INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Multipoint Flowmeter
Models MT86 and MT86HT

Doc. No. 003162 **Rev. F**

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Fluid Components Intl
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San Marcos, CA 92069
Attn: Customer Service Department

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For product information or product support outside the contiguous United States, Alaska, or Hawaii, contact your country's FCI International Representative or the one nearest to you. See list on following pages.

Appendix C contains a detailed explanation of the FCI customer service policy on returns, adjustments, in-field or factory repair, in- or out-of-warranty.

Reserved for Domestic Rep Map

Reserved for International Rep Map

REVISIONS

REV.	DESCRIPTION	DATE	AUTHOR
E	Entire text has been re-written.Errata #17EN000003 has been incorporated.	4/15/94	R. Sanders
F	Reformatted manual using new publishing program. There are minor differences in how the pages appear. There are changes in terminology for clarification purposes along with other modifications to the text and illustrations. Due to the number of changes no change bars will appear. Incorporated Errata 17EN00015. Incorporated changes for the software upgrade. Added remarks for ESD protection. Added CE mark information in Chapter 1. Added Appendix D to include CE information. Change Bars will not apper due to the number of changes.	10/10/96	R. Sanders

Contents

Tables

Figures

Symbols

The following symbols are used throughout the manual to draw 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 MT86 and MT86HT is an air and gas mass multipoint flowmeter that incorporates a flow element(s) that is connected to a flow transmitter. Together they are designed to measure the mass flow in pipes, ducts or stacks. The flowmeter accurately measures the irregular flow profiles found in pipes, ducts or stacks. An MT86 or MT86HT measures flow from up to eight individual sensing points. An average of the individual flow signals gives an output signal that represents the total mass flow. This output signal will operate up to four different output modules of choice.

Operating Principles

The flowmeter has flow elements containing sensing points that are connected to the flow transmitter (control circuit boards) by a wiring harness. The flow elements and the flow transmitter are usually separated by some distance that in some cases can be up to 1000 feet (300m). The output that comes from the flow transmitter goes to the customer's applications, such as valve control circuitry, alarms or meters. The operational theory of the flow element sensing points and the flow transmitter are as discussed below.

Flow Element

The flow element consists of 2 to 8 sensing points. Each sensing point has two pairs of thermowells (metal tubes) of the same size and shape. Each pair of thermowells is welded together. One thermowell pair has a heating element placed in one tube and an active Resistance Thermal Detector (RTD) placed in the other tube. The other thermowell pair has a reference RTD placed in one tube and an empty thermowell tube that is for mass equalization. See Figure 1-1 for a cut away view of one sensing point.

The two pairs of thermowells are physically separated by a distance that allows the process media to flow between them and yet prevents thermal interaction between the two pair.

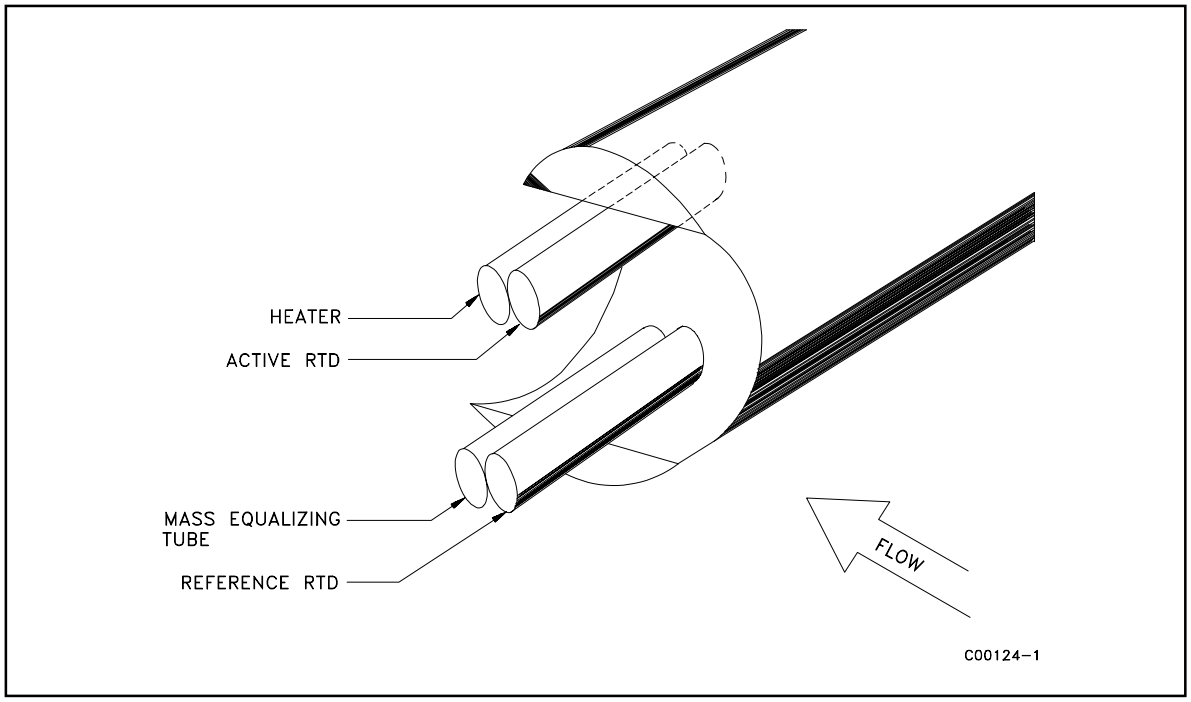

Figure 1-1. Cut-Away View of One Sensing Point

Flow Transmitter

The flow transmitter measures the voltage differential (DV) produced by the temperature differential (DT) between the active and reference RTDs for each individual sensing point. The flow transmitter amplifies the DV signal and converts it into a signal that is temperature compensated and linearized. The linearized signals from the sensing points are then averaged together and converted into the final output signal (4-20 mA, 0-5 Vdc, 0-10 Vdc, etc.) as specified by the customer.

The flow transmitter has a diagnostic alarm. If a problem exists with a sensing point, a Light-Emitting-Diode (LED) on the control board will flash to notify the customer.

Technical Specifications

- **Process connection**

  2 inch male NPT or 2 inch 150 lb. raised-face carbon steel flange.

- **Number of sensing points**

  Up to and including 8 sensing points.

- **Insertion length**

  The duct dimensions at the measurement site determine the insertion U-Length.

- **Material of construction**

  All wetted parts are 316 stainless steel with nickel-braze, per MIL-B-7883 using AMS 4777

- **Local enclosure (flow element terminal strip enclosure)**

  NEMA 4 enclosure with 1 inch female NPT connection ports.

- **Operating pressure**

  Standard MT86 is 0-50 PSIG or higher on application.

- **Operating temperature**

  Standard flow element: -50 to 350°F (-46 to 177°C).

  High temperature (HT) element: -50 to 850°F (-46 to 454°C).

  Flow transmitter: 0 to +150°F (-18 to 66°C) with LCD or -50 to 150°F (-46 to 66°C) without LCD.

- **Flow range**

  0.25 to 150 fps in gas under standard conditions (14.7 PSIA @ 70°F).

- **Flow element assemblies**

  May have 1, 2, 3 or 4 separate flow element assemblies. Must contain a minimum of 2 sensing points per flow element.

- **Remote enclosure (flow transmitter control circuit enclosure)**

  NEMA 4 enclosure with 1 inch female NPT connection ports.

- **Input power**

  Standard 100-130 Vac or 200-270 Vac, 50/60 Hz, 50 watt maximum. Optional 24 Vdc, 50 watt max.

- **Output signal**

  4-20 mA current loop capable of driving a 1000 ohm load. Optional:

  10-50 mA, 400 ohm load max.

  0-5 Vdc, 2 mA current max.

  1-5 Vdc, 2 mA current max.

  0-10 Vdc, 2 mA current max.

- **Interconnecting cable**

  24 AWG (min.) 8-conductor shielded cable with PVC insulation (100 feet maximum). Longer distances are possible using a heavier gauge wire for the heater circuit (see Table 2-1).

- **Turn down ratio**

  2:1 to 100:1 within flow element range customer specified.

- **Accuracy**

  ± 3% of full scale at the temperature of calibration; ±5% of full scale with temperature compensation over a range spanning 200°F. Manufacturer determines the accuracy for specific duct configurations upon submittal of a fully completed Multipoint Mass Flowmeter Application Data Sheet.

- **Repeatability**

  ± 1% of full scale.

- **Approvals**

  F.M., C.S.A., and CENELEC approvals are available for all MT Series Multipoint Mass Flowmeters.

Options

- **Enclosures**

  Explosion-proof NEMA 7 electrical enclosure is available for both the flow element and flow transmitter that complies with NEC Code, Class I, Divisions 1 & 2, Groups C & D; Class II, Divisions 1 & 2, Groups E, F, & G.

- **Flow Display Indicators**

  1) A three-and-one-half digit Flow Rate Display.
  2) An eight digit Flow Totalizer Display.

- **Available Outputs (up to four module circuit boards)**

  Switch point: DPDT relay at 2 or 10 amp, 115 Vac.

  Milliamp driver:
  Current loop, 4-20 or 10-50 mA.

  Analog voltage output:
  0-5, 0-10, or 1-5 Vdc.

  Remote sensor diagnostic alarm:
  SPDT relay, 6A at 115 Vac.

- **Rate Limit Board**

  Permits adjustment of the rate of change of the output signal with respect to the rate of change of the input signal. This option is used when the measured flow is fluctuating and a stable output signal is needed.

- **Mass-to-Volume Converter**

  Changes the mass flow signal to a signal representing actual cubic feet per minute or feet per second (actual velocity).

- **Accessories**

  The FC81 Field Calibrator simplifies calibration verification of an MT86/MT86HT in the field. This device provides the variable resistance required to input a Delta "R" test value and a digital read-out of the test output signal.

2. Installation

Receiving/Inspection

- Unpack carefully, observe Electro-Static Discharge (ESD) precautions if handling the flow transmitter.
- Inspect for damage to the flow element and the flow transmitter.
- Verify that all items in the packing list were received and are correct.
- Verify the Delta R Data Sheet and the Instrument Information Sheet are present in the plastic page protector found in the back of the manual.

If the above items are satisfactory then proceed with installation. If not, then stop and contact the FCI customer service representative for instructions.

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: Install the flowmeter with properly trained personnel only. Perform the installation according to the current edition of the National Electrical Code. Ensure that all power is OFF. Any instances where power is to be applied to the flowmeter will be noted in this manual. Where the instructions call for the use of power, 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 local or remote enclosure is not covered by product warranty.

The flow transmitter contains electrostatic discharge (ESD) sensitive devices. 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 antistatic 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 local (flow element terminal strip) enclosure, remote enclosure and flow transmitter control circuit serial numbers match. If they do not match, incorrect measurements will be made.

When multiple local enclosures are connected to one remote enclosure, each local enclosure serial number has a suffix that represents the flow element number. For example, if two local enclosures are connected to a remote enclosure, the local enclosure will have a base serial number of 123, then the first local enclosure would have the serial number 123-1. The second local enclosure would have the serial number 123-2.

Prepare or Verify Flow Element Location

The flow element location should have been previously determined before the time of order. Mounting the flow element in a position different than originally determined may cause reading errors.

The shape of the flow element is cylindrical with a diameter of 2.00 inches (50.8 mm). The flow element length (U-length) is customer specified. The recommended diameter for the clearance hole needed to mount the flow element is 2.16 inches (54.8 mm).

For the best performance, prepare an additional support for flow elements that are longer than 2 feet (61 cm). See Figure A-3 for the recommended connection.

Verify Dimensions

Verify the customer specified flow element U-length and instrument mounting interface dimensions are correct for the application. Compare the instrument hardware, Appendix A and the process interfaces for fit.

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. There is a FLOW ARROW etched in the FLAT. The FLOW ARROW indicates the direction of flow. See Figure 2-1 for details.

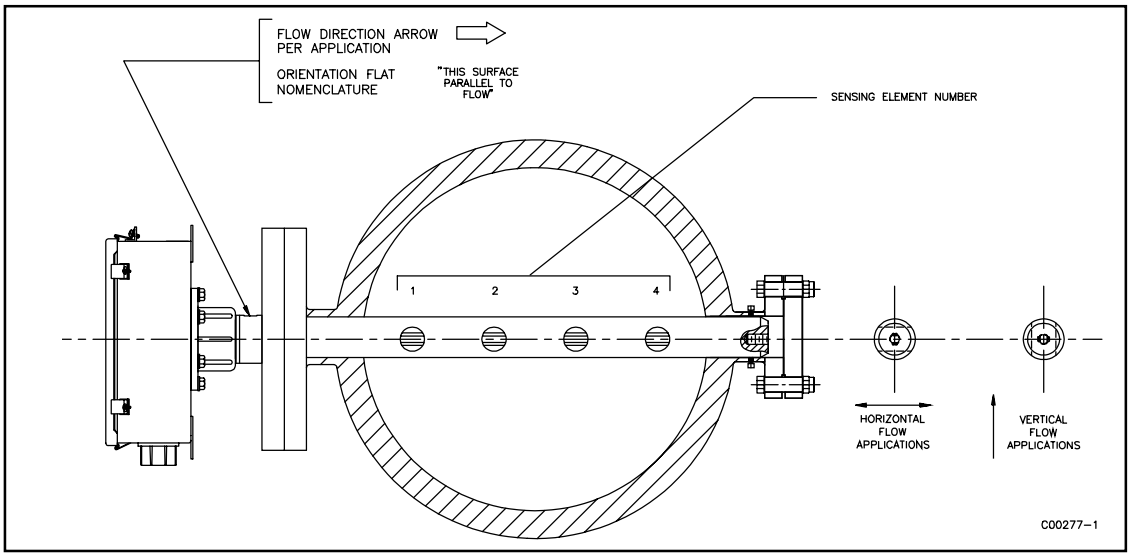

Figure 2-1. Flow Element Showing FLAT Area

Align the flow element so the FLAT is parallel to the direction of flow. Also, align the FLOW ARROW to point in the direction of flow. Failure to correctly install the flow element will reduce the accuracy of the flowmeter.

