Waveform
10	PG2	REF. GROUND	
11	PG3	FREQUENCY OUTPUT 2	
12	PG4	REF. GROUND	

1010PVCDN (Expanded 1010N-7 I/O Module)
Installation Drawing 1010N-7-7 (Sheet 3 of 3)
(Ultra Performance Flowmeters)

TB2

PIN#	SIGNAL	FUNCTION	NOTES
9	PG1	PRIMARY FREQUENCY OUTPUT / OPEN COLLECTOR	Digitally Synthesized Pulse Waveform
10	PG2	PRIMARY FREQUENCY OUTPUT / TTL	
11	PG3	QUADRATURE FREQUENCY OUTPUT / OPEN COLLECTOR	
12	PG4	QUADRATURE FREQUENCY OUTPUT / TTL	

2.10.2 RELAY SETUP

Use this menu to assign a function to channel relays. System 1010 supports 2 types of relay outputs, Alarm Relay and Pulse Relay. Alarm Relay outputs operate in "fail-safe" mode. The relay(s) are energized under normal conditions - an alarm condition causes the relay(s) to de-energize until alarm clears. The Pulse Relay output supports totalizer and batch relay functions. The output pulse width is approximately 200 ms; maximum activation rate is 2.5 pulses per sec. If totalizer pulses exceed this rate, excess pulses are stored in an overflow register. This allows the relay to "catch up" when flow decreases enough.

NOTE: Using the F1 key (Totalizer clear command) also clears all channel totalizers plus the overflow register described in the last paragraph.

Assigning Relay 1 and 2 Functions

The 1010PVN, depending on the model, provides four alarm relays. Please refer to the Hardware Installation Drawing for wiring details. Relays respond to any of the alarm conditions or data functions included on the Relay Option List.

Relay Option List

Not Used	Not Active
Power Off	Power Off alarm occurs when power fails
S High LiquIdent™	High LiquIdent™ value relay trip-point.
S Low LiquIdent™	Low LiquIdent™ value relay trip-point.
S High Temperature	High temperature value relay trip-point.
S Low Temperature	Low temperature value relay trip-point.
S High Flow	System flow rate exceeds high flow setpoint.
S Low Flow	System flow rate falls below low flow setpoint.
S Flow Alarm	System flow rate exceeds or falls below flow setpoints.
S Fault Alarm	System loses receive signal (all paths in fault).
S Soft Fault	Fault condition - memory mode active.
S Spacing	System transducer spacing needs adjusting.

Relay Option List *(continued)*

S Empty	Empty pipe alarm.
S Aeration	Aeration percentage exceeds alarm setpoint.
S Reverse Flow	Flow is in negative direction.
S Interface	Liquid Interface setpoint exceeded.
S BatchTot	Batch/Sample total advances.
S Pos Total	Positive total volume advances 1 digit.
S Neg Total	Negative total volume advances 1 digit.
S Fltwarn	System fault warning.

NOTE: For Multi-Path flowmeters: "1" = Path 1, "2" = Path 2 and "S" represents the system or average channel. These characters appear to the left of the option list parameter.

To assign functions to Relay 1:

To access the [Relay] option list press ⇨

Move the cursor to the desired Relay assignment by pressing ⇩ ⇧

To store selection press ENT. Repeat procedure for all other relays.

2.10.3 ANALOG INPUT SETUP *(optional function)*

The Analog Input Setup function assigns an active analog input to a measurement channel/path. The meter provides four DC current input ports for single channel and Dual Path units. The DC current input ranges from a zero level of 4 mA to a full scale of 20 mA. The [Analog Input Setup] menu cell allows you to enable this port and then span it to any desired scaling.

For example, when using the analog input viscosity function the numeric variables might be spanned as follows: 4mA=1 (water) and 20mA=100 (more viscous liquid). This spanning configuration allows the meter to use this constant numerical change to improve calibration in real time.

The various flowmeter models allow you to associate the analog input to active system variables such as specific gravity, viscosity and others (see table below).

NOTE: Refer to the Installation Drawings or I/O Module markings for the locations of these inputs and wiring procedures.

I/O Data Control ⇨	Analog Inp Setup ⇨	lin1 ⇨	Input	⇳ Off Aux cS PSIA BARA T1 Deg F T1 Deg C T2 Deg F T2 Deg C
⇳	⇳	⇳	⇳	
			4 mA	*numeric entry*
			20 mA	*numeric entry*
		lin2/lin3/lin4	See lin1 option list	

Note that the flowmeter recognizes the first analog input variable that is assigned to any given parameter and ignores any subsequent input with the same assignment. For example, if Iin1 and Iin2 are both assigned to represent pressure (PSIA), the meter will only use the pressure input from Iin1.

Setting up the Analog Current Input

The first step is to enable the DC current input port.

From the [Analog Input Setup] menu cell:

To access the [Iin] option list press the <Right Arrow> twice.

Move the cursor down to [Aux (n)] press the <Down Arrow> and then <ENT>. This enables the port to receive an input current. The cursor moves to [4 mA].

To enable numeric entry press the <Right Arrow>. Type a numeric value corresponding to a 4 mA input signal.

To store the data press <ENT>. This moves the cursor to [20 mA].

To enable numeric entry press the <Right Arrow>. Type the numeric value corresponding to a 20 mA input signal. To store the data, press <ENT>.

2.11 THE DIAGNOSTICS DATA MENU

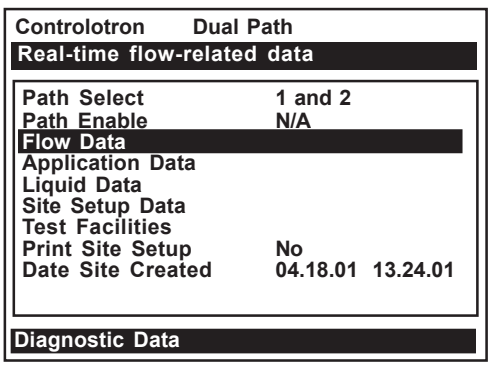
Some Diagnostic Data items require a successful transducer installation and meter initialization to become available. These will report [Chan Not Setup] until you complete the installation procedure.

The Diagnostics Data menu provides real-time application and setup data, plus test routines for the selected channel. To receive the best technical support, please be prepared to report any diagnostic data item upon request. Note also that these menus contain information that may only be meaningful to our technical support staff.

In [Dual Path Flow] mode, all diagnostic items are available for [Path 1] or [Path 2]. Some items are not available (N/A) when you select virtual Channel 3 mode. It will limit the list to flow data only.

2.11.1 MAIN DIAGNOSTICS DATA SCREEN

The Main Diagnostics Data screen provides menus that show Flow Data, Application Data, Liquid Data and Site Setup information. The [Test Facilities] menu provides test/control functions to optimize operation, analyze application conditions and to recover system operation.



NOTE: Diagnostic Data menus on [Dual Path Flow] meter setups include [Path Select] and [Path Enable]. Ch 1+2 Flow and Ch 1-2 Flow virtual Channel 3 menus only include [Flow Data], [Print Setup] and [Data Site Created].

DIAGNOSTIC DATA MENU STRUCTURE

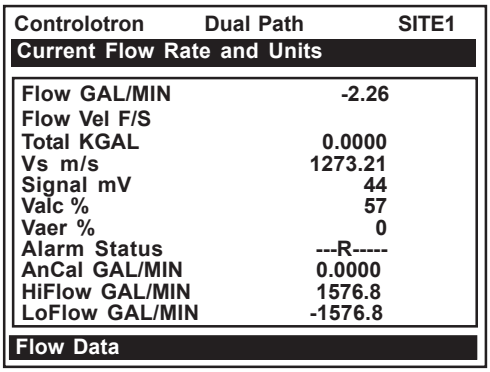
Diagnostic Data ⇨ ⇳	Path Select ⇨ ⇳	⇳ 1 and 2 1 2
	Path Enable ⇨	N/A
	Flow Data ⇨ ⇳	⇳ Flow (Units) Flow Vel F/S Total (Units) Vs m/s Signal mV Valc % Vaer % Alarm Status Ancal (Units) HiFlow (Units) LoFlow (Units)
	Application Info ⇨ ⇳	⇳ TN uSec TL uSec DeltaT nSec Burst/Sec % Accepted Last Makeup Makeup Status
	Liquid Data ⇨ ⇳	⇳ Temp 1 Temp 2 Reynolds # LiquIdent Pressure Viscosity (cS)
	Site Setup Data ⇨ ⇳	⇳ fx (drive) N (burst length Ltn in Vfmax Vs max m/s Vs min m/s Empty % Samples/Cycle HF
	Test Facilities ⇨ ⇳	⇳ Makeup Graph Tx Up Tx Dn Fixed ALC Tx Up Fixed ALC Tx Dn Fixed ALC Graph AutoZero
	Print Site Setup ⇨	⇳ No Yes
	Date Site Created ⇨	xx.xx.xx xx.xx.xx

DIAGNOSTIC MAIN MENU DESCRIPTION

Flow Data	This menu shows flow rate, total and alarm data; adjustable flow limits.
Application Info	This menu shows current meter operating status.
Liquid Data	This menu shows current Reynolds # and RTD temperature readings (if this system includes optional RTD Temperature measurement capability).
Site Setup Data	This menu shows current transducer setup data and signal status.
Test Facilities	This menu provides system test and recovery routines.
Print Site Setup	This Menu cell allows you to send an ASCII dump of the current Site Data to a RS-232 port device (e.g. a printer or laptop computer).
Date Site Created	This menu cell shows date and time when the current site was created.

2.11.2 FLOW DATA MENU

This sample menu provides a "live" display of all flow-related output data.



NOTE: Menu shows English units (i.e., gallons).

FLOW DATA MENU ITEMS

Flow	This is a real-time (updated) flow rate display in current rate units (e.g., GAL/MIN).
Flow Vel F/S	Linear fluid flow velocity in f/s or m/s depending on preferred units.
Total	This is a real-time (updated) flow total display in current total units (e.g., KGAL).
Vs m/s	Current liquid sonic velocity (Vs) in m/s. The Vs value depends on the liquid and its temperature. This menu cell allows "fine-tuning" when highlighted. Press the [+] key (coarse adjustment) or the [1] key (fine adjustment) to increase the reading, or the [-] key (coarse adjustment) or the [2] key (fine adjustment) to decrease the reading. ***CAUTION: Incorrect usage will result in reduced accuracy.***
Signal (mV)	Xdcr signal strength (in mV). This is the amplitude of the transit-time receive signals. Improper coupling, attenuative liquid or pipe could cause a low value.
Valc %	Input Amplifier gain indication. Larger % indicates a stronger liquid signal.
Vaer %	This shows the current percent of aeration detected by the meter.
Alarm Status	This letter code field shows the status of the meter's built-in alarms. A dash indicates an inactive alarm. Letter codes reflect the following alarm conditions: S = Transducer Spacing Warning E = Empty Alarm

(continued)

FLOW DATA MENU ITEMS *(continued)*

	R = Flow Rate Alarm (High or Low rate threshold exceeded) F = Fault Alarm A = Aeration Alarm M = Memory Activated (Fault Suppressed) K = Makeup Flag (May be Latched) I = Interface Alarm P = Pig Alarm (option)
AnCal	Flow Rate Simulator for calibrating external devices, etc. Highlight this item then press the <Right Arrow> to enable numeric entry. Type desired simulated flow rate. Be aware of the units prefix (K, M, etc.). **NOTE: AnCal remains active only while you remain in this menu cell.**
HiFlow GAL/MIN	Most positive expected flow rate for application (adjustable).
LoFlow GAL/MIN	Most negative expected flow rate for application (adjustable).

Vs m/s

This menu cell shows the current sonic velocity in m/s. If you move the cursor to this menu cell you will note that it switches from the usual arrow (→) to a question mark (?). This indicates that you can increase the reading by pressing the [+] key for coarse adjustment or the [1] key for fine adjustment; or reduce the reading by pressing the [-] key for coarse adjustment or the [2] key for fine adjustment. Sonic velocity (Vs) adjustment is a diagnostic tool intended for our technicians or experienced users only. Improper use will affect the meter accuracy.

HiFlow and LoFlow

The HiFlow and LoFlow menu cells allow you to enter maximum and minimum expected flow rates based on current operating conditions. Under normal circumstances, you should never need to change these settings. It is possible however, that a Controlotron customer service engineer may ask you to edit these settings during a support session. In such a case, a <Right Arrow> at the menu cell enables numeric entry.

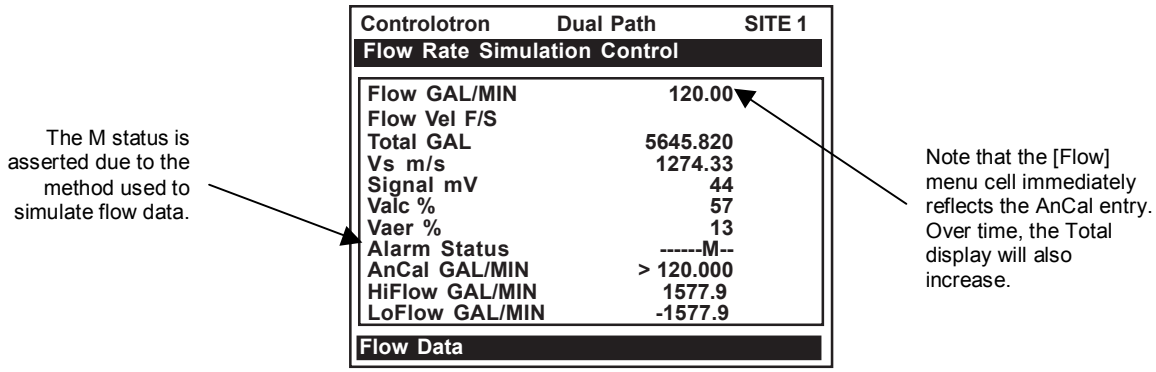
Important Note: *A caution on the use of upper and lower flow limits (used to prevent flow mis-registration) prior to using the Reversal Zero technique (ReversaMatic): If the negative flow rate that the meter reads in the step during which the transducers are reversed is more negative than the lower flow limit, the meter will re-register positive and the Reversal Zero cycle will thus be corrupted.*

Therefore, postpone the installation of upper and lower flow limits until the reversal zero procedure is executed successfully. For pipes that combine large diameters with very high flow velocities, it may be necessary to move the upper and lower flow limits out of the way until the reversal zero is completed. Moreover, pipes of this size frequently have excellent intrinsic zero performance and may not even need zeroing.

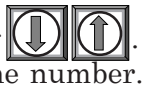
AnCal

This menu cell allows you to enter an artificial flow rate in current rate units that will drive the meter's analog outputs, totalizer output and the screen shown below. You can use

AnCal to check the analog outputs or as a reference source for calibrating external devices such as remote display screens or chart recorders and RTU's. To test the Totalizer function, leave AnCal active for enough time for an accumulation to appear on the screen below. Moving the cursor from the menu cell cancels the AnCal function.



To activate AnCal:

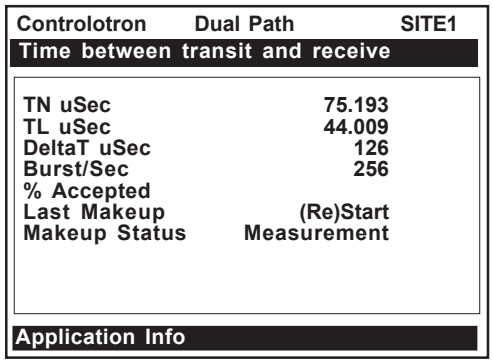
Move the cursor to the [AnCal] menu cell by pressing  . Press  to enable numeric entry. Note that an equal sign (=) appears before the number.

Type the desired flow rate using current rate units (e.g., 120.00 GPM). Note that the [Flow] menu cell now reflects the artificial rate.

Move the cursor away from the menu cell by pressing  to turn AnCal off.

2.11.3 THE APPLICATION INFO MENU

This menu provides a live display of the basic timing data used by meter during operation.

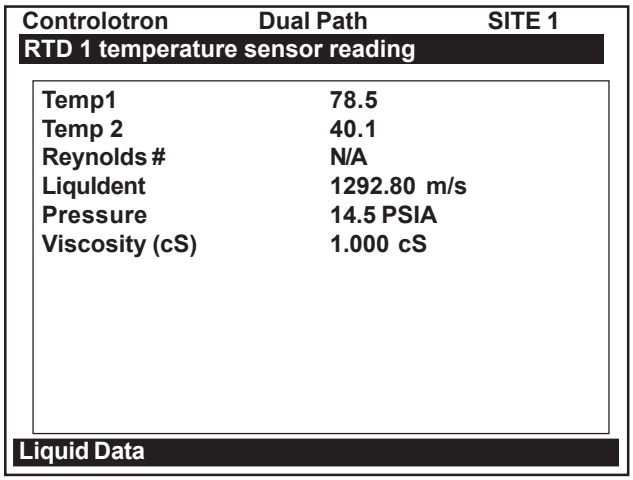


APPLICATION INFO MENU ITEMS

TN uSec	The total elapsed time between the transmission and reception of a sonic pulse.
TL uSec	The total time a sonic pulse takes to travel through the liquid.
DeltaT nSec	This is the instantaneous result of subtracting the down from the up transit times. **Note: This will appear to be more active than dampened flow readings**.
Burst/Sec	Number of transmissions per second under current operating conditions. The following factors influence this parameter: aeration, pressure transients, signal strength variation.
% Accepted	The running tally of accepted and rejected up/down burst sets.
Last Makeup	Reason for last Makeup (signal reacquisition).
Makeup Status	Current stage of Makeup routine. [Measurement = normal operation]

2.11.4 THE LIQUID DATA MENU

This menu shows the current Liquid Data parameters.



LIQUID DATA MENU ITEMS

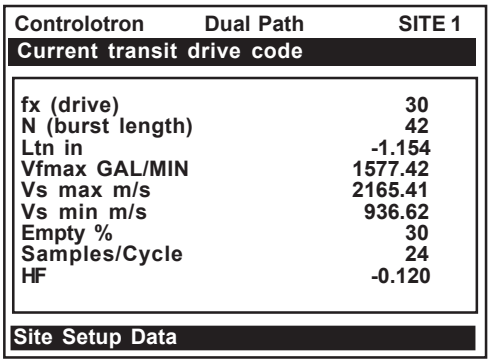
Temp1	Current liquid temperature.
Temp 2	Current liquid temperature.
Reynolds #	Current Reynolds number.
LiquIdent	The LiquIdent™ Index is the sonic velocity of the liquid at 60ºF(15.6ºC).
Pressure	Measured pressure.
Viscosity (cS)	Kinematic viscosity of a liquid measured in centistokes.

*Viscosity expresses the readiness with which a fluild flows when it is acted upon by an external force. Absolute viscosity of a fluid is a measure of its resistence to internal deformation or shear.

$$\text{viscosity (centistokes)} = \frac{\text{viscosity (centipoise)}}{\text{density(grams per cubic cm)}}$$

2.11.5 THE SITE SETUP DATA MENU

This menu provides data pertaining to transducer characteristics and operation. Some menu items are for technical support interpretation only.



SITE SETUP MENU ITEMS

fx (drive)	Current Transmit drive code selected during Initial Makeup. The drive code controls the sonic transmit signal.
N (burst length)	Transmit burst duration selected during Initial Makeup. To change N count press <Right Arrow>. At equal sign enter numeric value (1 to 9 only).
Ltn (in/mm)	Spacing distance between the transducers. It will be in inches or millimeters, depending on default units.
Vfmax	The flow velocity (in selected units) corresponding to one whole cycle offset between upstream and downstream receive signals.
Vs max m/s	Maximum correctly calibrated Vs for current transducer spacing.
Vs min m/s	Minimum correctly calibrated Vs for current transducer spacing.
Empty %	Value of Empty Alarm Setting. The meter will declare an empty status if signal strength drops below this value.
Samples/Cycle	Digital sampling rate.
HF	Flow registration correction parameter.

Introduction to [HF] Menu Item

All 1010 flowmeters with version 3.01.02 and later operating systems include a new Diagnostics Menu item that permits the entry of a flow registration correction parameter labeled [HF]. This “HF” parameter is the input for a proprietary algorithm which automatically compensates for signal beam blowing in pipes utilizing either 1011 clamp-on or insert transducers, thereby extending the upper flow limit of all 1010 flowmeters. This algorithm provides the most benefit for clamp-on meters where high flow velocities and low sound velocities create the most challenging conditions for digital signal processing routines.

Using the [HF] Menu Item

Two methods for adjusting this parameter are provided via the [HF] menu cell, located within the "Diagnostics / Site Setup" submenu. The "Manual" method provides direct entry of this parameter and is primarily intended for the advanced user, whereas the "Automatic" method allows the 1010 flowmeter to automatically measure the required correction and install the parameter.

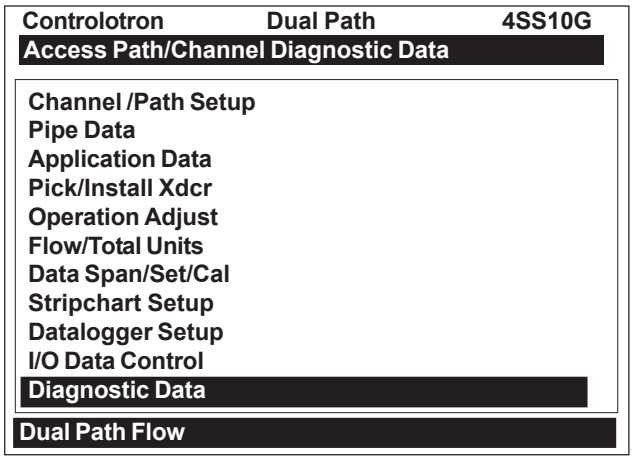
Guidelines for using the [HF] menu item are described below:

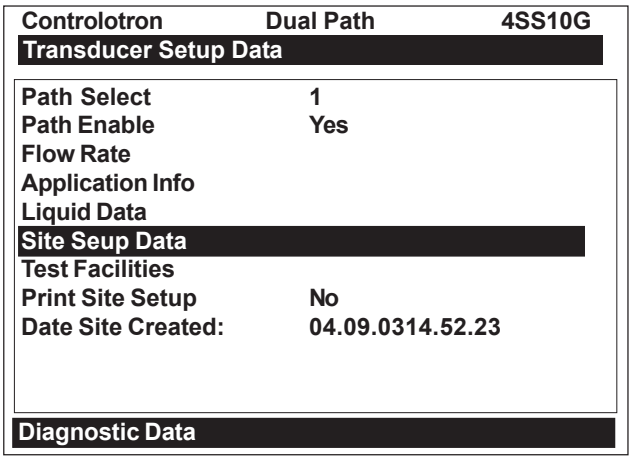
- This menu is only accessible for the transducer channels, not the virtual (average flow) channel of the flowmeter. (i.e., Diagnostics Path 1 or Path 2, but not Path 1 & 2).
- The 1010 flowmeter will inhibit the "Automatic" installation of the [HF] parameter if the flow rate is insufficient (too low) to accurately measure the required correction. If the maximum flow rate for the application is relatively low then this correction should not be required.
- If the flow rate is very high and the flowmeter is reporting erroneous or unstable flow, then the flowmeter may already be having trouble resolving the upstream and downstream signals. In this event, it may be necessary to first lower the flow rate to a moderate level before performing the "Automatic" HF adjustment. Once this is done the flowmeter should be able to properly measure the highest flow rates without problems.
- The limits of the "HF" parameter are +/- 0.7 and any attempt to manually install a larger value will cause the flowmeter to abort the installation of the parameter.

NOTE: Pressing the <Left Arrow> at any stage prior to accepting the measured value will abort the installation and return to the previous setting.

To access this [HF] menu item proceed as follows:

- At the [Meter Type] Menu, press the <Right Arrow> and then <ENT> to select the desired Path (e.g., Dual Path Flow).
- In the [Dual Path Flow] Menu, press the <Down Arrow> and scroll to the [Diagnostic Data] menu cell. Press the <Right Arrow> to select it.

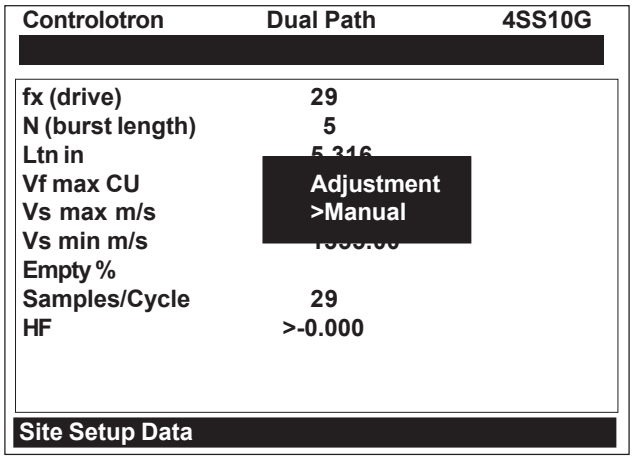


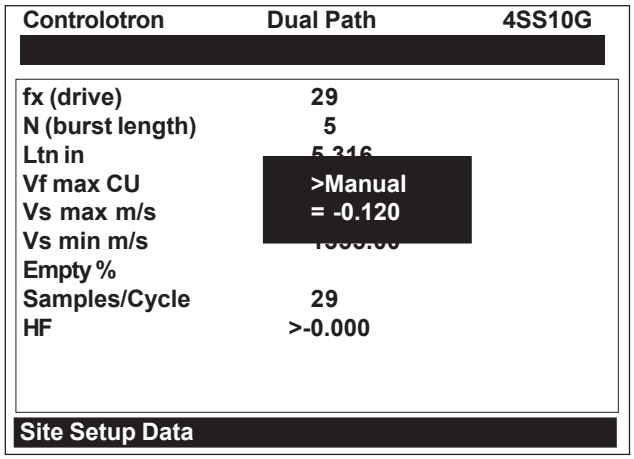


- In the [Diagnostic Data] Menu, highlight [Path Select] and select the desired transducer path. Press <ENT> to select path.
- Press the <Down Arrow> and scroll to the [Site Setup Data] menu cell. Press the <Right Arrow> to select it.

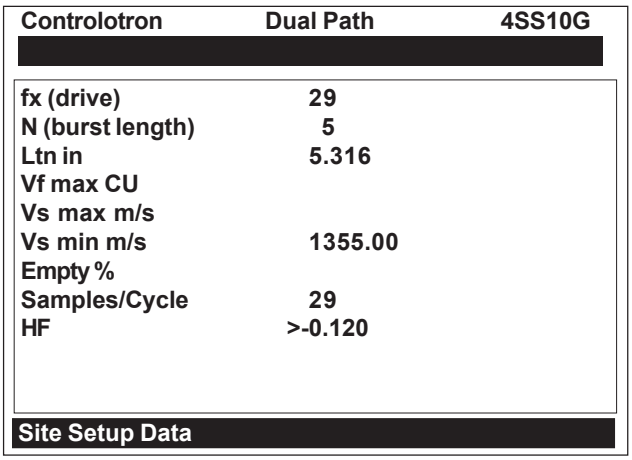
"Manual" Adjustment Procedure

- In the [Site Setup Data] Menu, press the <Down Arrow> and scroll to the [HF] menu cell. Press the <Right Arrow> and a pop-up [Manual] prompt will appear as shown below. *Note: Press the <Up/Down Arrow> to select [Automatic], if desired.*
- Use the numerical keys to input the desired correction value. Press <ENT> to input value.





- The new correction value will appear next to the [HF] menu cell as shown below.

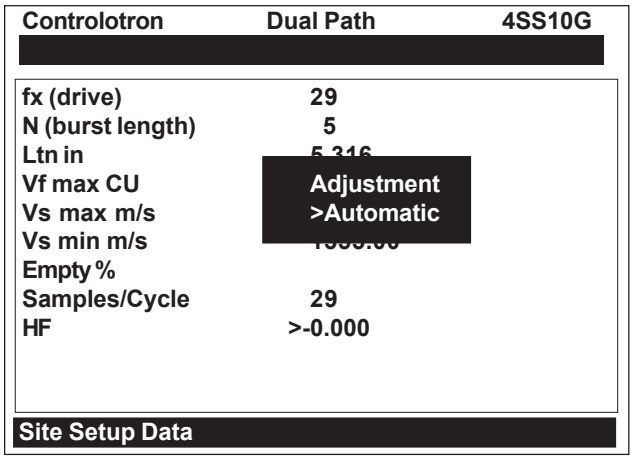


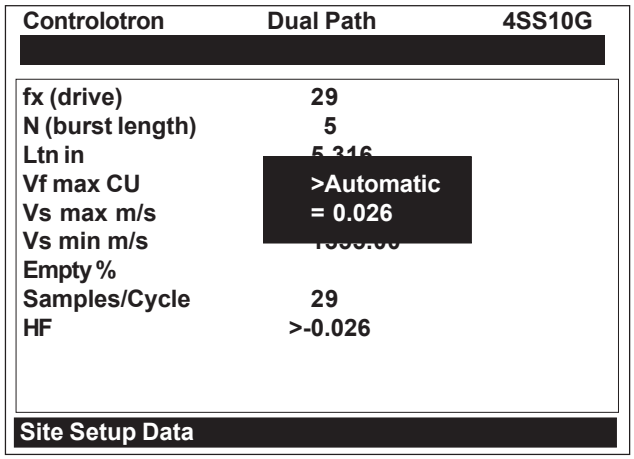
"Automatic" Adjustment Procedure

- In the [Site Setup Data] Menu, press the <Down Arrow> and scroll to the [HF] menu cell. Press the <Right Arrow> and a pop-up [Manual] prompt will appear.
- Press the <Up or Down Arrow> to select [Automatic] then press <ENT>.

- The current measured correction value is displayed (see below).
- Press <ENT> again to install this correction value which will now appear next to the [HF] menu cell.

NOTE: The value shown in the [Automatic] pop-up prompt can not be changed and is for user information only.

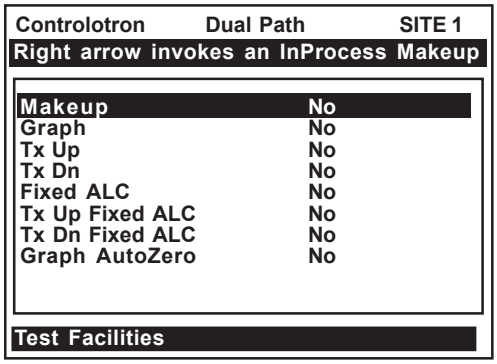




- If you decide not to use the [Automatic] selection, press any key other than <ENT> to abort the operation.

2.11.6 THE TEST FACILITIES MENU

The Test Facilities menu provides commands for system analysis and recovery. The most useful for the end-user are Makeup and Graph. Using these routines under the supervision of our technical support staff will help us to provide technical analysis and solutions.



To start a Test Routine:

To scroll the cursor to the test routine you want to use press ⇩ ⇧

To access the test option list press ⇨. Press ⇩ ⇧ to move the asterisk to [Yes].

