

# INSTALLATION, OPERATION AND MAINTENANCE MANUAL

## FR73B IN-LINE MINI FLOW MONITOR/TRANSDUCER

Doc. No. 06EN003282

Rev. -

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FCI Technical Publications Department

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### ***By Mail***

Fluid Components Intl  
1755 La Costa Meadows Dr.  
San Marcos, CA 92069  
Attn: Customer Service Department

### ***By Phone***

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

Reserved for Domestic Rep Map

Reserved for International Rep Map

# REVISIONS

<b>REV.</b>	<b>DESCRIPTION</b>	<b>DATE</b>	<b>AUTHOR</b>
—	New Release.	2/26/97	R. Sanders

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# Symbols

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



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



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



**Note:** Contains important information.

# 1. General Information

## Description

This document explains the operating principle of the Model FR78 Basic Low-Flow Switch/Monitor (see Figure 1-1). The following pages also present the recommended procedures for the installation, operation, maintenance, and troubleshooting of the Model FR78B.

The Model FR78B is an instrument that is capable of detecting liquid or gaseous environments. The instrument has field adjustable alarm set points for control of the media.

## Flow Element

The operational part of the flow element consists of two Resistance Temperature Detectors (RTD's) and one low power heater. The heater is positioned adjacent to the Active RTD and will raise it's temperature above the process ambient while the other RTD (Reference) will stabilize near the process temperature. This arrangement produces a temperature differential between the two RTDs that is measured and converted into an analog voltage signal. The temperature differential is greatest when the media is not flowing (no flow). As the process media begins to flow, forced convection cools the Active RTD and reduces the temperature differential between the two RTDs.

## Control Circuit

The basic functions of the control circuit are to provide power to the flow element, measure the resistance differential (DR) between the two RTDs, condition the sensing point signals, and provide relay alarm contacts for customer uses.

A Double Pole Double Throw (DPDT) relay is available in the instrument for connections to the customer alarm systems. The relay outputs can be set to be either open or closed when the sensing point is at low or no flow and closed or open when the sensing point is at high flow.

The place where the relays change state will vary depending on the type of media, as well as gas or liquid turbulence. Therefore the instrument has field adjustable alarm set points.

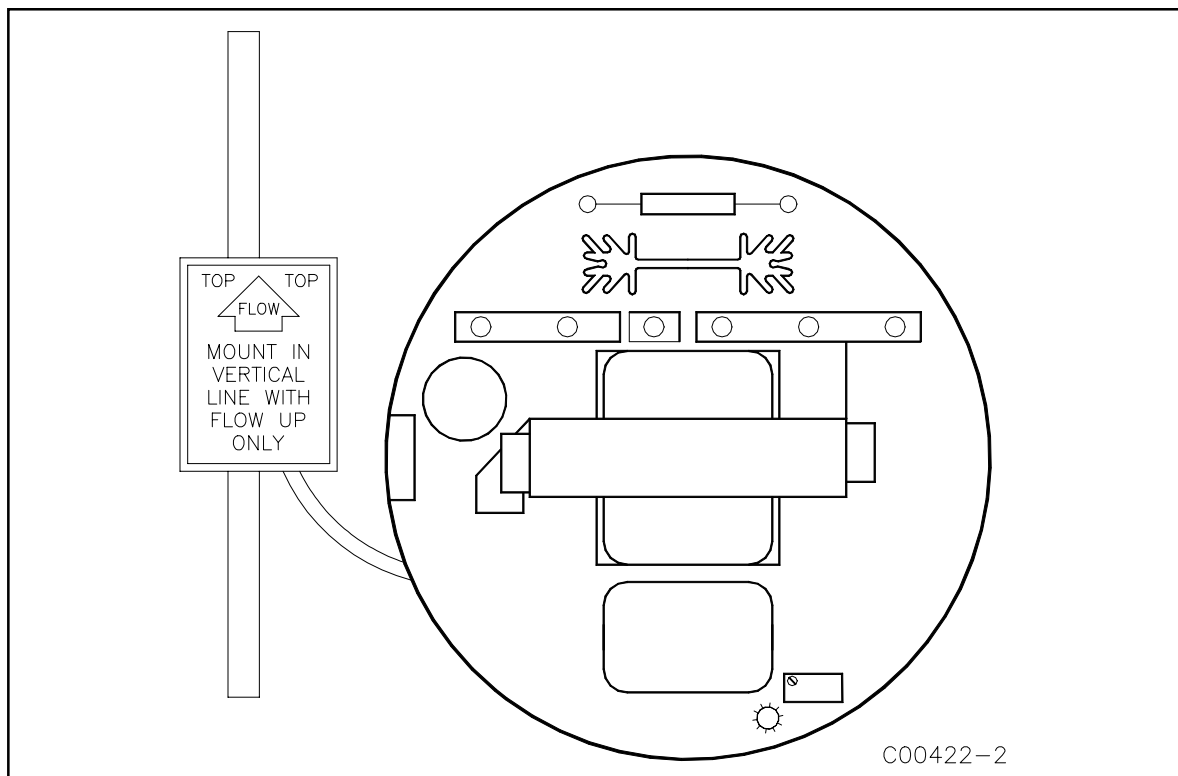


Figure 1-1. FR78B Fast Response Flow Switch/Monitor

## Specifications

- **Sensing/Flow Element Ranges**

Water: 0.08 to 2.25 cc/sec

Oil: 0.05 to 25 cc/sec

Air: 4.0 to 1500cc/sec

- **Adjustable Response Time**

1 to 150 seconds

- **Process Connection**

1/4 inch x 2 inch (6.4 x 50mm) long tubing,  
.0028 (7mm) wall thickness, .53 inches (13.5mm)  
total length. 3/8 inch (9.5mm) and 1/2 inch  
(12.7mm) tubing available

