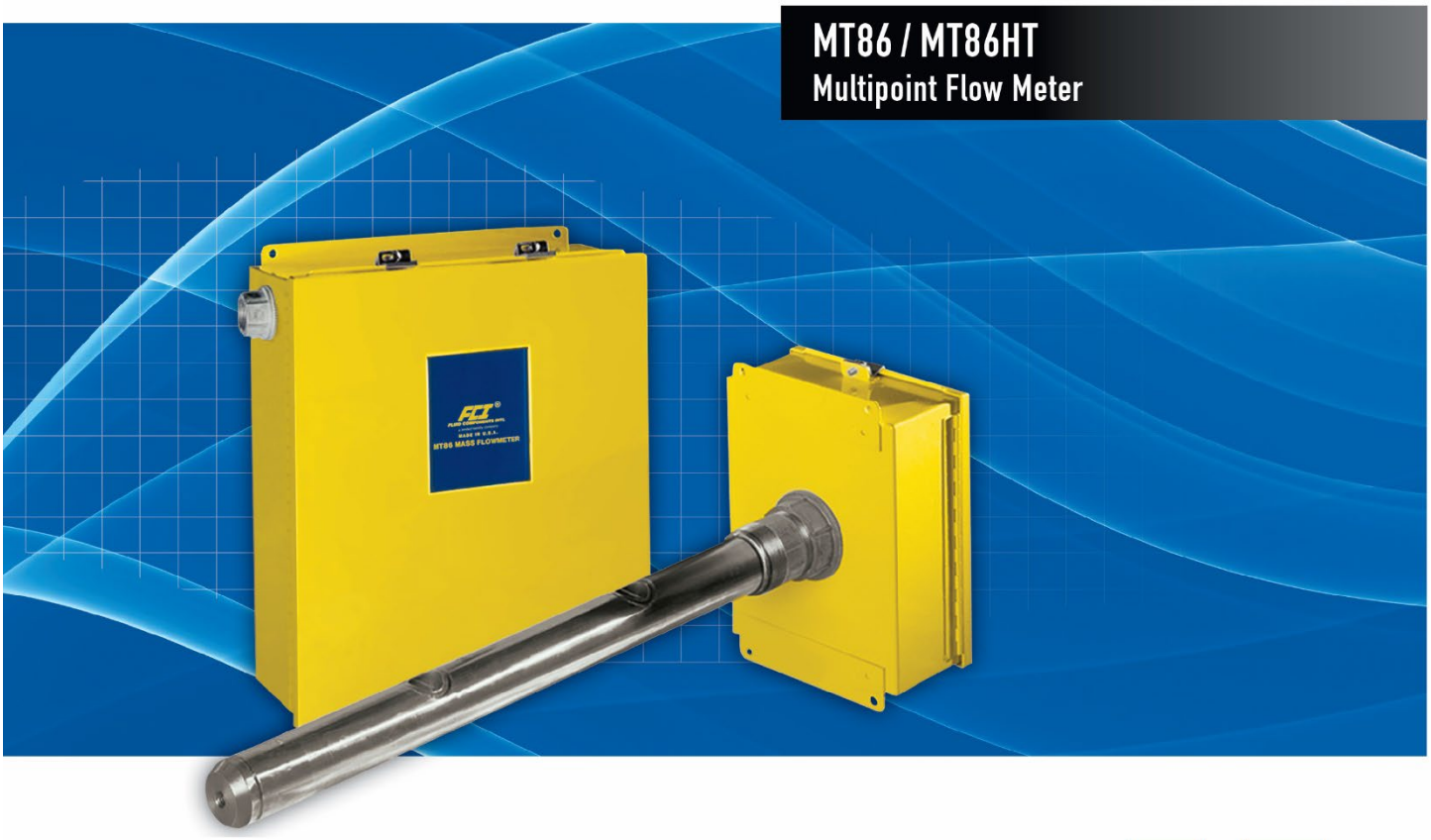
FLUID COMPONENTS INTERNATIONAL LLC

Installation, Operation & Maintenance Manual

Installation, Betrieb und Wartungshandbuch

Manual de Instalación, Operación y Mantenimento

安装、操作和维护手册



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1 GENERAL

Description

The MT86 and MT86HT is an air and gas mass multipoint flow meter that incorporates one or more flow elements connected to a flow transmitter. Together they are designed to measure the mass flow in pipes, ducts or stacks. The flow meter accurately measures the irregular flow profiles. 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 operates up to four different output modules of choice.

Operating Principles

The flow meter 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 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 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, see Figure 1 below.

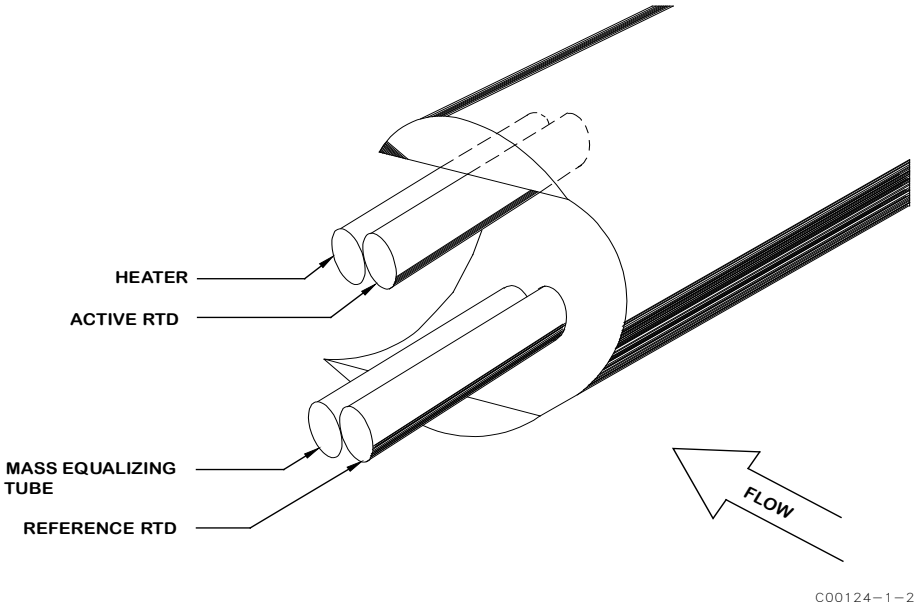

Figure 1 –Cut-Away View of One Sensing Point

Flow Transmitter

Each sensing point is connected to a separate flow transmitter circuit. The basic functions of the flow transmitter are to provide power to the flow element, measure the temperature differential (ΔT) between the two RTDs as a function of resistance, amplify and linearize the resistance differential (ΔR) measurement of the flow element input signal and to provide an output signal. 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 flashes to notify the customer.

Specifications

- **Process connection:**

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

- **Number of sensing points:**

  Up to 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 filler per AMS 4777.

- **Local enclosure:**

  NEMA 4X enclosure with 1 inch female NPT connection ports, stainless steel, QDC connector.

- **Remote enclosure:**

  NEMA 4X enclosure. Flow elements are equipped with 8-conductor, 22 AWG, Kapton insulated foil shielded cable.

- **Operating pressure:**

  Standard MT86 is 0-50 PSIG, or higher depending 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.

- **Input power:**

  Standard: 100-130 VAC or 200-270 VAC, 50/60 Hz,

  50 watts maximum.

  Optional: 18-36 VDC, 50 watts 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 (minimum) 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 1, page 6, for more information.

- **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 flow meter 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 flow meters.

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:**
  - 3½-digit Flow Rate Display.
  - 8-digit Flow Totalizer Display.
- **Available outputs (up to four module circuit boards):**

  Switch point: DPDT relay at 2 or 10 Amp, 115 VAC.

  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 FES-200 flow element simulator simplifies verification of the MT86/MT86HT in the field. This device provides the variable resistance required to input a Delta "R".

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, page 35.

Factory Calibration Note

The flow meter 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 flow meter in service.

Pre-Installation Procedure

Warning: Install the flow meter with qualified 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 flow meter will be noted in this manual. Where the instructions call for the use of mains power, the operator assumes all responsibility for conformance to safety standards and practices.

Caution: The flow meter 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 ensure there are 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 enclosure, remote enclosure and flow transmitter serial numbers match.

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. The first local enclosure would have the serial number 123-1 and the second local enclosure would have the serial number 123-2.

Prepare or Verify Flow Element Location

The flow element location has 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). Refer to APPENDIX A, page 35, for specific information.

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, page 35, and the process interfaces for fit.

Verify Flow Direction for Flow Element Orientation and Placement

The flow element comes with a flat surface machined on the flow element near the enclosure. This flat surface is known as the Reference Flat and includes a flow arrow etched on its surface to indicate flow direction. See Figure 2 for details.