To start the routine press ENT

To end the routine press ⇦

TEST FACILITIES COMMANDS

Makeup	Commands the meter to re-acquire the receive signal.
Graph	Enables an on-screen marker display. - Cor Q should be greater than 1.5. Larger number is better. Above 3 is desirable. SIG Q should be less than 10. A value of 8 or less is desirable.
Tx Up	Forces upstream transmission only.*
Tx Dn	Forces downstream transmission only.*
Fixed ALC	Select 'Yes' to command amplifier to hold a constant gain.*
TX Up Fixed ALC	Fixed ALC while transmitting up only.*
TX Dn. Fixed ALC	Fixed ALC while transmitting down only.*
Graph AutoZero	Use to establish a standard zero flow setting.

** For technical service diagnostics.*

Makeup

The Test Facility Makeup routine allows you to command the meter to re-acquire the operating parameters established during the Initial Makeup routine invoked by the [Install Completed?] command (see paragraph 2.4 Pick/Install Xdcr Menu).

To invoke the Makeup routine:

Press ⇩ ⇧ to scroll the cursor to [Makeup].

Press ⇨ to access the test option list. Press ⇩ ⇧ to move the cursor to [Yes].

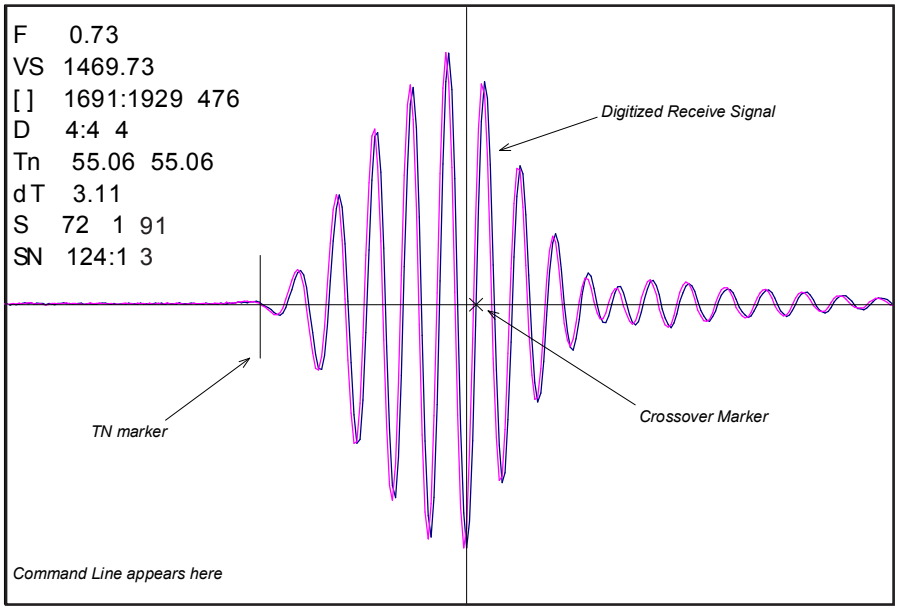
Press ENT to start the makeup routine.

The Test Facilities Graph Screen

NOTE: The following is intended for 1010 VFMT systems with Graphic Displays only. For VFMT capable 1010X systems (with or without digital displays) or 1010PVN blind systems, the digital receive signal can only be viewed as a text dump over the RS-232 output (i.e., by pressing the [F1] key and then the period key [.]). Access to the digital damping parameters can be found in the [Site Setup] menu cell of the Diagnostic Data menu. Refer to the appropriate System 1010 field manual for details.

When operating in the transit time mode the Test Facilities Graph Screen is an exceptional diagnostic tool for troubleshooting problem applications or simply determining receive signal quality. The primary function of this screen is the display of the digitized receive signal waveform with similar appearance and function of a digital oscilloscope. This screen also allows the user to override some of the 1010 default settings by permitting adjustment to the measured transit time, the digital averaging and the zero crossover used in the measurement of the up/down transit time difference. The figure shown on the next page is a representation of the 1010 diagnostic graph.

NOTE: The Test Facilities Graphic Screen requires significant CPU overhead. The 1010 meter should not be left in this mode during normal operation, where the Datalogger is the primary output, or during calibration work.



Entering the Diagnostic Graph Screen

Before you can view the Diagnostic Graph Screen the 1010 flow channel must first be properly installed and operating in a non-empty condition (refer to the appropriate 1010 Field manual). If a previously installed channel is in a "Fault" condition, but not reporting "Empty", you can still access the Graph Screen to aid in troubleshooting the cause of the failure to measure flow.

To view the Graph Screen first enter the [Test Facilities] menu, which is a submenu of the main [Diagnostic Data] menu.

- Pressing the <Up/Down Arrows>, scroll to the [Graph] menu item.
- Press the <Right Arrow> to enter the [Graph] menu and scroll to highlight the [Yes] item in the option list.
- Now press the <ENTER> key to access the Graph Screen.
- To exit the Graph Screen and return to the main menu, press the <MENU> key once.

Diagnostic Text Display

The text to the upper left-hand corner of the screen represents diagnostic items which can be individually turned on or off to reduce unnecessary clutter on the screen. This text display can be modified by pressing the <ENTER> key and scrolling up or down through the various parameters that appear in the Graph Display menu. Pressing the <ENTER> key will select the highlighted parameter (a "+" sign appears next to selected items) and pressing <CLR> will deselect the item. Pressing the <Left Arrow> will return you to the graph screen with the selected parameters appearing at the top left corner of the screen. (The figure above is shown with all diagnostics items selected).

Time Base Control

The digitized receive signal can be moved either to the left or right on the screen by pressing the <Left> or <Right> keypad arrows. The direction of the arrow actually represents the direction in which the receive "window" will move, thereby causing the receive signal to shift in the opposite direction on the screen (e.g., Pressing the <Left Arrow> moves the signal to the right).

The digitized receive signal can be expanded or contracted in the time domain by pressing the <+> or <-> keys on the keypad. This allows you to see the entire contents of the receive window, or zoom in to see greater detail. Pressing the <CLR> key once will automatically center the receive signal on the screen. When zooming in on the receive signal small vertical "tick" marks may appear. These marks represent the time at which the receive signal is digitally sampled.

Correlated Plot

During conditions of flow, the actual transit time delta (difference) can be observed in the displayed receive signal waveform when the [Correlated Plot] menu parameter is not selected. To observe this time difference simply depress the <+> key (to see greater signal detail) until the individual up and down receive signals are clearly discernible. To verify that the 1010 signal processing algorithms are properly correlating the up and down stream receive signals, select the [Correlated Plot] option from the display menu list.

Return to the graph screen and observe the relative position of the up and down waveforms. In a properly correlated receive signal the two images should be nearly superimposed on top of each other, even during high flow conditions. In the unlikely situation where the two images appear to be offset by one or more receive cycles then the flow readings should be considered questionable.

Command Modes

Although the 1010 signal processing algorithms are capable of accommodating a very wide range of signal conditions, it may be desirable to override these default settings under extremely difficult operating conditions. The following functions are available for this purpose:

Digital Damping Control: (Hot Key 1 and 2)

The System 1010 permits user modification of the digital averaging used by the signal processing routines. In general, the default damping values selected by System 1010 will provide optimal performance over a wide range of transit time applications. However, in extreme cases of unstable flow profile, low signal levels or high aeration it may be necessary to override these default settings to permit uninterrupted and reliable flow measurement.

The 1010 Graph Screen includes the capability to access a set of command codes, which enable a user to override a number of default setup parameters. The most important parameter is the *digital damping control*, which can be accessed by pressing number <1> or <2> on the keypad while in the graph screen mode.

Pressing the <1> key will cause [MinDamp #] to appear on the command line at the lower left-hand corner of the screen. The number listed to the right of the command code represents the exponent in the System 1010 exponential averaging routine, where the larger the number the greater the digital averaging. Pressing the <+> key will increase the damping value. Likewise, pressing the <-> key will decrease the damping value. To exit this mode, press the <0> key on the keypad.

Pressing the <2> key will bring up the [MaxDamp] command. The function of this parameter is similar to the [MinDamp] command described above, however, the two parameters interact in the following manner. The MinDamp value must not exceed the MaxDamp value, therefore increasing the MinDamp value above the previous MaxDamp value will set both parameters to the same value. In most cases, it is preferred that both damping parameters be set to the same value, however, in cases where rapid response to changes in liquid sound velocity is required, the two values may be set differently. In this situation the meter will use the MaxDamp value when sound velocity is stable, but then switch to a faster damping value (limited by MinDamp) when a significant change in sound velocity is perceived. To exit this mode, press the <0> key on the keypad.

Transit Time Adjustment: (Hot Key 3)

Observe the short vertical marker at the beginning of the receive signal in the Graph Screen above. This line represents the position in time (Tn) where the 1010 flowmeter perceives the arrival of the ultrasonic signal. There are actually two Tn markers, one for the upstream arrival time and one for the downstream arrival time. For proper liquid sound velocity measurement these Tn markers should be positioned near the beginning edge of the receive waveform envelope (as shown), however, in cases of poor signal conditions it is possible for this measurement to be off by several receive waveform cycles. To adjust the Tn mark position press the <3> key on the keypad to bring up the [TnSet] command.

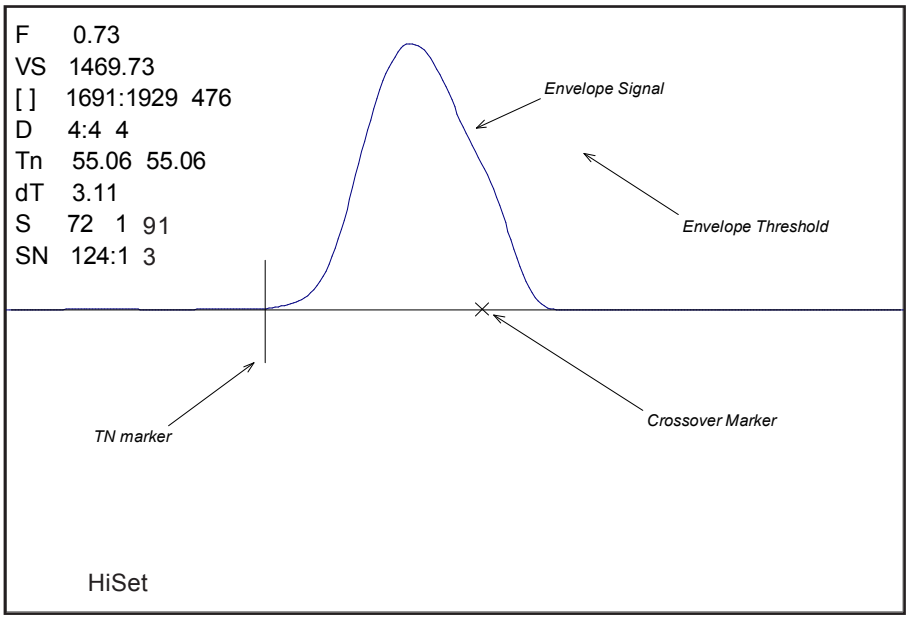
Pressing the <+> or <-> keys will cause the Tn marker to move later or earlier, respectively. As you adjust the Tn marker, both Tn and Vs (liquid sound velocity) will change accordingly. To exit this mode, press the <0> key on the keypad.

Zero Crossover Adjustment: (Hot Key 4)

Observe the small "X" mark located on the zero crossing line near the middle of the receive signal in the Graph Screen above. This "X" indicates the central crossover which the 1010 is using to measure the transit-time delta. This crossover will generally be close to the peak of the receive signal with at least one well formed (non-aberrated) receive cycle on each side of the crossover. If it appears that the placement of this crossover is unsatisfactory then it can be adjusted by pressing the <4> key on the keypad, which will invoke the [ZCOSet] command. The crossover point can then be moved in either direction on the waveform using the <+> or <-> keys. The change from the default value (in receive cycles) will appear in the number to the right of the command. To exit this mode, press the <0> key.

Envelope Threshold Adjustment: (Hot Key 5 & 6)

Pressing the <=> key causes the graph to toggle between the default signal waveform screen and the signal envelope screen (see example below). This envelope screen can aid in the diagnosis of Tn errors caused by unusual receive waveform distortion. Signal distortion is sometimes caused by poor transducer selection or poor pipe wall conditions, which may result in an incorrectly measured fluid sound velocity. To improve the automatic measurement of Tn, the envelope threshold limit can be adjusted to exclude portions of the envelope, which may be causing the Tn detection problem.



If it appears that the default placement of the Tn marker is incorrect or unstable, it can be adjusted by pressing the <5> key on the keypad to invoke the [EnvSet] command (while viewing the envelope screen). A horizontal line representing the envelope threshold level will appear along with a number indicating the percentage level. The High and Low thresholds can then be moved either up or down on the envelope using the <+> or <-> keys. While viewing the Tn marker position, adjust the thresholds so that they are well above the baseline "noise" level but below the first major peak. To exit this mode, press the <0> key.

Signal Masking Function: (Hot Key 7)

Under conditions of extremely low signal amplitude, a noise spike associated with 1010's receive signal window may be present on the extreme left side of the graph display. If this spike is large enough it may interfere with the signal detection routines. To eliminate this noise from the signal processing routines, press the <7> key to invoke the [MaskSet] command, then press the <+> key until the noise is no longer present in the receive waveform. Press <0> to exit this command.

DESCRIPTION OF GRAPH SCREEN TEXT DISPLAY PARAMETERS

Screen Text Parameters	Menu List item	Description
F	Flow	Measured flow rate in selected flow units.
VS	Vs (m/s)	Sound Velocity in meters per second.
[ ]	Display Metrics	Represents the digital sample position of the receive window.
	Correlated Plot	Displays the receive waveform in its proper superposition or registration. The true delta time will be displayed by NOT selecting "Correlated Plot".
	Centroid Mark	Indicates with a large vertical marker the peak energy of the receive waveform.
D	Damping	Displays the minimum and maximum digital damping exponent along with the active damping exponent.
Tn	Tn (usec)	Receive signal transit time in microseconds.
dT	Delta T (nsec)	Transit time delta (difference) in nanoseconds.
S	Signal Strength	Displays %Valc (amplitude), %Vaer (aeration factor) and numeric ALC.
SN	Signal to Noise Ratio	Indicates the signal to noise ratio of the receive signal. Increased damping will increase the S/N ratio as the asynchronous noise reduces.
	Envelope Signature	Percentage change of the signal from Initial Makeup conditions.

HOT KEY SUMMARY

Key	Command Line	Description
<+>		Expands (magnifies) waveform to view more detail.
<->		Contracts waveform to view more or the waveform.
<Left Arrow>		Shifts receive window to the left (waveform to the right).
<Right Arrow>		Shifts receive window to the right (waveform to the left).
<CLR>		Brings waveform to the center of the screen.
<ENTER>		Calls up Text Display menu items. <Left Arrow> to return to graph.
<MENU>		Exits the Graph Screen and returns to the main menu.
<1>	MinDamp	Minimum damping exponent control (+ or - to increase or decrease).
<2>	MaxDamp	Maximum damping exponent control (+ or - to increase or decrease).
<3>	TnSet	Transit time adjustment (use + or - to move Tn marker).
<4>	ZCOSet	Zero Crossover adjustment (use + or - to move crossover marker).
<5>	HiSet	Signal envelope threshold level (use + or - to move threshold).
<6>	LoSet	Signal envelope threshold level (use + or - to move threshold).
<7>	MaskSet	Leading edge masking functions (use + or - to alter number of samples masked).
<8>	Hold Set	Set this number higher if intermittant mis-registration occurs.
<0>		Exits the command line.
<=>		Toggle graph between receive waveform and envelope waveform.
<F1> and <.>		Dumps the digitized waveform data over the RS232 port. You must first leave the Graph Screen mode before invoking this command.

2.11.7 TROUBLESHOOTING TIPS

The System 1010 has highly reliable circuitry and will provide trouble-free operation within specified environments. Even a well-crafted precision instrument can fail if exposed to extreme temperature or vibration conditions during service, storage or transportation. The Diagnostic menu shows how the system interprets a problem. The test functions and alarm indicators identify "hidden" problems automatically. If a problem seems unsolvable, call our Technical Service Department or your local Controlotron Representative for expert help.

Flow Computer Messages

Certain actions or conditions invoke messages that may appear as a pop-up window, in the right-hand column of a given menu cell, or the highlighted prompt line at the top of the display screen. The following is a list of messages that you may encounter along with explanations, and in some cases, a recommended action.

MESSAGE	DESCRIPTION
Memory Full!	Response to an attempt to save site data, when data memory is full. Delete an obsolete site or clear Datalogger memory to make room for the new data.
Memory Corrupted!	Memory read error occurred while accessing the active site data.
Chan Not Setup	Response to an attempt to invoke an operation that requires a channel to be enabled. Enable the channel *[Channel Setup* ➔ *Channel Enable* ➔ *Yes*]. Note that a channel cannot be enabled until its transducers are operating.
Clr All Data?	Response to pressing the F4 key. Use the F4 function to restore operation if a severe event (e.g., a violent power surge) disrupts system operation.
Clr Dynamic Memory?	Response to pressing the F4 key, then selecting [No] for Clr Saved Data?
<EOT>	Response to a request to output datalogger data to the printer or the Graphics screen when no datalogger data exists. Set up the Datalogger.
Empty Pipe - Press [ENT]	Prompt to empty the pipe during the Actual MTY procedure. After emptying pipe, press <ENT>.
Fill Pipe - Press [ENT]	Prompt to fill the pipe during the Actual MTY procedure. After filling the pipe, press [ENT] (see paragraph 3.1.3).
No Sites	Response while trying to recall/delete a site setup when no Sites are stored.
Not Installed	Response to an attempt to access a menu function that is not included.
Re-space Index	Upon measuring the liquid sonic velocity (Vs), the meter recommends re-spacing the transducers to improve performance.
Invalid Setup (use Direct Mount)	During the Initial Makeup, the system detects invalid transducer spacing, erroneous liquid/pipe parameters, or some other factor that prevents it from completing the Initial Makeup. This may be due to one of the following: • An out-of-range data entry. • An invalid condition; (e.g., overlapping transducers in Reflect Mode). If selecting Direct Mode does not resolve, review all

(continued)

MESSAGE	DESCRIPTION
	site setup and transducer installation choices; particularly data entered for the pipe and liquid. • In Reflect Mode, the flow computer detects that the pipe wall signal may infringe upon the liquid signal. Use Direct Mode instead. Press <ENT>, <UP Arrow>, <DOWN Arrow>, or <LEFT Arrow> to abort install routine. Continue programming other site data in anticipation of resolving the difficulty later. Call technical support for help if necessary.
Low Signal- Press [ENT]	During the Initial Makeup, the meter decides that the level of the receive signal is insufficient for proper operation. Some reasons forlow signal are: • Invoking [Install Completed?] on an empty pipe. • Coupling compound insufficient, not applied, or evaporated. • A disconnected or broken transducer cable. • You need to condition the pipe at the mounting location. • Flush out Large air bubbles. • The Xdcr cables are defective or not connected to the correct channel. • The Set Empty routine performed when pipe was NOT actually empty.
Detection Fault	If you locate and correct the improper condition immediately, press <ENT> to resume the installation procedure. Otherwise, press the <LEFT Arrow> to abort the installation and conduct a thorough investigation. Appears if the meter cannot complete an Initial Makeup. It means that the pipe and/or liquid conditions do not permit a receive signal that meets the flow detection standards. The system will not be able to operate. Attempt to improve operating conditions by reinstalling the transducers at a different spacing offset, or even at a different location on the pipe. In addition, switching from Reflect to Direct Mount may solve the problem. However, operation may not be possible if there is poor liquid or pipe wall sonic conductivity or extreme liquid aeration.

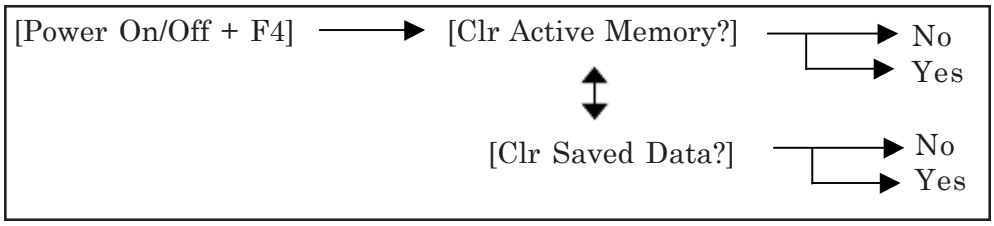
NOTE: If you receive a Detection Fault message, it is strongly recommended that you contact Technical Service for further orientation.

Using the "F4" Reset Sequence

You may encounter an operating problem that blocks access to the Diagnostics Menu, or the meter may operate erratically after exposure to a power transient or some other traumatic event. These cases may require use of the F4-reset sequence to restore operation.

The F4-reset sequence operates on two levels. The first F4-reset deletes all the data currently in Active Memory, but leaves Datalogger data and all stored Site Setups intact. This is the most desirable method since all you have to do to restore operation is reload a saved Site Setup. If this fails then you have to resort to the second level of the F4 sequence, which allows you to clear ALL Dynamic Memory. Be aware that this erases all saved Site Setups (***including flow calibrated sites)***. Datalogger Data and user-defined pipe and trans-

ducer tables. This will require you to completely re-install the system and repeat all desired default settings, custom pipe tables, etc. The chart below shows the sequence of the [F4] routine:



Procedure to clear Active Memory only:

Turn off power (if it is currently on). Press <F4> and keep it pressed while you turn on power. The prompt: **[Clr Active Memory? No]** appears at the top of the screen.

Press <Right Arrow> to access F4 Reset option list. Press <Down Arrow> to switch the option list to **[Clr Active Memory? Yes]**. Press <ENT> to clear all Active Site Data (but not saved Site Setups).

To restore operation, press <MENU> to access the installation menu. Create a new site setup or recall a stored site setup.

Re-select any Meter Facilities items (e.g., RS-232 setup parameters).

Procedure to clear ALL Dynamic Memory:

Turn off power (if it is currently on).

Press <F4> and keep it pressed while you turn on power. The prompt: **[Clr Active Memory? No]** appears at the top of the screen. Press the <Down Arrow>. Note that the prompt switches to **[Clr Saved Data? No]**.

To access the F4 Reset option list press the <Right Arrow>. Press the <Down Arrow> to switch the option list to **[Clr Saved Data? Yes]**.

CAUTION: Before proceeding further it is essential to understand that this function eliminates ALL data stored in RAM. This means that all saved site setups including the site data of a flow-calibrated site will be erased! In addition, the entire Datalogger file plus any custom factory or user-created pipe or transducer tables will be eliminated. The impact of this is such that we strongly recommend that you consult technical service before continuing with this procedure. Be aware that you will have to create a new Site Setup, re-enter all site specific parameters including pipe or transducer tables, plus all desired Meter Facilities entries.

To clear all Dynamic Memory press <ENT>.

Create a Site Setup before attempting to access other menu items.

To restore operation, press <MENU> to access the installation menu. Create a new site setup and complete the installation procedure.

Re-select desired Meter Facilities items (e.g., RS-232 setup parameters).

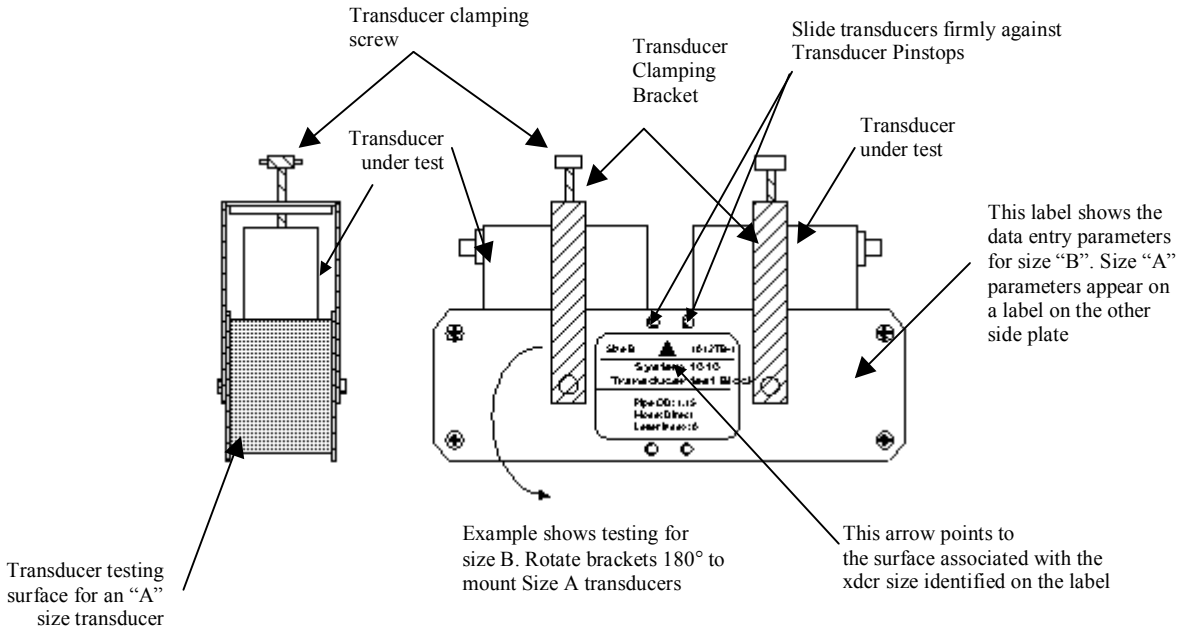
2.11.8 TROUBLESHOOTING WITH TRANSDUCER TEST BLOCKS

To resolve an apparent system malfunction, you have to determine whether the problem is due to equipment failure or an application condition. Our 1012 and 996 Transducer Test Blocks allow you to bench test the flow computer, transducers and their cables. If the system operates properly using the test block, then focus on application conditions as the source of the problem. Series A and B 1011 transducers use the 1012TB-1 Test Block and series C and D use the 1012TB-2 Test Block. At the present time, neither one support the 1011 High Precision transducers.

The 996PSP-pipe simulator allows you test a 1010 series flow computer and 991 transducers from size 0 to size 3. Note that although the 1010 flow computer operates with our 991 size 4 and 5 transducers, testing of these sizes with a 1010 flow computer is not currently supported.

2.11.9 USING THE 1012TB-1 AND 2 TEST BLOCKS

The 1012TB-1 and 1012TB-2 test blocks provide two test surfaces. Each surface supports a specific transducer size. For example, one surface of the 1010TB-1 supports Size "A" transducers and the other supports Size "B" transducers. The 1012 pipe simulators include two labels, one on each side-plate. The labels identify the transducer size, data to be entered, and the surface to be used with the specific transducer size. See drawing below.



MOUNTING TRANSDUCERS ON A 1012 TRANSDUCER TEST BLOCK

1. Identify the side of the simulator that applies to the transducers under test. Rotate the clamping bracket as required to mount transducers on the test surface.

2. Using a coupling compound (preferably CC-102), mount the transducers on the pipe simulator as shown above. Slide each transducer until it presses against the pin-stop. Use the clamping screws to hold the transducers in place.

3. Connect transducer cables between each transducer and the meter connectors for the channel under test. The Up and Down orientation is not important.

4. Access the Installation Menu. Select [Meter Type] [Single, Dual or Quad Channel] depending on meter type. Select the meter channel (1,2,3, or 4) depending on which measurement channel you intend to test. Select [Clamp-On] and then [Channel Setup].

5. Access the [Channel/Path Setup] menu. Move the highlight to [Create/Name Site]. Create a new Site Setup (e.g., TEST1). You can now enter data without altering an existing Site Setup.

6. Select the [Pipe Data] Menu. Referencing either the English or metric pipe simulator chart below, enter the pipe data corresponding to the transducer size under test.

1012TB-1 & 2 Universal Transducer Test Block Chart (English)

Part Number	Xdcr Size	Pipe OD (in.)	Pipe Mat'l	Wall Thk (in.)	Mount Mode	Spacing Offset	Number Index
1012TB-1	A	0.650	Steel*	0.100*	Reflect	Nominal	7
1012TB-1	B	1.150	Steel*	0.100*	Direct	Minimum	4
1012TB-2	C	2.000	Steel*	0.100*	Reflect	Nominal	11
1012TB-2	D	3.500	Steel*	0.100*	Direct	Minimum	Use Ltn

**System Default*

1012TB-1 & 2 Universal Transducer Test Block Chart (Metric)

Part Number	Xdcr Size	Pipe OD (mm)	Pipe Mat'l	Wall Thk (mm)	Mount Mode	Spacing Offset	Number Index
1012TB1	A	16.5	Steel*	2.54*	Reflect	Nominal	7
1012TB1	B	29.2	Steel*	2.54*	Direct	Minimum	4
1012TB2	C	50.8	Steel*	2.54*	Reflect	Nominal	11
1012TB2	D	88.9	Steel*	2.54*	Direct	Minimum	Use Ltn

**System Defaults*

7. Access the [Pick/Install Xdcr] menu. Check the [Transducer Size] menu cell. If necessary, enter the Xdcr Size option list and pick the transducer under test.

8. Check the [Xdcr Mount Mode] menu cell. Adjust to match the simulator chart above.

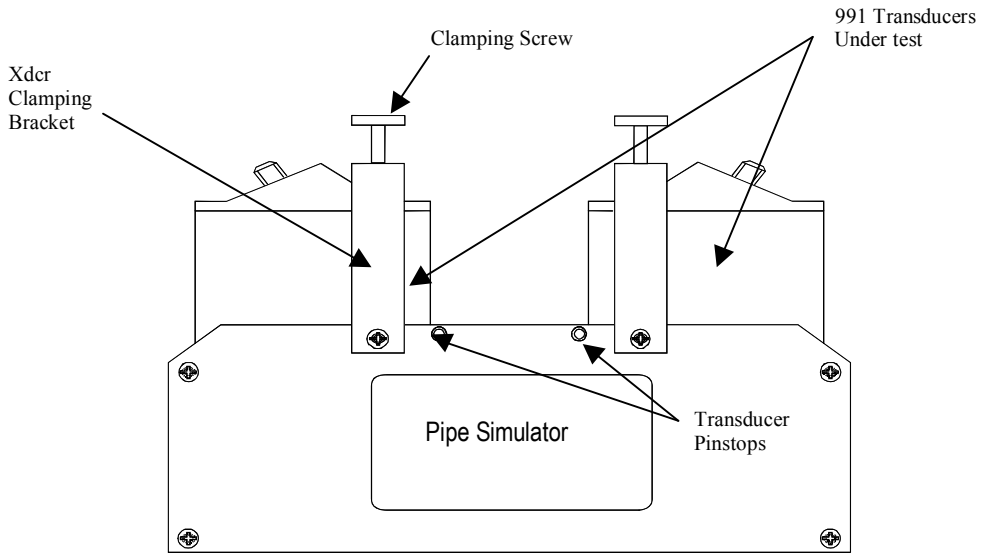
9. Move the highlight down to [Install Completed?] by pressing  . Access the option list. Move the cursor to [Install] by pressing  . Press  to start the transducer install routine.

NOTE: Since Sizes A and C transducers are installed in Reflect Mode, you will see a pop-up window that prompts you to: [Use Actual Zero]. You can ignore this by pressing the <Down Arrow>.

Upon the completion of the [Install] procedure, the flow computer should report a sonic velocity within the range of approximately 1350m/s to 1700 m/s (depending on the transducer size under test). Next, check **[Diagnostic Data]** menu. The [Valc %] item must be >35 for dependable operation. In addition, note the reading, then compare it to the [Vf max] item in the **[Diagnostic Data/Site Setup Data]** menu. The value of the reading should be less than 2% of the published Vf max. Confirming these values certifies that the entire system (computer, transducers, cables) is operating correctly. The investigation should proceed to a review of all site conditions to locate the operating problem.

