# Installation, Operation and Maintenance

# Nuclear Qualified FLT® 93 Series FlexSwitch™

## Flow, Level, Temperature Switch/Monitor

## Models: FLT93F, FLT93L, FLT93S

Doc 06EN003409

# Table of Contents

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# 1 GENERAL

## Description

The FLT Series models are multipurpose measurement instruments. The FLT Series models that are included in this manual are FLT93-S, FLT93-F, FLT93-HT and FLT93-L. Each model is a single instrument that is capable of detecting fluid flow and temperature. It is also able to detect liquid level or fluid media interfaces. The instrument has two field adjustable alarm set points, two buffered voltage outputs, as well as a built-in calibration circuit. The output of the alarm set points are 6 amp relay contacts that can be used to control customer process applications. An optional 10 amp relay contacts can be used to control the customer process application. One buffered voltage output is available for flow or level monitoring and the second buffered voltage output is available for temperature monitoring.

## Theory of Operation

The flow switch is a fixed position, single-point flow, level, interface and temperature switch. The operation of the sensing element is based upon the thermal dispersion principle: A low-powered 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.

## Sensing Element

The sensing element consists of two thermowells (hollow tubes) that when inserted into the flow process allows an unimpeded flow inside the process line. The top thermowell has a self-heated RTD inserted into it. The bottom thermowell has a reference RTD inserted into it. In order to correctly orient the sensing element a flow arrow has been etched onto the threaded portion of the sensing element. See Figure 1-1 for a view of the sensing element.

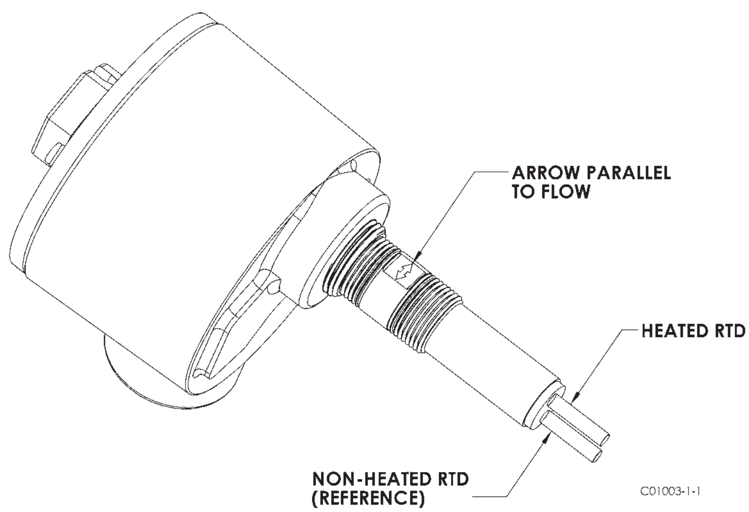


Figure 1-1 View of the Sensing Element

## Control Circuit

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

The control circuit contains field removable jumpers that configures the instrument to perform in the field as needed by the customer.

## Technical Specification

### Application

Flow rate and /or level /interface and temperature sensing in liquid, gas and slurry applications.

### Sensing Elements

- **Process Connection**
  *Models S and F*
  3/4 inch male NPT standard; optional 1 inch BSP, 1 inch male NPT, 3/4 inch Male NPT (FLT93-F only); flanges, or spool pieces.
  *Model L*
  1" male NPT or 3/4" female NPT, both ends with orifice; flanges optional.
- **Insertion Length**
  *Models S and F*
  Available in standard lengths of 1.2" [30mm], 2" [51mm], 4" [102mm], 6" [152mm], 9" [229mm], 12" [305mm], 18" [457mm] and custom-specified lengths.
  *Model L*
  3.375" [86mm] in-line body length
- **Sensing Element**
  *Models S and F*
  All wetted surfaces are 316L stainless steel with all-welded construction. Hastelloy C, Monel 400, electro-polished stainless steel and titanium (FLT93-S only) are optionally available.
  *Model L*
  All wetted surfaces are 316L stainless steel with all-welded construction. Hastelloy C, Monel 400 and titanium are optionally available.
- **Operating Temperature**
  Sensing Element:
  *All Models*
  Standard temperature configuration:
  -40°F to +350°F [-40°C to +177°C]
  Medium temperature configuration:
  -100°F to +500°F [-73°C to +260°C]
  *Model S Only*
  High temperature configuration:
  -100°F to +850°F [-73°C to +454°C]
  Control Circuit:
  *All Models*
  Ambient -40°F to +140°F [-40°C to + 60°C]
- **Operating Pressure**
  *Models S, F and L*
  2350 psig [ 162 bar(g)] maximum at 500°F [260°C]
  1450 psig [100 bar(g)] maximum at 850°F [454°C]

