INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Model MT91
Multipoint Flowmeter

Software Version 1.1xx
Doc. No. 003185 Rev. B

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Reserved for Domestic Rep Map

Reserved for International Rep Map

REVISIONS

REV.	DESCRIPTION	DATE	AUTHOR
B	Incorporated Errata 17EN000020 into the manual. Changed Appendix C. See change bars for all other changes.	03/17/97	R. Sanders

Contents

Figures

Tables

Symbols

The following symbols are used throughout the manual to draw your attention to items or procedures that require special notice or care.

Warning: Warns of possible **personal danger** to those handling the equipment.

Caution: Cautions against possible **equipment damage**.

Note: Contains important information.

1. General Information

Description

The MT91 is an air and gas mass multipoint flowmeter that incorporates a remote flow element connected to a microprocessor control and display package (flow transmitter) designed to measure mass flow in ducts, stacks, or places where irregular flow may reduce the accuracy of single point metering. The MT91 measures mass flow from up to 16 different sensing points. An average of all individual flow signals produces an output signal representing total mass flow. The MT91 can be factory calibrated to sense a range of mass flow from 0.25 SFPS to 150 SFPS in air at standard temperature and pressure (70°F at 14.7 PSIA).

Flow Element

The flow element holds all of the individual sensing points. Each sensing point consists of two pairs of thermowells of the same size and shape (see Figure 1-1). One thermowell pair contains a heater and an active Resistance Temperature Detector (RTD). The second pair contains the reference RTD and a thermal mass equalizer.

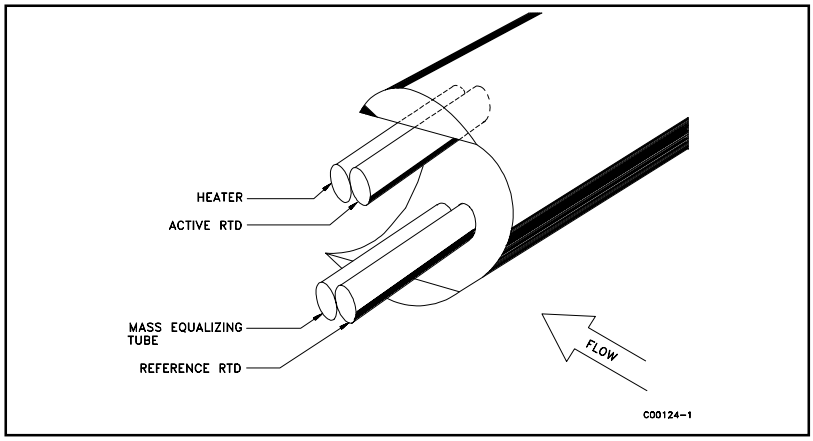


Figure 1-1. Flow Element Cutaway View of One Sensing Point

Flow Transmitter

The flow transmitter assembly provides power for the flow element, measure the Temperature Differential (DT) between the active and reference sensors for each individual sensing point, and averages all flow signals to one output signal. Available outputs options are field programmable to select 4-20 mA, 0-10 Vdc, 0-5 Vdc, digital, with relay output signals. Three serial communication ports, EIA-232C (RS-232C), EIA-422 (RS-422), or EIA-485 (RS-485), are also field selectable and programmable for output signals. Parameters are programmable using the keypad or serial communication interface. See Figure 1-2.

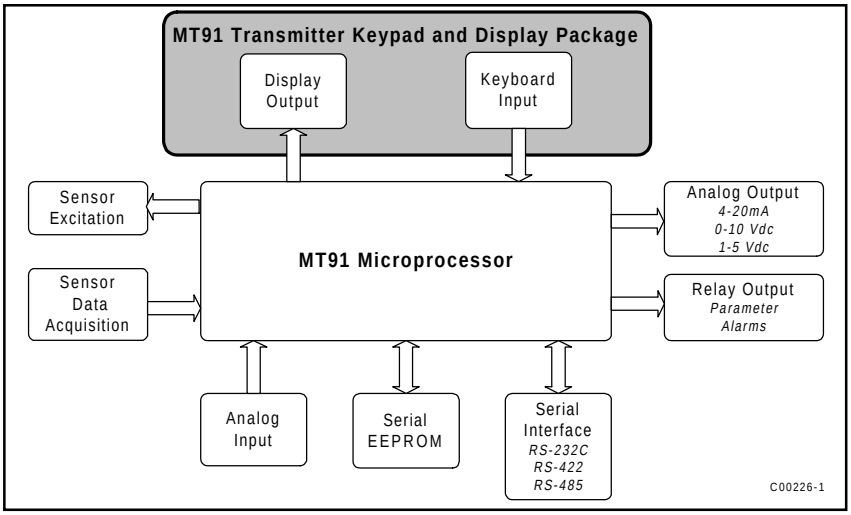


Figure 1-2. Functional Block Diagram

Theory of Operation

The flow element has multiple sensing points that consists of two pairs of thermowells of the same size, shape and mass. One pair contains a platinum RTD and a heater element. The other pair contains one RTD. The RTD located next to the heater element is called the active sensor. The other RTD is referred to as the reference sensor. Since the active sensor is adjacent to the heater, the temperature at the walls of the thermowell are always above the temperature of the process media. The temperature at the reference sensor is the temperature of the process media. When the process media is flowing past the active sensor a quantity of heat is carried off into the flow stream. The amount of heat taken from the active sensor is a function of the process media mass flow rate. A DT exists between the two pairs of thermowells and a proportional DR exists between the active and the reference sensors. The DR is measured by the flow transmitter. The relationship of DT to the mass flow rate is calculated by the flow transmitter and is converted into a signal and is sent to the flow transmitter's display.

Specifications

Process Connection

2 inch male NPT or 3 inch 150 lb. raised-face carbon steel flange. Other flange connection sizes and materials available.

Insertion Length

Variable

Material of Construction

All wetted surfaces are 316 Stainless Steel with nickel brazed joints per process specification AMS 4777. Hastelloy C-276 and other materials and electroless nickel plating also available.

Enclosure

Flow element: NEMA 4. NEMA 7 optional.

Flow transmitter Assembly: NEMA 4 or 19 inch Rackmount in accordance with DIN 41494 part 1, ANSI/ EIA-RS-310C. NEMA 7 optional.

Temperature Range for Flow Element

Low -50° to 350°F (-45° to 178°C)

High 350° to 850°F (178° to 458°C)

Temperature Range for Flow Transmitter

0° to 140°F (-18° to 60°C)*

* The LCD display will not function in temperatures below 32°F (0°C).

Operating Pressure

Up to 50 psig (3.5 barg)

Power Requirements

85 to 265 Vac, 47 to 63 Hz, 3.5 Amp fused 20 to 32 Vdc 24 Vdc nominal

Electrical Connection

1 inch female NPT

Relay Rating

2 relays per relay output board. Relays are DPDT, 0.3A at 125 Vac, 0.3A at 110 Vdc, 1.0A at 30 Vdc.

2. Installation

Receiving/Inspection

- Unpack carefully
- Verify that all items in the packing list are received and are correct.
- Inspect all instruments for damage or contaminants prior to installation.

If the above three items are satisfactory, proceed with the installation. If not, then stop and contact a customer service representative.

Packing/Shipping/Returns

These issues are addressed in Appendix C - Customer Service

Factory Calibration Note

The flowmeter is factory calibrated to the flow range specified in the order. There is no need to perform any verification or calibration steps prior to installing and placing the flowmeter in service.

Pre-Installation Procedure

Warning: Only qualified personnel should install this instrument. Install and follow safety procedures in accordance with the current National Electrical Code. Ensure that power is off during installation. Any instances where power is applied to the instrument will be noted in this manual. Where the instructions call for the use of electrical current, the operator assumes all responsibility for conformance to safety standards and practices.

Caution: The flowmeter is not designed for weld-in-place applications. Never weld to process connection or a structural support.

Damage resulting from moisture penetration of the flow transmitter or flow element enclosure is not covered by product warranty.

The flow transmitter containsESD components. Use standard ESD precautions when handling the flow transmitter. See below for ESD details.

Use Standard ESD Precautions

Use standard ESD precautions when opening an instrument enclosure or handling the flow transmitter. FCI recommends the use of the following precautions: Use a wrist band or heel strap with a 1 megohm resistor connected to ground. If the instrument is in a shop setting there should be static conductive mats on the work table and floor with a 1 megohm resistor connected to ground. Connect the instrument to ground. Apply anti static agents to hand tools to be used on the instrument. Keep high static producing items away from the instrument such as non-ESD approved plastic, tape and packing foam.

The above precautions are minimum requirements to be used. The complete use of ESD precautions can be found in the U.S. Department of Defense Handbook 263.

Verify Serial Numbers

Verify that the flow elements' serial number matches the flow transmitter serial number. A tag indicating the serial number is located on the local and remote enclosures, see Figures A-2, A-3, and A-4.

When multiple flow elements connect to one flow transmitter, each flow element serial number has a suffix that represents the flow element number. For example, if two flow elements connected to a flow transmitter have a base serial number of 123, then the first flow element would have the serial number 123-1, and the second flow element would have the serial number 123-2.

Prepare or Verify Flow Element Location

Mount the flow element at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct to achieve the greatest accuracy.

Mount the flow element where the flow stream temperature is well above the saturation temperature of any of the process gases. If a component of the process media is near its saturation temperature, it will probably condense on the sensing points. Liquid on the sensing points will drive the flow measurement higher than actual.

The flow element's shape is cylindrical with a diameter of 2 inches. The length is customer specified. The recommended diameter for the clearance hole needed to mount the flow element is 2.03 inches. See Figure A-5 for recommended process connection.

For optimum performance, prepare additional support at the end of the flow element for instruments exceeding 2 feet in length. Refer to Figure A-5, and A-6 for recommended end support configuration.

Verify Dimensions

Verify the flow element and flow transmitter dimensions as shown in Appendix A.

Verify Flow Direction for Flow Element Orientation and Placement

The flow element comes with a FLAT area machined on the flow element near the enclosure. Etched in the FLAT is a FLOW ARROW indicating the direction of flow. See Figure 2-1.

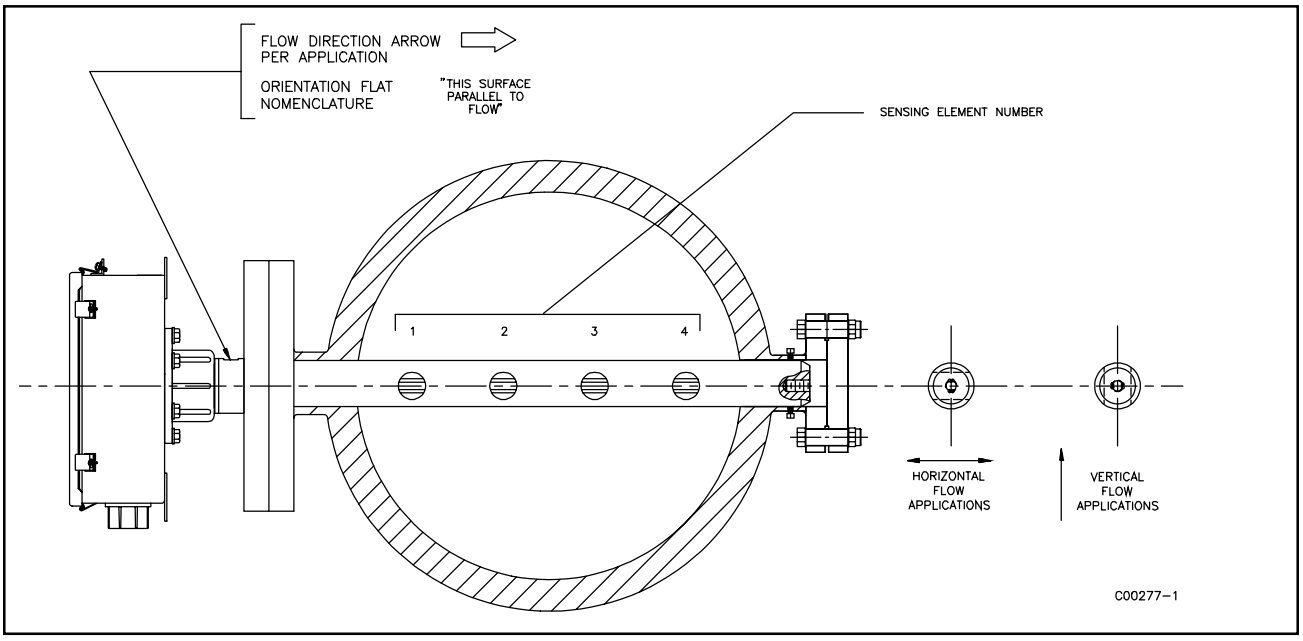


Figure 2-1. Flow Element Showing FLAT Area

Align the flow element during installation so the FLAT is parallel, to the direction of the process media flow, and the FLOW ARROW points in the direction of process media flow. Failing to install the flow element correctly will reduce the accuracy of the flowmeter.

Install Flow Element

Install the flow element as specified for the process connection type used. If applicable, connect the end of the flow element to one of the recommended mechanical supports. See Figure A-5 or A-6.

Threaded Mounting

Note: When mounting the flow element to the process duct, it is important that a lubricant/sealant is applied to the male threads of all NPT connections. Be sure to use a lubricant/sealant compatible with the process environment. Tighten all connections firmly. To avoid leaks do not overtighten or cross-thread connections.

1. Verify end hardware is loose if present. Carefully insert flow element into process mount. Align with end support if present.
2. Verify that the process media is in the same direction as the FLOW ARROW on the FLAT.
3. Threads are right-handed. Place pipe wrench on unthreaded portion of metal shaft. Rotate until snug and continue to turn until FLAT is horizontal to process flow. Apply even pressure so as not to disfigure nipple.

Caution: Do not apply any leverage to the local enclosure itself.

4. Tighten all connections firmly. Tighten all end hardware firmly if present.

Flanged Mounting

1. Verify end hardware is loose if present. Carefully insert flow element into process mount. Align with end support if present.
2. Attach the process mating flange with care. Maintain the correct orientation of the flow element to ensure accuracy.
3. Verify that the Process Media is in the same direction as the FLOW ARROW on the FLAT.
4. Apply the appropriate gasket and/or sealant to flange mount faces as required.
5. Attach with a bolt, two flat washers, lock washer and nut for each bolt hole; apply lubricant/sealant to male threads and torque. Refer to ANSI B16.5 specifications.
6. Tighten all connections firmly.

Install Flow Transmitter

Use Figures 2-2 and 2-3 throughout this section.

Caution: Pulling wires can cause damage to the electronic components. Use extreme care when pulling wires into the remote enclosure.

In applications where the flow element is located in an explosive environment, isolate the conduit before it leaves the environment. A potting Y may be used to provide the isolation.

Minimum Wire Size

Table 2-1 shows the smallest (maximum AWG number) copper wire that should be used in the electrical cables. Use a lower gauge of wire for less of a voltage drop. Contact FCI concerning greater distances than those listed in the chart.

Table 2-1. Interconnecting Cable Size (AWG)

Connection	Maximum Distance for AWG					
	10 ft. (3m)	50 ft. (15m)	100 ft. (31m)	250 ft. (76m)	500 ft. 152m)	1000 ft. (305m)
AC Power	22	22	22	20	18	16
Relay (2A)	28	22	20	16	12	10
Flow Element Wires*	24	24	24	22	22	18
*Requires a shielded cable which is connected to the Flow Transmitter						

Remote Hardware

Figures A-3 and A-4 show the remote enclosures along with physical dimensions to properly mount the flow transmitter. Select a location for the flow transmitter within 1000 feet of the flow element. This location should be easily accessible with enough room to open the enclosure cabinet door or remove a panel at any time. Secure the flow transmitter solidly to a vertical surface capable of providing support. Use nuts and bolts to secure the flow transmitter.

Power Connection Information

Note: The installation of an AC line switch between the AC power source and the flowmeter is recommended. This facilitates easy power disconnection and is an added safety feature.

The flow element power supply is not field selectable. Connect 85-265 Vac operating power and a power ground to the flow transmitter. Follow the appropriate procedure below to connect power.

NEMA 4 Remote Enclosure

Install the customer supplied conduit and/or cable through the 1 inch female NPT ports. Remove the terminal block shield located at the top right hand corner on TB1 and wire according to Figure 2-2.

Rackmount Remote Enclosure

Install the customer supplied conduit or cable though the back side of the enclosure. Remove the terminal block shield located on the left wall (looking from the rear) on TB1 and wire according to Figure 2-2.

Sensing Point Connections

There are up to 16 different sensing points per flow transmitter. Sensing point 1, on the flow element, is the point closest to the local enclosure. Sensing point 2 is the next down, etc.

In the local enclosure, sensing points are identified on the terminal board. For example, TB1-HD1 connects to sensing point 1. In the remote enclosure, sensing points are identified by the connector number. For example, J1 corresponds to sensing point 1.

1. Run eight-conductor-shielded cable from the local enclosure to the remote enclosure for each sensing point. Use Table 2-1 to determine which wire gauge to use.
2. In the local enclosure is an 8-pin connector for each sensing point, wire each cable to a connector per Figure 2-2.

Note: Before inserting the cable wires into the terminal strip connector, turn the screw counterclockwise 7 turns. If this is not done, it is possible to insert the wire between the top half of the clamp and the frame instead of between the two clamp segments.

3. Tag the cables to clarify which cable connects to which sensing point. Follow the appropriate procedure below to connect sensing points.

NEMA 4 Remote Enclosure

1. In the remote enclosure is a 10-pin connector for each sensing point. Open the enclosure door and remove connectors. Wire each cable to a connector per Figure 2-2.

Note: Do not wire to HBS and HBX.

2. Plug the connectors back into the appropriate sockets, matching sensing point number to each socket number. For example, connect sensing point #1 to socket J1. See Figure A-2.
3. After connecting all sensing points, secure door of enclosure.

Rackmount Remote Enclosure

Warning: High voltage is present on the inside of the right panel. Ensure that power is off before proceeding.

1. Remove the left panel to access connectors J1 through J6. Pull the panel away from the instrument and remove the ribbon cable from the display card connector (J18).
2. Remove the right panel to access connectors J7 though J16.
3. In the remote enclosure is a 10-pin connector for each sensing point. Remove connectors and wire each cable to a connector per Figure 2-2.