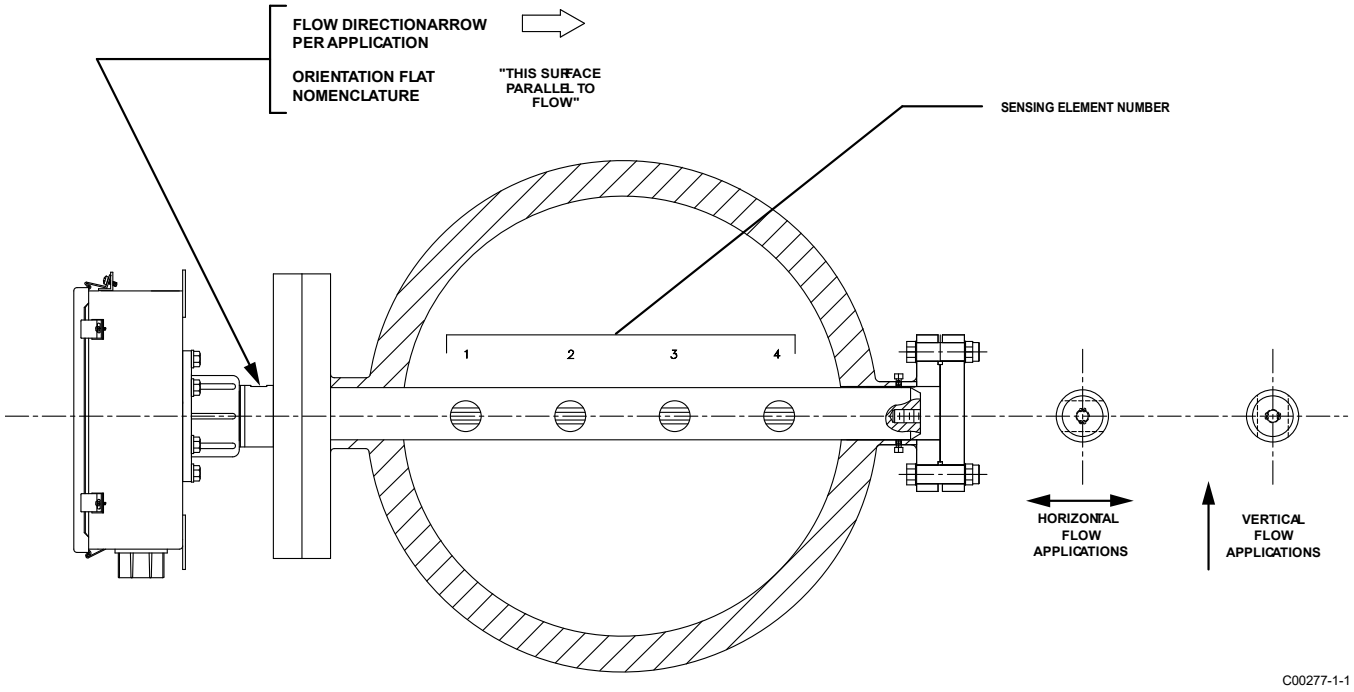

Figure 2 –Flow Element Showing Flat Area, Flange Mount Shown

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 reduces the accuracy of the flow meter. Refer to APPENDIX A, page 35, for specific information.

Install Flow Element

Install the flow element for the type of process connection used. If applicable, connect the end of the flow element to a recommended mechanical support. See APPENDIX A, page 35, for installation details. The following are general steps for flow element installation.

Threaded Mount

Note: When mounting the flow element, use a lubricant or sealant applied to the male threads of all NPT connections. Ensure that the lubricant or sealant is compatible with the process environment. 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 reference 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 reference 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 Mount

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 flow meter 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.

Refer to APPENDIX A, page 35, for specific information.

Install Flow Transmitter

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

Note: FCI recommends installing an AC or DC power disconnect switch and fuse near the flow transmitter to interrupt power during installation, maintenance, calibration, and troubleshooting procedures.

Remote Hardware

APPENDIX A, page 35, shows the remote enclosure along with physical dimensions to properly mount the flow transmitter. Select a location for the flow transmitter within 1000 feet of the flow element. Allow enough room for the hardware to be easily accessible and to be able to open the remote enclosure cabinet door at any time. Secure the flow transmitter solidly to a vertical surface capable of providing support. Use the appropriate hardware to secure the flow transmitter as required.

Power Connection Information

Conduit Routing

All electrical connections are to be made through the 1 inch NPT opening in the remote enclosure. Run all electrical cables through an appropriate conduit for the protection of the flow meter and personnel. See Figure 3 and Figure 4, page 7, for the specific mechanical details.

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 1 below shows the smallest (maximum AWG number) copper wire which can 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 1 – Interconnecting Cable Minimum Conductor Size (Maximum AWG Number)

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

*Note: 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 22 AWG. Refer to APPENDIX A, page 35, for specific information.

Flow Transmitter Wiring Connections

See the wiring diagrams in Figure 3 or Figure 4, page 7, for the flow element wiring to the input boards. Run separate excitation and sense wires for the Active, Reference, and Ground connections. The flow meter will not operate properly without these connections. If the Active and Reference wires are reversed the flow meter 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).

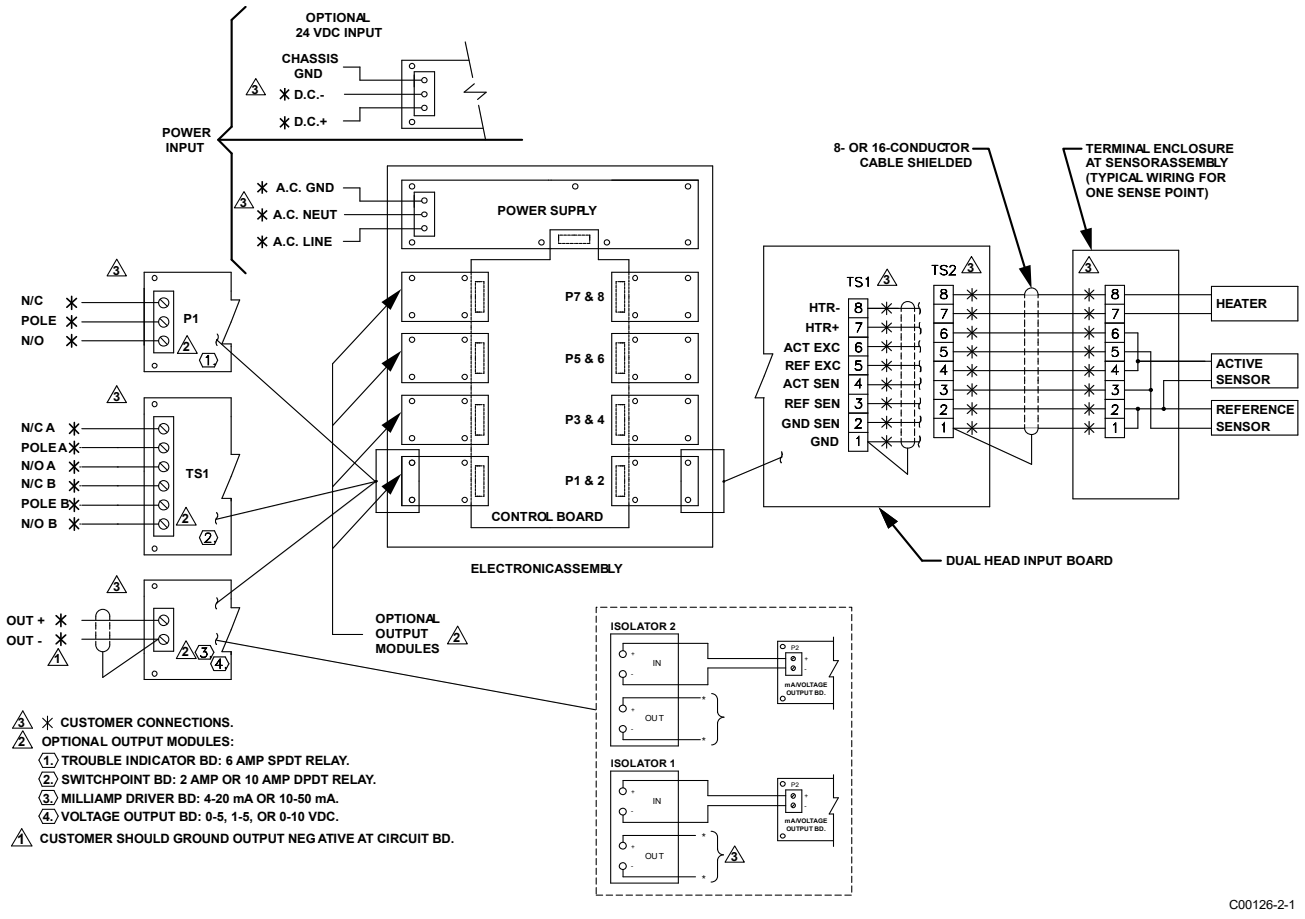

Figure 3 – MT86 or MT86HT Wiring Diagram

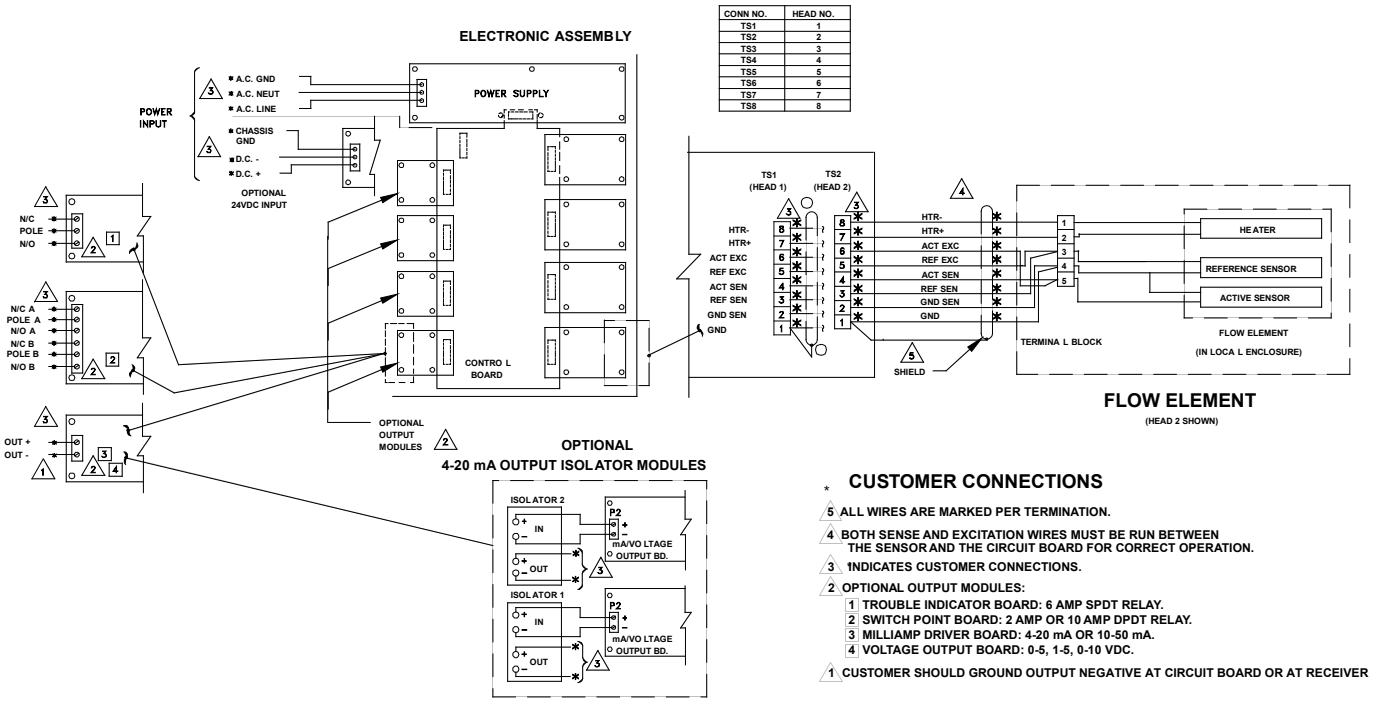

Figure 4 – GF90 Flow Element With Optional Isolator Module

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 flow meter. 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 flow meter (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 5 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 Figure 3 or Figure 4, page 7, 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.
2. Connect a milliampere meter in series with the input terminals.
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 5 below 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.