- **In-line Sensor Assembly Body Length**

5.3 inches (1.35mm); Customer specified body  
lengths available

- **Enclosure Classification**

Standard: No enclosure; Optional control circuit  
enclosure is Feralloy epoxy coated and resists the  
effects of weather and corrosion. NEMA and CSA  
Type 4 (meets IP66)

- **Sensing/Flow Element  
Operating Conditions**

Temperature: -100 to 350°F (-73 to 176°C)

Pressure: To 1000 psig [69 bar (g)]

Repeatability: 1% of full scale range at constant  
process conditions

- **Input Power**

115 ±15 or 230 ±30 Vac 50/60 Hz; or 22 to 30 Vdc,  
6 Watts

- **Relay Contacts**

DPTD, rating is 2 amps at 115 Vac and 24 Vdc or  
1 amp at 230 Vac. Coil de-energized at no-flow  
(default) or de-energized at flow (field selectable)

- **Material of Construction**

All wetted surfaces are 316 series stainless steel with  
nickel braze per process specifications AMS 4777.  
Optional wetted surface material customer specified

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# 2. Installation

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## Receiving/Inspection

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

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

## Packing/Shipping/Returns

These issues are addressed in Appendix C - Customer Service

## Factory Calibration Note

The instrument 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 instrument in service.

## Required Materials

Appropriate wire, cable, and conduit.



**Note:** Potting Y's for all the interconnecting wires are recommended when installing the instrument's control circuit in an enclosure. Other requirements may vary based on local wiring codes.

## Pre-Installation Procedure



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



**Caution:** Damage resulting from moisture penetration of the local or remote (optional) enclosure is not covered by product warranty.

## Verify Serial Numbers

Verify that the flow element serial number matches the control circuit serial number.

## Verify Installation Location

Prepare the vessel for installation, or inspect the already prepared location to ensure that the instrument will fit into the system. The location that should have been prepared at the time of order should be at least 20 pipe diameters downstream and 10 pipe diameters upstream from any bends or interference in the process pipe or duct to achieve the greatest accuracy.

## Flow Element Installation

Verify the correct orientation of the flow element. Install the flow element in-line with the process media flow. See the specifications in Chapter 1 for the various process connections available. See Appendix A for the dimensions of the flow element.

## Wiring Installation

### Conduit Routing

All socket and/or terminal block connections are to be made through openings in the remote enclosure if used. FCI strongly recommends that all electrical cables be run through an appropriate conduit for the protection of the instrument and personnel if a remote enclosure is used.

Protection of the control circuit from moisture is an important consideration. Keep the entry of the conduit into the enclosure in the downward direction so condensed moisture that collects in the conduit will not drain into the enclosure. In addition, FCI recommends sealing off the conduit with a potting Y or other sealing method to prevent moisture from entering the remote enclosure if used.

### Minimum Wire Size

Table 2-1 shows the smallest (maximum AWG number) copper wire that is to be used in the electrical cables for connecting the instrument to the customer alarms and power. Use a lower gauge of wire for less of a voltage drop. Contact FCI concerning greater distances than those listed in the table.

**Table 2-1. Interconnecting Cable Size (AWG)**

Connection	Maximum Distance for AWG					
	10ft. (3m)	50 ft. (15m)	100 ft (31 m)	250 ft. (76m)	500 ft. (152m)	1000 ft. (305m)
Input Power	22	22	22	20	18	16
Relay	24	22	20	16	12	10

### Cable Connections



**Caution:** In order to prevent circuit or component damage, remove the control circuit from the remote enclosure (if present) prior to the pulling of conduit wire.



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

Unplug the control circuit from its socket by pulling up on the transformer in the center of the circuit. Then connect the relay outputs to the customer alarms. Also connect the power to the instrument power input. See Appendix A for the appropriate connection information.

Replace the control circuit. Be sure any customer supplied gaskets, O-rings, seals or washers are correctly installed to prevent moisture from getting on the control circuit.

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# 3. Operation

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## Factory Calibrations

The instrument is delivered in its standard factory set point form unless a custom factory calibration was specified. The standard factory setting is mid-range between no flow and full flow. See Figure 3-1.

If the order included custom factory calibration and alarm set point, keep all settings unchanged. The instrument is ready for service without changes.

## Field Calibrations for Flow Applications

If the factory calibrations were not ordered then follow one of the procedures below based on the particular instrument purchased. If precise measurement is desired, FCI recommends that a FM71 Monitor/Calibrator be used. Then the precise measurement of the signal voltage versus flow rate can be calculated for the alarm set points.

## Alarm Set Point Adjustments By Observation or By Measurement

Alarm set points can be adjusted by observation or by precision measurements. The following procedure is adjustment by observation. If adjustment by measurement is desired, obtain an FCI FM71 Calibrator/monitor and follow the instructions found in the FM71 manual.

