INSTALLATION, OPERATION and MAINTENANCE MANUAL

FLT™ Series FlexSwitch™
Flow, Level, Temperature Switch/Monitor with Rack Mount Control Circuit

Doc. No. 06EN003250 **Rev. N/C**

U.S. Patent 4,967,593

CUSTOMER COMMITMENT PLEDGE

We will work closely with our customers to provide the best products and service

- at a competitive value
- on time
- with unquestioned support

in full compliance with our *COMPLETE CUSTOMER COMMITMENT.*

COMMITMENT TO QUALITY

In keeping with the overall commitment of management and employees of Fluid Components Intl to Total Quality Management, the Manual Committee (Quality Circle) expresses its pledge and mission to you, our customer:

"To support the creation and publication of world-class technical material which is technically accurate and practical, concise and user-friendly, attractive and professional in appearance, and consistent in form, format, content, and style."

QUALITY IMPROVEMENT

We appreciate your comments and suggestions which support our effort to constantly improve our product and services. Please address comments and suggestions to your nearest field representative or in-house technical support representative. Thank you.

CUSTOMER SERVICE/TECHNICAL SUPPORT

FCI provides full in-house technical support for our products 7 a.m. to 5 p.m. PST, Monday through Friday (excepting holidays and an annual plant closure between Christmas and New Year's day). Also, additional technical representation is provided by FCI field representatives. Before contacting one of our field or in-house representatives, please ensure that you have performed the troubleshooting techniques outlined in this document.

By Mail

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

By Phone

Contact the FCI regional representative in your area. If your are unable to contact the field representative or are unable to satisfactorily resolve the situation, contact the FCI Customer Service Department at (619) 736-6116 or call toll free (800) 854-1993.

By Fax

To describe your problems in a more graphic or pictorial manner, send your regional representative a fax. The fax should include your phone and fax number. Again FCI is available through facsimile if you have exhausted your possibilities with the authorized factory representative. Our fax number is (619) 736-6250; it is available 7 days a week, 24 hours a day.

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. See list on following pages.

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

Reserved for Domestic Rep Map

Reserved for International Rep Map

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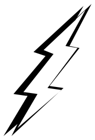
Symbols

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

The FLT™ Series uses FlexSwitch™ technology. The FLT Series models are multipurpose measurement instruments. They are individual instruments that are capable of detecting fluid flow and temperature. They are also able to detect liquid level or fluid interfaces. The instruments have two adjustable set-point alarms as well as a built-in calibration circuit. Relay contacts are the primary output, but the analog and fluid temperature signals can be monitored also.

The model control circuit is designed to interface with the FLT series sensing elements. It is packaged as a rack mounted 3U Eurocard configuration which conserves space when installing several sensing elements. The control circuit has two channels for two independent sensing elements. Each channel provides two alarm outputs for each channel. The first voltage output represents the signal developed from the flow or level condition of the media. The other signal represents the temperature of the media. Each channel has a calibration circuit that is useful when setting an alarm switch point. Other options are available with plug-able jumpers. These options will be discussed later in the manual.

Theory of Operation

The FLT models are a fixed position, single-point flow, level, interface, and temperature switch. The operation of the FLT sensing element is based upon the thermal dispersion principle: A low-power heater is used to produce a temperature differential between two resistance temperature detectors (RTDs). The RTD temperature differential varies as a function of forced convection for flow measurement and as a function of fluid thermal conductivity for level and interface measurement. The measurement of the fluid's temperature is obtained from the non-heated RTD.

The FLT control circuit converts the sensing element's RTD temperature differential into an analog DC voltage signal. Dual comparators monitor the sensing element signal and activate relay alarm circuits if the signal exceeds an adjustable set point value.

Technical Specifications

- **Process Connection:**

  3/4 in. male NPT standard. 1 in. BSP, 1 in. male NPT, or flange mounting optionally available.

- **Insertion Length:**

  1.13 in. (2.87cm) standard. 2 in. (5.1cm), 4 in. (10.2cm), 6 in. (15.2cm), 9 in. (22.9cm), 12 in. (30.5cm), 18 in. (45.7cm), or other customer specified lengths optionally available.

- **Material of Construction:**

  All wetted surfaces are 316 Stainless Steel, all welded. Other corrosion resistant materials are optionally available.

- **Operating Temperature:**

  Ambient: -40° to 140°F (-40° to 60°C) Process (standard temperature Sensing Element): -40° to 250°F (-40° to 121°C).

- **Operating Pressure:**

  Hydrostatically proof pressure tested to 3500 psi (241.3 bar) at 70 °F (21.1 °C). De-rated with temperature, the maximum recommended operation service is 2350 psi (162 bar) at 500 °F (260 °C). Higher ratings available with special construction and test certification.

- **Signal Output:**

  Buffered voltage output available as a standard for temperature and either flow or level/interface. The minimum load impedance is 10 Megohms.

- **Control Circuit:**

  Part Number: 5495
  3U, 19 inch rack (according to ANSI/IEEE 1101, DIN 41494 part 5).
  Mating Connector (DIN 41612, type F, 48 pins, female).

- **Heater Power:**

  Field Selectable for specific fluid service requirements at 0.75, 1.75, and 2.5 watts.

- **Relay Rating (Each Channel):**

  Dual SPDT or single DPDT field configurable 6 amp resistive at 115 VAC or 24 VDC.

- **Enclosure:**

  NEMA type 7. NEMA type 4x optionally available.

- **Input Power:**

  24 VDC (-3.5, +6). 500mA maximum for 2 channels.

- **Repeatability:**

  ±0.5% of monitoring reading.

  Up to ±0.05 inch (±0.13 cm) of level depending on model.

  ±1.0°F, (±0.56°C) of temperature.

Appendix D. Temperature Compensation

Introduction

Temperature compensation (Temp Comp) is an essential part of the FLT FlexSwitch circuitry. When the Temp Comp is set correctly, the instrument stays accurate over a process temperature range of 100 °F. The instrument is a thermal dispersion device. It relies on the temperature differential between the reference RTD, which is at the process media temperature, and the active RTD, which is heated to produce a temperature differential (ΔT). For example; with constant temperature, flow rate, process media and heater power, the ΔT is reduced and reaches a stable value. If the process media temperature goes up and all other conditions stay the same, the ΔT is reduced. Without Temp Comp the circuitry would process the signal as an increased flow rate.

To understand Temp Comp the output signal needs to be understood first. This temperature output signal is the absolute voltage drop across the reference RTD, and proportional to temperature. The instrument uses this voltage for two purposes. The voltage drop across the reference RTD is subtracted from the voltage drop across the Active RTD to produce a voltage differential. The voltage differential is used to set flow or liquid level alarms. Also, the voltage drop across the reference RTD adds to, or subtracts from, the output signal as a function of ΔT.

Note: In order to adjust the Temp Comp correctly certain parameters must be measured and calculated. All temperature measurements should converted to degrees Fahrenheit before a temperature differential is found. These parameters and measurements will be discussed later in this appendix.

Factory Temperature Compensation Settings

A Temp Comp adjustment procedure is performed on the instrument before it is shipped. Under normal conditions this setting will not have to be done by the customer. However, if there have been changes in environment since the instrument was ordered then the following instructions may need to be done by the customer.

Restoring Temp Comp Adjustments

When the control circuit is replaced or if the Temp Comp potentiometers are accidently moved the adjustments must be restored. There are three adjustments that need to be made on the control circuit in order to set the Temp Comp. Two of the adjustments are done with no power applied to the instrument and a third adjustment is done with power applied. Calibration values for each instrument are found on the Temp Comp calibration sheet that is found in the plastic page protector at the back of this manual. The calibration values are listed by the serial number of the instrument.

Equipment Required

5-1/2 digit digital multimeter (DMM). (Small clip leads are desirable.)

Adapter cable FCI part number to be determined, call FCI Customer Service.

Flat screw driver, capable of adjusting control circuit potentiometers.

Temp Comp calibration values from the page protector in the back of this manual.

Insulating varnish or equivalent to reseal the potentiometers.

Procedure

Note: Jumpers and potentiometer reference designations for channel B are in Brackets [ ].

1. Turn off the instrument power. Remove the control circuit form the socket.

2. Write down where the heater wattage control jumper is located on the control circuit. Refer to Figure 3-1. Remove the heater wattage control jumper and install it in position J4 [J30] (heater off). Refer to Figure 3-1 for the jumper location.
3. Remove jumpers J1 and J2 [J27 and J28] from the control circuit and set them aside.
4. Connect the DMM from TP1 (next to J1) [TP3 (next to J27)] to the right jumper post of J1 [J27]. Set the DMM to ohms. See Figure D-1 for test point placement.
5. Adjust potentiometer R9 [R50] [TP3] until the DMM reads the ohm value for R9 [R50] as shown on the Temp Comp calibration sheet that is in the plastic page protector in the back of this manual.
6. Remove the DMM and connect it from TP2 (next to J2) [TP4 (next to J28)], to the right jumper post of J2 [J28]. See Figure D-1 for the jumper post location.
7. Adjust potentiometer R12 [R51] until the DMM reads the ohm value for R12 [R51] as shown on the Temp Comp calibration sheet.
8. Remove the DMM and reinstall the jumpers. (Leave the heater jumper installed in the off position, J4 [J30].)
9. Connect the adapter cable to connector P2 and reinstall the control circuit on the socket. If the adapter cable is not available refer to the P2 pin out chart in figure D-1
10. Connect the DMM to the adapter cable or P2 with the positive lead connected to P2-1 and the negative lead connected to P2-2. Set the DMM to volts DC.
11. Turn on the instrument power and wait fifteen minutes for the instrument to stabilize. During this time make sure that the process media is flowing or the sensing elements are submerged. Do not make the following adjustment in still gas.
12. Adjust potentiometer R3 [R49] until the DMM reads 0 volts ±5mV.
13. Turn off the instrument power and remove the DMM. Also remove the jumper from J4 [J30] and install it in it's original position.

The Temp Comp adjustments are now restored. Turn on the power and make sure the instrument is functioning properly. Make adjustments to the alarm set points if needed.

Field Temp Comp Calibration

If the application of the instrument changes the Temp Comp may need to be re-calibrated. An example of when the Temp Comp needs to be re-calibrated is as follows: The process media is gas, the factory set Temp Comp is 40 to 140 °F. The instrument is then placed in an application that varies in temperature from 300 to 400 °F. In this case the instrument's accuracy would be greater with a new Temp Comp calibration performed.

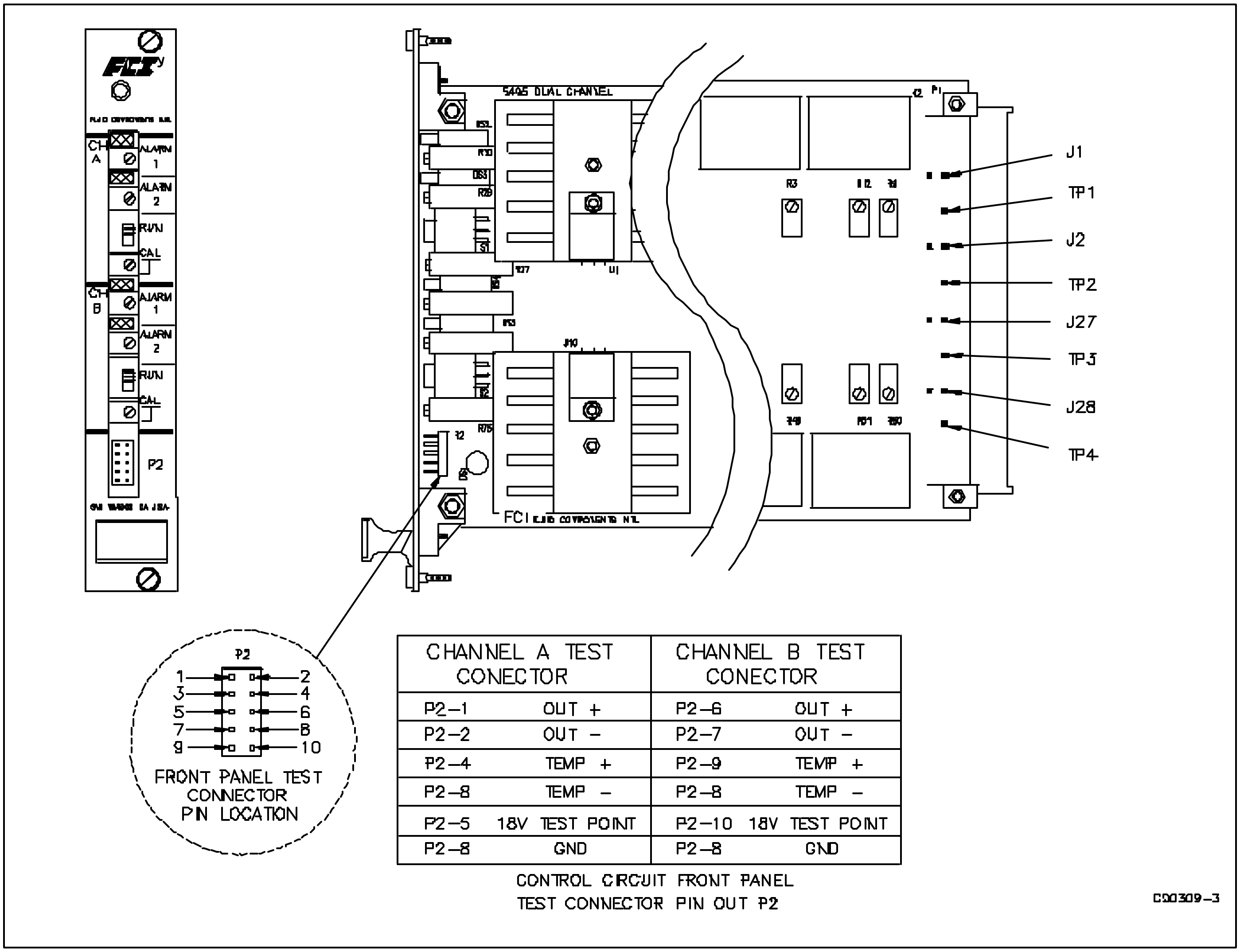
Another example of where the accuracy will be affected and a Temp Comp calibration would need to be done is when the process media is changed, i.e. from water to heavy oil.

Temp Comp calibration is possible to do in the field if the test conditions are met and the data is measured correctly. However, in many applications it is difficult to achieve these parameters and it is easier to have the switch factory calibrated. To do the procedure the following parameters are required:

- The maximum temperature differential does not exceed 100 °F.
- The maximum temperature does not exceed the instruments rated maximum temperature.
- The velocity at which the switch will alarm needs to be known.

Equipment Required

1 each	DC Power Supply, 0 to 20 Vdc minimum, at 0.5 Amps.
2 each	5-1/2 Digit DMM with 4 wire clip leads.
1 each	#1 Philips screw driver.
1 each	#1 Flat blade screw driver.
1 each	Flat screw driver, capable of adjusting control circuit potentiometers.
	Insulating varnish or equivalent to reseal the potentiometers.



CHANNEL A TEST CONECTOR		CHANNEL B TEST CONECTOR	
P2-1	OUT +	P2-6	OUT +
P2-2	OUT -	P2-7	OUT -
P2-4	TEMP +	P2-9	TEMP +
P2-8	TEMP -	P2-8	TEMP -
P2-5	18V TEST POINT	P2-10	18V TEST POINT
P2-8	GND	P2-8	GND

CONTROL CIRCUIT FRONT PANEL TEST CONNECTOR PIN OUT P2

Figure D-1. Potentiometer and Test Point Locations for Temp Comp

Procedure

1. Turn off the instrument power.
2. Install the instrument into the pipe or a test stand where it can be calibrated. Start the process media flowing at a normal rate. Cool the process media to the lowest temperature in the expected operating range.
3. Disconnect the wires leading to the sensing element (ACT, REF, COM HTR, HTR). Removal of the terminal strip from the enclosure may be necessary for access to the wires.
4. Connect the DMM's and the power supply to the sensing element as shown in Figure D-2.
5. Set the power supply voltage to the proper voltage as shown in Table D-1. Turn on the power supply and check the voltage setting.