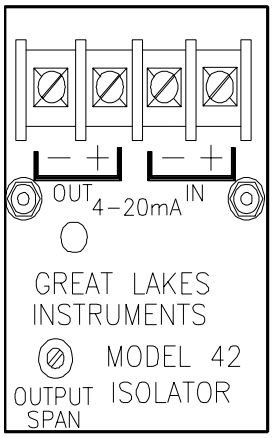

Figure 5 –Isolator Output Module

Installation Quick-Check List

1. Verify that serial numbers match.
2. Properly orient the flat and flow arrow.
3. Ensure there are no leaks at the process connection.
4. Verify that the wiring is properly connected per the wiring diagram.

3 OPERATION

Introduction

The flow meter has been configured and calibrated to custom specifications. Each flow meter contains distinct operating limits and units of measurement. This section will show how to determine and manipulate the configuration of the flow meter.

Caution: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See INSTALLATION, page 3, for ESD details.

Enable Optional Totalizer Back-up Battery

There is a totalizer option for the flow meter. 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 6 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.

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 6 below 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.

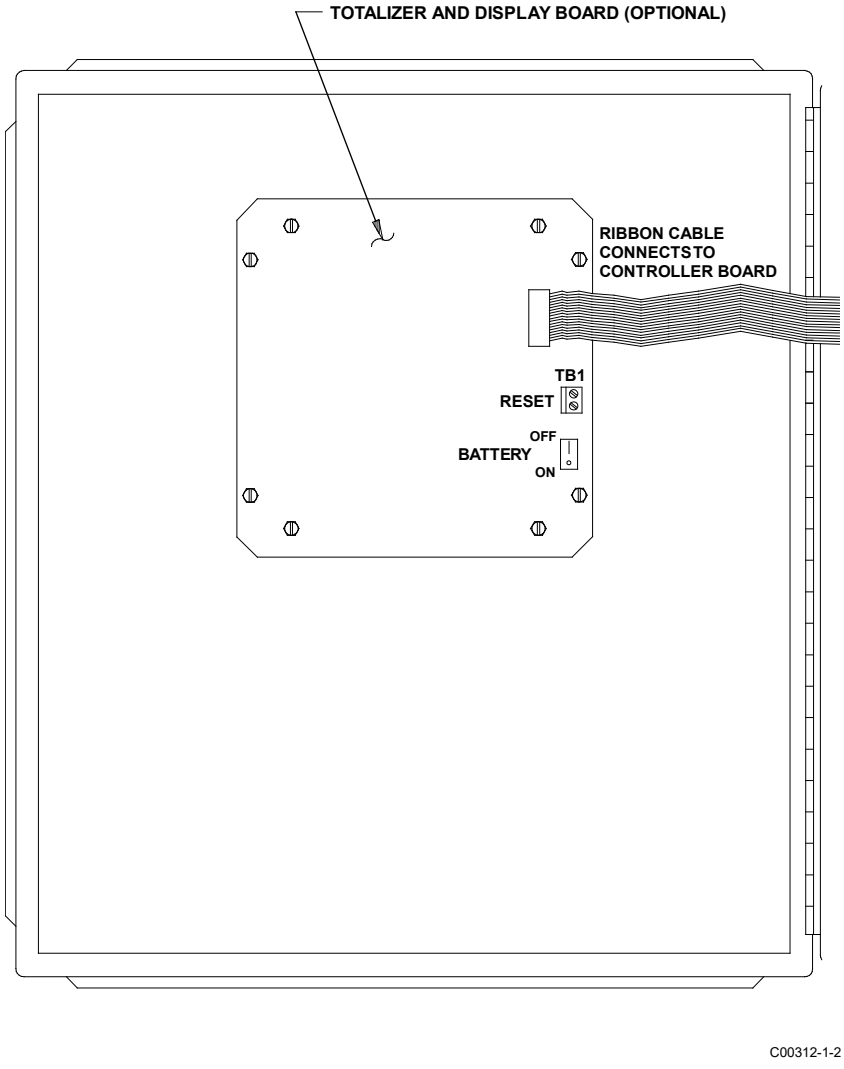

Figure 6 –Battery Jumper and Reset Locations

Apply Power

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

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

Wait a minimum of 10 minutes for flow meter to stabilize. The output signal indicates the media flow. There is no operator action needed because the flow meter operates from the factory settings.

If the output signal is zero, is out-of-range for the expected values or is obviously not right then turn off the power and go to TROUBLESHOOTING, page 19, to find the problem.

Operator Interaction

There is little need for interaction between the operator and flow meter. The flow meter is fully automatic when it operates in the normal monitor mode. FCI advises the use of factory default settings that the flow meter was ordered with. Do not reset the flow meter's operating values by trial and error.

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 output signal provides an instant readout of mass flow. The output signal shows only the flow rates between the upper and lower limits of the calibrated range. For zero-based instruments the output signal will show zero whenever the flow rate is below the calibrated lower limit. For non-zero-based instruments the output signal 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 4 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.

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 flow meter's output signal indicates 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 output signal will indicate the minimum calibrated flow.

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 7 for details. Flow meters cannot measure zero flow accurately. The flow meter reads out the low-limit signal (4 mA) from zero flow up to the minimum calibrated flow. Then the output signal steps up to the proper signal value of the mass flow.

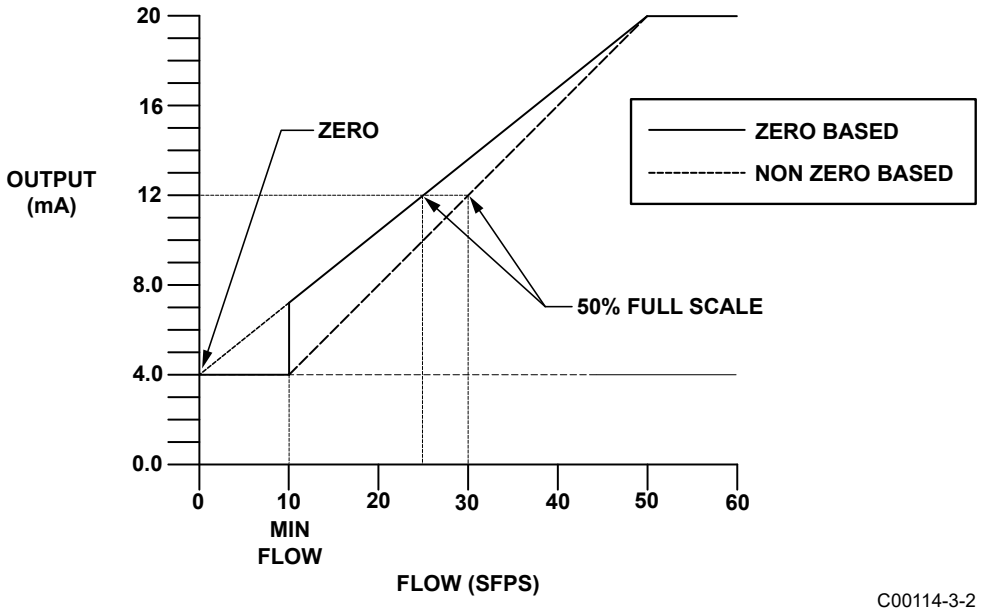

Figure 7 – Zero Based Calibration

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 flow meters have less signal to resolve over full scale. A zero-based flow meter 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 flow meter).

Zero-based calibration is the factory default.

Delta "R" Table

The Delta R Sheet (found in the plastic page protector in the back of this manual) contains the actual data chart for the flow meter. The Delta R portion of this sheet relates actual laboratory calibration measurement points of the differences (delta) between the reference and active RTDs at certain flow rates.

These parameters are used at the factory to determine the linearization coefficients (parameters) over the flow range in question to correct for non-linearity. The corresponding current and voltage output readings are also shown (again at factory default settings), changes to range and zero will only affect the output signals. Flow versus Delta R relationship is fixed for a given set of flow elements; do not change the coefficients except in special circumstances as the overall accuracy of the system is tied to these numbers. Call Customer Service if there is a problem in this area.

The Calibration Table is a printout (at factory default settings for zero and offset) of the relationship of displayed mass flow readings related to the current output when calculated over the entire flow range using the fitting equation and its respective coefficients.

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 13 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 flow meter 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 flow meter 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 the model FC81-8 Field Calibrator the displayed Delta "R" value is divided by 10 . For the 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 flow meter 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 flow meter 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 flow meter back into the operation mode.

New Calibration Procedure (in field)

Note: The flow meter 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 flow meter 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 12 for the electrical assembly layout. FCI recommends making a new “Delta R” table after any adjustment are made to the output. 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 flow meter must be known before going on with the following adjustment procedure. Record and have the information available for FCI to review.

To justify a span adjustment only, ensure the flow rate to be above 60% of full scale. 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 flow meter'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 13. 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 flow meter 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 flow meter. Record and have the information available for FCI to review. The procedure is basically the same as the span adjustment procedure. See Table 2 for jumper positions.

Table 2 – 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 listed 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 flow meter 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 flow meter is in the original configuration. The factory set calibrations are in control of the flow meter.

Table 2 shows the jumper settings that are needed to make the zero and span adjustments active. Figure 8 shows the zero and span effects on the flow meter.

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.