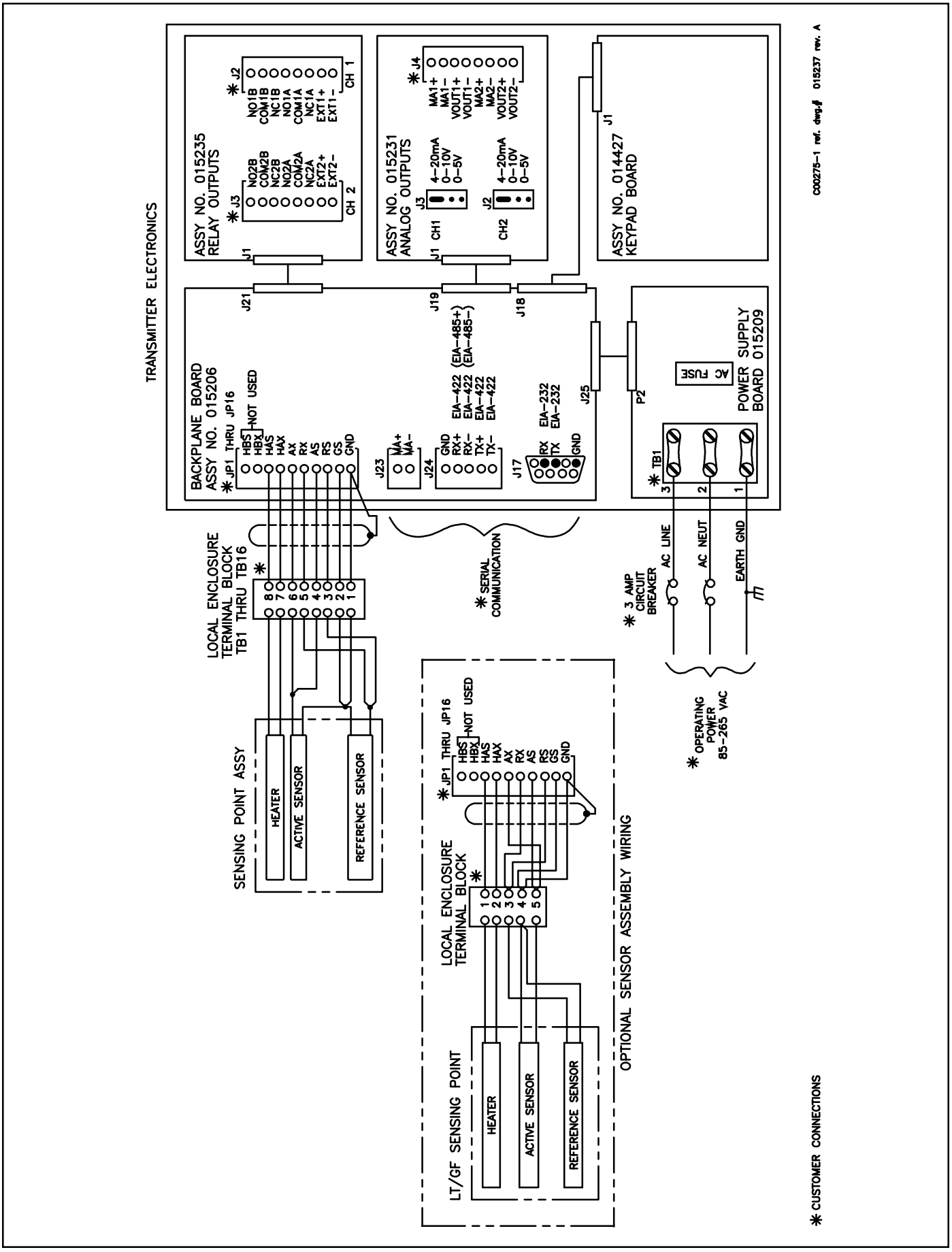


Figure 2-2. MT91 Wiring Diagram

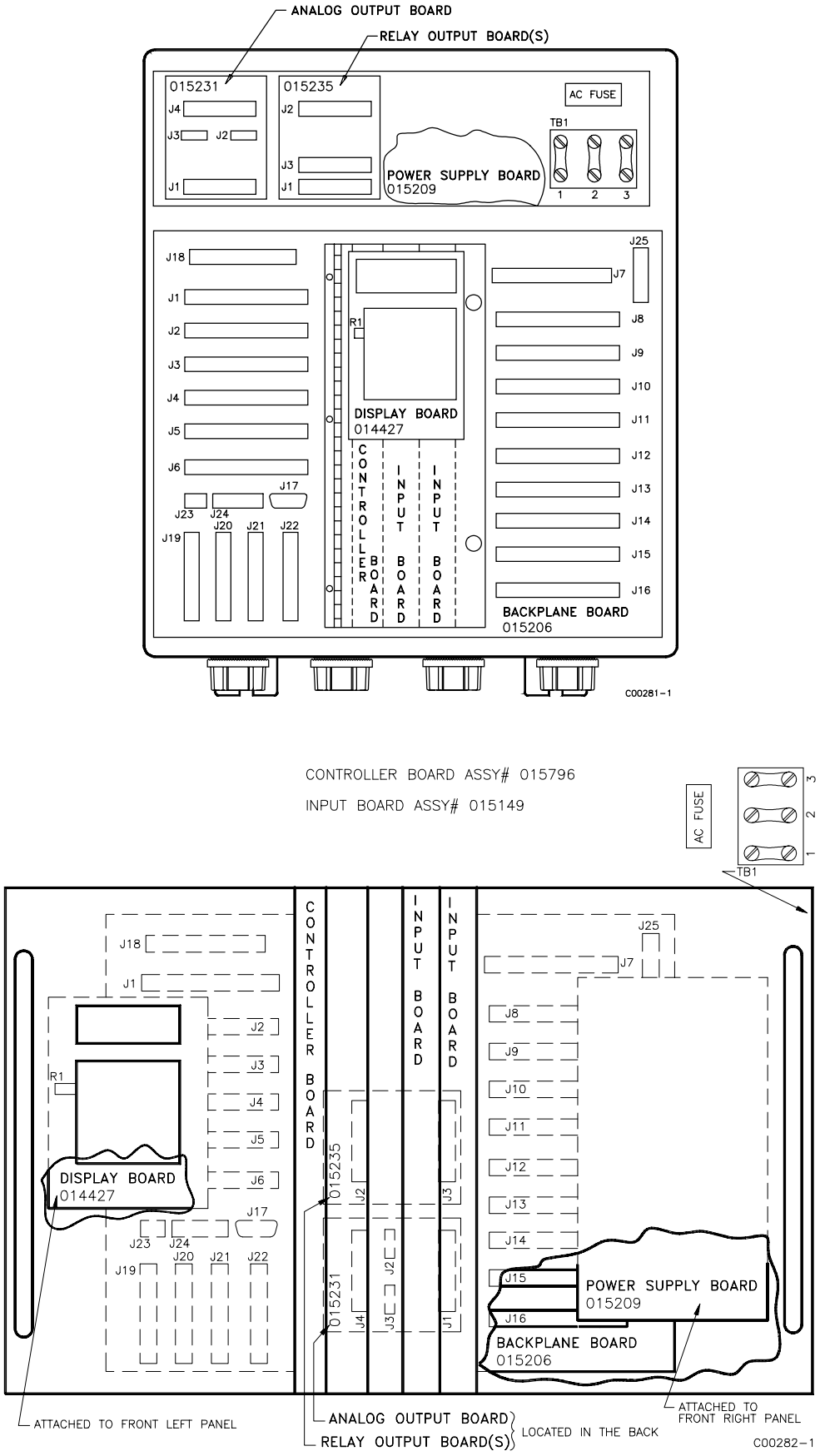


Figure 2-3. Flow Transmitter Outline for NEMA 4 and Rackmount Remote Enclosures

Note: Do not wire to HBS and HBX terminals.

3. Plug back in the connectors to the appropriate sockets, matching sensing point number to each socket number. For example, connect sensing point 1 to socket J1. See Figure 2-3.
4. After connecting all sensing points, plug the display ribbon cable back into J18 and secure panels of enclosure.

Customer Connections

Analog Output Board - Assy #015231 (see Figure 2-3 for location)

Note: If a different jumper position is selected other than the factory calibrated position, a complete re-calibration of the analog output board will be necessary. See Chapter 3 for how to calibrate the analog output board.

Jumper J2

This jumper provides three output options for channel 1. Select one and place the jumper in the corresponding position. See Figure 2-2 for jumper location.

- 4 to 20 milliamperes
- 0 to 10 volts
- 0 to 5 volts

Jumper J3

This jumper provides three output options for channel 2. Select one and place the jumper in the corresponding position. See Figure 2-2 for jumper location.

- 4 to 20 milliamperes
- 0 to 10 volts
- 0 to 5 volts

Connector J4

This connector interfaces with customer instrumentation. Refer to Table 2-2 for signal information.

Table 2-2. Connector J4 Signal Information

Signal (Power Isolated)	Description	
Vout2-	Channel 2 voltage output return.	Connected to system signal ground.
Vout2+	Channel 2 voltage output signal.	0 to 5 Vdc or 0 to 10 Vdc
MA2-	Channel 2 current output return.	Connected to system signal ground
MA2+	Channel 2 current output signal.	0 to 22 mAdc
Vout1-	Channel 1 voltage output return.	Connected to system signal ground.
Vout1+	Channel 1 voltage output signal.	0 to 5 Vdc or 0 to 10 Vdc
MA1-	Channel 1 current output return.	Connected to system signal ground.
MA1+	Channel 1 current output signal.	0 to 22 mAdc

Relay Output Board - Assy #015235 (see Figure 2-3 for location)

One relay output board supports up to 2 relays. Relays 3 and 4 are not associated with Analog Output Channels and are optional.

Connector J1

This connector interfaces with the flow transmitter backplane board.

Relays 1 and/or 2 Relay Board J1 connects to Backplane Board J21
Relays 3 and/or 4 Relay Board J1 connects to Backplane Board J22

Connector J2

This connector provides the relay outputs for relay 1 or 3, depending on which backplane connector J1 is associated. Refer to Table 2-3 for signal information.

Connector J3

This connector provides the relay outputs for relay 2 or 4, depending on which backplane connector J1 is associated. Refer to Table 2-3 for signal information.

Table 2-3. Connector J2 and J3 Signal Information

Signal (Power Isolated)	Description	
EXT1-	Relay 1 external signal drive signal.	Open collector of NPN transistor. +30 Vdc Max.
EXT1+	Fused connection to +24 Vdc	Fuse rating is 1/16 A (62.5 mA)
NC1A	Relay 1A Normally Closed terminal.	Continuity with COM1A when relay is de-energized
COM1A	Relay 1A Common terminal.	
NO1A	Relay 1A Normally Open terminal.	Continuity with COM1A when relay is energized.
NC1B	Relay 1B Normally Closed terminal.	Continuity with COM1B when relay is de-energized.
COM1B	Relay 1B Common terminal.	
NO1B	Relay 1B Normally Open terminal.	Continuity with COM1B when relay is energized.
EXT2-	Relay 2 external signal drive signal.	Open collector of NPN transistor. +30 Vdc Max.
EXT2+	Fused connection to +24 Vdc.	Fuse rating is 1/16 A (62.5 mA)
NC2A	Relay 2A Normally Closed terminal.	Continuity with COM2A when relay is de-energized
COM2A	Relay 2A Common terminal.	
NO2A	Relay 2A Normally Open terminal.	Continuity with COM2A when relay is energized.
NC2B	Relay 2B Normally Closed terminal.	Continuity with COM2B when relay is de-energized.
COM2B	Relay 2B Common terminal.	
NO2B	Relay 2B Normally Open terminal.	Continuity with COM2B when relay is energized.

Serial Communication Ports - Backplane Board Assy # 015206 (see Figure 2-3 for location)

Connector J17 - EIA-232

This connector provides serial communications for compatible equipment. Refer to Figure 2-4 for wiring configuration.

Connector J23 - 4-20 mA

This connector provides analog communication for compatible equipment. Refer to Figure 2-2 for wiring information.

Connector J24 - EIA-422/EIA-485

This connector provides serial communication for compatible equipment for a EIA-422 port or EIA-485 port. To use the EIA-422 connection, wire according to Figure 2-2 and 2-5. To use the EIA-485 connection, wire only the GND, RX+, and RX- according to Figure 2-2 and 2-5. Multiple instruments can interface with the host system with the EIA-485 connectors.

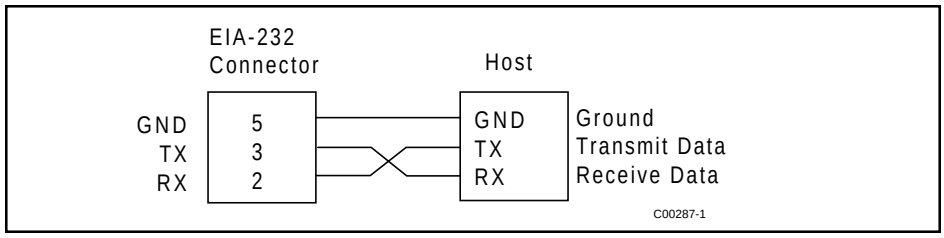


Figure 2-4. Wiring Diagram for Serial Connector EIA-232

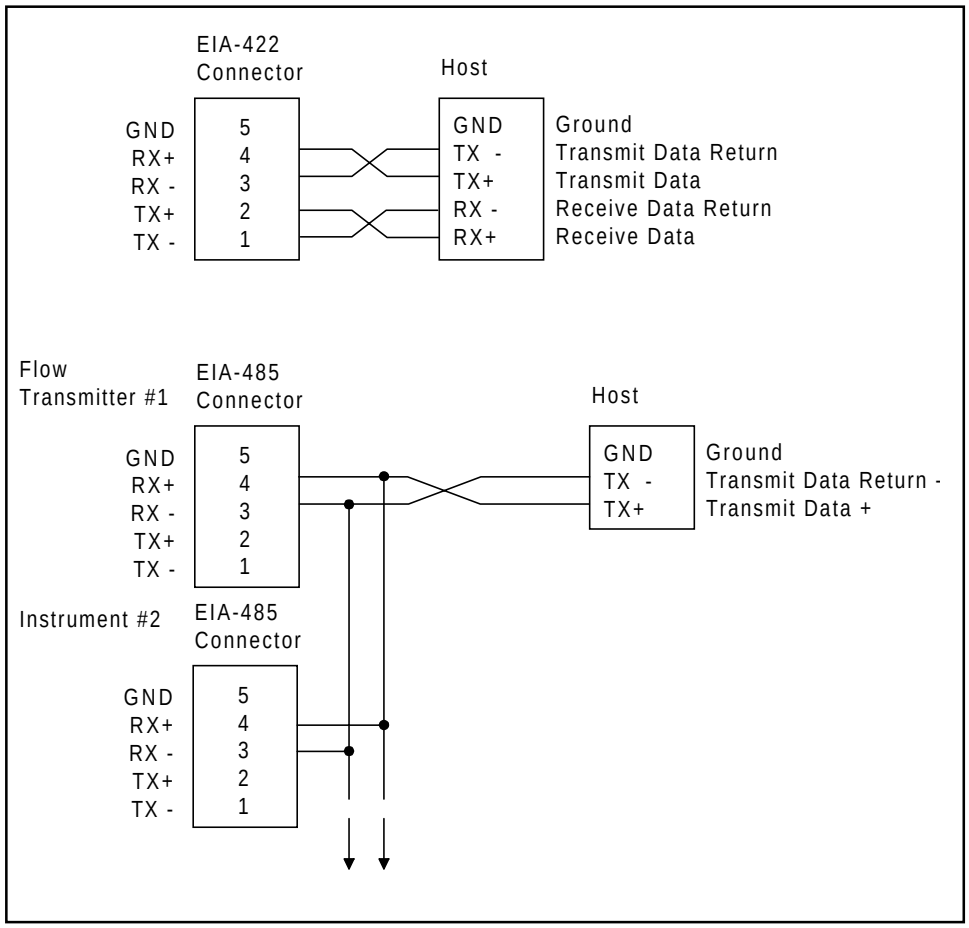


Figure 2-5. Wiring Diagram for Serial Connectors EIA-422 & EIA-485

Installation Quick-Check List

1. Verify that serial numbers match.
2. Be sure the FLAT and FLOW ARROW are properly oriented.
3. Ensure there are no leaks at the process connection.
4. Verify that the wiring is properly connected per the appropriate diagram.

Proceed to Chapter 3 - Operation to begin power-up sequence.

3. Operation

Caution: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 2, Installation for ESD details.

Introduction

The flowmeter has been configured and calibrated to customer specifications. Each flowmeter contains distinct operating limits and units of measurement. This chapter will show how to determine and manipulate the configuration of the flowmeter.

Start Up

Verify the wiring before applying power. Also verify the correct power connections have been made to the flow transmitter.

1. Apply Power.
2. Wait 5 minutes for the unit to warm-up and stabilize.
3. The flowmeter evaluates sensing points as out-of-range until they have warmed up to operating temperature. The flowmeter displays a system status message of "Check Heads" until all sensing points are functioning within their calibrated range. This status message should change to the normal display of "System OK" within the 5 minute warm-up period. The output signal displayed should be representative of the estimated or calculated current process media flow.
4. The unit automatically enters the flow metering mode and the display sets to normal operation.

The flowmeter outputs should now indicate the mass flow rate in the desired units of measure.

In the event that the display or the "System OK" message does not appear, or the values are out-of-range or obviously incorrect, then turn the power off and proceed to Chapter 5 - Troubleshooting.

Using the MT91 Software with Display

Display

The flowmeter contains a 4 x 20 character LCD display. Flow rate, temperature, and system status are all accessible through the display.

Menu Window

Four components make up the menu window. They are the menu level, title, selections, and prompt line. These components are illustrated in Figure 3-1. The top line displays a menu level and title. Lines two and three are used to scroll through available options. The prompt line indicates which menu commands are appropriate.

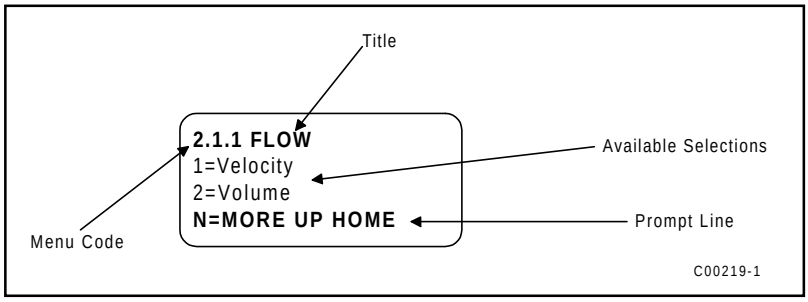


Figure 3-1. The Menu Window

The menu level is a numeric reference which identifies each window of the menu structure. The menu level in Figure 3-1 indicates that the user is three levels deep (Level 2, sublevel 1, sub-sub-level 1). This example code can be associated functionally as 2(SETUP).1(DISPLAY).1(FLOW). Occasionally, the depth of the menu makes displaying the complete menu level impractical. When this happens, the special character ">" indicates that the menu level may be deeper than the code indicates (e.g. "2.2.3.1>RLY[1] MODE").

The title gives the user a better idea of where the system is within the menu structure. Some titles are informative enough to completely describe the menu function, while other titles are ambiguous unless the parent menus are known.

Other Window Types

Another common window encountered is a non-scrolling menu. The window is similar to the menu window except that does not scroll and all choices are contained within the window. The current selection (if there is one) is also contained in the parenthesis to the left of the question mark.

Menu Control

The prompt line and available selections display key strokes for that menu level. If a key is pressed that is not valid for that menu, the screen will stay the same. The key pad layout is shown in Figure 3-2.

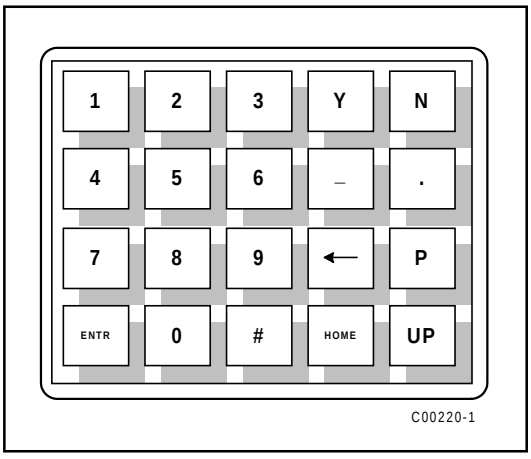


Figure 3-2. Keypad Layout

0-9	Enter numbers
Y	Yes to prompts
N	No to prompts; more display
-	minus sign
.	decimal point
←	backspace
P	no special use
ENTR	accepts current value
HOME	return to main menu
UP	backup one menu level

Table 3-1. Key Functions

See Table 3-1 for key pad assignments. At any time, press the HOME key to display the main menu. HOME can be used to escape from calibration routines, restart a progression into the menu structure, or quickly change from one area of the menu to another.

When N=MORE is displayed on the prompt line, more than two menu selections are available. Press N to scroll through all the selections.

When UP is displayed on the prompt line, the UP key can be used to back out of menus. The menu moves back one level each time the UP key is pressed.

To make a selection, press the numeric key associated with the desired menu selection. The selection does not have to be displayed, but it must be one of the available selections.

Every path through the menu will eventually cause control to pass from the menu structure to a routine that performs a task such as change a parameter value, initiate a test, or calibrate the system hardware. Some of these routines still provide selections that emulate the menu structure. When the system is operating outside the menu structure, there are subtle differences in the user interface. For example, the UP key may have no affect or the prompt line won't appear.

Menu Organization

The top level of the menu is shown in Figure 3-3. The menu structure is divided into four major groups, a display function, and the revision display.