### Alarm 1 Set Point Procedure for 5181 Control Circuit

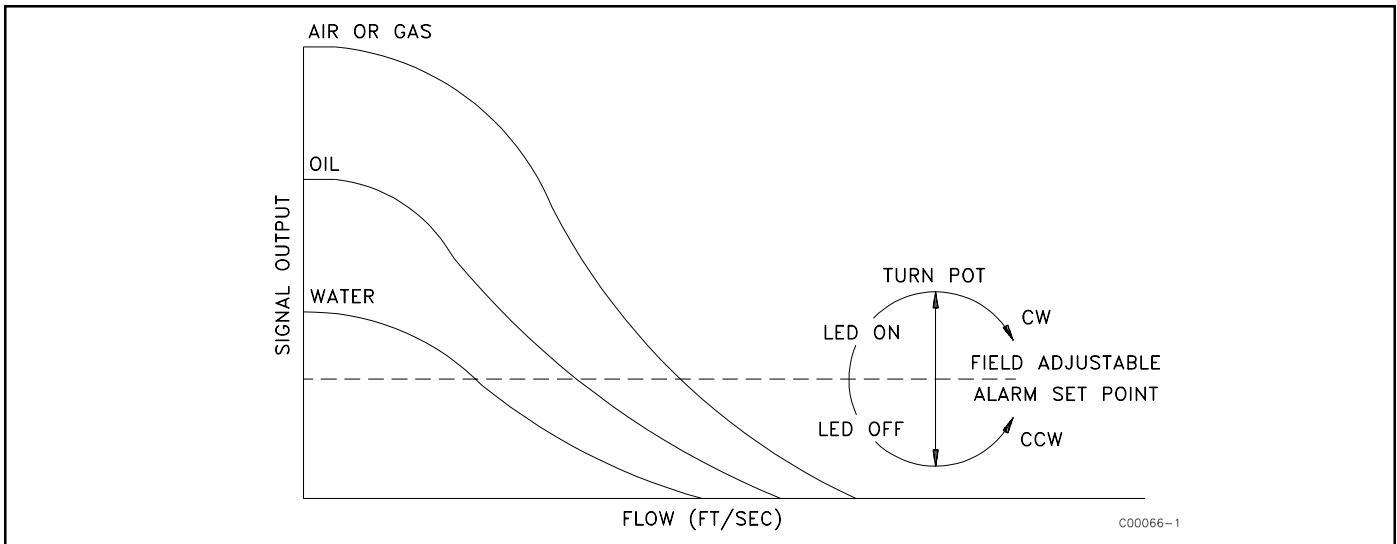
1. Flow the pipeline at the desired rate of flow.
2. Apply power to the instrument and allow 15 minutes for the sensing element to become active and stabilize.
3. Locate the potentiometer (R5) and the red LED on the control circuit. (See Figure 3-2.)
4. Choose A or B.

#### A. Detecting No Flow or Decreasing Flow Rate

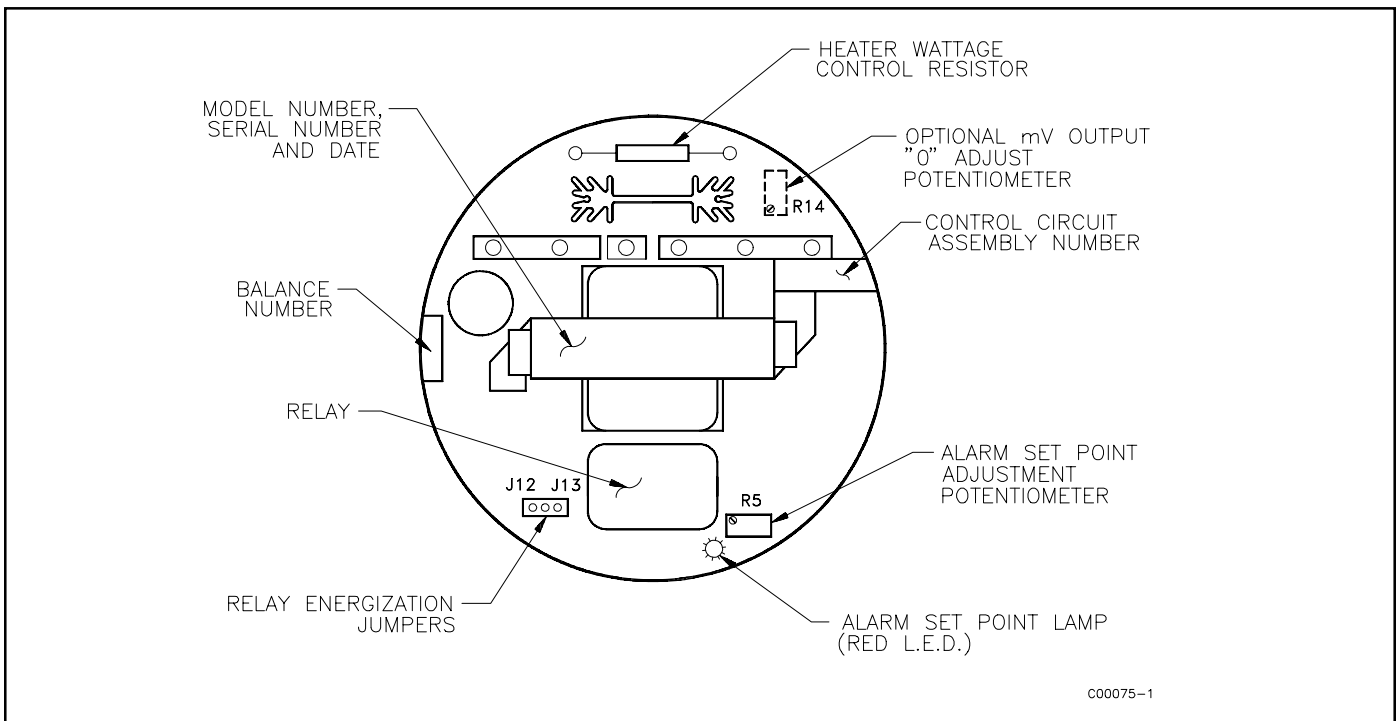
If the LED is off, turn the potentiometer clockwise until the LED turns on. If the LED is on, turn the potentiometer counterclockwise until the LED turns off, then turn the potentiometer clockwise until the LED just turns on. With the LED on, turn the potentiometer slowly counterclockwise until the LED just turns off. Turn the potentiometer one-half turn past the point at which the LED just turns off. Be aware that the potentiometer may have up to one quarter turn of hysteresis. If the mark is overshoot, the procedure should be repeated. (See Figure 3-1.)