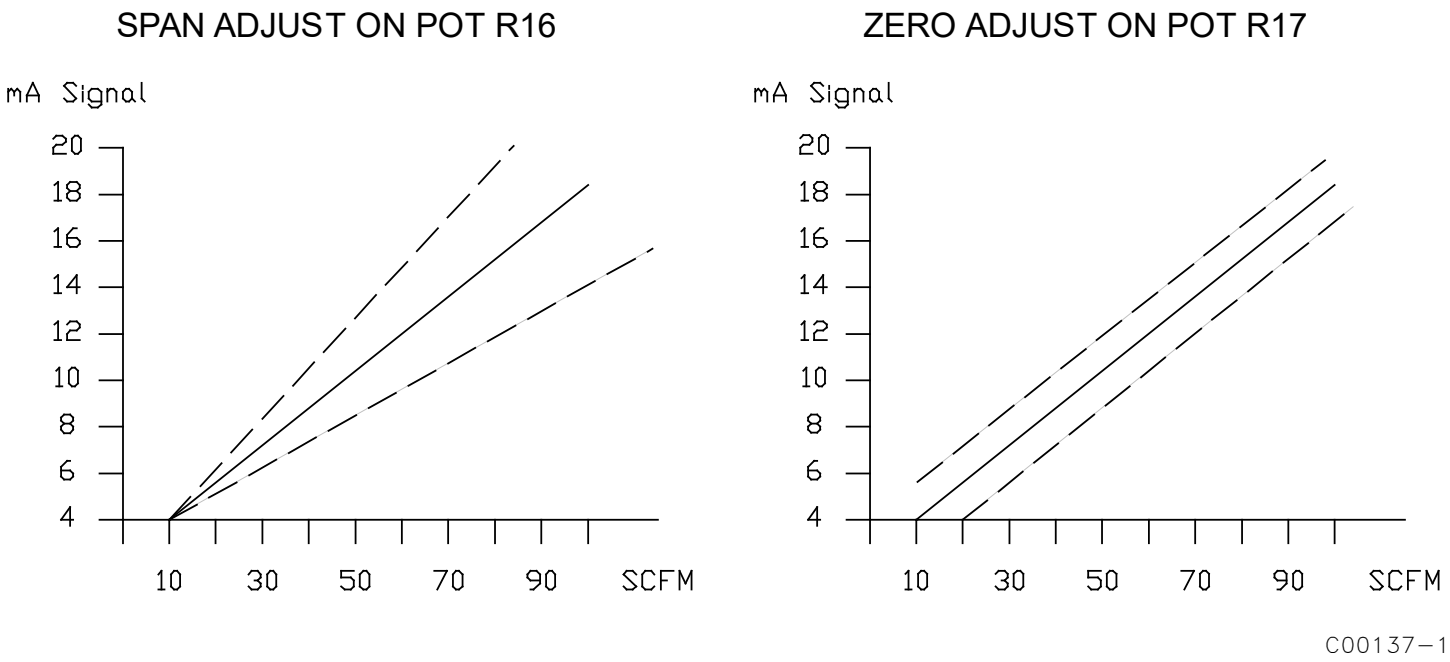

Figure 8 –Zero and Span Adjustment

If a span and zero adjustment cannot 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 flow meter only. Write down the results in the chart shown in Figure 9.

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

For the Temperature Compensated flow meter, 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 flow meter.

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 TROUBLESHOOTING, page 19) 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 9 – A/D Data Sheet

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4 MAINTENANCE

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

Caution: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See INSTALLATION, page 3, for ESD details.

Introduction

The flow meter needs very little maintenance. There are no moving parts or mechanical parts subject to wear in the flow meter. 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 RTD thermowell 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 flow meter 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 intact.

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. Faulty readings can be caused by build-up. Clean the flow element as needed with a soft brush and available solvents (compatible with stainless steel).

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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 INSTALLATION, page 3, for ESD details.

Quick-Check Troubleshooting

At this point, observe the system setup to verify operation. Use Table 3 as a quick check of problems and solutions. More in-depth discussions follow this table.

Table 3 – 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 multimeter (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.

Check Input Power

Check for intact fuses. Verify that the correct power source is connected and turned on.

Check Instrument Installation

Review the instrument installation information given in INSTALLATION, page 3, 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 can cause measurement errors.

Check Application Design Requirements

Application design problems usually occur with first time application instruments, but also check 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. For optimum flow meter performance place the flow element in a straight run of pipe at least 20 pipe diameters upstream and 10 diameters downstream.

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 INSTALLATION, page 35, 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 Flow Meter Switch Positions

Verify that switches SW1-1, SW1-2 and SW1-3 are in the open position. If the temperature compensation mode is used, place switch SW1-4 in the open position. If temperature compensation is not used, ensure switch SW1-4 is the closed position. 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 flow meter is setup to use temperature compensation. If they are not then no temperature compensation is used. An open switch is the switch pressed 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.

Check the General Process

Check all inputs and outputs to the system. Verify pump ratings and check damper or valves that might be open or closed causing the flow to be different from what is expected.

Verify Standard Versus Actual Process Conditions

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

Troubleshooting Process

Verify Delta " R" Sheets

Verify that the Delta "R" sheets in the rear of this manual match the flow meter's serial number. If there is a mismatch 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 flow meter 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 10 and Table 4 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 flow meter power to be disconnected or the flow elements to be unplugged then proceed to the Troubleshooting Process - Voltage Measurements section.

All resistances in Table 4 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.

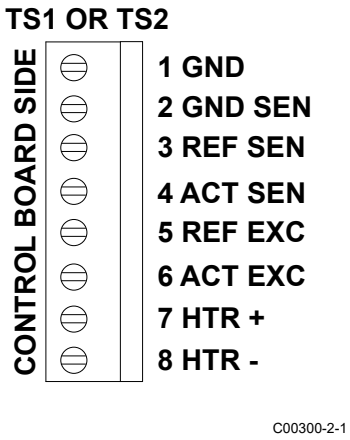

Figure 10 – Terminal Plug

Table 4 – Terminal Plug Resistances

Pin Number	Approximate Resistance MT86/MT86HT	Approximate Resistance ST98
2 to 3	1000 Ohms*	1000 ohms
2 to 4	1000 Ohms*	1000 ohms
2 to 5	1000 Ohms*	1000 ohms
2 to 6	1000 Ohms*	1000 ohms
2 to 7	220 Ohms	115 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 flow meter 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 3 in INSTALLATION.

If the flow element resistance and wiring check out, recheck the power supply; the fuse and the AC and DC voltages.

If there are multiple failures in the flow meter, the power supply is suspect.

Perform the following voltage checks with power applied to the flow meter. Place the flow meter 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 and Figure 11 for the proper operating voltages. If the voltage checks are correct, the power supply is functioning properly.

Table 5 – 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 6. If the voltage is still missing, then remove and replace the power supply.

Make the following measurements at the control board terminal strip. See Table 6 and Figure 12 for the measurements.