### Control Circuit Features

- **Control Circuit**
  Standard: Plug-in, socket mounted with dual alarm/trip epoxy sealed relays.
  Optional: Rack-mount configuration (card cage or enclosure not included)
- **Output Signal**
  Analog DC voltage related to flow or level / interface signal and proportional to temperature, standard.
- **Input Power**
  Field selected or pre-configured in the factory to 115 Vac (±15), 230 Vac (±30, 50 to 60 Hz), 24 Vdc (+4, -3) or 24 Vac (+2, -6); 100 Vac ±10 optionally available. LED indicates power on.
- **Power Consumption**
  AC units, 13 VA maximum; DC units, 7 watts maximum.
- **Heater Power**
  Field or factory selected to optimize switching performance and rangeability and selectable for specific fluid service requirements. 7 watts power consumption, 230 mA maximum.

| Typical Service | Sensing Element | Power (W) |
|---|---|---|
| Gas or Air | S-Style | 0.75 |
| | F-Style | 0.25 |
| Liquids | S-Style | 3.0 |

  The above typical service power selections are for reference only. Depending on application requirements, surface temperature rating requirements, and rangeability expectations, alternate power selections may be recommended. Other intermediate power selections can be made. Consult installation manual for recommendations in your service.
- **Relay Rating**
  Dual SPDT or single DPDT field configurable 6 amp resistive at 115 Vac, 240 Vac or 24 Vdc; hermetically sealed relay configurations optionally available.
- **Electrical Enclosure**
  Aluminum (epoxy coated) or optional stainless steel. Enclosures are rated for hazardous location use (Class I and II, Division 1 and 2, Group B, C, D, E, F and G; and EEx d IIC) and resists the effect of weather and corrosion (NEMA and CSA Type 4X and equivalent to IP66).

### For Flow Service

- **Setpoint Range**
  *Model S*
  Water-based Liquids:
  0.01 FPS to 0.5 FPS [0.003 MPS to 1.52 MPS]with 0.75 watt heater;
  0.01 FPS to 3.0 FPS [0.003 MPS to 0.9 MPS] with 3.0 watt heater.
  Hydrocarbon-based Liquids:
  0.01 FPS to 1.0 FPS [0.003 MPS to 0.3 MPS] with 0.75 watt heater;
  0.01 FPS to 5.0 FPS with [0.003 MPS to 1.5 MPS] with 3.0 watt heater.
  Air/Gas:
  0.25 SFPS to 120 SFPS [0.08 NMPS to 37 NMPS] with 0.75 watt heater at standard conditions; 70°F [21.1°C], 14.7 psia [1.013 bar(g)].
  Other Fluids: Contact the factory for approximate rangeability.
  *Model F*
  Air/Gas:
  0.25 SFPS to 120 SFPS [0.08 NMPS to 37 NMPS] 0.75 watt heater at standard conditions; 70°F [21.1°C], 14.7 psig [1.013 bar(g)].
  *Model L*
  Water-based Liquids: 0.015 cc/sec to 50 cc/sec
  Hydrocarbon-based Liquids: 0.033 cc/sec to 110 cc/sec
  Air/Gas: 0.6 cc/sec to 20,000 cc/sec

- **Factory Calibrated Switch Point Accuracy**
  Any flow rate within the instrument flow range may be selected as a setpoint alarm. A factory-calibrated setpoint adjustment may be optimally preset with accuracy of ±2% of setpoint velocity over an operating temperature range of ±50°F [±28°C].
- **Monitoring Accuracy**
  Based on a measured output voltage over the entire flow range, an operating temperature range of ±50°F [±28°C], and an operating pressure range of ±100 psig [±7 bar(g)]:
  Liquids: ±5% reading or ±0.04 SFPS [±0.012 NMPS], whichever is larger
  Gases: ±5% reading or ±2 SFPS [±0.61 NMPS], whichever is larger
- **Repeatability**
  ±0.5% reading

## For Level/Interface Service

- **Accuracy**
  *Model S*
  ±0.25° [±6.4 mm]
  *Model F*
  ±0.1° [±2.5 mm]
- **Repeatability**
  *Model S*
  ±0.125° [±3.2 mm]
  *Model F*
  ±0.05° [±1.3 mm]