2.11.10 USING THE 996PSP PIPE SIMULATOR

Using the proper coupling compound, mount the transducers on the pipe simulator as shown below. Slide each transducer until it presses against a pin-stop. Use the clamping screws to hold the transducers in place.



To mount transducers on a 996PSP Pipe Simulator

1. Using coupling compound, mount the transducers on the pipe simulator as shown above. Slide each transducer until it presses against a pin-stop. Use the clamps to hold the transducer in place.
2. Connect cables between each transducer and the computer connectors for the channel under test. The Up and Down orientation is not important.
3. Press <MENU> to access the Installation Menu. Select [Meter Type] [Single, Dual, or Quad Channel] depending on meter type. Select the meter channel (1,2,3, or 4) depending on the measurement channel you intend to test. Select [Clamp-on] and then [Channel Setup].
4. Access [Channel/Path Setup] menu. Move highlight to [Create/Name Site]. Create a new Site Setup (e.g., TEST1). You can now enter data without altering an existing Site Setup.
5. Select the [Pipe Data] Menu. Referencing either the English or metric pipe simulator chart below, enter the pipe parameters corresponding to the transducer size under test.

996PSP PIPE SIMULATOR CHART (English)

Part Number	Xdcr Size	Pipe OD (in)	Pipe Mat'l	Wall Thk (in)	Mount Mode	Letter Index	Number Index*
996PSP-0	0	2.420	PVC	0.076	Direct	A	6
996PSP-1	1	2.481	PVC	0.077	Direct	A	9
996PSP-2	2	2.743	PVC	0.136	Direct	A	6
996PSP-3	3	3.758	PVC	0.344	Direct	A	1
996PSP-4	4	6.500	PVC	1.000	Direct**	A	0

** The flow computer generates the Number Index.*
*** See note below.*

996PSP PIPE SIMULATOR CHART (Metric)

Part Number	Xdcr Size	Pipe OD (mm)	Pipe Mat'l	Wall Thk (mm)	Mount Mode	Letter Index	Number Index*
996PSP-0	0	61.47	PVC	1.93	Direct	A	6
996PSP-1	1	63.02	PVC	1.96	Direct	A	9
996PSP-2	2	69.67	PVC	3.45	Direct	A	6
996PSP-3	3	95.45	PVC	8.74	Direct	A	1
996PSP-4	4	165.1	PVC	25.4	Direct**	A	0

** The flow computer generates the Number Index.*
*** See note below.*

NOTE: When using a 996PS-4 Simulator, you must access the [Application Data] menu, select [Liquid Type] - [Other], then program the [Estimated Vs] for a value of 2100 m/s.

6. Access the [Pick/Install Xdcr] menu. Access the [Transducer Model] menu cell. Enter the Transducer Model option list. Select [991 Universal].

7. Check the [Transducer Size] menu cell. If necessary, enter the Transducer Size option list and pick the actual transducer under test.

8. Check the [Xdcr Mount Mode] menu cell. Adjust as necessary to match the simulator chart above.

9. Move the highlight down to [Install Completed?]. Access the option list. Move the cursor to [Install]. Press <ENT> to start the transducer install routine.

10. Check to make sure that the flow computer returns the Number Index listed in the chart above. Next, review and verify the Diagnostics data items as described previously. If the computer, cables and transducers are operating properly, then review all site conditions to locate the operating problem.

If a Pipe Simulator/Test- Block Test Fails:

1. Replace the transducer cables. If this allows you to complete the test as described above, then the cables were defective.

2. If the cables are proven to be good, replace the transducers on the pipe simulator with a "known good" set. If the system functions properly, then the original transducers under test are defective. Please return any defective transducers to Controlotron for repair.

3. If you replace the transducers and cables, and the system still fails to function correctly, then it is likely that the computer has a malfunctioning circuit module. If you have spare modules you may try module substitution to identify the defective module. Otherwise, please call Controlotron's Technical Service Department for further instructions.

2.12 GUIDE TO A SMOOTH INSTALLATION

NOTE: The following should be used in conjunction with the System 1010 Field Manual Diagnostic and Troubleshooting procedures.

2.12.1 CHECKLIST FOR 1010 STARTUP & PERFORMANCE

PROGRAMMING

- ❑ Select appropriate meter yype: Clamp-On, Reflexor, Dual Beam, Flow Tube, etc.
- ❑ Select proper channel (Dual or Multi-Channel Systems Only).
- ❑ Use “Full Site Setup”
- ❑ Create Site (or Recall Site).
- ❑ Program accurate Pipe Diameter, Material & Wall Thickness (or choose from tables).
- ❑ Program accurate Liner Material and Thickness (if applicable); Ensure Liner is well bonded.
- ❑ Program correct Liquid Type (Estimated Vs), Consult Vs Database for liquids not on meter menu.
- ❑ Select Recommended Transducer, HP for Steel Only; Use first choice for Universals, if possible.
- ❑ Ensure Transducer Type & Size match programming.
- ❑ Ensure transducer serial numbers match each other.

INSTALLATION/TRANSDUCER MOUNT GUIDELINES

- ❑ Install Transducers (Reflect/Direct) as recommended by meter; Use assigned spacing positions!
- ❑ Use Reflect Mount whenever possible (Not permitted on plastic pipes).
- ❑ Avoid placing transducers downstream of flow obstructions, pressure drops, elbows.
- ❑ Mount upstream of Orifice Plates, Turbines, Valves, “T’s”
- ❑ Allow a minimum of 10 diameters of straight pipe upstream of Transducers; More following multi elbows.
- ❑ If <10 diameters is available, mount Reflect within 2 diameters, in Plane-of-Elbow (on outside of bend).
- ❑ DO NOT mount Transducers on top and/or bottom of horizontal pipe!
- ❑ Ensure pipe is clean and smooth; remove external scale, loose or flaking paint.
- ❑ Use appropriate Coupling Compound for application (see charts below).

- ❑ Avoid mounting on pipe seams.
- ❑ Connect "UP" Cable to "Upstream Transducer" (closest to source of flow) and vice versa.

START-UP

- ❑ Ensure pipe is FULL (flowing or not).
- ❑ Select "Install Complete?".....INSTALL to Invoke "Initial Makeup" routine.
- ❑ Verify "Measured Vs" is accurate for liquid type & temperature (Consult Vs Database)
- ❑ Set Zero appropriately (AutoZero or ZeroMatic for Reflect, Actual Zero or ReversaMatic for Direct).
- ❑ After completion of Zeroing, access Flow Display by pressing <MENU> key.
- ❑ Use <UP/Down Arrows> to scroll through available displays.

DIAGNOSTIC/PERFORMANCE VERIFICATION

- ❑ Verify Vs is correct for Liquid and Temperature.
- ❑ Verify Valc is Greater Than 30.
- ❑ Verify Vaer is Less Than 10 when flowing.
- ❑ Check Signal Graph to be acceptable. See reference graphs below.
- ❑ For 100 Universal Transducers verify "VfMax" is significantly higher than maximum Flow Rate of application.
- ❑ Set "Hi Flow" at 90% VfMax; Ensure it is higher than Max Application Flow Rate.
- ❑ Set "Lo Flow" at –10% VfMax. (For unidirectional flow applications only!)
- ❑ Set "Lo Flow" at 10% Greater Than Maximum Negative Flow (Bi-Directional Applications).

2.12.2 OPTIMIZATION/CORRECTION OF PROBLEMS

Incorrect "Measured Vs"

- ❑ Verify actual pipe (outside) diameter matches meter programming.
- ❑ Verify actual Wall Thickness matches meter programming.
- ❑ Verify transducer Type and Size matches meter programming.
- ❑ Verify transducer mount method, and spacing positions (indices) match meter programming.
- ❑ Check actual transducer spacing matches "Ltn" dimension.

- ❑ Verify Graph is acceptable (see below).
- ❑ Use recommeded High Precision or first recommended Universal Transducer.
- ❑ Verify Liquid Vs in database (take into account actual temperature & pressure).
- ❑ Verify Liquid chemistry is as expected. (Ask about additives, Pressure, Temp.)
- ❑ Try "1-Cycle" Vs Correction in Diagnostics if error remains for a liquid with well defined Vs data.

Low Valc

- ❑ Clean and condition pipe surface.
- ❑ Use recommeded High Precision or first recommended Universal Transducer.
- ❑ Use Direct Mount (be sure of transducer 180º alignment!).
- ❑ Use larger size transducer (Universal Only!).
- ❑ Use wider spacing (Maximum or Letter D).
- ❑ Stop flow to check for Aeration/Cavitation.
- ❑ Try another location.
- ❑ Perform an Initial Makeup after ANY of the above changes!!

Detection Fault/Low Signal

- ❑ Perform all checks for "Low Valc"
- ❑ Ensure pipe is full.
- ❑ Ensure cables are terminated at both ends; Check continuity with Ohmmeter.
- ❑ Check operation on Pipe Simulator.
- ❑ Switch off any radiating electrical equipment in area (Transmitters, Variable Freq. Drives, etc.).

High Vaer

- ❑ Avoid transducer mounting near flow obstructions.
- ❑ Check for possible pressure drop sources (Pipe Expansion, Orifice, Check Valve, etc.).
- ❑ Check liquid "Flash Point" against application conditions.
- ❑ Pinch downstream valve (of Transducer) to raise pressure.
- ❑ Mount on suction side of pump.
- ❑ Raise tank levels; adjust Float switches.

- ❑ Switch off any radiating electrical equipment in area (Transmitters, Variable Freq. Drives, etc.).

Poor Signal

- ❑ Check that actual pipe dimensions and material match programmed data.
- ❑ Consult X-Select; Choose first recommended transducer.
- ❑ Relocate transducers.

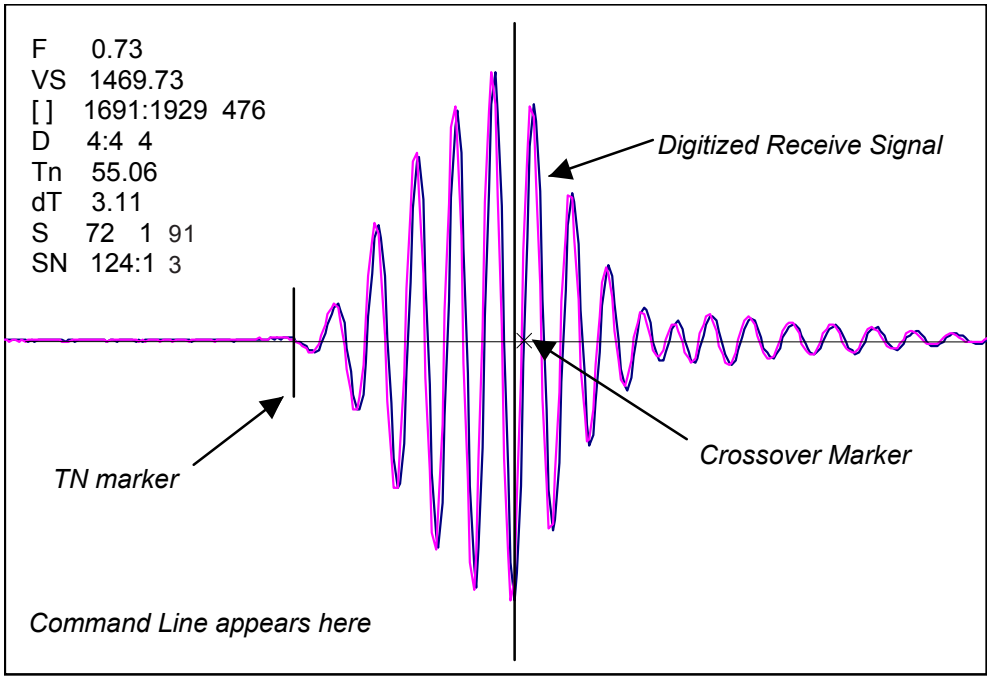
"Official" COUPLING COMPOUNDS

Part#	Name	Application	Max Temp.	Remarks
CC-102	Ultragel	Portable, Short Term (< 24 Hours)	110°F, 43°C	Water Soluble
CC-110	RTV-734	Permanent (Plastic Xducers Only)	150°F, 65°C	Avoid Humidity
CC-114	Magnalube	Long Term Teflon Grease	300°F, 159°C	Temp. affects life
CC-117	Dow-340	Temperature Sensors Only	400°F, 205°C	Heat Sync Comp.
CC-120	Denso	Submersible Applications	150°F, 65°C	Good Noise Damp
CC-122	KryTox	Long Term High Temperature	450°F, 232°C	Use for all HT
CC-124	Barco Bond	Permanent Epoxy for Metal Xdcrs	150°F, 65°C	Cure at Ambient
CC-128	SuperLube	Long Term Grease	375°F, 190°C	Avail. In Stores

"Alternative" COUPLING COMPOUNDS

Trade Name	Application	Max Temp.	Remarks
Motor Oil, Gear Oil, STP	Portable, Short Term	250°F, 121°C	Messy
Auto Wheel Bearing Grease	Moderate to Long Term	250°F, 121°C	Good Gen'l Compound
Silicone Rubber (RTV)	Permanent	As Rated	Cure at Ambient
2-Part Epoxy	Permanent	As Rated	Cure at Ambient
Gasket Cement	Permanent	375°F, 190°C	Cure at Ambient

Ideal Vsig Display



3. HARDWARE INSTALLATION GUIDE

3.1 PREPARING TO MOUNT THE TRANSDUCERS

Installing the transducers is fairly straightforward. However, careful planning will avoid any snags that may delay the installation. Previously, based on the input you fed into the meter's computer, it had recommended the transducers size, mounting option and spacing. With the transducers at hand, we are now ready to mount them. But first, some very important preliminary work must be done which consists of:

- Selecting a mounting option for your application
- Selecting a location on the pipe
- Preparing the pipe to accept the transducers

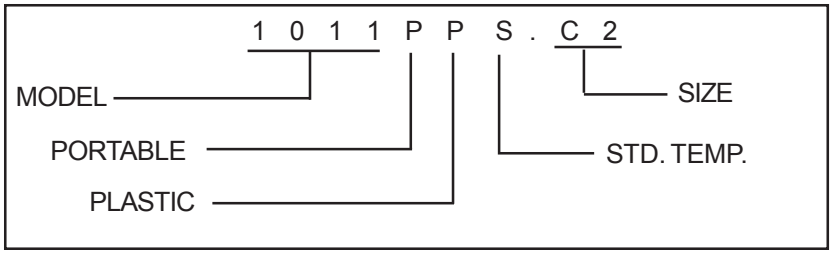
NOTE: When installing transducers, do not key in the V/M (Version/Modification) label number as the Transducer Size.

3.1.1 HOW TO IDENTIFY 1011 TRANSDUCERS AND MOUNTING HARDWARE

1011 series of universal transducers and mounting frames have the following color-codes for easy identification:

GOLD ..... SIZE 'A'	GREEN.....SIZE 'D'
BLUE..... SIZE 'B'	BLACK.....SIZE 'E'
RED ..... SIZE 'C'	

The transducer part number located on the front face provides a more detailed identification. *For example, the Part Number: 1011PPS-C2 means:*



3.1.2 SELECTING A LOCATION FOR CLAMP-ON TRANSDUCERS

- Locate the transducers downstream from the center of the longest available straight run. A location ten pipe diameters or greater downstream from the nearest bend will provide the best flow profile conditions.
- Do not (if possible) install the transducers downstream from a throttling valve, a mixing tank, the discharge of a positive displacement pump or any other equipment that could possibly aerate the liquid. The best location will be as free as possible from flow disturbances, vibration, sources of heat, noise, or radiated energy.

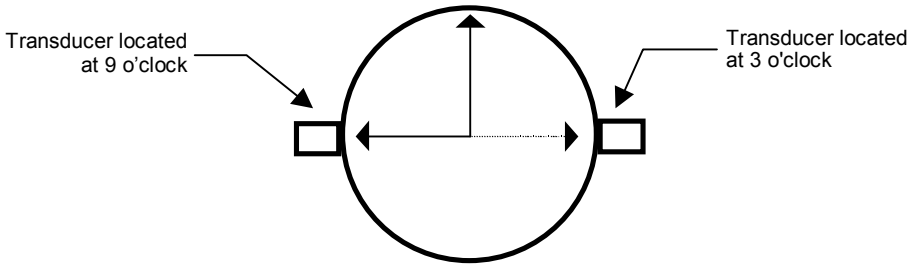
- Avoid mounting the transducers on a section of pipe with any external scale. Remove all scale, rust, loose paint, etc., from the location.

- Do not mount the transducers on a surface aberration (pipe seam, etc.)

- Do not mount transducers from different ultrasonic flowmeters on the same pipe. Also, do not run the transducer cables in common bundles with cables from communication equipment, other Controlotron systems, or any type of ultrasonic equipment. You can run these cables through a common conduit ONLY if they originate at the same flowmeter.

- Never mount transducers under water, unless you order submersible units and you install them in accordance with factory instructions.

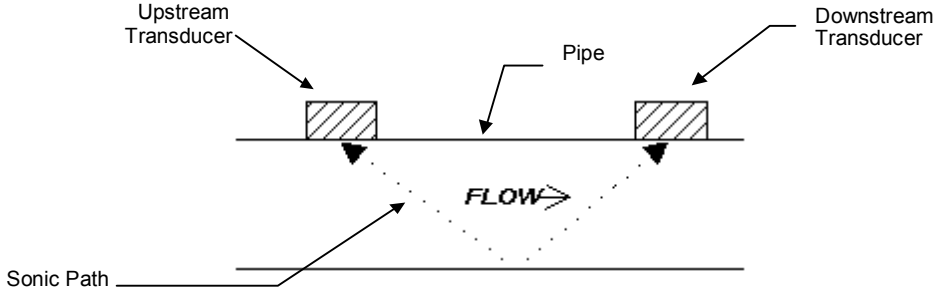
- Never mount transducers on the top or bottom of a horizontal pipe. The best placement on a horizontal pipe is either the nine o'clock or three o'clock position for Reflect Mode, or one transducer at nine o'clock and one transducer at three o'clock for Direct Mode. Mounting on a vertical pipe is recommended only if flow is in the upward direction. *When mounting on a vertical pipe flowing in a downward direction make sure there is sufficient back pressure in the system to maintain a full pipe.*



END VIEW
(Horizontal Plane)

3.1.3 CLAMP-ON TRANSDUCER MOUNTING MODES

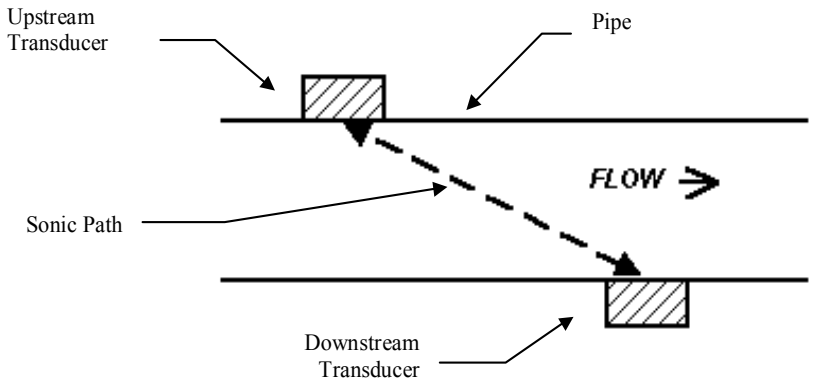
Controlotron clamp-on transducers support Direct or Reflect mounting modes. The flow computer recommends a mounting mode after analyzing your pipe and liquid data entries. However, you can install clamp-on transducers in the way that best suits your application and the transducer type you purchased.



REFLECT MOUNT
(Pipe shown in top view for ease in visualizing sonic path)

We recommend Reflect mount whenever possible. This is the simplest way to mount the transducers. Also, Reflect mount resists abnormal flow profile conditions such as cross-flow within the flow stream. Reflect mode supports the AutoZero™ function, which zeroes the meter automatically without user-participation. In addition, Reflect mount may be the only possibility if conditions do not allow access to the opposite side of the pipe.

Direct mount provides a shorter sonic beam path. This usually improves performance with sonically attenuative liquids or pipe materials. We recommend using Direct mount for plastic pipes. Compared to Direct mounting, Reflect mount requires almost double the amount of a straight pipe run. Therefore, Direct mount may be the only option if the availability of mounting space is limited.



DIRECT MOUNT

(Pipe shown in top view for ease in visualizing sonic path)

3.1.4 PREPARING THE PIPE

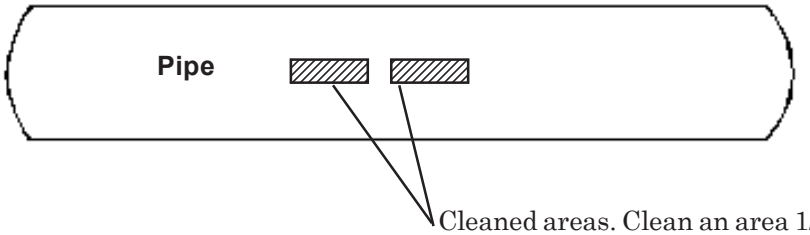
1. Pick a mounting location with the longest straight run. You must have easy access to at least one side of your pipe. The mounting location must remain full, even at zero flow.

2. Decide on your mounting mode (Direct or Reflect). Always use Reflect Mode whenever possible. You may only need to use Direct Mode if your pipe is plastic.

3. After receiving the spacing dimensions from the Installation Menu, prepare the pipe surface. De-grease the surface, if necessary, and remove any grit, corrosion, rust, loose paint, etc. Use abrasive material provided to provide a clean contact surface for the transducers.

4. Refer to the next sections for illustrated instructions on how to locate each area to be cleaned and how to use each mounting option.

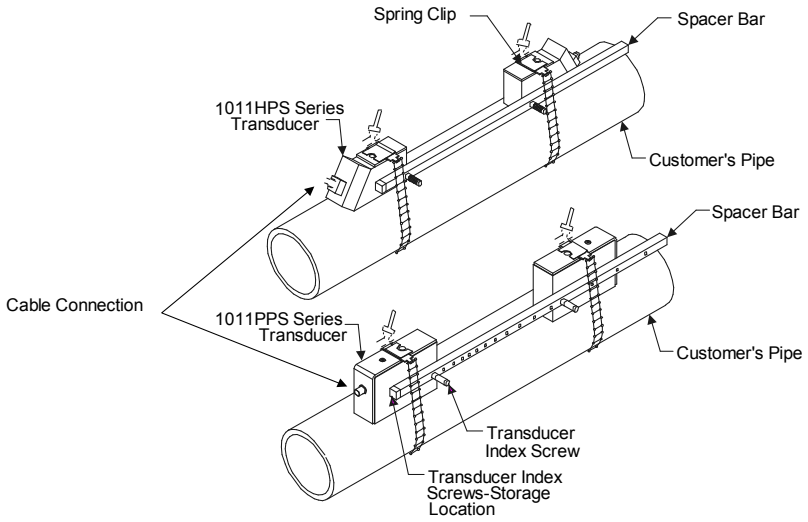
Please note that the instructions show vertical mounting for clarity purposes only. Do not install transducers on the top of a pipe.



PREPARING THE PIPE SURFACE

3.1.5 REFLECT MODE WITH EZ CLAMP AND SPACER BAR ONLY

The EZ Clamp is a quick and easy way to securely mount transducers on any pipe. The spacer bar eliminates manual spacing measurements and provides rigidity for mounting the transducers while maintaining axial alignment.



INSTALLATION - REFLECT MOUNT WITH EZ CLAMP AND SPACING BAR

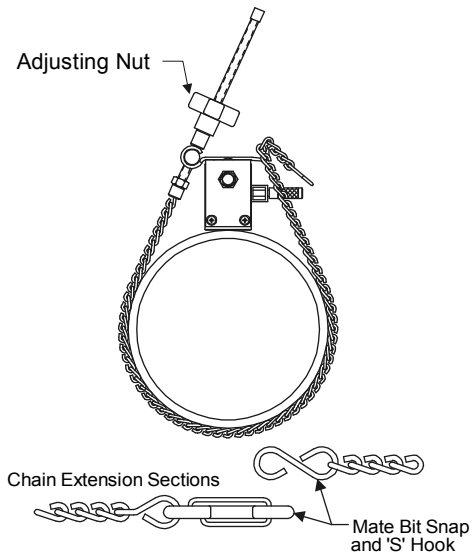
1. Perform all required menu steps until the flow computer issues the number index and prompts you to press [ENT] to finish the transducer install routine. Stop at this point. Note the number index value displayed in the Pick/Install menu. You will use this number to properly space the transducers. Check to ensure that you have a matched set of transducers. They both should have the same S/N number but marked with either an "A" or "B" (e.g., 100A and 100B).

2. Assemble the transducers to the spacer bar, with the cable connectors facing away from each other as shown above. The spacer bar is attached to a transducer using a transducer index screw. One transducer is attached using the "REF" hole on the spacer bar. The second transducer is attached to the spacer at the index hole specified in Step 1. Note that in some cases, the transducers may have two sets of holes for securing the transducers. When using the EZ Clamp assembly, use the lower set of holes when attaching the spacer bar.

3. Temporarily position the assembly (in the 9 o'clock position) at the location where you have determined it would be mounted. Ensure that this is a smooth area without any raised spots (seams, etc.). Mark a generous area around the transducers (with a pencil or chalk) where they contact the pipe. Remove the assembly.

4. Prepare the two areas you marked by de-greasing the surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided.

5. Remove the transducer from the spacer bar that was attached through the REF hole. Attach the EZ clamp to the transducer under the spring clip. The adjusting nut knob should be pointing up and on the side opposite of the spacer bar. Unscrew the knob until it's at the stop.



EZ CLAMPING TRANSDUCER TO PIPE

6. Apply a 1/8-inch continuous bead of couplant compound along the center (the long way) of the contact surface of the transducer. Place transducer on the pipe center in the middle of one of the areas you have cleaned with the cable connector facing away from where the other transducer will be placed.

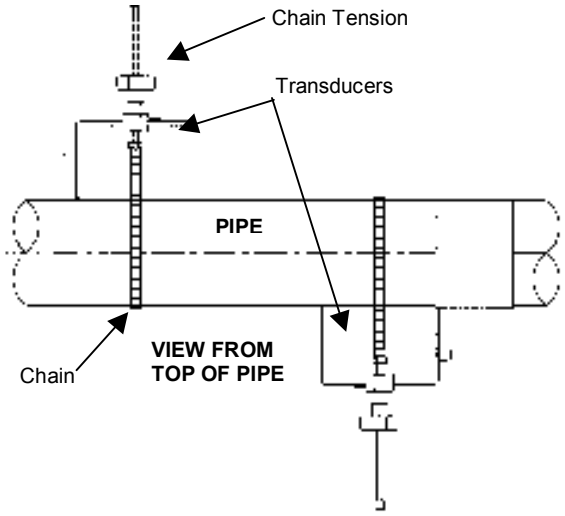
7. While holding this transducer in-place, bring the chain around the pipe and attach the closest cross-link onto the hook of the EZ clamp. Tighten the adjusting nut until the chain is just snug around the pipe. Ensure that the chain is straight around the pipe and the transducer contacts the pipe at the white dot just under the front label. Ensure that there is equal space between the edges of the transducer and pipe.

8. Repeat Steps 5 and 6 with the second transducer leaving it still attached to the spacer bar. Apply a 1/8-inch bead of couplant compound to the transducer. At the same time that you place it in the middle of the second area prepared, secure the spacing bar to the already mounted transducer by inserting the transducer index screw through the REF hole on the Bar and into lowest hole on transducer (for those transducers that have two holes). Sight along spacer bar to ensure axial alignment to the pipe. Adjust if necessary. Tighten both chains. Do not overtighten. Ensure that transducers did not move while tightening.

9. Connect the transducer cable, ensuring that you have observed the upstream/downstream orientation in respect to the cable and the input jack on the flow computer. If this is a dual-channel unit, make sure you are connecting the cables to the correct channel's input jacks. Repeat this procedure for the number index transducer.

3.1.6 DIRECT MODE WITH EZ CLAMP AND SPACER BAR ONLY

This section will present an easy, uncomplicated method of mounting transducers in Direct Mode and ensuring that they will line up exactly 180° from each other (9 o'clock - 3 o'clock positions) and spaced the proper distance apart.



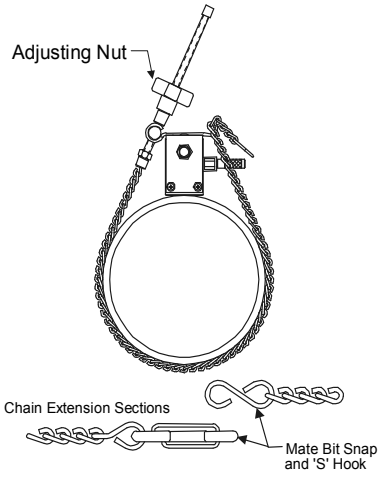
INSTALLATION - DIRECT MOUNT WITH EZ CLAMP AND SPACER BAR

1. Perform all required menu steps until the flow computer issues the number index and prompts you to press [ENT] to finish the transducer install routine. Stop at this point. Note the number index value displayed in the Pick/Install menu. You will use this number to properly space the transducers. Check to ensure that you have a matched set of transducers. They both should have the same S/N number but marked with either an "A" or "B" (e.g., 100A and 100B).

2. Temporarily position one transducer (in the 9 o'clock position) at the location where you have determined it would be mounted. Ensure that this is a smooth area without any raised spots (seams, etc.). Mark a generous area around the transducer where it contacts the pipe (with a pencil or chalk). Remove the transducer.

3. Prepare the area you marked by de-greasing the surface if needed and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided.

4. Attach the EZ clamp to the transducer under the spring clip. The adjusting nut knob should be pointing up and on the side opposite of the spacer bar. Unscrew the knob until it's at the stop.



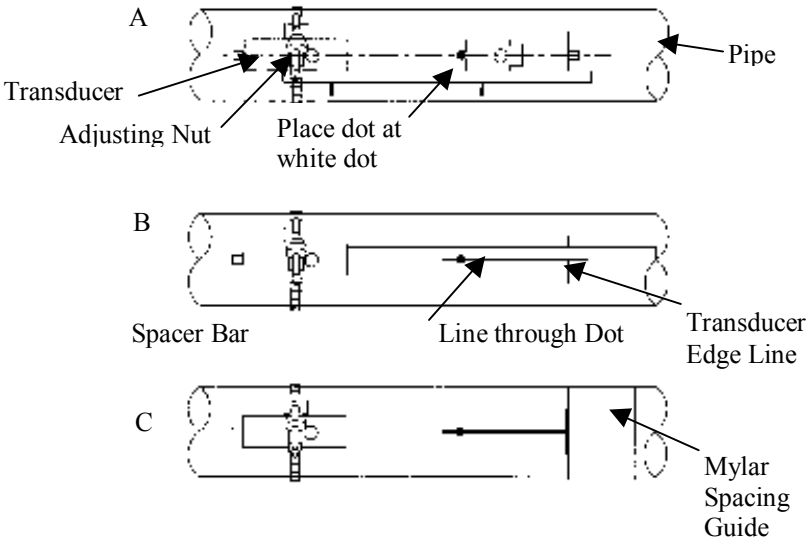
EZ CLAMPING TRANSDUCER TO PIPE

5. Apply a 1/8-inch continuous bead of couplant compound along the center (the long way) of the contact surface of the transducer. Position this transducer on the center of the pipe in the middle of area you have cleaned; the cable connector facing away from where the other transducer will go.