Table 6 – 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

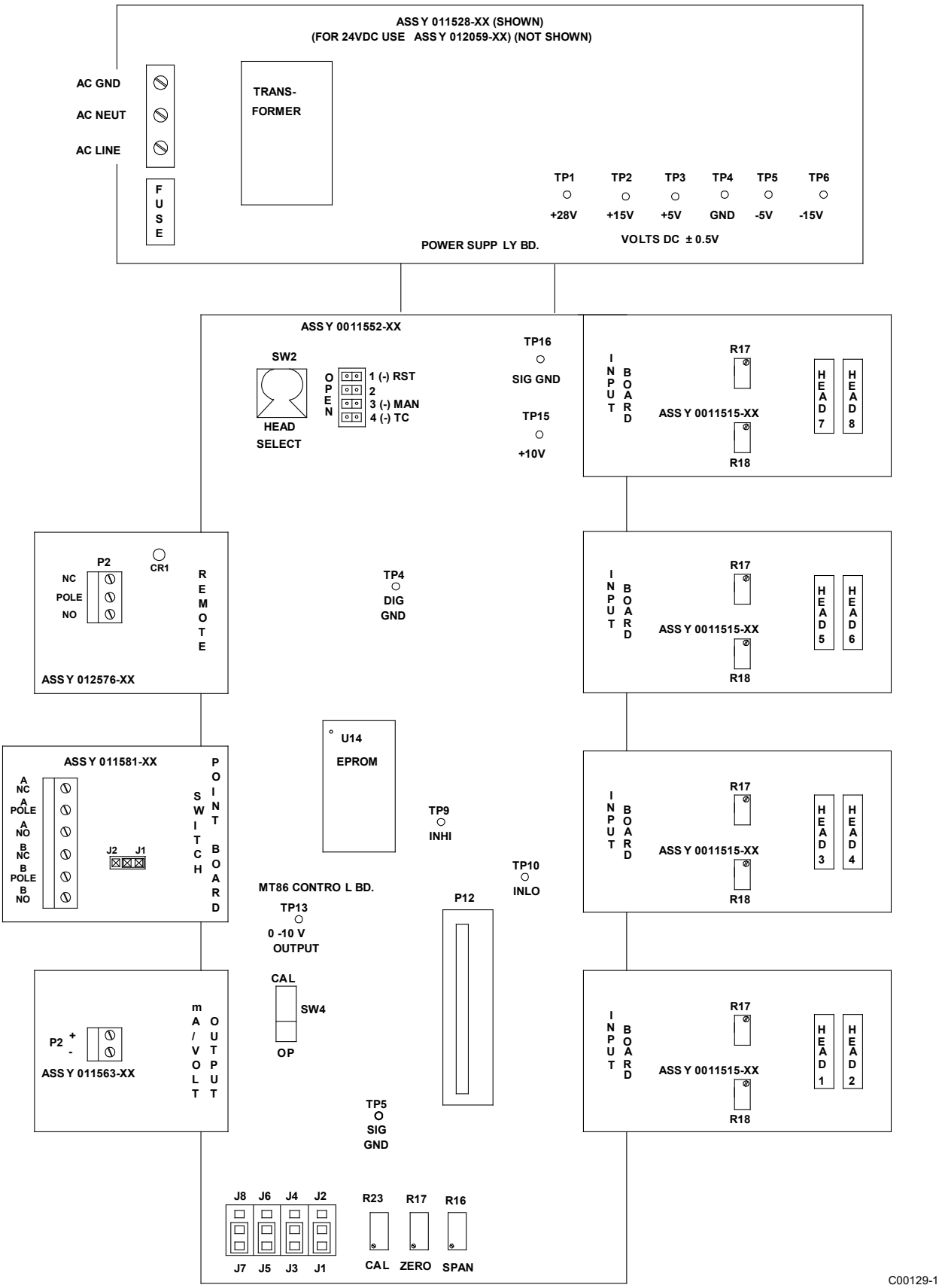

Figure 11 – Electrical Assembly Layout

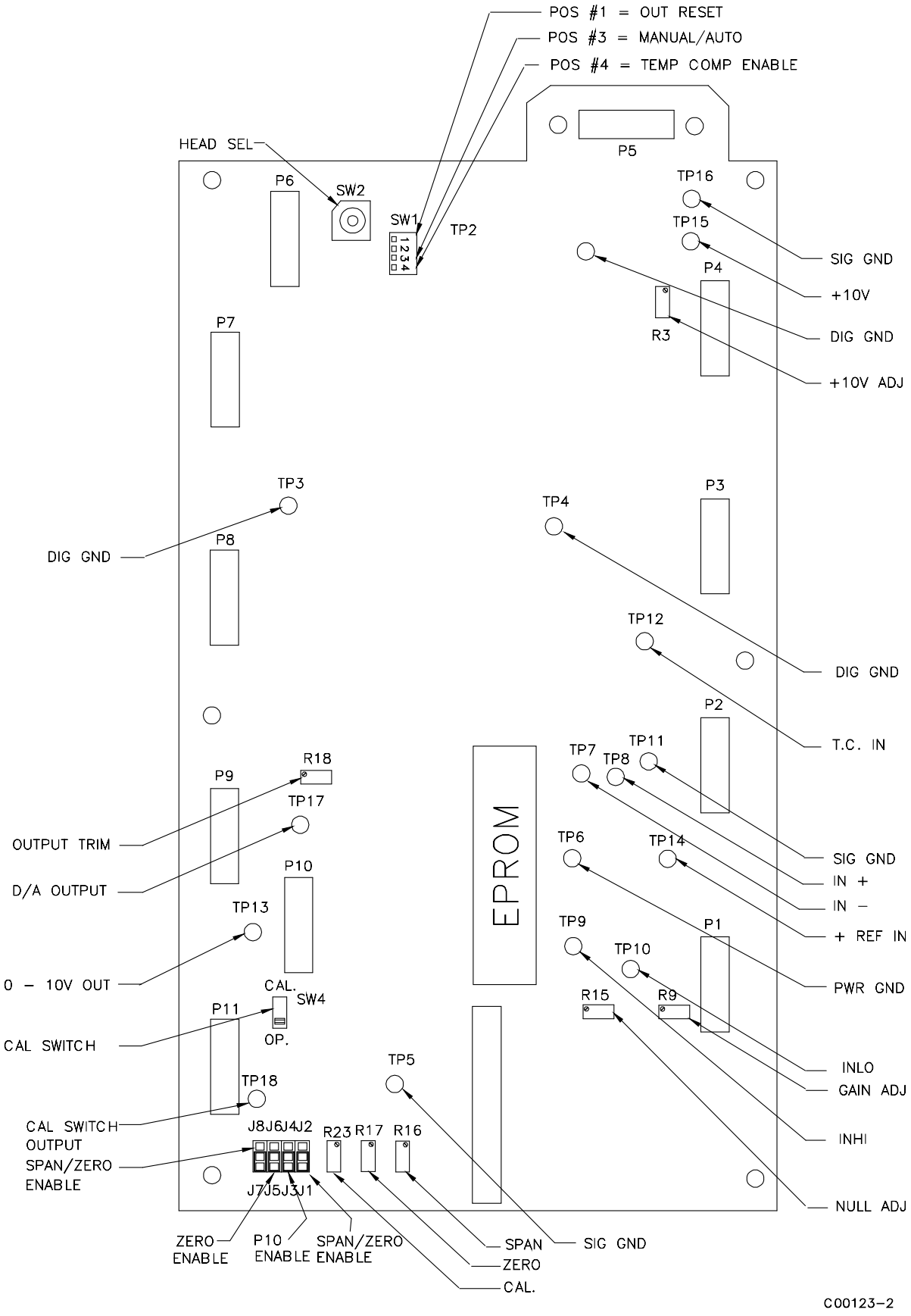

Figure 12 – Control Board Layout

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. Verify that all output signals 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 7 and Figure 10 for the measurements.

Table 7 – Input Board Terminal Voltage Check

Positive Lead (+)	Negative Lead (-)	Measured Value		
		MT86	MT86HT	ST98
HTR +	HTR -	16.5 VDC	16.5 VDC ± 1%	8.6 VDC
REF SEN	GND SEN	1.10 VDC	0.275 VDC*	1.10 VDC
REF EXC	GND SEN	1.10 VDC	0.275 VDC*	1.10 VDC
ACT SEN	GND SEN	1.25 VDC	0.275 VDC*	1.25 VDC
ACT EXC	GND SEN	1.25 VDC	0.275 VDC*	1.25 VDC

Note * 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 8 for the measurements.

Table 8 – 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 flow meter 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 flow meters have 1000 ohm RTD sensing points.

All MT86HT flow meters (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 flow meter 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 13.
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 - #.

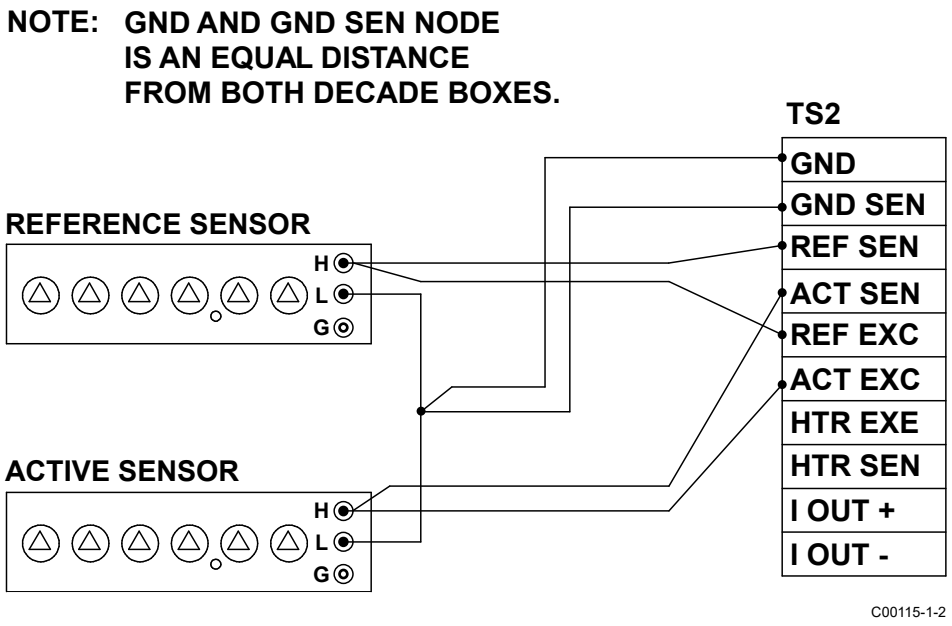

Figure 13 – Decade Box Wiring Diagram

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. Ensure it is 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. Verify the Delta "R" values are 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 2 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 flow meter. 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. Verify the Delta "R" data repeats 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 flow meter.

Switch Point Calibration Procedure

The flow meter 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 12.
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 12.
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 9 for the correct position of the totalizer decimal point.

Table 9 – 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 million “XXX”				

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

Check Procedure for Flow Meter Displays with Zero and Non-Zero Based Calibration

See the discussion on zero and non-zero based calibration in Operation, page x.

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 in APPENDIX C, page 41, 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 flow meter 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 flow meter to stabilize.
8. Make a new Delta "R" data sheet for each flow element when the flow meter 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 10. Table 10 covers the control board and input boards. The power supply, output board, and display are interchangeable regardless of flow meter 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 10 - Components for 100 and 1000 Ohm Flow Meters

Control Board		
Adjust Pot.	100 Ohm	1000 Ohm
R8	4.99K, 1%	21.5K, 1%
Gain	20X	10X
Input Board		
Adjust Pot.	100 Ohm	1000 Ohm
R1, R7	6.65K	Not Used
RN3	1K	10K
Jumpers Installed, Input Board		
Adjust Pot.	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 flow meter and flow element sensing points. See Figure 14 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-".

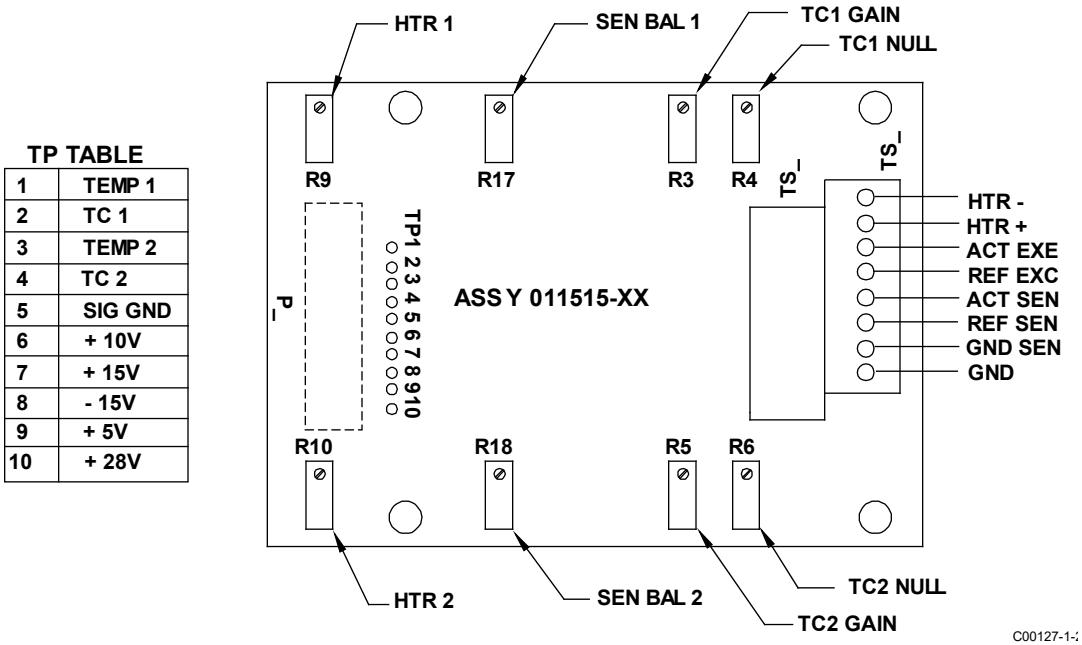

Figure 14 - Input Board

Spares

FCI typically recommends one or more complete sets of spare PWBs and flow element assemblies depending on how critical the monitoring process is, as well as the FC81 field calibrators for convenience. Contact the field representative or FCI for specific recommendations and part numbers. See Table 11 for spare parts and Table 12 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 flow meter was ordered.