- The first menu option places the units display into the **normal display** mode. When the system is in this mode, flow and/or temperature measurements are displayed. While in the normal display mode, pressing any key will cause the main menu to display.
- The **Setup** group presents the options for customizing the system inputs and outputs. Most of the settings will be made through menus in this group.
- The **diagnostics** group provides displays that help isolate problems and test the system integrity.
- The **calibration** group is used primarily by factory technicians, but there are displays that can be helpful to the customer.
- The **verify** group provides a means to view the values of important system parameters.
- Finally, the firmware **version** is available for display.

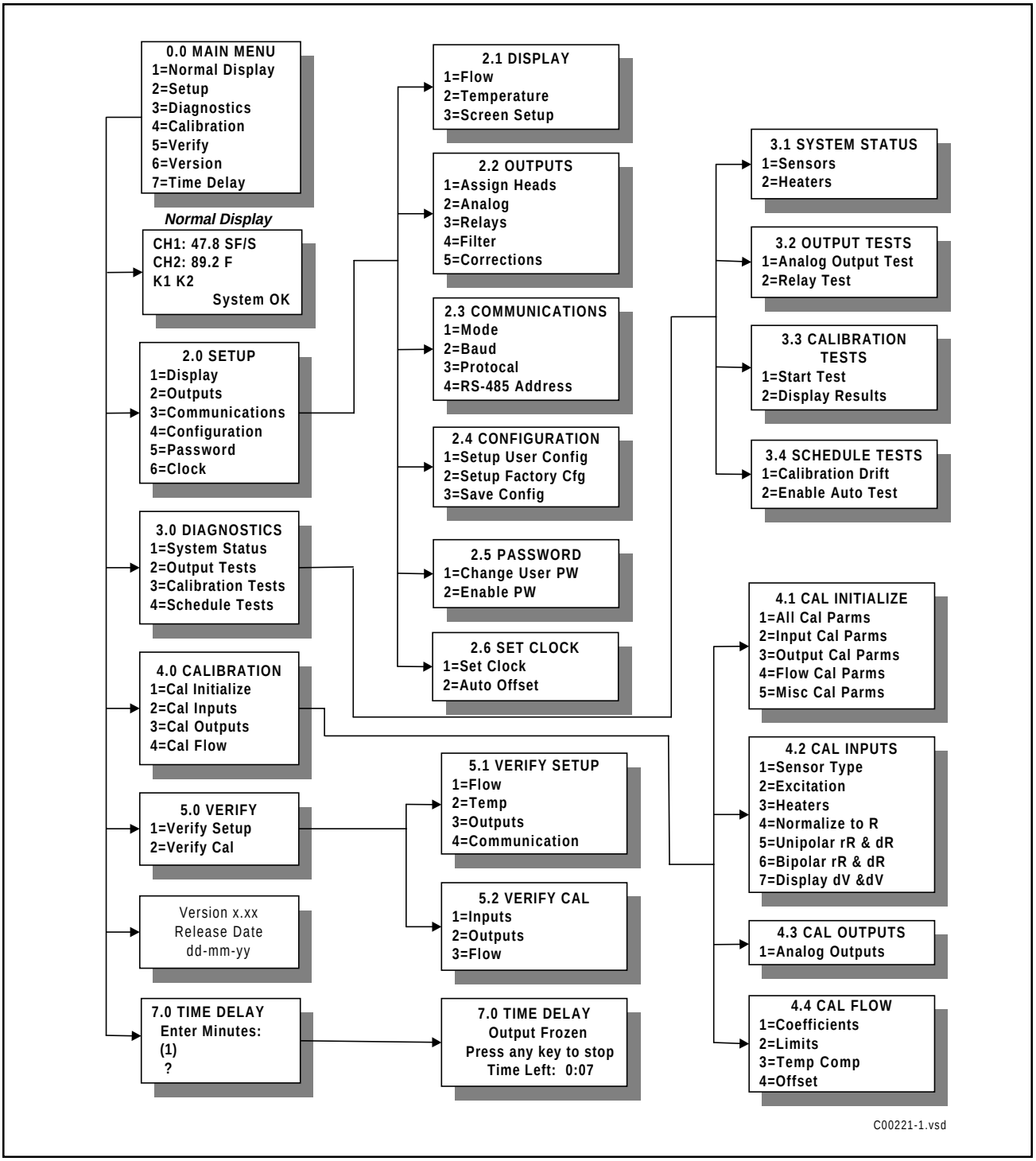


Figure 3-3 Menu Flowchart

Quick Custom Setup

In order to use the quick operation procedure, an assumption has been made that the password is enabled (this is the factory preset condition).

If mistakes in data entry are made, press the back arrow key to correct mistake.

Menu level refers to the sequence of key to press to reach a particular function from the MAIN MENU. For example, to go to menu level 2.2.1, press HOME, 2, 2, and 1.

Y/N refers to Y Save Permanently or Change Parameter or N Do Not Save Permanently or Do Not Change Parameter.

Using Main Functions

MAIN MENU	Press **HOME**. Returns user to MAIN MENU. In some cases, it may be necessary to press HOME more than once.
NORMAL DISPLAY	menu level **1**. To view the NORMAL DISPLAY
DelR and RefR	menu level **4.2.5** To view a sensing point's raw signal DelR and RefR. When prompted, enter the number of the sensing point to be viewed.
PASSWORD	menu level **2.5.1.2** Enable or Disable the PASSWORD
PASSWORD	menu level **2.5.1.1** Change the user PASSWORD. If the password protection is enabled, the user must enter the current password.

Selecting Units of Measurement

After reaching the menu level, select the combination of units that will produce the desired end result.

Velocity units	menu level **2.1.1.1**	
	Length	1=FT, 2=M and
	Time	1=Sec, 2=Min, 3=Hrs, 4=Day
Volume units	menu level **2.1.1.2**	
	Volume	1=SCF, 2=NCM, 3=NLP
	Area	1=Square Feet, 2=Square Meters
	Area Value	enter the area of the duct
	Time	1=Sec, 2=Min, 3=Hrs, 4=Day
Mass units	menu level **2.1.1.3**	
	Mass	1=LBM, 2=KG, 3=TON, 4=TONNE
	Area	1=Square Feet, 2=Square Meters
	Area Value	enter the area of the duct
	Time	1=Sec, 2=Min, 3=Hrs, 4=Day
Temperature units	menu level **2.1.2**	
		1=°F 2=°C 3=K 4=°R

Setting Up Analog Outputs

Sensing Point Outputs — menu level **2.2.1**

Channel 1=Chan 1 2=Chan 2

After selecting a channel, the menu automatically provides new selections to assign sensing points.

Sensing Points 1=Add All Heads 2=Add Head 3=Del All Heads 4=Del Head 5=View Assigned 6=Save

An "X" will mark on the display to show which sensing points are assigned to the selected channel. To keep changes, user *must* save assignments.

Output Parameters — menu level **2.2.2**

Channel 1=Chan 1 2=Chan 2

After selecting a channel, the menu automatically provides new selections to set output parameters.

*Output Signal**	1=0-5V 2=0-10V 3=4-20mA
Mode	1=Flow 2=Temp
Full Scale	enter a value
Port Zero	enter a value

*Set Jumpers to match. See Chapter 2.

Setting Up Relays

Relays 1 and 2 can be set as switch points or test/status parameters. If relays 1 or 2 are used for switch points, their mode must correspond to their respective analog output channels. (e.g. If relay 1 is set to be a *flow* switch point, then analog output channel 1 must be in the *flow* mode.) If relays 1 or 2 are set to flow or temperature modes, the user MUST set switch point and hysteresis parameters. If this is not done, a chattering noise will be heard. Relay 3 and 4 can only be set as test/status parameters.

Relay Mode — menu level **2.2.3.1**

Relay 1=Rly #1 2=Rly #2 3=Rly #3 4=Rly #4

After selecting a relay, the menu automatically provides new parameters to set the mode.

1=View Mode 2=Flow 3=Temperature
4=System Status 5=Zero Test 6= Span Test.

Switch Points — menu level **2.2.3.2**

Relay 1=Rly #1 2=Rly #2 3=Rly #3 4=Rly #4

After selecting a relay, the menu automatically provides new parameters to set the switch point.

1=View Sw. Pt. 2=Above 3=Below
4=Inside 5=Outside

Hysteresis — menu level **2.2.3.3**

Relay 1=Rly #1 2=Rly #2 3=Rly #3 4=Rly #4

In-Depth Custom Setup Procedure

When a flowmeter leaves the factory, it is configured to the application information know at the time of order. At installation time; however, changes to the factory settings may be necessary. There are several parameters that can be modified to customize the system. This section describes how to customize the flowmeter.

Menu level refers to the sequence of key to press to reach a particular function from the MAIN MENU. For example, to go to menu level 2.2.1, press HOME, 2, 2, and 1.

Each time a system parameter is changed, the display will prompt the user to save the change. For the change to endure through power off periods or a system reset, press Y. For a temporary change, press N. When changes are not saved, the user can restore the previous settings by cycling the input power or pressing any key for more than 10 seconds to reset the system.

In most cases, the existing value of the parameter that is changing will be displayed. If no change is required, press ENTR, select it again, or press HOME.

Since the flowmeter has multiple inputs and outputs, some parameters are stored in groups. For example, the analog output parameters apply to both channels one and two. The menu level to change the analog output parameters will prompt the user to select a channel. After making changes to that channel, back out of and re-enter the menu level to make changes to the other channels. Use either the UP key or the HOME key to back out of the menu level.

Password Protection

Before customizing the flowmeter configuration, the customer must have access to the system parameters. Two levels of password protection affect access to these parameters.

Factory Level

The highest level of protection requires a factory password for access. This password prevents inadvertent changes to variables associated with the system calibration, sensing point type, and other parameters that require factory resources to properly set.

User Level

The second level of protection requires a user password for access. This password provides the customer with the ability to limit access to parameters that affect the way the system operates.

Both levels of password protection can be enabled or disabled. When the system leaves the factory, the factory level protection will be enabled and the user level will be left disabled. No password is required to enable a level of protection, but the appropriate password is required to disable protection.

Note: The user password is set to “123” when the system is shipped.

- **To edit the user password**

1. Go to menu level 2.5.1 (SetupÞ PasswordÞ Change User PW).
2. If current user password if it is enabled, enter the current password, then press ENTR.
3. Enter desired password, then press ENTR.

- **To enable and disable user password protection**

1. Go to menu level 2.5.2 (SetupÞ PasswordÞ Enable PW).
2. If user password is already enabled, enter password. Select 2=Disable to disable password.
3. If user password is not enabled, select 1=Enable to enable the password.

Selecting Units of Measure

Internally, the unit will always work in units of standard feet per second (SF/S) and degrees Fahrenheit (°F). The user can choose from several types of units for display and output scaling. Table 3-2 shows the units of measure and their abbreviations for temperature and flow.

Table 3-2. Units of Measure and Abbreviations

Temperature	Length*	Volume*	Mass	Time
Fahrenheit (°F)	feet (SF)	cubic feet (SCF)	pounds mass (LB)	seconds (S)
Celsius (°C)	meters (NM)	cubic meters (NCM)	kilograms (KG)	minutes (M)
Kelvin (K)		liters (NLP)	English ton (TON)	hours (H)
Rankine (°R)			metric tonnes (TONNE)	days (D)

*Length and Volume units are based on FCI standard conditions (70°F and 14.7 PSIA); therefore, the units are preceded with an S.

A sequence of selections is required to set a new unit of measure for flow. At each step through this process, the existing unit will be displayed, even if it's undefined, and the user will be prompted to change it. Only Y or N will be acceptable responses to the prompts. To properly set new units, complete the menu entries until the new flow unit is displayed. If the change is only temporary, don't save any settings during the process.

Note: If only some of the settings in this process are saved, the units of measure may be incorrect after a system reset or power up.

The output may not conform to the units displayed if after partially completing the selection of new units, HOME or the hardware reset are used to exit the process.

➢ **To set a new unit of measure for flow rate:**

1. Go to menu level 2.1.1 (SetupÞ DisplayÞ Flow). Select from the following three options: 1 Velocity, 2=Volume, or 3=Mass and then follow the corresponding procedure below.

◆ *To set velocity units:*

2. Select 1=Velocity.
3. The program will prompt the user to change the units of length first. Select from the following units: 1=Feet or 2=Meters.
4. The program will prompt the user to change the units of time next. Select from the following units: 1=Seconds, 2=Minutes, 3=Hours, 4=Day. The units of velocity will display, press any key to exit to menu level 2.1.1.

◆ *To set volume units:*

2. Select 2=Volume.
3. The program will prompt the user to change the units of volume first. Select from the following units: 1=SCF - standard cubic feet, 2=NCM - normal cubic meters, or 3=NLP - normal liter per.
4. The program will prompt the user to change the units of area. Select from the following units: 1=Square Feet or 2=Square Meters.
5. The user will be prompted to change the value of the area. Enter a numeric value for the area.
6. The user will be prompted to change the units of time. Select from the following units: 1=Seconds, 2=Minutes, 3=Hours, or 4=Day. The selected units of volume will display, press any key to exit to menu level 2.1.1.

- *To set mass units:*

2. Select 3=Mass.
3. The user will be prompted to change the units of mass first. Select from the following units: 1=LBM - pounds mass, 2=KG - kilograms, 3=TON - English ton, or 4=TONNE - metric ton.
4. The user will be prompted to change the units of area. Select from the following units: 1=Square Feet or 2=Square Meters.
5. The user will be prompted to change the value of area. Enter numeric value for area.
6. The user will be prompted to change the units of time. Select from the following units: 1=Seconds, 2=Minutes, 3=Hours, 4=Day. The units of mass will display, press any key to exit to menu level 2.1.1.

➢ **To set a new unit of measure for temperature:**

1. Go to menu level 2.1.2 (Setup Þ Display Þ Temperature).
2. Select from the following units: 1=°F - degrees Fahrenheit, 2=°C - degrees centigrade, 3=K - Kelvin, or 4=°R - degrees Rankine.

Selecting the Normal Display Screen

There are two formats for displaying flow information. These formats are referred to as screen 1, and screen 2. Figure 3-4 shows an example of both screens.

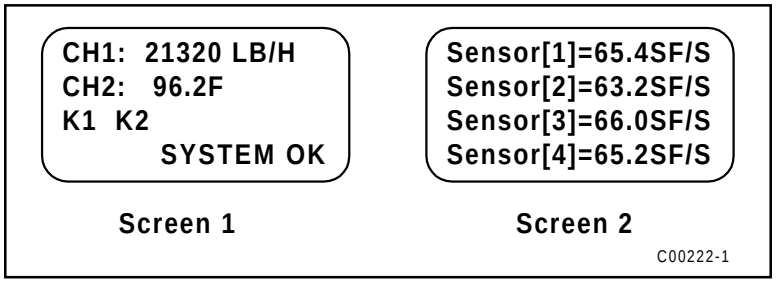


Figure 3-4. Normal Display Screen 1 and Screen 2

Screen 1 provides numeric output for the two analog channels.

Screen 2 provides for the display of velocity at four points simultaneously. Many systems use only four points. This display is useful when comparing the instrument with a Pitot traverse, or observing the flow profile.

➢ **To select screen 1 or 2:**

1. Go to menu level 2.1.3 (Setup Þ Display Þ Screen Setup).
2. Select from the following options: 1=Screen 1 or 2=Screen 2.

Assigning Sensing Points to Outputs

The first step to processing a sensing point input is to assign the sensing point to an output channel. There are two channels in the flowmeter. Assign any combination of one to sixteen sensing points signals to either or both channels.

➢ **To assign sensing points to outputs:**

1. Go to menu level 2.2.1 (Setup Þ Outputs Þ Assign Heads).
2. Select output channel, 1=Chan 1 or 2=Chan 2.
3. Select from the following options:
   1=Add All Heads - this will assign all sensing points to the selected output channel;
   2=Add Head - this will assign one sensing point at a time, the user can enter up to 16 different sensing points;
   3=Del All Heads - this is used to clear all assigned sensing points from the selected channel;
   4=Del Head - this is used to delete one sensing point at a time; or
   5=View Assigned - the user can view the current sensing points assigned to the selected channel for 2 seconds.

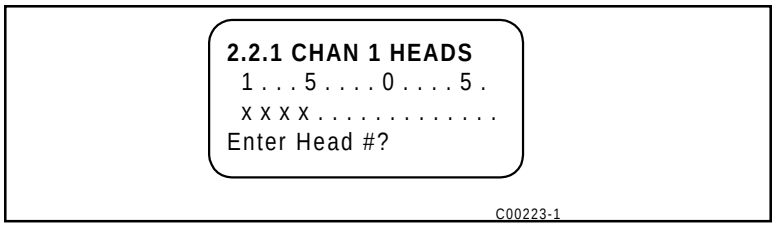


Figure 3-5 Assign Heads Displays

4. Figure 3-5 shows the display when adding or deleting heads. The 'x' signifies a selected head. To add or delete a head, enter the number of the head, then press ENTR. When finished, press ENTR again without an entry.
5. Select 6=Save to ensure survival of the changes through resets and power cycles.

Setting Analog Outputs

The analog output channels are defined by four parameters: zero, minimum flow, maximum flow, and full scale. Figure 3-6 shows how these parameters affect the output.

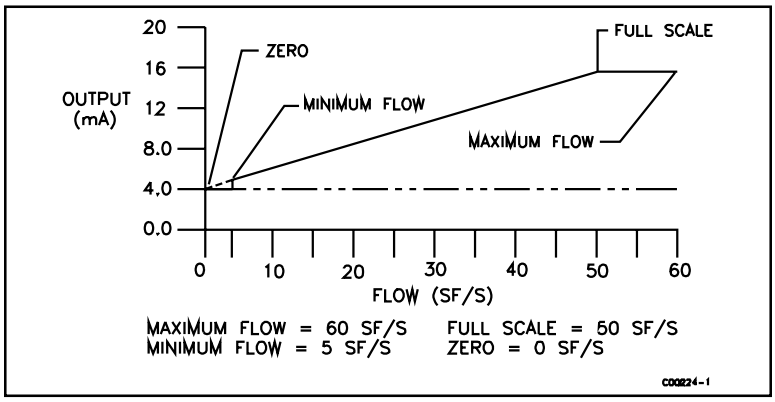


Figure 3-6. Analog Output

Full scale represents the flow or temperature value that corresponds with the maximum output signal.

Zero represents the flow or temperature value that corresponds with the minimum signal output. Minimum signal output can be set to indicate a flow of zero. This is often referred to as a zero-based signal output. A minimum signal that represents a value greater than zero is referred to as non-zero based.

Minimum and maximum flow are factory set parameters that do not appear as options in this menu level. Until the minimum flow value is reached, the output will remain at the zero level. Once the minimum flow threshold is met or exceeded, the output signal will jump to the value determined by the zero and full scale settings.

Output signal is physically selected with a jumper setting as described in Chapter 2. 0-5 Vdc, 0-10 Vdc and 4-20 mA are the available options.

Mode defines the channel as a flow or temperature output.

➢ **To set analog outputs:**

1. Go to menu level 2.2.2 (SetupÞ DisplayÞ Analog). Select 1=Chan 1 or 2=Chan 2.
2. Select 1=Output Signal. Then select from the following options: 1=0-5V, 2=0-10V, or 3=4-20mA.
3. Select 2=Mode. Then select from the following options: 1=Flow or 2=Temp.
4. Select 3=Full Scale. Enter a numeric value, then press ENTR to accept it.
5. Select 4=Port Zero. Enter a numeric value, then press ENTR to accept it.

Note: If a different output signal is selected other than the factory calibrated output, a re-calibration of the analog output board will be necessary. See following procedure. Ensure that the corresponding jumper is placed in the correct position. See Chapter 2 for jumper positions.

➢ **To calibrate the analog output boards:**

The analog output board calibration parameters are saved on the controller board. Therefore, analog output boards are not interchangeable.