6. While holding the transducer in-place, bring the chain around the pipe and attach the closest cross-link onto the hook of the EZ clamp. Tighten the adjusting nut until the chain is just snug around the pipe. Check to ensure that the chain is straight around the pipe and that the transducer is contacting the pipe at the white dot just under the front label. Ensure also that there is equal space on either side of the dot between the edges of the transducer and the pipe. Adjust if necessary. Tighten the chain but do not overtighten. Ensure the transducer did not move while tightening.

7. Attach the second transducer to the spacer bar at the index hole specified in paragraph #1. Note that in some cases, the transducers may have two sets of holes for securing the spacer bar. When using the EZ clamp assembly, use the lower set of holes when attaching the spacer bar.

8. Unlike the first transducer, do not apply any couplant at this point. Attach the spacer bar (with the second transducer attached to it) to the mounted transducer by inserting an index screw through the REF hole in the bar and into the lowest hole on the transducer. Tighten. Visually ensure that the spacer bar is axially aligned with the pipe. While holding in this position, pencil a line (or a fine line with chalk) along the back edge of the transducer and a dot below where the white dot is below the front label (see "A" below). Disassemble the spacer bar and second transducer from the mounted transducer and remove the transducer from the bar. Use the bar as a straight edge and, with one edge against the mounted transducer's white dot and the other crossing the dot you drew, draw a line crossing the dot (see "B" below). Set the bar aside.



9. Wrap the mylar spacing guide around the pipe so that the left edge is against the transducer edge mark (see "C" on previous page). Arrange so that one end overlaps the other by at least three inches. Trim to fit if necessary, ***but be sure not to trim at the overlapping end in order to keep it square***.

10. Realign the left edge of the guide with the transducer edge mark. Line up both vertical edges of the guide and ensuring that it is snug around the pipe; mark along the overlapping edge.

11. Remove the Mylar spacing guide and lay it out on a flat surface. Either, measure the exact distance halfway between the overlap edge and the mark at the overlap or fold the guide from the overlap edge to the overlap mark and draw a line at the fold or half way point.

12. Reinstall the spacing guide; its left edge abutting the transducers edge mark on the pipe and the overlapping edge in line with the dot (now a line) on the pipe (see "C" on previous page). Tape it in this position on the pipe. Take the second transducer and place it against the edge of the guide with its white dot centered on the center mark on the guide. Temporarily position the transducer (in the 3 o'clock position opposite the mounted transducer) where it will be mounted. Ensure that this is a smooth area without any raised spots (seams, etc.). While holding, mark a generous area around the transducer (with a pencil or chalk) where it contacts the pipe. Remove the transducer and the mylar guide.

13. Prepare the area you marked by de-greasing the surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided.

14. Replace the mylar guide back in the same position it was in and retape it to the pipe. Attach the EZ clamp to the transducer under the spring clip. Unscrew the knob until it's at the stop.

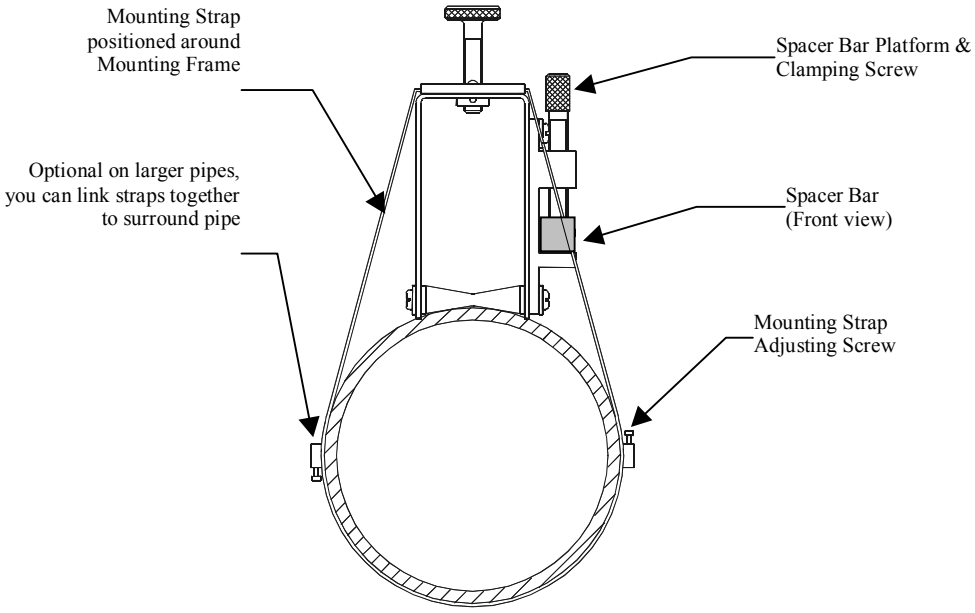
15. Apply a 1/8-inch continuous bead of couplant compound along the center (the long way) of the contact surface of the transducer. Position this transducer on the center of the pipe and aligned with the edge and center marks on the guide; with the cable connector facing away from the other transducer.

16. While holding this transducer in-place, bring the chain around the pipe and attach the closest cross-link onto the hook of the EZ clamp. Tighten the adjusting nut until the chain is just snug around the pipe. Check to ensure that the chain is straight around the pipe and that the transducer is contacting the pipe at the white dot which is just under the front label. Ensure that there is equal space on either side of the dot between the edges of the transducer and the pipe. Adjust if necessary. Tighten the chain but do not overtighten. Ensure that the transducer did not move while tightening.

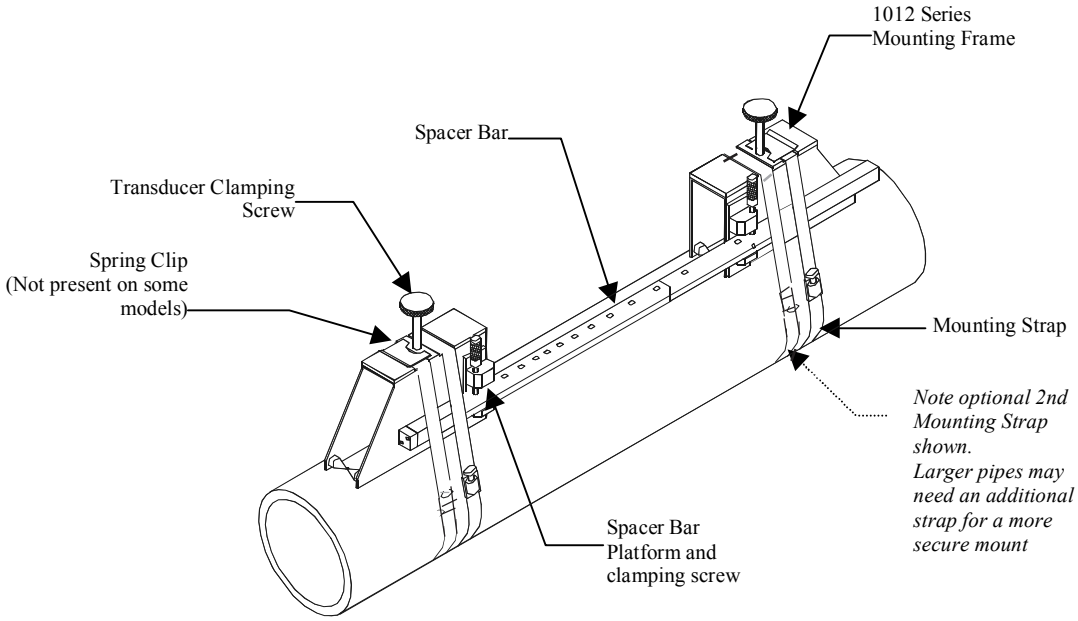
17. Connect the transducer cable, ensuring that you have observed the upstream/downstream orientation in respect to the cable and the input jack on the flow computer. If this is a dual-channel unit, make sure you are connecting the cables to the correct channel's input jacks. Repeat this procedure for the number index transducer.

3.1.7 REFLECT MODE - MOUNTING FRAMES AND SPACER BAR

The combination of a spacer bar with mounting frames is the easiest way to mount in Reflect Mode. The result is a rigid structure that eliminates spacing measurements, and maintains the transducer-to-transducer geometry. In addition, reflect mounting allows you to move the entire assembly while maintaining the original transducer spacing.



INSTALLATION - REFLECT MOUNT WITH FRAMES AND SPACER BAR
NOTE: Minimum Ltn 0.75 in. (18 mm)



1. Perform all required menu steps until the flow computer issues the number index and prompts you to press <ENT> to finish the transducer install routine. Stop at this point.

Note the number index value displayed in the Pick/Install menu. You will use this number to properly space the transducers. Check to ensure that you have a matched set of transducers. They both should have the same S/N number but marked with either an “A” or “B” (e.g., 100A and 100B).

2. On a flat surface, attach the spacer bar to a mounting frame so that the reference hole on the spacer bar fits over the post on the platform of the frame; tighten the securing screw. Slide the second mounting frame onto the other end of the spacer bar, align the number index hole with the post on the platform; then tighten the securing screw. Ensure that the angled sides of both frames face away from each other. At the mounting location, place the mounting frame/spacer bar assembly on the pipe so that it rests on the top of the pipe. Wrap a mounting strap around the pipe. Engage the end of the mounting strap with the mounting strap adjusting screw. Slide it under the spring clip (if so equipped) of one of the mounting frames. Make sure to position it for easy access to the mounting strap adjusting screw. Do the same to the other mounting frame.

3. Tighten the mounting strap screw enough to take up all of the slack, but not enough to prevent rotation of the assembly. Rotate the assembly on the pipe to the 9 o'clock position ensuring that it is a smooth area without any raised spots or seams. Mark a generous area around the mounting frames (1/2" on either side and half again the length front and back) with a pencil or chalk. Move or revolve the assembly away from the area marked (loosen straps if necessary to do this).

4. Prepare the two areas you marked by de-greasing the surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided. Clean the pipe of all debris and abrasive particles.

5. Reposition the assembly over the center of the prepared surfaces. Tighten the mounting straps to seat the assembly firmly on the pipe. Do not overtighten.

   Apply a continuous 1/8-inch bead of coupling compound to the center of the face of a transducer, then slide it into the mounting frame but holding it away from making contact with the pipe until it butts up against the stop (to keep from smearing couplant where it's not needed); then push down onto the pipe. Tighten the transducer clamping screw to hold the transducer firmly in place. Repeat for the other transducer.

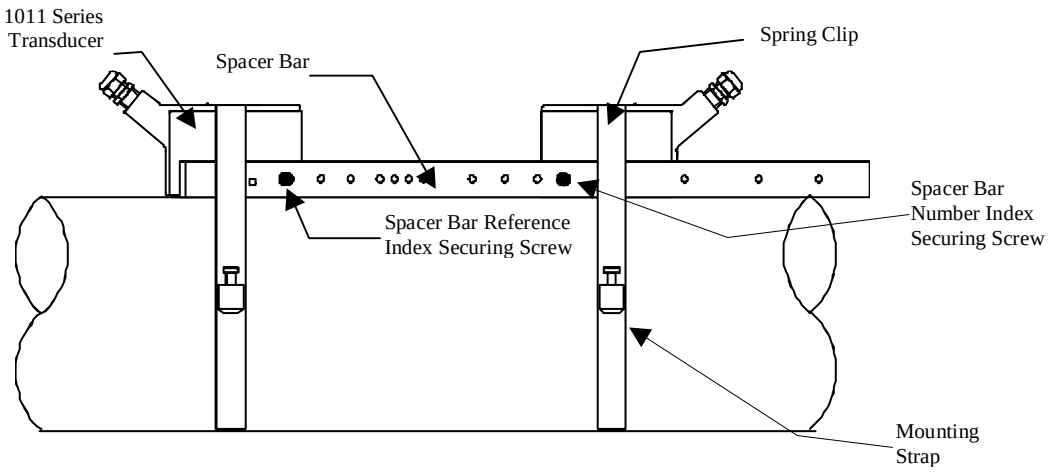
6. Observing the upstream to downstream orientation, attach the UP and DN cables to the transducers. Attach the other ends to the flowmeter's UP and DN terminals. See Engineering Drawing 1010N-7, Single Channel or 1010DN-7 Dual-Channel.

7. You can now press <ENT> to finish the transducer install routine. The available Mounting Strap kits are listed below. Each kit comes with up to two band sizes to cover its designated pipe diameter range and a spacing guide for Direct Mount.

Strap Mounting Kit P/N	Pipe Diameter	Band Sizes (Qty.)
1012MS-1A	2" (50.8mm) to 7" (177.8mm)	#88 (2) #128 (2)
1012MS-1	2" (50.8mm) to 13" (330.2mm)	#88 (2) #152 (2)
1012MS-2	13" (330.2mm) to 24" (609.6mm)	#188 (2) #280 (2)
1012MS-3	24" (609.6mm) to 48" (1219.2mm)	#152 (2)

3.1.8 REFLECT MODE WITH SPACER BAR ONLY

The spacer bar eliminates manual spacing measurements and provides rigidity for mounting the transducers while maintaining axial alignment.



INSTALLATION - REFLECT MOUNT WITH TRANSDUCERS AND SPACING BAR

1. Perform all required menu steps until the flow computer issues the number index and prompts you to press <ENT> to finish the transducer install routine. Stop at this point.

   Note the number index value displayed in the Pick/Install menu. You will use this index to properly space the transducers. Check to ensure that you have a matched set of transducers. They both should have the same S/N number but marked with either an "A" or "B" (e.g., 100A and 100B).

2. Assemble the transducers to the spacer bar, with the cable connectors facing away from each other as shown above. The spacer bar is attached to a transducer using a transducer index screw. One transducer is attached using the "REF" hole on the spacer bar. The second transducer is attached to the spacer at the index hole specified in Step 1.

3. Temporarily position the assembly (in the 9 o'clock position) at the location where you have determined it would be mounted. Ensure that it is a smooth area without any raised spots or seams. Mark a generous area around the transducers (1/2" on either side and half again the length front and back) with a pencil or chalk. Remove the assembly.

4. Prepare the two areas you marked by de-greasing the surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided. Clean the pipe of all debris and abrasive particles.

5. Remove transducer from the spacer bar that was attached through the REF hole. Put a mounting strap around the pipe and engage an end into the adjusting screw (adjusting screw should be pointing up). Apply a 1/8-inch continuous bead of couplant compound down the center (the long way) of the contact surface of one of the transducers (see Recommended Sonic Coupling Compounds Section 5, page 5-9). Place the transducer on the pipe center in the middle of one of the areas you have cleaned with its cable connector pointing away from the other cleaned area. Holding the transducer in place, slide the mounting strap over it (and under the clip if there is one) and tighten with a screwdriver. While tightening, check to ensure that the white dot under the front label is centered on the pipe and that there is equal space on both edges. Also, Make sure to position strap for easy access to the mounting strap adjusting screw.

6. Repeat Step 5 with the second transducer leaving it still attached to the spacer bar. Apply a 1/8-inch bead of couplant to the transducer. At the same time you place it in the middle

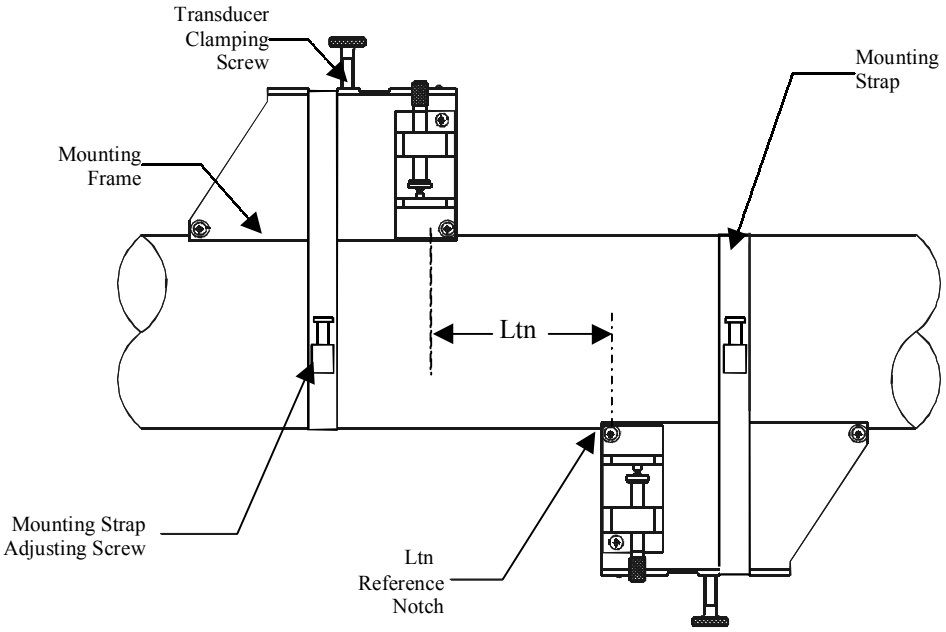
of the second area prepared, secure the spacing bar to the already mounted transducer by inserting the transducer index screw through the REF hole on the Bar. Put mounting strap around transducer and tighten as in Step 5. Sight along spacer bar to ensure axial alignment to the pipe. Adjust if necessary and do not overtighten. Ensure that the transducers do not move while tightening.

7. Connect the transducer cable, ensuring that you have observed the upstream/downstream orientation in respect to the cable and the input jack on the flow computer. If this is a dual-channel unit, make sure you are connecting the cables to the correct channel's input jacks. Repeat this procedure for the number index transducer.

8. Return to the menu, and press <ENT> to finish the transducer install routine.

3.1.9 DIRECT MODE - MOUNTING FRAMES, SPACER BAR AND SPACING GUIDES

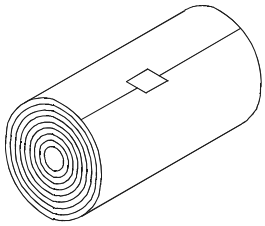
The combination of mounting frames, spacer bar and spacing guides is the recommended way to mount Direct Mode transducers. The mounting frame establishes the axial alignment of the transducers, and allows you to remove and replace either transducer while preserving their exact mounting location.



INSTALLATION - DIRECT MODE WITH TRANSDUCERS, MOUNTING FRAMES SPACER BAR (Not Shown) AND SPACING GUIDE

For Direct Mode mounting, you will use a spacer bar to establish the distance between transducers and a spacing guide to easily locate the transducers at the nine o'clock and three o'clock positions. Should the distance between transducers be beyond the span of a spacer bar, a measuring tape can be used. The Mylar spacing guide comes in various lengths and widths to accommodate most pipe sizes (see list below).

Spacing Guide P/N	Size
1012-145-1A	2" x 26" (50.8 x 660.4 mm)
1012-145-1	2" x 45" (50.8 x 1143.0 mm)
1012-145-2	4" x 81" (101.6 x 2057.4 mm)
1012-145-3	4" x 155" (101.6 x 3937.0 mm)



MYLAR™ SPACING GUIDE

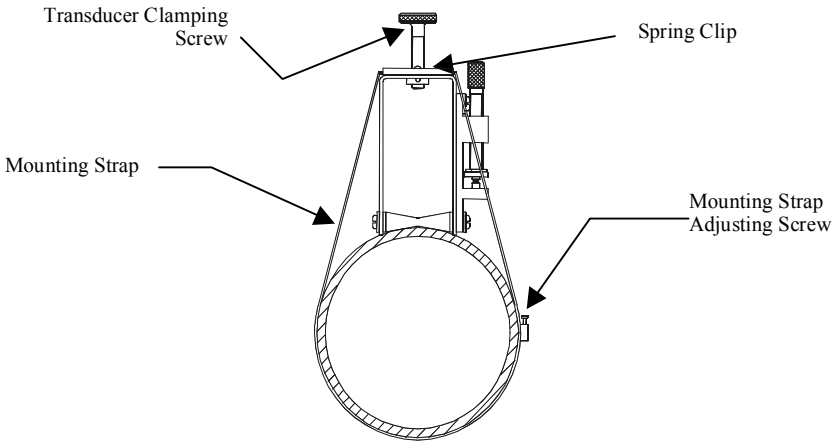
1. Perform all the required menu steps up until the point where the flow computer issues the number index and prompts you to press <ENT> to finish the transducer install routine.

   Make a note of the number index displayed in the Pick/Install menu. Check to ensure that you have a matched set of transducers. They both should have the same S/N number but marked with either an "A" or "B" (e.g., 100A and 100B).

2. Temporarily position one of the frames on the pipe where you will be mounting it. Ensure that this is a smooth area without any raised areas (seams, etc.) With a pencil or chalk, mark a generous area around the frame (1/2" on either side and half again the length front and back). Remove the assembly.

3. Prepare the area you marked by de-greasing surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive material provided.

4. Put a mounting strap around the pipe and engage an end into adjusting screw (screw should be pointing up). Position frame in the middle of area you have cleaned and centered on the pipe with its angled end facing away from where the other frame will sit.

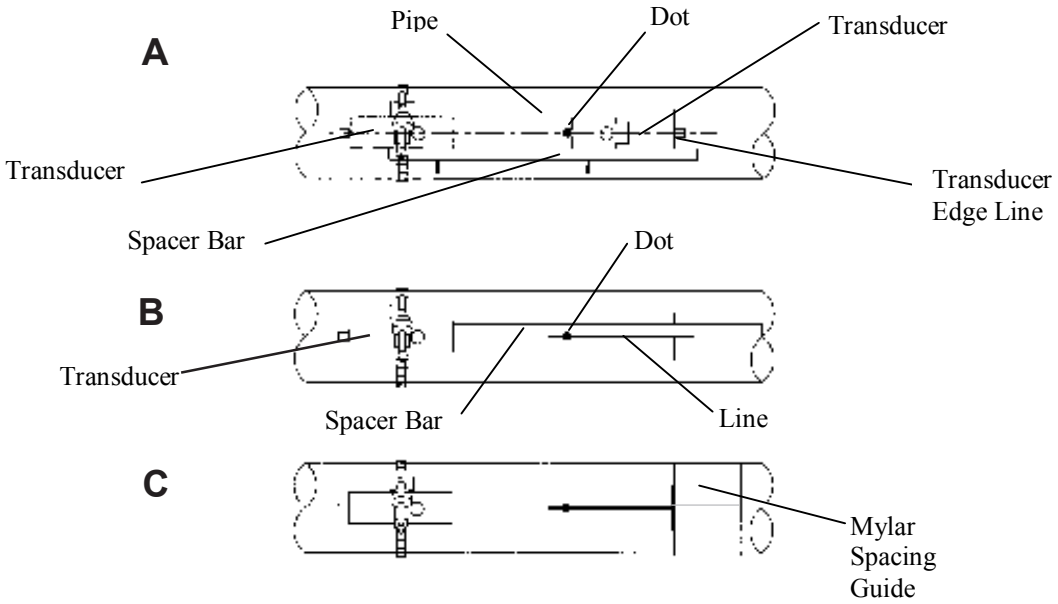


WRAPPING STRAP UNDER PIPE AND ATTACHING TO ADJUSTING SCREW

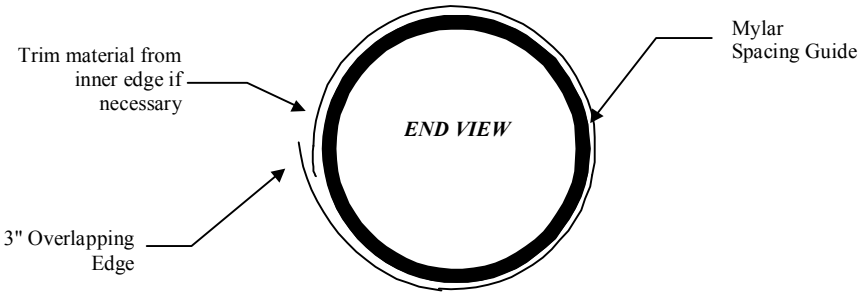
5. Slide the mounting strap over it (and under the clip if there is one) and tighten with a screwdriver. While tightening, check to ensure that the center of the tapered roller is centered on the pipe.

6. Attach the second frame to the spacer bar with an index spacer screw into the index hole specified in Step 1. The angle on the frame should be facing away from the direction the length of the bar is going. Now attach the free end of the spacer bar by inserting an index spacer screw through the REF hole on the spacer bar and then into the hole on the mounted frame. Tighten. Sight to ensure that this frame is lined up in center of pipe and while holding alignment, place a dot (with pencil or chalk) in the center of the tapered roller

at the bottom of the frame (see A below). While holding, also mark along the front edge of the frame with pencil or fine chalk line (see B below).



7. Disassemble the spacer bar and the unmounted frame. Use the bar as a straight edge and, with one edge against the mounted frames tapered roller center and the other crossing the dot you drew, draw a line crossing the dot (see "B" above). Set the bar aside.

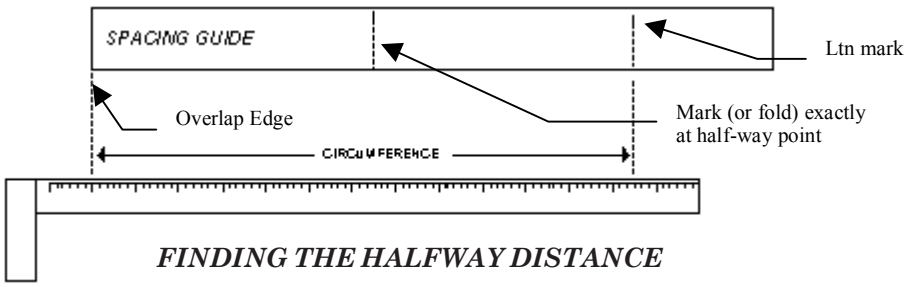


WRAPPING THE MYLAR SPACING GUIDE AROUND THE PIPE

8. Wrap the mylar spacing guide around the pipe so that the left edge is against the transducer edge mark (see "C" above). Arrange so that one end overlaps the other by at least three inches. Trim to fit if necessary, ***but be sure not to trim at the overlapping end in order to keep it square***.

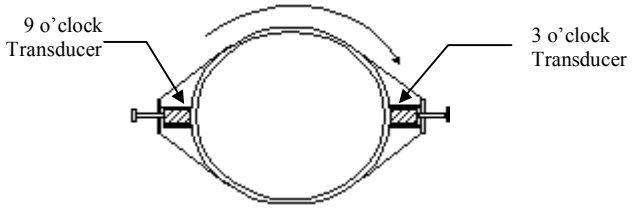
9. Realign left edge of the guide with the transducer edge mark. Line up both vertical edges of the guide and ensuring that it is snug around the pipe, mark along the overlapping edge.

10. Remove Mylar spacing guide and lay it out on a flat surface. Either measure the exact distance halfway between the overlap edge and the mark at the overlap, or fold the guide from the overlap edge to overlap mark and draw a line at the fold or halfway point (see next page).



FINDING THE HALFWAY DISTANCE

11. Reinstall the spacing guide; its left edge abutting the transducers edge mark on the pipe and the overlapping edge in line with the dot (now a line) on the pipe (see "C" on previous page). Tape it in this position on the pipe. Take the second frame and place it against the edge of the guide with its tapered roller centered on the center mark on the guide. Temporarily position the frame (in the 3 o'clock position opposite the mounted frame - see below) where it will be mounted. Ensure that this is a smooth area without any raised spots (seams, etc.). Mark a generous area around the mounting frames (1/2-inch on either side and half again the length front and back) with a pencil or chalk. Remove the frame and the mylar guide.



ALIGNING THE TRANSDUCERS FOR DIRECT MODE OPERATION

12. Prepare the area you marked by de-greasing the surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided. Clean the pipe of any debris and abrasive particles.

13. Replace the mylar guide back in the same position it was in and retape it to the pipe.

14. Put a mounting strap around the pipe and engage an end into adjusting screw (screw should be pointing up). Position frame in the middle of area you have cleaned and centered on the pipe with its angled end facing away from where the other frame will sit; and aligned with the edge and center marks on the guide. Slide the mounting strap over it (and under the clip if there is one) and tighten with a screwdriver. While tightening, check to ensure that the center of the tapered roller is centered on the pipe.

15. Apply a 1/8-inch continuous bead of couplant compound down the center (the long way) of the contact surface of one of the transducers. Place the transducer into one of the frames so that the couplant compound does not smear until it contacts the pipe. Slide it in until it butts against the stop and, while holding in-place, tighten the transducer clamping screw tight enough to hold firmly in-place. Do the same with the other transducer.

16. Connect the transducer cable, ensuring that you have observed the upstream/downstream orientation in respect to the cable and the input jack on the flow computer. If this is a dual-channel unit, make sure you are connecting the cables to the correct channel's input jacks. Repeat this procedure for the number index transducer.

17. Return to the menu, and press <ENT> to finish the transducer install routine.

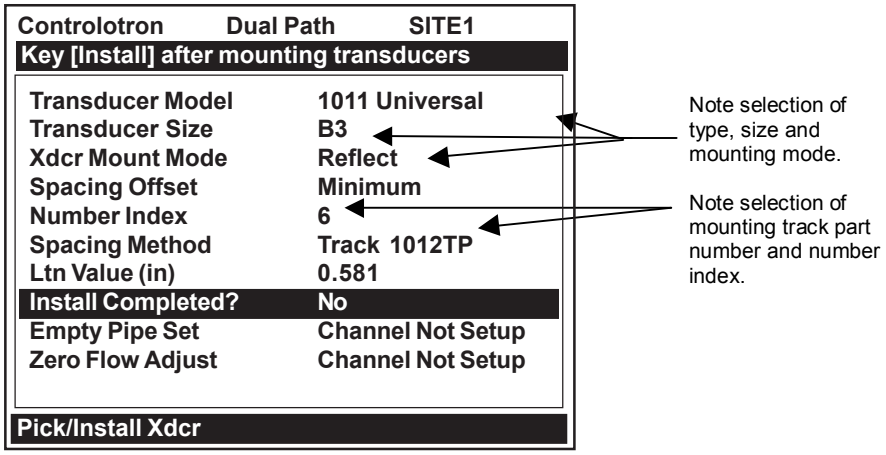
3.1.10 USING 1012T MOUNTING TRACKS

The 1012TP and 1012THP Mounting Tracks provide a rigid mounting platform for Series 1011 universal or high precision size A or B transducers. The mounting tracks service pipe sizes up to a maximum of 5.00" (140 mm) outer diameter. Operating temperatures are supported up to 250°F (121°C). The assembly consists of lightweight aluminum track rails with integral transducer clamping screws. Attached index pins enable positive locating of the transducers at fixed spacing locations. Roller-chains and tension screws secure the assembly to the pipe. The following instructions refer to 1011 universal transducers. Please refer to Engineering Drawing 1012THP-7A for reflect mounting of high precision transducers and 1012THP-7B for direct mounting of high precision transducers.