Table D-1. Heater Voltage Settings

POWER SUPPLY SETTINGS				
FLT93-S	3 Watts	1.75 Watts	0.75 Watts	0.27 Watts
	Set For 18.0 Vdc	Set For 13.8 Vdc	Set For 9.0 Vdc	Set For 4.9 Vdc
FLT93-F	0.75 Watts	0.52 Watts	0.49 Watts	0.20 Watts
	Set For 18.0 Vdc	Set For 17.0 Vdc	Set For 15.0 Vdc	Set For 10.6 Vdc

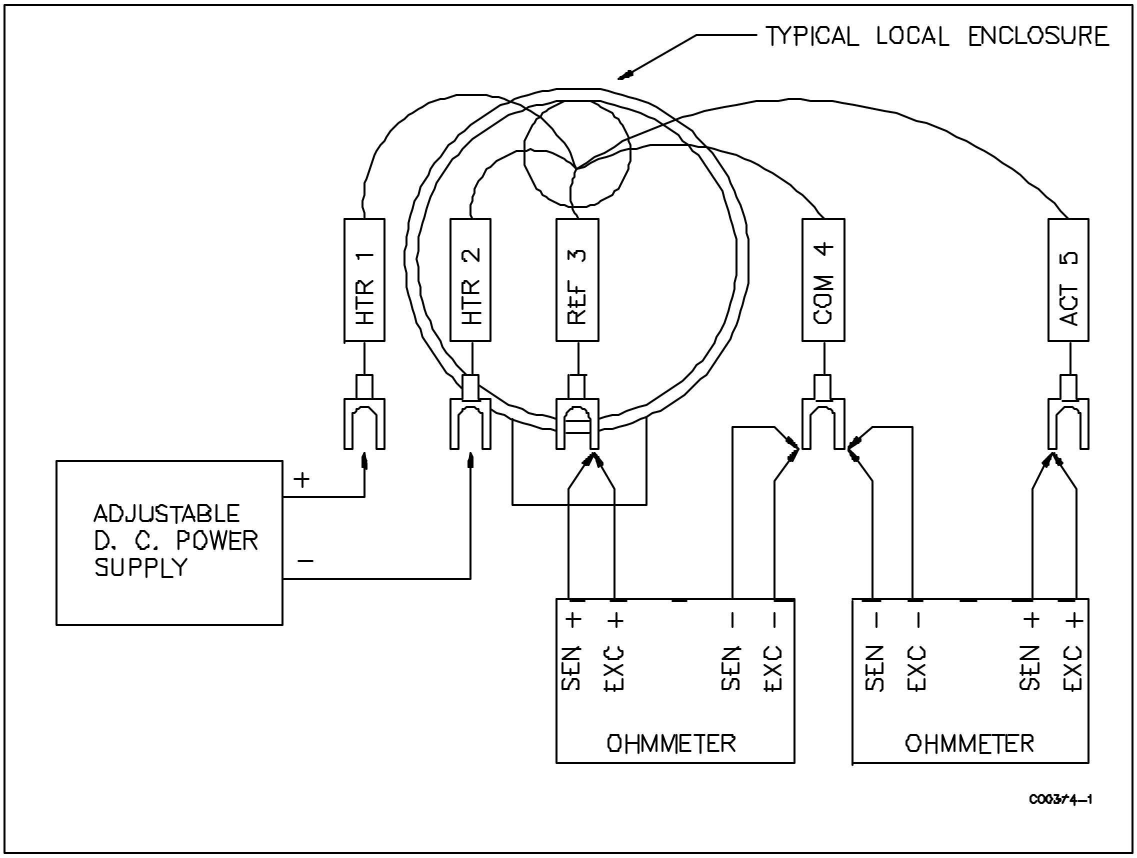


Figure D-2. Sensing Element Calibration Connections

6. Stop the process media flow and make sure that the media is at no flow and then let the instrument stabilize for fifteen minutes.
7. Record the resistance values of the sensing elements and calculate the resistance differential (ΔR). If ΔR does not exceed the maximum ΔR of 280 ohms then proceed with the calibration. If the ΔR is above 280 ohms use the next lower heater wattage setting and let the instrument stabilize. Recheck the ΔR
8. Start the process media flowing at the desired switch point velocity and at the low temperature, let the instrument stabilize for fifteen minutes.
9. Record the resistance values of the active and reference RTD's at the low temperature.
10. Raise the temperature of the process media to the maximum expected temperature. With the instrument power on, let the instrument stabilize for fifteen minutes. The difference between the low and the high temperature should not exceed 100 °F.
11. Record the resistance values of the active and reference RTD's for the high temperature.
12. Calculate the Temp Comp factor with the formula shown below.

$$\text{TEMP COMP FACTOR} = \frac{\Delta R \text{ Low Temperature} - \Delta R \text{ High Temperature}}{(\text{R Reference High Temperature}) - (\text{R Reference Low Temperature})}$$

The Temp Comp factor is not to exceed ±0.041.

13. If the Temp Comp factor is within tolerance, turn off the power to the instrument and stop the process media if needed. Disconnect the DMM's and the power supply from the instrument. Reconnect the sensing element wires to the control circuit socket and reinstall the socket in the enclosure if it was previously removed. Do not pinch the wires between the socket and the enclosure.
14. Look up the resistance values to adjust potentiometers in the Temp Comp Factor table (Table D-2). Follow the procedure in the Restoring Temp Comp adjustment section using the values found in the table below.

15. If the calculated Temp Comp factor exceeds the allowable tolerance by a small amount (±0.01), using the maximum Temp Comp factor may make the instrument perform satisfactorily. However, if the factor is out of tolerance by more than ±0.01 then it will be necessary to repeat the calibration to verify the result. Continue with the adjustment procedure if the second result is within tolerance.

Table D-2. Temp Comp Factor Table

TEMP COMP FACTOR	R12 [R51] K OHMS	R9 [R50] K OHMS	TEMP COMP FACTOR	R12 [R51] K OHMS	R9 [R50] K OHMS	TEMP COMP FACTOR	R12 [R51] K OHMS	R9 [R50] K OHMS
0.042	119.75	263.16	0.013	123.38	149.25	-0.016	127.00	104.17
0.041	119.88	256.41	0.012	123.50	147.06	-0.017	127.13	103.09
0.040	120.00	250.00	0.011	123.63	144.93	-0.018	127.25	102.04
0.039	120.13	243.90	0.010	123.75	142.86	-0.019	127.38	101.01
0.038	120.25	238.10	0.009	123.88	140.85	-0.020	127.50	100.00
0.037	120.38	232.56	0.008	124.00	138.89	-0.021	127.63	99.01
0.036	120.50	227.27	0.007	124.13	136.99	-0.022	127.75	98.04
0.035	120.63	222.22	0.006	124.25	135.14	-0.023	127.88	97.09
0.034	120.75	217.39	0.005	124.38	133.33	-0.024	128.00	96.15
0.033	120.88	212.77	0.004	124.50	131.58	-0.025	128.13	95.24
0.032	121.00	208.33	0.003	124.63	129.87	-0.026	128.25	94.34
0.031	121.13	204.08	0.002	124.75	128.21	-0.027	128.38	93.46
0.030	121.25	200.00	0.001	124.88	126.58	-0.028	128.50	92.59
0.029	121.38	196.08	0.000	125.00	125.00	-0.029	128.63	91.74
0.028	121.50	192.31	-0.001	125.13	123.46	-0.030	128.75	90.91
0.027	121.63	188.68	-0.002	125.25	121.95	-0.031	128.88	90.09
0.026	121.75	185.19	-0.003	125.38	120.48	-0.032	129.00	89.29
0.025	121.88	181.82	-0.004	125.50	119.05	-0.033	129.13	88.50
0.024	122.00	178.57	-0.005	125.63	117.65	-0.034	129.25	87.72
0.023	122.13	175.44	-0.006	125.75	116.28	-0.035	129.38	86.96
0.022	122.25	172.41	-0.007	125.88	114.94	-0.036	129.50	86.21
0.021	122.38	169.49	-0.008	126.00	113.64	-0.037	129.63	85.47
0.020	122.50	166.67	-0.009	126.13	112.36	-0.038	129.75	84.75
0.019	122.63	163.93	-0.010	126.25	111.11	-0.039	129.88	84.03
0.018	122.75	161.29	-0.011	126.38	109.89	-0.040	130.00	83.33
0.017	122.88	158.73	-0.012	126.50	108.70	-0.041	130.13	82.64
0.016	123.00	156.25	-0.013	126.63	107.53	-0.042	130.25	81.97
0.015	123.13	153.85	-0.014	126.75	106.38			
0.014	123.25	151.52	-0.015	126.88	105.26			

Appendix C. Customer Service

Point of Contact

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

Reference Documents

Return Authorization Request/Certificate of Non-Contamination (Document 1)
FCI Hazardous Materials Control Procedure for Repair Items (Document 2)
Warranties (Document 3)
Documents 1, 2 and 3 are are included in this appendix.

Hardware Return Procedure

1. Complete a Return Authorization (RA) Request/Certificate of Non-Contamination form (Document 1) and mail or fax it to an FCI field representative. After FCI issues you an RA number, complete the following steps.
2. Thoroughly clean the hardware.
3. Package each instrument with protective packing material similar to the original FCI shipment carton. **All damage occurring in transit is the customer's responsibility.**
    a. Cover instruments weighing less than 80 pounds with protective wrap, such as bubble wrap or surround it with "popcorn." Secure instruments weighing greater than 80 pounds in wooden crates by bolting them 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. Ship packages weighing more than 50 pounds via carriers who specialize in the transport of industrial instruments.
    e. Note the RA number on the packing list and mark it 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.

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.
Return Authorization Request/Certificate of Non-Contamination

1. Company Name:____
2. Contact Name: ____
3. Contact Phone No. ______________________________ Fax No.: _________________________
4. Bill to Address:____

   ____
5. Ship to Address: ____

   ____
6. Model Number: ____________________________ Serial Number: _________________________
7. Equipment Symptom: ____

   Please detail the Troubleshooting Checks that were made:_______________________________

   ____

   Action To Be Taken By FCI: ____

   ____

Note: If calibration is required, please complete an Application Data Sheet.

8. Warranty: ___YES ___NO Purchase Order No. _______________

Note: FCI Will Assess A Minimum Charge Of $110.00 On All Nonwarranty Repairs Or Evaluations.

9. Have you contacted your local representative regarding this return?
   ___YES ___NO

Certificate Of Non-Contamination

____I certify that the item(s) listed below has (have) not been contaminated by a hazardous material, hazardous substance or a toxic material or substance as defined by Federal and State law.

____I certify that the item(s) has (have) been thoroughly and completely cleaned and if the item(s) has (have) been exposed to hazardous material, hazardous substance or toxic materials or substances that the undersigned have thoroughly and completely neutralized such substances and any contamination which may have occurred to the returned items. Furthermore, I understand that this Certificate shall not waive our responsibility to provide a decontaminated product for repair to FCI.

Process Medium: ____

Company Name: ____

Authorized Signature: ____

Document 2.
FCI Hazardous Materials Control Procedure for Repair Items

In order for FCI to process your repair expeditiously, the returned item must be accompanied by documentation regarding hazardous materials to which the item was exposed.

Hazardous materials are regulated by Federal, State (California), County, and City laws. These laws provide our employees the right to know the materials with which they come in contact while handling our products. Consequently, our Repair Department employees must have access to data regarding the materials with which they may come in contact while processing your repair.

In accordance with FCI's Hazardous Materials Control procedures, we request that you thoroughly clean and neutralize any process material on your equipment before returning it to FCI. Further, you are required to choose one of the following options for declaring the hazardous condition of the hardware:

1. Complete and sign the Certificate of Non-Contamination (at the bottom of Document 1) evidencing your compliance.

or

2. Complete a Material Safety Data Sheet (MSDS) which covers all process materials exposed on the instrument. Send the completed MSDS to your field service representative with a completed RA form.

Note: Submission of an MSDS or Certificate of Non-Contamination will not waive your responsibility for proper decontamination of the instrument. The cleanliness of a returned item or the acceptability of the MSDS will be at the sole discretion of FCI.

Returned items that do not comply with these procedures will be returned to you at your expense. FCI does not wish to inconvenience you; however, we are required by law to adhere to hazardous material handling procedures to protect our employees.

Document 3. Warranties

Warranties

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

Appendix B. Glossary

ABBREVIATIONS

Delta-R (DR)	Differential Resistance
Delta-T (DT)	Differential Temperature
DMM	Digital Multimeter
DPDT	Double Pole Double Throw
FCI	Fluid Components Intl
HTR	Heater
LED	Light Emitting Diode
POT	Potentiometer
RA	Return Authorization
RTD	Resistance Temperature Detector
SFPS	Standard Feet Per Second
SPDT	Single Pole Double Throw

DEFINITIONS

Active RTD	The of the sensing element that is heated by the heater. The active RTD is cooled due to increases in the process fluid flow rate or density (level sensing).
Differential resistance Delta-R (DR)	The difference in resistance between the active and reference RTDs.
Differential temperature Delta-T (DT)	The difference in temperature between the active and reference RTDs.
Heater (HTR)	The part of the sensing element that heats the active RTD.
Local enclosure	The enclosure attached to the sensing element.
Reference RTD	The part of the sensing element that senses the process media temperature.
Resistance Temperature Detector (RTD)	A sensor whose resistance changes proportionally to temperature changes.
Sensing element	The transducer portion of the instrument. The sensing element produces an electrical signal that is related to the flow rate, density (level sensing), and temperature of the process media.
Thermowell	The part of the sensing element that protects the heater and RTDs from the process fluid.
Turndown	The ratio of the upper to lower flow rate values.

Appendix A. Drawings

Inch [mm]

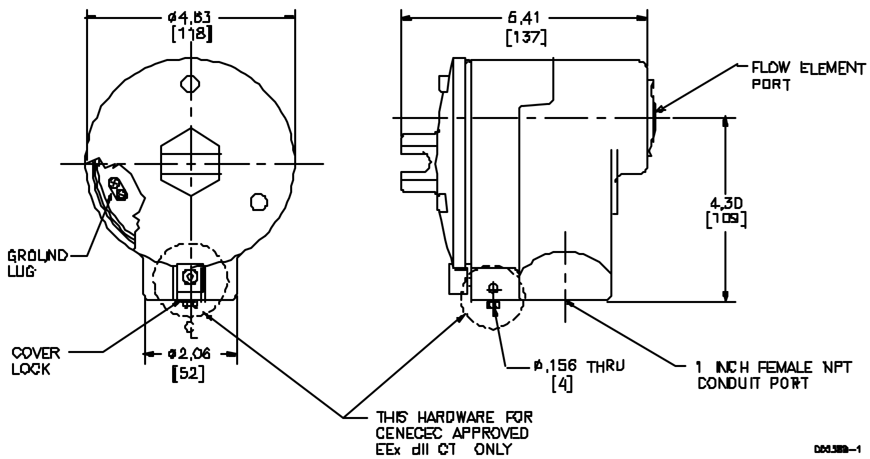


Figure A-1. Local Enclosure, NEMA Type 4X and Hazardous Location (Aluminum Enclosure Shown)

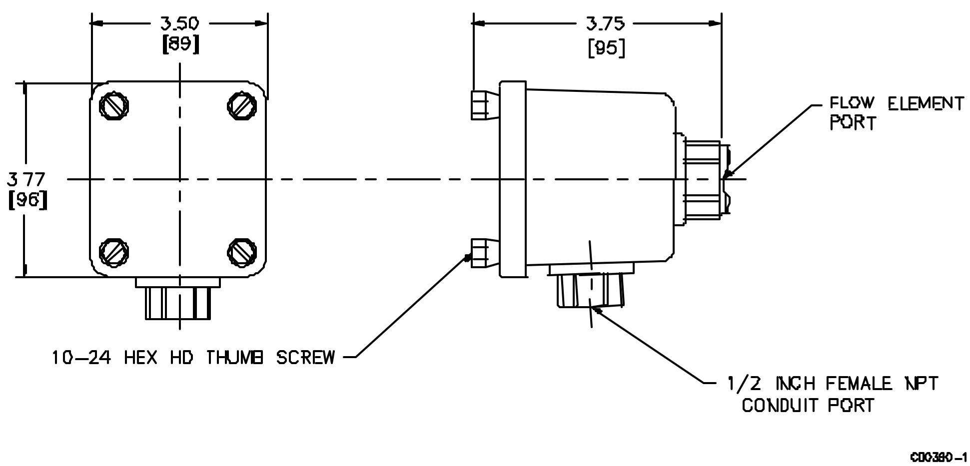


Figure A-2. Local Enclosure NEMA Type 4X (Fiberglass Shown)