Tools needed:

DVM (4 1/2 digit minimum)
Calibrated 250W resistor

1. Turn off the power to the flowmeter.
2. Set both jumpers on the analog output board to the output type selected above.
3. Connect a DVM to the appropriate connection of the analog output board. Use a precision 250ohm resistor if the output is 4 to 20mA.
4. Apply power to the flowmeter.
5. Go to menu level 2.2.2 (SetupÞ OutputsÞ Analog). Select the Channel 1. Press 1 to select output signal.
6. Select appropriate signal type. Save selection if signal type was changed.
7. Go to menu level 4.3.1 (CalibrationÞ CalOutputsÞ Analog Outputs). Select Channel 1.
8. Press keys as indicated to reach 4mA for 4-20mA output signal or press ENTR (0) for 0-5Vdc output signal and 0-10Vdc output signal.

Note: The DVM may read 20-30mV for 0-10Vdc output signal or 10-15mV for 0-5Vdc output signal.

9. Press keys as indicated to reach 20mA for 4-20mA output signal or press keys as indicated to reach 5.000Vdc for 0-5Vdc output signal or press keys as indicated to reach 10.00Vdc for 0-10Vdc output signal.
10. Repeat steps 5 through 9 for Channel 2.

Setting Discrete Outputs

Four sets of relay contacts provide the user with discrete outputs. The relays can be assigned to the parameters marked in Table 3-3.

Table 3-3. Relay Assignment by Parameters

Relay #	Flow	Temperature	Calibration Test	Zero Test	Span Test	System Status
1	♦	♦	•	•	•	•
2	♦	♦	•	•	•	•
3			•	•	•	•
4			•	•	•	•

♦ **Dependent on analog outputs**

➢ **To set discrete outputs**

1. Go to menu level 2.2.3.1 (SetupÞ OutputsÞ RelaysÞ Mode)
2. Select the relay to be set: 1=Rly #1, 2=Rly #2, 3=Rly #3, or 4=Rly #4.

Note: Only relays 1 and 2 can be set as switch points.

3. Select from the following options:
   1=View Mode - this can be used to verify current setup;
   2=Flow - select this if a switch point is going to be set;
   3=Temperature - select this if a switch point is going to be set;
   4=System Status - this relay is used to notify the customer when the "System OK" is no longer displayed;
   5=Zero Test - this is used with the Calibration Testing discussed in the next section. During the zero test phase (4mA), the Zero Test relay is closed.
   6=Span Test - this is used with the Calibration Testing discussed in the next section. During the full scale test phase (20mA), the Span Test relay is closed.
   During the mid range test phase (12mA), both the Zero and Span Test Relays are closed.

If assigned, the test/status relays are ready to be connected to customer equipment.

When assigned to flow or temperature, relays 1 and 2 are affiliated directly with analog output channels 1 and 2, respectively. For this reason, relay 1 can only be assigned as a flow or temperature switch point when analog output channel 1 is assigned as a flow output for flow switch or temperature output for temperature switch. The same applies to relay 2.

Switch points are not appropriate for the test/status parameters since they are already discrete signals. Relays 1 and 2 can be assigned as switch points or as test/status parameters. As switch points, when the signal level crosses into a specified range, the relay will activate. Hysteresis can be set to prevent the relay from chattering at the switch point threshold.

The user can choose from four sets of switch point ranges. These are referred to as above, below, inside, and outside. With hysteresis, the relay will deactivate at a different threshold than at which it activates. Figure 3-7 illustrates the four switch point ranges with arbitrary hysteresis assigned.

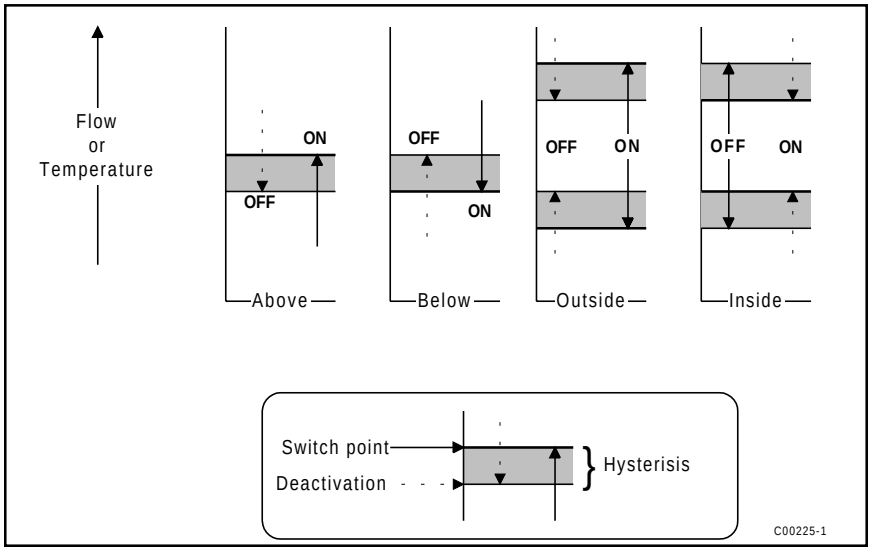


Figure 3-7. Relay Switch Points Schemes

➢ **To set the switch points and hysteresis:**

1. Go to menu level 2.2.3.2 (Setup Þ Outputs Þ Relays Þ Switch Points). Relays 1 or 2 must be in a flow or temperature mode. See above section.

2. Select 1=Rly #1 or 2=Rly #2. To view the current switch point settings select 1=View Sw. Pt. To set the switch point follow one of the procedures below.

   a. Select 2=**Above** to activate the relay above a switch point value. Enter a numeric value for the upper limit of the switch point. Press ENTR to accept the value.

   b. Select 3=**Below** to activate the relay below a switch point value. Enter a numeric value for the lower limit of the switch point. Press ENTR to accept the value.

   c. Select 4=**Inside** to activate the relay if flow or temperature values approach the switch point from the outside going inside. Enter a numeric value for the upper limit of the switch point range. Press ENTR to accept the value. Enter a numeric value for the lower limit of the switch point range. Press ENTR to accept the value.

d. Select 5=**Outside** to activate the relay if flow or temperature values go outside the switch point range. Enter a numeric value for the lower limit of the switch point range. Press ENTR to accept the value. Enter a numeric value for the upper limit of the switch point range. Press ENTR to accept the value.

4. Select 3=Hysteresis from menu level 2.2.3 Relays.

5. Select 1=Rly #1 or 2=Rly #2. Enter a numeric value for the desired deactivation of the switch point. The display will read "Recovers xxx", this is the deactivation point. Press ENTR to accept the value.

Note: The factory recommends that the password be enabled after making changes to the system parameters if it has been disabled.

Daily Calibration Testing

The calibration error test interrupts the normal flow metering process to test for shifts or changes in parameters that affect the calibrated accuracy of the flowmeter. This test can be manually initiated by using the keypad to make a selection from the system menu, or it can be scheduled to automatically occur periodically with a 24-hour interval.

Both channels of the analog output card are driven to set values during the test. Figure 3-8 shows the screens that will display during the calibration test sequence.

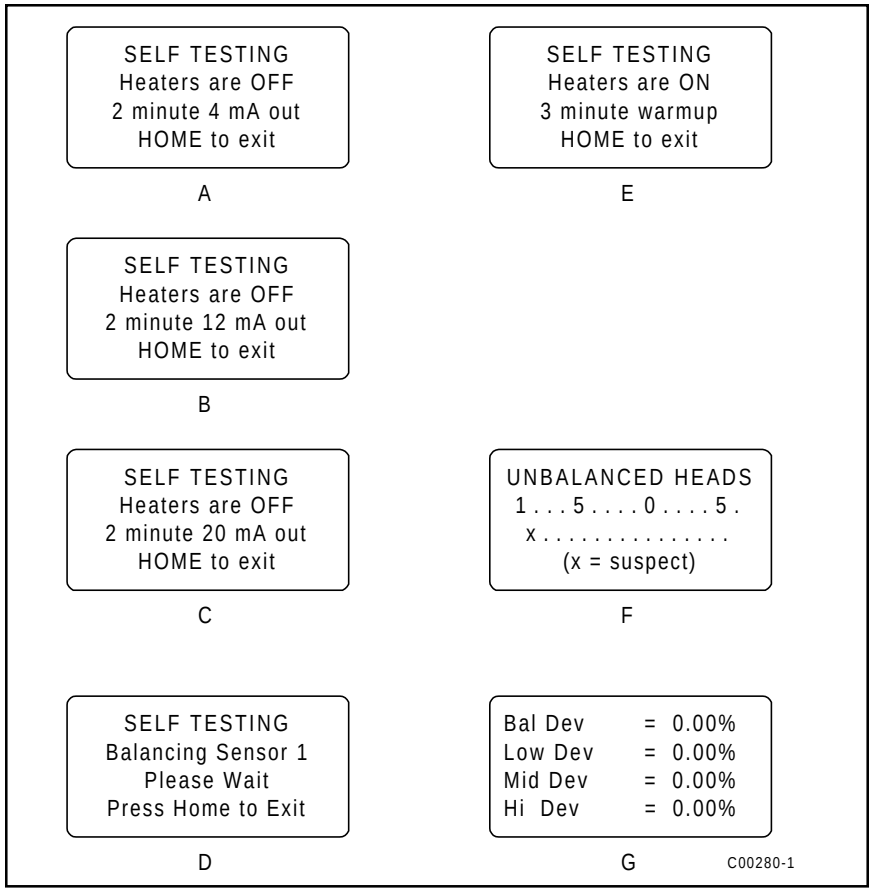


Figure 3-8. Calibration Test Display Screens

While screen A is displayed, the analog outputs are at a 4 mA or 0 Vdc level. While screen B is displayed, the analog outputs are at a 12 mA, 2.5 Vdc or 5 Vdc. While screen C is displayed, the analog outputs are at 20 mA, 5 Vdc, or 10 Vdc. Each of these screens and corresponding outputs are sustained for two minutes. Screen D will display for each sensing point that is assigned to the flowmeter. From this point until the conclusion of the test, the analog output will be fixed at 4 mA. When screen E displays, the system has completed the calibration test and the heaters have been turned back on.

➢ **To manually initiate the Calibration Test**

1. Go to menu level 3.3.1 (DiagnosticsÞ Calibration TestsÞ Start Test). The sequence of screens A through E will display.
2. To view the results of the test, select 2=Display Results, from the menu level 3.3. If the system is unable to balance out one of the sensing points, the suspect head will be noted with an x as shown in screen F. If no balance problems occurred, screen F will not display. Finally, screen G displays the deviation of the stimulated signals from the expected results.

➢ **To set up the automatic Daily Calibration Test**

◆ *Set the time of day.*

1. Go to menu level 2.6 (SetupÞ Clock). Enter the hour and press ENTR.
2. Enter the minutes and press ENTR.
3. Press any key to exit.

◆ *Set the time of the test.*

1. Go to menu level 3.4 (DiagnosticsÞ Schedule Tests).
2. Select 1=Calibration Drift.
3. Enter the hour and press ENTR.
4. Enter the minutes and press ENTR.
5. Enter the seconds and press ENTR.

◆ *Enable the automatic test.*

1. Go to menu level 3.4 (DiagnositcsÞ Schedule Tests).
2. Select 2=Enable Auto Test.
3. Select 1=Enable or 2=Disable.

With the daily automatic test enabled, the calibration drift test will run the same time each day. The normal outputs will be driven to test values and the calculated results will be available for display.

Advanced Features

The remainder of this chapter contains topics that may not be applicable to every user of the flowmeter. In most case the flowmeter will be ready for use straight out of the box. However, there may be instances where the advanced features of the flowmeter may be needed. This section discusses how to correct for bias errors due to non-ideal installations and how to communicate with the flowmeter through the serial port.

Flow Rate Correction Equation

The flow rate correction equation or corrector is used to bias the flow rate output. The correction equation contained in the flowmeter allows the user to correct for bias errors due to non-ideal installation effects. The correction equation is applied to the measured flow rate and then this corrected flow rate is used to drive the analog outputs and manipulate the relays. The flow rate shown on the display is also the corrected value. The correction equation for the flowmeter is shown below.

$$m_{new} = C_1 + (C_2 \times m_0) + (C_3 \times m_0^2) + (C_4 \times m_0^3)$$

where m_0 = Measured Flow Rate
C_i = Correction Equation Coefficients (i = 1 through 4)
Default configuration is C_1= 0, C_2= 1, C_3= 0, and C_4= 0.
m_{new} = Corrected Flow Rate

Application of the correction equation will be illustrated in the following example. Through analysis of the process flow stream it is determined that the flow rate must be multiplied by 1.056 to output the desired value. The correction equation takes the following form.

Example:

$$m_{new} = 0 + (1.056 \times m_0) + (0 \times m_0^2) + (0 \times m_0^3) = 1.056 \times m_0$$

where $C_1 = 0$
$C_2 = 1.056$
$C_3 = 0$
$C_4 = 0$

A more complicated situation would be where the multiplication factor varies with the flow rate. Figure 3-9 shows the variation of desired flow rate versus the measured flow rate.

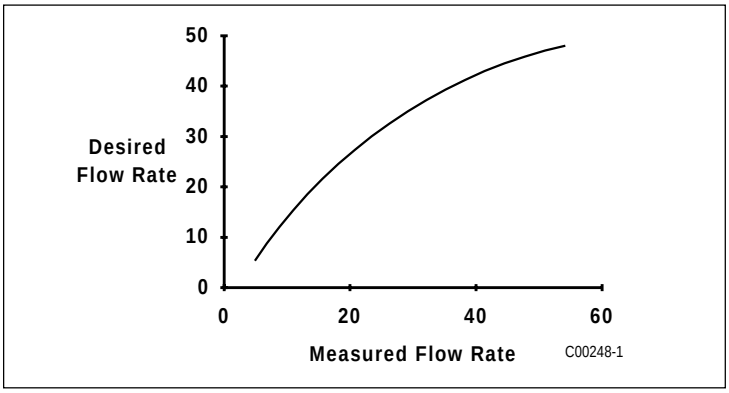


Figure 3-9. Desired Flow Rate Versus Measured Flow Rate

The relationship between the measured and the desired flow rates was determined through a least squares analysis. The coefficients for the above relation are:

$C_1 = -7.5672$ $C_2 = 2.09253$
$C_3 = -0.037082$ $C_4 = 0.0003505$

➢ **To enter the correction equation coefficients and enable it:**

1. Go to menu level 2.2.5 (Setup Outputs Corrections).
2. Press 2=Enter Correction. Enter the user password (if it enabled).
3. Enter all the desired coefficients. When complete, press 6=Verify and Save. Scroll through the displayed coefficients then save them if they are correct.
4. Press ENTR and then 1=Enable. Select 1=Enable or 2=Disable.

Offset Adjustment of Sensing Points

Using the offset adjustment allows the customer to shift the calculated flow rate up or down to agree with another reference instrument. FCI uses a balanced order polynomial equation to map the sensing point information to a curve. The general form of this equation is shown below.

$$Flow = C1(\Delta R^{-2}) + C2(\Delta R^{-1}) + C3 + C4(\Delta R) + C5(\Delta R^2)$$

Figure 3-10 illustrates the effect of adding an offset of plus 1 ohm and adding an offset of minus 1 ohm to the raw signal.

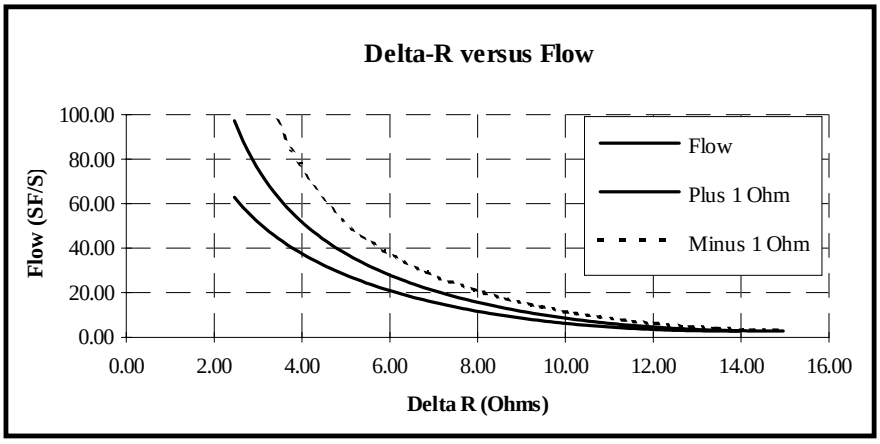


Figure 3-10. Delta-R Versus Flow Rate

➢ **To enter an offset value:**

1. Go to menu level 4.4.4 (CalibrationÞ Cal FlowÞ Offset).
2. Select 1=Offset Values. Enter sensing point number and value of desired offset. Units are always in ohms.
3. Select 2=Enable Offset.

Applying the Filter

For applications with noisy flow profiles, the filter can be used to reduce jumps or oscillations in the output signal. The flowmeter takes samples of the flow rate periodically at each active sensing point. If the current value jumps up when the next sample is taken, applying the filter can help smooth this jump out. The rate at which a sample is taken depends on the number of active sensing points. The more sensing points that are active, the longer the intervals between samples.

The filter strength acts stronger with increasing interval time. A filter strength of 2 for a 4-point system takes twice as long to apply than a filter strength of 2 for a 2-point system. See Figure 3-11.

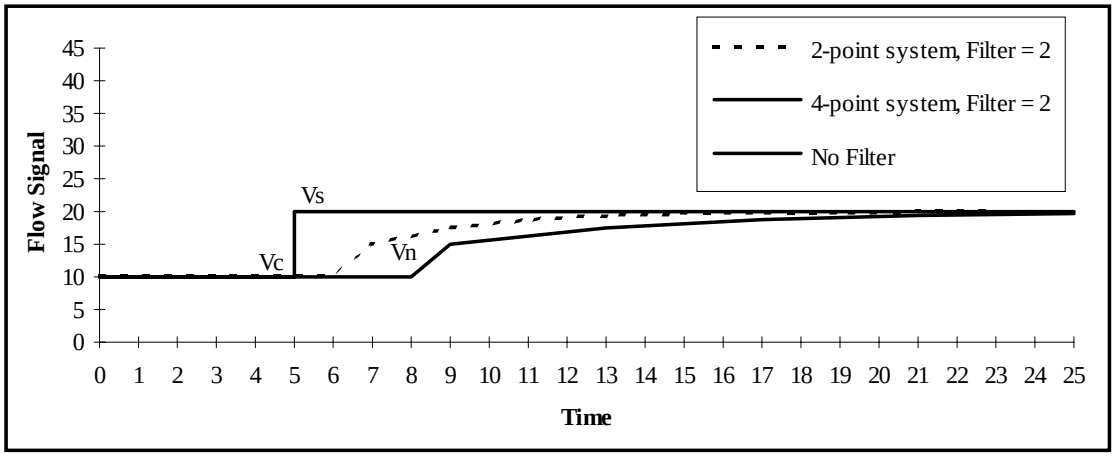


Figure 3-11. Effects of Filter on Flow Signal Versus Time

The filter uses the following equation to adjust the output signal.

$$V_n = V_c + \frac{(V_s - V_c)}{f}$$

V_n = New or desired value
V_c = Current Value
V_s = Sample Value
f = Filter Strength

➢ **To change the filter strength:**

1. Go to menu level 2.2.4 (Setupþ Outputsþ Filter).
2. Enter desired filter strength.

Serial Communications

The flowmeter has one serial port that can be configured to use one of three EIA standard interfaces: EIA-232C, EIA-422, or EIA-485. The data transfer rate can be set to either 4800, 9600, or 19200 baud. The number of bits in a character is set to eight, and no parity bit is used.

➢ **To use serial communications:**

1. Go to menu level 2.3.3 (Setupþ Communicationsþ Protocol).
2. Select 1=Pro1 or 3=Pro 3. Protocol 1 is a command and response protocol. Protocol 2 is not defined. Protocol 3 is a limited command and response protocol used to extract flow and raw signal data for up to 4 sensing points.
3. Set the data transfer rate, character bits, and parity bit on the host system.
4. To use protocol 1, refer to Table 3-4 for a list of commands and responses. These commands must be entered in capitalized letters to be recognized by the system.
5. To use protocol 3, use the single character 'F' (flow) followed by a carriage return to display 4 sets of flow values. Use the single character 'R' (resistance) to display 4 sets of sensing point resistance values.