## For Temperature Service

- **Accuracy**
  ±2.0°F [±1°C] with field setpoint adjustment. Monitoring accuracy ±3.5°F [±2°C] with standard curve fit output voltage operation across the selected instrument temperature range. Higher accuracy available with factory calibrations.
- **Repeatability**
  ±1.0°F [±0.6°C]

  *The above accuracy is based on liquid or slurry service and in gas service with a minimum 1 SFPS [0.3 NMPS] velocity past the sensing element or with the heater deactivated for temperature sensing service only.*

- **MTBF:** 190 years
- **SIL:** SIL-2 compliant, safe failure fraction (SFF) 82% to 84%

## Factory Application-Specific Set-up and Setpoint Calibration

Standard instrument factory default setting, unless otherwise selected at order entry, will be as follows:

- 115 Vac input power for all FM Approved units. 230 Vac for all other agency approval units.
- Dual SPDT alarms set for:
- Alarm No. 1: Preset for flow or level and to de-energize with decreasing conditions.
- Alarm No. 2: Preset to de-energize for increasing temperature at 10 °F [5 °C] below the maximum instrument process temperature.
- Heater power at 0.25 watt on Model F or 0.75 watt on Model S.
- Calibration switch set at "operate."

Factory calibration including set-up for specific service, process fluid and alarm conditions optionally available. Contact factory for fluid handling capabilities.

## Nuclear Safety Certification

FLT93 sensor elements were qualified for harsh environment applications under the guidelines of iEEE-323, iEEE-344 and iEEE-382.

- **Radiation Exposure**
  *Models S and F*
  $2 \times 10^8$ rads
  *High Temperature*
  $5 \times 10^7$ rads
  *Electronics Module [5294] qualified for radiation harsh*
  $5 \times 10^5$ rads
- **Seismic Level**
  *Models S and F*
  3g ZPA's
  *High Temperature*
  8g ZPA's

## Shipping Weight (approximate)

Integral: 8 lb [3.6 kg]
Remote: 13 lb [5.9 kg]

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# 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 D - 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 contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control circuit. See below, for ESD details.

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

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

**Use Standard ESD Precautions**

Use standard ESD precautions when opening an instrument enclosure or handling the control circuit. 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.

**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.

Review the requirement for the supply power and alarm circuit connections.

**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 Sensing Element Flow Direction and Placement Orientation (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.

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.

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 Sensing Element Flow Direction and Placement Orientation (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 Figure 2-1 for proper mounting.