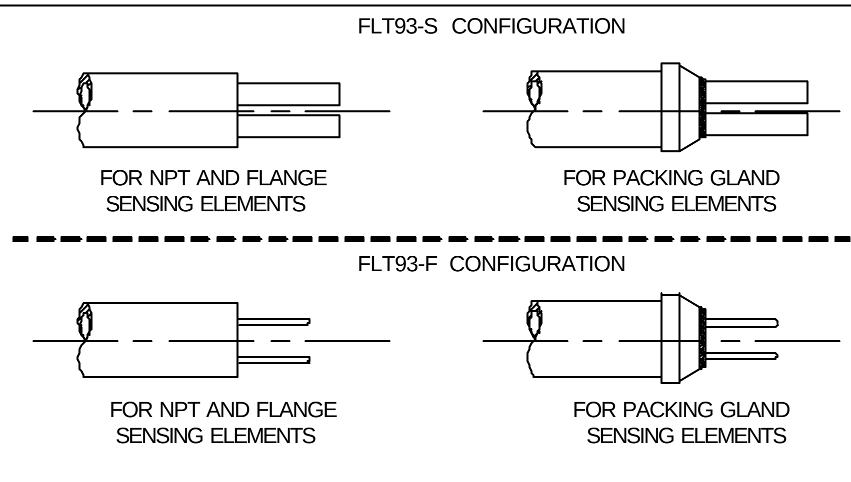


Figure A-3. FLT93-S and FLT 93-F Sensing Element Configurations

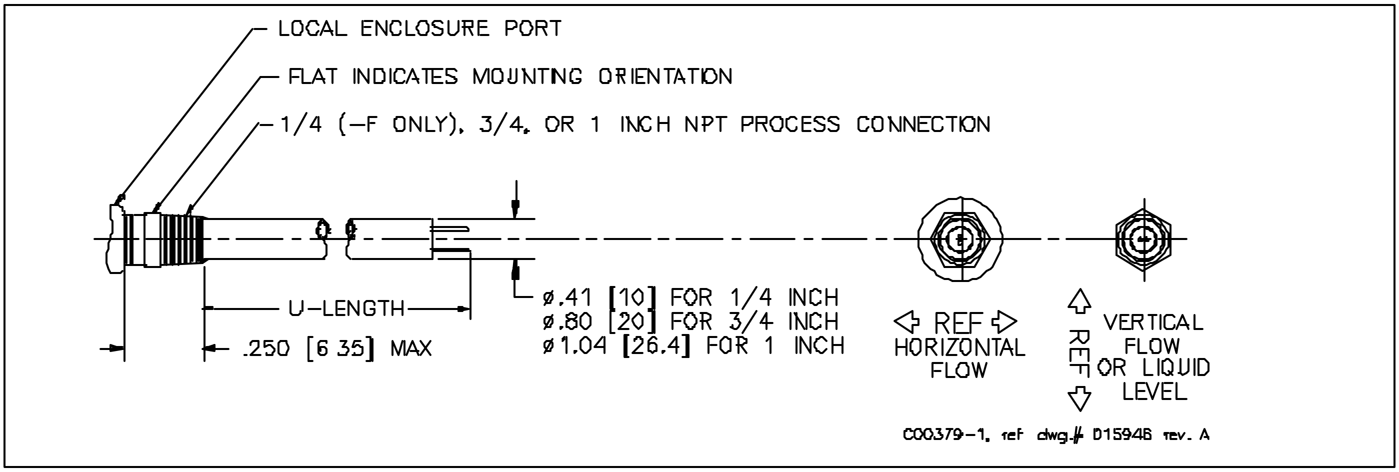


Figure A-4. 1/4 (FLT-F Only), 3/4 or 1 Inch NPT Process Connection

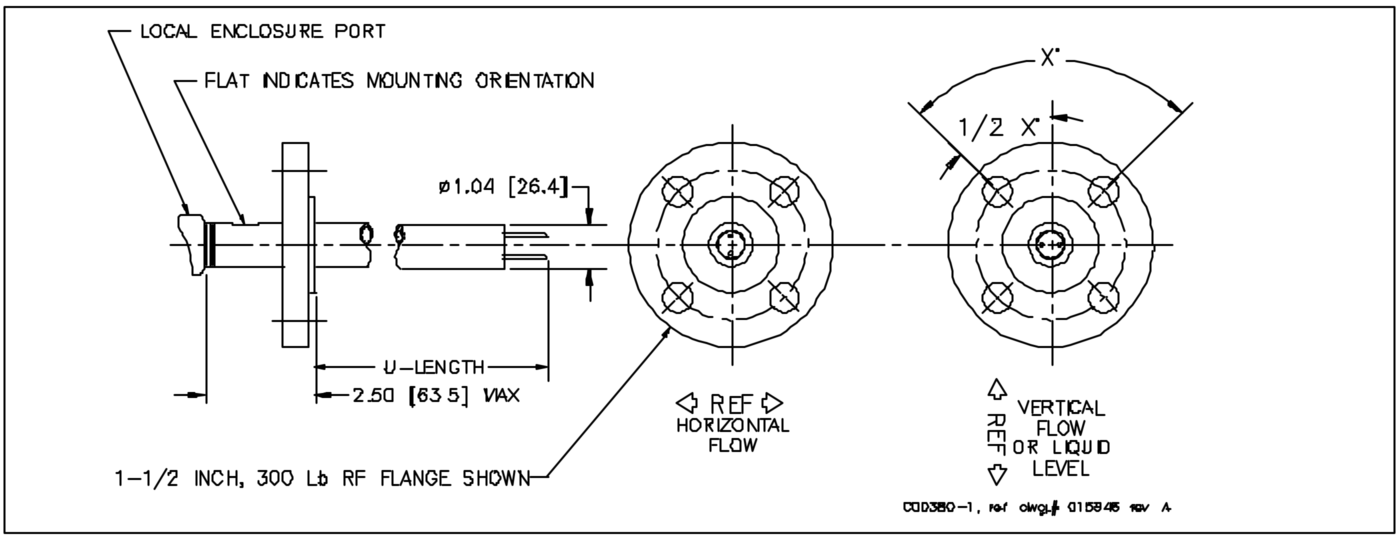


Figure A-5. Flanged Process Connection

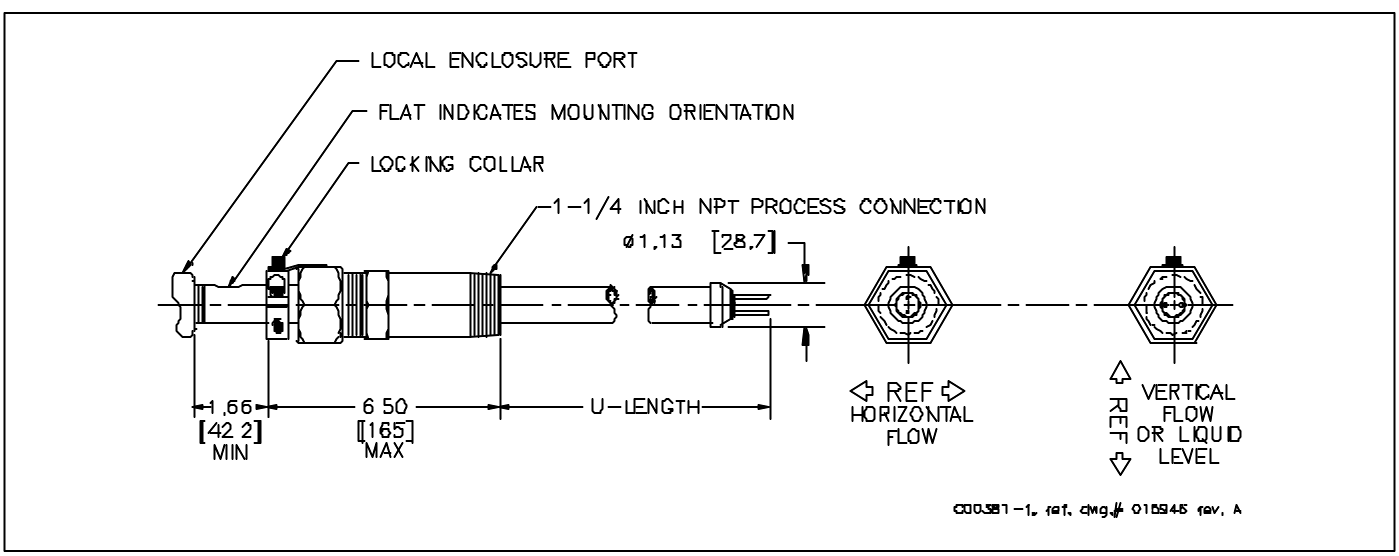


Figure A-6. Low Pressure Packing Gland

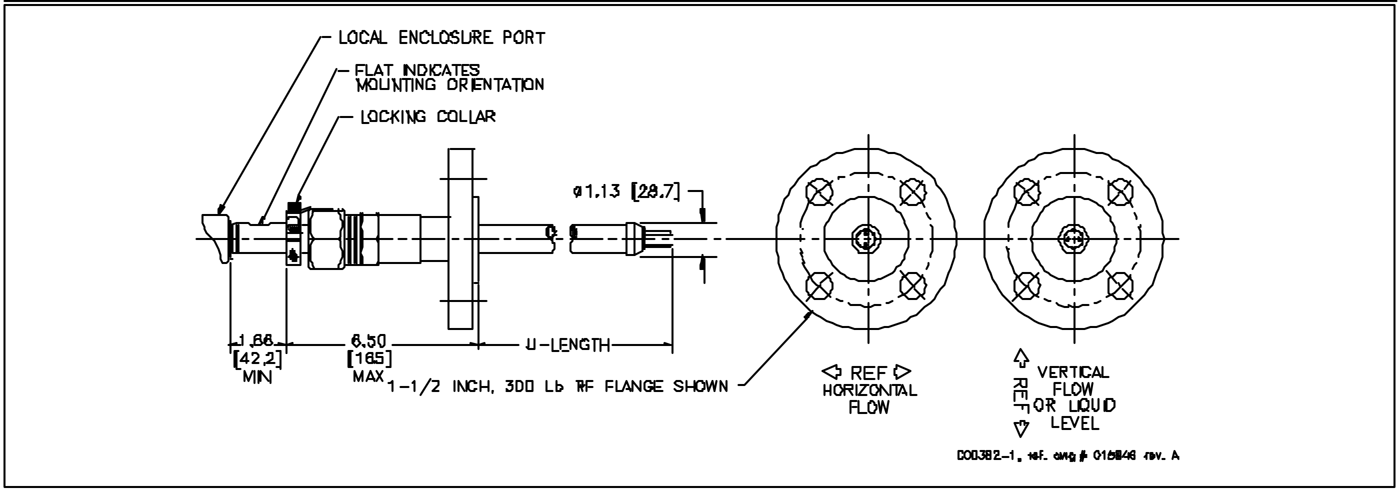


Figure A-7. Flanged Low Pressure Packing Gland Process Connection

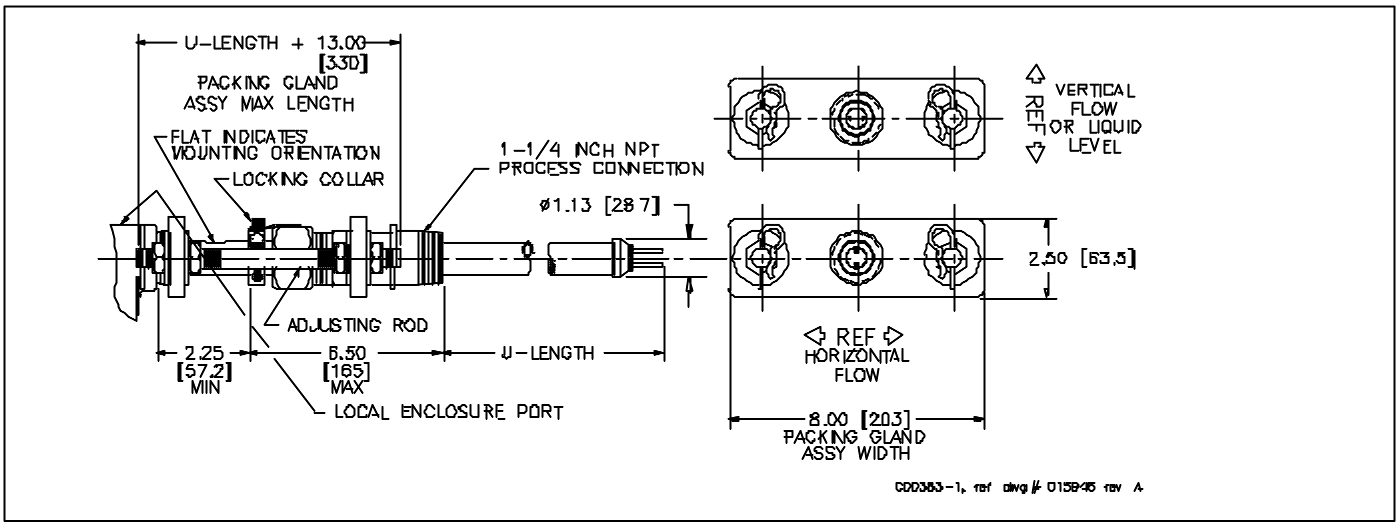


Figure A-8. 1-1/4 Inch Medium Pressure Packing Gland Connection

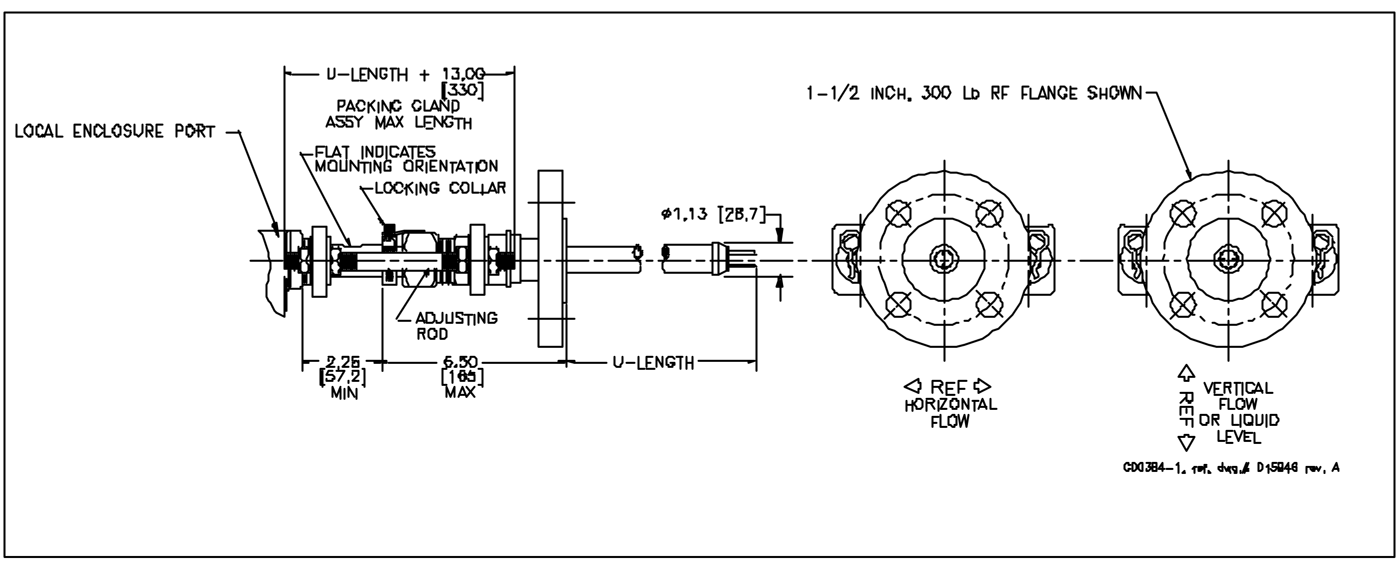


Figure A-9. Flanged Medium Pressure Packing Gland Process Connection

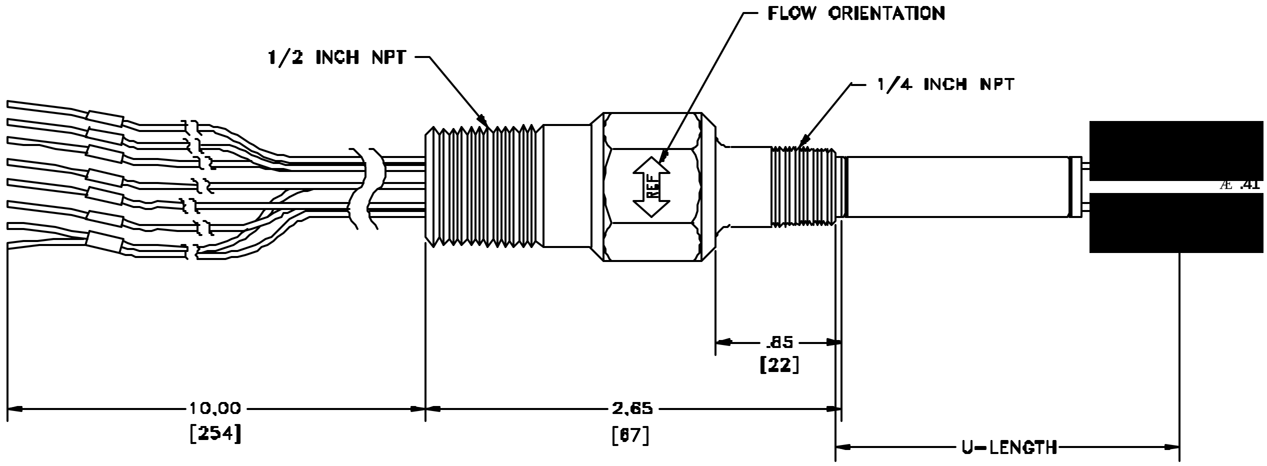


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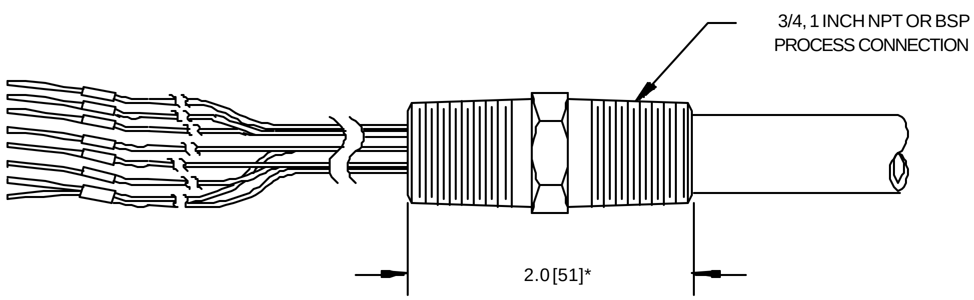
Figure A-10. 1/4 Inch Process Connection