Install Flow Element

Install the flow element for the type of process connection used. Follow one of the next paragraphs to install the flow element. If applicable, connect the end of the flow element to a recommended mechanical support. See Figure A-1 for the end connection.

Threaded Mounting

Note: When mounting the flow element, use a lubricant or sealant applied to the male threads of all NPT connections. The lubricant or sealant and process environment should be compatible. Make sure all the process connections are tight. To avoid leaks do not over tighten or cross-thread the connections.

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

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

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

Flanged Mounting

1. Verify end hardware is loose if present. Carefully insert the flow element into the process mount. Align the flow element with the end support if present.
2. Attach the process mating flange with care. Maintain the correct orientation of the flow element to ensure flowmeter accuracy.
3. Verify that the FLOW ARROW points in the same direction as the process media flow, and the FLAT is parallel to flow.
4. Apply the appropriate gasket and/or sealant to the 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. For correct hardware and torque, refer to ANSI B16.5 specifications.
6. Tighten all of the connections.

Install Flow Transmitter

Caution: For flow elements in explosive environments, isolate the conduit before it leaves the environment. Use a potting "Y" to provide the isolation.

Mounting the Remote Enclosure

Figure A-1 shows the flowmeter enclosure with the physical dimensions for mounting of the flow transmitter enclosure.

Note: The factory recommends removal of the flow transmitter control circuitry while pulling the necessary cables; this will prevent damaging electronic components. To remove the circuit boards unbolt the four outermost screws on the mounting plate.

Power Connection Information

Conduit Routing

All electrical connections are to be made through the 1 inch female NPT opening in the remote enclosure. FCI strongly recommends that all electrical cables be run through an appropriate conduit for the protection of the flowmeter and personnel. See Figure 2-2 for the wiring diagram.

The flow transmitter design requires the power and output conduit to connect with the remote enclosure's left access port and the local enclosure conduit to connect with the right access port(s).

Protection of the flow transmitter from moisture is important. Keep the entry of the conduit into the enclosures in the downward direction so condensed moisture that collects in the conduit will not drain into the enclosure. The local enclosure may not be turned more than 180° using the threads on the enclosure to gain an acceptable orientation. In addition, FCI recommends sealing off the conduit with a potting Y or other sealing method to prevent moisture from entering the enclosures.

Minimum Wire Size

Table 2-1 shows the smallest (maximum AWG number) copper wire which 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
Relay (10A)	22	16	12	8	6	Not Recommend
Flow Element Wires*	24	24	24	22	22	18

*Requires a shielded cable. The shield is connected to the GND pin of TS_ of the input board. The other end of the shield is left floating (no connection to the flow element enclosure).
The standard cable provided is 22AWG.

Flow Transmitter Wiring Connections

See the wiring diagram in Figure 2-2 for the flow element wiring to the input boards. Run separate excitation and sense wires for the ACTIVE, REFERENCE, and GROUND connections. The flowmeter will not operate properly without these connections. If the ACTIVE and REFERENCE wires are reversed the flowmeter will output incorrect flow rates. Use shielded cable with all signal applications. Connect the shield to the input board only and not to the flow element terminal strip. Connect the shield to pin 1 of TS_ on the input board.

The connector for sensing point 1 must be plugged into the innermost connector on the input board which is plugged into P1 of the control board. Sensing point 2 is connected to the outermost connector of the same input board. Sensing point 3 is plugged into the innermost connector on the input board which is plugged into P2 of the control board. Sensing points 4 through 8 are plugged in the same manner.

Make the customer connections to the output modules (relay logic, current or voltage).

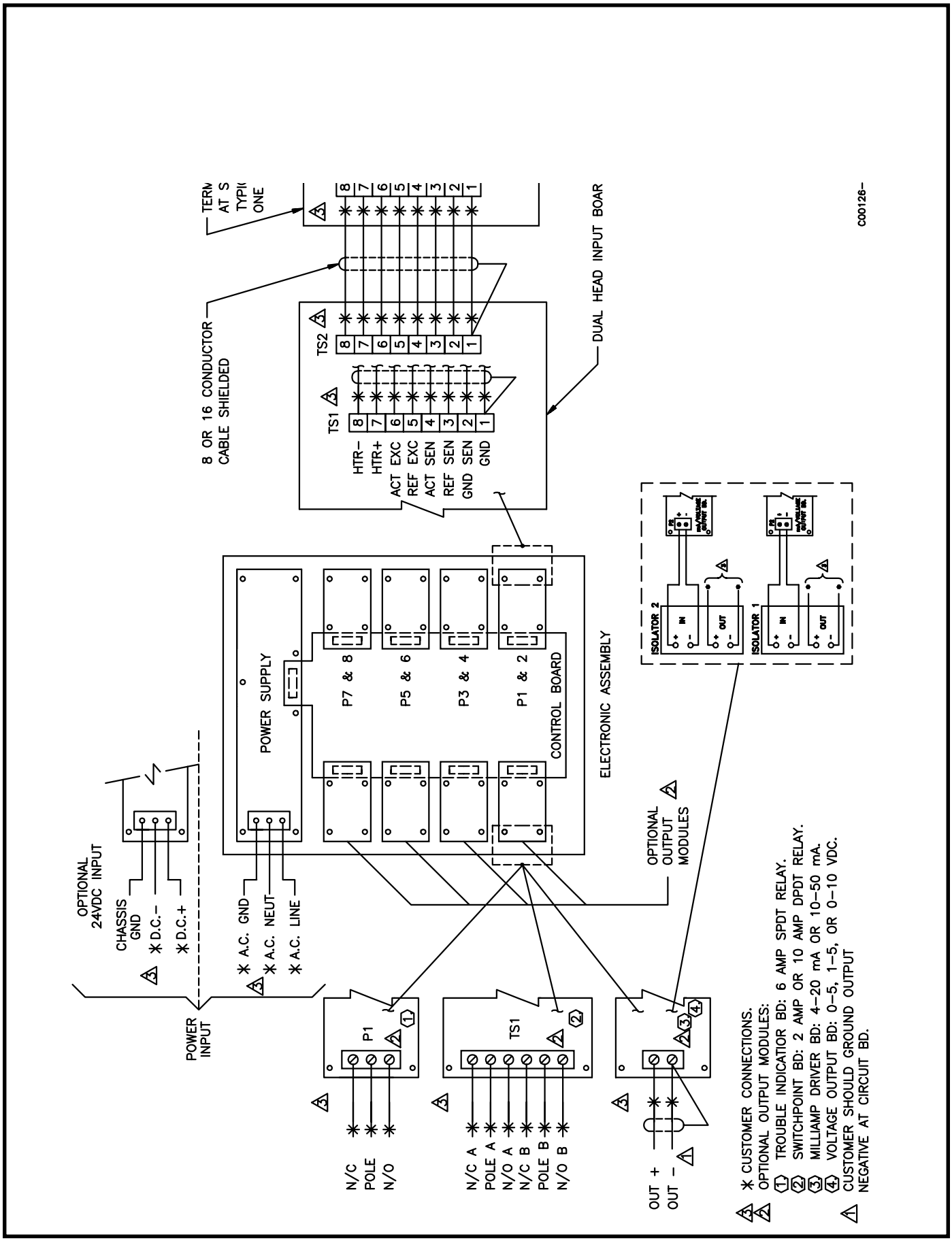

Figure 2-2. MT86, MT86HT Wiring Diagram

Input Power

Warning: The output terminals are not power isolated with use of 24 Vdc as a power source.

Note: Before inserting the cable core into the terminal strip connector, first turn the terminal screws 10 turns counterclockwise. If this is not done, there is a possibility of inserting the wires between the top half of the clamps and the frames instead of between the two clamp segments.

FCI strongly recommends installing an AC line disconnect switch (and possibly a fuse) between the power source and the flowmeter. The line switch is an easy way to remove power for calibration and maintenance procedures. Also the line switch is an added safety feature.

100 Vac, 115 Vac, 230 Vac or 24 Vdc is the power source for the flowmeter (use only one power source). Wire the power directly to the power supply terminal strip TS1.

Isolated Output Option and 4-20 mA Adjustment

An isolated 4 to 20 milliampere (mA) output is an available option. The isolated output is available by connecting a loop powered isolator module to the transmitter output. Figure 2-9 shows the isolator output module. The module has its own set of output terminals which provide an isolated 4 to 20mA output equal to the non-isolated instrument output. This one-to-one current isolation is used to prevent instrumentation ground loops. See Figures 2-10 or 2-11 for the appropriate wiring diagram to install the isolated output module.

Use of the isolator module will add a small signal conversion error to the instrument output and limit the output load to 350 ohms. The module must be adjusted in the field to the specific customer load. A red LED on the module indicates when loop power is applied.

1. Connect the customer load with a milliampere meter in series with the output terminals of the isolators. Observe the correct wiring polarity.
2. Connect a milliampere meter in series with the input terminals. Observe the correct wiring polarity.
3. Apply power to the instrument. Initiate a full process media flow. Allow a 10 minute warm-up period.
4. Adjust the isolator output span potentiometer (see Figure 2-3 for placement) so both of the milliampere meters read the same.
5. This completes the output isolator setup. Turn off the power, remove the milliampere meters and reconnect the wiring.

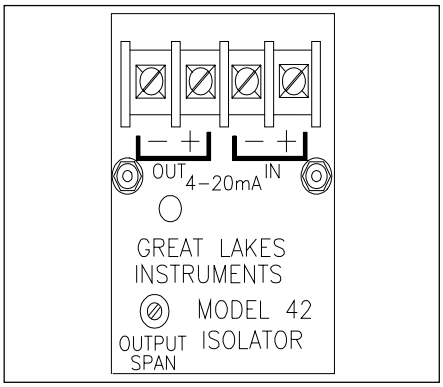

Figure 2-3. Isolator Output Module

Installation Quick-Check List

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

3. Operation

Introduction

The flowmeter has been configured and calibrated to custom 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.

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.

Apply Back-Up Battery Power

There is a totalizer option for the flowmeter. This option has a backup battery that keeps power applied to the memory that holds the accumulated count during loss of power. There is a jumper on the back of the totalizer and display board that needs to be repositioned to the ON position. See Figure 3-1 for the jumper location. The estimated life of the battery is 3 years of power off operation. The battery power is drained only when the operating power is off and the battery power is on. During shipment and storage, the battery jumper is OFF to conserve power.

Apply Power

Warning: When an open flowmeter has power applied, the operator assumes all responsibility for conformance to safety standards and safe practices.

Verify the wiring, then apply power to the flowmeter. There are no special instructions for shutdown of the flowmeter; just remove the operating power.

Wait a minimum of 5 minutes for flowmeter to stabilize. The display will indicate the current media flow. There are no operator actions needed because the flowmeter operates from the factory settings.

If the display is blank, is out-of-range for the expected values or is obviously not right then turn off the power and go to Chapter 5 - Troubleshooting, to find the problem.

Operator Interaction

There is little need for interaction between the operator and flowmeter. The flowmeter is fully automatic when it operates in the monitor mode. Setting the output signal and switch point relay closures as well as other options depend on individual applications. FCI advises the use of factory default settings that the flowmeter was ordered with. Do not reset the flowmeter's operating values by trial and error. Standard output options, such as a switch point relay closure, operate automatically as a function of the output signal level.

A calibration table can be found in the back of this manual. The table shows a listing of the actual mass flow values as indicated by the output signal. For example: using the standard 4-20 mA output signal, if the signal is 12.0 mA, find 12.0 in the milliamp row and read across to the next column for the measured flow.

The display provides an instant readout of mass flow. The display shows only the flow rates between the upper and lower limits of the calibrated range. For zero-based instruments the display will show zero whenever the flow rate is below the calibrated lower limit. For non-zero-based instruments the display will read the minimum specified flow rate.

The flow totalizer accumulates the total quantity of media that has passed the flow element over a specific time.

Short two connector terminals together on the display board to reset the flow totalizer display, see Figure 3-1 for details. In applications where the operator is required to reset zero, FCI recommends that these terminals be brought out to a convenient reset switch.