The 1012T mounting tracks support both Direct and Reflect mounting modes. The flow computer recommends the appropriate transducers, mounting track and mounting mode, based on the pipe data entries. Refer to the instructions in paragraph 2.4 for details on the Transducer Installation procedure. If necessary, review paragraphs 3.1.2 through 3.1.4 for details on how to select and prepare a mounting location on your pipe.

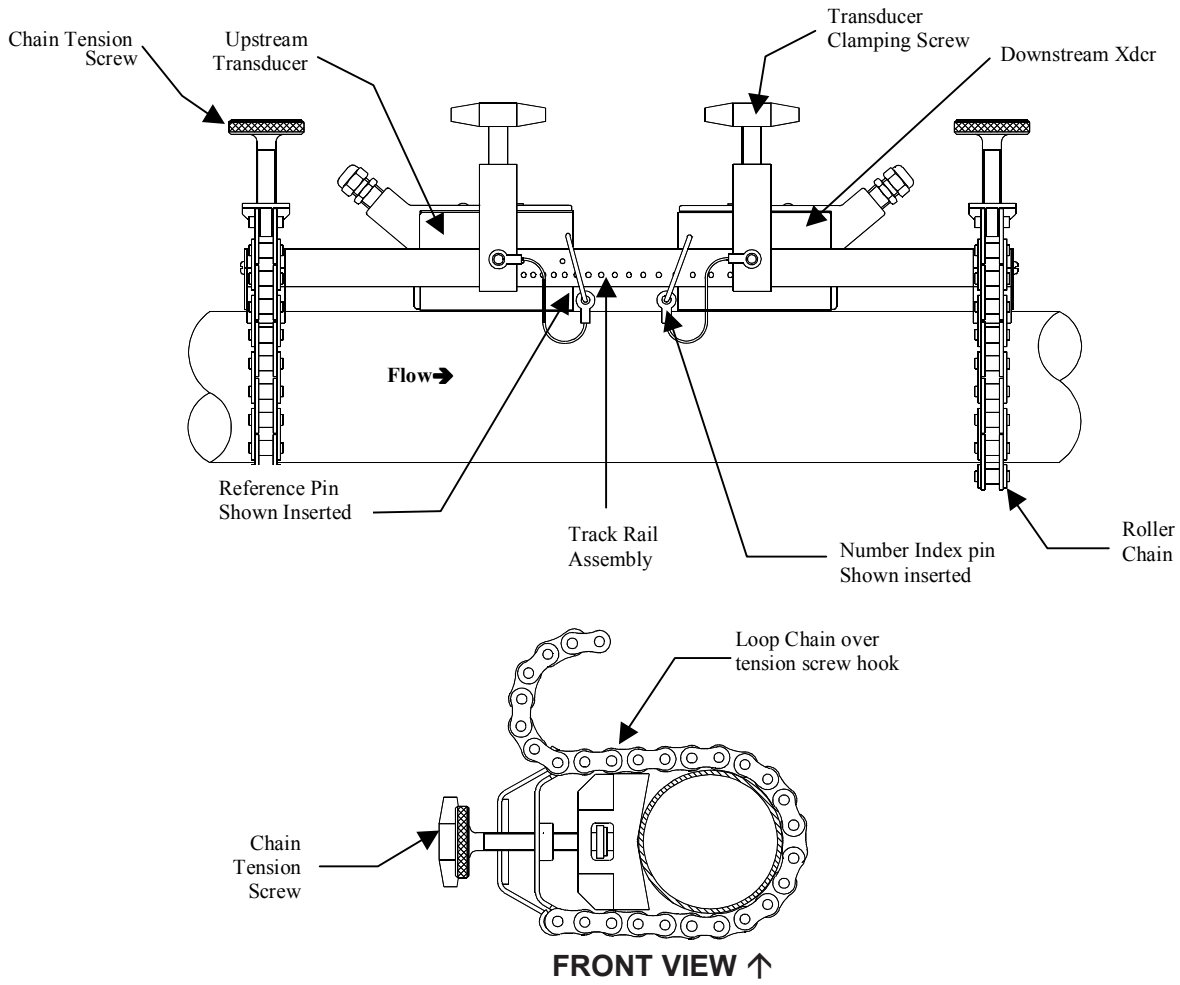
Installing a 1012T Mounting Track in Reflect Mode

Paragraph 2.4 describes the Transducer Installation procedures that lead up to the automatic selection of transducers, mounting mode and spacing method. Examine the figure below, which shows a typical Pick/Install Xdcr menu screen. Note the automatic assignment of model numbers for the transducer and mounting track, plus the designation of the number index.



This example requires a Model 1012T Mounting Track to accommodate size B3 universal transducers. Note the reported number index. You will be inserting an index pin into this hole on the track rail to position one of the transducers (see diagram on next page).

1. Perform all required menu steps up until the point where you respond to the [Install Completed?] prompt. Note the reported number index. You will be inserting index pins into this hole and the reference hole on the track rail (see diagram on next page). Check to ensure that you have a matched set of transducers. They both should have the same S/N number but marked with either an "A" or "B" (e.g., 100A and 100B).



INSTALLATION - REFLECT MOUNT WITH MOUNTING TRACK

2. Place the track rail assembly on the top surface of the pipe at the location where you have determined it would be mounted. Ensure that it is a smooth area without any raised spots or seams. Holding the assembly in place, loop one of the roller chains under the pipe, pull it around and maintain tension while slipping a link over the tension screw hook. Tighten the tension screw enough to hold the assembly on the pipe, but still allow rotation. Repeat for the other roller chain. Rotate the track rail assembly to the intended nine o'clock mounting position on the pipe, then tighten both tension screws just enough to prevent rotation. Do not overtighten.

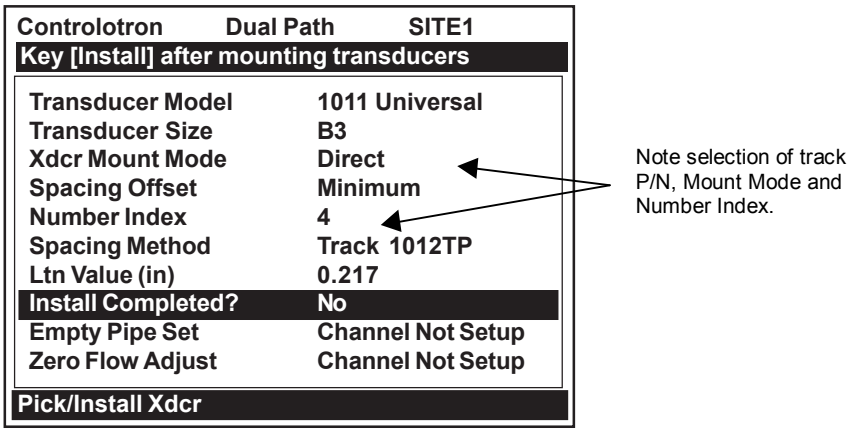
3. Mark a generous area around the transducers (1/2-inch on either side and half again the length front and back) with a pencil or chalk. Loosen and move the assembly away from marked area. Prepare the two areas you marked by de-greasing the surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided. Clean the pipe of all debris and abrasive particles.

4. Insert the index pin into the reference hole. Select a transducer, apply a thin band of couplant compound to the transducer's contact surface. Place the transducer between the track rails, slightly behind the pin and under the clamping screw assembly. Slide it forward until it butts up firmly against the reference pin.

5. Once transducer is in place, secure with the transducer clamping screw. Do not overtighten. Observe the upstream/downstream orientation and connect the transducer cable to the computer's input jack. If a dual-channel unit, make sure you connect the cable to the input jacks of the correct channel. Repeat this procedure for the number index transducer.

Installing a 1012T Mounting Track in Direct Mode

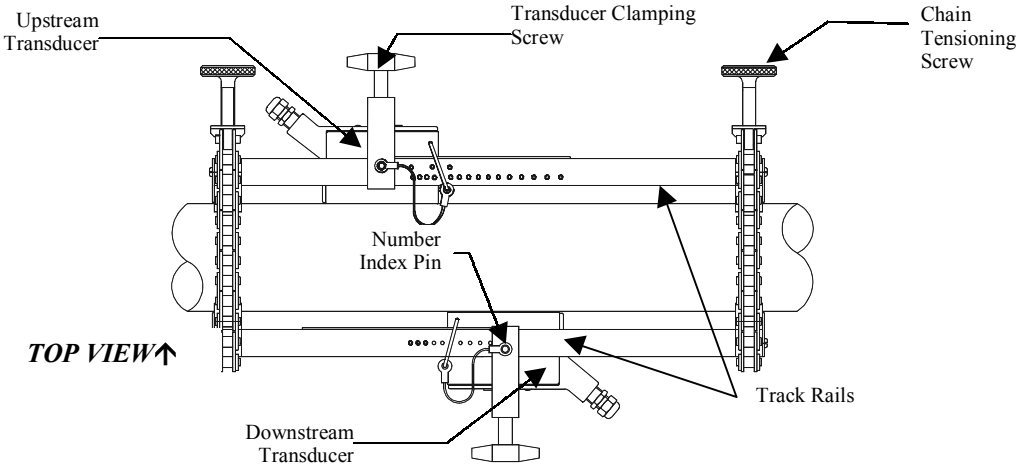
Paragraph 2.4 describes the Installation procedures that lead up to the automatic selection of transducers, mounting mode and spacing method. Shown is a Model 1012T mounting track to accommodate size B3 universal transducers. Examine the figure below which shows a typical Pick/Install Xdcr menu screen. Note the automatic assignment of model numbers for the transducer and mounting track, plus the designation of number index.



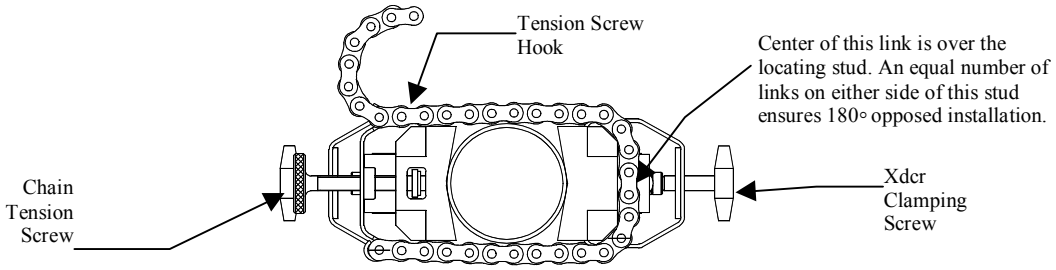
1. Perform all required menu steps up until the point where the flow computer prompts you to press <ENT> to finish the transducer install routine. Note the reported number index.

You will be inserting an index pin into this hole and the reference hole. Check to ensure that you have a matched set of transducers. They both should have the same S/N number but marked with either an "A" or "B" (e.g., 100A and 100B).

2. The direct mount configuration uses two track rails, one for each transducer, installed 180^0 apart on the pipe. One track rail includes the tension screw while the other has a locating stud to support the chain (see below and on next page).



INSTALLATION – DIRECT MOUNT 180º OPPOSED WITH MOUNTING TRACK



3. If this is a horizontal pipe, place the track with the chain tension screws on top of the pipe (screws up, the chains hanging down and the numbered scale facing you) where you have determined it would be best to mount it.

4. Place the other track (with the centering stud on the bottom and the lettering on the scale toward the same side as the top track) directly underneath it (180^0). Hold in place while you wrap the chain around the pipe; first onto the centering stud on the bottom track and then onto the hook under the Tensioning Screw. With the chain in-place, count the number of links between the beginning of the chain and the centering stud; and then between the centering stud and the hook. They both should have the same number of links. Arrange so they do and then loosely tighten. Do the same with the other chain. For a vertical pipe installation, it will probably be much easier to tie, tape or bungee cord the two tracks in place while chaining.

5. Wrap a length of the mylar spacing guide around the pipe and against the end of the track assembly. Ensure that the edges on both sides align and tape to the pipe. Loosen the chains enough to allow you to rotate the track assembly 90^0 until one track is in a 9 o'clock position and the other in a 3 o'clock position on the pipe (horizontal pipe). Tighten both chains but not too tight.

6. Insert an index pin into the REF hole of the track with the tensioning screws. Take one of the transducers and insert it between the track rails and to the left of the index pin with the cable connector pointing away from the pin. Move the transducer right until the pin stops it. Hold it in this position and move the transducer clamping screw over the transducer and tighten. Insert the other index pin into the index hole (see step #1) on the other track marked "Direct Mode Spacing." Insert the second transducer (with its cable connector pointing away from the pin) between the track rails on the right side of the pin and move the transducer left until it's stopped by the pin and then follow the same procedure as with the first transducer.

7. Mark a generous area around the transducers where they contact the pipe with a pencil or chalk. Make a mark showing the center between the tracks on the mylar guide. Release the tension on the transducers and remove them. Loosen the chains and rotate the track assembly on the pipe so you can gain access to the areas marked.

8. Prepare the area you marked by degreasing the surface, if needed, and removing any grit, corrosion, rust, loose paint or surface irregularities with the abrasive pipe conditioning material provided.

9. Revolve the tracks on the pipe into the position they were originally in by using the edge of the mylar guide as a stop for both the upper and lower tracks and the mark on the guide to center that track. This time, before installing each transducer, apply a 1/8-inch continuous bead of couplant compound along the center (the long way) of the contact surface of the transducer. Also, keep the transducers lifted slightly from the pipe when installing until the transducer is against the pin; then push down against the pipe. Remember to install the transducers with the cable connectors facing away from each other.

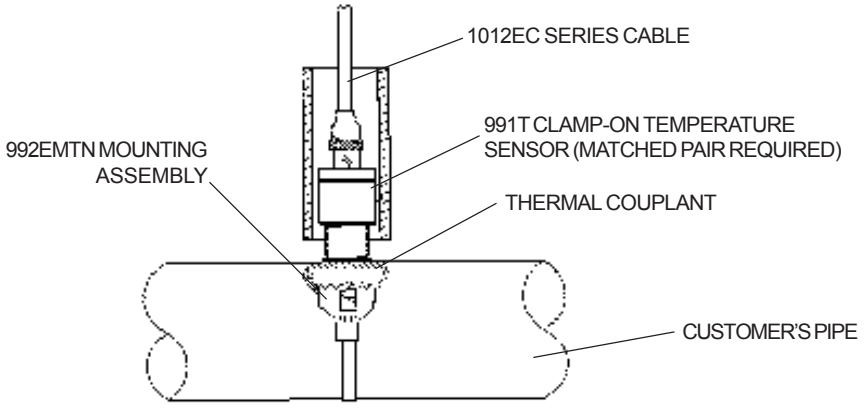
Once the transducer is in place, Secure it with its clamping screw. Do not overtighten.

NOTE: Some transducers require a right-angle adapter. This adapter should be installed before placing the transducer in the tracks.

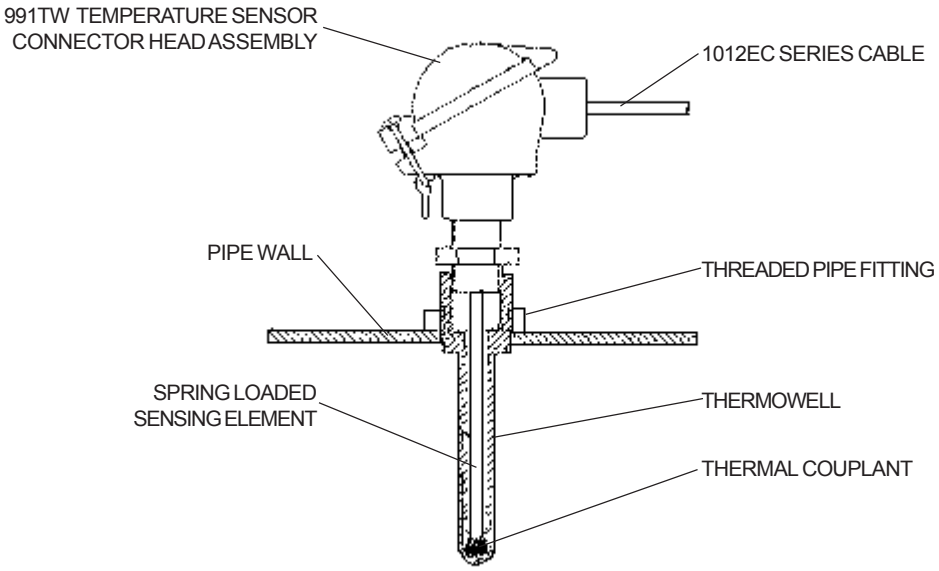
10. Connect the transducer cable, ensuring that you have observed the Upstream/Downstream orientation in respect to the cable and the input jack on the flow computer. If this is a dual-channel unit, make sure you are connecting the cables to the correct channel input jacks.

3.2 MOUNTING TEMPERATURE SENSORS

In order to accurately measure temperature differential in energy flow loops, Controlotron's Energy Flowmeters are designed to work with a pair of matched temperature sensors. These are available in clamp-on style 991T, or in insert (thermowell) style 991TW. Both styles incorporate 1000 ohm platinum RTD's for high precision.



Clamp-on style sensors are mounted on the surface of the monitored pipe using 992EMT series mounting assemblies. Apply a generous quantity of the thermal couplant provided to the tip of the sensor and attach it securely to the cleaned pipe surface with the proper mounting assembly. Temperature measurement anomalies resulting from variations in the ambient conditions can be minimized by insulating the pipe and sensor after installation.

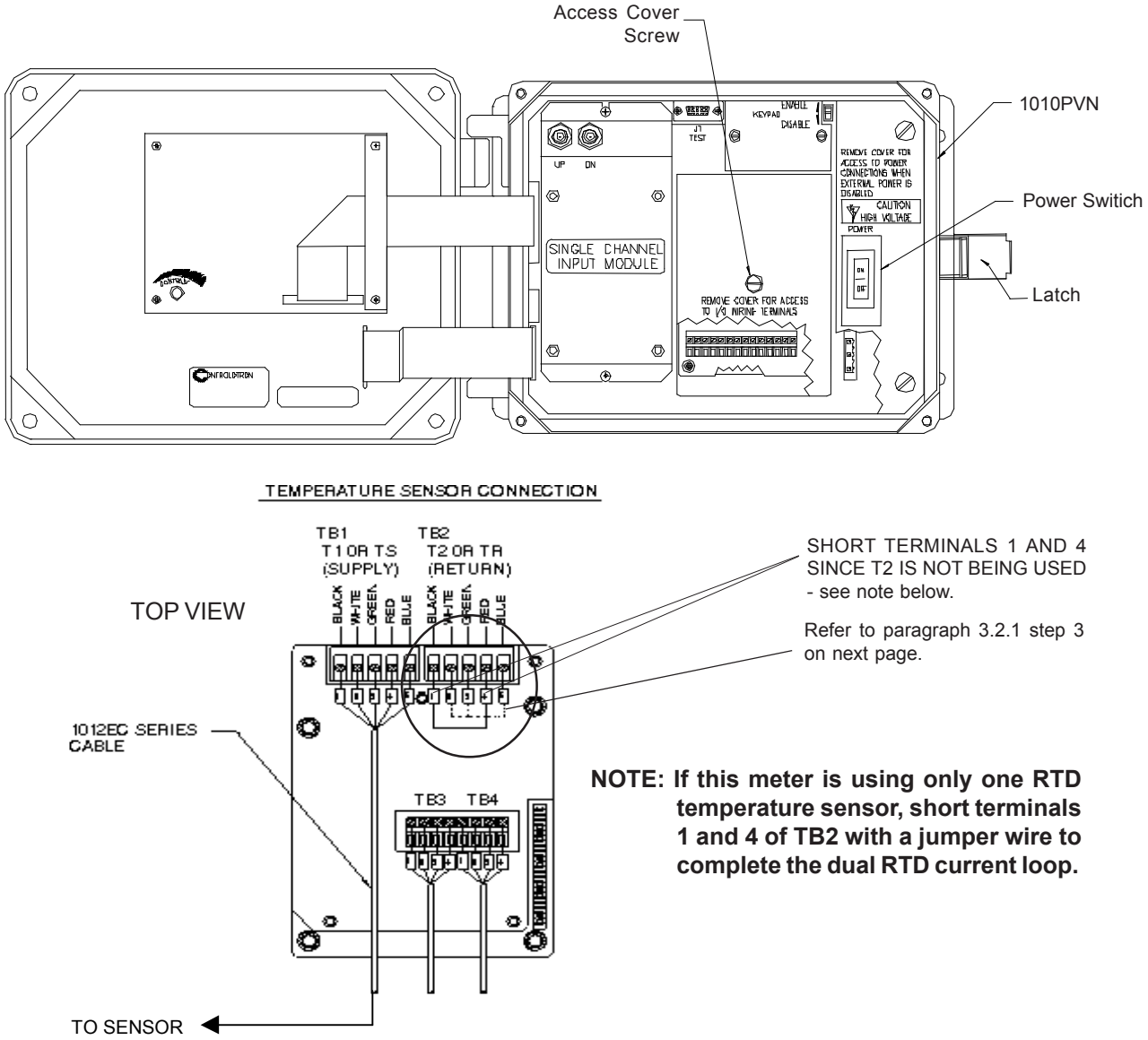


The 991TW insert sensors are designed to be used in pipes equipped with Thermowells. These are spring-loaded, 1/4" diameter sensors with 1/2" NPT integral connection heads, available in several lengths to accommodate a range of pipe sizes. Thermowells for new installations are available from Alloy Engineering Company in Bridgeport, Connecticut.

3.2.1 WIRING TEMPERATURE SENSOR TO THE ANALOG INPUT MODULE

WARNING: Set flowmeter and instrumentation power to OFF when inserting or removing the Analog Input Module, or when making connections to TB1, TB2, TB3, and TB4.

- Open the 1010PVN flowmeter top cover by releasing the cover latch.
- Place the power switch to the OFF position.
- Loosen the captive thumbscrew securing the Access Cover and remove Access Cover.
- Using a flat-blade screwdriver, remove four captive screws securing the I/O board.
- Carefully remove the I/O board and set it aside.



1010PVN Single Channel Temperature Sensor Inputs

- Using a flat-blade screwdriver, loosen Terminal Block TB1 and TB2 screws.
- Connect the wires of the 1012EC Series cable as follows:

1. Connect the RTD liquid temperature cable (1012EC) as shown in the table below:

1012EC Series Cable	TERMINAL TB1
WIRE #1 (Black)	to TB1-1
WIRE #2 (White	to TB1-2
WIRE #3 (Green)	to TB1-3
WIRE #4 (Red)	to TB1-4
WIRE #5 GND/SHLD (Blue)	to TB1-5

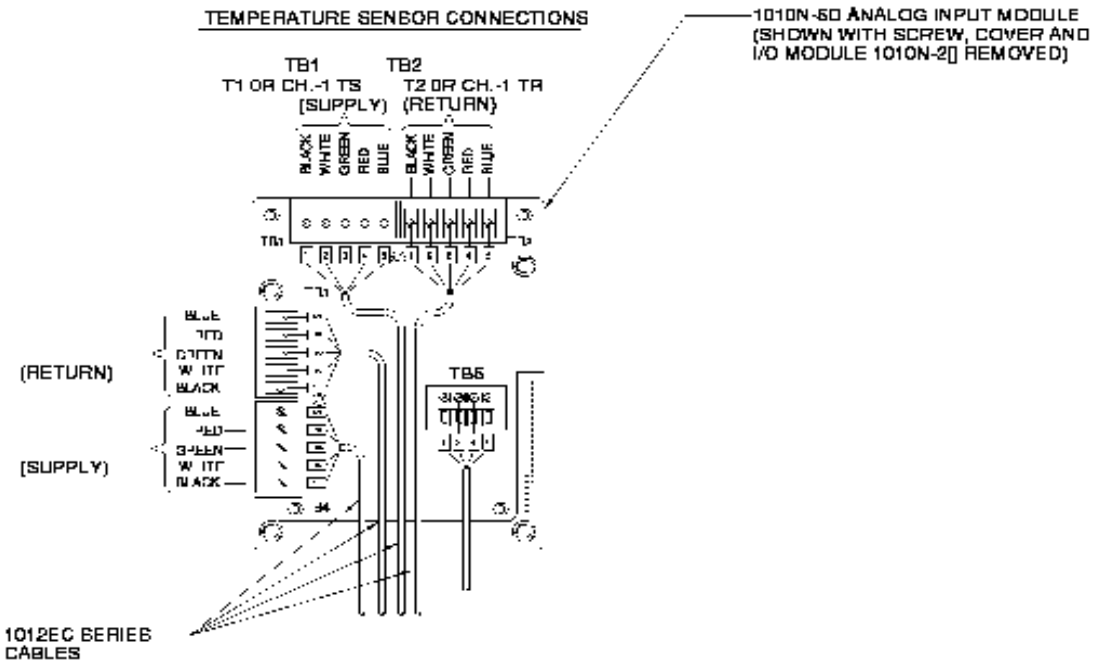
2. Complete the temperature sensor current loop by shorting together terminals 1 and 4 of the unused TB2 temperature sensor terminal block.
3. Ground the voltage sensing leads (terminals 2 and 3 of TB2) by connecting them both to terminal 5.

- Tighten all TB1 and TB2 terminal block screws.
- Replace I/O Board and secure with four captive screws.
- Replace Access Cover and finger tighten captive thumbscrew.

3.2.2 1010PVN SUPPLY AND RETURN CONNECTIONS

Terminals for the supply and return sensor connections are located on the Analog Input Module as previously shown. For other terminal locations on System 1010N Single Channel and Dual Channel units, see drawings 1010N-5-7 or 1010N-5D-7, respectively. For terminal locations on Multi-Channel units, see drawing 1010N-8M-7.

WARNING: Set meter and instrumentation power to OFF when inserting or removing the module, or when making connections to TB1, TB2, TB3, and TB4.



1010PVDN Dual Path Temperature Sensor Inputs

3.2.3 NOTES ON SYSTEM 1010 ANALOG INPUT MODULES

Single Channel Models

- System 1010 NEMA flowmeters report input module temperature sensor connections T1 and T2 as system variables.

Dual Path Models

- The Dual Path instrument uses T1 to report liquid temperature. (Note that T2 is used to report ambient temperature in some Leak Detector systems.)

- The Analog Input of temperature takes priority over the built-in RTD (Resistive Thermal Device) measurement of temperature.

3.2.4 CLAMP-ON RESISTIVE TEMPERATURE DEVICE (RTD) INSTALLATION NOTES

The Clamp-On RTD sensor, with which your 1010PVN is supplied, is extremely sensitive and precise. Its contribution to the performance of your meter can be as important as that of the liquid flow sensors. Please consult the installation drawings for details on physical installation and wiring of the RTD. In order to produce the best possible tracking of the true liquid temperature, try to make your installation conform to the notes on the installation drawing and these following tips:

- Prepare the pipe surface by removing paint to expose bare metal and by smoothing out any remaining rough spots.

- Use the thermal couplant compound (CC#117) between the face of the RTD element and the pipe surface to improve the conductivity of the metal-to-metal contact.

- Keep the RTD out of direct sunlight or other non-pipe sources of heat or cold that may affect their temperature sensing. The foam insulator supplied helps in this regard, but consider using additional pipe insulation for all installations exposed to extreme ambient conditions. Consider mounting the RTD under the pipe in order to keep it out of direct sunlight.

- In installations where RTD elements are exposed to harsh conditions such as condensation, salt spray, etc., use CC#110 couplant compound to coat the connection between the cable and the RTD sensor. Consult Installation Drawing 991TN-7 for details.

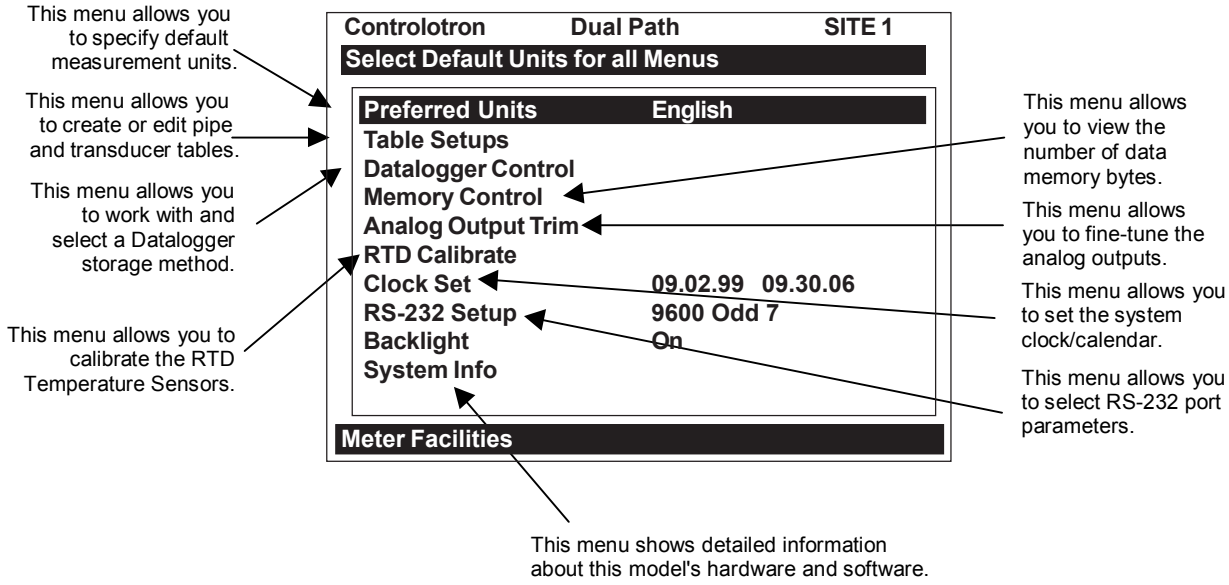
- Be sure to install the supply RTD Sensors (see diagram on previous page) in the appropriate locations.

- Be sure to correctly indicate where the flow is being measured in the “Location” item of the 1010 menu; either supply or return.

4. THE METER FACILITIES MENU AND GRAPHIC DISPLAY SCREENS

Meter Facilities functions are available immediately after pressing <MENU>. The Meter Facilities menu provides global control that enables you to identify and activate the following functions and features of the hardware supported by this model.

- Select data entry and meter output in either English (default) or metric units.
- Customize the default pipe and transducer tables to suit your requirements.
- Output, display, erase and select a memory management method for the Datalogger.
- Determine the amount of memory available.
- Verify/Adjust the analog output voltage and current using a multimeter.
- Verify/Adjust the analog pulse output using a frequency counter.
- Calibrate the RTD temperature sensors.
- Set the system clock/calendar.
- Obtain detailed software/hardware identification.



4.1 PREFERRED UNITS

The selection you make in this menu cell becomes the default units for all menu items and data outputs. You can choose either English or metric units. The factory setting is English.

To specify metric default units for all meter functions:

To access the [Preferred Units] option list press 

Move the cursor to [Metric] by pressing 

To register your selection press 

4.2 THE TABLE SETUPS MENU

The [Table Setups] menu allows you to pre-condition your pipe table and transducer types. The edits made in [Table Setups] become the default settings for creating a new site. Transducers "marked" in the [Transducer Types] menu will be preferentially selected when the meter recommends transducers during the automatic Pick/Install Transducer routine.