#### B. Detecting Maximum Flow or Increasing Flow Rate

If the LED is on, turn the potentiometer counterclockwise until the LED turns off. If the LED is off, turn the potentiometer clockwise until the LED turns on, then turn the potentiometer counter clockwise until the LED just turns off. With the LED off, turn the potentiometer slowly, clockwise until the LED just turns on. Turn the potentiometer one-half turn past the point at which the LED just turns on. Be aware that the potentiometer may have up to one quarter turn of hysteresis. If the mark is overshoot, the procedure should be repeated. (See Figure 3-1.)



**Figure 3-1. Setting Alarm Switch Points**



**Figure 3-2. Control Circuit 5181 Outline Drawing**

### Creating a Calibration Curve Using an FM71 Calibrator

1. Apply power to the instrument and establish a constant flow rate in the pipe for the first data point to be taken. Let the instrument stabilize for 10 minutes.
2. Attach an FM71 meter to the control circuit. Dial in the balance number found near the edge of the control circuit. The read out /calib. switch should be in the read out position. Record the flow rate versus the meter readout.
3. Repeat steps 1 and 2 at different flow rates. Record enough flow points to be able to make a millivolt versus flow curve.

To set a switch point, use the instructions that come in the FM71 manual.



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# 4. Maintenance

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The instrument requires very little maintenance. There are no moving parts or mechanical parts subject to wear.



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

## Maintenance

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

### Alarm Set Point Verification

Periodically verify the alarm set point.

### Enclosure (If Present)

Periodically verify that the moisture barriers and seals of the remote enclosures are adequate and that no moisture is entering the enclosure.

### Electrical Wiring

Periodically inspect the power, flow element, and output wiring for signs of corrosion or deterioration.

### Electrical Connections

Periodically inspect wire connections on the socket. Verify that terminal connections are tight and physically sound with no sign of corrosion.

### Process Connection

Periodically 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.



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# 5. Troubleshooting

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

## Tools Needed

Digital Multimeter (DMM)

## Quick Check

Check the jumper positions of J12 and J13. If present, check the jumper positions of J16 and J17. Jumper J12 and J17 energize the relay(s) at flow or wet. Jumpers J13 and J16 energize the relay(s) at no flow.

Check that the control circuit is firmly seated into its socket.

Check if power is present and customer fuses are good, if they are used.

Follow the trouble shooting flow chart in Figure 5-1 near the end of this chapter.

## 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 and the control circuit are the same when the instrument is used with the remote enclosure option. The flow element and the control circuit are a matched set and cannot be operated independently of each other.

### Check Input Power

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

### Check the Instrument Installation

Review the information on instrument installation in Chapter 2 to verify correct mechanical and electrical installation.

At the time of order, the flow element placement should have been determined. However, if not, the flow element should be mounted at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct for best accuracy.

### Check for Moisture

Check for moisture on the control circuit. Moisture on the control circuit may cause intermittent operation.

If a component of the process media is near its saturation temperature, it may condense on in the flow element tubing. Place the flow element where the process media is well above the saturation temperature of any of the process gases.

## Check Application Design Requirements

Application design problems can occur when instruments are first installed into the process media. The application design should also be checked on instruments that have been in operation for some time. If the application design does not match field conditions, errors occur.

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

## Control Circuit Dash Number Specification

Verify that wiring is connected per the wiring diagram in Appendix A.

## Verification of Flow Element Resistance

The measurements are based on a standard (4K ohm RTD at 70°F, or 21°C) flow element. Variation of  $\pm 100$  ohms from nominal is to be expected, depending on temperature. The maximum allowable difference in resistance between matched RTD's is 1% at ambient temperature (immersed in water). The heater resistance should be  $221 \pm 5$  ohms.

1. Turn off the operating power to the instrument.
2. Gently remove (pull straight out) the control circuit from the socket. Using a DMM, measure the resistance of the active and reference RTD sensing elements.



**Note:** The resistance of the active RTD will be greater than the resistance of the reference RTD whenever the heater is on.

3. Measure the resistances as found in Table 5-1 to determine if the flow element is functional. The resistance is dependent on a temperature of 70°F (21°C)

**Table 5-1. Flow Element Resistances In Ohms**

Terminal Pin Number (Wire Color)	Resistance In Ohms
From Pin 7 (White, Black and Shield) To Pin 8 (Yellow)	4000
From Pin 8 (Yellow) To Pin 9 (Red)	4000
From Pin 7 (White, Black and Shield) To Pin 10 (Blue)	221
From Pin 7 (White, Black and Shield) To Pin 9 (Red)	8000
From Pin 8 (Yellow) To Pin 10 (Blue)	4221
From Pin 9 (Red) To Pin 10 (Blue)	8221
Shield To All Pins	Open Circuit

If an open circuit exists for one RTD and a value of twice the resistance exists for the other RTD, then there is probably a miswiring or mislabeling problem.

After replacing the flow element, it will be necessary to follow the set point adjustment procedures found in the Operation chapter before returning the instrument to service.

If the flow element resistance is correct, proceed to the voltage verification test.

## Verification of Flow Element Voltage

If the above resistance checks are good, plug in the control circuit and apply power. Measure the voltages in Tables 5-2. If the voltages are not correct, then remove and replace the control circuit.

**Table 5-2. Flow Element Voltages**

From Terminal Pin	Pin	Voltage Expected*
9 (+)	7 (-)	22VDC
8 (+)	7 (-)	12VDC
9 (+)	8 (-)	10VDC
10 (+)	7 (-)	22VDC (2 Watt Heater) 19VDC (1.5 Watt Heater) 15 VDC (1 Watt Heater)

\*\*Voltages are dependent on temperature.