Table 11 - Recommended Spare Parts

Quantity	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 12 - Recommended Special Test Equipment

Quantity	Description
1	Model FC81-8 field calibrator for MT86 (1000 ohm RTDs)
1	Model FC81-7 field calibrator for MT86 (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 flow meter, 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, page 41, for specific Customer Service policy provisions.

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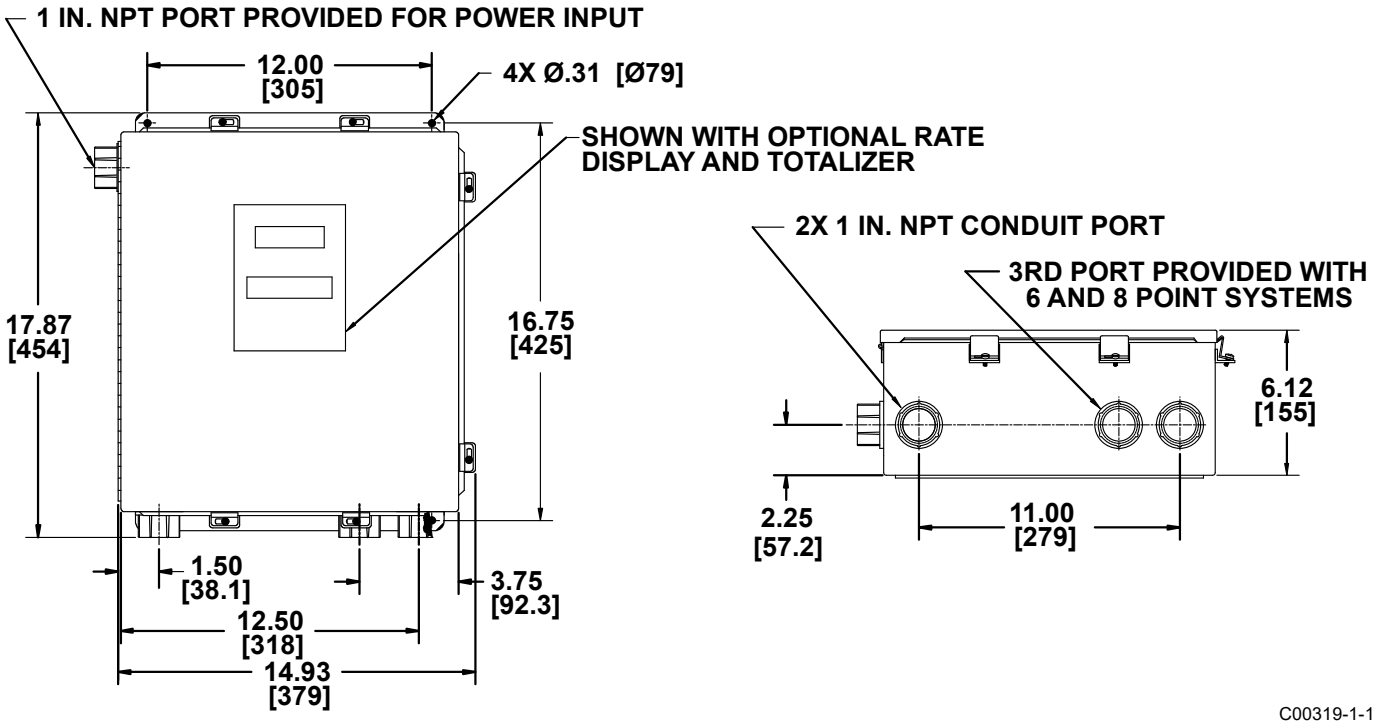
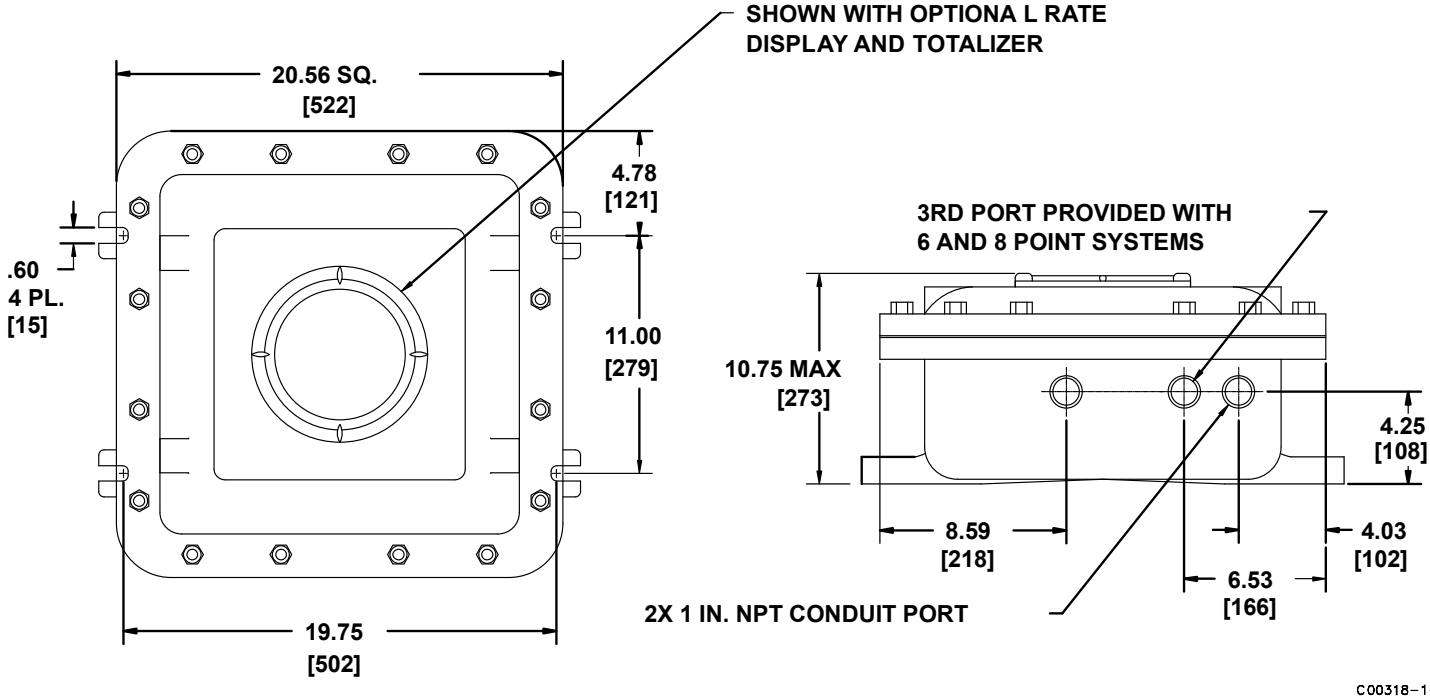
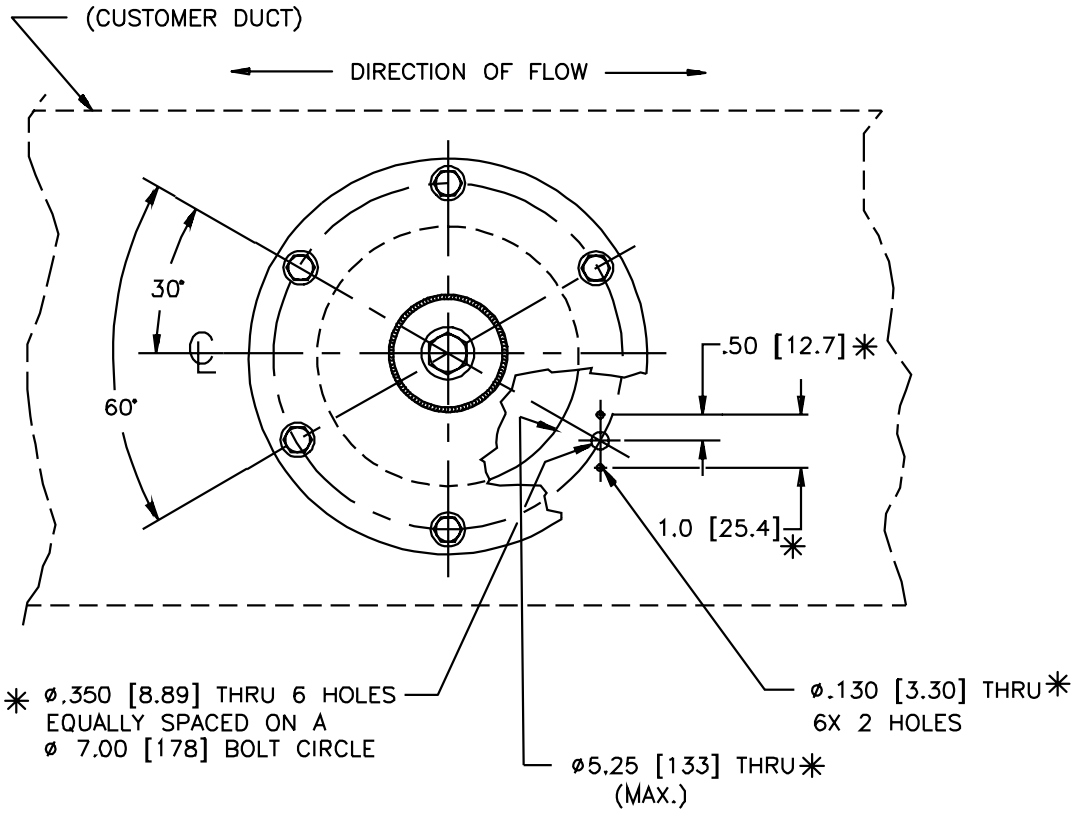
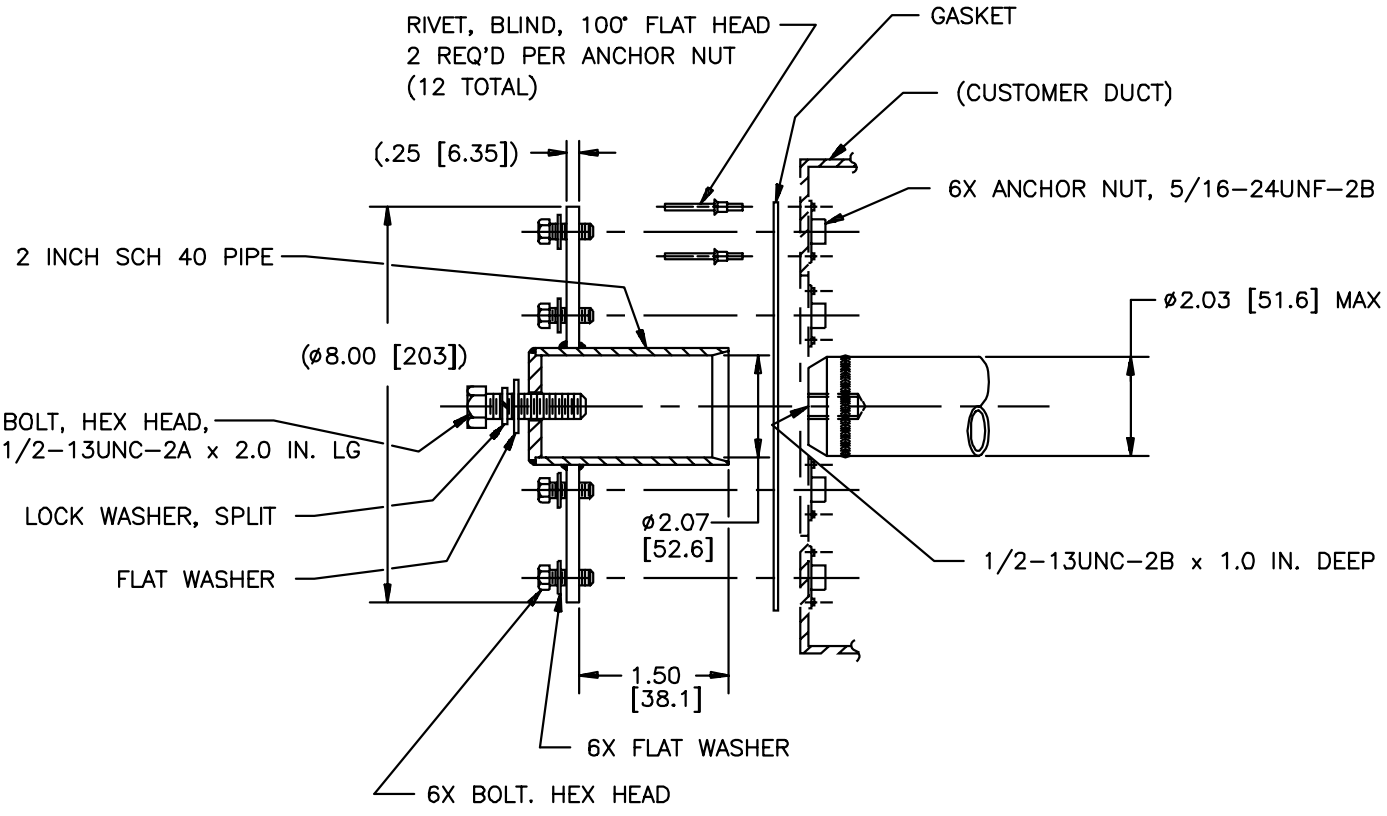
APPENDIX A DRAWINGS