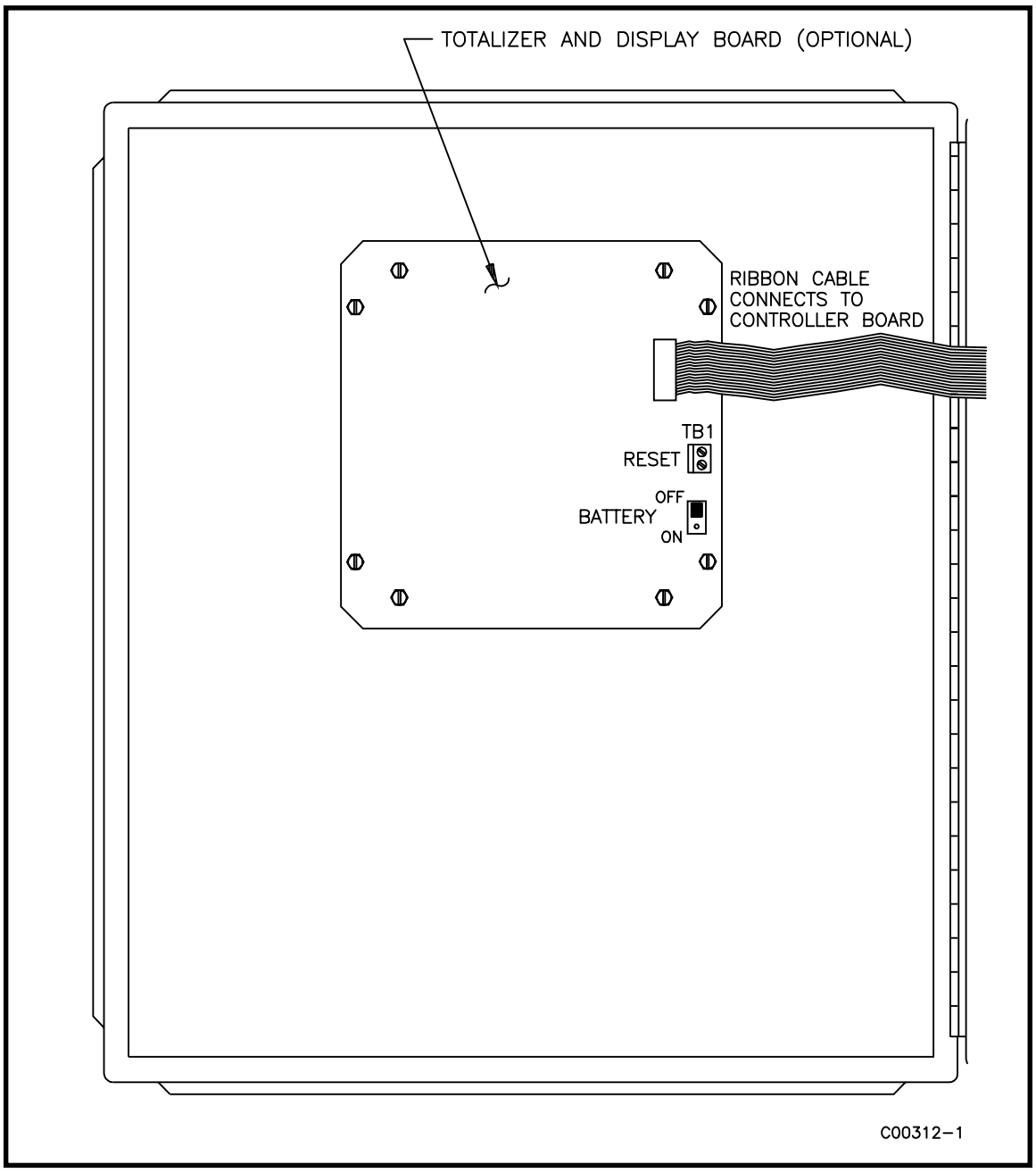

Figure 3-1. Battery Jumper and Reset Locations

Non-Zero Based Calibration

This is a factory preset item.

In a non-zero based calibration, the low-limit output signal (4 mA) is equal to the minimum calibrated flow. The minimum calibrated flow is a value greater than zero. The flowmeter's output signal will indicate the low-limit flow signal (4 mA) from zero flow up to the low-flow limit parameter. Use a non-zero based calibration when the minimum flow rate does not approach zero and the turndown ratios are small.

At no-flow, the minimum customer specified flow rate will appear on the display.

Zero Based Calibration

In a zero based calibration, the slope of the output signal is shifted so the low-limit flow output signal (4 mA) is equal to zero flow. See Figure 3-2 for details. Flowmeters cannot measure zero flow accurately. The flowmeter will readout the low-limit signal (4 mA) from zero flow up to the minimum calibrated flow. Then the output signal will step up to the proper signal value of the mass flow.

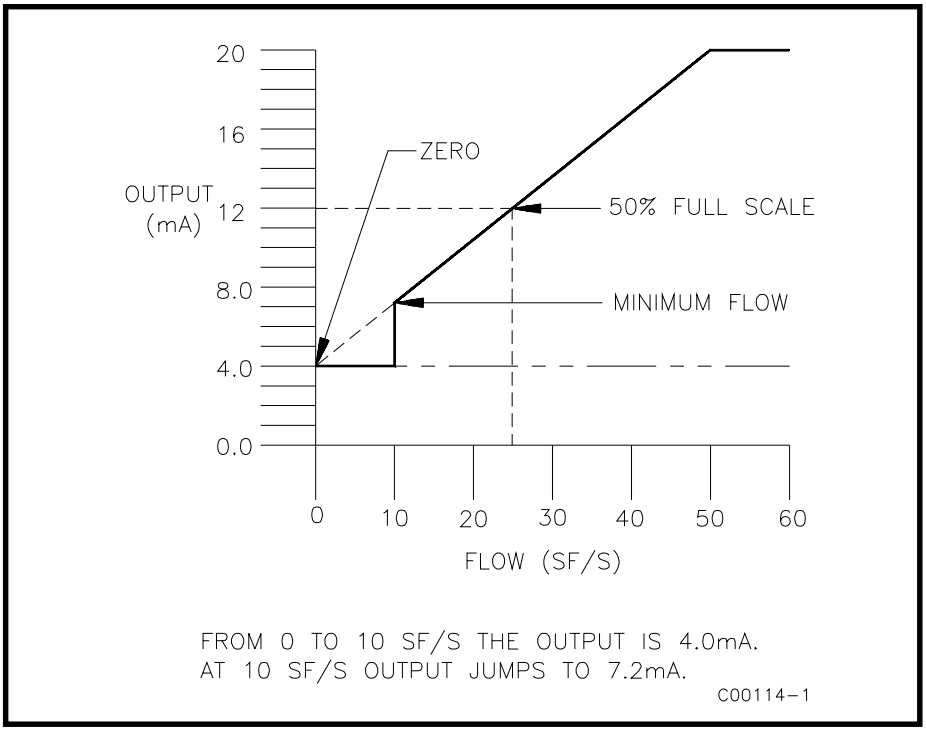

Figure 3-2. Zero Based Calibration

The output signal is easier to interpolate when milliamp output is interfaced with control room 0 to 100% gauges; 50% of the signal will correspond to 50% of the maximum flow rate.

Zero based flowmeters have less signal to resolve over full scale. A zero based flowmeter with a turndown ratio of 10:1 will have 10% less output range to resolve flow (5.6 mA to 20 mA instead of 4 mA to 20 mA in a non-zero based flowmeter).

Delta "R" Table

The actual data chart for this particular flowmeter can be found in the page protector at the back of this manual. The Delta "R" part of this sheet gives the factory calibration measurement points of the Delta "R" differences between the REF and ACT RTDs at certain flow rates. These measurements used by the factory determine the linearization coefficients that are applied over the desired flow range. The corresponding current and voltage output readings are also shown for the factory default settings.

The flow versus Delta "R" relationship is fixed for a given set of sensing points. There is a lookup table that is in the page protector in the back of this manual. It is a printout of factory default settings for zero and offset readings. The table shows the relationship between the displayed mass flow readings as they are related to the current output. The output is calculated over the entire flow range with the use of a fitting equation and its respective coefficients.

The Delta "R" Table has a great deal of useful information. The table can be used to verify the correct operation of the flow transmitter without the flow elements connected. By using the Delta "R" Table the flow element sensing points are simulated with precision resistors or decade boxes.

Generating New Delta "R" Tables

Using the FC81 Calibrator

1. Obtain the correct FC81 Field Calibrator for the MT86 or MT86HT Flowmeter:

   Model FC81-8 is used for the MT86 with 1000 ohm flow element sensing point RTDs.
   Model FC81-7 is used for the MT86HT with 100 ohm flow element sensing point RTDs.

2. Turn the operating power OFF and then disconnect the flow element cable from the terminal block TS1 on the input board.
3. Connect the FC81 Field Calibrator cable to terminal block TS1 (sensing point 1). Also, connect the cable to one of the output module connectors P7, P8, P9, or P11 that is located on the control board. A set of precision decade boxes can be used instead of the FC81 Field Calibrator. Use the wiring diagram in Figure 5-4 to connect the decade boxes.
4. On the control board, monitor the voltage (VDC) across TP10 (-) and TP9 (+) and from TP5 (-) to J8 (+).
5. On the output board, monitor the output signal (4 to 20 mA, 10 to 50 mA, 0 to 5 VDC, etc.,) with a DMM.
6. Close switch SW1-3 that puts the flow transmitter in the manual mode; this enables the head-select switch SW2 to select and monitor one sensing point.
7. Set the head-select switch SW2 to the number one (1) position.
8. Verify that switch SW4 is in the OP (OPerate) position.
9. Turn the operating power ON and let the system stabilize for a minimum of 5 minutes.
10. Set the FC81 Field Calibrator to the "READ VOLTS" position and remove the "ADD OHMS" by setting both buttons to the OUT position. The voltage on the FC81 Field Calibrator can now be read. This is the same voltage that is across TP5 (-) and J8 (+). Adjust the voltages by turning the "OHMS ADJUST" potentiometer.
11. On a blank Delta "R" sheet, write down the serial number of the flowmeter and the flow element serial number. Blank Delta "R" sheets are obtained from FCI Customer Service.
12. Adjust the "OHMS ADJUST" potentiometer to give an output of 4.00 mA, which is zero volts on the FC81 Field Calibrator.
13. On the Delta "R" sheet record the TP9 to TP10 voltage, the TP5 to J8 voltage (which is the same voltage that the FC81 Field Calibrator displays), the MILLIAMP OUTPUT and the LOCAL DISPLAY reading, if applicable.
14. Depress the "SET OHMS" button on the FC81 Field Calibrator to display the new Delta "R" value for the 4.00 mA output. With the FC81 Field Calibrator "SET OHMS" Button depressed the flowmeter does not read the Delta "R" values. The DMMs will give open circuit or random values.
15. Record the new Delta "R" on the data sheet. For Model FC81-8 Field Calibrator the displayed Delta "R" value is divided by 10 . For Model FC81-7 there is no division necessary.
16. Set the calibrator to "READ VOLTS" and then adjust the "OHMS ADJUST" potentiometer to give the following outputs: 5.00, 6.00, 8.00, 12.00, 16.00, and 20.00 mA and repeat Steps 13 through 16 for each.
17. Turn the operating power OFF. Then transfer the FC81 Field Calibrator cable to terminal block TS2.
18. Turn the operating power ON. Allow one minute for the flowmeter to stabilize.
19. Set the calibrator to "Read Volts" and repeat Steps 10 through 16. Remember to set the head-select switch, SW2, to the number 2 position for sensing point number 2.
20. Repeat this procedure for all the remaining sensing points in the system. Remember to set the head-select switch SW2 to the sensing point number that a new Delta "R" table is generated for.
21. When the Delta "R" table has been completed for the whole system, set the head-select switch to the total number of sensing points in the system. For example, a flowmeter that has 4 sensing points should have the head-select switch SW2 in position 4.
22. Open switch SW1-3, which places the flow transmitter in the automatic mode. This puts the flowmeter back into the operation mode.

New Calibration Procedure (in field)

Note: The flowmeter is calibrated for use with specific customer applications and flow ranges. There may be cause in the field to readjust the calibration to meet the field data or applications.

A flowmeter EPROM stores data to accommodate a range expansion of up to 25% above full range. If any changes are performed a new Delta "R" table will be needed to represent the adjustment. If an output adjustment is made, properly record the data and make it available for FCI records.

The flowmeter has a method for changing the span and zero adjustment in the field without losing the original factory setting. The factory set span and zero will have jumpers J1, J5 and J7 installed, see Figure 5-3 for the electrical assembly layout. FCI recommends that after any adjustment are made to the output, a new Delta "R" table should also be made. Once an adjustment is made the original Delta "R" table does not represent the changes made.

Span Adjustment Only

The true flow rate of the process flow and the indicating milliamp output of the flowmeter need to be known before going on with the following adjustment procedure. Record and have the information available for FCI to review.

The flow rate should be above 60% of full scale to justify a span adjustment only. Do not perform a span adjustment if the data obtained is at a flow rate below 40%.

The following procedure is for sensing point (head) number one (1), but any sensing point can be used. The sensing point number that is selected must match the head number selected at the head-selector, switch SW2.

1. Record the true flow of the process media and the flowmeter's milliamp output.
2. Turn the operating power OFF.
3. Connect the FC81 Field Calibrator to sensing point number 1. A set of precision decade boxes can be used instead of an FC81 Field Calibrator. For the decade box wiring diagram refer to Figure 5-4.