## Spares

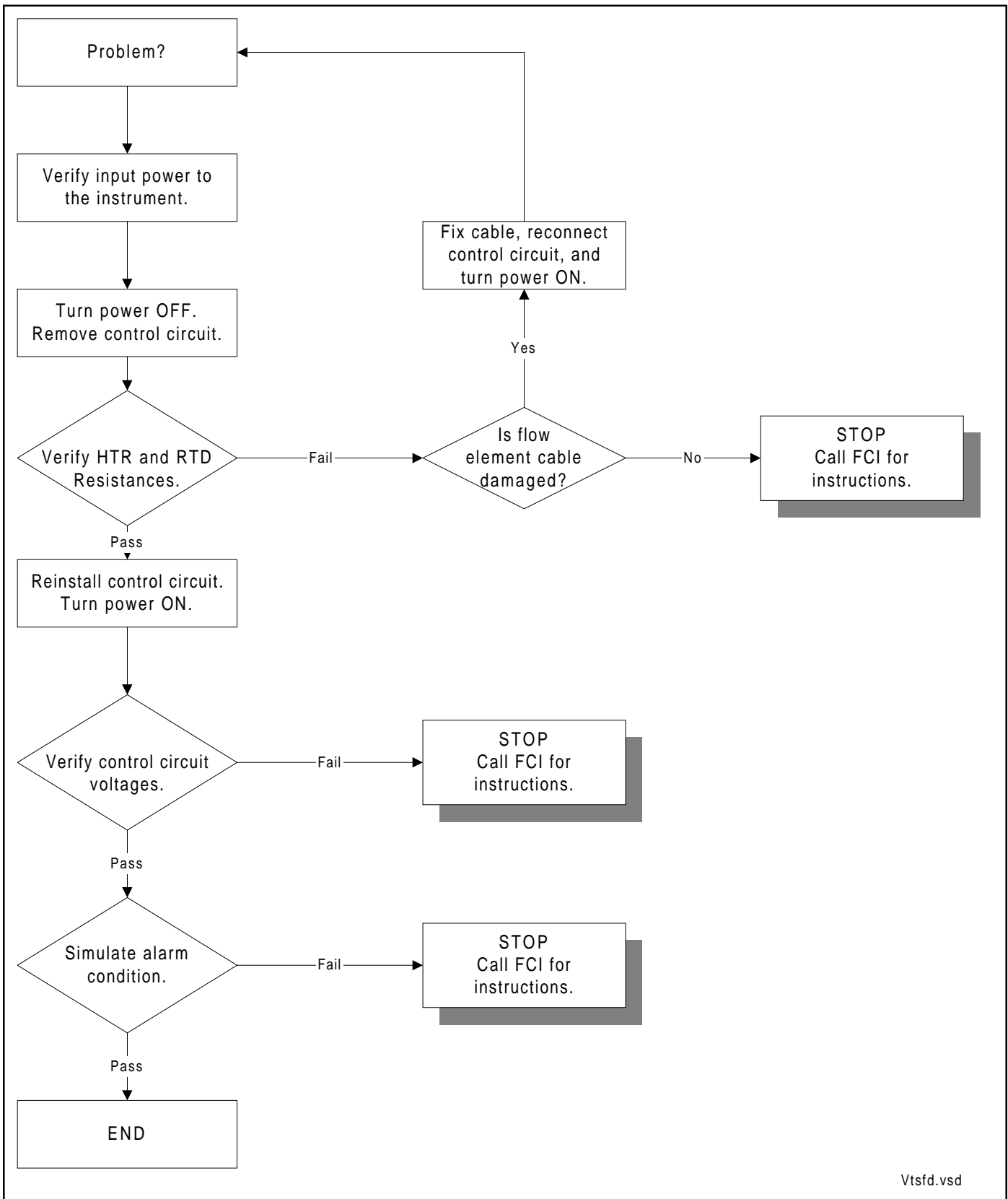
FCI recommends that one control circuit be kept as a spare. Check the Order Information Sheet that was filled out at the time of order for the correct part and dash number. Contact FCI for specific recommendations.

## Defective Parts

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

## Customer Service

1. In the event of problems or inquiries regarding the instrument, 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, be sure that all the applicable information is near so that a more effective, efficient and timely response may be provided.
3. Refer to Appendix C for specific Customer Service policy provisions.