To access the Table Setups menu press 

Table Setups ⇨ ⇳	Pipe Table
	Transducer Type

4.2.1 PIPE TABLE

The factory-programmed pipe table describes over sixty standard English and metric pipes. The table can save you programming steps by loading all required data at once from option list selection. The Pipe Table configuration is [PIPE CLASS ➔ PIPE NAME]. Pipe Class presents a list of standard metric and English Pipe classifications. Selecting a class (e.g., ASA Carbon Steel) conditions the Pipe Name option list to all the stored pipes within that class (see Menu Chart above). Selecting a pipe by its name (e.g., 2SS10) loads a description of that pipe in the remaining menu cells. Note that liner data is not provided. If your pipe is lined, then you will be required to enter the liner material and its thickness manually.

To access the Pipe Table menu press 

PIPE TABLE MENU STRUCTURE

Create/Edit Pipe ⇨	Choose Pipe Class ⇨	⇳ **ASA Stainless Steel***		
	⇳	ASA Carbon Steel		
		ASA Plastic		
		Metric DN Steel		
		Metric SGP Steel		
		Cast Iron Table		
		Ductile Iron Table		
⇳		Copper Tube Table		
	⇨ Choose Pipe Name ⇨	**ASA Stainless Steel***	ASA Carbon Steel	ASA Plastic
		⇳ **1SS10**	⇳ 1CS40	⇳ 1P40
		2SS10	1CS80	1P80
	⇳	**3SS10**	2CS40	2P40
		4SS10	2CS80	2P80
		6SS10	3CS40	3P40
		8SS10	3CS80	3P80
		Metric DN Steel	4CS40	4P40
		50DN	4CS80	4P80

(continued)

NOTE:** The highlighted selection in the above table illustrates how to choose the ***ASA Stainless Steel **Pipe Class** and all its available Pipe Name selections. All other Pipe Classes (e.g., ASA Carbon Steel) listed can be selected in the same manner.

PIPE TABLE MENU STRUCTURE *(continued)*

	Choose Pipe Name ⇨ (continued)	⇳ 100 DN 200 DN 400 DN 800 DN	⇳ 6CS40 6CS80 8CS40 8CS80 10CS XS 10CS40 12CS STD 12CS XS 16CS STD 16CS XS 18CS STD 18CS XS 20CS STD 20CS XS 24CS STD 24CS XS 30CS STD 30CS XS 36CS STD 36CS XS	⇳ 6P40 6P80 8P40 8P80 10P XS 10P40 12P STD 12P XS 16P STD 16P XS 18P STD 18P XS 20P STD 20P XS 24P STD 24P XS 30P STD 30P XS 36P STD 36P XS
		⇨ Metric SGP Steel ⇳ 20A-SGP 25A-SGP 32A-SGP 40A-SGP 50A-SGP 65A-SGP 80A-SGP 90A-SGP 100A-SGP 125A-SGP 150A-SGP 175A-SGP 200A-SGP 225A-SGP 250A-SGP 300A-SGP 350A-SGP 400A-SGP 450A-SGP 500A-SGP	⇨ Cast Iron Table ⇳ 6” cls C 10” cls C 12” cls C 16” cls C 20” cls C ⇨Ductile Iron Table ⇳ 6” cls 52 8” cls 52 10” cls 52 12” cls 56” 16” cls 52 24” cls 52	⇨ Copper Tube Table ⇳ 1” type M 1” type K 1” type L 2” type M 2” type K 2” type L 4” type M 4” type K 4” type L 6” type M 6” type K 6” type L
	Outer Diameter (in) ⇨	x.xxx *(numeric entry)*		
	Wall Thickness (in) ⇨	x.xxx *(numeric entry)*		
	Liner Material ⇨ ⇳	⇳ None Cement Coal Tar Enamel Glass Plastic HDPE Teflon Rubber		
	Liner Thickness ⇳ ⇨	x.xxx *(numeric entry)*		
Delete Pipe ⇨	⇨Choose Pipe Class	**See Create/Edit Pipe*		
	Pick Pipe Name	**See Create/Edit Pipe*		

4.2.2 CREATE/EDIT PIPE

The Pipe Table provides the primary data that the system uses to operate with different classes of pipes. This menu allows you to edit the pipe table by modifying any existing pipe or add an entirely new pipe.

An example of how to use the Create/Edit Function:

To access the Create/Edit menu press 

To access the Pipe Class option list press 

Scroll the option list to a class that provides the closest match to your pipe

To select the [Pipe Class] press ENT. This moves the highlight to [Choose Pipe Name].

To access the [Pipe Name] option list press .

Scroll the option list to a pipe name and press ENT to select it.

This loads Outer Diameter and Wall Thickness for the selected pipe.

The highlight moves to [Outer Diameter]. Press to enable numeric entry. Type the actual pipe OD using the appropriate English or metric units. Press ENT to store the OD. The highlight moves to [Wall Thickness].

Press to enable numeric entry. Type the actual wall thickness using the appropriate English or metric units. Press ENT to store the wall thickness.

Select a Liner Material and enter its thickness (if required).

Press to leave the Create/Edit Pipe menu. This triggers the Save Pipe pop-up Window. Note that the second line lists the name of the selected pipe. Press and then press ENT to use this name.

To use a new name, press and then use the appropriate arrow keys to rename the pipe (8 chars. Max.). Press ENT. This adds the new pipe to the pipe class.

4.2.3 DELETE PIPE

This menu allows you to remove any of the pre-loaded pipes within a class from a pipe table. We recommend that you use this function only to delete pipes that you have added so as to preserve the factory presets.

To delete a pipe from the Pipe Table:

To access the [Delete Pipe] menu press . To access the [Pipe Class] option list

Scroll the option list to the class that contains the pipe to be deleted.

To select [Pipe Class] press ENT. This moves the highlight to [Choose Pipe Name].

To access the [Pipe Name] option list press .

Scroll the option list to the pipe to be deleted by pressing .

To remove it from the pipe table press ENT.

4.3 TRANSDUCER TYPE MENU

During the Transducer Install procedure, System 1010 analyzes the entered pipe and liquid data, then automatically generates a list of the transducer sizes most suited for the applica-

tion. The Transducer Type menu allows you to place "marks" next to any transducers that you may want the meter to consider preferentially during its recommendation routine. These transducers will be included on the recommended list, which appears from on the reverse-video prompt line at the top of the display screen. The left-most transducer on the list is the most applicable while the right-most transducer on the list is the least applicable.

TRANSDUCER TYPE MENU STRUCTURE

Transducer Type ⇨	1011 Universal ⇨	⇳ A1 A2 B1 B2 B3 C1 C2 C3 D1 D2 D3 E1 E2 E3
	1011H High Precision ⇨	⇳ A1H A2H A3H B1H B2H B3H C1H C2H D1H D2H D3H D4H
⇳	991 Universal ⇨	⇳ 0A 0 1 2 2A 3 3A 4 4A 5 5A

To mark Transducers:

To access the [Transducer Type] menu press  .

Scroll the highlight  to a transducer type (e.g., 1011H High Precision) then press  to access the size option list.

Scroll through the option list by pressing  and use ENT to "mark" desired transducers. Note that a plus sign (+) appears before each "marked" transducer.

If you want to clear a "marked" transducer, move the highlight to the transducer then press the CLR key. Note that this removes the plus sign.

To leave an option list press  .

4.4 THE DATALOGGER CONTROL MENU

The Datalogger Setup menu in the Channel Setup menu provides the Datalogger controls for the meter's measurement channels. It allows you to enable usage, select data items/ alarm events, a logging interval and a destination for your Datalogger reports. While the Datalogger Setup menu is measurement channel specific, this Datalogger Control menu provides global control functions. This means that the settings made here apply to all measurement channels, meter types, operating modes, etc. This is possible because the meter stores logged data in a *single* file. This is significant for dual-channel systems, since the logged data from both channels are combined. Therefore, select the Site ID item for each channel to be logged.

Datalogger Control allows you to select a [Circular Memory] mode that will over-write the oldest Datalogger data automatically when the Datalogger memory becomes full due to the data compression scheme employed. Note that this is only available for dual-channel systems. The [Est Log Time Left] menu view-only menu cell shows an estimate of the hours and minutes of logging time remaining. This only applies to non-circular datalogging. Selecting Circular memory blanks this field. For convenience sake, the Display Datalogger command is essentially a duplicate of the menu cell in Datalogger Setup. It sends Datalogger data to the graphic screen with or without line wrapping. For dual-channel systems with logging enabled on both channels, a screen dump from menu will show data from both channels. The Output Datalogger command sends data to an external device via the RS-232 serial port. Data transmitted from this menu will be from both channels of a dual-channel system. The Clear Datalogger command erases the entire Datalogger file. For dual-channel systems, you are cautioned not to use this command if your intention is to clear the logged data of only one channel.

To access the Datalogger Control Menu press 

DATALOGGER CONTROL MENU STRUCTURE

Datalogger Control ⇨	Display Datalogger ⇨	Off ⇳ Line Wrap No Line Wrap
	Output Datalogger ⇨	⇳ No Yes
	Circular Memory ⇨	⇳ No Yes
	Est. Log Time Left ⇨	⇳ —:—
	Clear Datalogger ⇨	⇳ No Yes

4.4.1 DISPLAY DATALOGGER

This menu cell allows you to send the Datalogger contents to the display screen. This command is effective only after a successful install. You can set the report to scroll on the screen with or without line-wrap. Selecting line wrap, forces a line feed after approximately 40 characters. In addition, you have to enable datalogging and then select items in the Datalogger Setup menu. Note that this command transmits the data from both channels.

To send Datalogger contents to the display screen:

To access the Display Datalogger option list press 

Scroll cursor to either [Line Wrap] or [No Line Wrap] by pressing 

To view Datalogger contents press ENT

To return to Datalogger Control press MENU

4.4.2 OUTPUT DATALOGGER

This menu cell allows you to send the Datalogger contents to an external device (usually a computer or printer) via the meter's RS-232 Serial I/O port. This command is effective only after a successful install. In addition, you have to enable datalogging and select data items in the Datalogger Setup menu. Note: This command sends the data collected by both channels of a dual-channel system. Therefore, you should include [Site ID] (current site setup name), [Date] and [Time] in your report so that you can identify the source of each report.

The meter interfaces with most serial printers or personal computers. Controlotron offers the model 996P portable serial printer. You must use the proper cabling between the flow computer and the external device. In addition, you must configure the RS-232 Setup correctly. You should turn off the Datalogger function before you transmit an extensive printout. This will avoid contaminating the printout with new Datalogger data. Datalogger reports are sequential ASCII text files.

To send Datalogger contents to the RS-232 Serial Port:

Check the flow computer-to-external device connections and your RS-232 Setup parameters (see RS-232 Setup).

To access the [Output Datalogger] option list press →

Scroll the cursor to [Yes] by pressing ↓ ↑

To transmit Datalogger contents to external device via the serial port press ENT

To stop printout press ←

4.4.3 CIRCULAR MEMORY

In its default mode, the Datalogger collects data until its memory becomes full. At that time the flowmeter suspends data logging and cannot resume until the datalogger memory is cleared (see Clear Datalogger command). Multi-Channel systems include Circular Memory and Single Channel systems do not. Circular Memory allows the Datalogger to "'write over" its oldest records when memory reaches full capacity. If you enable Circular Memory, you are assured of always collecting the most recent data. But, also remember that you will lose the oldest Datalogger reports. Note further that invoking Circular Memory deletes the current contents of the Datalogger.

NOTE: To avoid potential data loss, the flowmeter prevents you from altering the Circular Memory setting when a channel is active.

To setup and enable Circular Memory:

The Datalogger Mode menu must have the [Memory] menu cell selected.

Datalogger items must be selected (e.g., Site ID, Date, Time, etc.).

All active channels in the Channel Setup menu must be disabled. To disable active channels, select the [Channel Enable] menu cell and then [No].

In the Datalogger Control menu, select [Circular Memory].

Press  to access the [Circular Memory] option list.

Move the cursor to [Yes] by pressing 

To store selection press 

Lastly, re-enable the channels that you disabled earlier to begin logging.

4.4.4 EST LOG TIME LEFT

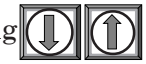
Est Log Time Left is a "view-only" menu cell that shows an estimate of the amount of Datalogger time remaining in hours and minutes. This menu cell becomes active after you enable datalogging. Selecting Circular Memory and/or event-based datalogging (see Datalogger Setup), blanks the field [Est Log Time Left] and is based on the log interval and data selections made in the Datalogger Setup. For Single-Channel flowmeters, this time is an estimated minimum since data compression is employed for improved storage efficiency.

4.4.5 CLEAR DATALOGGER

If you use the Datalogger in its default mode, eventually you will use all the memory available for Datalogger storage. When this occurs, you will not be able to log more data until you free up the memory. The Clear Datalogger command erases ALL stored Datalogger data. Therefore, you should evaluate the currently stored data, and print any valuable information before using this command. *Note: Saved Sites also consume datalogger RAM.*

To clear Datalogger Data Memory:

To access the [Clear Datalogger] option list press 

Move the cursor to [Yes] by pressing 

To clear the memory press 

4.5 THE MEMORY CONTROL MENU

Memory Control is a reference menu that shows the amount of bytes of data memory left. The data memory capacity depends on the number and complexity of the site setups stored in memory and the size of the current datalogger file. Capacity is also affected by the RAM option with which your 1010 is equipped with - either 900K expanded or 170K standard RAM.

MEMORY CONTROL MENU

Data Memory Left	⇨	⇩ **XXXXX**
Memory Map	⇨	⇩ **Yes** **No**
Defragment	⇨	⇩ **No** **Yes**

Data Memory Left: This view only menu cell shows the minimum remaining number of characters available for Datalogger and site storage. When the Datalogger is enabled for circular mode, the meter alocates all of memory except for two conventional empty sites worth for datalogger use.

Memory Map: Selecting YES for this item enables a snapshot display of current memory usage. In this display, the asterisk indicates a used block, a space indicates a free block, while a dash character indicates unused filler.

Defragment: Selecting YES for this item consolidates memory data blocks into contiguous storage; collapsing the filler regions. You may be able to use an additional block for site or datalogger storage as a result. Use this command if you seem to be out of memory even though the Data Memory Left item indicates free capacity.

To view the amount of data memory bytes available press 

4.5.1 THE ANALOG OUTPUT TRIM MENU

Analog Output Trim allows you to fine-tune the meter's analog voltage and current outputs using a multimeter connected to the output under test. In addition, you can use a frequency counter to fine-tune the meter's pulse rate output.

NOTE: The current, voltage, and Pgen trimming will be limited by the 12-bit resolution of the meter's D/A Convertor (DAC).

To access the Analog Output Trim menu press 

ANALOG OUTPUT TRIM MENU STRUCTURE

Analog Output Trim ⇨	Io1 (Io2) ⇨	⇳	Operate Trim @ 4mA ⇨ *Indicated mA = x.xx*
⇳	⇨ Vo1 (Vo2) ⇨	⇳	Operate Trim @ 2V ⇨ *Indicated V = x.xx*
	⇨ Pgen1(Pgen2)	⇳	Operate Trim @ 1kHz ⇨ *Indicated Hz = xxxx*

4.5.2 CURRENT OUTPUT TRIM (Io1 & Io2)

(Note: Can be trimmed to within .005 mA of nominal.)

To calibrate a current output (Io1 or Io2):

Set up the multimeter to read Amps, then connect it to the supply and return terminals of the current output under test.

Move the highlight to the port to be tested, press  , then press  to move the cursor to [Trim @ 4mA].

Press  . This triggers a 4.00 mA pop-up window. The multimeter should now be reading 4.00 mA.

If the multimeter reading does not match, use the numeric keys to type in the multimeter reading.

Press  to register setting. This adjusts the meter's DAC (digital-to-analog converter) so that a 4mA output corresponds with 4mA on the multimeter.

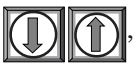
Re-check the multimeter to make sure that it is now reading 4mA.

4.5.3 VOLTAGE OUTPUT TRIM (Vo1 & Vo2)

(Note: Can be trimmed to within .0025 V of nominal.)

To calibrate a voltage output (Vo1 or Vo2):

Set up the multimeter to read volts, then connect it to the supply and return terminals of the voltage output under test.

Move the highlight to the port to be tested  , press  , then press  to move the cursor to [Trim @ 2V].

Press  . This triggers a 2.00 Volts pop-up window. The multimeter should now be reading 2.00 Volts.

If the multimeter reading does not match, use the numeric keys to type in the multimeter reading.

Press ENT to register setting. This adjusts the meter's DAC (digital-to-analog converter) so that a 2.00 Volts output corresponds with 2.00 Volts on the multimeter.

Re-check the multimeter to make sure that it is now reading 2.00 Volts.

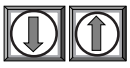
4.5.4 PGEN OUTPUT TRIM (Pgen 1 & Pgen 2)

NOTE: Not available in Custody Transfer flowmeters.

(Note: Can be trimmed to within 1.25 Hz of nominal.)

To calibrate a pulse rate output (Pgen1 or Pgen2):

Connect a frequency counter to the supply and return terminals of the pulse rate output under test.

Move the highlight to the port to be tested  , press the  , then press  to move the cursor to Trim @ 1kHz.

Press ENT. This triggers a 1 kHz pop-up window. The frequency counter should now be reading 1 kHz.

If the frequency counter reading does not match, use the numeric keys to type in the frequency counter reading.

Press ENT to register setting. This adjusts the meter's DAC (digital-to-analog converter) so that a 1 kHz output corresponds with 1 kHz on the frequency counter.

Re-check the frequency counter to make sure that it is now reading 1 kHz.

4.6 THE RTD CALIBRATE MENU *(optional)*

The RTD Calibrate Menu appears on all 1010N models. Use this menu to calibrate the 991T or 1011TN RTD Temperature Sensors to an external standard. It is important to note that Controlotron RTD temperature sensors are factory-calibrated for high accuracy. We recommend that before deciding to perform the calibration, check the current RTD reading in [Diagnostics/Liquid Data]. You may find that you do not even need to calibrate the sensor. In any case, make sure that the temperature reading stabilizes before proceeding further. The RTD Calibrate menu allows you to perform an external calibration, which can be accomplished either by data entry of the current RTD temperature or by a 32^0F (0^0C) Ice-Bath procedure. You can switch between the intrinsic and external calibration modes at any time.

NOTE: If you perform an external temperature calibration, you should mark and record the location of each connector and sensor-cable. Once you have re-calibrated the temperature sensors, changing the sensor/connector orientation established during the procedure may void the calibration.

To access the RTD Calibrate menu press 

RTD CALIBRATE MENU STRUCTURE (Single Channel 1010)

RTD Calibrate ⇨	RTD 1 ⇨	⇳ Factory User Cal
	RTD 2 ⇨	⇳ Factory User Cal

4.6.1 RTD CALIBRATION BY DATA ENTRY

The RTD Calibrate menu allows you to adjust the intrinsic RTD reading to match an external reference thermometer by directly entering its reading. Only perform this procedure while the RTD under test is installed and currently measuring temperature.

To enter the current RTD temperature

Move the highlight to the RTD you want to calibrate (RTD1 or RTD2).

To access the RTD option list press  .

Move the highlight to [User Cal] or [Factory] Cal then press ENT. This triggers the pop-up window:

To enable numeric entry  , then type in the reading of the reference thermometer (e.g., 72.0).

To recalibrate the RDT sensor ENT. To verify the calibrated reading, go to [Diagnostics/ Liquid Data] to check the current RTD output. Make sure that it coincides with the reading of the reference thermometer. Repeat for the other RTD if necessary.

NOTE: Factory Calibration provides an additional prompt after a new temperature is entered: *[Are you Sure? No Yes]*. It is recommended that you use *[User Cal]* to avoid alteration of preset factory calibration.

4.6.2 ICE BATH RTD CALIBRATION

Use distilled, deionized water and ice mixture at 0ºC (32ºF) equilibrium for an ice bath. Ensure temperature with a reference thermometer. Controlotron can not assume responsibility for the incorrect design, construction or operation of an Ice Bath.

CAUTION: DO NOT ALLOW AN RTD SENSOR TO MAKE DIRECT CONTACT WITH ICE DURING AN ICE BATH CALIBRATION.

To perform a 32ºF (0ºC) RTD Calibration:

Immerse RTD sensor in deionized water and ice mixture. Stir the mixture constantly.

Move the highlight  to the RTD you want to calibrate (RTD1 or RTD2).

To access the RTD option list  . Move the highlight to [User Cal] then press ENT. This triggers the pop-up window.

When you are sure that the RTD Sensor is at 32ºF (0ºC), press ENT to recalibrate the RDT sensor. To verify the calibrated reading, go to [Diagnostics/Liquid Data] to check the current RTD output. Make sure that it coincides with the reading of the reference thermometer. Repeat for the other RTD if necessary.

```
Calib @ deg F
=32.0
```

4.7 THE CLOCK SET MENU

The Clock Set menu allows you to set the time and date. The meter uses its internal clock/calendar to record the real-time when certain data and diagnostic events occur. In addition, the clock/calendar provides the Datalogger and Stripchart date and time stamps.

CLOCK SET MENU STRUCTURE

Clock Set	Date	xx.xx.xx *(date entry)*
	Time	xx.xx *(time entry)*

Notice:
All Controlotron flowmeters include a real-time clock to provide a convenient date/time stamp for display screens and datalogger reports. The operating system does not rely on the date and time-of-day for any flowmeter operation. Therefore, the "Turn Of The Century" had no effect on the proper functioning of any of our systems. Although we limit the year to 2 digits in all our displays, 1010's datalogger reports are Y2K complaint using an industry standard algorithm to form a 4 digit year field.

4.7.1 DATE

The Date command sets the month, day and year for the meter's internal clock/calendar. Enter the date using the [MM.DD.YY] format. Replace MM with two digits to indicate the month. Replace DD with two digits to indicate the day. Replace YY with two digits to indicate the year. Type the period (.) separator between each set of digits. For example, you would enter December 7, 1997 by typing 12.07.97. You can use the <Right Arrow> to move the cursor back to a number if you need to re-type it. Press the <CLR> key to remove the current setting.

To set the Date:

To enable numeric entry press →

Use the numeric keys to type the date (MM.DD.YY).

To store the date press ENT. This moves the cursor to [Time].

4.7.2 TIME

The Time command sets the hours and minutes for the meter's internal clock/calendar. Enter the time using the [HH.MM.SS] format. Replace HH with 2 digits to indicate the hour (use 24-hr. clock format). Replace MM with 2 digits to indicate the minutes. Replace SS to indicate the seconds. You also have to type the period (.) separator between each set of digits. For example, you would enter ten minutes after two o'clock in the afternoon by typing: 14.10.00 You can use the <Right Arrow> to move the cursor back to a number if you need to re-type it. Press the <CLR> key to remove the current setting.

To set the clock:

To enable numeric entry press 

Use the numeric keys to type the time (HH.MM).

To store the time press ENT. This moves the cursor to RS-232 Setup.

4.8 RS-232 SETUP

Use the RS-232 Setup menu to set the operating parameters of the serial I/O port. Settings include baud rate, parity, data bits, line feed, network ID number and waiting period before a RTS time-out. Only activate the RS-232 output if you intend to transmit serial data. This will avoid burdening the system with unnecessary data transferals while it is performing flow computations.

NOTE: The RS-232 stop bit implementation is fixed. If you are using a communication program, such as Windows 3.xx Terminal™ or Windows 95/98 Hyper-Terminal™, that includes a field for stop bits, select 1 stop bit.

RS-232 SETUP MENU STRUCTURE

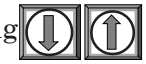
RS-232 Setup	Baud Rate	300 1200 2400 4800 9600 38400
	Parity	None Odd Space Even Mark
	Data Bits	7 8
	Line Feed	No Yes
	Network ID	xx *(numeric entry)*
	RTS Key Time	0.2 Sec. 0.4 Sec. 0.6 Sec. 0.8 Sec. 1.0 Sec. 2.0 Sec. 3.0 Sec. 4.0 Sec.

4.8.1 BAUD RATE

The Baud Rate menu cell sets the asynchronous serial transmission data transfer rate of the RS-232 port. It provides a selection of standard baud rates up to 38,400 baud. The selected baud rate must match the baud rate setting of the receiving external device. The factory-set baud rate is 9600.

To change the Baud Rate:

To access the []Baud Rate] option list press 

Move the cursor to the required baud rate by pressing 

To store selection press  .This moves the cursor to [Parity].

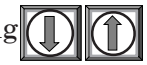
4.8.2 PARITY

Parity is a simple method to check the accuracy of an asynchronous serial data transfer. The parity setting tells the meter how to format the data words it sends to an external device. Parity is usually an additional bit added to each data word. For example, if you select [EVEN], the total sum of all the bits in a single data word (including the parity bit) will always be an even number.

The [Parity] option list includes all the standard parity settings for asynchronous serial transmission. The selected parity must match the parity setting of the receiving external device. Some devices ignore parity entirely; therefore, the option list includes [None]. The factory setting is [None].

To edit the Parity Setting:

To access the [Parity] option list press 

Move the cursor to the required parity setting by pressing 

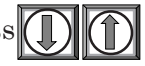
To store the data press  . This moves the cursor to [Data Bits].

4.8.3 DATA BITS

You can specify how many data bits the meter uses to format data words for serial transmissions. The default setting is [7]. Note that the 996P portable printer requires a word length of [8].

To set the Data word length:

To access the [Data Bits] option list press 

To move the asterisk to the required bit setting press 

Press  to store data. This moves the cursor to [Line Feed].

4.8.4 LINE FEED

Some serial devices (printers, terminals, etc.) insert a line feed automatically after they receive a carriage return character. When communicating with these device types, you should set the Line Feed to [OFF]. This instructs the flow computer to send a carriage return character without adding a line feed to avoid creating an additional blank line after each carriage return. Setting the Line Feed to [ON] tells the flow computer to insert a line feed character

after each carriage return that it transmits. This may be necessary to avoid the constant "wrapping" of transmitted data onto a single line. The factory setting is [NO] (line feed disabled). Note that the 996P portable printer requires [NO].

To enable (or disable) Line Feed:

To access the [Line Feed] option list press 

Use  to move the asterisk to [Yes] Line feed enabled, or [No] Line feed disabled.

To store the data press  . This moves the cursor to [Network ID].

4.8.5 NETWORK ID

The [Network ID] menu cell stores an identification number to facilitate host computer polling when you use this system in a network environment. The Network ID number can be any value other than 0 (zero). The default setting, zero, disables the network function. Note that entering a non-zero Network ID number suspends all routine Datalogger activity regardless of any selected options.

NOTE: If you are using the flowmeter for a "stand-alone" application, you must keep the zero Network ID number.

To assign a Network ID number

To enable numeric entry  .

Use the numeric keys to type the Network ID number.

To store Network ID  . This moves the cursor to RTS Key Time.

4.8.6 RTS KEY TIME

During a serial transmission session, you can select how long the flow computer holds its *request-to-send* line high until it receives a *clear-to-send* signal. If the RTS key time expires, the 1010 will return its RTS line low and abort the transmission attempt. Data entry units are *seconds*. The default RTS key time is 0.2 seconds.

NOTE: The RTS Key Time function is only provided when the meter's network ID number is non-zero.

To set the RTS Key Time:

To access the RTS Key Time option list press 

To move the asterisk to the required RTS time press 

To store the data press 

4.9 BACKLIGHT

This menu cell allows you to specify how long you want to maintain the backlighting for the LCD Graphic Display. Select [On] for continuous illumination. Press the <Right Arrow> to access the option list and then scroll to desired time delay (before turn-off). Press <ENT> to store your setting.

4.10 SYSTEM INFO

This menu provides general information about the flowmeter.

System Info Menu Structure

Version	This is the meter's operating system version number. Controlotron's Technical Services Group may request this number during consultations.
Reset Date/Time	Shows the date and time of this meter's last <F4> reset.
Op System P/N	Meter's operating system part number.
Checksum	Operating System verifying code. Controlotron's Technical Services Group may request this number during a consultation.
Code	Software Compile Date/Time. Operating System identifier. Controlotron's Technical Services Group may request this number during a consultation.
System Time	Use to set system time and date. Format: xx.xx.xx xx.xx.xx

4.11 THE 1010 GRAPHIC DISPLAY SCREENS

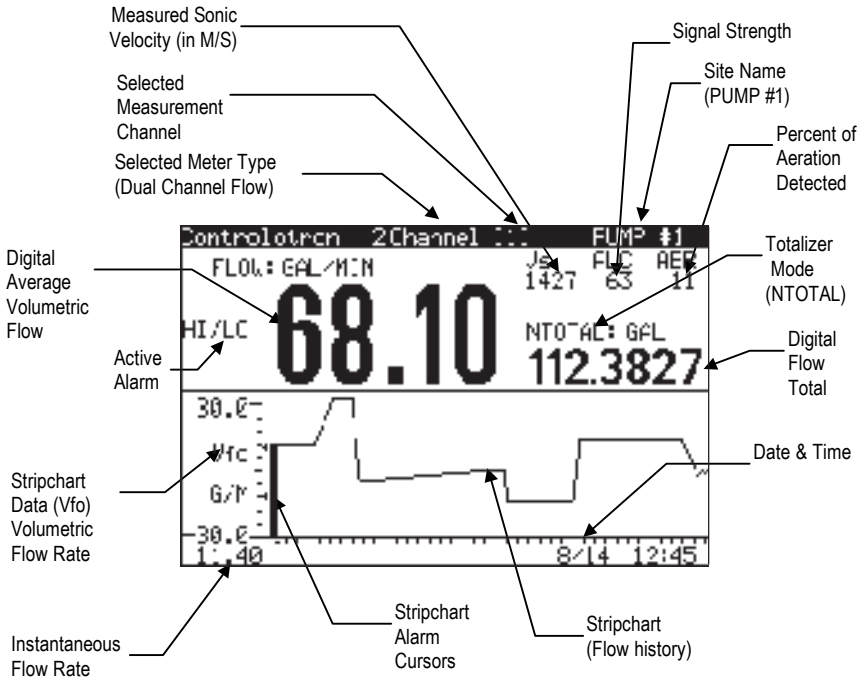
The 1010 family Graphic Display Sub-System is a versatile resource which provides visual access to all system variables and conditions. Depending upon your selection, details of the display my vary, but all elements are always clearly labeled with units and variable names. You're always free to move through the displays by using the arrow keys. The meter will hold the last display selected indefinitely or until the menu is selected by pressing the <Menu> key. When you again leave the menu, the last selected display will be shown upon your return.

After completing the Site Setup, Check your local display screen to ensure that everything is operating properly. The meter begins to measure flow as soon as you complete the transducer installation.