   Model FC81-8 is used for the MT86 with 1000 ohm flow element sensing point RTDs.
   Model FC81-7 is used for the MT86HT with 100 ohm flow element sensing point RTDs.
4. Close switch SW1-3 that puts the flow transmitter in the manual mode; this enables the head-select switch SW2 to select and monitor one sensing point. Turn ON the operating power.
5. Adjust the FC81 Field Calibrator, or precision decade boxes, to give the milliamp output that was recorded in Step 1. Record the Delta "R" that produced this output.
6. Remove jumpers J1 and J7. Add jumpers J2 and J8. This makes the span circuitry active.
7. With the FC81 Field Calibrator still at the Delta "R" from Step 5, adjust the span potentiometer, R16, to the new output as calculated from the true flow measurement in Step 1.
8. From the Delta "R" table, put in the Delta "R" resistance value that represents the 4.0 milliamp output. Verify that the output has not been affected by the span adjustment.
9. Turn OFF the operating power. Open switch SW1-3, and position the head-select switch SW2 to the number of sensing points in the system. This puts the flowmeter back in the operation mode.
10. Remove the FC81 Field Calibrator or decade boxes and connect sensing point number 1 to the input board.

Span and Zero Adjustment

As with the span adjustment, field data is also needed to perform adjustments. The information that is needed is the true flow rate and the indicating milliamp output of the flowmeter. Record and have the information available for FCI to review. The procedure is basically the same as the span adjustment procedure. See Table 3-1 for jumper positions.

Table 3-1. Jumper Configuration For Output Adjustment

MODE	INSTALL JUMPER							
	J1	J2	J3*	J4*	J5	J6	J7	J8
Factory Set Span and Zero	YES	NO	YES	NO	YES	NO	YES	NO
Span Only Adjust Activated	NO	YES	YES	NO	YES	NO	NO	YES
Span and Zero Activation	NO	YES	YES	NO	NO	YES	NO	YES

* J3 and J4 will always be in this position unless the factory has authorized option changes.

1. Repeat steps 1 through 5 from above. Record the Delta "R" that was required to generate the milliamp output for both the low and high flow rates.
2. Remove jumpers J1, J5 and J7. Add jumpers J2, J6 and J8, to make the span and zero circuitry active.
3. Adjust the FC81 Field Calibrator, or precision decade boxes, to the Delta "R" resistance that represents the low flow milliamp output of Step 1.
4. Adjust the zero potentiometer, R17, on the control board to give the milliamp output that represents the calculated low flow.
5. Adjust the FC81 Field Calibrator, or precision decade boxes, to the Delta "R" resistance value that represents the high flow milliamp output from Step 1.
6. Repeat Steps 3 through 5 until the correct milliamp output matches the Delta "R" for the high and low flows.
7. Disconnect the FC81 Field Calibrator or precision decade boxes and reconnect the sensing point to its original input board.
8. Return switch SW1-3 to the open position.
9. Set the head-selector, SW2, to the number of sensing points in the system. The flowmeter can be reset to the factory set calibration with the use of the original jumper setup. The originally installed jumpers are J1, J3, J5 and J7. The above span and zero adjustments are not in effect when the flowmeter is in the original configuration. The factory set calibrations are in control of the flowmeter. Table 3-1 shows the jumper settings that are needed to make the zero and span adjustments active. Figure 3-3 shows the zero and span effects on the flowmeter.

If only the zero adjust needs to be done, the span and zero jumpers will need to be set. Then proceed with the zero adjustment.

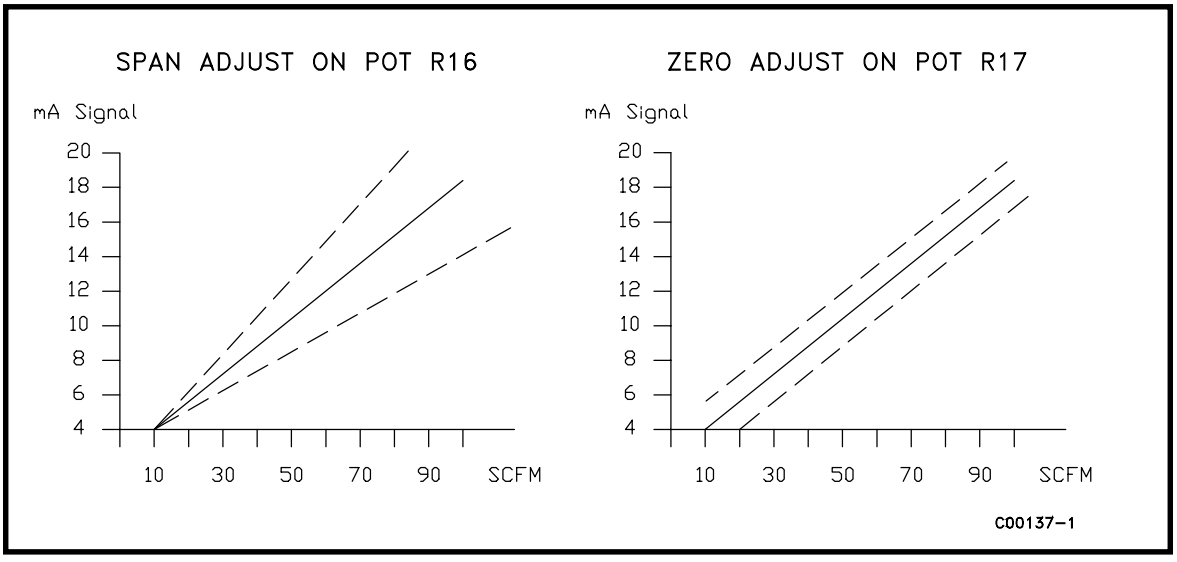

Figure 3-3. Zero and Span Adjustment

If a span and zero adjustment can not be done, the other choice for adjustment is an EPROM replacement. The EPROM stores the data that represents the calibrated flow rate and the performance curve. FCI can provide a new EPROM with the new data and/or range. The customer does have to provide FCI with Analog-to-Digital (A/D) information and the flow rate so the EPROM can be made. Look at the Delta "R" table to get the A/D number. In the Delta "R" table, one column is categorized as Voltage In Non-Linear, [TP9 (+) to TP10 (-)].

Use the following equation to calculate the A/D number for the Non-Temperature Compensated flowmeter only. Write down the results in the chart shown in Figure 3-4.

$$A/D = ([TP9 - TP10 (Vdc)]/2) \times 5(4096)$$

For the Temperature Compensated flowmeter, the A/D equation is:

$$A/D = [([TP9 - TP10 (Vdc)]/2) \times (4096)]/(TC\ Gain)$$

TC Gain is a function of the reference temperature. Additional data for the TC Gain is needed. This data is the REF SEN (+) to GND SEN (-) voltage from terminal block TS#.

Note: This A/D versus flow information is needed for each flow element sensing point in the flowmeter.

FCI strongly recommends that as much data as possible be gathered because the calibration will be only as good as the data supplied. Once a new EPROM is provided it will need to be installed (see the Repair procedure in Chapter 5) and a new Delta "R" table generated (see the preceding section for the procedure).

A/D DATA SHEET

SERIAL NUMBER_____ DATE_____
SERVICE _____ UNIT_____
FLOW RATE/LOAD _____ COMPANY_____
OUTPUT (mA) _____ (TOTAL OUTPUT)

SENSOR POINTS	DIS	mA	TP9-10	R. VDC*	A/D**
1					
2					
3					
4					
5					
6					
7					
8					

SENSOR POINTS	DIS	mA	TP9-10	R. VDC*	A/D**
1					
2					
3					
4					
5					
6					
7					
8					

* R. VDC is the reference voltage measured at the individual connectors from points numbered 2(-) to number 3 (+).

** A/D will be calculated at FCI with the above information.

Close dip switch 3 at SW1 (for manual operation) then dial the head selector, SW2, to the desired flow element.

Figure 3-4. A/D Data Sheet

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 divices. Use standard ESD precautions when handling the flow transmitter. See Chapter 2, Installation, for ESD details.

Introduction

The flowmeter needs very little maintenance. There are no moving parts or mechanical parts subject to wear in the flowmeter. The flow element that is exposed to the process media is all stainless steel construction with nickel braze. The flow element is only subject to chemical attack based on the corrosion relationship between the flow element sensing point material and process media.

Maintenance

No specific maintenance steps are made for inspecting, cleaning, or testing procedures without detailed knowledge of the process media components. However, shown below are some general guidelines for maintenance. Use operating experience to set the frequency for each type of maintenance.

Calibration - Every 18 months as a minimum, verify the calibration of the flowmeter and re-calibrate if necessary (contact the factory).

Electrical Connections - Periodically inspect the cable connections, the terminal strips and the terminal blocks for good connections. Verify that terminal connections are tight and physically sound with no sign of corrosion.

Enclosures - Verify that the moisture barriers and seals that protect the local and remote enclosures are in tact.

Electrical Cables - Periodically inspect the power cable, flow element cable(s) and output cable. Check for deterioration of the cable's insulation.

Flow Element Mounting 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. Also the flow element can be removed at appropriate plant shutdown schedules. 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 build-up could cause faulty readings. Clean the flow element as needed with a soft brush and available solvents (compatible with stainless steel).

5. Troubleshooting

Warning: Only qualified personnel should attempt to test this instrument. 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 Troubleshooting

At this point, observe the system setup to verify operation. 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 Output	Check power application, check power supply fuse.
Flashing LED	Set SW2 on the control board to the total number of sensing points.
Unexpected Outputs	Check all connectors for proper seating. Switches SW1-1 through 1-3 should be open, 1-4 is a temp. comp. switch, that is open when temp. comp. is used and closed when temp. comp. is not used. Check jumper positions (factory set positions are jumpers 1, 3, 5 and 7 installed). The above switches and jumpers are on the control board. Check the flow elements FLAT and FLOW ARROW versus the flow media.

Troubleshooting Equipment

2 each, Digital Multi-Meter (DMM) capable of measuring ohms, milliamps, and AC or DC voltage with a 4 1/2 digit resolution.

3 each, precision decade resistance boxes (however they are optional if fixed precision resistors are used).

1 each, 1K ohm resistor for model MT86 or 100 ohms for model MT86HT.

Non-Maintenance Observations

At this point, 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 element(s) 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. See Chapter 2 for a complete explanation of serial numbers.

Check Input Power

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

Check Instrument Installation

Review the instrument installation information given in Chapter 2 to verify correct mechanical and electrical installation. Be sure the connectors are firmly mated, and the wires are firmly attached to the connector. (Be sure the wires are inserted between the metal clamps and not between the clamp and plastic connector enclosure.)

Check for Moisture

Check for moisture in the enclosures. Moisture on the electronics can cause faulty operation.

If a component of the process media is near its saturation temperature, then the component may condense on the sensing points. Liquid on the sensing points will drive the flow measurement higher than the true measurement.

Check Application Design Requirements

Application design problems usually occur with first time application instruments, although the design should also be checked on instruments 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.

Check Flow Element Placement

If there are measurement errors check for process flow irregularities. A swirling or pulsating flow can exist near valves, elbows and other obstructions. The flow element should be placed in a straight pipe run with 20 pipe diameters upstream of the flow element, and 10 pipe diameters down stream of the flow element.

Check Flow Element Orientation

Verify that the FLAT on the flow element is parallel to the pipe and the FLOW ARROW points in the direction of the flow stream. If the FLAT and the FLOW ARROW are not correct, the flow measurement will not be correct. See Chapter 2 for the instructions on proper installation.

Check Proper Flow Element Insertion Depth

The flow element's sensing points must be located at the center line of the pipe unless the factory specifies otherwise. Improper insertion depth may cause error in the flow measurement. See Chapter 2 for the instructions on proper installation.

Check Flowmeter Switch Positions

Switches SW1-1, SW1-2 and SW1-3 should be in the open position. Switch SW1-4 should be in the open position if the temperature compensation mode is used. Switch SW1-4 should be in the closed position if temperature compensation is not being used. An easy way to verify temp. comp. is used is to see if the top of the null and gain potentiometers have been sealed. If they are sealed the flowmeter is setup to use temperature compensation. If they are not then no temperature compensation is used. (An open switch is the switch depressed on the left or lower side of the switch bank.

Verify that the head-select switch SW2 is set on the number that corresponds to the last sensing point that is connected to the flow transmitter.

Verify that the switch SW4 is in the OP position.

Troubleshooting Process

Verify Delta " R" Sheets

Verify that the Delta "R" sheets in the rear of this manual match the flowmeter's serial number. If there is a miss-match the calibration could be incorrect. Contact FCI if the proper Delta "R" Sheets are missing.

Verify Faulty Flow Elements

Caution: Inform all personnel involved with monitoring the flow media that the flowmeter output readings may change. The change of output could affect the plant peripheral equipment and or alarms.

To identify a bad flow element rotate the Head-Select switch, SW2, through its numbered positions. Pause at each position to monitor a red Light Emitting Diode (LED), CR1. CR1 is located on the MT86 Control Board. If a problem exists with a sensing point, the LED will flash. The LED may also flash if there is no sensing point that corresponds to the switch position. If the Head-Select switch is pointing to a valid sensing point and the LED is flashing the sensing point is bad.

Verify Resistance Readings

Use Figure 5-1 and Table 5-2 to determine if the flow elements are wired incorrectly or have failed. Turn the power OFF to the flow transmitter. Unplug the problem flow element at the Input Board. Measure the resistances described below by touching the DMM test leads to the terminal screws. (Remember to reconnect the flow element when the troubleshooting is finished.)

Note: If the system process does not allow the flowmeter power to be disconnected or the flow elements to be unplugged then proceed to the section, In-Depth Troubleshooting - Voltage Measurements.

All resistances in Table 5-2 are based on a temperature of 32°F (0°C). Resistances across the ACT and the REF RTDs for an MT86 are approximately 1000 ohms, resistances for an MT86HT are approximately 100 ohms. The resistances will continue to increase for higher temperatures at the sensing points. Resistance values will vary with temperature.