*1 INCH NPT PROCESS CONNECTION HAS A
3 INCH [76] LONG THREADED LENGTH

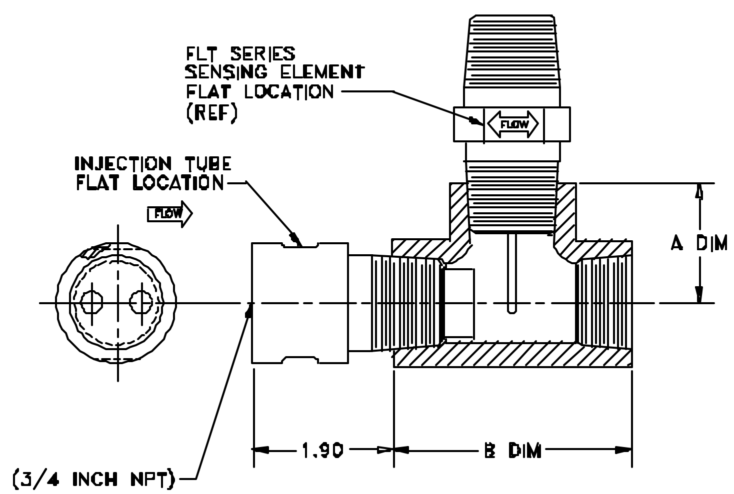
C00421-1

Figure A-11. Pigtail Process Connection

DESCRIPTION BLOCK

PIPE TEE SIZE	A DIM	B DIM
150 LB.	1.32	2.64
3000 LB.	1.50	3.00

NOTE: RECOMMENDED U-LENGTH: 1.2 INCHES.



C00423-1

Figure A-12. Injection Tube with Tee Fitting

5. Troubleshooting

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

Introduction

In new or re-calibrated instruments, operating problems are most often caused by an improper installation. Review the information on instrument installation in Chapter 2 to verify correct mechanical and electrical installation.

Troubleshooting is more effective if the operation of the equipment is understood before trying to solve the equipment problems. Be familiar with the way the instrument operates (Chapter 3) before troubleshooting an instrument that does not function properly.

Replacement parts must be of the same part type and number. Therefore, contact the FCI Customer Service Department for the correct replacement parts.

Damage to the equipment due to negligence or lack of technical skill is not covered by the warranty, or is damage to the control circuit caused by part replacement in the field. When parts are replaced, the verification and calibration procedures should be performed by a qualified technician to ensure the accuracy and calibration of the instrument.

Troubleshooting Equipment

Digital Multi-Meter (DMM) (at least 4 1/2 digits resolution recommended) capable of measuring ohms, milliamperes, and volts AC and DC.

Non Maintenance Observations

At this point, observe the system setup to verify operation. No testing is required at this time. Perform the following tasks:

Check Power

Verify that the power source is in accordance with the installation site specification. Also verify that the control circuit power jumpers are in accordance with the specified power source.

Note: Power ON is indicated by the yellow LED on the control circuit.

Check the Instrument Installation

Verify that the sensing element is mounted properly.

Check the Serial Numbers

If the instrument is new, the serial numbers on the sensing element and control circuit must match.

Check for Moisture

Check for moisture on the sensing element (for normally dry conditions). Excess moisture buildup on the sensing element causes for air or gas flow applications.

Moisture on the control circuit may cause intermittent operation.

For Factory Calibrated Instruments, Check the Application Data Sheet (ADS)

Design problems usually occur with first-time applications. If the Application Data Sheet does not match the instrument's actual process conditions, errors occur. See the plastic sleeve at the back of the manual for a copy of the ADS.

1. Review the instrument's ADS with plant operation personnel and plant engineers.
2. Verify that the process media, as well as the range of process temperature and pressure, agrees with the instrument's ADS.

Verify the Sensing Element Resistances

The following procedure provides a step-by-step checkout. The measurements are based on a standard sensing element (1.1K ohm RTDs at 80°F). Variation of ±500 ohms from nominal is to be expected. The maximum allowable difference in resistance between matched RTDs is 1% at ambient temperature (immersed in water). The heater resistance should be 110 ±5 ohms for the S model sensing element and 560 ±13 ohms for the F model sensing element.

Check the Resistance at the Control Circuit Connector

Warning: Turn the instrument's power OFF.

Gently remove the control circuit from the rack. Use a multimeter to measure the resistance of the sensing element's heater and RTDs (see Tables 5-1 and 5-2 for nominal values).

Note: If enough time has not been allowed for the sensing element to cool, then the resistance of the active RTD will be greater than the resistance of the reference RTD.

Table 5-1. Matrix of Nominal Resistance Values (ohms at 80°F) at P1 CH. A

Pin No.	P1-B10 (ACT)	P1-D8 (COM)	P1-D10 (REF)	P1-Z8 (HTR +)	P1-B8 (HTR RTN)
P1-B10 (ACT)	0	1.1K	2.2K	OPEN	OPEN
P1-D8 (COM)	1.1K	0	1.1K	1.3K	OPEN
P1-D10 (REF)	2.2K	1.1K	0	2.4K	OPEN
P1-Z8 (HTR +)	OPEN	OPEN	OPEN	0	110 S MODEL 560 F MODEL
P1-B8 (HTR RTN)	OPEN	OPEN	OPEN	110 S MODEL 560 F MODEL	0

Table 5-2. Matrix of Nominal Resistance Values (ohms at 80°F) at P1 CH. B

Pin No.	P1-B20 (ACT)	P1-D22 (COM)	P1-D20 (REF)	P1-Z22 (HTR +)	P1-B22 (HTR RTN)
P1-B20 (ACT)	0	1.1K	2.2K	OPEN	OPEN
P1-D22 (COM)	1.1K	0	1.1K	1.3K	OPEN
P1-D20 (REF)	2.2K	1.1K	0	2.4K	OPEN
P1-Z22 (HTR +)	OPEN	OPEN	OPEN	0	110 S MODEL 560 F MODEL
P1-B22 (HTR RTN)	OPEN	OPEN	OPEN	110 S MODEL 560 F MODEL	0

Note: There is no continuity between the above pins and earth ground.

Troubleshooting Flow Chart

Figure 5-1 shows a troubleshooting chart for ease of troubleshooting.

Defective Parts

Before returning any equipment to FCI, please obtain a return authorization number (see Appendix C) for authorization, tracking, and repair/replacement instructions. Remove the defective instrument, replace with a spare, calibrate, and return the defective instrument to FCI freight prepaid for disposition.

Spares

FCI typically recommends one complete set of spare electronics and flow element assemblies depending on how critical the monitoring process is.

Storage Information

Spare parts should be kept above grade and indoors. Keep the instrument dry. Add desiccant and enclose in plastic wrap for extended storage periods. There is no predetermined shelf life; reinspect at six month intervals.

Customer Service

If problems or questions exist regarding the instrument, please contact the regional or country authorized FCI Field Agent (manufacturer's representative). There is an extensive list of these representatives at the front of this manual. If additional technical assistance is required, contact the FCI Customer Service Department at (619) 744-6950 or (800) 854-1993.

Refer to Appendix C for specific customer service policy and procedures.

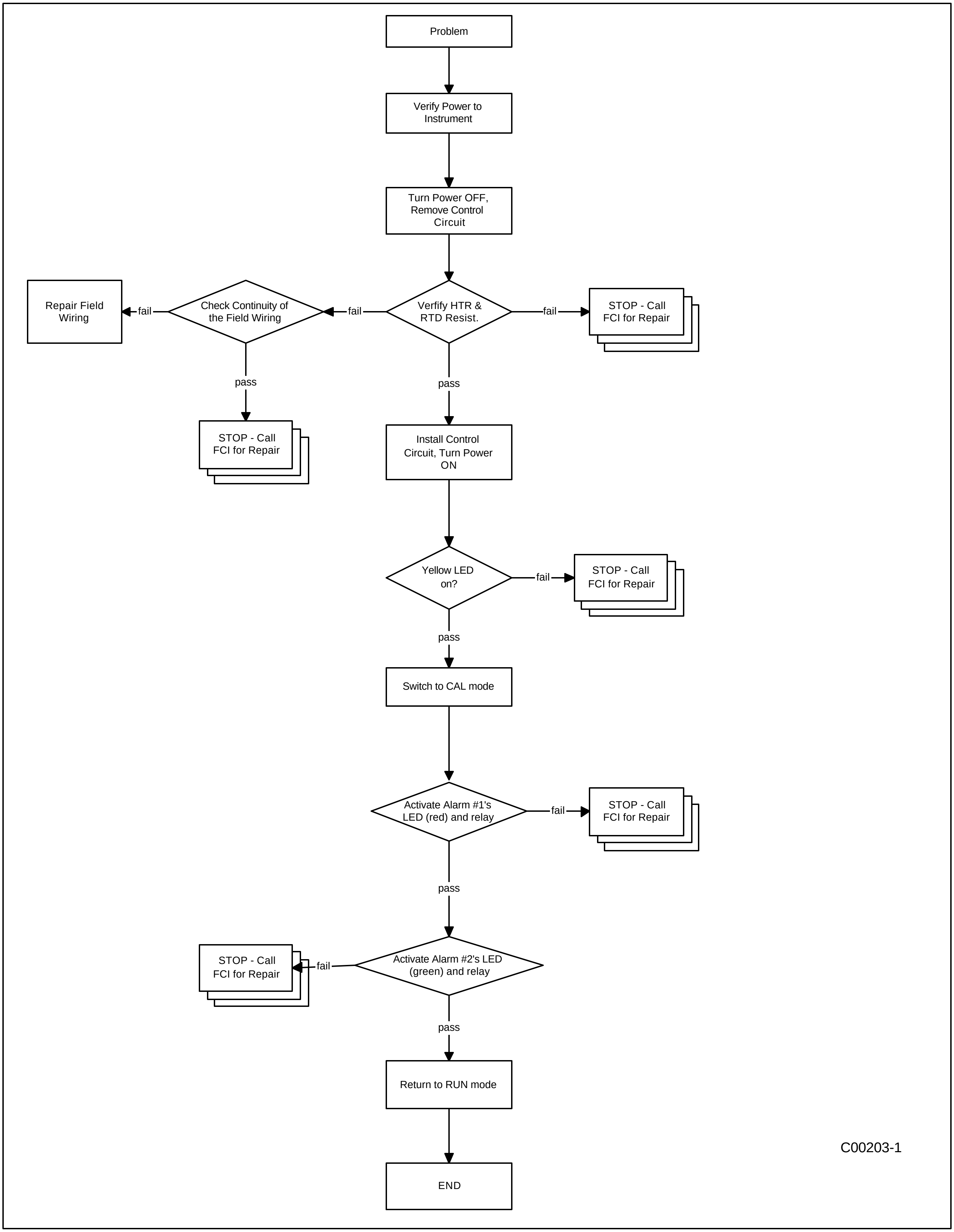


Figure 5-1. Troubleshooting Flow Chart

4. Maintenance

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

Introduction

The instrument requires very little maintenance because there are no moving parts or mechanical parts subject to wear. The sensing element has been constructed from stainless steel with nickel braze and is only susceptible to chemical attack based on the corrosion relationship between the metal and braze and the process media. For optimum instrument performance, the sensing element thermowells should be kept clean.

General Maintenance

Without detailed knowledge 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.

Calibration

Periodically verify the instrument's calibration and re calibrate if necessary (every 18 months minimum).

Electrical Connections

Periodically inspect the connector and, if appropriate, the terminal strip connections. Verify that the connections are tight and physically sound with no sign of corrosion.

Electrical Wiring

Periodically inspect the power wiring; relay wiring; and if appropriate, the signal output and sensing element to control circuit field wiring. Inspect the conductors for corrosion and check the cable insulation for signs of deterioration.

Enclosures

Periodically verify that the moisture barriers and seals protecting the control circuit are adequate and that no moisture is entering the enclosure. If appropriate, verify that the moisture barriers and seals protecting the terminal strip in the local enclosure are adequate and that no moisture is entering the enclosure.

Sensing Element Process Connection

Periodically verify that all process connection seals are performing properly and that the process media is not leaking. Check for deterioration of the gaskets and environmental seals.

Sensing Element

Periodically remove the sensing element for inspection based on historical evidence of debris, foreign matter, or scale buildup and appropriate plant shutdown schedules and procedures. Check for corrosion, stress cracking, and/or buildup of oxides, salts, or foreign substances. The thermowells must be free of excessive contaminants and be physically intact. Any debris or residue buildup could cause inaccurate switching. As necessary, clean the sensing element with a soft brush and available solvents that are compatible with stainless steel and nickel braze.

3. Operation

Factory Default Configuration

Unless a custom factory setup or calibration is specified, the FCI instrument is delivered in a standard factory default configuration. The standard configuration is shown in Table 3-1.

Table 3-1. Standard Default Configuration

Input Power	24VDC.
Heater Power	0.75 Watts for air flow or liquid level applications (CH A, J5; CH B, J31).
Numer of Alarms	Two (CH A, J18; CH B, J44). Each alarm has one set of SPDT contacts.
CHANNEL A	
Alarm 1 Red LED Set Point Pot. R30	Set to monitor flow or level signals (J14). Relay energized at flow or wet (J21). Set point at approxinately 10 to 15 sfps decreasing flow.
Alarm 2 Green LED Set Point Pot. R29	Set to monitor temperature signals (J15). Relay energized below temperature (J19). Set point at approximately 240 ±5°F (115 ±3°C).
CHANNEL B	
Alarm 1 Red LED Set Point Pot. R58	Set to monitor flow or level signals (J40). Relay energized at flow or wet (J47). Set point at approxinately 10 to 15 sfps decreasing flow.
Alarm 2 Green LED Set Point Pot. R69	Set to monitor temperature signals (J41). Relay energized below temperature (J45). Set point at approximately 240 ±5°F (115 ±3°C).

If the order included custom factory setup and calibration, leave all settings alone. The instrument should be ready for service without changes.

If the custom factory setup or calibration was not ordered, configure the control circuit using the configurable jumper tables below and then follow the set point adjustment section that is appropriate to the application.

Configuration Jumpers

If the order did not specify for the control circuit to be factory configured, the standard configuration can be changed using Figure 3-1 and Table 3-2 though Table 3-6. The factory default configuration is shown as being underlined.