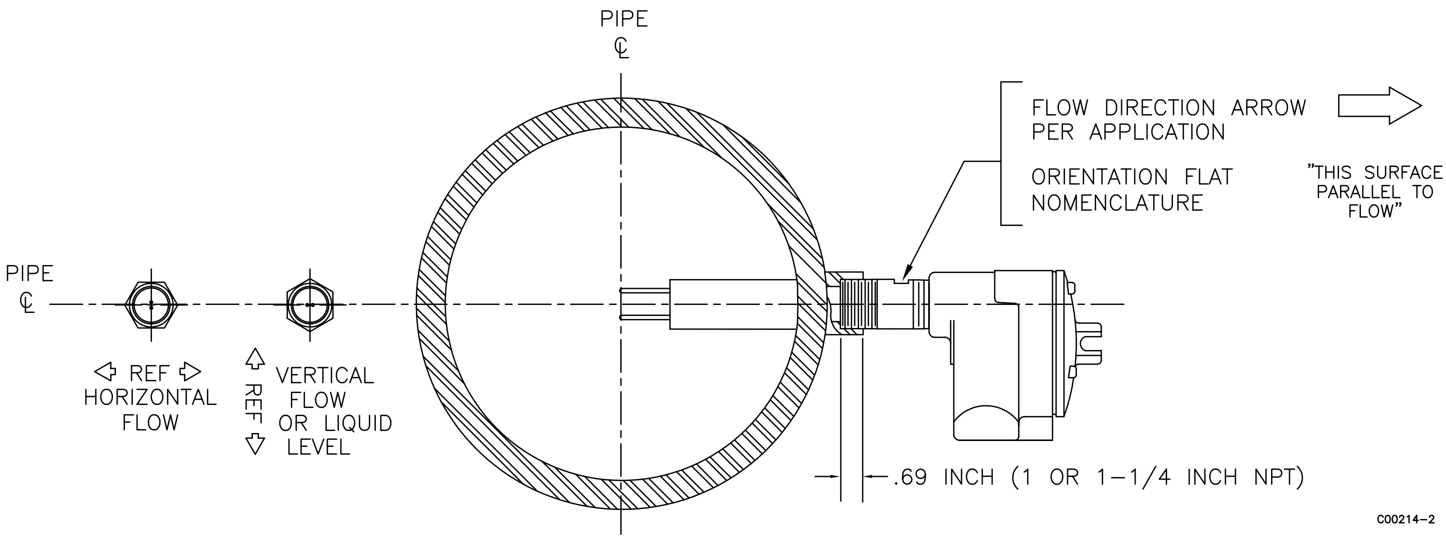


Figure 2-1 NPT Pipe Thread Mount

### 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 Figure 2-2.

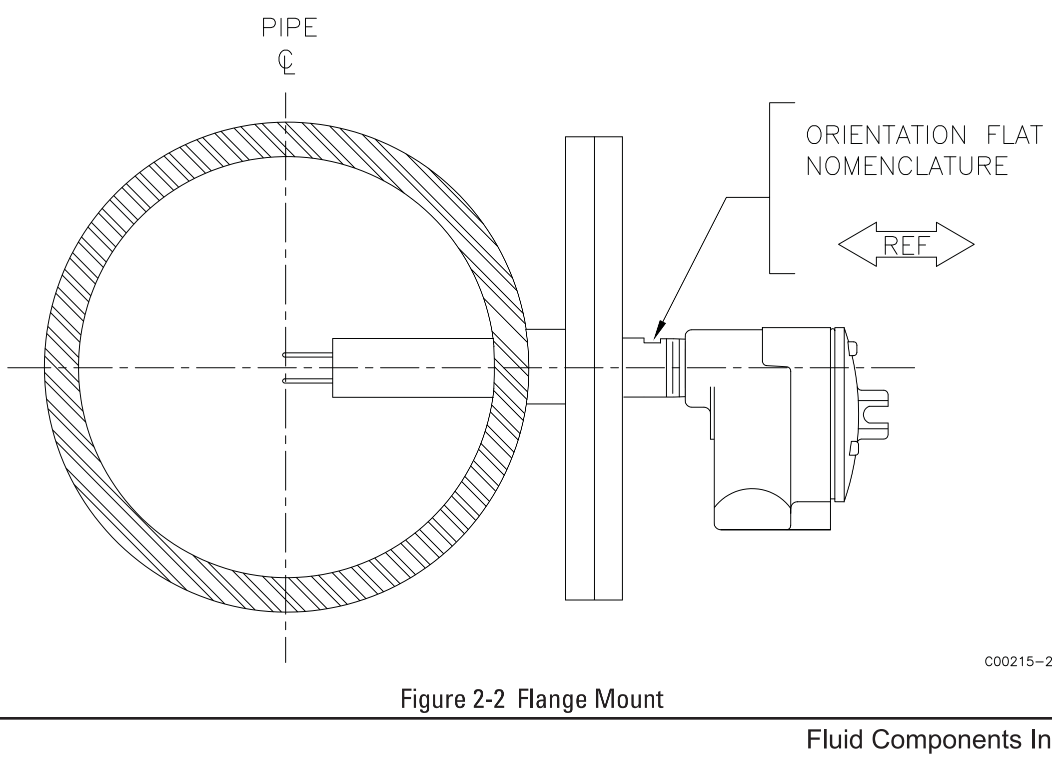


Figure 2-2 Flange Mount

### Packing Gland Assembly

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.

### In-line NPT Assembly (FLT93-L)

The body length of the in-line assembly should be verified to be sure the assembly will fit into the process line. The direction of flow is important for proper operation. There is a flow direction arrow on the in-line pipe that is to point in the direction of flow. See Figure 2-3 for the correct orientation.

If the instrument is a butt weld assembly, be sure to do the following: Remove the circuit board, properly ground the flow element before welding, GTAW is highly recommended.

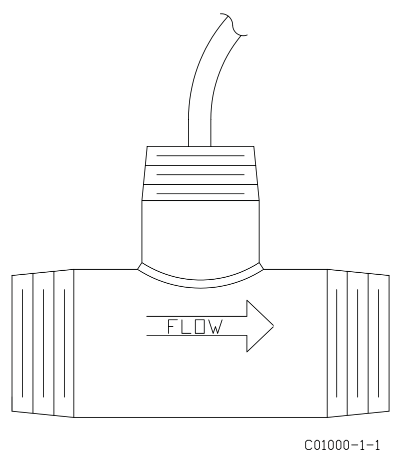


Figure 2-3 FLT93-L In-Line Flow Element

### Install and Wire the Enclosure(s)

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

Pulling wires can cause damage to the control circuit. Therefore, remove the control circuit from the enclosure and use extreme care when pulling wires into the enclosure.