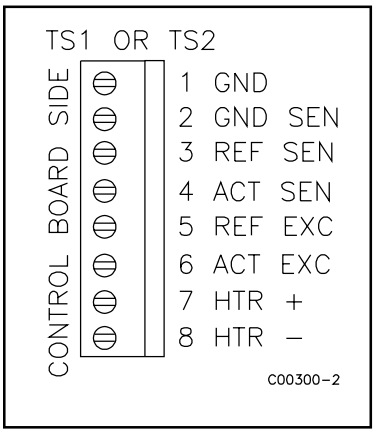

Figure 5-1. Terminal Plug

Table 5-2. Terminal Plug Resistances

Pin Number	Approximate Resistances
2 to 3	1000 Ohms*
2 to 4	1000 Ohms*
2 to 5	1000 Ohms*
2 to 6	1000 Ohms*
8 to 7	220 Ohms

*For the MT86HT flow element divide by 10.

The resistance of the active RTD will be greater than the resistance of the reference RTD whenever the heater is on and the flow rate is below the high-limit flow. Also if the flowmeter has been on for some time, the resistance of the active RTD will be greater than the reference until it cools down.

The flow element cable has a shield that ONLY connects to the flow transmitter side of the cable. There is no shield connected to the flow element.

If one sensing point appears to be an open circuit and the other sensing point appears to be twice the resistance, a wiring problem probably exists.

Voltage and current checks can be made on the flow elements. Before checking the flow element voltages and current, other voltages need to be verified first. See the following paragraphs for the proper sequence of checks to make.

If the flow element is bad, replace it with a spare flow element. Return the bad flow element to FCI for repair and, or replacement. See Appendix C for the Customer Service return procedure.

Troubleshooting Process - Voltage Measurements

Verify the use of the correct power source. Verify the power source is on and that the wiring matches the wiring diagram in Figure 2-2 of Chapter 2.

If the flow element resistance and wiring check out, recheck the power supply; the fuse and the AC and DC voltages. The power supply should be suspect when there seems to be multiple failures in the flowmeter.

Perform the following voltage checks with power applied to the flowmeter. The flowmeter should be put in normal operating conditions. Make all measurements with the use of a DMM that has a differential (non-grounded) input.

Note: The flow element sensing point voltage readings are for 1000 ohm RTDs.

Power Supply Source Voltages

Measure the power source at the power supply terminal block TS1 to be sure the correct power is applied.

Check the power supply voltages, using the test points provided. See Table 5-3 and Figure 5-2 for the proper operating voltages. If the voltage checks are correct, the power supply is functioning properly.

Table 5-3. Power Supply Voltages - Power Supply Board

POSITIVE LEAD (+)	NEGATIVE LEAD (-)	MEASURED VALUE
TP1	TP4	28 Vdc ±1 Vdc
TP2	TP4	15 Vdc ±.6 Vdc
TP3	TP4	5 Vdc ±.3 Vdc
TP5	TP4	-5 Vdc ±.3 Vdc
TP6	TP4	-15 Vdc ±.6 Vdc
VC6	VGND	-26.43 Vdc ±1 Vdc*
VC1	VGND	43.4 Vdc ±2 Vdc*

*Measurement points are not available on some power supplies.

If operating power is at terminal block TS1 and the test points do not have power, check fuse F1 on the power supply board.

Remove power and unplug the power supply from the control board. Apply power to the power supply and re-measure the voltages as shown in Table 5-4. If the voltage is still missing, then remove and replace the power supply.

Make the following measurements at the control board terminal strip. See Figure 5-3 and Table 5-4 for the measurements.

Table 5-4. Power Supply Voltages - Control Board

Positive Lead (+)	Negative Lead (-)	Measured Value
TP15	TP16	10 Vdc ±.02 Vdc
RN1 PIN 3	TP16	5 Vdc ±.04 Vdc
U5 PIN 7	TP16	-10 Vdc ±.06 Vdc

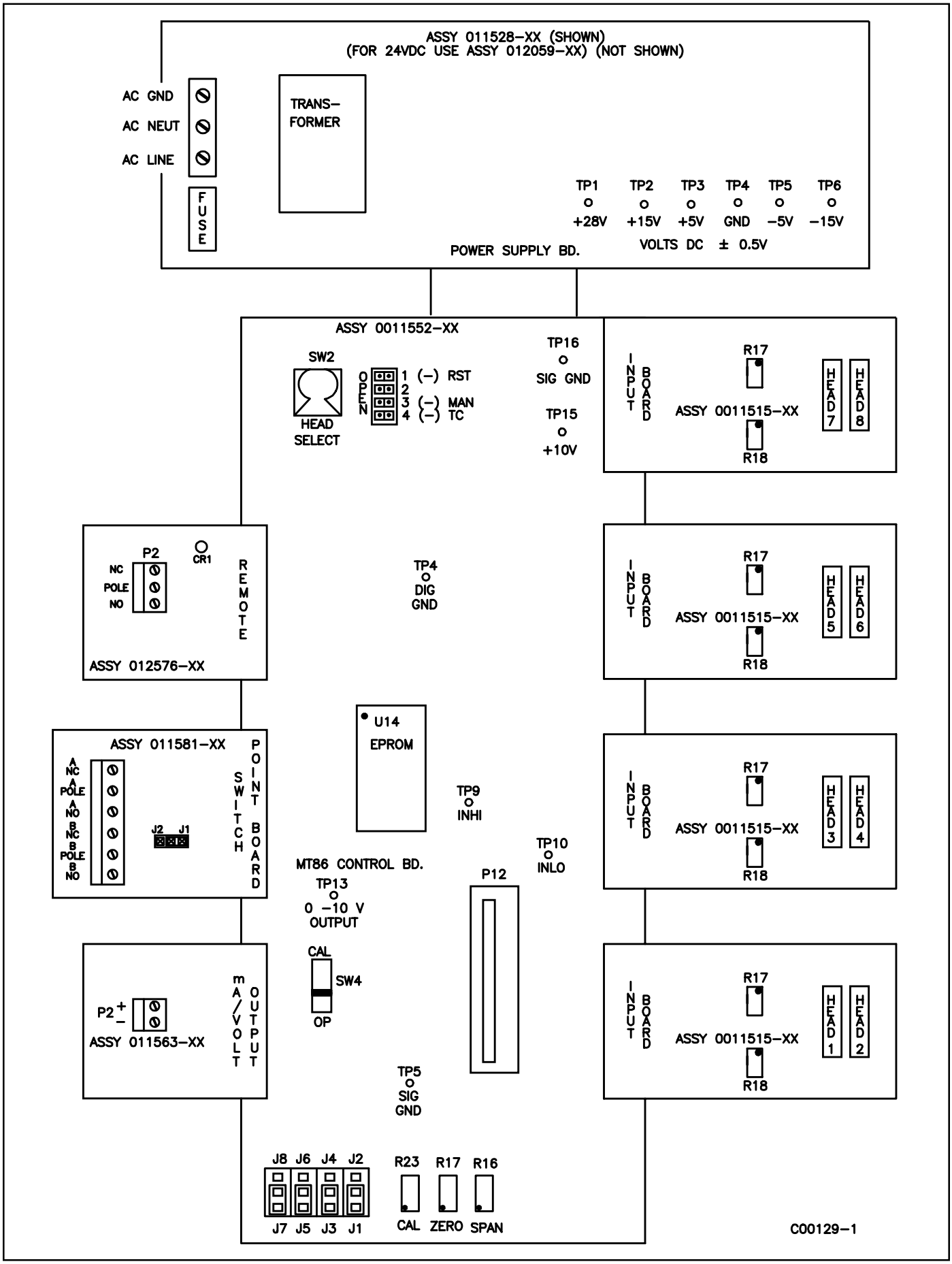

Figure 5-2. Electrical Assembly Layout

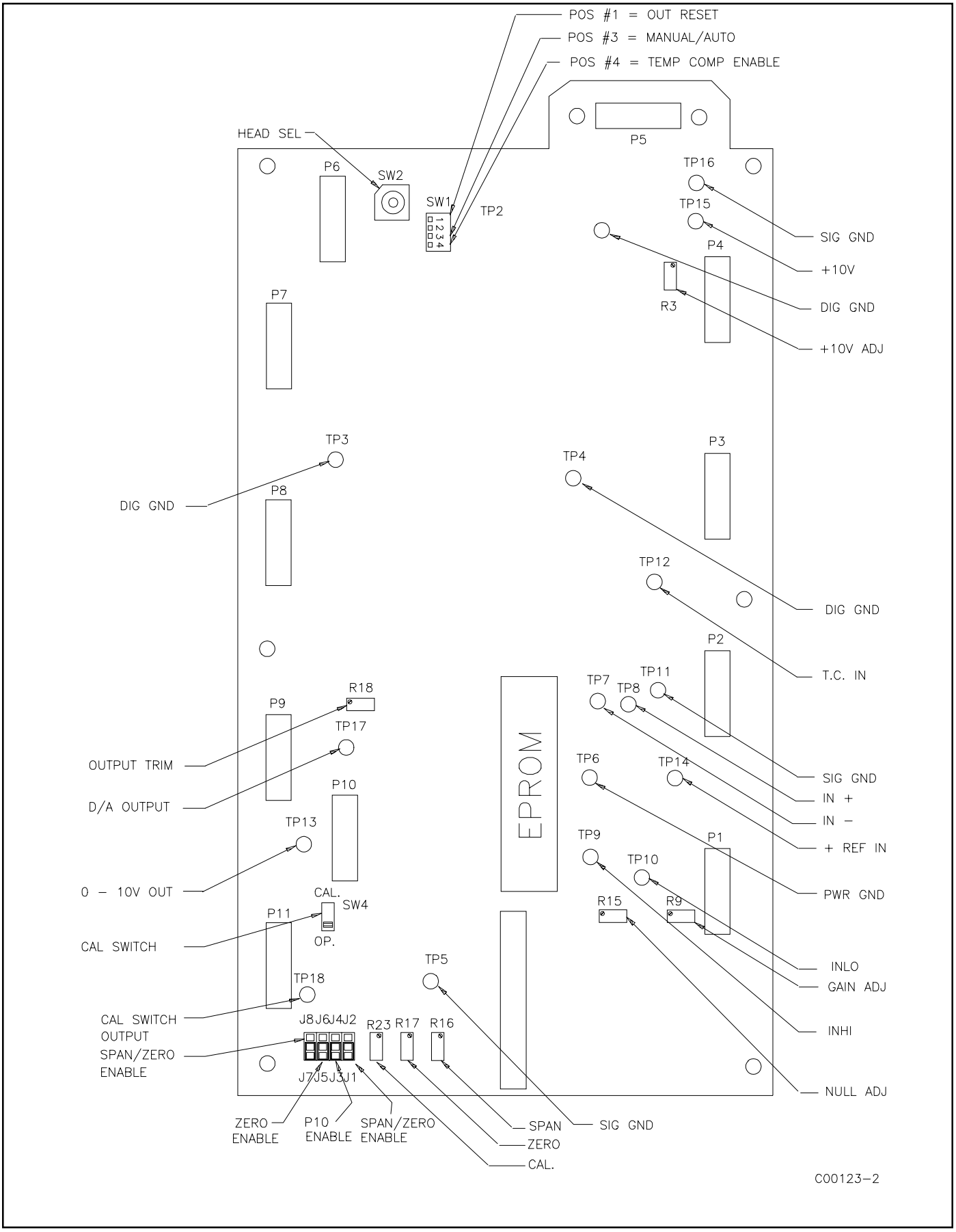

Figure 5-3. Control Board Layout

If a voltage is missing, unplug all the input and output boards. Measure the voltage again to see if the voltage has returned. If it has returned plug in the boards one at a time until the board is found that is loading the circuit. Remove and replace the board. If the voltage does not return, replace the control board.

Flow Element Operating Voltages

Close switch SW1-1. All output signals should go to the minimum signal level. Return switch SW1-1 to the open position after testing. Make the following measurements at the input board terminal strip. See Table 5-5 and Figure 5-1 for the measurements.

Table 5-5. Input Board Terminal Voltage Check

Positive Lead (+)	Negative Lead (-)	Measured Value	
		MT86	MT86HT
HTR +	HTR -	16.5 Vdc	16.5 Vdc ±1%
REF SEN	GND SEN	1.10 Vdc	0.275 Vdc*
REF EXC	GND SEN	1.10 Vdc	0.275 Vdc*
ACT SEN	GND SEN	1.25 Vdc	0.275 Vdc*
ACT EXC	GND SEN	1.25 Vdc	0.275 Vdc*

*The above readings are at 80°F (27°C) and 14.7 PSIA and at no-flow. The readings will vary with temperature and flow. However, the reference voltages should always match and the active voltages should always match. The active voltages should be higher than the reference voltages.

Troubleshooting Process - Flow Element Current

To measure the currents put a DMM in series with the desired lead. See Table 5-6 for the measurements.

Table 5-6. Current Measurements

Component	Measured Value (mA DC)	
	MT86	MT86HT
REF SEN	0.00	0.00
ACT SEN	0.00	0.00
REF EXC	1.00	2.50
ACT EXC	1.00	2.50
HTR +	75.0 ±5%	75.0

If there are no problems, the flow elements are good. Further trouble shooting must concentrate outside of this area. Go to the following sections.

Field Calibration Techniques

The flowmeter circuit cards and the flow element can be replaced as separate items. A field calibration is needed after the replacement of the parts.