Time Delay

The time delay function freezes the outputs for an operator specified time period.

➢ **To use time delay:**

1. Go to menu level 7.0 (Time Delay).
2. Enter the amount of time in minutes desired for the delay length.
3. The instrument will count down the time, while freezing the output. Any key can be pushed to exit the time delay. When the time has expired the instrument will continue with normal operation.

Table 3-4. Commands and Responses for Protocol 1

Command	System Response	Description
SFPnn	X.XXXXXXXXX	Linear flow in SF/S for sensor nn
SFOPn	X.XXXXXXXXX	Average flow of output n (see SFUNI)
STPnn	X.XXXXXXXXX	Standard Temperature (F) of sensor nn
STOPn	X.XXXXXXXXX	Average temp of output n (see STUNI)
SSHnn	X	Status of sensor nn. 1 - ok, 0 - not ok
SCBnn	X.XXXXXXXXX	Bias offsets for sensor nn (Ohms)
SC1nn	X.XXXXXXXXX	Linearization coefficient 1 for sensor nn
SC2nn	X.XXXXXXXXX	Linearization coefficient 2 for sensor nn
SC3nn	X.XXXXXXXXX	Linearization coefficient 3 for sensor nn
SC4nn	X.XXXXXXXXX	Linearization coefficient 4 for sensor nn
SC5nn	X.XXXXXXXXX	Linearization coefficient 5 for sensor nn
SI1nn	X.XXXXXXXXX	Reference Gain cal. factor for sensor nn
SI2nn	X.XXXXXXXXX	Reference Offset cal. factor for sensor nn
SI3nn	X.XXXXXXXXX	Active Gain cal. factor for sensor nn
SI4nn	X.XXXXXXXXX	Active Offset cal. factor for sensor nn
SMNnn	X??	Minimum delta-r for sensor nn
SMXnn	X??	Maximum delta-r for sensor nn
SCTnn	X.XXXXXXXXX	Temperature compensation adjustment
SCFnn	X.XXXXXXXXX	Correction factor to flow output
SAREA	X.XXXXXXXXX	Area of duct
SAUNI	TTTTT????	Units of measure for area
SFUNI	TTTT??	Units of measure for flow
SFFAC	X.XXXXXXXXX	Conversion factor SF/S to ????
SPMPn	TTTT	Mode of output n. FLOW or TEMP
SPOPn	TTTT??	Analog output type for output n
SPSPn	X.XXXXXXXXX	Span value for output n in ??? units
SP0Pn	X.XXXXXXXXX	Zero value for output n in ??? units
STUNI	T	Units of measure for temperature
STMPF	X.XXXXXXXXX	Conversion multiplier for temperature
STADF	X.XXXXXXXXX	Conversion offset for temperature
SRRnn	X.XXXXXXXXX	Reference resistance for sensor nn
SRDnn	X.XXXXXXXXX	Delta-R resistance for sensor nn
SSCEM	XXXX	Hex code for heads which won't balance
SBCEM	X.XXXXXXXXX	Percent (FS) deviation from balance cal test
SLCEM	X.XXXXXXXXX	Percent (FS) deviation from Low Flow cal. test
SMCEM	X.XXXXXXXXX	Percent (FS) deviation from Mid Flow cal test
SHCEM	X.XXXXXXXXX	Percent (FS) deviation from High Flow cal test
?????	?	RESPONSE TO UNKNOWN COMMAND

4. Maintenance

Warning: To avoid hazards to personnel, ensure that all environmental isolation seals are properly maintained.

Caution: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 2, Installation for ESD details.

The flowmeter requires very little maintenance. There are no moving parts or mechanical parts subject to wear in the flowmeter. The sensor assembly which is exposed to the process media is all stainless steel construction with nickel braze and is only susceptible to chemical attack based on the corrosion relationship of the RTD thermowell material with the process media.

Maintenance

Without detailed knowledge of the environmental parameters of the application surroundings and process media, FCI cannot make specific recommendations for periodic inspection, cleaning, or testing procedures. However, some suggested general guidelines for maintenance steps are offered below. Use your operating experience to establish the frequency of each type of maintenance.

Calibration

Periodically verify the calibration of the output and recalibrate if necessary. See Chapter 5. FCI recommends every 18 months at a minimum.

Electrical Connections

Periodically inspect cable connections on terminal strips and terminal blocks. Verify that terminal connections are tight and physically sound with no sign of corrosion.

Remote Enclosure

Verify that the moisture barriers and seals protecting the electronics in the probe assembly enclosure and the electrical assembly enclosure are adequate and that no moisture is entering those enclosures.

Electrical Wiring

FCI recommends occasional inspection of the system's interconnecting cable, power wiring and probe assembly wiring on a "common sense" basis related to your application environment. Periodically the conductors should be inspected for corrosion and the cable insulation checked for signs of deterioration.

Flow Element Connections

Verify that all seals are performing properly and that there is no leakage of the process media. Check for deterioration of the gaskets and environmental seals used.

Flow Element Assembly

Periodically remove the flow element for inspection based on historical evidence of debris, foreign matter, or scale build-up and appropriate plant shutdown schedules and procedures. Check for corrosion, stress cracking, and/or build-up of oxides, salts, or foreign substances. The thermowells must be free of excessive contaminants and be physically intact. Any debris or residue build-up could cause inaccurate switching. Clean the probe, as necessary, with a soft brush and available solvents (compatible with Stainless Steel).

5. Troubleshooting

Warning: Only qualified personnel should attempt to test this device. The operator assumes all responsibilities for safe practices while troubleshooting.

Caution: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 2, Installation for ESD details.

Quick Check

Use Table 5-1 as a quick check of problems and solutions. More in-depth discussions follow this table.

Table 5-1. Quick Check Troubleshooting

Problem	Solution
No Display	Check fuses. Verify correct power is applied. Verify the ribbon cable between the backplane board J18 and the display J1 is solidly connected and the red stripe is at pin 1. See Figures 2-3 and 2-4.
No Display or Dim Display	Adjust potentiometer R1 (located on display board) clockwise (10 turns maximum) until display appears. See Figures 2-3.
Display is locked up	Cycle the input power or press any key for more than 10 seconds.
Incorrect Readings	Verify that all ribbon cables are firmly seated. See Figure 2-3 and 2-4.

Non-maintenance Observations

At this point, simply observe the system setup to verify operation. No disassembly or testing is required at this time.

Check Serial Numbers

Verify that the serial number of the flow elements and the flow transmitter are the same. The flow elements and the flow transmitter are a matched set and cannot be operated independently of each other.

Check Input Power

Verify that the correct power source is turned on and connected.

Check the Unit Installation

Review the information on instrument installation in Chapter 2 to verify correct mechanical and electrical installation. Verify that all ribbon cables are seated firmly.

- Relay Output Board J1 Þ Backplane Board J21 and/or J22
- Analog Output Board J1 Þ Backplane Board J19
- Display Board J1 Þ Backplane Board J18

Check for Moisture

Check for moisture on the flow transmitter. Moisture on the flow transmitter may cause intermittent operation.

Check Application Design Requirements

Application design problems usually occur with first time application units, although the design should also be checked on units that have been in operation for some time. If the application design does not match field conditions, errors occur.

1. Review the application design with plant operation personnel and plant engineers.
2. Ensure that plant equipment such as pressure and temperature instruments conform to the actual conditions.
3. Verify operating temperature, operating pressure, line size, and gas medium.

Verify Standard Versus Actual Process Conditions

The flowmeter measures the mass flow rate. The mass flow rate is the mass of the gas flowing through a pipe per time. Other flowmeters, such as an orifice plate or a pitot tube, measure the volumetric flow rate. The volumetric flow rate is the volume of gass per time. If the readings displayed by the MT91 does not agree with another instrument, some calculations may be necessary before comparing them. To calculate the mass flow rate, the volumetric flow rate, and the pressure and temperture at the point of measurement must be known. Use the following equation to calculate the mass flow rate (Standard Volumetric Flowrate) for the other instrument.

Equation:

$$Q_S = Q_A \times \frac{P_A}{T_A} \times \frac{T_S}{P_S}$$

Where:

Q_A = Volumetric Flow Q_S = Standard Volumetric Flow
P_A = Actual Pressure T_A = Actual Temperature
P_S = Standard Pressure T_S = Standard Temperature
and Pressure and Temperature are in absolute units.

Example:

Q_A = 1212.7 ACFM Q_S = 1485 SCFM
P_A = 19.7 PSIA T_A = 120°F (580°R)
P_S = 14.7 PSIA T_S = 70°F (530°R)

$$\left(\frac{1212.7\,\text{ACFM}}{1}\right)\left(\frac{19.7\,\text{PSIA}}{580^\circ\,\text{R}}\right)\left(\frac{530^\circ\,\text{R}}{14.7\,\text{PSIA}}\right) = 1485\ \text{SCFM}$$

Troubleshooting Process

Verify Units

Observe the normal display screen to verify that the unit of measure for channel 1 and 2 are the expected units.

If units are correct, proceed to the next section. If units are not correct, refer to Chapter 3 for instructions on selecting measurement units.

Verify Channel Assignment

If there is no reading or faulty reading, make sure that the sensing points are assigned to the correct channel. Refer to Chapter 3 for instructions on assigning sensing points if they need to be assigned.

1. Go to menu level 2.2.1 and select the desired channel (Setup Þ Outputs Þ Assign Heads) .
2. Select 5=View Assigned. An ‘x’ will appear under the sensing point number if it is assigned.

If the correct sensing points are assigned, continue with the next section.

Verify Limits

If there is a no flow indication when flow exists, the DelR min may have been set to high.

1. Go to menu level 4.2.5, select the head number in question and record the DelR value.
2. Go to menu level 5.2.3.1 (Verify Þ Calibration Þ Flow Þ Limits).
3. Press any key to scroll down to the desired display. For example, if sensing point 16 is being tested, press any key until the display shows dRMin 16.

If the dRMin is set below the recorded value in Step 1, continue with the next section.

If the dRMin is set above the recorded value in Step 1, contact Customer Service.

Check for Suspect Sensing Points and Heaters

An annunciator on the normal display will indicate "Check Head" if the flow transmitter detects a problem with one or more sensing points. Use the diagnostics menu to identify which sensing points are suspect.

1. First go to menu level 3.1.1 (Diagnostics Þ System Status Þ Sensors).
2. Suspect sensing points are indicated on the display by a 'x'. Note any suspect sensing points.
3. Go to menu level 3.1.2 (Diagnostics Þ System Status Þ Heaters). This display indicates suspect heaters.
4. Go to menu level 4.2.5 (Calibration Þ Cal Inputs Þ Unipolar rR & dR).
5. Enter the number of the suspect sensing point. Check for valid RefR and DelR levels.
   The RefR signal depends on the temperature of the media and ranges from 1080 (108 high temperature units) at room temperature beyond 1650 (165 for high temperature units) at approximately 350°F (177°C). The DelR depends on the flow rate and can range from 10 (3 for high temperature units) to more than 100 (20 for high temperature units).

If the DelR is very low or zero and the RefR appears normal, the heater circuit may be broken. Measure the resistance of the wiring from HAX to HAS. If the resistance is approximately 20 ohms the input board may have a failed heater component, contact Customer Service.

Verify the Calibration Parameters

The flowmeter uses a set of predetermined calibration parameters to process flow and temperature signals. Most of these parameters should not change. A data package located at the rear of this manual contains the "MT91 Delta R Data Sheet" and the "MT91 Delta R Parameters". These contain the calibration parameters stored in the flow transmitter at the factory. (See Appendix D for an explanation of these parameters.) Verify that these parameters have not changed using the steps described next.

Note: The units being verified are always displayed in the MT91's internal units. Flow is always displayed in SF/S, temperature is displayed in Fahrenheit, and area is displayed in ft^2.

1. Identify the appropriate Delta R Parameter sheets by serial number. At the top of each column is the menu level that displays the parameters. For example, 5.1.1 are the numbers to press to get from the main menu to the submenu.
2. Go to the menu level for the parameters of interest (e.g. 5.1.1 Verify Þ Setup Þ Flow). Note any differences in values.

If parameters in the verify cal categories have changed, this may indicate a problem. Please contact Customer Service. If the parameters have not changed, continue with the next section.

Check the Resistance of the Sensing Points

To simplify the discussion below, the nomenclature J1 and TB1-HD1 will be used to represent all individual sensing points.

Use Table 5-2 to determine if the flow element is wired incorrectly or has failed. Turn off the input power to the flow transmitter. Disconnect the suspect sensing point's connector from the remote enclosure. Measure resistances at the points shown in Table 5-2 by touching the DMM test leads to the connector terminal screws. See Figure 5-1. (Plug the connector back in when finished.)

Note: All resistances referred to below are for standard instruments using 1000 ohms RTDs. For high temperature units, replace 1000 ohms with 100 ohms.

All resistances in Table 5-2 are based on a temperature of 32°F (0°C). Expect reading to be higher at room temperature, approximately 1080 ohms for a standard instrument or 110 ohms for a high temperature instrument. For a closer estimation, use the following equation:

$R_a = R_i \times [1 + (0.00385 \times T)]$

R_i = initial resistance (100 ohms for high temperature flowmeters, 1000 ohms for standard temperature flowmeters)

R_a = actual resistance

T = degrees Celsius

The numbers in Figure 5-1 have been added to the wire designations for discussion purposes and are not found on the connector plugs or wires.

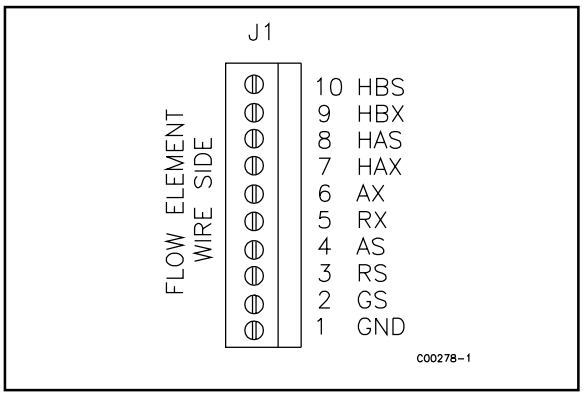


Figure 5-1. J1 Connector Plug on the Backplane Board

Pin Number	Approximate Resistance
2 to 3	1000 ohms
2 to 4	1000 ohms
2 to 5	1000 ohms
2 to 6	1000 ohms
7 to 8	220 ohms
3 to 5	0 ohms
4 to 6	0 ohms

Table 5-2. Resistances at J1 Connector Plug on the Backplane Board

If the measured resistances correspond to Table 5-2, then the sensing point is sound. The problem lies else where. Skip the rest of this section and proceed with the next section, Analog Output Test.

If the measured values do not correspond to Table 5-2, then a problem exists in the flow element or the cable. Wires within the cable could be shorted or open. To isolate a problem with the cable, check the sensing point resistances of the corresponding terminal connector located within the flow element enclosure. Measure resistances at the points shown in Table 5-3 by touching the DMM test leads to the terminal screws. See Figure 5-1.

If the values do not correspond with Table 5-3, remove the cable wires from the terminal connector and measure resistances again. The measured resistances should correspond approximately to the values in Table 5-3.

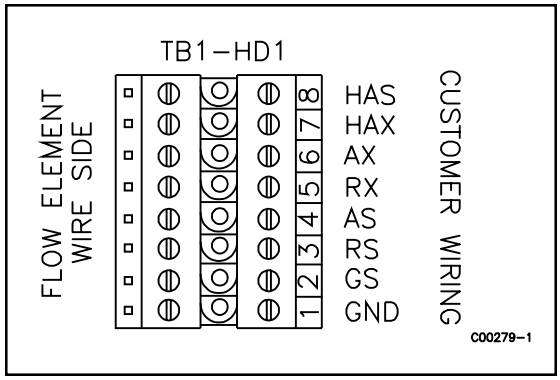


Figure 5-2. TB1-HD1 Terminal Connector

Terminal No.	Approximate Resistance
2 to 3	1000 ohms
2 to 4	1000 ohms
2 to 5	1000 ohms
2 to 6	1000 ohms
7 to 8	220 ohms
4 to 6	0 ohms
3 to 5	0 ohms

Table 5-3. Resistance at TB1-HD1 Terminal Connector

If the measured resistances correspond to Table 5-3, but not to Table 5-2, the cable is defective or the flow element is misswired. Replace cable and recheck resistances. If resistances are still off, contact Customer Service.

If the measured values do not correspond to Table 5-3, then the sensing element is defective. Contact Customer Service.

Check the Analog Outputs

Before using this utility, the analog outputs must be correctly configured. Refer to Chapter 3 for setting up the analog outputs. For signal connections, refer to Figure 2-2 and Table 2-2 in Chapter 2.

1. Go to menu level 3.2.1 (Diagnostics Þ Output Tests Þ Analog Out Test).
2. Select the desired channel.
3. Enter the percent of full scale.

Note: For outputs configured 0 to 5 Vdc and 0 to 10 Vdc, the output should be the selected percentage of the full scale value. For outputs configured as 4 to 20 mA, the output should be 4 mA plus the selected percentage of 16 mA.

4. If the correct value is not obtained, refer to Chapter 3 to re-calibrate the output channel.
5. If the calibration is unsuccessful, remove and replace assembly 015231.

Check the Relays

Refer to Chapter 3 for setting up the relay outputs. For signal connections, refer to Figure 2-2 and Table 2-2 in Chapter 2. This utility will operate the relays regardless of their configuration.

1. Go to menu level 3.2.2 (Diagnostics Þ Output Tests Þ Relay Test).
2. Select the desired relay.
3. The present state of the relay is displayed on the second line. Press the appropriate key to change the state of the relay.
4. To observe the output, connect an ohmmeter between the relay contacts of interest (refer to Figure 2-2 and Table 2-2).
5. If the relay fails to operate, remove and replace assembly 015235.

Run the Calibration Test

See Chapter 3 for a full description of the function of the calibration test and for instructions on scheduling automatic calibration tests. Test for shifts in calibration parameters or unbalance sensing points.

1. Go to menu level 3.3.1 (DiagnosticsÞ Calibration TestsÞ Start Test).
2. Both channels of the analog output board (see Figure 2-2) are driven to preset vales during the test.
3. The sequence of screens A through E shown in Figure 3-8 will display throughout the test.
   a. Screen A displays for 2 minutes while the outputs are held at the zero level.
   b. Screen B displays for 2 minutes while the outputs are held at mid-scale level.
   c. Screen C displays for 2 minutes while the outputs are held at full scale level.
   d. Screen D displays while the system balances and tests each sensing point input channel. From this point until the conclusion of the test, the analog output will be fixed at zero percent scale.
   e. Screen E signals the end of the calibration test. The heaters are turned back on and the system waits three minutes for them to warm up.
4. To view the test results, go to menu level 3.3.2 (DiagnosticsÞ Calibration TestsÞ Display Results). If Screen F appears, the sensing points that the system could not balance will be displayed.
   a. Verify wiring between the flow element and the flow transmitter. If the resistance is very high, the REF EXC and ACT EXC wires may be switched. Switch the REF EXC wire with the ACT EXC wire and vice versa.
   b. At high temperatures, the balance point may be too far from zero to balance out. Verify if this condition exists by breaking the heater circuit of the suspect sensing point by removing one of the heater wires (HTR A SEN or HTR A EXC) from the connector. Then view the sensing point values at menu level 4.2.6. Select the suspect sensing point. Make note of the DelR[x] and RefR[x] values. If DelR[x] does not drop to a value between -1.0 and 1.0, the balance deviation is too large. Contact Customer Service.
5. Screen G will appear next or immediately after selecting menu level 3.3.2.
   a. If the values are not above 3% deviation, the instrument has not drifted more than the daily allowable drift as specified in 40CFR675.
   b. If the values are above 3% deviation, re-calibration of the input board may be necessary, contact Customer Service.