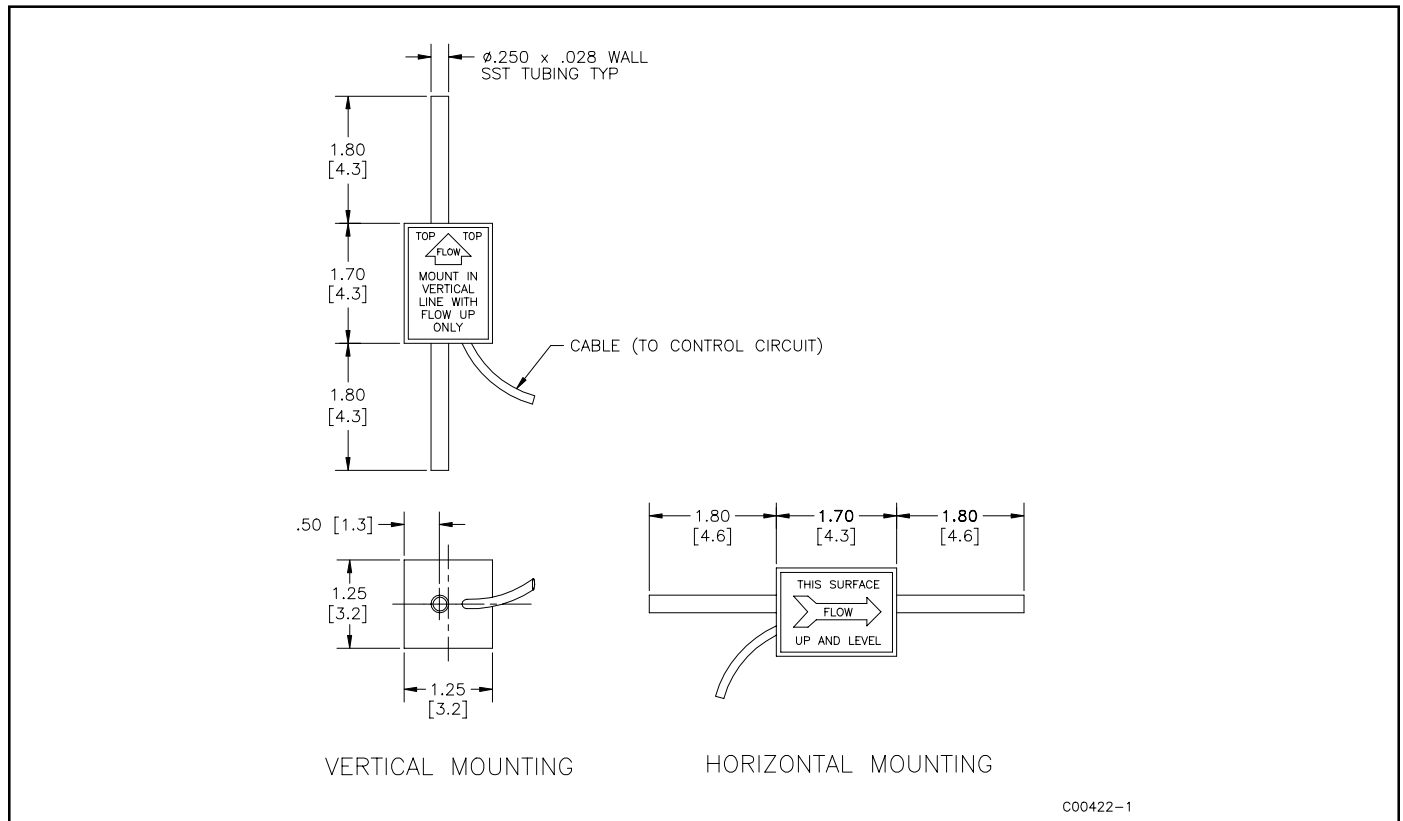


Vtsfd.vsd

Figure 5-1. Troubleshooting Flow Chart

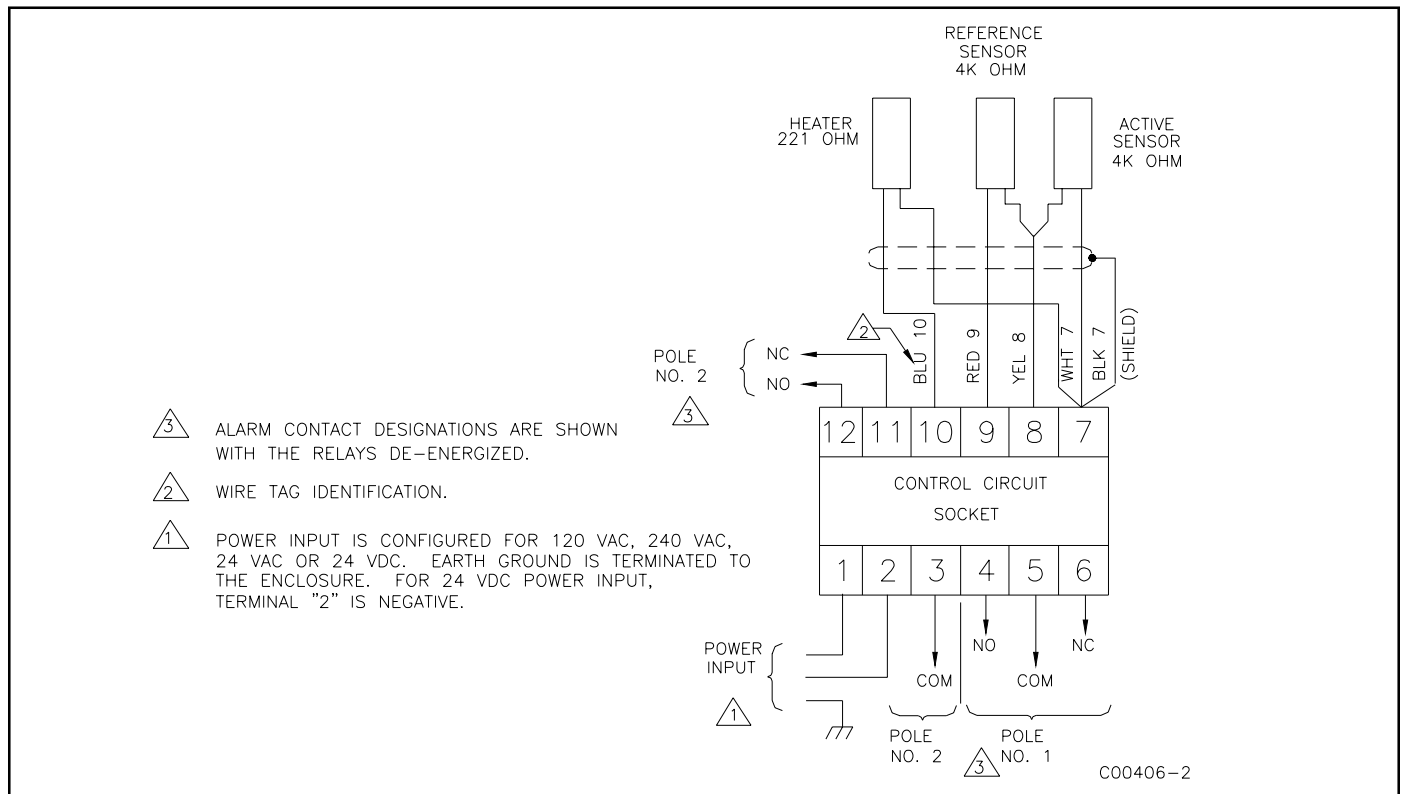
# Appendix A. Drawings

Inches [mm]