Warning: Only qualified personnel should test or repair the instrument. The operator assumes all responsibilities for safe practices while trouble shooting. Damage due to negligence or lack of technician skill is not covered by the warranty.

Note: If field repair is attempted, replacement parts must be of the same part, type and number.

Calibration Verification Procedure (Using Decade Boxes)

Note: ALL MT86 flowmeters have 1000 ohm RTD sensing points.
ALL MT86HT flowmeters (high temperature flow elements) have 100 ohm RTD sensing points.
Determine which MT86 model type is present and use the ohm value that corresponds to the model type.

Verify each sensing point one at a time. Select the manual operation mode of the flow transmitter by closing switch SW1-3. When the flowmeter is in the manual mode, the flow transmitter monitors only the sensing point that the head-select switch SW2 selects.

Refer to the Delta "R" table for:

1. Delta "R" value in ohms
2. Vdc across 250 ohms
3. Milliamp output signal values
4. Raw signal (un-linearized)
5. 0-10 Vdc analog output signal
6. Display flow rate reading (in customer units) for each signal

Apply the recorded Delta "R" input values to the selected input terminal on the input board. Having the correct data sheet for the correct input terminal is important.

Procedure

If an FC81 Field Calibrator is used, then go to the verification with a field calibrator procedure.

1. Turn OFF the power to the instrument. Disconnect the flow element cable from the input board terminal block TS1.
2. Connect two decade boxes or one decade box and a fixed resistor to terminal block TS1 (or TS2 as applicable) on the input board as shown in the diagram of Figure 5-4.
3. Connect the positive lead of the DMM to the jumper J8 or to test point TP13 located at the bottom of the control board. Connect the negative lead to the signal ground TP5(-). This readout is the analog signal, 0-10 Vdc, that is before the span and zero activation circuitry.
4. Close switch SW1-3 that puts the flow transmitter in the manual mode; this enables the head-select switch SW2 to select and monitor one sensing point.
5. Verify that switch SW4 near the bottom of the control board is in the OP (OPerate) position.
6. Set the head-select switch SW2 to position number one; this selects the terminal block TS1 input where the decade boxes are connected.
7. Set the decade box for the reference sensing point to 1000.00 ohms (100.00 ohms for HT).
8. Refer to the Delta "R" Data Sheet and set the decade box for the active sensing point to 1000.00 ohms (100.00 ohms for HT) plus the recorded Delta "R" resistance value for each sensing point that is designated by SN - #.

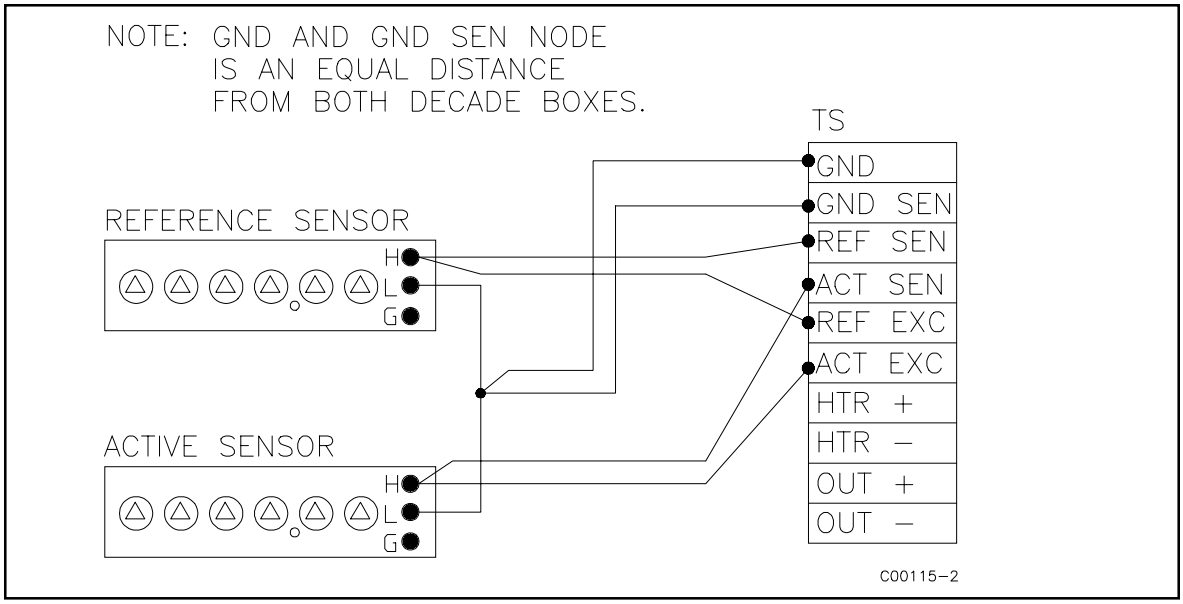

Figure 5-4. Decade Box Wiring Diagram

9. Turn the power ON and let the system stabilize for 1 minute. If the LED (CR1) is flashing, recheck the wiring per Chapter 2.
10. Read the signal displayed on the DMM. It should be equal to the signal value recorded on the Delta "R" Data Sheet ± 0.20 Vdc.
11. Repeat the above steps for other values on the Delta "R" Data Sheet. Adjust the active decade box to give one of the recorded output signals. Then, determine what the Delta "R" value setting is and compare it with the recorded value from the Delta "R" Data Sheet. The Delta "R" values should be equal to within ± 1.25%.
12. Repeat this verification procedure for each of the sensing points in the system. Be sure to use the proper Delta "R" Data Sheet for each sensing point being verified.
13. Upon completion of the verification procedure, set the head-select switch SW2 to the number of sensing points present in the system. The flow transmitter only scans the number of flow elements set on head-select switch SW2. Open SW1-3 for the automatic mode. Leaving these switches set in the wrong positions will cause an operation error.

Calibration Verification Procedure (Using an FC81 Field Calibrator)

Note: All output modules and display options operate from the same 0-10 Vdc analog output signal. If the optional span and zero activation circuitry has been added to the output signal, then the Delta "R" Data for the output modules and displays will not match the values recorded on the Delta "R" Data Sheet. See the jumper listing in Table 3-1 to determine if the span and zero activation circuitry option has been added to the output signal circuitry.

The FC81 Field Calibrator replaces the decade resistance boxes and the DMM that are used in the verification procedure. The field calibrator can switch its readout between the Delta "R" resistance values and the output signal. The use of the field calibrator requires having the correct Delta "R" Data Sheets for each flow element. The field calibrator is ideal for the field verification of MT86 and MT86HT installations.

Model FC81-8 is used for the MT86 with 1000 ohm flow element sensing point RTDs.

Model FC81-7 is used for the MT86HT with 100 ohm flow element sensing point RTDs.

FC81 Field Calibrator Control Functions

The display shows the Delta "R" values or the output signal level depending on the position of the function switch. The function switch, is a 2 position push-button switch, located on the left front panel of the FC81 field calibrator.

When the function switch is pressed to the in position the Delta "R" input resistance is displayed in ohms.

When the function switch is pressed to the out position the output signal is displayed in volts (0-10 Vdc).

Note: Follow the instructions on the front panel of the FC81 field calibrator to read the digital display.

Ohms Adjust

On the right side of the front panel is a 10-turn potentiometer that is used to input the desired Delta "R" resistance values.

Add Ohms Switch

A Delta "R" value may be more than the maximum value of the ohms adjust potentiometer. If this happens, there is another push-button switch on the right hand side of the panel that adds a fixed resistance to the displayed value.

If an MT86HT has a Delta "R" value greater than 10 ohms, use the add ohm switch.

If an MT86 has a Delta "R" value greater than 100 ohms, use the add ohm switch.

The display's readout does not show the ohms added. The ohms added MUST be added to the displayed resistance for determination of the actual applied Delta "R". The ohms added and the displayed value MUST be combined to get the actual Delta "R" value.

Connector Receptacle

On the rear panel of the field calibrator is an AMP brand receptacle with round post connectors for the test cable.

FC81 Field Calibrator Operating Procedure

1. This procedure adjusts the Delta "R" values to give a recorded output signal. Then Delta "R" value reading is compared to the recorded value. This procedure verifies the proper operation of the flow transmitter. Be sure to have the correct Delta "R" Data Sheet by checking the serial number of the flow element and the serial number on the sheet.
2. Turn OFF the power to the flowmeter. Record where the jumpers are on the control board before the testing begins. Remove the connector from the input board's terminal block TS1. Remove jumpers J2 and J8 if they are present on the control board. If jumpers J1 and J3 are not installed, then install them at this time.
3. Connect the cable from the FC81 field calibrator to the input board terminal block TS1. Connect the ribbon cable to any available output module connector; P7, P8, P9 or P11.
4. Turn the power ON and allow 5 minutes for the control circuits to stabilize.
5. Close switch SW1-3 that puts the flow transmitter in the manual mode; this enables the head-select switch SW2 to select and monitor one sensing point. Select the sensing point to be tested with the head-select switch, SW2.
6. With the FC81 field calibrator function switch in the out position, to readout the output signal, turn the ohms adjust potentiometer to give a recorded voltage out.
7. Push the function switch in and read the Delta "R" (in ohms) that produced the recorded voltage out reading. Record the measured signal.
8. Repeat Steps 6 and 7 for all values listed on the Delta "R" Data Sheet. The Delta "R" Data should repeat the recorded value within 1.25% of full scale.
9. If all the measurements are within the limits, turn the power OFF and move the FC81 field calibrator to the next sensing point to be verified. Repeat the procedure for the next sensing point to be verified. When the procedure is finished, open switch SW1-3, and position the head-select switch SW2 to the number of sensing points in the flowmeter.

Switch Point Calibration Procedure

The flowmeter has field adjustable switch point relays. Relay energization is changed by moving a plug-jumper on the circuit board. Each switch point circuit has an LED which indicates the relative condition of the flow signal. In all cases, the LED is illuminated when the flow signal is below the set point. Jumper positions J1 and J2 select the energization state of the switch point relay number 1 (K1). With J1 in place, the relay is energized when the signal is above the set point. With J2 in place, the relay is energized when the signal is below the set point.

1. Connect an appropriate meter to TP13 and TP5 on the main circuit board.
2. Set the calibration switch (SW4) on the main circuit board to the CAL position. See Figure 5-2.
3. Adjust the CAL potentiometer (R23) on the main circuit board until the meter readout shows the desired switch point signal level (select the desired signal level form the calibration table).
4. If the red LED is lit, turn potentiometer R3 counterclockwise until the LED turns off. With the LED off, turn R3 very slowly clockwise, just until the LED turns on, then stop.
5. Vary the set point by turning the potentiometer (R23) clockwise and counterclockwise through the set point to see that the relay changes at the desired point.
6. Remove the meter from the test points. Seal the adjusted potentiometer (R3).
7. Set the calibration test switch to OP, the operate position.

Switch Point Verification Procedure

Note: Switch point relay boards can be located on any of the output buss connectors P7 through P9 and P11. All switch points are totally independent of each other and may be set to actuate at any flow signal.

1. Connect an appropriate meter to TP13 and TP5 on the main circuit board.
2. Set the calibration switch (SW4) on the main circuit board to the CAL position. See Figure 5-2.
3. Adjust the CAL potentiometer (R23) on the main circuit board until the test signal level passes through the switch point setting. Observe the LED to determine exactly where the set point is.
4. If the red LED is lit, within 2% of the full-scale signal range, the set point is properly adjusted. If the set point is out of tolerance, go the switch point calibration procedure above. If the set point is within tolerance go to the next step.
5. Remove the meter from the test points.
6. Set the calibration test switch to OP, the operate position.

Analog Output Test Procedure

To verify operation of the output modules and related circuitry, a convenient test signal is applied to the analog output. Use this test signal to sweep through the full signal range (0-10 Vdc) and observe operation of the output modules and customer interface circuitry.

1. Place switch SW4 in the CAL (CALibrate) position.
2. Connect a DMM between test point TP13(+) and TP5(-) signal ground.
3. Potentiometer R23 adjusts the test signal level through the full scale 0-10 Vdc operating range.
4. Observe the operation of the output modules and the customer interface circuitry.
5. When the testing is complete, return the switch SW4 to the OP (OPerate) position.

Check Procedure for Totalizer and Rate Display

Note: Setting the rate display automatically sets the totalizer.

1. Remove the rate totalizer circuit board from it's mounting position in the cabinet door.
2. Connect the ribbon cable from connector P6 on the MT86 control board to connector P1 on the rate totalizer.
3. Turn the operating power ON.
4. Examine the full scale value of the measured units to be displayed. Set the decimal point on the display to use the highest resolution available (use as many digits as possible).

Note: The Liquid Crystal Display (LCD) shows six places, however, the right two zeros of the LCD are dummy zeros that make easier decimal point placement.

5. Select the rate decimal point by installing a jumper to give the decimal point. With the jumper in position number one (far right), there is no decimal displayed.
6. Set the period jumper for the period of the rate being displayed; SEC, MIN, HR, or DAY.
7. Refer to Table 5-7 for the correct position of the totalizer decimal point.

Table 5-7. Totalizer Decimal Point Position

RATE	SEC	MIN	HR	DAY
6	2	3	5	6
5	1	2	4	5
4	3*	1	3	4
3	2*	3*	2	3
2	1*	2*	1	2
1	3**	1*	3*	1
* Use label reading thousand "XXX"				
** Use label reading milliion "XXX"				

Note: "XXX" is the Mass or Volume unit used in the Rate Display.