Heater Cut-Off

The control circuit has a heater cutoff switch that limits the temperature of the sensing element to a temperature differential of approximately 150 °F (66 °C) above the process temperature. In the case where the instrument is used as a gas flow switch, and the heater wattage is set too high, the temperature differential (ΔT) between the RTDs may exceed the usable input range of the control circuit. The usable input range can also be exceeded in the case where the instrument is used in liquid flow applications where the heater wattage is set at the highest value, and when the sensing elements go dry. When the temperature differential is less than 150 °F (66 °C) the heater automatically turns back on.

The reason for operation in the above extreme conditions is that the input signal range is at the widest point making the alarm set point adjustment easier to perform. If the heater does cycle the operator may need to use the next lower wattage setting.

It is possible to use one of the alarms to detect when the heater is being shut down because of an over-range situation. The alarm must be set to activate with flow/level signals.

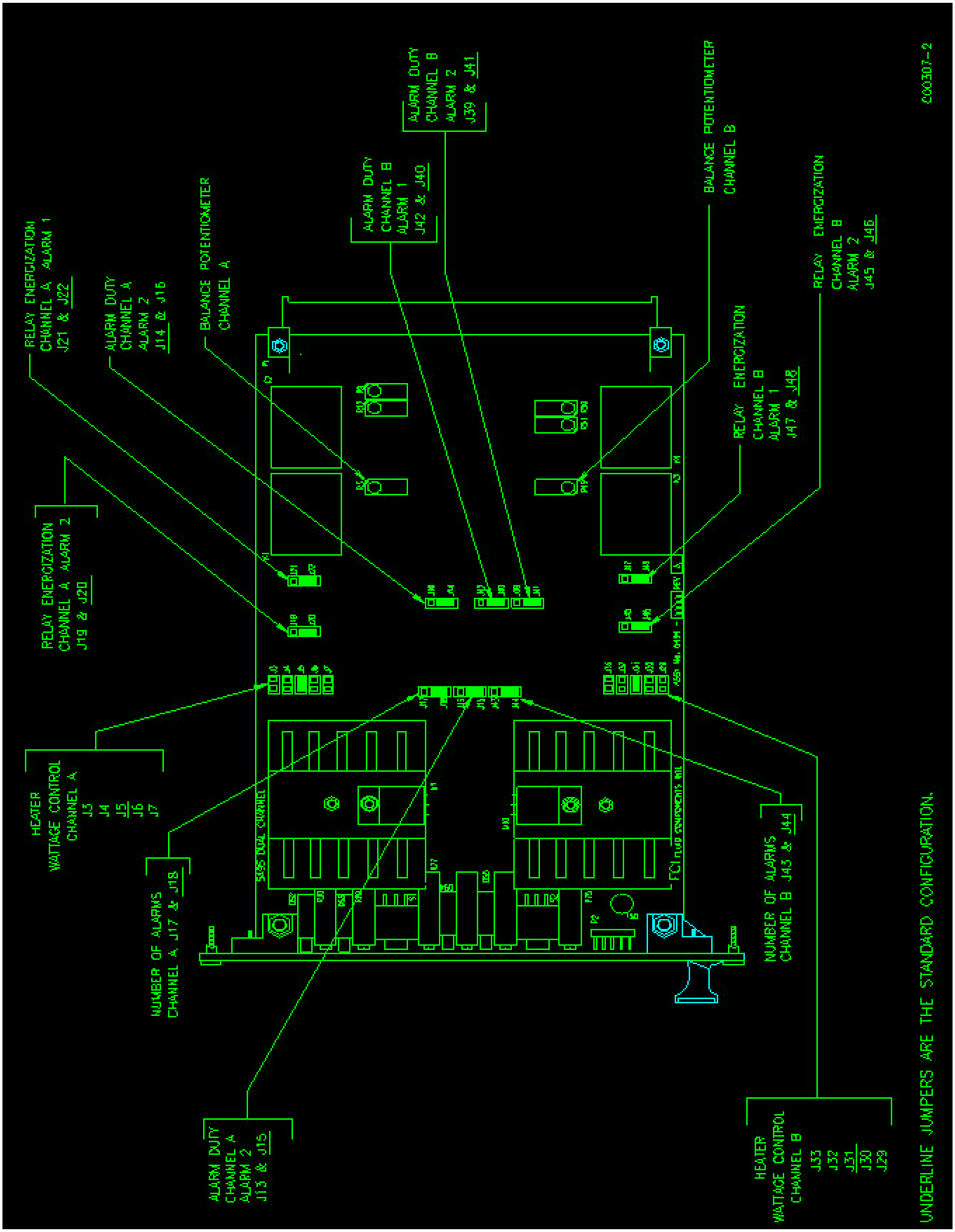


Figure 3-1. 5495 Control Circuit Configuration Jumper Locations

Table 3-2A. Selectable Heater Wattage Control

Jumper CH A	J7	J6	J5*	J3*	J4
Jumper CH B	J33	J32	J31*	J29*	J30
FLT93-F Element (560 Ohm Heater)	0.57 Watts	0.52 Watts	0.49 Watts	0.20 Watts	OFF
FLT93-S Element (110 Ohm Heater)	3 Watts	1.75 Watts	0.75 Watts	0.27 Watts	OFF

*J5 and J31are standard for FLT93-S and J3 and J29 are standard for FLT93-F.

Table 3-2B. Fixed Heater Wattage Control

Jumper CH A	J5	J3	J4
Jumper CH B	J31	J29	J30
FLT93-F Element (560 Ohm Heater)	Not Applicable	0.20 Watts	OFF
FLT93-S Element (110 Ohm Heater)	0.75 Watts	Not Applicable	OFF

Table 3-3. Application

	Flow/Level	Temp.
Channel A, Alarm 1	J14	J16
Channel A, Alarm 2	J13	J15
Channel B, Alarm 1	J40	J42
Channel B, Alarm 2	J39	J41

Table 3-4. CH A Alarm Condition

Conditions		Channel A Alarm 1 Red LED	Channel A Alarm 2 Green LED
Flow/Level Switch	Temp. Switch		
De-energized At No Flow Or Dry	De-energized When Above Temperature	J22	J20
De-energized At Flow Or Wet	De-energized When Below Temperature	J21	J19

Table 3-5. CH B Alarm Condition

Conditions		Channel B Alarm 1 Red LED	Channel B Alarm 2 Green LED
Flow/Level Switch	Temp. Switch		
De-energized At No Flow Or Dry	De-energized When Above Temperature	J48	J46
De-energized At Flow Or Wet	De-energized When Below Temperature	J47	J45

Table 3-6. Relay Contact Configuration

Channel A	1 Alarm	J17	Alarm 2 Disabled
	2 Alarms	J18	
Channel B	1 Alarm	J43	Alarm 2 Disabled
	2 Alarms	J44	

Numerical Adjustment versus Adjustment by Observation

A set point is established using either numerical or empirical adjustment. The empirical adjustment requires the customer to establish normal process operation and adjust the set point relative to this condition. The numerical approach requires measuring normal and alarm process conditions with a voltmeter and setting up the instrument in the calibrate mode based on these values. The empirical adjustment requires little time and one tool to establish the set point. The numerical adjustment requires control of the process as well as additional time and tools to establish the set point. Refer to Table 3-7 to determine which method is more appropriate for the application requirements.

Table 3-7. Numerical versus Observation Factors

	Numerical Adjustment	**Observation Adjustment**
Tools Needed	One small flat blade screwdriver. One DC voltmeter (digital preferred) capable of resolving to 0.001 volts on a 20 volt range.	One small flat blade screwdriver.
Estimated Time Required	The time required to establish the normal and alarm process conditions, plus ten to twenty minutes to make instrument adjustments.	The time required to establish the normal process condition, plus five to ten minutes to make instrument adjustments.

Numerical Set Point Adjustment

The control circuit has two mutually exclusive alarms for each channel; they are identified as Alarm 1 and Alarm 2. Each has a set point adjustment potentiometer and a LED indicator. Both alarms can be setup for one of three applications: flow, level/interface, or temperature. The following application specific adjustment procedures are generic and can be used for setting either or both alarms on each channel. Channel A will be used to explain the setup procedures. The procedures to setup Channel B are the same steps except for the component designations. Refer to Tables 3-1 through 3-6 and Figures 3-1 and 3-2.

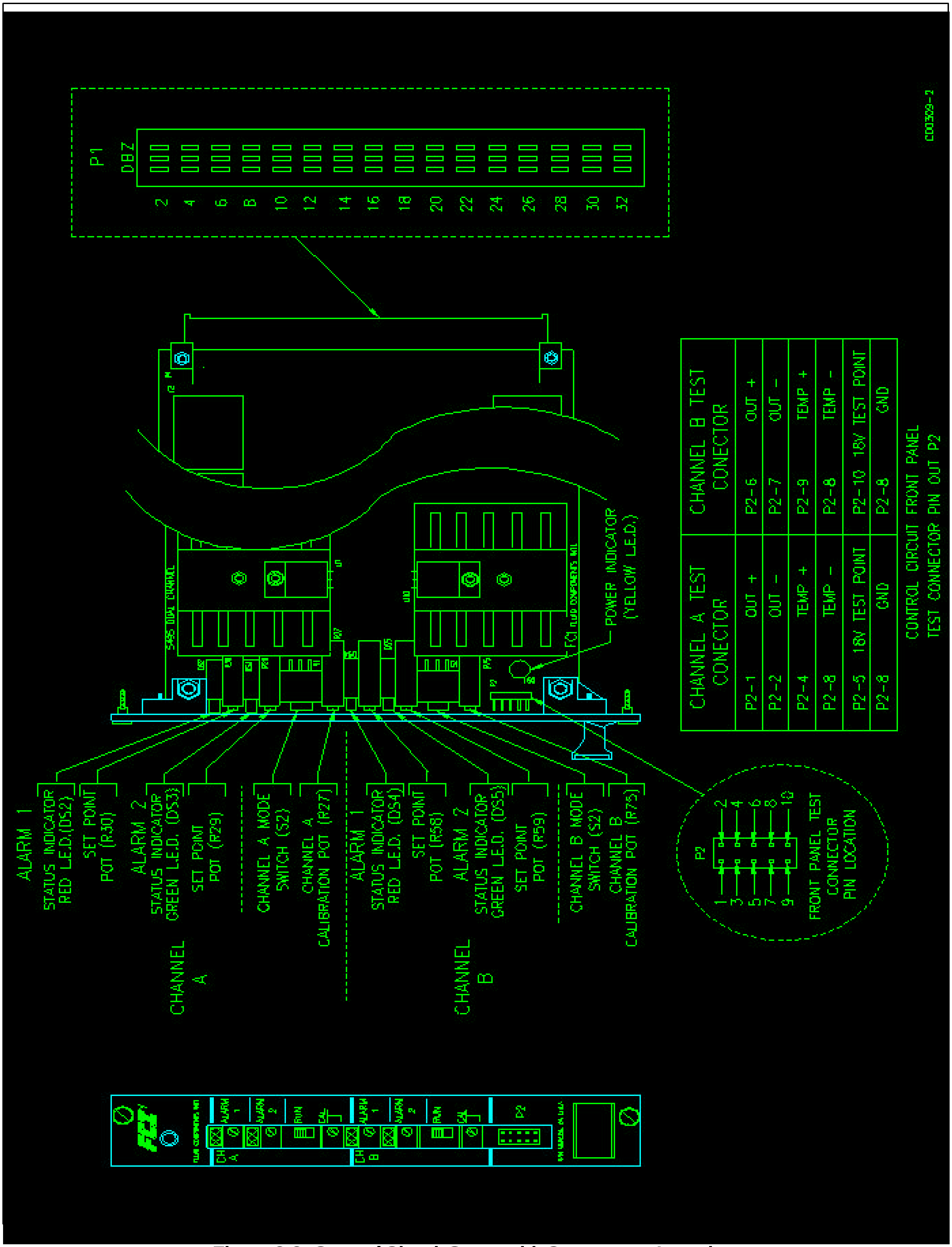


Figure 3-2. Control Circuit Setup with Component Locations

Balance Adjustment

Under normal circumstances the control circuit balance procedure has been done by the factory. This procedure needs to be done by the customer if the control circuit or the sensing element have been replaced, the sensing element and control circuit are sent under separate cover, or extra cable is added between the control circuit and the sensing element.

1. Extend the circuit card on the circuit card extender.
2. Turn off the heater (see Table 3-2 for jumper information). Turn ON the instrument power and adjust potentiometer R3 (for CH. A) or R 49 (for CH.B) for a voltage of 0.0V ±2.0mV. For channel A the voltage is between pins P1-D12 (+) and P1-B12 (-) or P2-1 (+) and P2-2 (-). For channel B the voltage is between pins P1-D18 (+) and P1-B18 (-) or P2-6 (+) and P2-7 (-).
3. Turn OFF the power, return the heater(s) to normal and replace the circuit card in the slot.

Air/Gas Flow Applications

1. Ensure the configuration jumpers on the control circuit are correct for this application. (See Tables 3-2 through 3-6.)
2. Apply power to the instrument. Verify the yellow LED is on and allow the instrument fifteen minutes to warm-up.
3. Verify the mode switch is in the RUN position.
4. Attach a DC voltmeter to the P1 connector with the positive (+) lead to pin P1-D12 and the negative (-) lead to pin P1-B12; or the P2 connector with the positive (+) lead to pin P2-1 and the negative lead (-) to P2-2.
5. Establish the normal process flow condition and allow the signal to stabilize.

Note: The output signal will vary inversely with changes in the process flow rate. The output signal level is relative to the type of process media being measured. (See Figure 3-3.)

6. Record the normal flow signal value.

   Normal Flow Signal = ________ volts DC

7. Follow either the Detecting Decreasing Flow or the Detecting Increasing Flow procedure for each flow application alarm.

Detecting Decreasing Flow (low flow alarm)

a) Stop the process flow and allow the signal to stabilize.

b) Record the no-flow signal. (The no-flow signal should be greater than the normal flow signal.)

   No-Flow Signal = ________ volts DC

c) Determine the set point by calculating the arithmetic mean of the normal and no-flow output signals. (i.e.; If the normal signal is 2.000 volts and the no-flow signal is 5.000 volts, then the calculated set point would be 3.500 volts.)

d) Record this value.

   Calculated Alarm Set Point = ________Volts DC

Note: The calculated set point must be at least 0.020 volts greater than the normal signal to ensure that the alarm will reset.

e) Slide the mode switch to the CAL position.

f) Adjust the CAL potentiometer R27 (below the mode switch) until the voltmeter equals the calculated set point.

g) For the appropriate alarm, determine whether the status LED is on or off (red for alarm 1 or green for alarm 2).

1) If the LED is off, turn the alarm set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) slowly clockwise just until the LED turns on.

2) If the LED is on, turn the set point adjustment potentiometer (R30 for alarm 1 or R25 for alarm 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.

Detecting Increasing Flow (high flow alarm)

a) Establish the excessive process flow condition and allow the signal to stabilize.

b) Record the high flow signal. (The high flow signal should be less than the normal flow signal.)

High Flow Signal = ________ volts DC

c) Determine the set point by calculating the arithmetic mean of the normal and high flow output signals. (i.e., If the normal signal is 2.000 volts and the high flow signal is 1.000 volts, then the calculated set point would be 1.500 volts.)

d) Record this value.

Calculated Set Point = ________ volts DC

Note: The calculated set point must be at least 0.020 volts less than the normal signal to ensure that the alarm will reset.

e) Slide the mode switch to the CAL position.

f) Adjust the CAL potentiometer (R27) until the voltmeter equals the calculated set point.

g) For the appropriate alarm, determine whether the status LED is on or off (red for alarm 1 or green for alarm 2).

1) If the LED is on, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) slowly counterclockwise just until the LED turns off.

2) If the LED is off, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

8. Slide the mode switch to the RUN position.
9. Establish the normal process flow condition. For low-flow alarm setups, the status LED should be off. For high flow alarm setups, the status LED should be on.
10. Establish the process alarm condition and monitor the voltmeter display.
11. When the output signal passes through the calculated set point value, the status LED should turn on for low-flow alarms, off for high flow alarms, and the relay contacts should switch.
12. Reestablish the normal process flow condition. Both the LED and the relay contacts should reset.
13. Disconnect the voltmeter from P1 or P2.

Note: The alarm can be set for a specific flow rate. Follow the procedure above to step 7 except establish the specific flow rate rather than the normal flow. The output signal will be the set point value. Determine whether the alarm should actuate with decreasing or increasing flow and skip to the appropriate step 9.d) respectfully. Enter the specific flow rate value as the set point and follow the remaining steps.