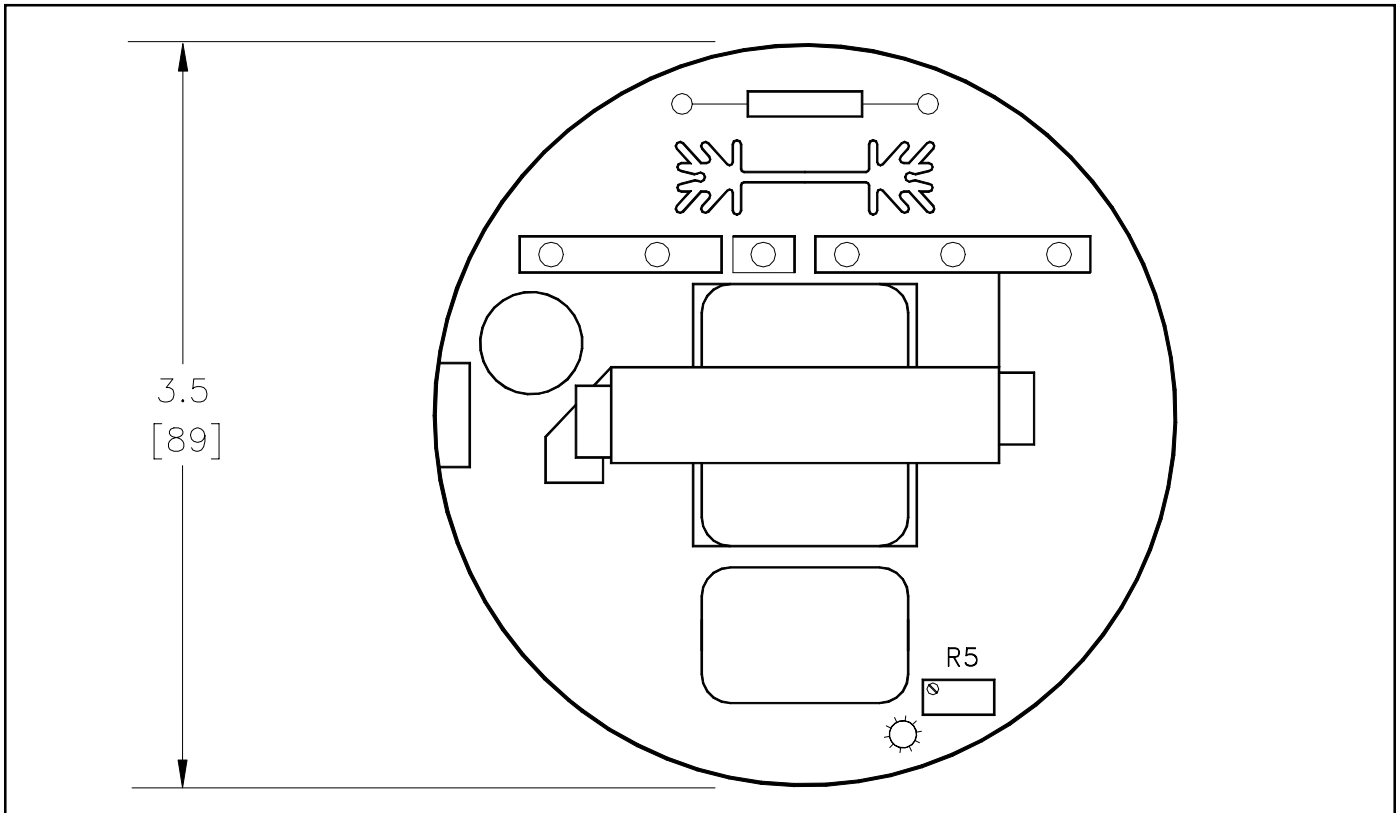
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Figure A-1. Flow Element Dimensional View