Check Procedure for Flowmeter Displays with Zero and Non-Zero Based Calibration

See the discussion on zero and non-zero based calibration in Chapter 3 - Operation.

1. Install jumpers in positions J1 and J4.
2. Place switch SW4 in the CAL (CALibrate) position and adjust the cal potentiometer, R23 to full scale output; 10 Vdc, 20 mA, etc,.
3. Adjust the span potentiometer (R16) to give a displayed value of full scale.
4. Adjust R23 to 0 Vdc or 4 mA.
5. Adjust the zero potentiometer (R17) to give a displayed value of the low limit.

6. Return switch SW4 to the OP (OPerate) position.

If additional technical assistance is needed, contact the customer service department at 1 (800) 854-1993.

Repair

There are no field-repairable items at the component level other than fuses.

Note: Any unauthorized repairs that are done at the component level will void the warranty.

Contact the authorized FCI field representative (see the list of regional territories and the respective agents) or the factory (see the telephone and FAX numbers at the front of this manual) to determine the best course of action.

EPROM Replacement Procedure

1. Turn the operating power OFF.

Caution: EPROMS are Electro-static Sensitive Devices (ESD). Use approved ESD procedures.

2. On the control board, remove the original EPROM from its socket (U14).
3. Store the original EPROM on Electro-Static safe foam or in an Electro-Static safe bag for possible future use.
4. Do not remove the new EPROM from its chip carrier. Install the chip carrier and EPROM as a single unit into the control board. The serial number on the new EPROM MUST match the serial number on the control board.
5. Verify the following switch positions on the control board:

   SW1-1 open
   SW1-2 open
   SW1-3 open
   SW1-4 open if temp. comp. is used. closed if temp. comp. not used
   SW2 set on the position that corresponds to the maximum number of sensing points
   SW4 OP (OPerate) position

6. If the flowmeter has a local display and the new EPROM changes the calibration range, then the display will need to be re-spanned to the new range.
7. Turn the operating power ON, and then allow five minutes for the flowmeter to stabilize.
8. Make a new Delta "R" Data Sheet for each flow element when the flowmeter is operating correctly. The new sheets will be useful when future calibration and verification checks are made.

General Circuit Board Replacement Procedure

For matching equipment, 100 ohm or 1000 ohm, see Table 5-8. Table 5-8 covers the control board and input boards. The power supply, output board, and display are interchangeable regardless of flowmeter type.

The control board is interchangeable for same type call-out. In other words, a control board for a 1000 ohm sensing element is interchangeable with another control board for a 1000 ohm sensing element, adjustments may be needed.

Table 5-8. Components for 100 and 1000 Ohm Flowmeters

CONTROL BOARD		
Adj. Pot.	**100 Ohm**	**1000 Ohm**
R8	4.99K, 1%	21.5K, 1%
Gain	20X	10X
INPUT BOARD		
Adj. Pot.	**100 Ohm**	**1000 Ohm**
R1, R7	6.65K	Not Used
RN3	1K	10K
JUMPERS INSTALLED, INPUT BOARD		
Dash No.	**100 Ohm**	**1000 Ohm**
001	N/A	J1, 2, 4, 6, 7, 8, 10, 12
002	N/A	J1, 2, 4, 6
003	J3, 5, 9, 11	N/A
004	J3, 5	N/A
JUMPERS INSTALLED, OUTPUT BOARD		
4-20 mA Output		**Jumper**
Non Zero-Based		J1, 4
Zero-Based		J1, 5

Input Board Replacement Procedure

Spare input boards MUST be factory pre-adjusted for the specific flowmeter and flow element sensing points. See Figure 5-5 for the PWB parts placement.

1. Turn the operating power OFF.
2. Disconnect the flow element cable from the input board.
3. Remove the four hold-down screws from the input board being replaced. Grasp the PWB and lift while gently rocking the board from side to side.
4. Position new PWB in the same orientation as the old PWB. Gently press down over the connector to seat it.
5. Install the four hold-down screws in the new PWB.
6. Reconnect the flow element cables to the PWB. Remove the "HTR+" and "HTR-" wires from the connectors and continue with the next procedure.
7. Perform a sensing point balancing procedure. Contact FCI customer service for the appropriate procedure.
8. When the sensor balancing procedure is completed, seal all adjusted potentiometers.
9. Turn the operating power OFF. Reconnect the heater circuit wires "HTR+" and "HTR-".

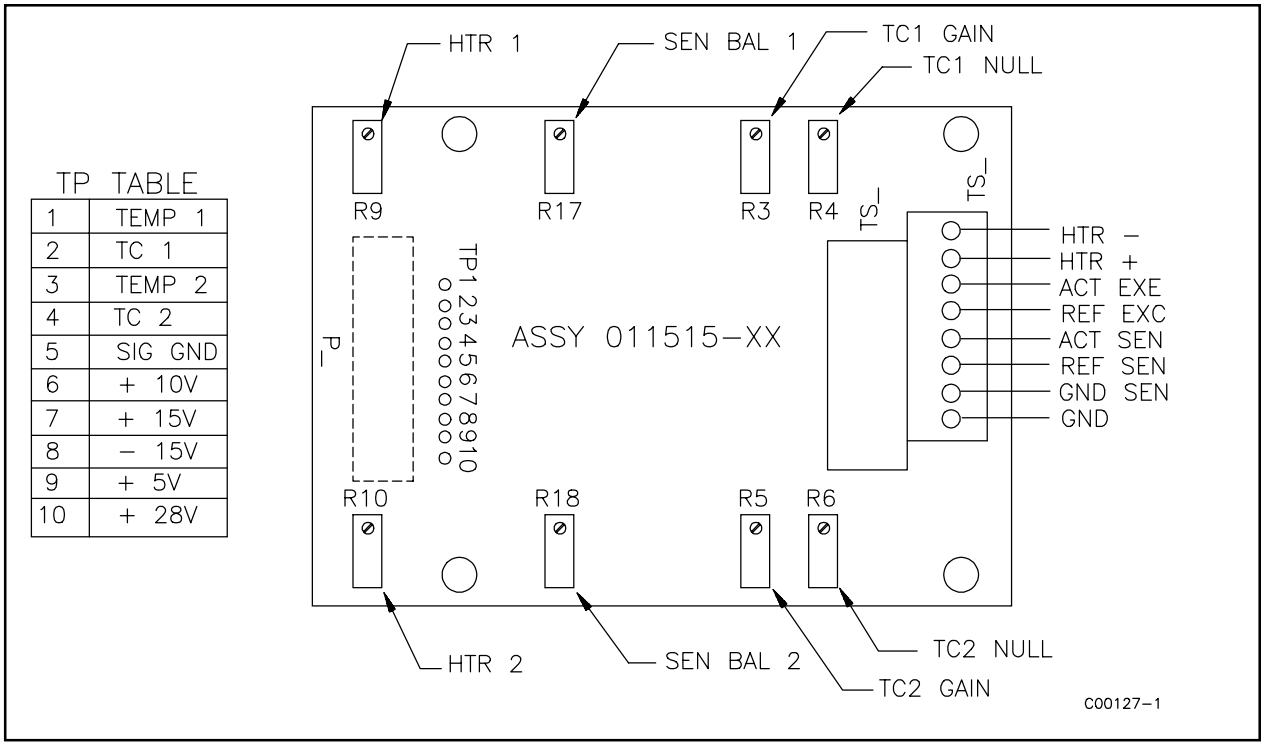

Figure 5-5. Input Board

Spares

FCI typically recommends one or more complete sets of spare PWBs and flow element assemblies depending on how critical the monitoring process is. Also recommended is the FC81 field calibrators for convenience. Contact the field representative or FCI for specific recommendations and part numbers. See Table 5-9 for spare parts and Table 5-10 for the recommended special test equipment. When ordering the PWBs the part dash numbers also need to be given to the factory. The dash numbers can be obtained by looking at the existing hardware or by looking at the Order Information Sheet that was filled out at the time the flowmeter was ordered.

Table 5-9. Recommended Spare Parts

QTY	DESCRIPTION
1	Power supply board P/N 011528-XX or 012059-XX for DC
1	Control Board P/N 01552-XX
1	EPROM with additional calibration (see factory)
1	Optional Output Modules: mA/DC voltage board P/N 011563-XX Switch point board P/N 011581-XX Remote board P/N 012576-XX
1	Input board P/N 011515-XX
1	Lithium Battery (see factory for part number)

Table 5-10. Recommended Special Test Equipment

QTY	DESCRIPTION
1	Model FC81-8 Field Calibrator for MT86 (1000 Ohm RDTs)
1	Model FC81-7 Field Calibrator for MT86HT (100 Ohm RTDs)
1	Document Number 003169 - FC81 Operating Manual

Defective Parts

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

Inches [mm]

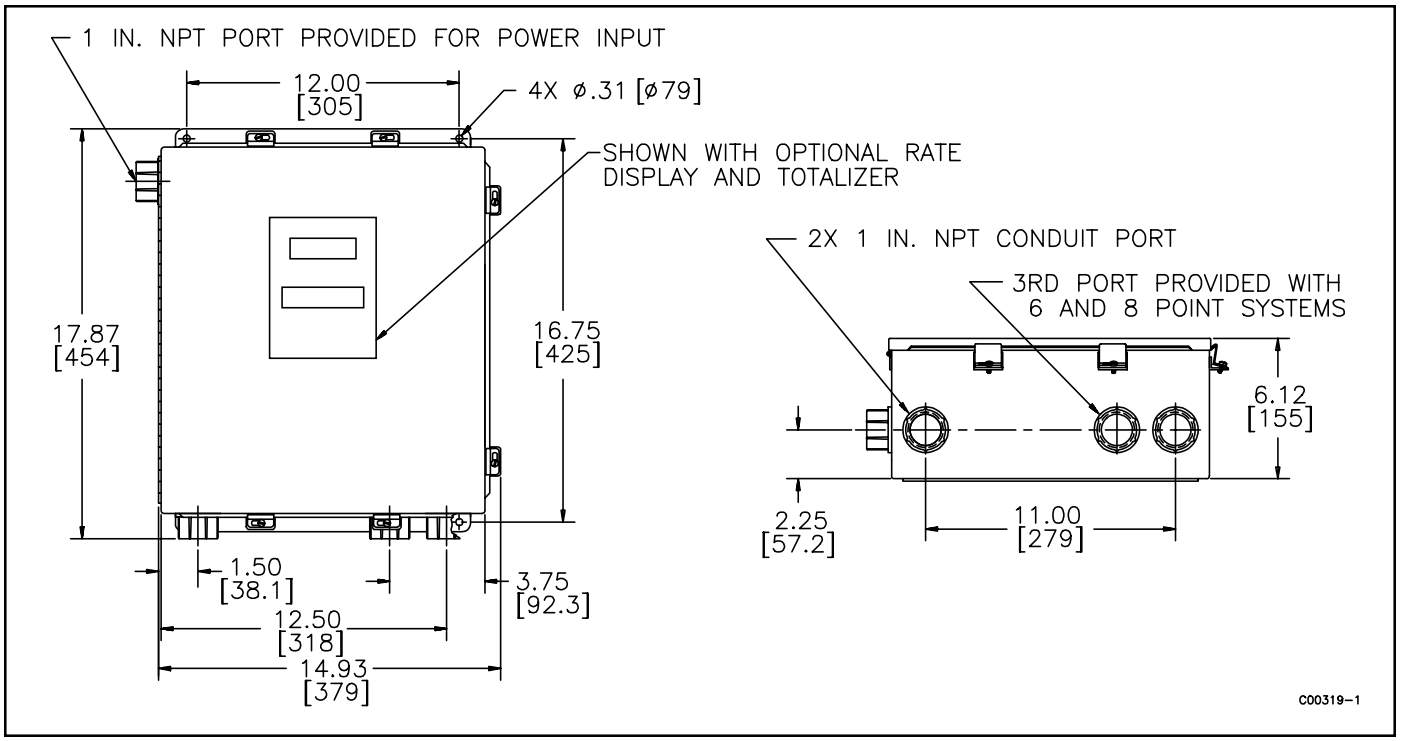

Figure A-1. Remote Enclosure Dimensions (NEMA Type 4)