Note: The relay logic default configuration is set for the relay coil to be de-energized when the flow signal is greater than the set point value. (i.e., Assume that the normal process flow condition has been established. In this state, the relay coil will be energized if the alarm has been set for low-flow detection and de-energized if the alarm has been set for high flow detection.)

Wet/Dry Liquid Level Applications

1. Ensure the configuration jumpers on the control circuit are correct for this application. (See Tables 3-2 through 3-6.)
2. Apply power to the instrument. Verify the yellow LED is on and allow the instrument fifteen minutes to warm-up.
3. Verify the mode switch is in the RUN position.
4. Attach a DC voltmeter to the P1 connector with the positive (+) lead to pin P1-D12 and the negative (-) lead to pin P1-B12; or the P2 connector with the positive (+) lead to pin P2-1 and the negative lead (-) to P2-2.
5. Raise the process fluid level so the sensing element is wet.
6. Allow the output signal to stabilize and record the wet condition value.

   Wet Condition Signal = ________ volts DC

Note: The output signal is relative to the type of process media detected. (See Figure 3-4.)

7. Lower the process fluid level so the sensing element is dry.
8. Allow the output signal to stabilize and record the dry condition value. (The dry signal should be greater than the wet signal.)

   Dry Condition Signal = ________ volts DC

9. Determine the set point by calculating the arithmetic mean of the wet and dry output signals. (i.e., If the wet signal is 0.200 volts and the dry signal is 4.000 volts, then the calculated set point would be 2.100 volts.)
10. Record this value.

    Calculated Set Point = ________ volts DC

Note: The calculated set point must be at least 0.020 volts greater than the wet signal and 0.020 volts less than the dry signal to ensure that the alarm will reset.

11. Slide the mode switch to the CAL position.
12. Adjust the calibrate potentiometer R27 (below the mode switch) until the voltmeter equals the calculated set point.
13. For the appropriate alarm, determine whether the status LED is on or off (red for alarm 1 or green for alarm 2).
14. Follow either the Detecting Dry Condition or the Detecting Wet Condition for each Level application alarm.

Detecting Dry Condition (low level alarm)

a) If the status LED is off, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) slowly clockwise just until the LED turns on.

b) If the status LED is on, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.

Detecting Wet Condition (high level alarm)

a) If the status LED is on, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) slowly counterclockwise just until the LED turns off.

b) If the status LED is off, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

15. Slide the mode switch to the RUN position. The status LED should be on if the sensing element is dry and off if the sensing element is wet.
16. Monitor the voltmeter display while raising or lowering the process fluid level. When the output signal passes through the set point, the status LED should change states and the relay contacts should switch.
17. Reestablish the normal level condition. Both the LED and relay contacts should reset.
18. Disconnect the voltmeter from P1 or P2.

Note: The relay logic default configuration is set for the relay coil to be de-energized when the level signal is greater than the set point value. (i.e., The relay coil will be de-energized when the sensing element is dry.)

Temperature Applications

For temperature versus voltage values, see Table 3-8 located at the rear of this chapter. These values have an accuracy of ±5 °F (2.78 °C). If a factory calibration chart was ordered, look for it in the plastic page protector at the back of this manual. Make sure the serial number of the chart matches the instrument to be adjusted.

1. Ensure the configuration jumpers on the control circuit are correct for this application. (See Tables 3-2 through 3-6.)

Caution: If both alarms are to be used for temperature, then set the heater power jumper to the off (J4 for channel A or J30 for channel B) position. If one alarm is for temperature and the other is for flow or level, then the preferred heater power is 0.75 watts (J5). (See Table 3-2.)

2. Apply power to the instrument. Verify the yellow LED is on and allow the instrument fifteen minutes to warm-up.
3. Verify the mode switch is in the RUN position.
4. Attach a DC voltmeter to the P1 connector with the positive (+) lead to pin P1-Z12 and the negative (-) lead to pin P1-Z10; or to the P2 connector with the positive (+) lead to P2-4 and the negative lead (-) to P2-8.
5. Establish the normal process temperature condition and allow the signal to stabilize.
6. Record the normal temperature signal value.

   Normal Temperature Signal = ________ volts DC

Note: The output signal will vary directly with the process temperature.

7. Follow either the Detecting Increasing Temperature or the Detecting Decreasing Temperature procedure for each temperature application alarm.

Detecting Increasing Temperature (high temperature alarm)

a) Slide the mode switch to the CAL position.

b) Adjust the calibrate potentiometer R27 (below the mode switch) until the voltmeter equals the normal temperature signal.

c) For the appropriate alarm, determine whether the status LED is on or off (red for alarm 1 or green for alarm 2).

1) If the LED is off, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) slowly clockwise just until the LED turns on.

2) If the LED is on, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.

Detecting Decreasing Temperature (low temperature alarm)

a) Slide the mode switch to the CAL position.

b) Adjust the calibrate potentiometer R27 (below the mode switch) until the voltmeter equals the normal temperature signal.

c) For the appropriate alarm, determine whether the status LED is on or off (red for alarm 1 or green for alarm 2).

1) If the LED is on, turn the set point adjustment potentiometer [R30 (below the red LED) for alarm 1 or R29 (below the green LED) for alarm 2] slowly counterclockwise just until the LED turns off.

2) If the LED is off, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

8. Slide the mode switch to the RUN position.
9. Establish the normal process temperature condition. For the high temperature alarm setups, the status LED should be off. For the low temperature alarm setups, the status LED should be on.
10. Establish the process alarm condition and monitor the voltmeter display.
11. When the output signal passes through the set point value, the status LED should turn on for high temperature alarms, off for low temperature alarms, and the relay contacts should switch.
12. Reestablish the normal process temperature condition. The LED and relay contacts should reset.
13. Disconnect the voltmeter from P1 or P2.

Note: The relay default configuration is for the relay coil to be de-energized when the temperature signal is greater than the set point value. (i.e., Assume that the normal process temperature condition has been established. In this state, the relay coil will be energized if the alarm has been set for increasing temperature detection and de-energized if the alarm has been set for decreasing temperature detection.)

Liquid Flow Applications

1. As necessary, set the following control circuit configuration jumpers. (See Tables 3-2 through 3-6.)

a) Application: J14 or J13 (Flow/Level) for alarm 1 or 2, respectively.

b) Heater Power: J7 (2.5 watts).

2. Apply power to the instrument. Verify the yellow LED is on, allow the instrument fifteen minutes to warm-up.
3. Verify the mode switch is in the RUN position.
4. Attach a DC voltmeter to the P1 connector with the positive (+) lead to pin P1-D12 and the negative (-) lead to pin P1-B12; or the P2 connector with the positive (+) lead to pin P2-1 and the negative lead (-) to P2-2.

Note: The output signal will vary inversely with changes in the process flow rate. The output signal level is also relative to the type of process media being measured. (See Figure 3-3.)

5. Establish the normal process flow condition and allow the signal to stabilize.
6. Record the normal flow signal value.

   Normal Flow Signal = ________ volts DC

7. Follow either the Detecting Decreasing Flow or Detecting Increasing Flow procedure for each Liquid flow application alarm.

Detecting Decreasing Flow (low flow alarm)

a) Stop the process flow and allow the signal to stabilize.

b) Record the no-flow signal. (The no-flow signal should be greater than the normal flow signal).

   No-Flow Signal = ________ volts DC

c) Determine the set point by calculating the arithmetic mean of the normal and no-flow output signals. (i.e.; If the normal signal is 0.080 volts and the no-flow signal is 0.300 volts, then the calculated set point would be 0.190 volts.)

d) Record this value.

   Calculated Set Point = ________ volts DC

Note: The calculated set point must be at least 0.020 volts greater than the normal signal to ensure that the alarm will reset.

e) Slide the mode switch to the CAL position.

f) Adjust the calibrate potentiometer R27 (below the CAL pot) until the voltmeter equals the calculated set point.

g) For the appropriate alarm, determine whether the status LED is on or off (red for alarm 1 or green for alarm 2).

   1) If the LED is off, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) slowly clockwise just until the LED turns on.

   2) If the LED is on, turn the set point adjustment potentiometer (R30 for alarm 1 or R29 for alarm 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.

Detecting Increasing Flow Rate (high flow alarm)

a) Establish the excessive flow condition and allow the signal to stabilize.

b) Record the high flow signal. (The high flow signal should be less than the normal flow signal.)

   High Flow Signal = ________ volts DC

c) Determine the set point by calculating the arithmetic mean of the normal and high flow output signals. (i.e.; If the normal signal is 0.080 volts and the high flow signal is 0.030 volts, then the calculated set point would be 0.055 volts.)

d) Record this value.

   Calculated Set Point = ________ volts DC

Note: The calculated set point must be at least 0.015 volts less than the normal signal to ensure that the alarm will reset.

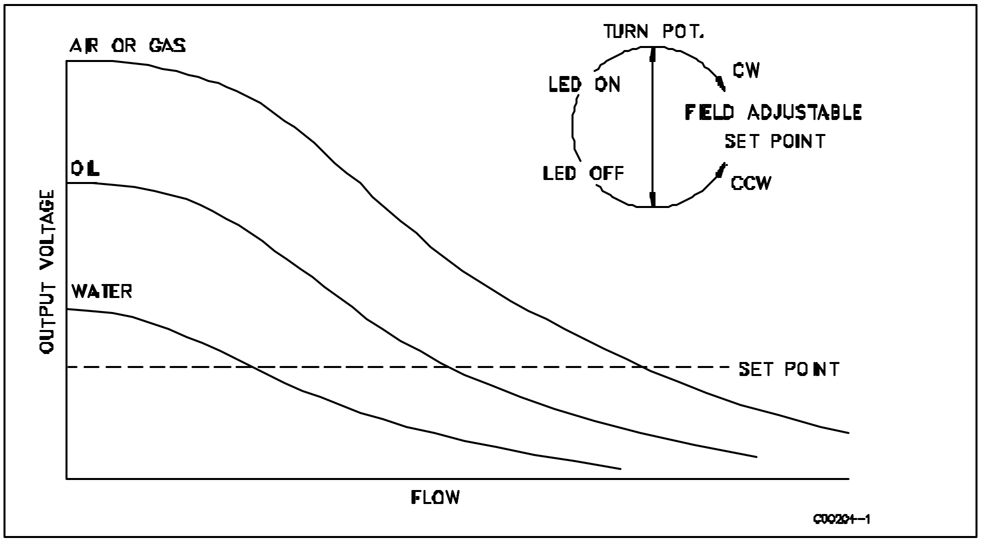


Figure 3-3. Flow Application Signal Output

e) Slide the mode switch to the CAL position.

f) Adjust the calibrate potentiometer (R24) until the voltmeter equals the calculated set point.

g) For the appropriate alarm, determine whether the status LED is on or off (red for alarm 1 or green for alarm 2).

1) If the LED is on, turn the set point adjustment potentiometer (R26 for alarm 1 or R25 for alarm 2) slowly counterclockwise just until the LED turns off.

2) If the LED is off, turn the set point adjustment potentiometer (R26 for alarm 1 or R25 for alarm 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

8. Slide the mode switch to the RUN position.
9. Establish the normal process flow condition. For low-flow alarm setups, the status LED should be off. For high flow alarm setups, the status LED should be on.
10. Establish the process alarm condition and monitor the voltmeter display.
11. When the output signal passes through the calculated set point value, the status LED should turn on for low-flow alarms, off for high flow alarms, and the relay contacts should switch.
12. Reestablish the normal process flow condition. Both the LED and the relay contacts should reset.
13. Disconnect the voltmeter from P1 or P2.

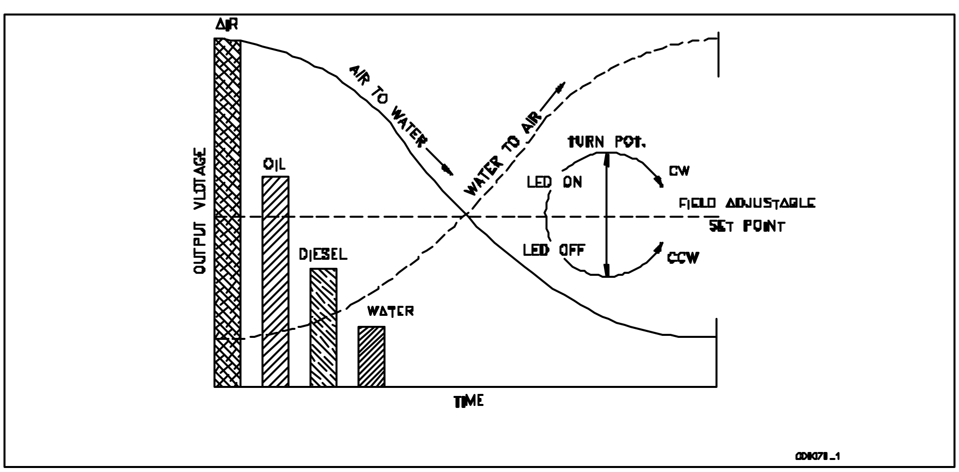


Figure 3-4. Level Application Signal Output

Note: The alarm can be set for a specific flow rate. Follow the procedure above to step 5 except establish the specific flow rate rather than the normal flow. The output signal will be the set point value. Determine whether the alarm should actuate with decreasing or increasing flow and skip to the appropriate step 7.d). Enter the specific flow rate value as the set point and follow the remaining steps.

Note: The relay logic default configuration is set for the relay coil to be de-energized when the flow signal is greater than the set point value. (i.e., Assume that the normal process flow condition has been established. In this state, the relay coil will be energized if the alarm has been set for low-flow detection and de-energized if the alarm has been set for high flow detection.)

Set Point Adjustment by Observation

Note: The control circuit has two mutually exclusive alarms; they are identified as Alarm 1 and Alarm 2. Each has a set point adjustment potentiometer and LED indicator. Both alarms can be setup for one of three applications: Flow, level/interface, or temperature. The following application specific adjustment procedures are generic and can be used for setting either or both alarms. The mode switch must be in the OP position. Use Figure 3-2 to help locate the important setup components (potentiometers, LEDs, etc.).

Flow Applications

1. Ensure that the instrument has been properly installed in the pipeline. Fill the pipeline so the sensing element is surrounded by the process medium.
2. Power the instrument and allow 15 minutes for the sensing element to become active and stabilize.
3. Flow the pipeline at the normal or expected rate.

Detecting Decreasing Flow (low flow alarm)

If the status LED is off, turn the set point adjustment potentiometer clockwise until the LED turns on. With the LED on, slowly turn the potentiometer counterclockwise one turn past the point at which the LED just turns off. The potentiometer may have up to one-quarter turn of backlash plus deadband; therefore, if the mark is overshot, the procedure should be repeated.

Detecting Increasing Flow (high flow alarm)

If the status LED is on, turn the set point adjustment potentiometer counterclockwise until the LED turns off. With the LED off, slowly turn the potentiometer clockwise one-half turn past the point at which the LED just turns on. The potentiometer may have up to one-quarter turn of backlash plus deadband; therefore if the mark is overshot, the procedure should be repeated.

Signal Output for Flow Applications

The output signal varies inversely with flow rate. The output signal level is also relative to the type of process media (See Figure 3-3.)

Level Applications

1. Ensure that the instrument has been properly installed in the vessel.
2. Power the instrument and allow 15 minutes for the sensing element to become active and stabilize.

Detecting Dry Condition (adjustment with sensing element wet)

Verify that the sensing element is wet. If the status LED is off, turn the set point adjustment potentiometer clockwise until the LED turns on. With the LED on, slowly turn the potentiometer counterclockwise one turn past the point at which the LED just turns off. The potentiometer may have up to one-quarter turn of backlash plus deadband; therefore, it the mark is overshot, the procedure should be repeated.

Detecting Wet Condition (adjustment with sensing element dry)

Caution: Consideration should be given to the fact that air or gas flowing over the sensing element may decrease the output signal and result in a false alarm. In cases where the sensing element is exposed to air or gas flow in the dry condition, or where the process media is highly viscous, set point adjustments should be made in the wet condition only.

Field adjustments made in the dry condition should be performed in the actual service environment or within a condition that approximates that environment. Provision should be made for the worst case condition of air or gas flow on the sensing element. If the status LED is on, turn the set point adjustment potentiometer counterclockwise until the LED turns off. (If the LED cannot be turned off, the instrument must be set in the wet condition.)

With the LED off, slowly turn the potentiometer clockwise one turn past the point at which the LED just goes on. The potentiometer may have up to one-quarter turn of backlash plus deadband; therefore, if the mark is overshot, the procedure should be repeated.