Mount and wire the control circuit either locally or remotely (option) by following the local or remote enclosure procedure below.

### Minimum Wire Size

Table 2-1 shows the smallest (maximum AWG number) copper wire that is used in the electrical cables. Use a lower gauge of wire for less of a voltage drop. Contact FCI concerning greater distances than those listed in the table. The sensing element cable must be shielded. If the cable is spliced the shield wire must be continued through the splice. If a terminal block is used, the shield must have its own terminal.

### Enclosures Covers

All enclosure covers must be in place and securely closed to achieve environmental and safety classifications.

All circular thread-on covers should be tightened about 1/3-turn past hand tight.

Cover locks must be in place and secure if required by a particular approval.

Note: Nitrile (buna-N) O-rings are standard on the circular thread covers;n these O-rings have a 250°F (121°C) maximum useage temperature.

A Viton O-ring [400°F (204°C) max. temp.] is available for the thread-on covers; these O-rings have a 500°F (260°C) maximum useage temperature.

To receive a Viton O-ring, provide FCI with the following information:

- Shipping address
- Quantity required
- Desired P/N:
  Use P/N 000391-01 for the single conduit port enclosure (Local)

### Cable and Conduit Entry Devices

The cable and conduit entry devices and blanking elements shall be of a certified flameproof type EEx d, suitable for the conditions of use and correctly installed. With the use of conduit entries a ceiling device shall be provided immediately on the entrance of the device.

All cable glands and conduit fittings, includign conduit plugs, must meet or exceed the area approval where the unit is being installed.

| Connection | Maximum Distance for AWG | | | | | |
|---|---|---|---|---|---|---|
| | 10 ft. (3m) | 50 ft (15m) | 100 ft. (31m) | 250 ft. (76m) | 500 ft. (152m) | 1000 ft. (305m) |
| AC/DC Power | 22 | 22 | 22 | 20 | 18 | 16 |
| Relay (6A) | 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. | | | | | | |

Table 2-1 Maximum AWG Number

### Wiring the Local Enclosure

This procedure is for instruments with the control circuit located in the sensing element enclosure.

1. Remove the control circuit from its socket. Do not remove the control circuit socket. Removal of the control circuit socket may cause damage to the instrument.
2. Install conduit between the local enclosure and the power source and monitoring circuit. Provide watertight hardware and apply thread sealant to all connections to prevent water damage.

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

3. When connecting the relay wiring, do so with complete understanding of what the process requires of the instrument. The instrument has dual SPDT or single DPDT relay output contacts dependent on the jumper configuration for each alarm switch point. For the relay logic, refer to Figure 2-5. Also refer to Table 3-5 and Table 3-6 in Chapter 3 - Operation. Relay contacts are shown with the relays de-energized. Wire in accordance with the system requirements.

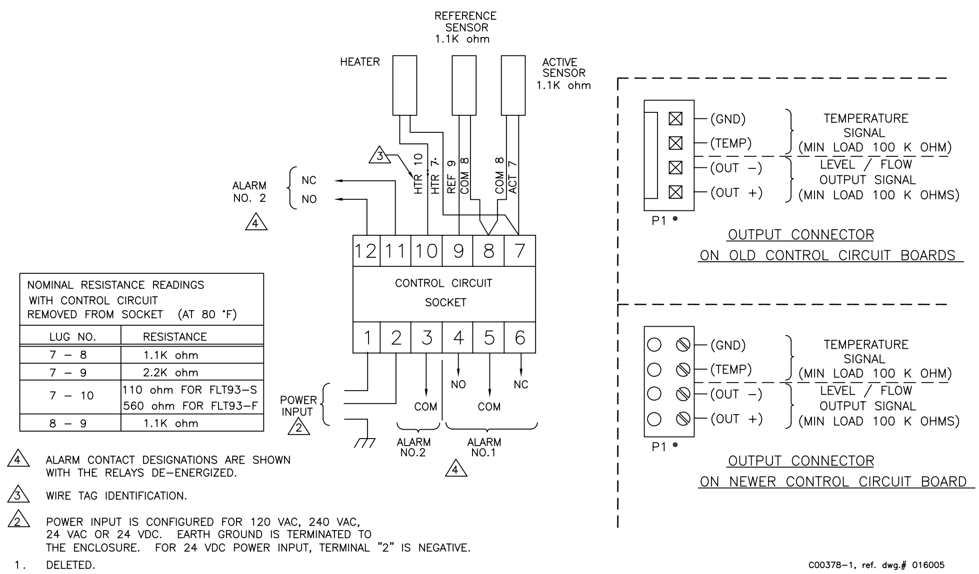


Figure 2-5 Local Wiring Diagram

### Wiring the Remote Enclosure

This procedure is for instruments with the control circuit located remotely from the sensing element.