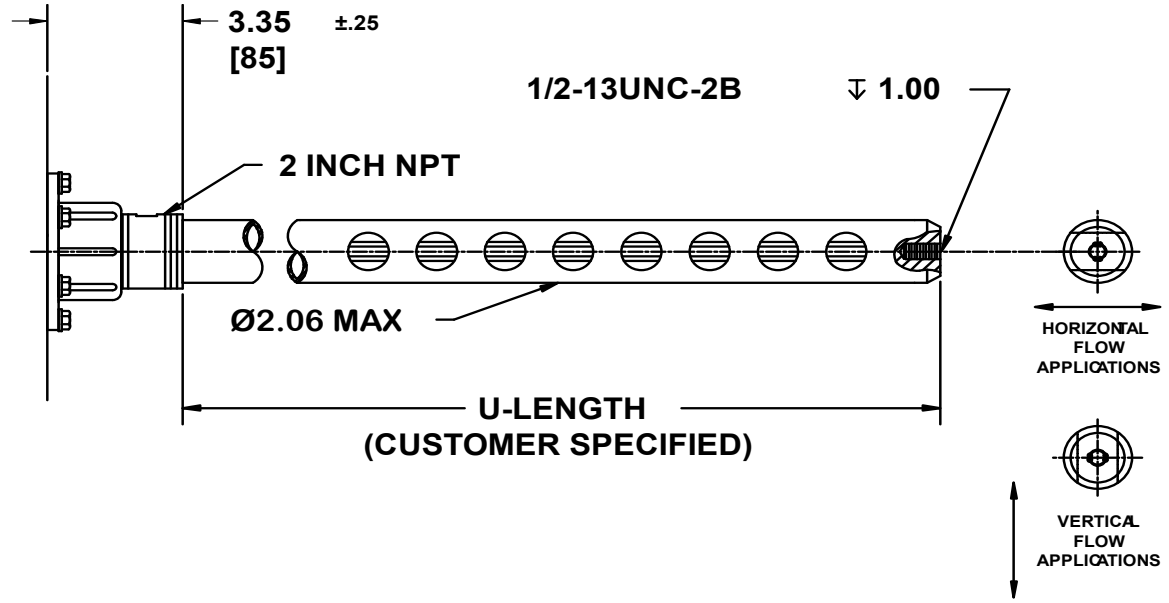


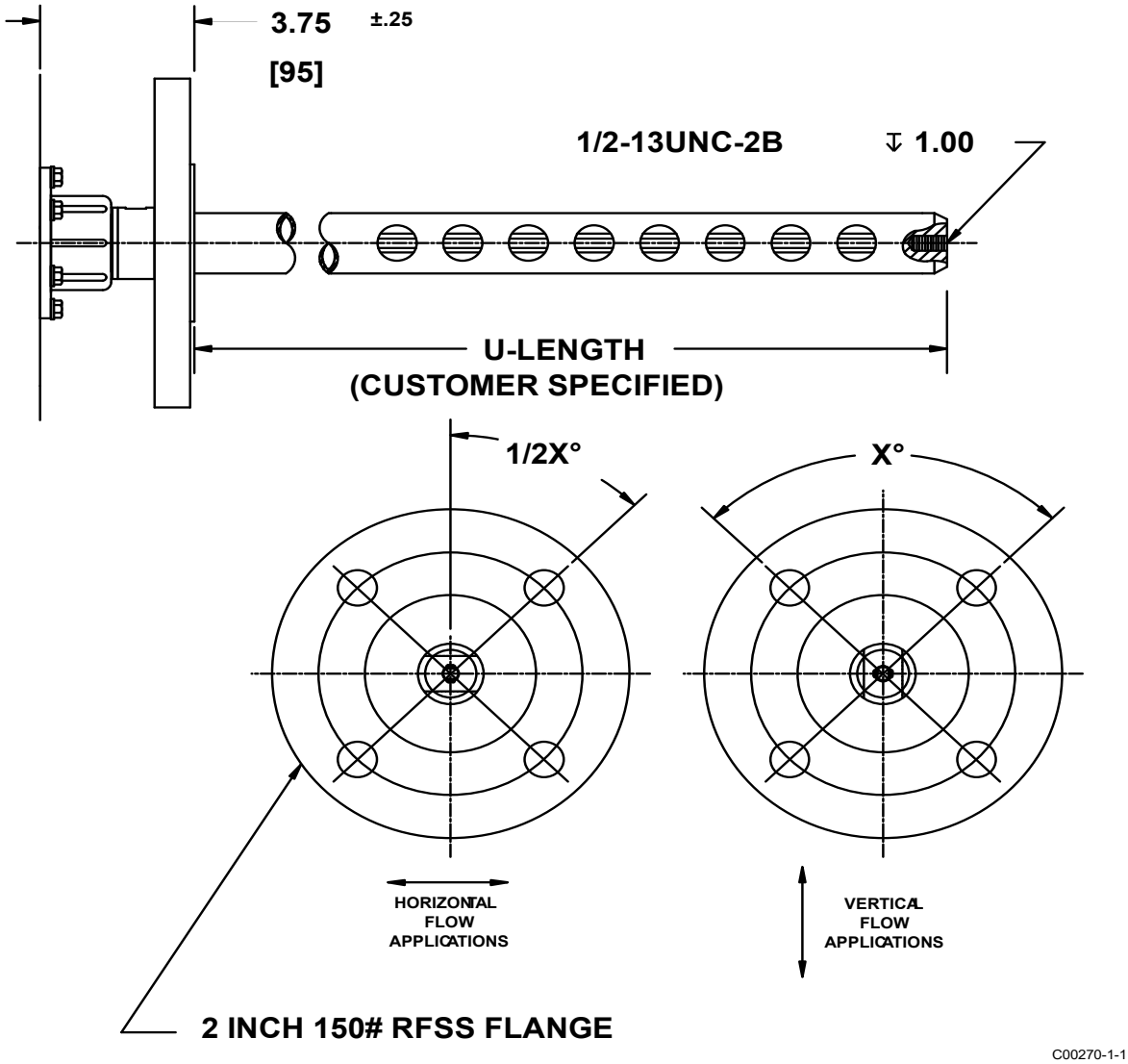



(CUSTOMER DUCT)
DIRECTION OF FLOW
30°
60°
.50 [12.7]*
1.0 [25.4]*
* ø.350 [8.89] THRU 6 HOLES EQUALLY SPACED ON A ø 7.00 [178] BOLT CIRCLE
ø.130 [3.30] THRU* 6X 2 HOLES
ø5.25 [133] THRU* (MAX.)