Signal Output for Level Applications

The output signal varies relative to the type of process media. (See Figure 3-4).

Temperature Applications

Caution: Do not use the instrument for a dual flow and temperature application in air or gas unless the flow rate is greater than 5 SFPS. (The instrument may be used for a dual flow and temperature application in liquids at any flow rate.)

Caution: When using the instrument for dual level and temperature applications, the temperature signal can be as much as 50°F (28°C) high when the sensing element is dry.

Note: Turn the heater off for temperature only applications. When a temperature alarm is combined with either a flow or level alarm, best results will be obtained by setting the heater power for 0.75 watt and ensuring that the sensing element is always in liquid.

1. Ensure that the instrument has been properly installed.
2. Power the instrument and allow 15 minutes for the sensing element to become active and stabilize.
3. Establish the normal or expected temperature.

Detecting Increasing Temperature (high temperature alarm)

If the status LED is off, turn the alarm adjustment potentiometer clockwise until the LED turns on. With the LED on, slowly turn the potentiometer counterclockwise one half turn past the point at which the LED just turns off. The potentiometer may have up to one-quarter turn of backlash plus deadband; therefore if the mark is overshot, the procedure should be repeated.

Detecting Decreasing Temperature (low temperature alarm)

If the status LED is on, turn the set point adjustment potentiometer counterclockwise until the LED turns off. With the LED off, slowly turn the potentiometer clockwise one-half turn past the point at which the LED just turns on. The potentiometer may have up to one-quarter turn of backlash plus deadband; therefore if the mark is overshot, the procedure should be repeated.

Table 3-8. Temperature versus Voltage Output (sheet 1 of 5)

0.00375 OHMS/OHMS/ C° 1000 OHMS PLATINUM							
TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93							
T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT
-100	1.434	-57	1.620	-14	1.804	29	1.987
-99	1.439	-56	1.625	-13	1.809	30	1.992
-98	1.443	-55	1.629	-12	1.813	31	1.996
-97	1.447	-54	1.633	-11	1.817	32	2.000
-96	1.452	-53	1.637	-10	1.822	33	2.004
-95	1.456	-52	1.642	-9	1.826	34	2.008
-94	1.460	-51	1.646	-8	1.830	35	2.013
-93	1.465	-50	1.650	-7	1.834	36	2.017
-92	1.469	-49	1.655	-6	1.839	37	2.021
-91	1.473	-48	1.659	-5	1.843	38	2.025
-90	1.478	-47	1.663	-4	1.847	39	2.030
-89	1.482	-46	1.667	-3	1.851	40	2.034
-88	1.486	-45	1.672	-2	1.856	41	2.038
-87	1.491	-44	1.676	-1	1.860	42	2.042
-86	1.495	-43	1.680	0	1.864	43	2.047
-85	1.499	-42	1.685	1	1.868	44	2.051
-84	1.504	-41	1.689	2	1.873	45	2.055
-83	1.508	-40	1.693	3	1.877	46	2.059
-82	1.512	-39	1.698	4	1.881	47	2.063
-81	1.517	-38	1.702	5	1.885	48	2.068
-80	1.521	-37	1.706	6	1.890	49	2.072
-79	1.525	-36	1.710	7	1.894	50	2.076
-78	1.530	-35	1.715	8	1.898	51	2.080
-77	1.534	-34	1.719	9	1.902	52	2.085
-76	1.538	-33	1.723	10	1.907	53	2.089
-75	1.543	-32	1.728	11	1.911	54	2.093
-74	1.547	-31	1.732	12	1.915	55	2.097
-73	1.551	-30	1.736	13	1.919	56	2.101
-72	1.556	-29	1.740	14	1.924	57	2.106
-71	1.560	-28	1.745	15	1.928	58	2.110
-70	1.564	-27	1.749	16	1.932	59	2.114
-69	1.569	-26	1.753	17	1.936	60	2.118
-68	1.573	-25	1.757	18	1.941	61	2.122
-67	1.577	-24	1.762	19	1.945	62	2.127
-66	1.581	-23	1.766	20	1.949	63	2.131
-65	1.586	-22	1.770	21	1.953	64	2.135
-64	1.590	-21	1.775	22	1.958	65	2.139
-63	1.594	-20	1.779	23	1.962	66	2.144
-62	1.599	-19	1.783	24	1.966	67	2.148
-61	1.603	-18	1.787	25	1.970	68	2.152
-60	1.607	-17	1.792	26	1.975	69	2.156
-59	1.612	-16	1.796	27	1.979	70	2.160
-58	1.616	-15	1.800	28	1.983	71	2.165

Table 3-8. Temperature versus Voltage Output (sheet 2 of 5)

0.00375 OHMS/OHMS/ °C 1000 OHMS PLATINUM							
TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93							
T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT
72	2.169	121	2.374	170	2.577	219	2.779
73	2.173	122	2.378	171	2.581	220	2.783
74	2.177	123	2.382	172	2.585	221	2.787
75	2.181	124	2.386	173	2.590	222	2.791
76	2.186	125	2.391	174	2.594	223	2.795
77	2.190	126	2.395	175	2.598	224	2.799
78	2.194	127	2.399	176	2.602	225	2.803
79	2.198	128	2.403	177	2.606	226	2.807
80	2.202	129	2.407	178	2.610	227	2.811
81	2.207	130	2.411	179	2.614	228	2.816
82	2.211	131	2.415	180	2.618	229	2.820
83	2.215	132	2.420	181	2.623	230	2.824
84	2.219	133	2.424	182	2.627	231	2.828
85	2.223	134	2.428	183	2.631	232	2.832
86	2.228	135	2.432	184	2.635	233	2.836
87	2.232	136	2.436	185	2.639	234	2.840
88	2.236	137	2.440	186	2.643	235	2.844
89	2.240	138	2.445	187	2.647	236	2.848
90	2.244	139	2.449	188	2.651	237	2.852
91	2.248	140	2.453	189	2.656	238	2.856
92	2.253	141	2.457	190	2.660	239	2.860
93	2.257	142	2.461	191	2.664	240	2.865
94	2.261	143	2.465	192	2.668	241	2.869
95	2.265	144	2.469	193	2.672	242	2.873
96	2.269	145	2.474	194	2.676	243	2.877
97	2.274	146	2.478	195	2.680	244	2.881
98	2.278	147	2.482	196	2.684	245	2.885
99	2.282	148	2.486	197	2.688	246	2.889
100	2.286	149	2.490	198	2.693	247	2.893
101	2.290	150	2.494	199	2.697	248	2.897
102	2.295	151	2.499	200	2.701	249	2.901
103	2.299	152	2.503	201	2.705	250	2.905
104	2.303	153	2.507	202	2.709	251	2.909
105	2.307	154	2.511	203	2.713	252	2.913
106	2.311	155	2.515	204	2.717	253	2.917
107	2.315	156	2.519	205	2.721	254	2.922
108	2.320	157	2.523	206	2.725	255	2.926
109	2.324	158	2.528	207	2.729	256	2.930
110	2.328	159	2.532	208	2.734	257	2.934
111	2.332	160	2.536	209	2.738	258	2.938
112	2.336	161	2.540	210	2.742	259	2.942
113	2.340	162	2.544	211	2.746	260	2.946
114	2.345	163	2.548	212	2.750	261	2.950
115	2.349	164	2.552	213	2.754	262	2.954
116	2.353	165	2.556	214	2.758	263	2.958
117	2.357	166	2.561	215	2.762	264	2.962
118	2.361	167	2.565	216	2.766	265	2.966
119	2.366	168	2.569	217	2.770	266	2.970
120	2.370	169	2.573	218	2.775	267	2.974

Table 3-8. Temperature versus Voltage Output (sheet 3 of 5)

0.00375 OHMS/OHMS/ °C 1000 OHMS PLATINUM							
TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93							
T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT
268	2.978	317	3.176	366	3.373	415	3.567
269	2.982	318	3.180	367	3.377	416	3.571
270	2.987	319	3.184	368	3.381	417	3.575
271	2.991	320	3.188	369	3.385	418	3.579
272	2.995	321	3.192	370	3.388	419	3.583
273	2.999	322	3.196	371	3.392	420	3.587
274	3.003	323	3.200	372	3.396	421	3.591
275	3.007	324	3.205	373	3.400	422	3.595
276	3.011	325	3.209	374	3.404	423	3.599
277	3.015	326	3.213	375	3.408	424	3.602
278	3.019	327	3.217	376	3.412	425	3.606
279	3.023	328	3.221	377	3.416	426	3.610
280	3.027	329	3.225	378	3.420	427	3.614
281	3.031	330	3.229	379	3.424	428	3.618
282	3.035	331	3.233	380	3.428	429	3.622
283	3.039	332	3.237	381	3.432	430	3.626
284	3.043	333	3.241	382	3.436	431	3.630
285	3.047	334	3.245	383	3.440	432	3.634
286	3.051	335	3.249	384	3.444	433	3.638
287	3.055	336	3.253	385	3.448	434	3.642
288	3.059	337	3.257	386	3.452	435	3.646
289	3.063	338	3.261	387	3.456	436	3.650
290	3.068	339	3.265	388	3.460	437	3.654
291	3.072	340	3.269	389	3.464	438	3.658
292	3.076	341	3.273	390	3.468	439	3.662
293	3.080	342	3.277	391	3.472	440	3.665
294	3.084	343	3.281	392	3.476	441	3.669
295	3.088	344	3.285	393	3.480	442	3.673
296	3.092	345	3.289	394	3.484	443	3.677
297	3.096	346	3.293	395	3.488	444	3.681
298	3.100	347	3.297	396	3.492	445	3.685
299	3.104	348	3.301	397	3.496	446	3.689
300	3.108	349	3.305	398	3.500	447	3.693
301	3.112	350	3.309	399	3.504	448	3.697
302	3.116	351	3.313	400	3.508	449	3.701
303	3.120	352	3.317	401	3.512	450	3.705
304	3.124	353	3.321	402	3.516	451	3.709
305	3.128	354	3.325	403	3.520	452	3.713
306	3.132	355	3.329	404	3.523	453	3.716
307	3.136	356	3.333	405	3.527	454	3.720
308	3.140	357	3.337	406	3.531	455	3.724
309	3.144	358	3.341	407	3.535	456	3.728
310	3.148	359	3.345	408	3.539	457	3.732
311	3.152	360	3.349	409	3.543	458	3.736
312	3.156	361	3.353	410	3.547	459	3.740
313	3.160	362	3.357	411	3.551	460	3.744
314	3.164	363	3.361	412	3.555	461	3.748
315	3.168	364	3.365	413	3.559	462	3.752
316	3.172	365	3.369	414	3.563	463	3.756

Table 3-8. Temperature versus Voltage Output (sheet 4 of 5)

0.00375 OHMS/OHMS/ °C 1000 OHMS PLATINUM							
TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93							
T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT
464	3.760	513	3.950	562	4.139	611	4.327
465	3.763	514	3.954	563	4.143	612	4.330
466	3.767	515	3.958	564	4.147	613	4.334
467	3.771	516	3.962	565	4.151	614	4.338
468	3.775	517	3.966	566	4.155	615	4.342
469	3.779	518	3.970	567	4.159	616	4.346
470	3.783	519	3.974	568	4.162	617	4.349
471	3.787	520	3.977	569	4.166	618	4.353
472	3.791	521	3.981	570	4.170	619	4.357
473	3.795	522	3.985	571	4.174	620	4.361
474	3.799	523	3.989	572	4.178	621	4.365
475	3.803	524	3.993	573	4.182	622	4.368
476	3.806	525	3.997	574	4.185	623	4.372
477	3.810	526	4.001	575	4.189	624	4.376
478	3.814	527	4.005	576	4.193	625	4.380
479	3.818	528	4.008	577	4.197	626	4.384
480	3.822	529	4.012	578	4.201	627	4.387
481	3.826	530	4.016	579	4.205	628	4.391
482	3.830	531	4.020	580	4.208	629	4.395
483	3.834	532	4.024	581	4.212	630	4.399
484	3.838	533	4.028	582	4.216	631	4.403
485	3.842	534	4.032	583	4.220	632	4.406
486	3.845	535	4.035	584	4.224	633	4.410
487	3.849	536	4.039	585	4.228	634	4.414
488	3.853	537	4.043	586	4.231	635	4.418
489	3.857	538	4.047	587	4.235	636	4.422
490	3.861	539	4.051	588	4.239	637	4.425
491	3.865	540	4.055	589	4.243	638	4.429
492	3.869	541	4.059	590	4.247	639	4.433
493	3.873	542	4.062	591	4.250	640	4.437
494	3.877	543	4.066	592	4.254	641	4.440
495	3.880	544	4.070	593	4.258	642	4.444
496	3.884	545	4.074	594	4.262	643	4.448
497	3.888	546	4.078	595	4.266	644	4.452
498	3.892	547	4.082	596	4.270	645	4.456
499	3.896	548	4.086	597	4.273	646	4.459
500	3.900	549	4.089	598	4.277	647	4.463
501	3.904	550	4.093	599	4.281	648	4.467
502	3.908	551	4.097	600	4.285	649	4.471
503	3.912	552	4.101	601	4.289	650	4.474
504	3.915	553	4.105	602	4.292	651	4.478
505	3.919	554	4.109	603	4.296	652	4.482
506	3.923	555	4.113	604	4.300	653	4.486
507	3.927	556	4.116	605	4.304	654	4.490
508	3.931	557	4.120	606	4.308	655	4.493
509	3.935	558	4.124	607	4.311	656	4.497
510	3.939	559	4.128	608	4.315	657	4.501
511	3.943	560	4.132	609	4.319	658	4.505
512	3.947	561	4.136	610	4.323	659	4.508

Table 3-8. Temperature versus Voltage Output (sheet 5 of 5)

0.00375 OHMS/OHMS/ °C 1000 OHMS PLATINUM							
TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93							
T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT	T(°F)	V OUT
660	4.512	709	4.696	758	4.878	807	5.058
661	4.516	710	4.700	759	4.881	808	5.062
662	4.520	711	4.703	760	4.885	809	5.065
663	4.523	712	4.707	761	4.889	810	5.069
664	4.527	713	4.711	762	4.892	811	5.072
665	4.531	714	4.714	763	4.896	812	5.076
666	4.535	715	4.718	764	4.900	813	5.080
667	4.538	716	4.722	765	4.904	814	5.083
668	4.542	717	4.726	766	4.907	815	5.087
669	4.546	718	4.729	767	4.911	816	5.091
670	4.550	719	4.733	768	4.915	817	5.094
671	4.554	720	4.737	769	4.918	818	5.098
672	4.557	721	4.741	770	4.922	819	5.102
673	4.561	722	4.744	771	4.926	820	5.105
674	4.565	723	4.748	772	4.929	821	5.109
675	4.569	724	4.752	773	4.933	822	5.113
676	4.572	725	4.755	774	4.937	823	5.116
677	4.576	726	4.759	775	4.940	824	5.120
678	4.580	727	4.763	776	4.944	825	5.124
679	4.584	728	4.767	777	4.948	826	5.127
680	4.587	729	4.770	778	4.951	827	5.131
681	4.591	730	4.774	779	4.955	828	5.134
682	4.595	731	4.778	780	4.959	829	5.138
683	4.599	732	4.781	781	4.962	830	5.142
684	4.602	733	4.785	782	4.966	831	5.145
685	4.606	734	4.789	783	4.970	832	5.149
686	4.610	735	4.793	784	4.974	833	5.153
687	4.614	736	4.796	785	4.977	834	5.156
688	4.617	737	4.800	786	4.981	835	5.160
689	4.621	738	4.804	787	4.985	836	5.164
690	4.625	739	4.807	788	4.988	837	5.167
691	4.629	740	4.811	789	4.992	838	5.171
692	4.632	741	4.815	790	4.996	839	5.175
693	4.636	742	4.819	791	4.999	840	5.178
694	4.640	743	4.822	792	5.003	841	5.182
695	4.644	744	4.826	793	5.007	842	5.185
696	4.647	745	4.830	794	5.010	843	5.189
697	4.651	746	4.833	795	5.014	844	5.193
698	4.655	747	4.837	796	5.018	845	5.196
699	4.658	748	4.841	797	5.021	846	5.200
700	4.662	749	4.844	798	5.025	847	5.204
701	4.666	750	4.848	799	5.029	848	5.207
702	4.670	751	4.852	800	5.032	849	5.211
703	4.673	752	4.856	801	5.036	850	5.214
704	4.677	753	4.859	802	5.040	851	5.218
705	4.681	754	4.863	803	5.043	852	5.222
706	4.685	755	4.867	804	5.047	853	5.225
707	4.688	756	4.870	805	5.051	854	5.229
708	4.692	757	4.874	806	5.054	855	5.233

2. Installation

Receiving/Inspection

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

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

Packing/Shipping/Returns

These issues are addressed in Appendix C - Customer Service.