Spares

When system down time is critical, FCI recommends one of each of the following should be kept as a spare: controller board (P/N 015796), input board (P/N 015149), relay board (P/N 015235), analog output board (P/N 015231), display board (P/N 014427) and battery (P/N 011616-01. Removal and replacement of boards may resolve problem faster than troubleshooting. Contact FCI for specific recommendations.

Defective Parts

Before returning any equipment to FCI, please obtain an RA number for authorization, tracking, and repair/ replacement instructions. If a return is required, remove defective unit, replace with spare, calibrate, then return defective unit to FCI freight prepaid for disposition.

Customer Service

1. In the event of problems or inquiries regarding the flowmeter, please contact the Regional or Country Authorized FCI Field Agent. There is an extensive list of these representatives at the front of this manual.
2. Before contacting the FCI representative, please be sure that all the applicable information is near so that a more effective, efficient and timely response may be provided.
3. Refer to Appendix C for specific Customer Service policy provisions.

Appendix A. Drawings

All dimensions are shown in inches. Brackets [ ] indicate dimensions in millimeters.

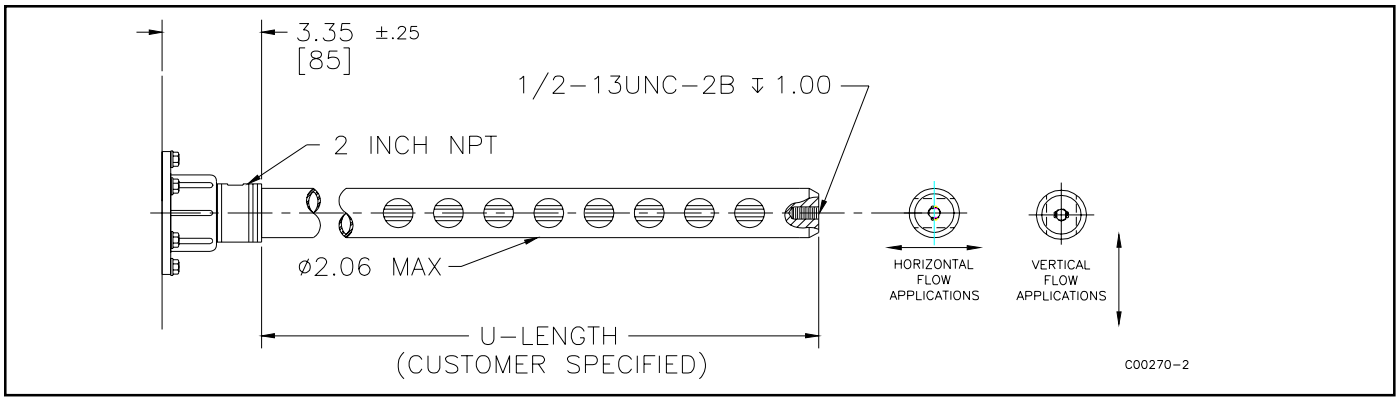


Figure A-1. Threaded Flow Element Installation Drawing

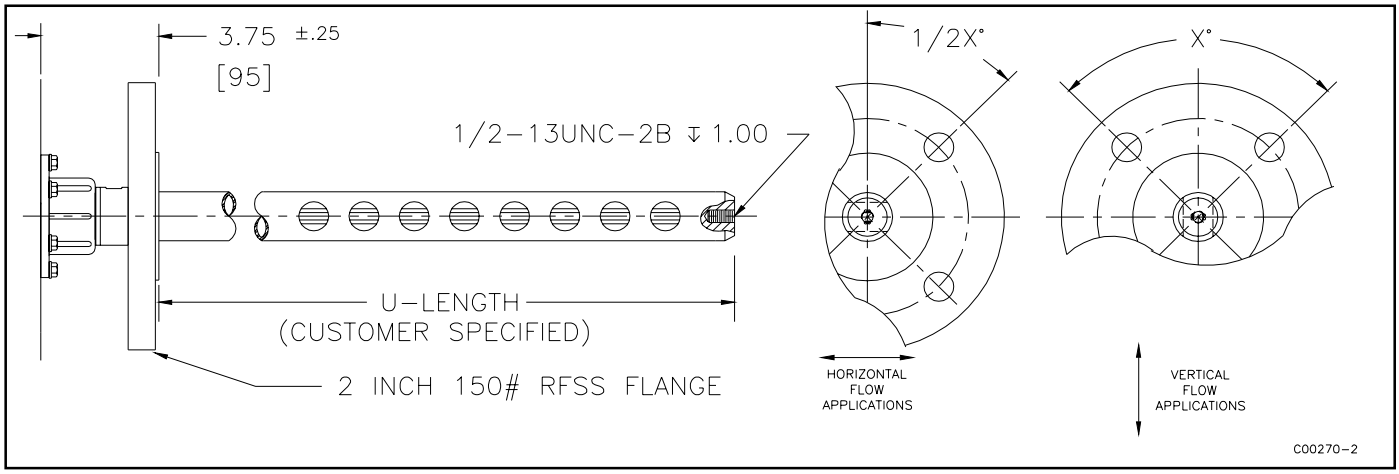
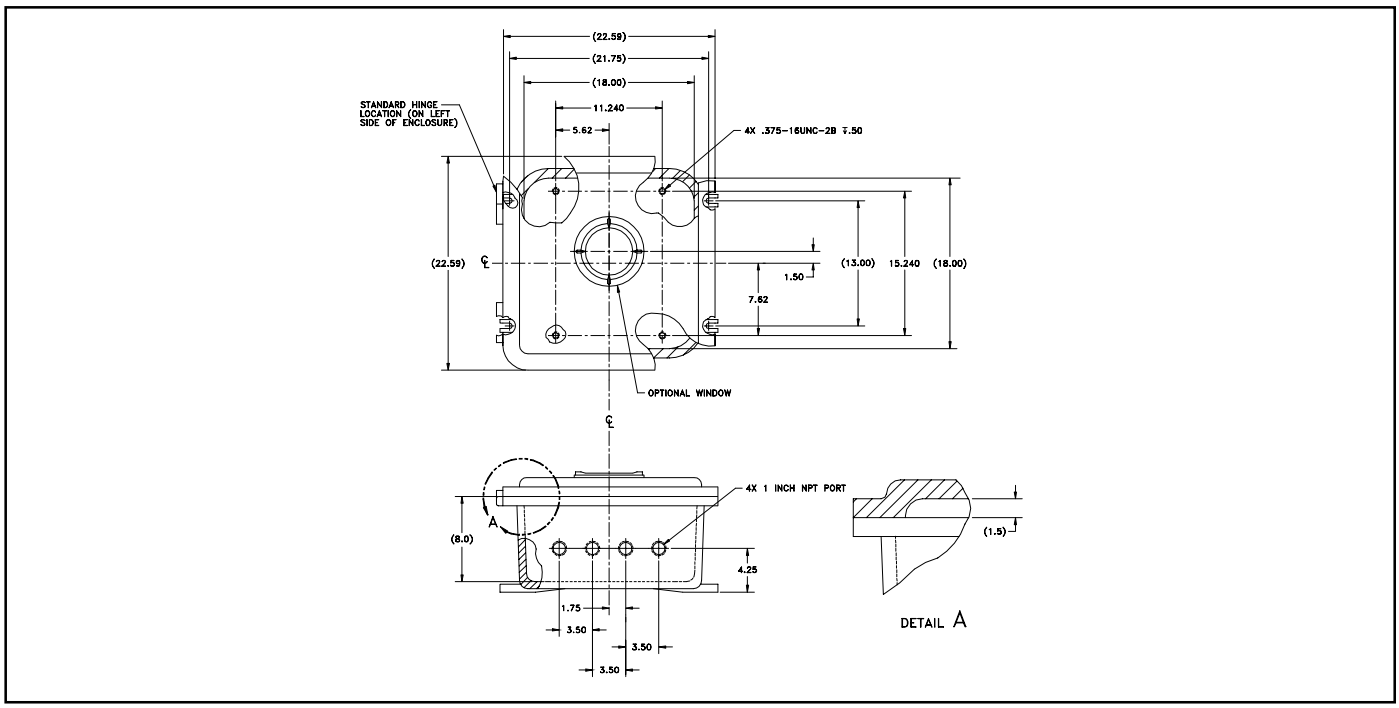


Figure A-2. Flanged Flow Element Installation Drawing



A-3. Explosion Proof Enclosure 18 X 18 X 8

Figure A-2. Local Enclosures

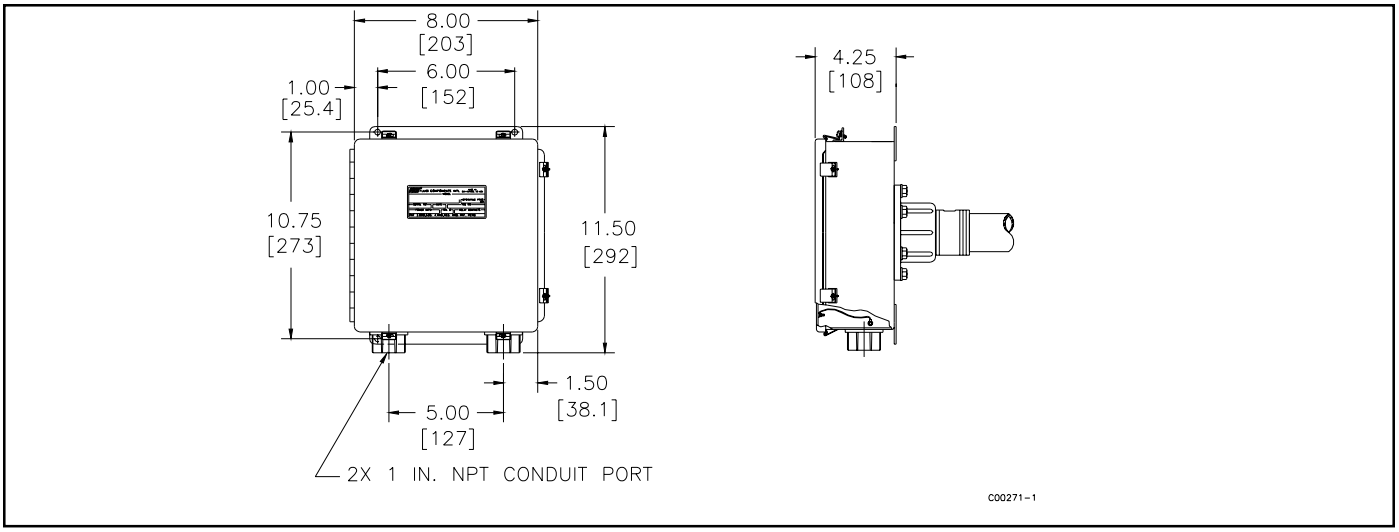


Figure A-4. NEMA Type 4 Local Enclosure

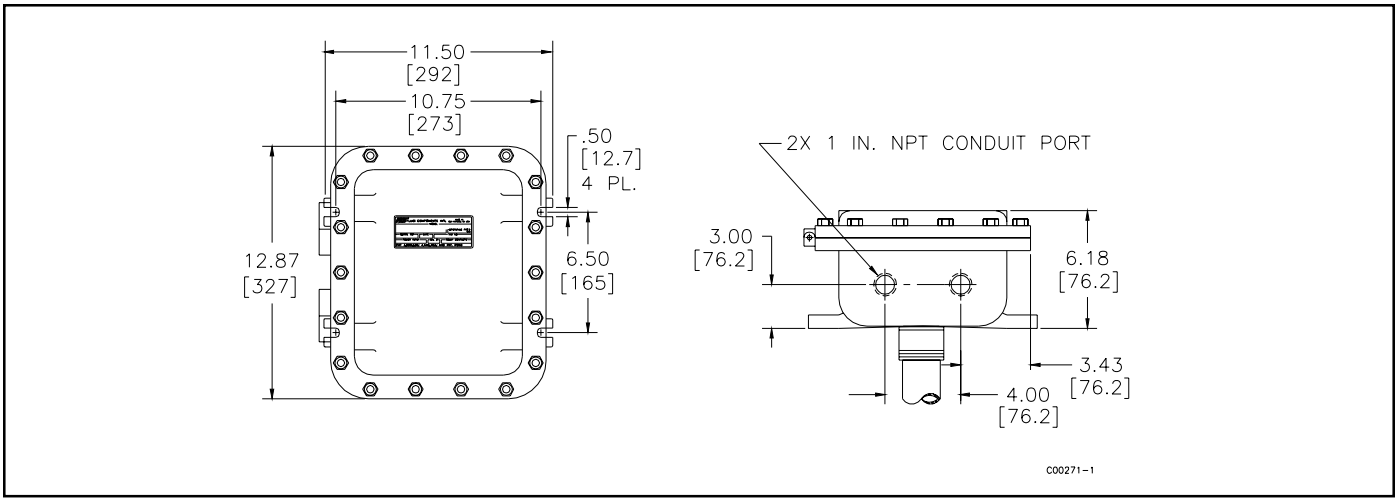


Figure A-5. NEMA Type 7, Groups B,C And D Hazardous Locations Local

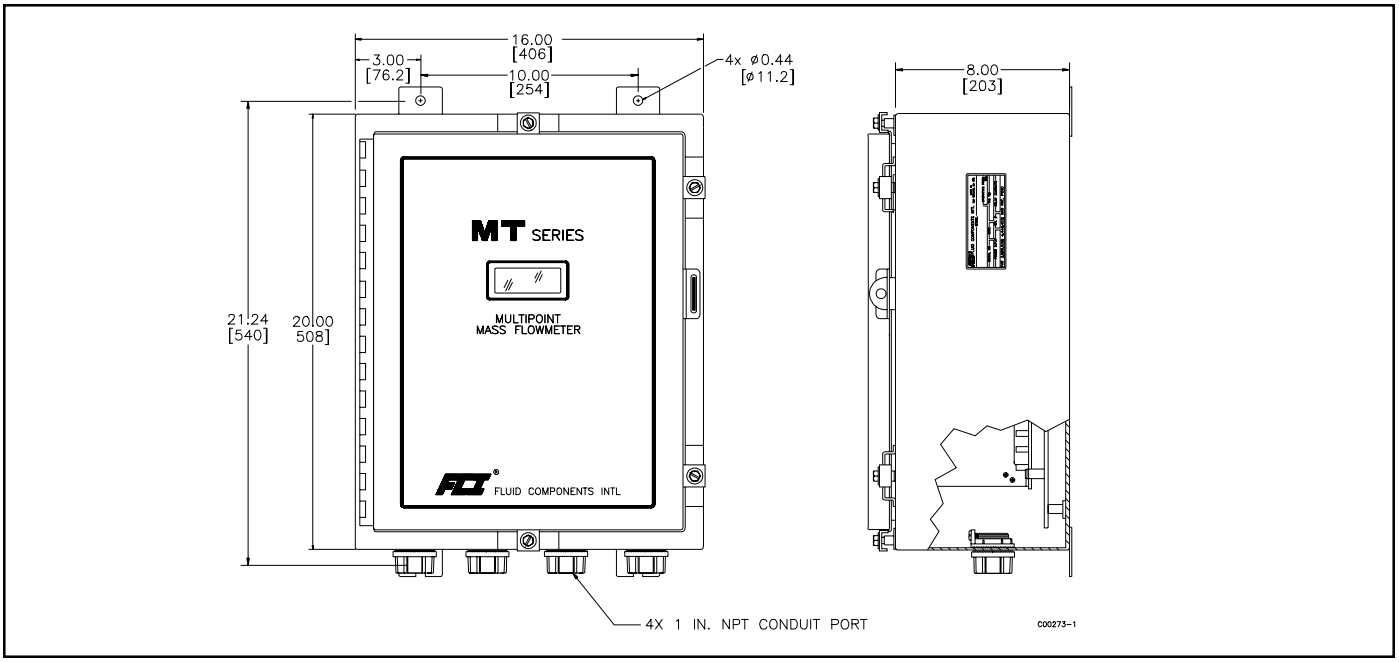


Figure A-6. NEMA 4 Remote Enclosure

Appendix B. Glossary of Terms

Area

Cross-sectional area for a process line or duct.

$$\text{Area of a circular duct} = \pi r^2 \text{ or } \pi\left(\frac{\text{I.D.}}{2}\right)^2$$

$$\textit{Area of a Rectangular duct} = h \times w$$

Bipolar

Allows users to view both negative and positive values for DR.

DVM

Digital Voltmeter

EIA

Electronics Interface Association

C1 - C5

C1 through C5 are flow coefficients for the balanced polynomial equation. The flow coefficients characterize the shape of the curve generated by the equation.

$$Flow = C1(\Delta R^{-2}) + C2(\Delta R) + C3 + C4(\Delta R) + C5(\Delta R^2)$$

C1- C5 are unique to each sensing point. On the Delta R Paramter sheet, they are shown as H01C1 through H01C5 for sensing point 1. (H = head, 01 = sensing point 1).

Comm Mode

Serial communication mode. There are three options: EIA-232, EIA-422, EIA-485.

CorrF[1] - [4]

CorrF[1] through CorrF[4] are correction factors that apply to the Corrected Flow Rate equation. See Chapter 3 - Operation for more information.

$$\textit{Corrected Flow Rate} = C_1 + (C_2 \times m_0) + (C_3 \times m_0^2) + (C_4 \times m_0^3)$$

dR Min

DR value low end cutoff. Should be set to approximately 5 ohms less than the lowest calibrated DR.

dr Max

DR value high end cutoff. Should be set to approximately 5 ohms greater than the lowest calibrated DR.

Flow Element

The Flow Element includes the local enclosure and the sensing points.

Flow Factor

The Flow Factor is the multiplier that converts the internal flow rate (SFPS) to the user selected flow untis.

Flow Min

Minimum calibrated flow rate in standard feet per second (SFPS)

Flow Max

Maximum calibrated flow rate in standard feet per second (SFPS)

Flow Transmitter

The Flow Transmitter consists of the remote enclosure and all of the electronics contained within.

Full Scale

Full scale is from the zero value to the max flow value. For zero based applications this is from 0.00 to the maximum flow value. For non-zero based applications full scale is from minimum flow value to the maximum flow value.

Offset 1 - 16

Offset value for each sensing point. Offset Equation = DR + Offset Value

Port [1]	Channel 1 for output signal. Port [2] corresponds to Channel 2.
RTD	A Resistance Temperature Detector operates on the principle of change in resistance as a function of temperature.
Span	Span is the full scale value minus the minimum flow value.
Standard Density	Standard Density is the density of media (customer's original request) at standard conditions usually at 14.7 PSIA and 70°F: used by firmware for conversion when a mass flow rate unit is chosen such as LB/HR etc.
Sensing Point	The Sensing Points contain the four thermowells that house the resistance temperature detectors and the heater.
DR	The difference between two resistance values.
DT	The difference between two temperature values.
Unipolar	Allows users to view only positive values for DR.
Zero	0.00 for zero based applications. For non-zero based applications the zero is at minimum flow.