RIVET, BLIND, 100° FLAT HEAD 2 REQ'D PER ANCHOR NUT (12 TOTAL)
GASKET
(CUSTOMER DUCT)
(.25 [6.35])
6X ANCHOR NUT, 5/16–24UNF–2B
2 INCH SCH 40 PIPE
ø2.03 [51.6] MAX
(ø8.00 [203])
BOLT, HEX HEAD, 1/2–13UNC–2A x 2.0 IN. LG
LOCK WASHER, SPLIT
FLAT WASHER
ø2.07 [52.6]
1/2–13UNC–2B x 1.0 IN. DEEP
1.50 [38.1]
6X FLAT WASHER
6X BOLT. HEX HEAD

C01156-1-1


3.35 ±.25
[85]
1/2-13UNC-2B ↧ 1.00
2 INCH NPT
Ø2.06 MAX
HORIZONTAL FLOW APPLICATIONS
U-LENGTH
(CUSTOMER SPECIFIED)
VERTICAL FLOW APPLICATIONS


3.75 ±.25
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1/2-13UNC-2B ↧ 1.00
U-LENGTH
(CUSTOMER SPECIFIED)
1/2X°
X°
HORIZONTAL FLOW APPLICATIONS
VERTICAL FLOW APPLICATIONS
2 INCH 150# RFSS FLANGE

C00270-1-1

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APPENDIX B GLOSSARY

Abbreviations

Delta-R (ΔR)	Resistance differential
Delta-T (ΔT)	Temperature differential
ESD	Electrostatic discharge
FCI	Fluid Components International
HTR	Heater
GND	Ground
LCD	Liquid crystal display
LED	Light Emitting Diode
RTD	Resistance Temperature Detector
SFPS	Standard Feet Per Second

Definitions

Active RTD	The flow element part that senses the fluid flow rate.
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 Transmitter	The portion of the flow meter that conditions, converts and scales the flow signal.
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).
Reference Flat	A flat part on the sensor head that is used to orient the sensor head to the flow.
Reference RTD	The flow element part that senses the fluid temperature.
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.
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.

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APPENDIX C CUSTOMER SERVICE

Customer Service/Technical Support

FCI provides full in-house technical support. Additional technical representation is also provided by FCI field representatives. Before contacting a field or in-house representative, please perform the troubleshooting techniques outlined in this document.

By Mail

Fluid Components International LLC
1755 La Costa Meadows Dr.
San Marcos, CA 92078-5115 USA
Attn: Customer Service Department

By Phone

Contact the area FCI regional representative. If a field representative is unable to be contacted or if a situation is unable to be resolved, contact the FCI Customer Service Department toll free at 1 (800) 854-1993.

By Fax

To describe problems in a graphical or pictorial manner, send a fax including a phone or fax number to the regional representative. Again, FCI is available by facsimile if all possibilities have been exhausted with the authorized factory representative. Our Fax number is 1 (760) 736-6250; it is available 7 days a week, 24 hours a day.

By E-Mail

FCI Customer Service can be contacted by e-mail at: techsupport@fluidcomponents.com.

Describe the problem in detail making sure a telephone number and best time to be contacted is stated in the e-mail.

International Support

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.

After Hours Support

For product information visit FCI at www.fluidcomponents.com. For product support call 1 (800) 854-1993 and follow the prerecorded instructions.

Point of Contact

The point of contact for service, or return of equipment to FCI is your authorized FCI sales/service office. To locate the office nearest you, please go to www.fluidcomponents.com.

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.

Non-Warranty Repairs or Returns

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

Extended Warranty

An extended warranty is available. Please contact the factory for information.

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 the customer's account until all freight charges are cleared, 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

Contact an 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 after the technician's return to the factory or office.

Field Service Rates

All field service calls are billed at the prevailing rates as listed in the FCI Price Book unless previous arrangements have been made with the FCI Customer Service Manager.

Customers are charged for all travel expenses including airfare, auto rental, meals and lodging. In addition, the customer shall pay all costs of transporting parts, tools or goods to and from the job site. Invoicing travel time, field service work and other expenses will be performed by FCI's Accounting Department.

FLUID COMPONENTS INTERNATIONAL LLC
1755 La Costa Meadows Drive, San Marcos, CA 92078-5115 USA
760-744-6950 / 800-854-1993 / Fax: 760-736-6250
Web Site: www.fluidcomponents.com
E-mail: techsupport@fluidcomponents.com

RA #_____

Return Authorization Request

1. **Return Customer Information**

Returning Company's Name: _____ Phone# _____

Return Contact Name: _____ Fax # _____

Email Address: _____

2. **Return Address**

Bill To: _____ Ship To: _____

_____ _____

_____ _____

_____ _____

3. **Mandatory End User Information**

Contact: _____ Company: _____ Country: _____

4. **Return Product Information**

Model No: _____ Serial No(s): _____

Failure Symptoms *(Detailed Description Required)*: _____

_____

What Trouble Shooting Was Done Via Phone or Field Visit by FCI: _____

_____

FCI Factory Technical Service Contact: _____

5. **Reason For Return** ❑ Sensor Element ❑ Electronics ❑ As Found Testing ❑ Credit
❑ Recalibrate (New Data) ❑ Recalibrate (Most Recent Data) ❑ Other

(Note: A new Application Data Sheet (ADS) must be submitted for all recalibrations and re-certifications)

6. **Payment Via** ❑ Faxed Purchase Order ❑ VISA ❑ MasterCard

(Note: A priced quotation is provided for all Non-Warranty repairs after equipment has been evaluated. All Non-Warranty repairs are subject to a minimum evaluation charge of $250.00)

Factory Return Shipping Address:

Fluid Components International LLC
1755 La Costa Meadows Drive
San Marcos, CA 92078-5115
Attn: Repair Department
RA #_____

FCI Document No. 05CS000004D [U]

FLUID COMPONENTS INTERNATIONAL LLC

The following Return Authorization Request form and Decontamination Statement ***MUST be completed, signed and faxed back to FCI before*** a Return Authorization Number will be issued. The signed Decontamination Statement and applicable MSDS Sheets **must be included with the shipment**. FCI will either fax, email or telephone you with the Return Authorization Number upon receipt of the signed forms.

Packing Procedures

1. **Electronics** should be wrapped in an **anti-static** or **static-resistant** bag, then wrapped in protective bubble wrap and surrounded with appropriate dunnage* in a box. Instruments weighing **more than 50 lbs., or extending more than four feet**, should be secured in wooden crates by bolting the assemblies in place.
2. **The sensor head must be protected** with pvc tubing, or retracted the full length of the probe, locked and secured into the Packing Gland Assembly (cap screws tightened down).
3. FCI can supply crates for a nominal fee.
4. No more than **four (4)** small units packaged in each carton.
5. **FCI will not be held liable for damage caused during shipping.**
6. To ensure immediate processing **mark** the RA number on the outside of the box. Items without an RA number marked on the box or crate may be delayed.
7. Freight **must be "PrePaid"** to FCI receiving door.

* Approriate dunnage as defined by UPS, will protect package contents from a drop of 3 feet.

*** Decontamination Statement *** This Section Must Be Completed ***

Exposure to hazardous materials is regulated by Federal, State, County and City laws and regulations. These laws provide FCI's employees with the "Right to Know" the hazardous or toxic materials or substances in which they may come in contact while handling returned products. Consequently, FCI's employees must have access to data regarding the hazardous or toxic materials or substances the equipment has been exposed to while in a customer's possession. Prior to returning the instrument for evaluation/repair, FCI requires thorough compliance with these instructions. The signer of the Certificate must be either a knowledgeable Engineer, Safety Manager, Industrial Hygienist or of similar knowledge or training and responsible for the safe handling of the material to which the unit has been exposed. **Returns without a legitimate Certification of Decontamination, and/or MSDS when required, are unacceptable and shall be returned at the customer's expense and risk.** Properly executed Certifications of Decontamination must be provided before a repair authorization (RA) number will be issued.

Certification Of Decontamination

I certify that the returned item(s) has(have) been thoroughly and completely cleaned. If the returned item(s) has(have) been exposed to hazardous or toxic materials or substances, even though it (they) has (have) been thoroughly cleaned and decontaminated, the undersigned attests that the attached Material Data Safety Sheet(s) (MSDS) covers said materials or substances completely. Furthermore, I understand that this Certificate, and providing the MSDS, shall not waive our responsibility to provide a neutralized, decontaminated, and clean product for evaluation/repair at FCI. Cleanliness of a returned item or acceptability of the MSDS shall be at the sole discretion of FCI. **Any item returned which does not comply with this certification shall be returned to your location Freight Collect and at your risk.**

This certification must be signed by knowledgeable personnel responsible for maintaining or managing the safety program at your facility.

Process Flow Media _____

Product was or may have been exposed to the following substances: _____

Print Name _____

Authorized Signature _____ Date _____

Company Title _____

Visit FCI on the Worldwide Web: www.fluidcomponents.com
1755 La Costa Meadows Drive, San Marcos, California 92078-5115 USA ‡ Phone: 760-744-6950 ‡ 800-854-1993 ‡ Fax: 760-736-6250

FCI Document No. 05CS000004D [U]

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.

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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 & MT86HT		BCDE	

All options conform to CE marking requirements.

XY X or Y options only conform to CE marking.

All other configurations must be approved for CE marking conformity by FCI's engineering department.

CONDITIONALLY APPROVED CE MARKING 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.

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Flow & Level Instrumentation
Solutions for Industrial Processes

FCI's Quality Management System is
ISO 9001 and AS9100 Certified