Factory Calibration Note

The instrument is factory calibrated to the applications as specified at the time of order. There is no need to perform any verification or calibration steps prior to installing and placing the instrument in service, unless the application has been varied.

Pre-Installation Procedure

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

Caution: The instrument 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.

Prepare or Verify Sensing Element Location

Prepare the process pipe for installation, or inspect the already prepared location to ensure that the instrument will fit into the system.

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

Verify Dimensions

Verify the instrument's dimensions versus the process location to be sure of a correct fit. Also see Appendix A for dimensions.

Verify Flow Direction and Placement Orientation for the Sensing Element (Flow Application)

For flow detection, the sensing element surface marked with direction arrows should be oriented parallel to the process flow . The flow can be from either direction. See the appropriate figure in Appendix A for the flow arrow marking.

For liquid flow service, the sensing element should be located in the process pipe so that the thermowells are always completely wet.

When mounted in a tee or section of pipe larger than the normal process pipe, position in a vertical run of pipe with flow upward. This will prevent air or gas bubbles from becoming trapped at the sensor assembly.

Vertical positioning with flow downward is only recommended for higher flow rate applications (consult FCI).

Verify Flow Direction and Placement Orientation for the Sensing Element (Level Application)

If the sensing element is side-mounted on the process vessel, then the surface marked with direction arrows should be vertically oriented.

If the sensing element is top- or bottom-mounted on the process vessel, the orientation of the surface marked with direction arrows does not matter.

Install the Sensing Element

Male NPT Mounting

When mounting the sensing element to the process pipe, it is important that a lubricant/sealant be applied to the male threads of all connections. Be sure to use a lubricant/sealant compatible with the process environment. All connections should be tightened firmly. To avoid leaks, do not overtighten or cross-thread connections. See the appropriate figure in Appendix A for mounting dimensions.

Flange Mounting

For flange mounted sensing elements, attach the process mating flange with care. The correct orientation of the sensing element must be maintained to ensure optimum performance or calibration. See drawings in Appendix A.

Packing Gland Assembly

Applications involving the use of a packing gland (low or medium pressure) should refer to the drawings in Appendix A for additional detail.

1. Threaded or flanged packing gland mounts are available. The valve assembly with appropriate connections are customer supplied. Follow the male NPT mounting procedure above to attach the pipe thread portion or flange mounting portion as applicable.
2. Tighten the packing nut until the internal packing is tight enough so that the friction fit on the shaft is adequate to prevent leakage but not prevent the shaft from sliding. Position the etched flow arrow parallel with the flow (±1°of level) and position the flow arrow so it is pointing in the direction of the flow.
3. Proceed to insert the probe into the process media line. Use the adjusting nuts on the all-thread to pull the sensing element into proper predetermined depth position.
4. Tighten the opposing lock nuts on the all-threads. Tighten the packing nut another half to full turn until tight (approximately 65 to 85 ft/lbs [88 to 115 N•m] torque).
5. Rotate the split ring locking collar to line up with the connecting strap welded to the packing nut. Tighten the two 1/4-28 hex socket cap screws on the split ring locking collar.

Reverse these steps for removal.

Control Circuit Wiring

Mount the control circuit remotely by following the procedure below.

Warning: Ensure that all power is OFF before wiring any circuit.

Wiring

The input/output connector for the control circuit is a 48 pin type F Eurocard connector, (DIN 41612). Shielded cable must be used when running the cables to the sensing elements, as well as the signal voltage outputs if they are used. Refer to Table 2-1 for the pin designations.

Table 2-1. Control Circuit Connector Pin-Outs

POWER SUPPLY PINS			
P1-Z14	AGND		
P1-D14	+24VDC		
CH A RELAY PINS		**CH B RELAY PINS**	
ALARM 1		ALARM 1	
P1-D4	POLE	P1-D32	POLE
P1-B4	N.O.	P1-B32	N.O.
P1-Z4	N.C.	P1-Z32	N.C.
ALARM 2		ALARM 2	
P1-D2	POLE	P1-D30	POLE
P1-B2	N.O.	P1-B30	N.O.
P1-Z2	N.C.	P1-Z30	N.C.
CH A INPUT/OUTPUT PINS		**CH B INPUT/OUTPUT PINS**	
P1-D12	OUT + A	P1-D18	OUT + B
P1-B12	OUT - A	P1-B18	OUT - B
P1-Z12	TEMP +A	P1-Z18	TEMP +B
P1-Z10	TEMP - A	P1-Z16	TEMP - B
P1-B14	SHIELD GND	P1-B16	SHIELD GND
P1-Z8	HTR + A	P1-Z22	HTR + B
P1-B8	HRT RTN A	P1-B22	HRT RTN B
P1-D8	COM A	P1-D22	COM B
P1-D10	REF A	P1-D20	REF B
P1-B10	ACT A	P1-B20	ACT B
P1-Z6	SHIELD GND	P1-Z20	SHIELD GND
P1-D6	CHASSIS GND	P1-D28	CHASSIS GND
CHANNEL A TEST CONNECTOR		**CHANNEL B TEST CONNECTOR**	
P2-1	OUT +	P2-6	OUT +
P2-2	OUT -	P2-7	OUT -
P2-4	TEMP +	P2-9	TEMP +
P2-8	TEMP -	P2-8	TEMP -
P2-5	18V TEST POINT	P2-10	18V TEST POINT
P2-8	GND	P2-8	GND

Remote Mounting

1. Mount the control circuit rack to an appropriate and accessible surface. (See Figure 2-1.)
2. FCI's recommendation is to install conduit between the local enclosure and the remote enclosure, as well as installing conduit between the remote enclosure and the power source and monitoring circuit. Provide water tight hardware and apply thread sealant to all connections to prevent water damage.

3. Install 5 connector shielded cable (factory or customer supplied) between the sensing element and the control circuit. Refer to Figure 2-1 or 2-2 for connection information.
4. Ensure the specified operating power is supplied to the control circuit. Refer to Figure 2-1 or 2-1 for connection information. FCI recommends that a switch and a line fuse be installed near the control circuit rack in order to interrupt operating power during installation, maintenance, and troubleshooting.
5. When connecting the relay wiring, do so with complete understanding of what the process requires of the instrument. The instrument has dual switch points with a SPDT contact configuration for each switch point. For the relay logic, refer to Figure 2-1 or 2-2 and Tables 3-4 through 3-6 (Chapter 3 - Operation). Relay contacts are shown with the relays de-energized. Wire in accordance with the system requirements.
6. Plug the control circuit into its rack position.
7. Verify the proper installation of the instrument by checking the following items.
   - Check that the assemblies are secure and the wiring is correct.
   - Check that the serial numbers on the sensing element match the serial numbers on the control circuit. The sensing elements and control circuit are tested and adjusted as a matched set at the factory. Mismatching of the sensing element and control circuit will cause poor performance.

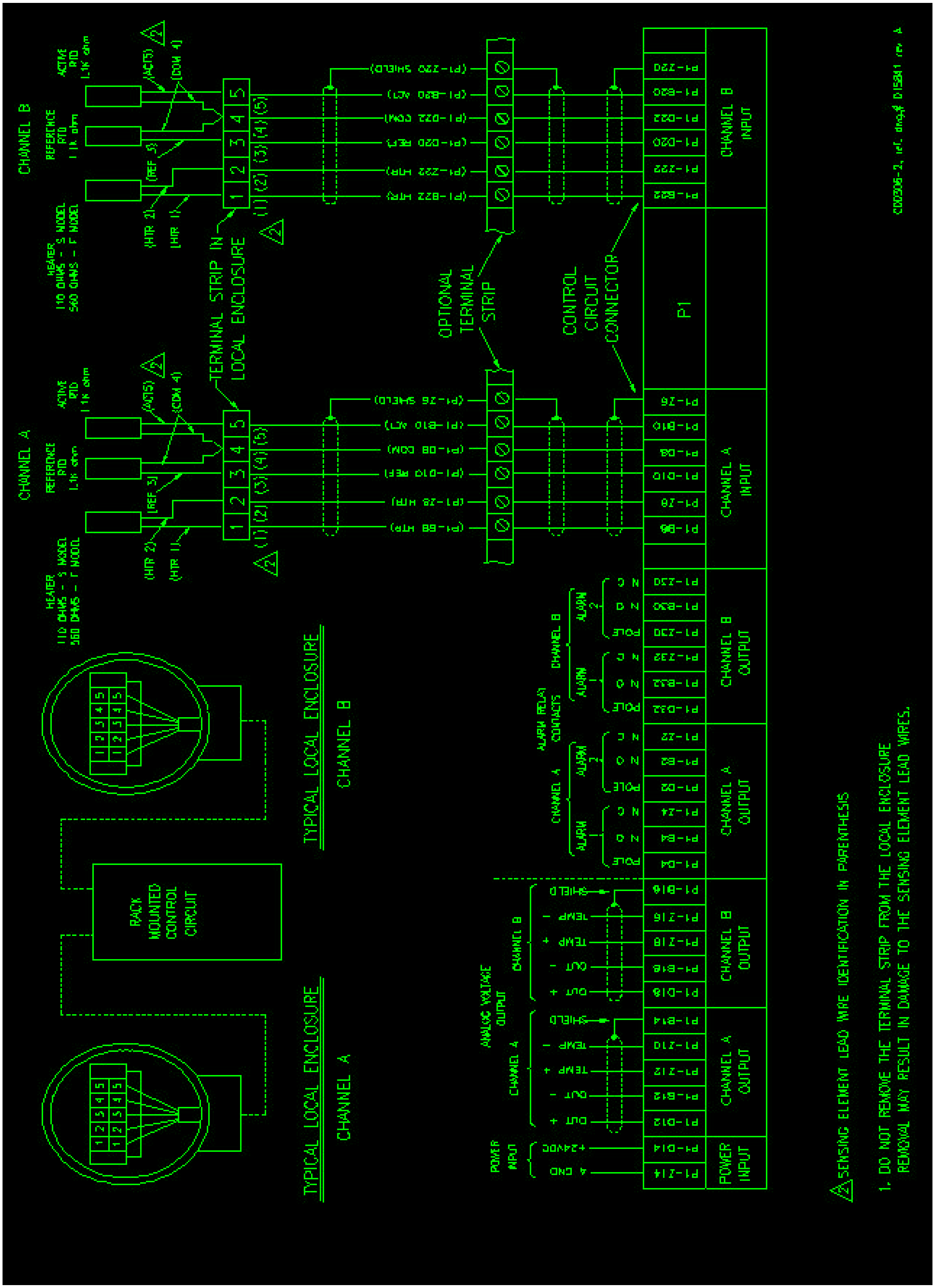


Figure 2-1. Wiring Diagram: Remote Mounting

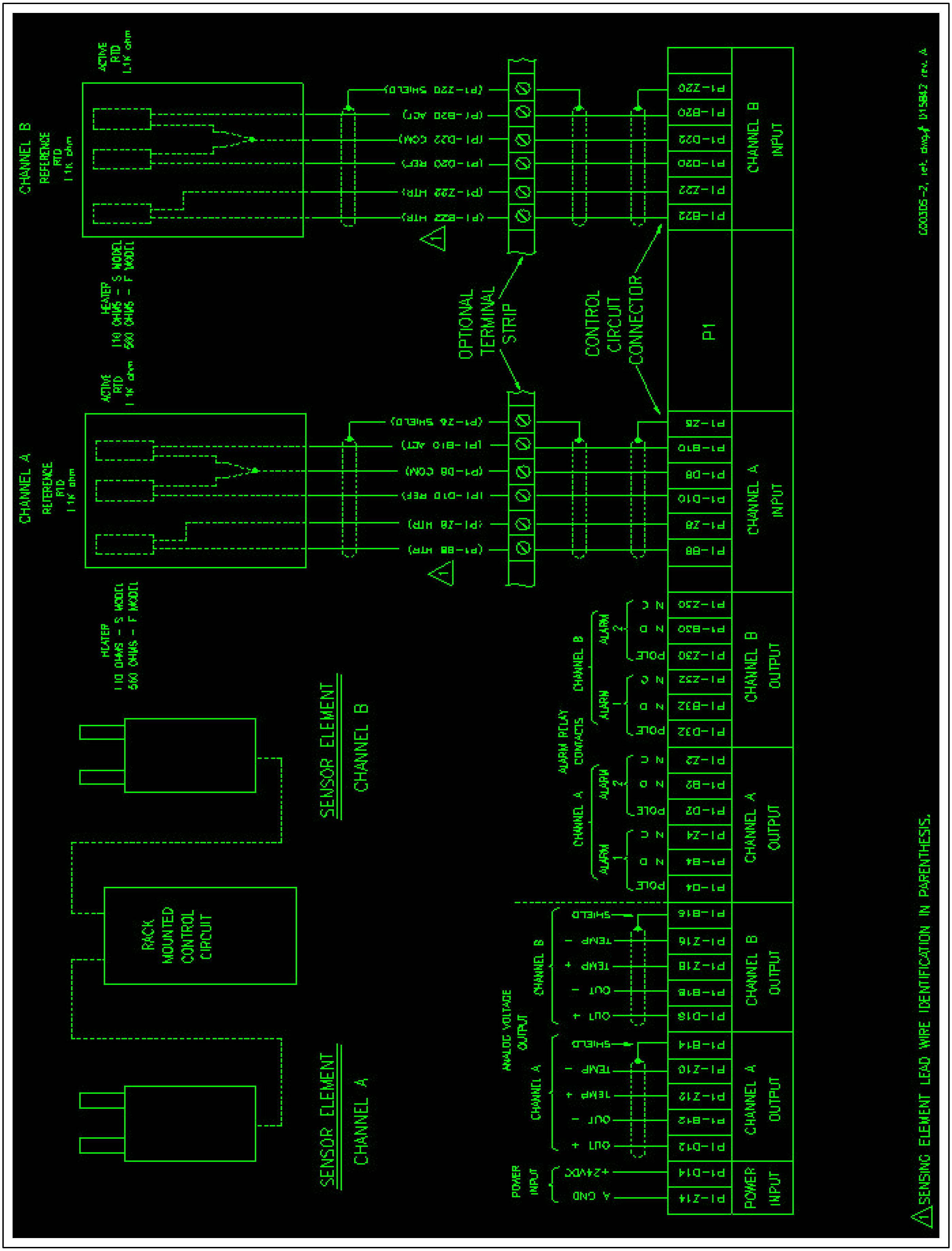


Figure 2-2. Wiring Diagram: Remote Pig Tail

ERRATA DESCRIPTION

Appendix E is added for the CE mark. Also a wire length Table is added to the installation. See the following information.

Appendix E. CE Conformance

Approved CE marking FLT Series FlexSwitch 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 enclosures
6) all specified application combinations
7) all cable jackets and lengths

Approved Part Numbers

	General			Sensing Element							Control Circuit						
	1	2		3	4	5	6	7	8		9	10	11	12	13	14	15
FLT93-S or FLT93-F	3	(yellow)	—	(yellow)	(yellow)	(yellow)	(yellow)	(yellow)	C D E	—	1 or 2	(yellow)	(yellow)	(yellow)	0 A B C D	(yellow)	(yellow)

(yellow) All options conform to CE marking Requirements.

X Y — X or Y options only conform to CE

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

Conditionally Approved CE marking FLT Series FlexSwitch Configurations

24 VDC Operation

Since 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.

Rack Mounted Control Circuit Options

The models included in this family are rack mounted (code 3 block 9 as derived from the above chart) control circuit boards. Since the manufacturer does not supply an EMC enclosure for these configurations, the associated compliance to the EMC Directive shall be the responsibility of the User.

INSTALLATION CONFORMITY CRITERIA

Grounding

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

Interconnecting Cables

All interconnecting cables between the FlexSwitch local enclosure, remote enclosure, power source and monitoring device shall be enclosed in metal conduit.

Standard ESD Precautions

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

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

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, PH: 31-40-2-571-972 FAX: 31-40-2-517-809.

Location of CE mark documentation (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.

Add the Following Table to the Bottom of Page 2-4:

Table 2-2. Maximum AWG Number For Wiring the Instrument

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