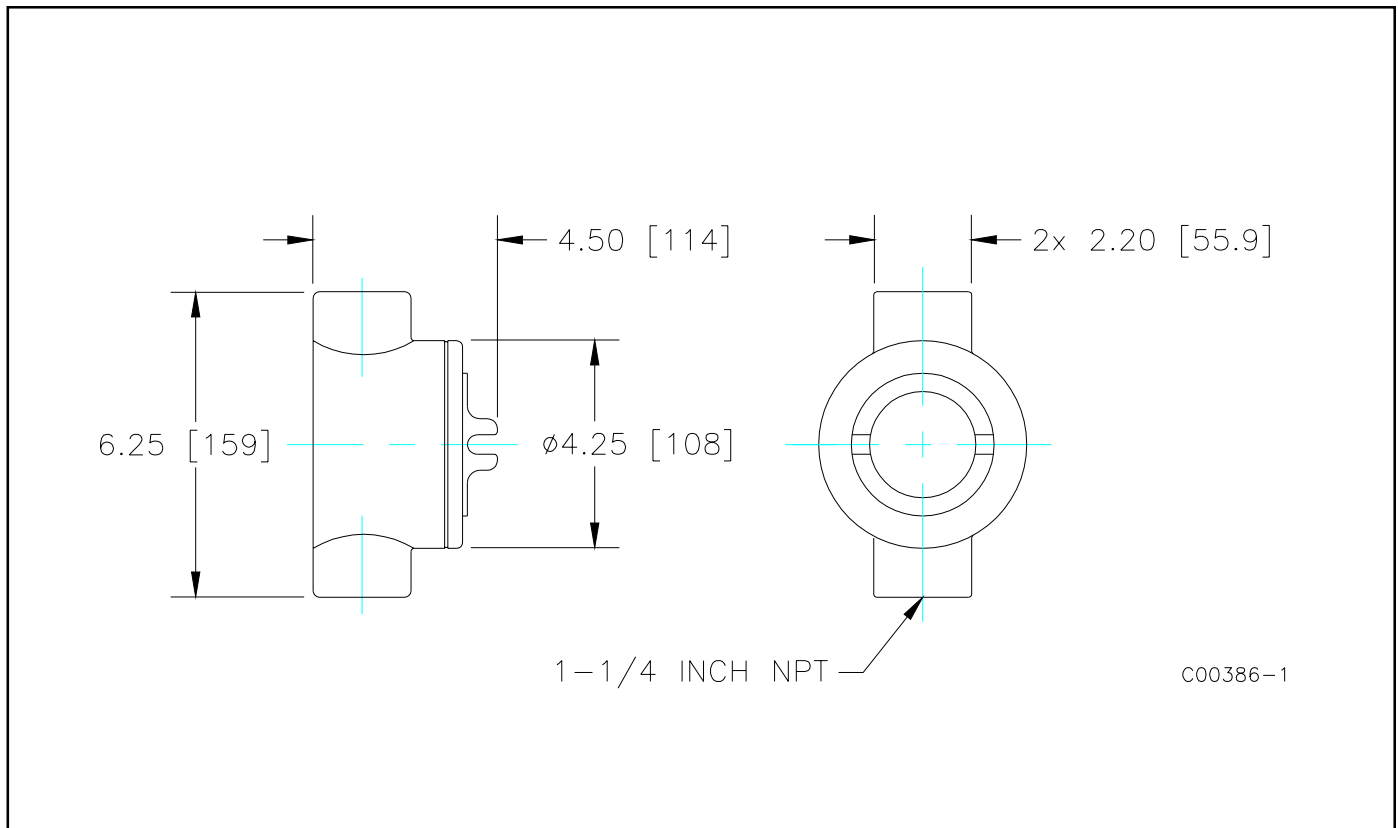


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Figure A-2. Wiring Diagram



**Figure A-3. 5181 Control Circuit**



**Figure A-4. Optional Remote Enclosure NEMA Type 4 (Feraloy® Epoxy Coated)**



# Appendix B. Glossary

## ABBREVIATIONS

<b>Delta R (DR)</b>	Differential Resistance
<b>Delta T (DT)</b>	Differential Temperature
<b>DMM</b>	Digital Multimeter
<b>FCI</b>	Fluid Components Intl
<b>HTR</b>	Heater
<b>LED</b>	Light Emitting Diode
<b>RA</b>	Repair Authorization
<b>RTD</b>	Resistance Temperature Detector

## DEFINITIONS

<b>Active RTD</b>	The flow element part that senses the fluid flow rate.
<b>Balance</b>	A number that is used to balance or match the active and reference RTDs when the heater is off.
<b>Control Circuit</b>	The portion of the flow switch that conditions, converts, and scales the flow element signal.
<b>Differential resistance Delta -R (DR)</b>	The flow element signal.
<b>Differential temperature Delta -T (DT)</b>	The difference in temperature between the active and reference RTDs.
<b>Flow element</b>	The portion of the flow switch that contains the thermowells, RTDs, and produces a signal with a defined relationship to the flow rate.
<b>Heater (HTR)</b>	The flow element part that heats the active RTD.
<b>Reference RTD</b>	The flow element part that senses the fluid temperature.
<b>Remote enclosure</b>	The enclosure that contains the control circuit, and is connected to the flow element by an electrical cable.
<b>Resistance Temperature Detector (RTD)</b>	A sensor whose resistance changes proportionally to detector temperature changes.



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# Appendix C. Customer Service

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## Point of Contact

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

## Reference Documents

Return Authorization Request/Certificate of Non-Contamination (Document 1)

Warranties (Document 2)

The above documents are included in this Appendix.

## Hardware Return Procedure

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

## Shipping/Handling Charges

### All Shipping (Warranty and Nonwarranty Repairs or Returns)

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

FLUID COMPONENTS INTL  
1755 LA COSTA MEADOWS DRIVE  
SAN MARCOS, CA. 92069  
ATTN: REPAIR DEPT.  
RA NUMBER: \_\_\_\_\_

## Warranty Repairs or Returns

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

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

## Nonwarranty Repairs or Returns

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

## Return to Stock Equipment

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

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

## Field Service Procedures

### Field Service Requests

Contact your FCI field representative to request field service.

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

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

### Rates

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

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

Document 1.

FCI RETURN AUTHORIZATION REQUEST

Customer Information

Name of Company Returning Hardware \_\_\_\_\_

Contact Name: \_\_\_\_\_ Phone # \_\_\_\_\_ Fax # \_\_\_\_\_

Customer Bill to Address: \_\_\_\_\_ Ship to: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Purchase Agent Contact: \_\_\_\_\_ Phone # \_\_\_\_\_ Fax # \_\_\_\_\_

Product Information

Model Number(s) \_\_\_\_\_ Serial Number(s) \_\_\_\_\_

Sending: Electronics only  Sensor only  Complete unit  Number of units \_\_\_\_\_

Failure Symptoms \_\_\_\_\_

\_\_\_\_\_

Troubleshooting done in the field by FCI representative  or by Customer  : \_\_\_\_\_

\_\_\_\_\_

Action to be taken by FCI \_\_\_\_\_

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

Process Flow Media: \_\_\_\_\_

Who is your FCI factory technical contact: \_\_\_\_\_

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

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

Decontamination Information

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

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

Authorized Signature \_\_\_\_\_ Date \_\_\_\_\_

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

## Document 2. Warranties

### Warranties

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