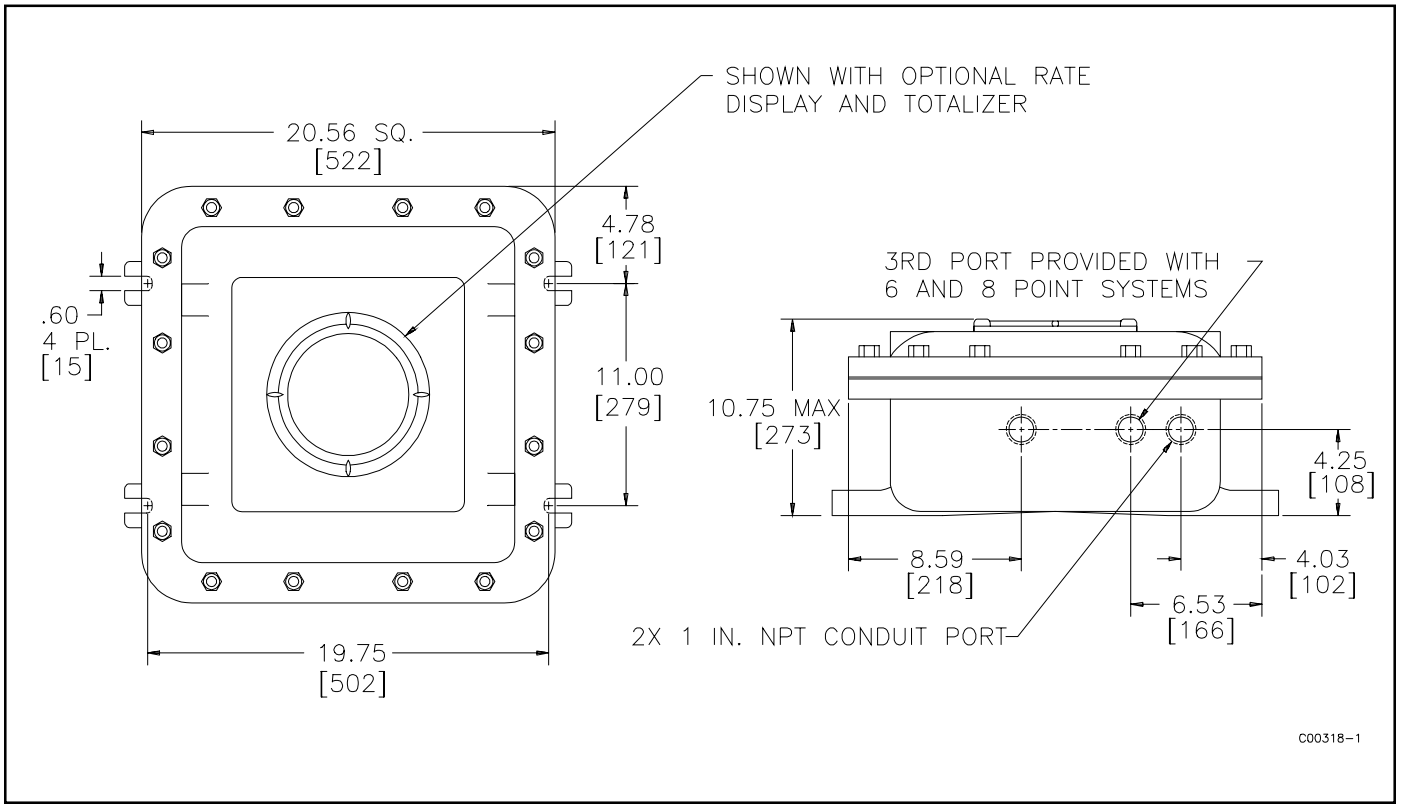

Figure A-2. Remote Enclosure Dimensions (NEMA Type 7)

Inches [mm]

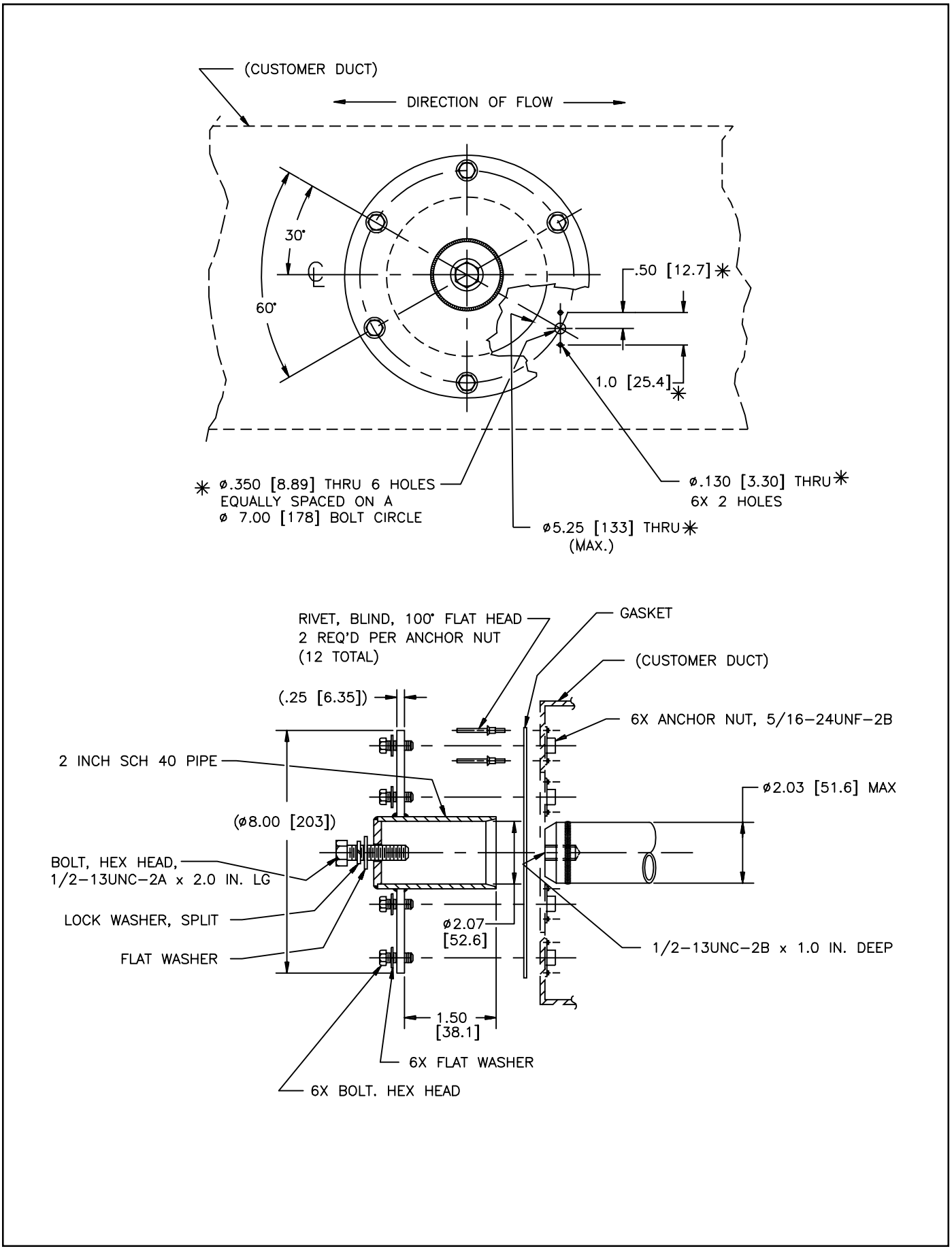

Figure A-3. Recommended End Support

Inches [mm]

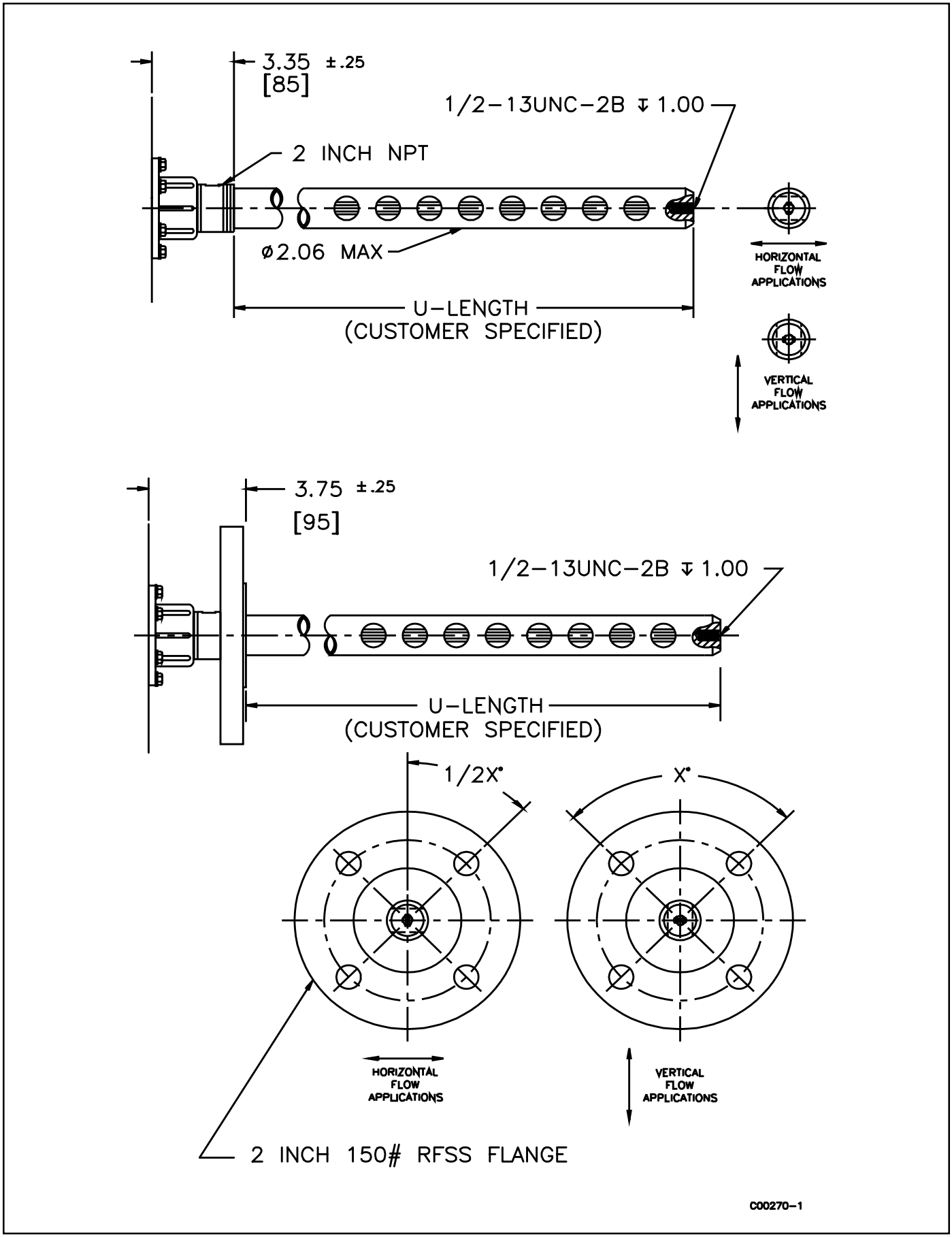

Figure A-4. Flow Element Dimensions

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) and mail or fax it to the FCI customer department. After FCI issues you 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 D. CE Conformance

APPROVED CE MARKING CONFIGURATIONS

Approved Options

1) All process temperature ranges
2) All metallic sensor elements
3) All process connections and flanges
4) All insertion U-lengths
5) Aluminum and 300 series stainless steel NEMA 4X local and remote enclosures
6) All specified application combinations
7) All cable jackets and lengths
8) 115/230 VAC input power

Approved Part Numbers

	1-20	21	22-40
MT86 and MT86HT		B C D E	

All options conform to CE marking requirements.

X Y — 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 CONFIGURATIONS

24 VDC Factory Selectable Option

The models included in this family may be factory selected for input power of 24 VDC. 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 Mounted Control Circuit Options

Input power of 24 Vdc may be optionally selected. Sense the manufacturer does not supply the power source 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.

INSTALLATION CONFORMITY CRITERIA

Grounding

All enclosures must be grounded to earth ground through a path of less than 1 ohm.

Interconnecting Cables

All interconnecting cables between the instrument's local enclosure, remote enclosure, power source and mounting 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.

LOCATION OF CE MARK DOCUMENTATION

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: (800) 854-1993 FAX: (619) 736-6250.

Appendix B. Glossary

ABBREVIATIONS

ACT EXC	Active excitation
ACT SEN	Active sense
Delta R (DR)	Differential resistance
Delta T (DT)	Differential temperature
ESD	Electrostatic discharge
FCI	Fluid Components Intl
GND	Ground
GND SEN	Ground sense
LCD	Liquid crystal display
LED	Light emitting diode
REF EXC	Reference excitation
REF SEN	Reference sense
RTD	Resistance Temperature Detector

DEFINITIONS

Active excitation ACT EXC: The active RTD supply current.

Active RTD The flow element part that senses the fluid flow rate.

Active sense ACT SEN: The active RTD voltage measurement.

Differential resistance Delta -R (DR): The flow element signal.

Differential temperature Delta -T (DT): The difference in temperature between the active and reference RTDs.

Flow arrow An indication mark used to properly orient the flow element in relation to the “ fluid flow direction.

Flow transmitter The portion of the flowmeter that conditions, converts and scales the flow signal.

Ground sense GND SEN: The ground voltage measurement.

Heater HTR: The flow element part that heats the active RTD.

Local enclosure The enclosure attached to the flow element (usually contains the wiring terminal block).

Orientation Flat A datum plane used to properly orient the flow element in the fluid conduit.

Range The flow rate measurement region as defined by the lower and upper limits.

Reference excitation REF EXC: The reference RTD supply current.

Reference RTD The flow element part that senses the fluid temperature.

Reference sense REF SEN: The reference RTD voltage measurement.

Remote enclosure The enclosure that protects the flow transmitter.

Resistance Temperature Detector	RTD: A sensor whose resistance changes proportionally to detector temperature changes.
Span	An adjustment that establishes at what flow rate the flow transmitter's output is full scale. (Also, the difference between the upper and lower flow rate values.
Thermal flowmeter	An instrument that uses thermal technology to measure fluid flow rate.
Thermowell	The flow element part that protects the heater and RTDs from the process fluid.
Turn down	The ratio of the upper to lower flow rate values.
Zero	An adjustment that establishes at what flow rate the flow transmitter's output is zero.