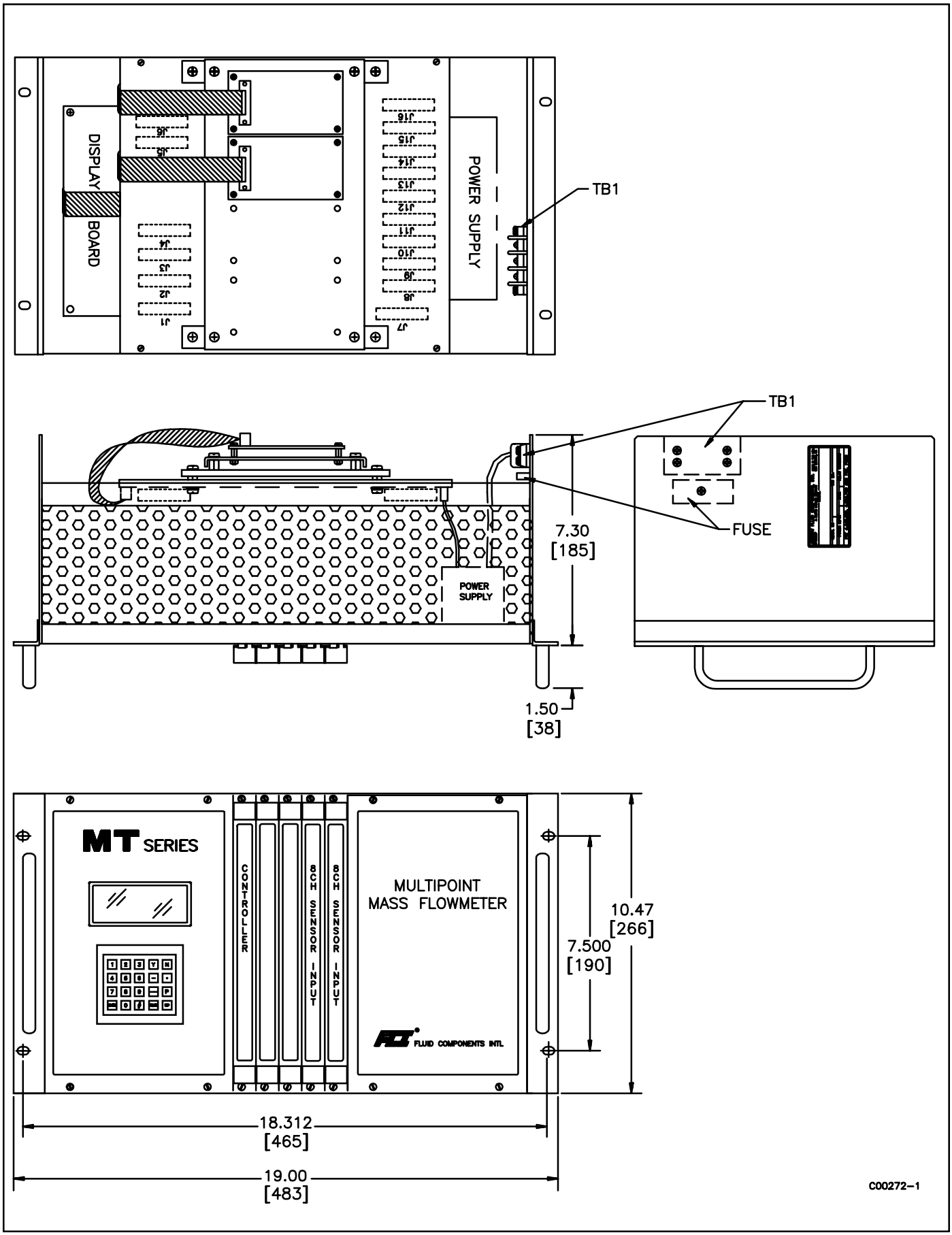


Figure A-7. Rack Mount Remote Enclosur

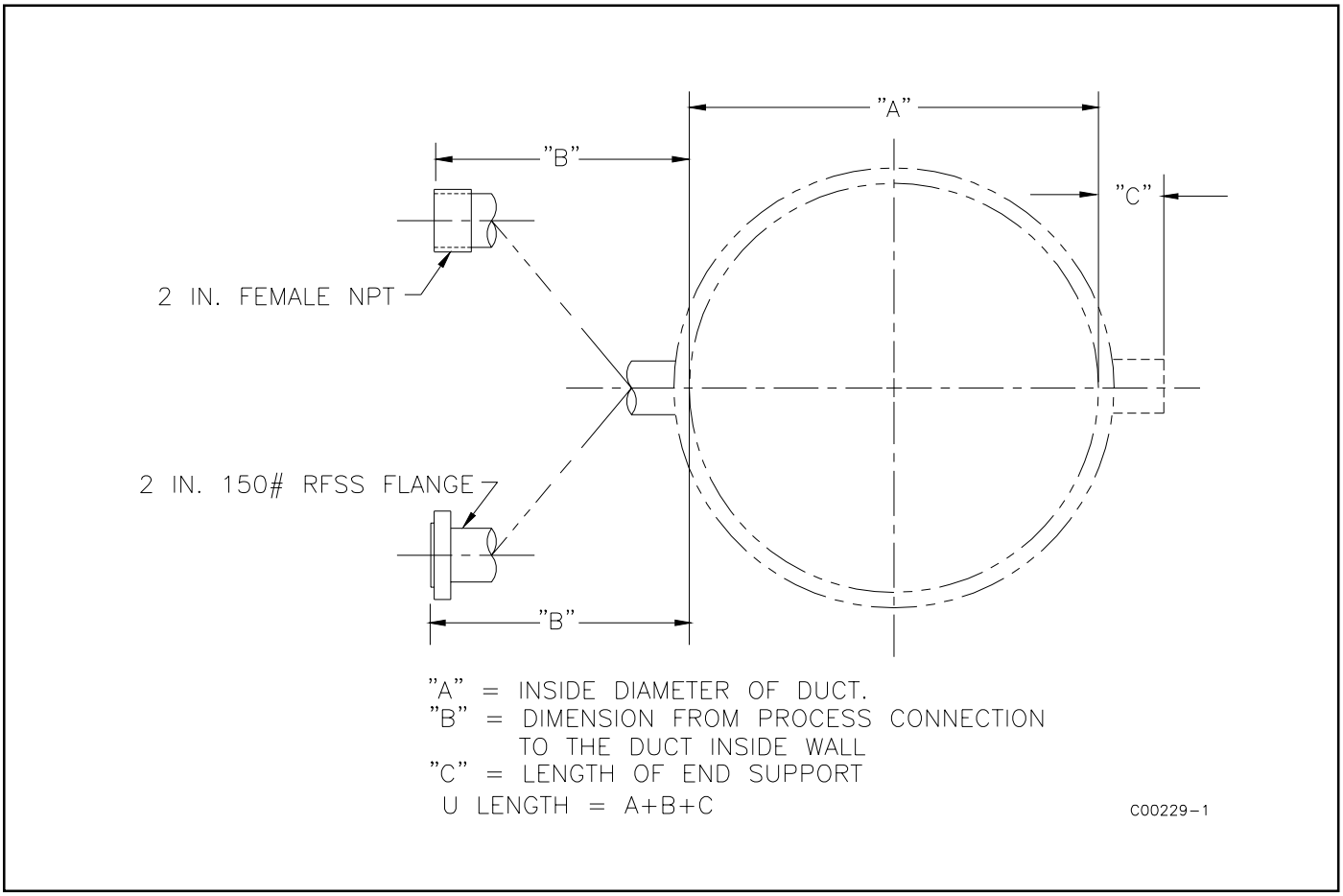


Figure A-8. Recommended Customer Process Connection

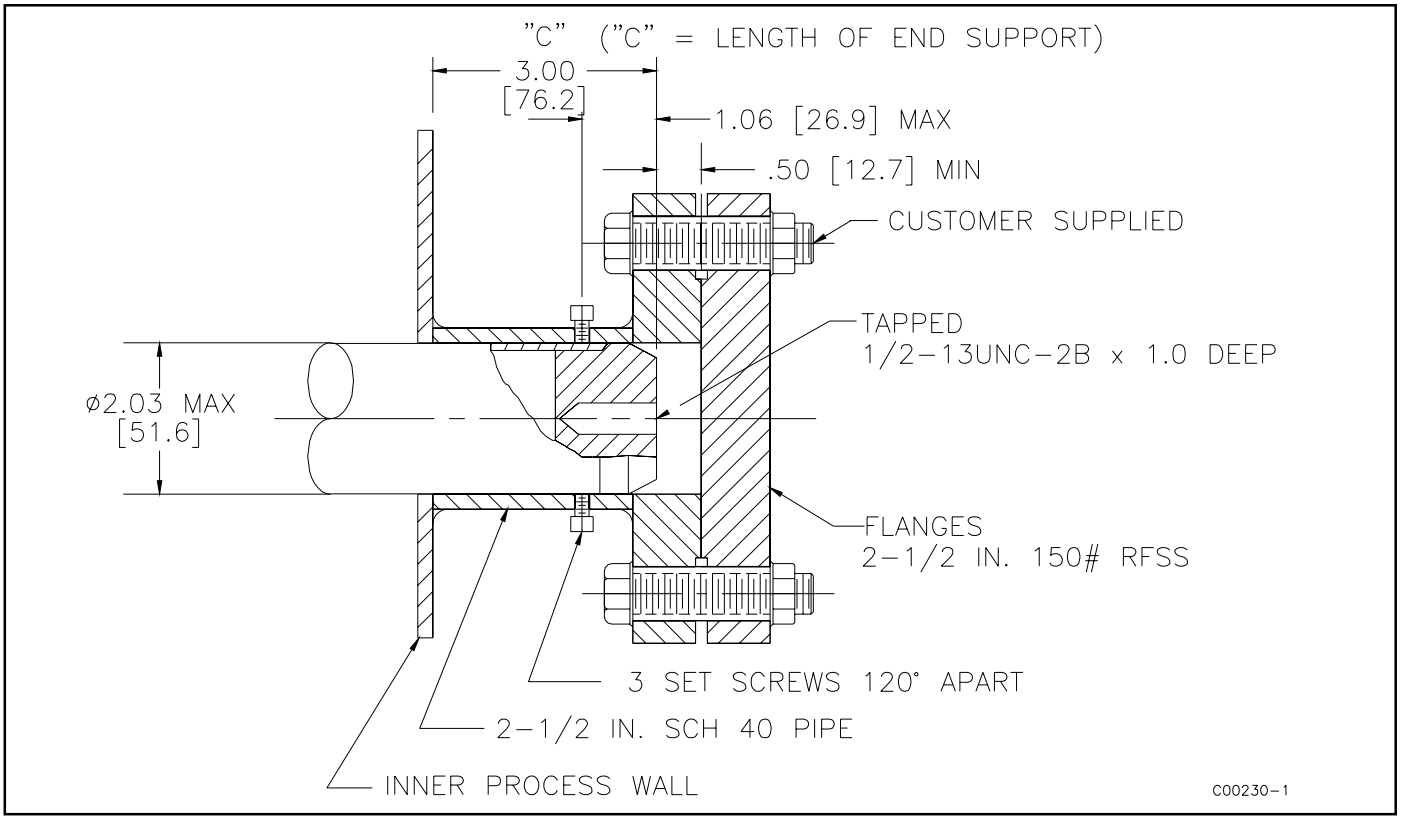


Figure A-9. Recommended End Support Configuration

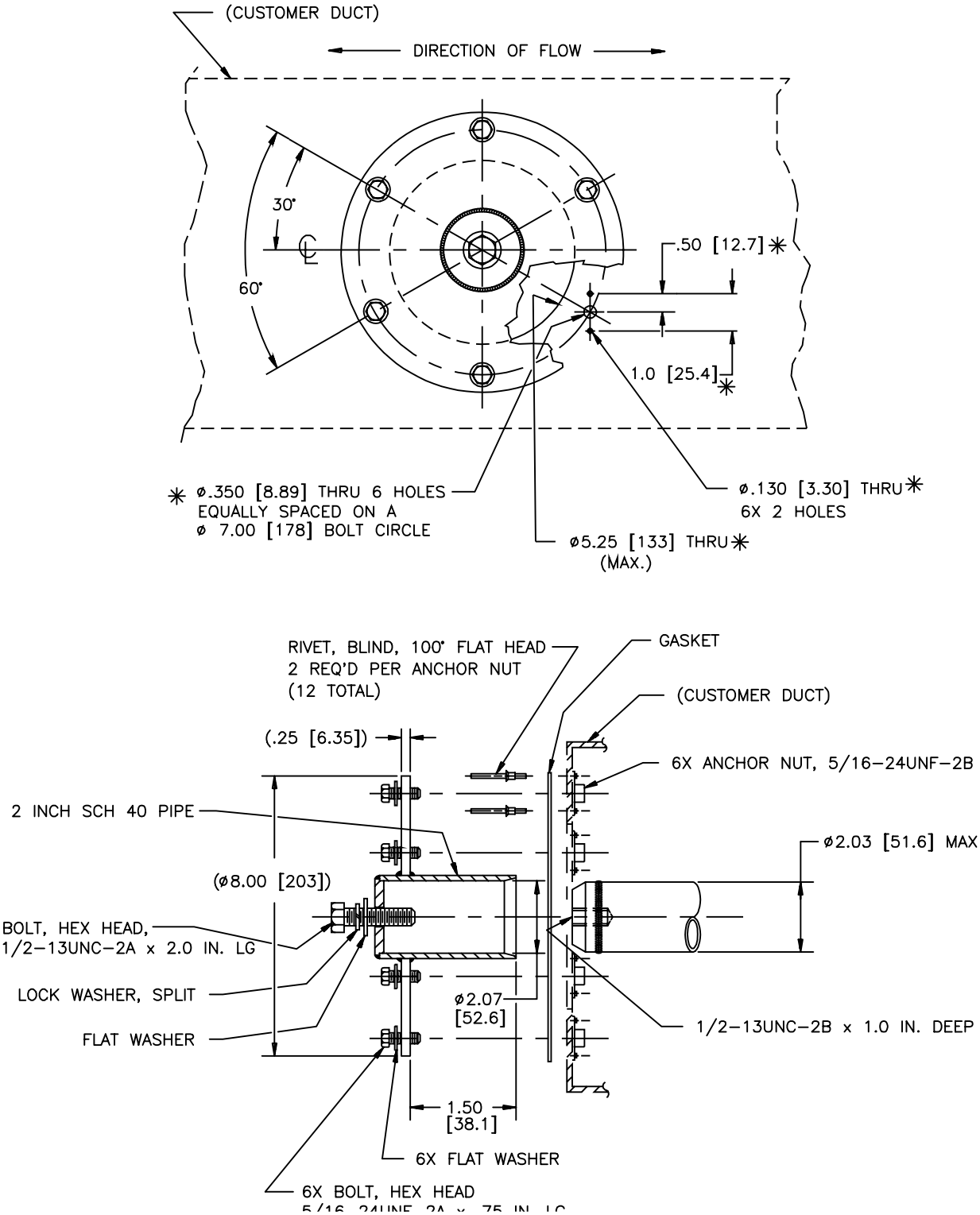


Figure A-10. Alternate End Support Configuration

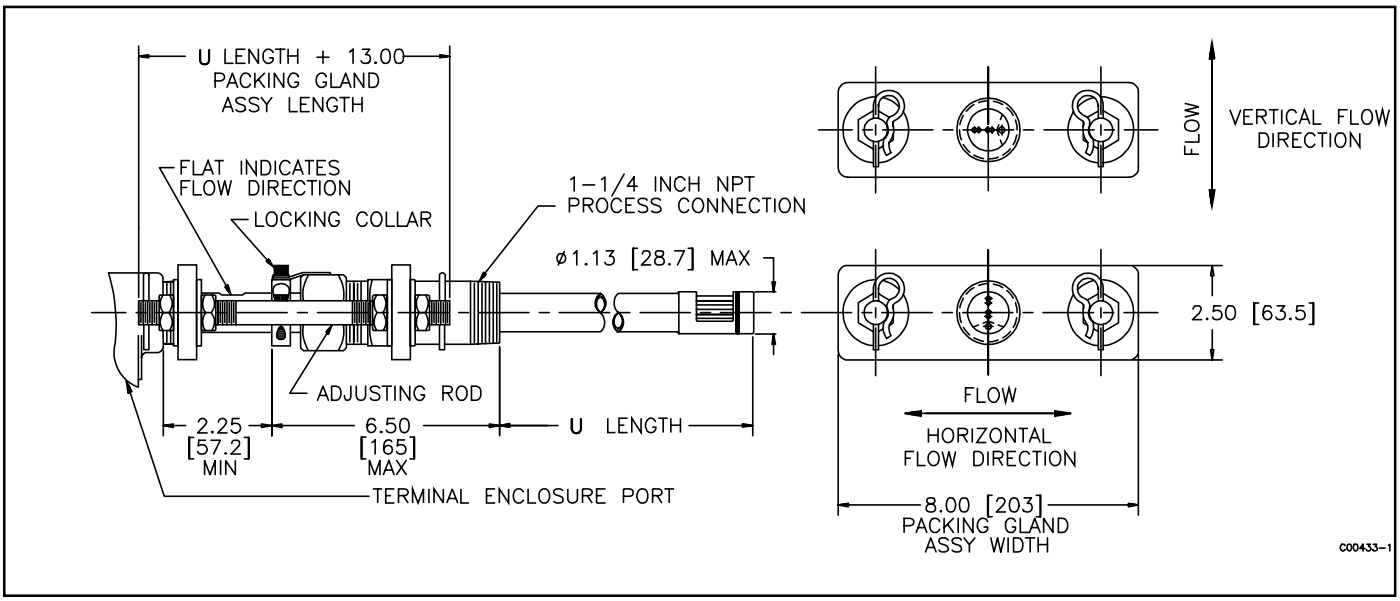


Figure A-11. LT or GF Medium Pressure Sensing Element Configured For MT91

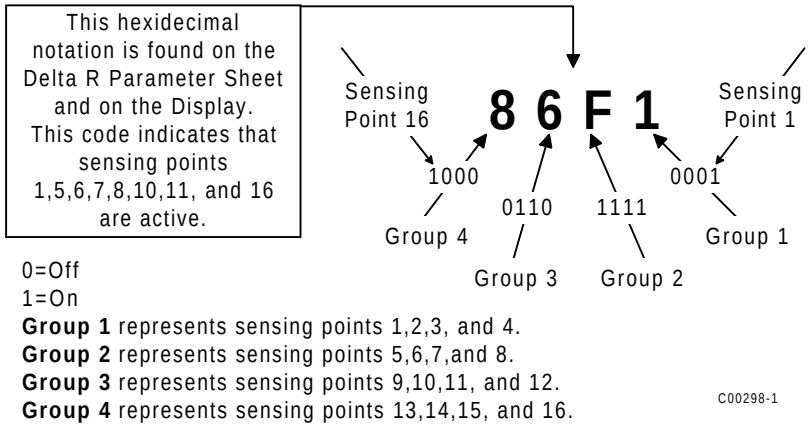
Appedix D. MT91 Delta R Parameters

For each instrument there are "MT91 Delta R Parameters" sheets and a 4-20mA look up table inserted in the rear page protector. Appendix D explains the codes found on the Delta R Parameters sheets. A sample of both the Delta R Parameter sheet and the 4-20mA look up table follow the explanations.

Above each column is a menu level code. When verifying parameters, access the menu level and then scroll down through the menu until the value in question appears on the screen. For example, to view the parameter "dRmin 1", press HOME, 5, 2, 3, and 1. (Verifyþ Verify Calþ Flowþ Limits). Scroll down by pressing ENTR until "dRmin 1" appears on the screen.

The instrument uses internal units of Standard Feet per Second and degrees Fahrenheit. Therefore, all values on this sheet are in Standard Feet per Second. Refer to "Verify Standard vs. Actual Conditions" in Chapter 5 to convert actual readings to standard readings.

In menu levels 5.1.1 and 5.1.3 active sensing points are designated by hexadecimal notation. Use the following diagram and table to decipher which sensing points are active. For example, the number 0003 in hexadecimal notation means sensing points 1 and 2 are active.