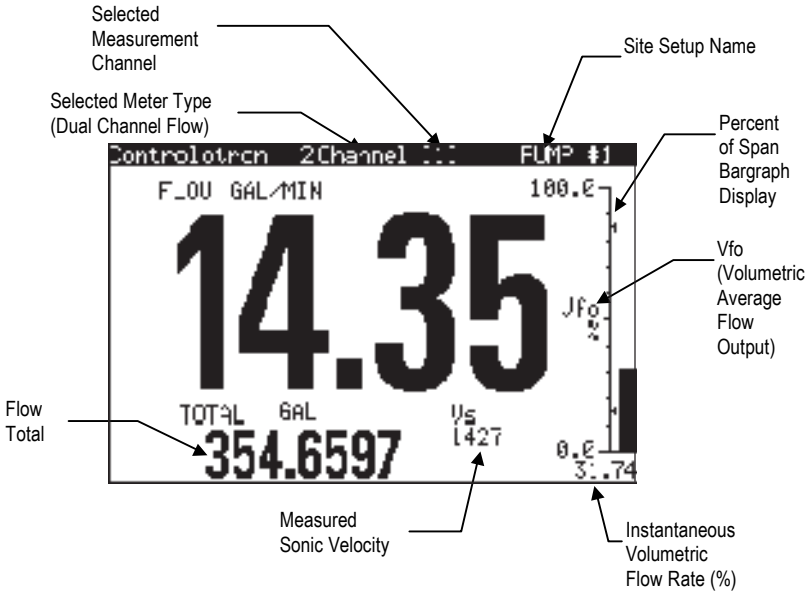
When you press <MENU> to leave the menu, you will see the hybrid digital display screen (see page 4-17). Note that it includes a digital flow, total numeric display and a Stripchart.

The StripChart contains a number of special elements that deserve mention:

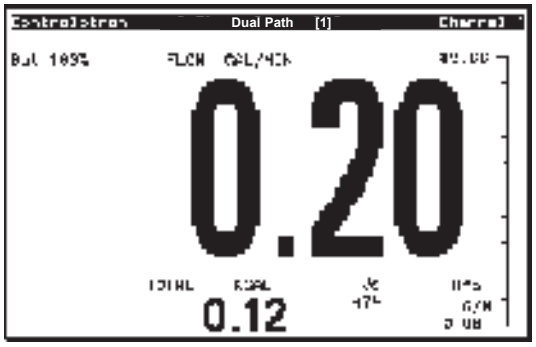
- *The spanning of the stripchart's vertical axis obeys the same user settings that define the span limits for the analog outputs. If the variable "pegs," the numerical expression of that variable will also peg.*
- *Alarm limits, or thresholds, are indicated by triangular cursors shown near the stripchart bar. These are also defined in the Data Span/Set/Cal area of the menu.*
- *Each time the stripchart is altered in a manner that can cause misinterpretation of already displayed data (re-spanned, new interval, etc.), a vertical bar is drawn on the stripchart. Only the data to the left of the vertical bar is correctly displayed.*
- *Due to limitations in display area, certain rate or total units may be displayed with fewer characters than are needed for unambiguous interpretation. Consult the 1010's Flow and Total Units menu cells for clarification in these cases.*



To switch the screen to the "big digits" display press 



You can press  to scroll between the available display screens.



The flow display uses the first (prompt) line display for the purpose of identifying the type of meter currently enabled (Dual Path) and the path from which the current display is derived (3 for the computed or average channel in a dual-path meter). The Site Name is displayed in the upper right-hand corner of the digital display.

5. SYSTEM 1010 APPLICATION NOTES

System 1010 is an extremely versatile transit-time flowmeter that operates with either non-intrusive clamp-on or in-line (non-wetted) flow transducers. Please review the following application guidelines to obtain the best service from this equipment.

System 1010 provides a simple menu-driven interface for site programming. During the installation procedure, you tell the system what you need it to do. It will then verify the pipe and liquid conditions, and based on your selections, optimize its operation automatically. However, the system cannot protect itself from critical data entry errors that you input. Its performance depends on the accuracy of the information that you provide it.

For normal operation, the flow computer only needs a receive signal of sufficient amplitude to activate its automatic gain controlled detection circuits. Severely adverse application conditions may reduce system performance, or cause apparent operational failures. Finding the culprit that caused this can usually also reveal an appropriate remedy. Should this still present a problem, call us for technical assistance.

5.1 TO OBTAIN TECHNICAL ASSISTANCE

Our Technical Service Group provides assistance upon request. You can obtain toll-free assistance from 8:30 until 5:00 o'clock EST by calling 800-275-8480. In addition, you can request help via e-mail by contacting the Technical Service Group at TSG@controlotron.com. The meter's computer provides comprehensive diagnostics data. Using this data, our Engineers can analyze the system in relation to the application in detail. Proper analysis will provide solutions to virtually any application problem.

5.2 CONSIDERATIONS FOR CRITICAL APPLICATIONS

All flowmeters depend on site flow conditions and proper installation to achieve precise, critical flow measurements. Unfavorable factors such as liquid non-homogeneity or stratification and aeration/cavitation increase the possibility of reduced accuracy. This applies to all flowmeters, regardless of their design, sophistication, expense and published intrinsic accuracy. These factors become critical when applications involve custody transfer, tenant billing, and nuclear or other safety-related flows.

System 1010 flowmeters automatically compensates for adverse flow conditions to achieve extremely high accuracy. This requires following the instructions for proper equipment selection, use of the correct clamp-on transducer or flow tube configuration, and paying close attention to installation instructions. Such judicious use implies expert equipment knowledge and experience, plus a thorough understanding of flow conditions.

If your application requires critical measurement accuracy, it is not realistic to simply install the flowmeter and expect optimum performance. Carefully review your piping configuration, select the best mounting location and install the transducers or flow tube in strict accordance with the published instructions. Even when the system is calibrated for enhanced precision at a flow laboratory, this does not relieve you of the responsibility of adhering to the programming instructions and installation requirements. We recommend that all potential installers for critical applications participate in our training programs. Another alternative is to commission our trained professionals to start-up the system for you.

5.3 PIPE CONSIDERATIONS FOR CLAMP-ON TRANSDUCER

Clamp-on flow transducers operate on any round pipe that conducts sound. Suitable pipe materials include most metals, plastics, glass and mandrel wound FRP. Pipes with a fine grain structure (e.g., carbon and stainless steel) conduct sound more freely than cast iron, ductile iron or copper pipes. Nevertheless, all are usually acceptable. Unsuitable pipes include concrete or other non-homogeneous materials. Pipe liners are acceptable if they are sonically conductive and bonded solidly to the inner wall of the pipe. The system operates successfully on pipes with cement liners that are “spun” onto the pipe interior to exclude any air bubbles. Pipes with smoothly applied bituminous and epoxy coatings are also acceptable. Plastic liners are universally acceptable, if they are in intimate contact with the inner wall and not merely slipped within the pipe.

5.3.1 PIPE DIMENSIONS

Controlotron manufactures transducer assemblies to service pipes from 0.25" to 360" in outer diameter. During the transducer install procedure, the flow computer will recommend transducer sizes based on the site data that you enter. Pipes with OD-to-Wall thickness (OD/W) ratios greater than 10 to 1 are ideal applications. Operation on pipes with OD/W ratios of 7 to 1 (or less) are acceptable, but may exhibit reduced stability and linearity. Generally, higher OD/W ratios provide better stability. If a pipe has a low OD/W ratio, you should use the smaller of the recommended transducer sizes (if the flow computer recommends two transducer sizes).

5.3.2 PICKING THE APPROPRIATE TRANSDUCER

To ensure that you select the appropriate transducers for your application, consider the pipe outer diameter, temperature range and degree of precision required. Decide whether you need two independent flow channels or if you have to operate the system in dual-path configuration for greater accuracy and flow profile aberration immunity.

Initial transducer size recommendations are based on your pipe outer diameter, wall thickness and pipe material entries. However, you can override the meter recommendations to accommodate specific situations. For example, you may own a set of transducers whose size does not appear on the meter list. You may be able to use transducers on a pipe size outside of their nominal pipe OD range. During transducer install, the flow computer recommends Spacing Indices (for spacer bars and mounting tracks) or **Ltn,** (actual distance required between transducers). Once you mount transducers and invoke the install routine, you can determine the suitability of your transducers by checking the signal strength and comparing the reported sonic velocity with the actual sonic velocity of the liquid to be measured.

NOTE: Transducer pairs must have matching serial numbers.

5.3.3 FLOW VELOCITY RANGE

System 1010’s flow velocity range with clamp-on transducers is at least ±40 ft/sec regardless of the diameter of the pipe. Depending on application conditions, this range can extend to over 100 ft/sec. This measurement range is greater than needed for virtually any application.

5.3.4 OVERVIEW OF SYSTEM PERFORMANCE

Our system performance specifications are based on acceptable liquid sonic conductivity and other pertinent application conditions. The diversity that characterizes liquid flow, makes it impossible for us to cover all possible application conditions that have the potential to reduce performance. Performance within specifications depends primarily on the receive signal's signal-to-noise ratio and amplitude. The information below may point to application conditions that could reduce system performance below its normally high level.

5.3.5 ACCURACY

Although system accuracy is exceptional over a wide turndown ratio, at extremely low flow rates, a small zero offset becomes a high percentage of actual flow. Obviously, the ultimate accuracy will be obtained by performing an on-site flow calibration. A flow calibration can increase system accuracy to between 0.3% to 0.5%, depending on application conditions.

Two common data-entry mistakes may reduce performance. If you enter an incorrect liquid viscosity value, you could compromise the intrinsic flow profile compensation curve. Incorrectly identifying the transducers will reduce accuracy. Measured sonic velocity (Vs) errors will usually reveal this problem and by simply returning to the appropriate menu cells, entering the correct values, and then repeating the transducer installation it will resolve it.

5.3.6 REPEATABILITY

Some applications require repeatability rather than absolute accuracy. System 1010 features excellent repeatability specifications since its digital "no moving parts" design avoids the adverse effects of hysteresis and other wear mechanisms typical of mechanical devices.

5.3.7 DATA STABILITY

Two main factors influence the system's data stability: *Data Scatter and Drift.*

Data Scatter

Data scatter is a rapid variation in flow readings (within a span of about 0.1 to 5 seconds). Minimal data scatter (approximately 0.01 to 0.03 ft/sec) is a natural by-product of digital computation that extracts the extremely small difference in the up vs. down sonic transit time. Minimal data scatter will not influence the integrated flow total over periods as short as several minutes. Naturally, it will be a greater percentage of the reading when the meter measures extremely low flow rates. Poor liquid sonic conductivity may attenuate sonic signal to a level that increases data scatter. You should check the signal level (Valc %) item on the Diagnostic Menu. Usually, this is indicated by a low Valc % value (less than 30).

System 1010 does not exhibit inertia since it has no moving parts. In addition, it takes readings ten times per second. Therefore, it can detect and track very brief flow fluctuations that are beyond the response capability of some conventional meters. This performance level is required for detecting very fast and short flow transients or for a fast-response servo control loop application. However, you can use the damping and slewing controls to smooth the output response if you want the system to ignore rapid flow fluctuations or data scatter.

Data Drift

Drift is a defined as a long-term cyclical flow deviation resulting from the variation of liquid temperature or liquid sonic velocity. Drift may be more noticeable when combined with a poor signal-to-noise ratio. System 1010 is carefully designed to minimize the effects of drift. There are no drift-prone analog phase-locked loop devices in the primary detection circuits. In addition, we use only the most stable plastics or steel to construct our transducers.

5.4 FLOW CONDITIONS

Very rarely are real-world flow conditions uniform and predictable. Therefore, the 1010 operating system provides a considerable degree of control over the stability/agility of the flow rate output. System 1010 is significantly more agile in tracking pressure wave induced Vs transients, and will recover from mistracking more quickly and smoothly than any other competing transit-time flowmeter.

5.4.1 LOW FLOW RATES

Our 1010 Systems provide a flow resolution and measurement range that surpasses any other type of flowmeter. Therefore, it operates superbly for low or high flow rate applications. However, with our clamp-on systems, using the highest resolution when measuring a low flow rate may cause natural data scatter to become a high percentage of the reading. Since it is data scatter, it will not contribute any error to a totalizer reading accumulating for at least several minutes. However, if the flow rate is extremely low (e.g., under 0.25 ft/sec) the minute zero drift retained by the system may cause an observable performance decline. Therefore, if your application involves extremely low flow velocities, and your line size is 2" or under, our 992DFT or 1011FT Flow Tubes might serve you best.

5.4.2 FLOW DATA SCATTER AND DAMPING

The transit-time flowmeter's ability to respond to the extremely fast flow fluctuations that characterize "real" flow may surprise you. Most conventional flowmeters cannot detect these rapid flow fluctuations since they are subject to unavoidable mechanical inertia. System 1010's response speed is ideal for tracking fast flow transients. However, if this performance is unnecessary, you can smooth the System 1010's response time to suit any application.

System 1010 Damping and Slewing Controls

System 1010 can detect and display minute flow fluctuations that are always present, though not usually detectable by typical flowmeters. This rapid response accommodates applications that require the tracking of fast flow transients.

Time Average is our recommended filter that controls the output damping (the number of samples averaged together to produce the instrument's primary rate output). It integrates the instantaneous flow rate over a selectable time period. Time Average function is very useful when stability in flow readings are essential.

It allows the user to enter a value in seconds that the flow computer uses to integrate its response to flow changes. Do not confuse this with the update speed of analog outputs. This occurs every 0.2 seconds, regardless of the time average that you select. One practical application is to set the time average damping so that the meter maintains a smooth output when it is installed downstream from devices (e.g., a positive displacement pump) that may cause regular surges in the liquid flow.

SmartSlew™ is a digital signal processing method that generates a variable time constant based on the real-time assessment of collected data. When the flow data exhibits a steady trend, SmartSlew™ extends the time constant and the resulting output is smooth data.

5.4.3 NOTES ON LIQUID CONDITIONS

Successful transit-time flow measurement depends on sonic transmit signals traveling through liquid and arriving at the receive transducer without excessive attenuation. Receive signals can be scattered by liquids carrying dispersed particulate matter, either of a solid, non-homogeneous or gaseous nature. This is especially true if the dispersed material is of different sonic impedance than the base liquid. Liquids that contain an excess of gas bubbles or mineral solids may prove to be unsatisfactory transit-time applications. However, these liquids are perfectly suitable for Reflexor™ flowmetering. Liquids containing dissolved gasses or dissolved organic solids will not cause any problems for transit-time operation.

Most liquids are excellent sonic conductors, regardless of their electrical or optical properties. Although highly viscous liquids exhibit a greater degree of sonic attenuation, System 1010 operates perfectly with the vast majority of these liquids. The ***Valc %*** (signal strength) item on the Diagnostic Menu is a good indicator of this condition. A low value (under 30) indicates a possible low liquid sonic conductivity, or improper transducer installation.

5.4.4 ERRONEOUS LIQUID PARAMETER SPECIFICATION

The viscosity of the liquid is an important factor. It governs the degree of Reynolds Number compensation that the flow computer applies to the final rate output. Therefore, flow data errors could result if you enter an inaccurate viscosity value. Controlotron's Technical Service Department can provide reliable viscosity data for most liquids.

5.4.5 LIQUID COMPATIBILITY

Since our clamp-on transducer systems never contact liquid, the issue of liquid compatibility only applies to entrained gases or mineral solid content that might impair sonic signals Since System 1010 is designed to measure flow using both transit-time and Reflexor™ techniques, we can safely say that it will operate most successfully on virtually all liquids.

5.4.6 AERATION

Undissolved gases, having very low sonic impedance, may cause sonic beam scattering. In large quantities, they can reduce the sonic signal strength. Small bubbles, caused by cavitation, usually provoke more signal loss than an equal quantity of large gas bubbles. Usually, the problem can be alleviated by eliminating the cause. Aeration may be caused by a mixing tank, throttling valve cavitation, or air suction upstream of the transducer location.

System 1010 can operate successfully with a larger amount of aeration than any other transit-time flowmeter. It measures and reports the aeration level as the analog output, Vaer %. This represents the relative degree of aeration detected within the flow stream. Its computer reports the Vaer level until it impedes operation and forces a Fault Alarm. The Vaer output accommodates applications requiring an aeration indicator. The Vaer % also appears on the display screen. The aeration percentage can be used as an alarm relay set-point. You can set the aeration alarm setpoint such that it trips before aeration reaches a level that impairs flow measurement.

NOTE: Before performing the installation routine, allow enough time for the liquid to flush out all air trapped in the pipe.

5.4.7 SLURRIES

High-density undissolved solids (e.g., sand slurry) may cause application problems if present in sufficient quantity to scatter the sonic beam significantly. Low-density solids, such as organic materials, coal slurries and unaerated sewage sludge, are usually adequate sonic conductors and their sonic impedance is very close to most liquids. Excessive mineral solids though could trigger the aeration alarm.

5.4.8 TWO-PHASE LIQUIDS

Two-phase liquids (e.g., oil and water) cause some sonic beam scattering. However, these usually conduct sonic beams sufficiently for proper operation (unless heavy aeration is present also). Two-phase liquids with large quantities of different components, such as sand or free gas, could prove to be too attenuative for transit-time operation. However, switching to Reflexor™ mode will keep the meter operational under these circumstances.

5.4.9 VISCOUS LIQUIDS

Highly viscous liquids tend to "absorb" some of the energy of the sonic beam. This causes a reduction of signal amplitude when compared to low viscosity liquids. However, most high viscosity liquids are sufficiently conductive for acceptable operation. A low Valc % value usually indicates low sonic conductivity.

5.4.10 TEMPERATURE AND PRESSURE RATINGS

We rate our standard (universal) transducers for operation up to 250°F. We offer High (H) temperature flow transducers rated for operation up to 375°F. We also manufacture Very High (VH) temperature transducers for applications where the temperature exceeds 375°F, but is less than 450°F. Please refer to Section 6 for flow tube pressure and temperature ratings.

5.5 OVERVIEW OF SYSTEM 1010PVN MEMORY RESOURCES

The System1010PVN memory resources include both Read-Only-Memory (ROM) and battery-backed Random Access Memory (RAM). The ROM memory contains the system operating instructions, on-line help text, default data, and the pipe, transducer and liquid tables.

The flowmeter uses 1 Mega byte of RAM (standard) to provide three discrete storage functions:

Active Memory - Site Storage Memory - Datalogger Memory.

Upon creating a site, the meter copies all ROM-based defaults into the meter's operational database, the *Active Memory*. This provides two advantages. First, RAM-based operation increases performance. Second, this creates an immediate Site Setup, based on the meter's defaults. To make the meter operational, you just have to enter *required* data (e.g., pipe and transducer data) and edit other default settings to suit your application. When you program the meter, all your entries are retained in the Active Memory. This enables you to use the meter immediately after finishing a Site Setup. You're not limited to one set of site parameters. You can copy site data from *Active Memory* to *Site Storage Memory*.

Site Storage Memory provides permanent storage area for several inactive Site Setups. The multi-site storage feature allows rapid reinstallation at many locations. All you have to do to

reactivate an inactive Site Setup is to recall it back into to *Active Memory*. However, be aware that this action over-writes ALL the data residing in the *Active Memory* area.

The Datalogger logs data collected at preset intervals during operation. It uses the system RAM resources independently of *Active Memory* and *Site Storage Memory*. Therefore, data movement between Active Memory and Site Storage memory will not affect it directly. However, all stored data shares a common RAM pool. The meter allocates the actual amount of bytes available for each storage function dependent on the demands of each facility. Therefore, an unusually large Datalogger file may reduce the amount of site storage memory available. Storing several inactive site setups may reduce the available logging capacity.

If you receive a [Memory Full!] message when you try to save a Site Setup, then you will have to delete an obsolete Site Setup or clear the Datalogger Memory to make room. Another Datalogger memory consideration applies to dual-channel systems, when both measurement channels are actively logging data. Dual-channel meters store logged data from BOTH channels in a common file so you must include Site ID for each line to identify the applicable measurement channel.

The 1010 also offers a Memory Map and Defragmenting command in the Meter Facilities area of the menu as an aid in visualizing and maximizing the efficient utilization of your meter's memory resources.

5.6 REFERENCE TABLES

The following tables provide reference data that may be required during the Site Setup.

SONIC VELOCITY (in meters/sec) FOR COMMON LIQUIDS @ 68°F

Liquids/Oils	Vs(m/s)	Liquids/Oils	Vs(m/s)
Acetate, Butyl (n)	1270	Ethanol	1180
Acetate, Ethyl	1180	Ethylene Glycol	1620
Acetate, Methyl	1150	Gasoline	1250
Acetate. Propyl	1180	Glycerine	1920
Alcohol	1440	Linalool	1400
Alcohol, Butyl (n)	1270	Linseed Oil	1770
Alcohol, Ethyl	1180	Methylethyl Ketone	1210
Alcohol, Methyl	1120	Motor Oil (SAE 20/30)	1487
Alcohol, Propyl (i)	1170	Paraffin Oil	1420
Alcohol, Propyl (n)	1220	Pentane	1010
Benzene	1330	Petroleum	1290
Benzol, Ethyl	1340	Trichlorethylene	1050
Butyrate, Ethyl	1170	Transformer Oil	1390
Carbon Tetrachloride	938	Turpentine	1280
Diethyl Ketone	1310		

SONIC VELOCITY FOR PURE WATER @ VARIOUS TEMP. (meters/sec)

Liquid	Deg. C	Deg. F	Vs (m/s)	Liquid	Deg. C	Deg. F	Vs (m/s)
Water	0	32	1402	*Water*	120	248	1519
	10	50	1447		130	266	1503
	20	68	1482		140	284	1485
	30	86	1509		150	302	1466
	40	104	1529		160	320	1440
	50	122	1543		170	338	1412
	60	140	1551		180	356	1390
	70	158	1555		190	374	1360
	80	176	1554		200	392	1333
	90	194	1550		220	428	1268
	100	212	1543		240	464	1192
	110	230	1532		260	500	1110

Vps VALUES (in inches/second) FOR SOME COMMON METALS

Metal	Vps (in/sec)	Metal	Vps (in/sec)
Aluminum	120,000	Magnesium O-1	120,000
AL 1100 (2S)	121,000	Magnesium ZK-60A-TS	120,000
AL 1100-0 (2S0)	122,000	Monel	107,000
AL 2014 (14S)	121,000	Molybdenum	132,000
AL 2024-T4 (24ST)	124,000	Nickel	118,000
AL 2117-T4 (17ST)	123,000	Steel, 302 Cres.	123,000
Brass	89,400	Steel, 347 Cres.	122,000
Brass, Alpha	79,500	Steel, 1020	128,000
Brass, Half Hard	80,700	Steel, 1095	126,000
Brass, Naval	83,500	Steel, 4150, Rc14	110,000
Bronze, Phosphor	87,800	Steel, 4150, Rc18	125,000
Cadmium	59,100	Steel, 4150, Rc43	126,000
Carpenter 20 Steel	117,900	Steel, 4340	126,000
Columbium	82,700	Tantalum	114,000
Columbium (10W, 10TN)	74,800	Tin	65,700
Constantan	104,000	Titanium	122,000
Copper	89,400	Titanium, T1 150A	124,000
Iconel	119,000	Titanium Carbide	203,000
Iron	127,000	Tungsten	113,000
Iron, Cast	110,000	Vanadium	109,000
Magnesium AM-35	122,000	Zinc	94,900
Magnesium PS-1	119,000	Zirconium	88,600
Magnesium J-1	118,000		

SYSTEM 1010 REYNOLDS COMPENSATION FACTOR

Reynolds #	Positive Comp	Negative Comp
0	0.7808	0.7808
1277	0.7869	0.7869
1566	0.7930	0.7930
1694	0.7991	0.7991
1830	0.8052	0.8052
1930	0.8113	0.8113
1986	0.8174	0.8174
2044	0.8234	0.8234
2104	0.8295	0.8295
2166	0.8356	0.8356
2227	0.8417	0.8417
2287	0.8478	0.8478
2348	0.8539	0.8539
2410	0.8600	0.8600
2476	0.8661	0.8661
2558	0.8722	0.8722
2656	0.8783	0.8783
2759	0.8844	0.8844
2853	0.8905	0.8905
3077	0.8965	0.8965
3477	0.9026	0.9026
4006	0.9087	0.9087
4651	0.9148	0.9148
5678	0.9209	0.9209
7582	0.9270	0.9270
10000	0.9296	0.9296
13326	0.9331	0.9331
33832	0.9375	0.9375
97443	0.9420	0.9420
278428	0.9464	0.9464
779166	0.9508	0.9508
2184262	0.9553	0.9553

DV LIQUID TABLES

LiquIdent	S.G.	Viscosity	Compressibility	Name
1100	0.6465	0.15	0.00001	MTBE (Additive for Oxygen)
1180	0.717	0.6	0.00001	LFP (Lead Free Premium)
1200	0.733	0.6	0.00001	LR (Leaded Regular)
1330	0.775	1.0	0.00001	KEROSENE
1350	0.818	1.16	0.00001	AVJET (AV Jet Fuel)
1380	0.819	1.95	0.00001	HSD (High Sulfur Diesel)
1410	0.885	2.75	0.00001	LSD (Low Sulfur Diesel)
1420	0.959	3.2	0.00001	GASSOIL (Sour Light Cycle Gas Oil)
1490	0.9300	119.00	0.00001	FO (Fuel Oil)
1579	0.9850	1049.00	0.00001	HFO (Heavy Fuel Oil)

LiquIdent	S.G.	Viscosity	Visc. Slope	Liquid Name	K0	K1
1100	0.6465	0.15	0.00001	MTBE (Additive for Oxygen)	192.4571	0.2438
1180	0.717	0.6	0.00001	LFP (Lead Free Premium)	192.4571	0.2438

(continued)

LiquIdent	S.G.	Viscosity	Visc. Slope	Liquid Name	K0	K1
1200	0.733	0.6	0.00001	LR (Leaded Regular)	192.4571	0.2438
1330	0.775	1.0	0.00001	KEROSENE	330.301	0.0
1350	0.818	1.16	0.00001	AVJET (AV Jet Fuel)	330.301	0.0
1380	0.819	1.95	0.00001	HSD (High Sulfur Diesel)	103.872	0.2701
1410	0.885	2.75	0.00001	LSD (Low Sulfur Diesel)	103.872	0.2701
1420	0.959	3.2	0.00001	GASSOIL (Sour Light Cycle Gas Oil)	103.872	0.2701
1490	0.9300	119.00	0.00001	FO (Fuel Oil)	103.872	0.2701
1579	0.9850	1049.00	0.00001	HFO (Heavy Fuel Oil)	103.872	0.2701

RECOMMENDED SONIC COUPLING COMPOUNDS

ITEM	CC#	USE	CHARACTERISTICS
1	101	Temporary and portable use on Clamp-on flow transducers. Temp. range: -40°F to 100°F.	Low in halogens and sulfur content.
2	102	Temporary and portable use for all Clamp-on flow transducers. Well suited for survey use. Temp. range: -30°F to 100°F.	Low in halogens and sulfur content. Water soluble.
3	109	Temporary and portable use for all Clamp-on flow transducers. Temp. range: -40°F to 300°F.	Low viscosity Petroleum product.
4	110	High temp. temporary couplant to be used when setting up high temp. plastic flow transducers. Temp. range: 255°F to 450°F.	Resists breakdown and thinning out at high temperatures.
5	111	Permanent high temp. couplant for plastic flow transducers. Temp. range: 255°F to 450°F.	Room temperature vulcanizing silicone rubber.
6	112	Permanent ambient temperature couplant for plastic flow transducers. Temp. range: -40°F to 250°F.	Room temperature vulcanizing silicone rubber.
7	113	Protective spray for providing corrosion resistance to exposed transducer and track parts.	Spray on liquid. Excellent resistance to salt water atmosphere.
8	114	Temporary and long term couplant for all flow transducer types. Temp. range: -40°F to 255°F.	Teflon filled grease. Water resistant.
9	117	Long term and permanent couplant for Clamp-on transducers. Temp. range: -40°F to 450°F.	Silicone grease loaded with metal oxides. Resists Breakdown and thinning at high temperatures.
10	120	Submersible couplant. To be used on all submerged transducer applications.	Extremely water resistant. Consult Controlotron before using.
11	122	Long term and permanent couplant for Clamp-on transducers. Temp. range: -40°F to 450°F.	Long chain polymer grease. Resists breakdown and thinning at high temperatures.
12	124	Long term and permanent couplant for Clamp-on transducers. Temp. range: -40°F to 250°F.	Two part room temperature cure adhesive.
13	128	Temporary and long term couplant for all flow transducer types. Temp. range: -40°F to 375°F.	High viscosity silicone grease. Water resistant.
14	129 129A	Adhesive backed Dry/Damping couplant for all flow transducer types.	Viscoelastic polymer sheet. Water resistant.

Notice: *Controlotron holds US Patent Number 4,929,368 on the CC#122 Coupling Compound and all compounds of this type. Its use is restricted to Controlotron products only, un-*

less a special license has been obtained. Licenses for use with other products are available through the Controlotron Sales Department.

TERMINOLOGY CHART

This chart provides explanations for uncommon terms used in this manual.

TERM	EXPLANATION
Active Memory	Section of RAM allocated for active site parameters (all current values). The flow computer receives site-specific operating instructions from Active Memory.
Alphanumeric Field	An 8-character data entry field that allows you to specify a Site Name or a Security code.
Arrow Keys	Use the <Up, Down, Left and Right> Arrows to navigate through the Installation Menu in their respective directions. The <Up or Down> Arrows allow you also to scroll through option list items.
Asterisk	Refers to the marker used in the Installation menu to indicate a current option list selection. When you access an option list, you can move the asterisk with the <Up or Down> Arrows to a new selection, then press <Enter> to select the item.
CLR (Clear) Key	Use the <CLR> key to erase a numeric value or clear a selection from a multiple select option list.
Cursor	This refers to the highlighted text and the arrow cursor that you move via the arrow direction when navigating through menus or menu cells.
Data Entry	Refers to data entered into a menu cell (either numeric or option list selection).
Datalogger Memory	Memory segment that stores data items logged during operation. You can view the Datalogger contents either on-screen or transmit it to an external device via the RS-232 serial port. The amount of Datalogger memory depends on how many sites reside in Site Storage memory.
ENT (Enter) Key	Use the <ENT> key to store a current numeric value or option list item.
Flow Computer	Refers to the meter itself (system refers to the meter and transducers combined).
Flow Tube	Refers to our in-line (non-wetted) transducer assemblies suited for small (under 2" lines) and extremely low-flow applications.
Graphic Screen	Refers to the integral display screen.
Initial Makeup	An internal process performed during installation, where the flow computer acquires its receive signal and enhances other parameters for optimal operation at a site.
In-process Makeup	An internal process where the flow computer recovers its Initial Makeup parameters, after a fault condition interrupts operation.
Installation Menu	The meter's overall menu structure. Allows you to define all aspects of the meter's operation.
Interface m/s	Refers to an alarm function that declares the passage of a liquid interface by a comparison of the relative sonic velocities of the two liquids.
LAPTOT	Refers to a system function that freezes the Totalizer display, while the Totalizer continues to update its registers.