Group Code	Hex #	Group Code	Hex #
'0000	0	1000	8
'0001	1	1001	9
'0010	2	1010	A
'0011	3	1011	B
'0100	4	1100	C
'0101	5	1101	D
'0110	6	1110	E
'0111	7	1111	F

Explanation of Parameters and Code

5.1.1 Verify Setup Flow

Flow Units	Customer Specified Unit
Flow Heads	Hexadecimal Notation
Area Unit	Customer Specified Unit
Area	Area of Customer Pipe or Duct
TC Ena	Temperature Compensation Enabled
Corr Ena	Correction Enabled
Offset Ena	Offset Enabled
Filter	Filter Strength (See Chapter 3)
Density	Standard Density of Customer Media in LBM per cubic feet.
Flow Fac	Flow Factor

5.1.2 Verify Setup Temperature

Temp Type	Units used during calibration.
Temp Heads	Hexadecimal Notation

5.1.3 Verify Setup Outputs

[1] = Channel 1 [2] = Channel 2

PortUnit[1]	0 = Flow 1 = Temperature
PortUnit[2]	0 = Flow 1 = Temperature
Out Head[1]	Hexadecimal Notation
Out Head[2]	Hexadecimal Notation
Zero[1]	Zero output setting at either zero (0) or minimum flow. (e.g. 4mA represents either 0 or minimum flow)
Zero[2]	
Span[1]	High point of output signal.(e.g. 20mA represents high point)
Span[2]	

5.1.4 Verify Setup Communication

Comm Mode	0 = EIA-232C	1 = EIA-422	2 = EIA-485
Comm Rate	0 = 4800	1 = 9600	2 = 19.2K
Comm Prot	0 = Protocol 1	1 = Protocol 2	2 = Protocol 3
485 Addr			

5.2.1 Verify Cal Inputs

URRG1	Unipolar Reference R Gain	Channel 1
URRG2		Channel 2
URRO1	Unipolar Reference R Offset	Channel 1
URRO2		Channel 2
UDRG1	Unipolar Delta R Gain	Channel 1
UDRG2		Channel 2
UDRO1	Unipolar Delta R Offset	Channel 1
UDRO2		Channel 2
BRRG1	Bipolar Reference R Gain	Channel 1
BRRG2		Channel 2
BRRO1	Bipolar Reference R Offset	Channel 1
BRRO2		Channel 2
BDRG1	Bipolar Delta R Gain	Channel 1
BDRG2		Channel 2
BDRO1	Bipolar Delta R Offset	Channel 1
BDRO2		Channel 2
RxAdj1	Reference Adjust (sensing points 1 through 8)	Output Board 1
RxAdj2	Reference Adjust (sensing points 9 through 16)	Output Board 2
HtAdj1	Heater Adjust	Sensing Point 1
HtAdj2		Sensing Point 2
HtAdj3		Sensing Point 3
HtAdj4		Sensing Point 4
HtAdj5		Sensing Point 5
HtAdj6		Sensing Point 6
HtAdj7		Sensing Point 7
HtAdj8		Sensing Point 8
HtAdj9		Sensing Point 9
HtAdj10		Sensing Point 10
HtAdj11		Sensing Point 11
HtAdj12		Sensing Point 12
HtAdj13		Sensing Point 13
HtAdj14		Sensing Point 14
HtAdj15		Sensing Point 15
HtAdj16		Sensing Point 16

5.2.2 Verify Cal Outputs

Zero[1]	A to D Values
Zero[2]	A to D Values
Span[1]	A to D Values
Span[2]	A to D Values
Slope[1]	A to D Values
Slope[2]	A to D Values
Off[1]	A to D Values
Off[2]	A to D Values
CorrF[1]	Correction Factor 1
CorrF[2]	Correction Factor 2
CorrF[3]	Correction Factor 3
CorrF[4]	Correction Factor 4

5.2.3.1 Verify Cal Flow Limits

FlowMin	Customer specified and factory calibrated value for minimum flow.
FlowMax	Customer specified and factory calibrated value for maximum flow.
TempMin	Customer specified and factory calibrated value for minimum temperature.
TempMax	Customer specified and factory calibrated value
RRmin	Reference R minimum Calibration Value
RRmax	Reference R maximum Calibration Value
dRMin 1	Delta R minimum Calibration Value Sensing Point 1
dRMin 2	Sensing Point 2
dRMin 3	Sensing Point 3
dRMin 4	Sensing Point 4
dRMin 5	Sensing Point 5
dRMin 6	Sensing Point 6
dRMin 7	Sensing Point 7
dRMin 8	Sensing Point 8
dRMin 9	Sensing Point 9
dRMin 10	Sensing Point 10
dRMin 11	Sensing Point 11
dRMin 12	Sensing Point 12
dRMin 13	Sensing Point 13
dRMin 14	Sensing Point 14
dRMin 15	Sensing Point 15
dRMin 16	Sensing Point 16
drMax 1	Delta R maximum Calibration Value Sensing Point 1
drMax 2	Sensing Point 2
drMax 3	Sensing Point 3
drMax 4	Sensing Point 4
drMax 5	Sensing Point 5
drMax 6	Sensing Point 6
drMax 7	Sensing Point 7
drMax 8	Sensing Point 8
drMax 9	Sensing Point 9
drMax 10	Sensing Point 10
drMax 11	Sensing Point 11
drMax 12	Sensing Point 12
drMax 13	Sensing Point 13
drMax 14	Sensing Point 14
drMax 15	Sensing Point 15
drMax 16	Sensing Point 16

5.2.3.2 Verify Cal Flow Coefficients

H01C1	Sensing Point 1	Coefficient 1	H09C1	Sensing Point 9	Coefficient 1
H01C2		Coefficient 2	H09C2		Coefficient 2
H01C3		Coefficient 3	H09C3		Coefficient 3
H01C4		Coefficient 4	H09C4		Coefficient 4
H01C5		Coefficient 5	H09C5		Coefficient 5
H02C1	Sensing Point 2	Coefficient 1	H10C1	Sensing Point 10	Coefficient 1
H02C2		Coefficient 2	H10C2		Coefficient 2
H02C3		Coefficient 3	H10C3		Coefficient 3
H02C4		Coefficient 4	H10C4		Coefficient 4
H02C5		Coefficient 5	H10C5		Coefficient 5
H03C1	Sensing Point 3	Coefficient 1	H11C1	Sensing Point 11	Coefficient 1
H03C2		Coefficient 2	H11C2		Coefficient 2
H03C3		Coefficient 3	H11C3		Coefficient 3
H03C4		Coefficient 4	H11C4		Coefficient 4
H03C5		Coefficient 5	H11C5		Coefficient 5
H04C1	Sensing Point 4	Coefficient 1	H12C1	Sensing Point 12	Coefficient 1
H04C2		Coefficient 2	H12C2		Coefficient 2
H04C3		Coefficient 3	H12C3		Coefficient 3
H04C4		Coefficient 4	H12C4		Coefficient 4
H04C5		Coefficient 5	H12C5		Coefficient 5
H05C1	Sensing Point 5	Coefficient 1	H13C1	Sensing Point 13	Coefficient 1
H05C2		Coefficient 2	H13C2		Coefficient 2
H05C3		Coefficient 3	H13C3		Coefficient 3
H05C4		Coefficient 4	H13C4		Coefficient 4
H05C5		Coefficient 5	H13C5		Coefficient 5
H06C1	Sensing Point 6	Coefficient 1	H14C1	Sensing Point 14	Coefficient 1
H06C2		Coefficient 2	H14C2		Coefficient 2
H06C3		Coefficient 3	H14C3		Coefficient 3
H06C4		Coefficient 4	H14C4		Coefficient 4
H06C5		Coefficient 5	H14C5		Coefficient 5
H07C1	Sensing Point 7	Coefficient 1	H15C1	Sensing Point 15	Coefficient 1
H07C2		Coefficient 2	H15C2		Coefficient 2
H07C3		Coefficient 3	H15C3		Coefficient 3
H07C4		Coefficient 4	H15C4		Coefficient 4
H07C5		Coefficient 5	H15C5		Coefficient 5
H08C1	Sensing Point 8	Coefficient 1	H16C1	Sensing Point 16	Coefficient 1
H08C2		Coefficient 2	H16C2		Coefficient 2
H08C3		Coefficient 3	H16C3		Coefficient 3
H08C4		Coefficient 4	H16C4		Coefficient 4
H08C5		Coefficient 5	H16C5		Coefficient 5

5.2.3.3 Verify Cal Flow Offsets

Offset 1	Offset Value added to the Raw Signal.	Sensing Point 1
Offset 2		Sensing Point 2
Offset 3		Sensing Point 3
Offset 4		Sensing Point 4
Offset 5		Sensing Point 5
Offset 6		Sensing Point 6
Offset 7		Sensing Point 7
Offset 8		Sensing Point 8
Offset 9		Sensing Point 9
Offset 10		Sensing Point 10
Offset 11		Sensing Point 11
Offset 12		Sensing Point 12
Offset 13		Sensing Point 13
Offset 14		Sensing Point 14
Offset 15		Sensing Point 15
Offset 16		Sensing Point 16

5.2.3.4 Verify Cal Flow Temp Comp

Cal Ref	Temperature Compensation Calibration Reference Value	
TCAdj01	Temperature Compensation Coefficient	Sensing Point 1
TCAdj02		Sensing Point 2
TCAdj03		Sensing Point 3
TCAdj04		Sensing Point 4
TCAdj05		Sensing Point 5
TCAdj06		Sensing Point 6
TCAdj07		Sensing Point 7
TCAdj08		Sensing Point 8
TCAdj09		Sensing Point 9
TCAdj10		Sensing Point 10
TCAdj11		Sensing Point 11
TCAdj12		Sensing Point 12
TCAdj13		Sensing Point 13
TCAdj14		Sensing Point 14
TCAdj15		Sensing Point 15
TCAdj16		Sensing Point 16

Appendix C. Customer Service

Point of Contact

Your point of contact for service, or return of equipment to FCI is your authorized FCI service representative (see list in the front matter of this manual).

Reference Documents

Return Authorization Request/Certificate of Non-Contamination (Document 1)
Warranties (Document 2)
Documents 1 and 2 are included in this appendix.

Hardware Return Procedure

1. Complete a Return Authorization (RA) Request/Certificate of Non-Contamination form (Document 1). Mail or fax it to FCI customer service department. After FCI issues an RA number, complete the following steps.
2. Thoroughly clean the hardware.
3. Package each instrument with protective packing material similar to the original FCI shipment cartons indicated below. **All damage occurring in transit is the customer's responsibility.**
    a. Instruments weighing less than 25 pounds each are to be covered with protective wrap, i.e. bubble wrap or surrounded with "popcorn". Instruments weighing greater than 60 pounds or extending more than four feet should be secured in wooden crates by bolting the sensing element assembly in place.
    b. Protect the sensing element with a cardboard tube or other sturdy wrapping.
    c. Do not pack more than four small instruments in each carton.
    d. Packages weighing in excess of 70 pounds or with a combined length and girth of more than 138 inches cannot be shipped by United Parcel Service. Larger packages or crates should be shipped by carriers who specialize in the transport of industrialized instrumentation.
    e. The RA number should be noted on the packing list and marked clearly on the outside of the box.
4. Prepay freight to the FCI receiving door.

Shipping/Handling Charges

All Shipping (Warranty and Nonwarranty Repairs or Returns)

The customer prepays all shipping, freight, duty/entry and handling charges from the customer site to the FCI door. If the customer does not prepay, FCI will invoice the customer for the charges that appear on the freight bill. Address the return equipment to :

FLUID COMPONENTS INTL

1755 LA COSTA MEADOWS DRIVE

SAN MARCOS, CA. 92069

ATTN: REPAIR DEPT.

RA NUMBER: _____

Warranty Repairs or Returns

FCI prepays ground transportation charges for return of freight to the customer's door. FCI reserves the right to return equipment by the carrier of our choice.

International freight, handling charges, duty/entry fees for return of equipment are paid by the customer.

Nonwarranty Repairs or Returns

FCI returns repaired equipment to the customer either collect or prepaid and adds freight charges to the customer invoice.

Return to Stock Equipment

The customer is responsible for all shipping and freight charges for equipment that is returned to FCI stock from the customer site. These items will not be credited to customer's account until either all freight charges are cleared or until the customer agrees to have any freight costs incurred by FCI deducted, along with applicable return to stock charges, from the credit invoice. (Exceptions are made for duplicate shipments made by FCI.)

If any repair or return equipment is received at FCI, freight collect, without prior factory consent, FCI bills the sender for these charges.

Field Service Procedures

Field Service Requests

Contact your FCI field representative to request field service.

A field service technician is dispatched to the site from either the FCI factory or one of the FCI representative offices. After the work is complete, the technician completes a preliminary field service report at the customer site and leaves a copy with the customer.

Following the service call, the technician completes a formal, detailed service report. The formal report is mailed to the customer within five days of the technician's return to the factory or office.

Rates

All field service calls are billed at the prevailing rates as listed in the FCI Price Book unless specifically excepted by the FCI Customer Service Manager. FCI reserves the right to bill for travel times at our discretion.

Customers are charged for shipping costs related to the transfer of equipment to and from the job site. They are also invoiced for field service work and travel expenses by FCI's Accounting Department.

Document 1.

FCI RETURN AUTHORIZATION REQUEST

Customer Information

Name of Company Returning Hardware _____

Contact Name: _____ Phone # _____ Fax # _____

Customer Bill to Address: _____ Ship to: _____

_____ _____

_____ _____

_____ _____

Purchase Agent Contact: _____ Phone # _____ Fax # _____

Product Information

Model Number(s) _____ Serial Number(s) _____

Sending: Electronics only ☐ Sensor only ☐ Complete unit ☐ Number of units ____

Failure Symptoms _____

_____

Troubleshooting done in the field by FCI representative ☐ or by Customer ☐ : _____

_____

Action to be taken by FCI _____

(Note: Re-calibration/Re-certification requires the completion of a new Application Data Sheet)

Process Flow Media: _____

Who is your FCI factory technical contact: _____

Note: FCI will charge a **$100 minimum** handling fee on all non-warranty evaluations.

Have you contacted your local FCI representative for assistance? _____ yes _____ no

Decontamination Information

Exposure to hazardous materials is regulated by Federal, state (California), County and City laws and regulations. These laws provide FCI's employees with the right to know the hazardous materials with which they come in contact while handling our products. Consequently, our employees must have access to data regarding the hazardous materials which the equipment has been exposed to in your process(es). Accordingly, prior to returning your instrument for repair, please sign the certification below and thoroughly comply with the instructions, if applicable.

I certify that the item(s) has (have) been thoroughly and completely cleaned and if the item(s) has (have) been exposed to or contacted by a hazardous material, hazardous substance or toxic materials or substances that the undersigned can assure the returned item(s) has (have) been thoroughly and completely decontaminated and neutralized of such substances and contamination. I have also attached a Material Safety Data Sheet (MSDS) which covers all hazardous material, hazardous substance or toxic materials or substances exposed to or contacted by the instrument. Furthermore, I understand that this Certificate, or providing a MSDS, shall not waive our responsibility to provide a neutralized, decontaminated, and clean product for repair to FCI.

Authorized Signature _____ Date _____

Cleanliness of a returned item or the acceptability of the MSDS shall be at the sole discretion of FCI.
Any returned item which does not comply with these instructions shall be returned to you at your expense.

Document 2. Warranties

Warranties

Goods furnished by the Seller are to be within the limits and of the sizes published by the Seller and subject to the Seller's standard tolerances for variations. All items made by the Seller are inspected before shipment, and should any of said items prove defective due to faults in manufacture or performance under Seller approved applications, or fail to meet the written specifications accepted by the Seller, they will be replaced or repaired by Seller at no charge to Buyer provided return or notice of rejection of such material is made within a reasonable period but in no event longer than three (3) years for non-calibration defects and one (1) year for calibration defects from date of shipment to Buyer, and provided further, that an examination by Seller discloses to Seller's reasonable satisfaction that the defect is covered by this warranty and that the Buyer has not returned the equipment in a damaged condition due to Buyer's or Buyer's employees', agents', or representatives' negligence and Buyer has not tampered, modified, redesigned, misapplied, abused, or misused the goods as to cause the goods to fail. In addition, this warranty shall not cover damage caused by Buyer's exposure of the goods to corrosive or abrasive environments. Moreover, Seller shall in no event be responsible for (1) the cost or repair of any work done by Buyer on material furnished hereunder (unless specifically authorized in writing in each instance by Seller), (2) the cost or repair of any modifications added by a Distributor or a third party, (3) any consequential or incidental damages, losses, or expenses in connection with or by reason of the use of or inability to use goods purchased for any purpose, and Seller's liability shall be specifically limited to free replacement, or refund of the purchase price, at Seller's option, provided return or rejection of the goods is made consistent with this paragraph, and the Seller shall in no event be liable for transportation, installation, adjustment, loss of good will or profits, or other expenses which may arise in connection with such returned goods, or (4) the design of products or their suitability for the purpose for which they are intended or used. Should the Buyer receive defective goods as defined by this paragraph, the Buyer shall notify the Seller immediately, stating full particulars in support of his claim, and should the Seller agree to a return of the goods, the Buyer shall follow Seller's packaging and transportation directions explicitly. In no case are the goods to be returned without first obtaining a return authorization from the Seller. Any repair or replacement shall be at Seller's factory, unless otherwise directed, and shall be returned to Seller transportation prepaid by Buyer. If the returned goods shall prove defective under this clause they will be replaced or repaired by Seller at no charge to Buyer provided the return or rejection of such material is made within a reasonable period, but in no event longer than (1) year from the date of shipment of the returned goods or the unexpired terms of the original warranty period whichever is later. If the goods prove to be defective under this paragraph, the Buyer shall remove the goods immediately from the process and prepare the goods for shipment to Seller. Continued use or operation of defective goods is not warranted by Seller and damage occurring due to continued use or operation shall be for Buyer's account. Any description of the goods contained in this offer is for the sole purpose of identifying them, and any such description is not part of the basis of the bargain, and does not constitute a warranty that the goods will conform to that description. The use of any sample or model in connection with this offer is for illustrative purposes only, is not part of the basis of the bargain, and is not to be construed as a warranty that the goods will conform to the sample or model. No affirmation of that fact or promise made by the Seller, whether or not in this offer, will constitute a warranty that the goods will conform to the affirmation or promise. THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES WITH RESPECT TO THE GOODS OR THEIR INSTALLATION, USE, OPERATION, REPLACEMENT OR REPAIR, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS OF PURPOSE; AND THE GOODS ARE BEING PURCHASED BY BUYER "AS IS". SELLER WILL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL LOSS OR DAMAGE RESULTING FROM THE USE OR LOSS OF USE OF THE GOODS.

Appendix E. CE Conformance

Approved CE Marking For The MT91 Configuration

Approved Options

1) all insertion U-lengths
2) all specified application combinations
3) 85 to 260 VAC power input.
4) all metallic sensor elements
5) all cable jackets and lengths
6) Aluminum and 300 series stainless steel NEMA 4X local and remote applications.
7) All process connections and flanges
8) All process temperature ranges

Approved Part Numbers

MT91	1-15	16	17-18
	■	2	■

■ All options conform to CE marking requirements.

XY X or Y options only conform to CE marking

All other configurations must be approved for CE marking conformity by FCI's Engineering Department.

Conditionally Approved CE Marking

24 VDC Factory Selectable Options

Input power of 24 VDC may be optionally selected. Since the manufacturer does not supply the power source or transformer for these connections, the responsibility for the conditioning of these sources and associated compliance to the EMC Directive shall be the responsibility of the user.

Panel and Rack Mounted Control Circuit Options

Conditionally approved models included in this family are supplied with panel or rack mounted electronic assemblies without a remote enclosure (MT91 block 16, codes 1 or 3). Since the manufacturer does not supply an EMC enclosure for these configurations the associated compliance to the EMC directive shall be the responsibility of the user.

Installation Conformity Criteria

Grounding

The enclosure must be grounded to earth ground through a path of less than 1 ohm.

Interconnecting Cables

All interconnecting cables between the local enclosure, power source and monitoring device shall be enclosed in metal conduit. AC power input cabling shall be enclosed separately in conduit before entrance into the instrument and is not to be combined with switch or monitor output cabling.

Documentation Location

European Location

The technical documentation file part A resides at Fluid Components Intl, European Service Center, Beatrix De Rijkweg 8, 5657 Eg Einhoven, Netherlands, Phone: 31-40-2-571-972 FAX: 31-40-2-517-809.

Manufacturer Location

The technical documentation file part B resides at the Configuration Management department of Fluid Components Intl, 1755 La Costa Meadows Dr. San Marcos, CA. 92069 USA, Phone: 1 (800) 854-1993
FAX: 1 (619) 736-6250.