(continued)

TERM	EXPLANATION
Local Display	Refers to the 1010PVN's integral display screen.
Menu	Sub-sections of the Installation Menu that you to define specific operational functions (e.g., RS-232 Setup).
Menu Cell	location within a Menu where you define either a single numeric value or option list selection that supports the Sub-Menu's function. Certain view-only menu cells show reference data appropriate to the current application.
NEGFLOW	Totalizer mode for negative flow total only.
NETFLOW	Totalizer mode that combines positive and negative flow totals.
NOTOT	System function that disables the internal Totalizer.
Number Index	Computed transducer spacing index based on the estimated sonic velocity measurement. This Index **cannot** be overridden by installer.
Numeric Data	Refers to a value entered into a menu cell. An example would be the pipe outer diameter.
Numeric Entry	Refers to a number you type into menu cell that stores numeric data.
Numeric Keys	Use the numeric keys to type a numeric value where appropriate.
OpSys ROM	The read only memory that stores its basic operating instructions and permanent defaults.
Option List	Lists of options presented at menu cells that allow you to select a either a single item or multiple items (depending on the function that the menu cell controls).
Parameter	Refers to value (either numeric or list selection) stored in a menu cell.
POSFLOW	Totalizer mode for positive flow total only.
Site Name	A user-entered name that meter associates with a stored Site Setup. You retreive a particular Site by selecting its name from a site name list.
Site Setup	A collection of parameters used by the meter to service a specific site (or location).1010 allows you to store several independent Site Setups.
Site Storage Memory	Section of RAM allocated for permanent data storage. This memory segment stores inactive site setups (including a backup of active site). The meter's Site Setup storage capacity depends on the dynamic memory allocation as dictated by each application. In addition, the meter uses Site Storage Memory to store configurable operating parameters such as pipe and liquid tables.
TOTCNT	A totalizer pulse count function used for Batching or Sampling.
Transducer	Clamp-on flow sensors that the meter uses to measure the flow rate.
Register	Refers to a memory location used by the flow computer to store data such as the flow total, etc.
RTD	Temperature sensors used with energy flow of mass flow systems.
Spacing Index	Refers to the Number Index, used by the flow computer to determine the space between the upstream and down stream transducers on clamp-on systems.
Spacing Offset	Fixed transducer offset assigned by the flow computer. This can be overridden by the installer.
Vaer	The meter's aeration percent output.
Vps	The sonic propagation velocity of a pipe.
Vs	The sonic velocity of a liquid.

5.7 THE NEMA DUAL-PATH MENU CHART

This section shows the Dual Path Flow menu.

THE METER TYPE MENU

Meter Type ⇨	Dual Path Flow ⇨	Channel/Path Setup

THE METER FACILITIES MENU

Meter Facilities ⇨	⇨ Preferred Units	⇨ English Metric		
	⇨ Table Setups	⇨ Pipe Table	⇨ Create/Edit Pipe	⇨ Choose Pipe Class Choose Pipe Name ⇳ Outer Diameter Wall Thickness (in) Liner Material (in) Liner Thickness
			⇨ Delete Pipe	⇨ Choose Pipe Class ⇳ Pick Pipe Name
		⇨ Transducer Table	⇨ 1011 Universal ⇳ 1011H Hi Precision 991 Universal	
	⇨ Datalogger Control	⇨ ⇳ Display Datalogger Output Datalogger Circular Memory Est Log Time Left Clear Datalogger		
	⇨ Memory Control	⇨ Data Memory Left ⇳ Memory Map Defragment		
	⇨ Analog Output Trim	⇨ Trim Io 1	⇨ Operate Trim @ 4mA	
		⇨ Trim Io 2	⇨ Operate Trim @ 4mA	
		⇨ Trim Vo 1	⇨ Operate Trim @ 2V	
		⇨ Trim Vo 2	⇨ Operate Trim @ 2V	
		⇨ Trim Pgen 1	⇨ Operate Trim @ 1Khz	
		⇨ Trim Pgen 2	⇨ Operate Trim @ 1Khz	
		⇨ Trim Pgen 2	⇨ Operate Trim @ 1Khz	
	⇨ RTD Calibrate	⇨ RTD-1	⇨ User Cal. Factory	
		⇨ RTD-2	⇨ User Cal. Factory	

(continued)

METER FACILITIES MENU *(continued)*

⇨ Meter Facilities ⇳	⇨ Clock Set ⇳	⇨ ⇳ Date Time
	⇨ RS-232 Setup ⇳	⇨ ⇳ Baud Rate Parity Data Bits Line Feed Network ID RTS Key Time
	⇨ Backlight	⇨ 30 sec, 1 min, 2 min, 3 min, 5 min, 10 min
	⇨ System Info ⇳	⇨ ⇳ Version Reset Date/Time Op System P/N Checksum Code

THE CLAMP-ON MENU

⇨ Clamp-On ⇳	⇨ Chan/Path Setup ⇳	⇨ ⇳ Recall Site Setup Channel Enable Create/Name Site Site Security Delete Site Setup Save/Rename Site	
	⇨ Pipe Data ⇳	⇨ ⇳ Select Pipe Class Select Pipe Size Pipe OD (in / mm) Pipe Material Wall Thickness Liner Material Liner Thickness ThermExp Coef 1/F Mod of Elast PSIA	
	⇨ Application Data ⇳	⇨ Liquid Class ⇳ ⇨	⇳ Select Liquid Estimated Vs m/s Viscosity (cS) Density S.G.
		⇨ LiquidTable ⇳ ⇨	⇳ Table Active LiquIdent Slope Pressure Slope Base Temperature LiquIdent Index
		⇨ Temperature Range ⇳	⇳ -40 to 250F -40 to 375F -40 to 450F
		⇨ Pipe Configuration ⇳	⇳ Fully Developed 1 Elbow Dbl Elbow + Dbl Elbow - Valve Expander Reducer Norm Entry Header Inlet Intrusions
		⇨ Anomaly Diams	10
	⇨ Pick/Install Xdcr ⇳	⇨ ⇳ Install Path Transducer Model Transducer Size	

(continued)

THE CLAMP-ON MENU *(continued)*

⇨Clamp-On	⇨ Pick/Install Xdcr	⇨⇳ Xdcr Mount Mode Spacing Offset Number Index Spacing Method Ltn Value Install Completed? Empty Pipe Set Zero Flow Adjust	
	⇨ Operation Adjust	⇨⇳ Damping Control	⇨⇳ Time Average Smart Slew
		Deadband Control	0.000 (numeric entry)
		Memory/Fault Set	Fault/Memory
		Memory Delay (sec)	N/A
	⇨ Flow/Total Units	⇨⇳ Flow Volume Units Flow Time Units Flow Display Range Flow Display Scale Total Volume Units Totalizer Scale Total Resolution Totalizer Mode Batch/Sample Total	
	⇨ Data Span/Set/Cal	⇨ Span Data	⇨⇳ *Pgen (Units) Max Flow (Units) Min Flow (Units) Max LiquIdent Min LiquIdent Max Vs m/s Min Vs m/s Max Viscosity cS Min Viscosity cS Max Temperature Min Temperature
		⇨ Set Alarm Levels	⇨⇳ HIgh FLow (Units) Low Flow (Units) High Liquident Low Liquident High Viscosity cS Low Viscosity cS High Temperature Low Temperature Interface Vs m/s Aeration % Makeup Latch

*Only available in Custody Transfer flowmeters. *(continued)*

THE CLAMP-ON MENU *(continued)*

Clamp-On ⇕	⇨ Data Span/Set/Cal ⇕	⇨ Calibrate Flow Rate	⇕ Intrinsic Kc			
		⇨ Calib. Table 1 ⇕	⇨ Index Variable 1 ⇕	⇕ None Flow Vs Liquident Viscosity (cS) Valc Vaer Temp 1 Reynolds # Pressure Aux		
			⇨ Calib. Table 1 ⇕	New Point ⇨	⇕ Cal. Index Value PosFlow Corr NegFlow Corr Accept/Clear ⇨	x.xxx x.xxx x.xxx Accept Pt. Clear Pt.
			⇨ Table Active 1	No		
			⇨ Clear Table 1	⇕ No Yes		
		⇨ Calib. Table 2	⇨ See Table 1			
		⇨ Calib. Table 3	⇨ See Table 1			
	⇨ Stripchart Setup ⇕	⇨ Select Data ⇕	⇕ LiquIdent Visc Temp Vs Valc Vaer Vfo Vfab			
		⇨ Data Display ⇕	⇕ Data Rate Units Percent of Span			

(continued)

THE CLAMP-ON MENU *(continued)*

⇨ Clamp-On	⇨ Datalogger Setup	⇨ Time Base	⇨⇳ 1 second 3 seconds 6 seconds 12 seconds 24 seconds 1 minute 3 minutes 6 minutes 12 minutes 24 minutes 1.2 hours	
		⇨ Stripchart Clear	⇨⇳ Yes No	
		⇨ Datalogger Mode	⇨⇳ Off Memory RS-232 Output	
⇳	⇳	⇨ Datalogger Data	⇨⇳ Site Id Date Time Path Flow* Flow Average Flow Raw Flow Total Path Vs* Vs Path Valc* Valc Aeration LiquIdent Viscosity Path Alarms* Alarms Temperature Path Delta T* Analog Inputs	
		⇨ Log Time Interval	⇨⇳ 5 sec. 10 sec. 15 sec. 30 sec. 1 Min. 5 Min. 15 Min. 30 Min. 1 Hr. 2 Hr. 4 Hr. 6 Hr. 12 Hr. 24 Hr. Demand	

NOTE: For Dual Path Flow flowmeter types only.

(continued)

THE CLAMP-ON MENU *(continued)*

Clamp-On	⇨ Datalogger Setup	⇨ Datalogger Events	⇨⇳ Fault Alarm Memory Relay 4 Relay 3 Relay 2 Relay 1 Spacing Empty Aeration Interface Flow Alarm Fault Alarm Memory Makeup	
		⇨ Display Datalogger	⇨⇳ Off No Line Warap Line Wrap	
	⇨ I/O Data Control	⇨ Analog Out Setup	⇨ Io1	⇨⇳ Vfo Vfab Vs Valc Vaer LiquIdent m/s Viscosity T1 Iin1 Iin2 Iin3 Iin4
			⇨ Io2	See Io1 list above.
			⇨ Vo1/2	See Io1 list above.
			⇨ Pgen1/2	See Io1 list above.
		⇨ Relay Setup	⇨ Relay 1	⇨⇳ Off Power On High LiquIdent Low LiquIdent High Viscosity Low Viscosity Hi Temperature Low Temperature High Flow Low Flow Flow Alarm Fault Alarm Spacing Empty Aeration Interface Reverse Flow BatchTot Pos Total Neg Total Fltwarn Soft Fault Pig Detect
			⇨ Relays 2	See Relay 1 list above
			⇨ Relays 3	See Relay 1 list above
			⇨ Relays 4	See Relay 1 list above

(continued)

THE CLAMP-ON MENU *(continued)*

⇨ Clamp-On	⇨ Analog Input Setup	⇨ Iin1	⇨ Input	⇨⇳ Off Aux cS PSIA BARA T1 Deg F T1 Deg F T2 Deg C T2 Deg C
			⇨ 4 mA	x.xxx (numeric entry)
			⇨ 20 mA	x.xxx (numeric entry)
		⇨ Iin 2/Iin3/Iin4	⇨ See Iin1 above	
	⇨ Diagnostic Data	⇨ Path Select	⇨ 1 and 2, 1, 2	
		⇨ Path Enable	Yes/No	
		⇨ Flow Data	⇨⇳ Flow (Units) Flow Vel F/S Total (Units) Vs m/s Signal mV Valc % Vaer % Alarm Status AnCal (Units) HiFlow (Units) LoFlow (Units)	
		⇨ Application Info	⇨⇳ TN uSec TL uSec DeltaT nSec Burst/Sec % Accepted Last Makeup Makeup Status	
		⇨ Liquid Data	⇨⇳ Temp 1 Temp 2 Reynolds # LiquIdent Viscosity (cS) Pressure	
		⇨ Site Setup Data	⇨⇳ fx (drive) N (burst length) Ltn in Vfmax (Units) Vs max m/s Vs min m/s Empty % Samples/Cycle HF	
		⇨ Test Facilities	⇨⇳ Makeup Graph Tx UP Tx Dn Fixed ALC Tx Up Fixed ALC Tx Dn Fixed ALC Graph AutoZero	⇨⇳ No/Yes No/Yes No/Yes No/Yes No/Yes No/Yes No/yes No/Yes
		⇨ Print Site Setup	⇨⇳ No Yes	
		⇨ Date Site Created:	xx.xx.xx xx.xx.xx	

CONTROLOTRON

APPENDIX A

Couplant Installation Instructions

APPENDIX B

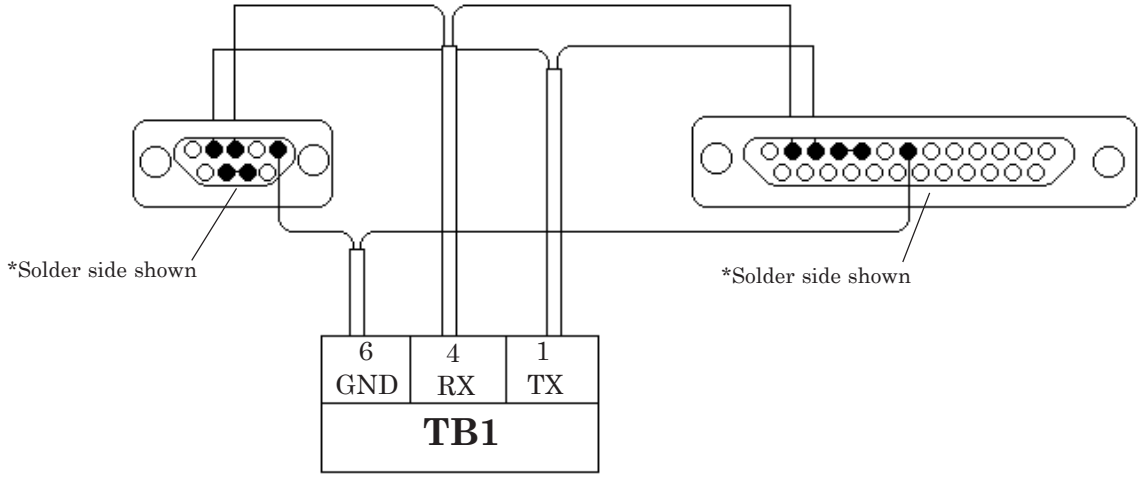
SITE SETUP CONSIDERATIONS FOR 1010N BLIND SYSTEMS

Controlotron offers an economical "blind" 1010 NEMA system (without a local keypad and graphic display screen). This supplement describes the hardware and software requirements for programming these models. Site setup for a blind unit requires a PC connected to the RS-232 serial port. These models include a serial interface cable for this purpose. The serial interface cable includes 9-pin and 25-pin connectors to accommodate both types of IBM-compatible serial ports. A PC communication program such as Terminal (Windows 3.x™) or HyperTerminal (Windows 95/98™) serves as the data entry interface. These programs reproduce the menu screens that would appear on the system's graphic screen. In fact, the example screens in this manual are actual HyperTerminal™ screen captures. Once the serial interface is established, the site setup procedure for blind and graphic display systems are identical. You could choose to program a graphic display system using a PC and a communications program. However, note that for models with a local display screen, the serial interface cable is an option.

NOTE: You can use a DOS-based communications program also. Make sure that your PC is loading the ANSI.SYS driver via your Config.sys file. Set the program's RS-232 parameters to match those of the flowmeter (see HyperTerminal™ example screen on next page).

THE RS-232 INTERFACE CABLE

The physical connection between the flow computer and your PC is accomplished using a serial interface cable, part number: 1015CPC-N. The schematic below shows the configuration of the cable. The wire ends for the flow computer termination are tinned for easy insertion into TB1 on the flow computer. Each wire is labeled to identify the correct terminal pin on TB1. In addition, both connectors have their CTS pin shorted to the RTS pin (pins 4 - 5 on 25-pin connector and pins 7 - 8 on 9-pin connector). This eliminates the need for hardware "handshaking."



1015CPC-N SERIAL INTERFACE CABLE

COMMUNICATING WITH SYSTEM 1010 VIA THE RS-232 INTERFACE

The following sections assume that you are familiar with the basics of using a Windows 3.x™ or Windows 95/98™ based communications program. All PC computers provide at least one serial port using either a 9-pin or 25-pin D-type connector. The port designation can be either COM 1 or COM 2. Usually, when a computer includes two serial ports, COM 1 will be the 9-pin connector and COM 2 will be the 25-pin connector. However, port designations can vary from manufacturer to manufacturer, so you will have to positively identify the COM port you wish to use for the flow computer interface. Connect the cable between the flow computer and your PC using either the 25-pin or 9-pin connector, depending upon the port's architecture.

HOW TO USE THE Windows 95/98™ HyperTerminal™ PROGRAM

Windows 95/98™ provides a communication program called HyperTerminal™, which is ideal for interfacing your computer with the flow meter. The following example explains how to set up HyperTerminal.

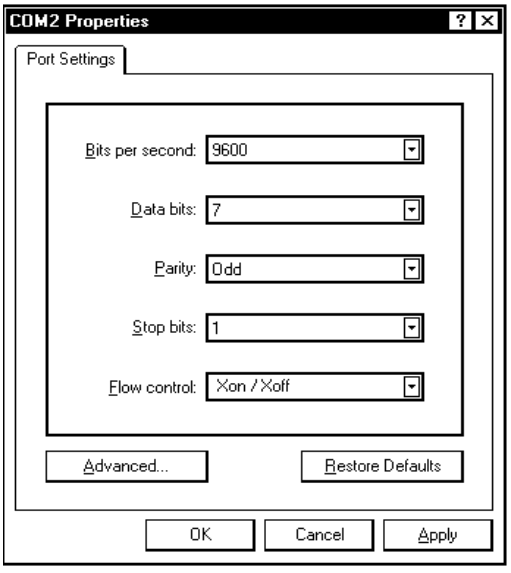
1. From the Windows 95/98™ desktop, left-click on the [START] button.

2. Holding down the left mouse button, move the highlight up to [Programs], then across to [Accessories]. Slide the highlight down to [HyperTerminal], then release the left mouse button.

3. Within the HyperTerminal window, move the mouse pointer down to [Hyperterm.exe] and then double-click the left mouse button.

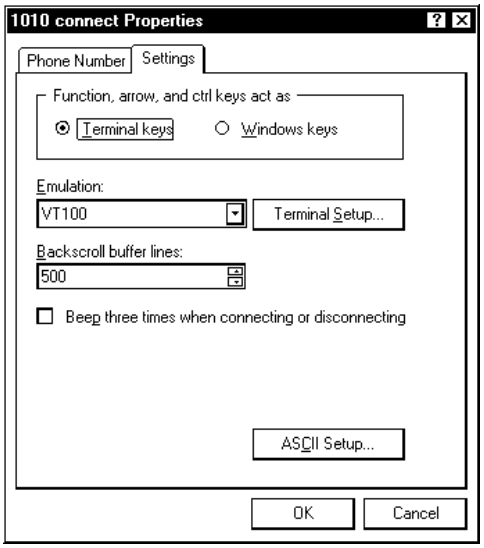
4. This selects the [Connection Description] dialog box. Enter a name for your connection (e.g., 1010N). You can optionally select an icon for this connection by clicking on one of the icons displayed in the scrolling frame at the bottom of the window. Click [OK].

5. This selects the [Phone Number] dialog box. Move the cursor to the arrow at the right of the [Connect Using] field. Left click on the arrow to expand the field and then move the highlight down to [Direct to Com 1 (or 2)] depending on the port connected to the interface cable. Click [OK] to select the [Com 1 (or 2) Properties] Dialog box. Set up your RS-232 parameters as shown in the example below. Left-click on the [OK] button.

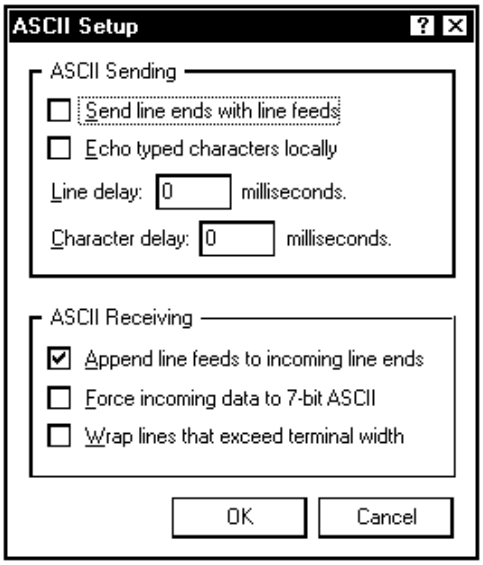


6. You will now see a blank terminal screen. Next left-click [File] on the top menu bar. Drag the highlight down to [Properties] and then left-click.

7. Left-click the [Settings] tab. Expand the [Emulation] box by left-clicking the <Down Arrow> on the right-hand side. Drag the highlight down to [VT-100] and then left-click to select it (as shown below).



8. Next, left-click on the [ASCII Setup] button (see screen above). In the [ASCII Sending] dialog box, make sure that both [send line ends with line feeds] and [Echo Typed characters locally] are UNCHECKED. In the [ASCII Receiving] dialog box, left-click to place a check mark before the [Append line feeds to incoming line ends] dialog. When your screen looks like the example below, left-click the [OK] button.



9. You are now ready to communicate with the 1010 flow computer. But first, save your settings by moving the mouse cursor to [File], sliding the cursor to [Save], then clicking [OK] on the Save dialog box.

10. The next time you want to use HyperTerminal™:

    Click on *Start*.

    Drag to Programs.

    Drag to Accessories. Drag to *HyperTerminal,* and click.

    Double-click the icon you selected for the connection.

NOTE: For easier access, create a shortcut to the connect icon from your desktop. Right-click on the icon to open its dialog box. Left-click on [Copy] and then move the mouse cursor to a blank area on your desktop. Right-click to open dialog box and then left-click on [Paste] to place a shortcut to the connect icon on your desktop.

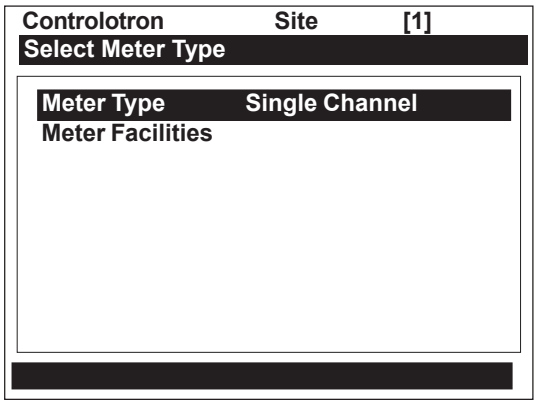
Accessing the Installation Menu

Once the parameters are set, HyperTerminal ™ automatically initiates *Command* mode. You will see a blank screen.

Press ENTER a few times until you see [? For Help] on the screen.

Type: ? (question mark) and then press ENTER to see a list of the available commands.

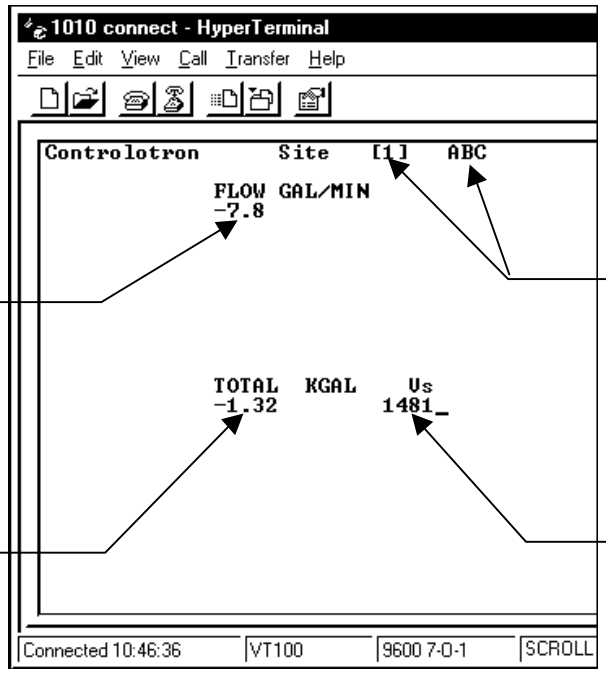
Use the MENU command (type [Menu] and then press ENTER) to access the top level of the Installation Menu. You will see a screen similar to the example on the next page.



NOTE: To facilitate connecting through modems, the [Menu] command times out after three minutes of inactivity. To maintain a longer connection type: menu 1000 and press <ENTER>. The optional number is the amount in minutes that the connection will be maintained. Typing [Menu 1000] essentially keeps the interface alive until you cancel it.

Data Display Mode

After you complete the installation, you can toggle between Installation Menu mode to Data Display mode. This is the same as using the <MENU> key on the 1010 keypad (see manual). The PC keyboard equivalent to the <MENU> key is <CNTRL> + <L>. Note that the 1010 RS-232 interface does not support graphics. Therefore, when you use HyperTerminal™ to view the data display screens, you will see the same data in alphanumeric form only (as shown below). You can still use the <Up Arrow> and <Down Arrow> to switch between available display screens.



This is the current flow reading and flow units. (This would be a large graphic characters on the1010 screen.

This is the name of the current active site setup. The [1] indicates that measurement channel is currently active.

This is the flow total display.

This is the current measured liquid sonic velocity (Vs).

Navigating Through the Installation Menu

After accessing the Installation Menu, you can begin to setup your flowmeter according to the instructions in this manual. The chart below shows the PC keyboard equivalents to the 1010 keypad keys while you are in the menu.

1010 Keyboard	PC Keyboard	Description
<Up Arrow>	<Up Arrow>	Move up 1 menu cell (or Flow Display screen)
<Down Arrow>	<Down Arrow>	Move down 1 menu cell (or Flow Display screen)
<Right Arrow>	<Right Arrow>	Move right 1 menu cell (or Flow Display screen)
<Left Arrow>	<Left Arrow>	Move left 1 menu cell (or Flow Display screen)
<Menu>	^L (Cntrl L)	Toggle between Menu and Flow Display
<Datalog>	^D (Cntrl D)	Generate Datalogger report
<CLR>	<Backspace> or <DEL>	Deselect list selection
<ALT+Up Arrow>	^U (Cntrl U)	Logger Display Page Advance
<+/-> (chg sign)	| (bar, shift + backslash)	Change numeric sign. Can also type (-) key.
<ENT>	<Carriage Return>	Enter Key
Digits	Digits	Numerals zero through 9
/	/	Divide by
X	* (upper case 8)	Multiply by
+	+	Plus
-	-	Minus
=	=	Equals
.	.	Decimal Point

Reset Procedure for Blind Systems

1010N Blind systems allow you to perform a system reset via the RS-232 interface. The following instructions require the flow computer to connected serially to a PC.

NOTE: Custom RS-232 settings for baud rate, parity and data bits may not be preserved. Therefore, be prepared to set your communications program back to the default (9600, Odd, 7) settings.

To Clear Active Memory Using the RS-232 Interface

1. Turn off power (if it is currently on). Turn power on. As soon as you apply power, immediately type the @ character three times. The prompt: [Clr Active Memory? No] appears at the top of the screen.

2. Press the <Right Arrow> and then the <Down Arrow> to switch the option list to: [Clr Active Memory? Yes] Press <ENT> to clear all Active Site Data (but not saved site setups).

3. To restore operation, press <MENU> to access the Installation Menu. Create a new site setup or recall a stored site setup. Re-select any Meter Facilities items (e.g., RS-232 setup parameters).

To Clear All Dynamic Memory Using the RS-232 Interface:

CAUTION: Before proceeding further , it is essential to understand that this function eliminates all data stored in RAM. This means that all saved site setups, including the site data of a flow-calibrated site will be erased! Also, the entire Datalogger file plus any custom factory or user-created pipe or transducer tables will be eliminated. The impact of this is such that we strongly recommend that you consult our technical service department before continuing with this procedure. If you choose to continue, be aware that you will have to create a new site setup, re-enter all site specific parameters including pipe or transducer tables, plus all desired Meter Facilities entries.

1. Turn off power (if it is currently on).

2. Turn the power on. As soon as you apply power, type the @ character three times.

The prompt: [Clr Active Memory?] appears at the top of the screen. Press the <Down Arrow>.

Note that the prompt switches to [Clr Saved Data? No] .

3. Press the <Right Arrow> and then the <Down Arrow> to switch the option list to: [Clr Saved Data? Yes]

4. Press <ENT> to clear all Active Site Data (but not saved site setups).

5. To restore operation, press <MENU> to access the Installation Menu. Create a new site setup or recall a stored site setup. Reselect any Meter Facilities items (e.g., RS-232 setup parameters).

APPENDIX C
ENGINEERING DRAWINGS

Flow Computer Drawings

1010N-7	Installation Drawing, 1010 Series Single Channel Flow Computer
1010N-8	Outline Dimensions, 1010 Series Single Channel Flow Computer
1010DN-7	Installation Drawing, 1010 Series Dual Channel Flow Computer
1010DN-8	Outline Dimensions, 1010 Series Dual Channel Flow Computer
1010NS2-7	Installation Drawing, 1010 Series Flow Computer, FM Approved
1010NS2-8	Outline Dimensions, 1010 Series Flow Computer, FM Approved
1010N-7-7	Installation Drawing, Expanded I/O Module
1010N-5-7	Installation Drawing, Analog Input Module
1010N-2-7	Installation Drawing, I/O Module

Transducer and Accessory Drawings

1011HNFS-7	Installation, 1011HNFS Series Dedicated Plastic Body Transducer
1011HNFS-8	Outline Dimension, 1011HNFS Series Dedicated Plastic Body Transducer
1011NFPS-7	Installation 1011NFPS Series Dedicated Plastic Body Transducer
1011NFPS-8	Outline Dimensions, 1011NFPS Series Dedicated Plastic Body Transducer
1012BN-8	Outline Dimensions, 1010 Series Spacer Bar
1012FN-8	Outline Dimensions, 1011 Series Dedicated Transducer Mounting Frames
1012FNH-8	Outline Dimensions, 1011HN Series Dedicated Transducer Mounting Frames
1012MS-8	Installation/Outline, Adjustable Mounting Strap
1012TB-8	Installation/Outline, 1011 Series Test Block
1012TN-7	Installation Drawing, 1010 Series Transducer & Mounting Tracks
1012TN-8	Outline Dimensions, 1012 Series Mounting Tracks
1012TNH-7	Installation Drawing, 1010 Series Transducer & Mounting Tracks
1012TNH-8	Outline Dimensions, 1012 Series Mounting Tracks
1012F-DB-7	Installation Drawing, Dual Path Transducer Set w/Mounting Frames
990TDMVH-7A	Installation Drawing, 990 Series Transducer & Tracks, Very High Temp., Direct Mode
990TDMVH-7B	Installation Drawing, 990 Series Transducer & Tracks, Very High Temp., Direct Mode
990TRMVH-7A	Installation Drawing, 990 Series Transducers & Tracks, Very High Temp., Reflect Mode
990TRMVH-7B	Installation Drawing, 990 Series Transducers & Tracks, Very High Temp., Reflect Mode
191N1S-7	Installation Drawing, 191N1S Transducer, NEMA 4
191N1S-8	Outline Dimensions, 191N1S Transducer, NEMA 4
191N1H-7	Installation Drawing, 191N1H Transducer, Hi Temp., NEMA-4
191N1H-8	Outline Dimensions, 191N1H Transducer, Hi Temp., NEMA-4
991TN-7	Installation Drawing, Temperature Sensor, NEMA-4
991TN-8	Outline Dimensions, Temperature Sensor, NEMA-4
991TN-7A	Installation Drawing, 990 Series, Temperature Sensor, NEMA-4
991TN-8A	Outline Dimensions, 990 Series, Temperature Sensor, NEMA-4
991TW-8	Installation/Outline Dimensions, Insert Temperature Sensor, 990E System
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