### Locate the Remote Hardware Location

Select a location for the remote enclosure within a 1000 feet (305 m) of the sensing element. Pigtail sensing elements can not be located more than 10 feet (3 m) from the enclosure unless the pigtail is extended with the proper size cable listed in Table 2-1. If the cable is extended the cable connections should be located in a junction box with a 6 position terminal block. All 5 conductors and the shield must have its own termination. The remote enclosure should be easily accessible with enough room to open the enclosure cabinet cover at any time. Secure the remote enclosure solidly to a vertical surface capable of providing support. Use appropriate hardware to secure the enclosure.

1. Remove the control circuit from the remote enclosure.
2. Run a five-conductor, shielded cable from the local enclosure to the remote enclosure. Use Table 2-1 to determine which wire gauge to use.
3. Wire between the local and remote enclosures according to Figure 2-6.

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

4. When connecting the relay wiring, do so with complete understanding of what the process requires of the instrument. The instrument has dual SPDT or single DPDT relay output contacts dependent on the jumper configuration for each alarm switch point. For the relay logic, refer to Figure 2-6. Also refer to Table 3-5 and Table 3-6 in Chapter 3 - Operation. Relay contacts are shown with the relays de-energized. Wire in accordance with the system requirements.

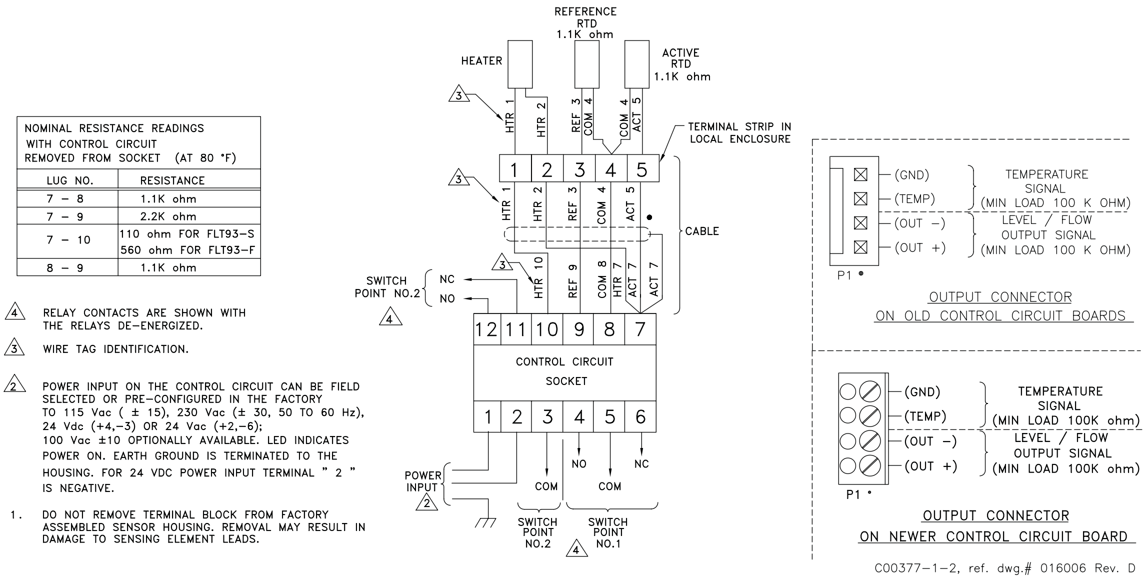


Figure 2-6 Remote Wiring Diagram

relay board is in the same enclosure as the control circuit. Both boards are mounted on the same panel and have been wired together at the factory. This configuration can be ordered without an enclosure which can be supplied by the customer.

The alarm connections are made at the auxiliary relay board where each alarm is driving a DPDT relay.

**Caution:** Do not connect any loads to the control circuit socket. Damage will occur to the control circuit if the alarm circuit is energized.

Be sure the correct relay board has been ordered for the correct output. See the following paragraph.

This configuration uses a control circuit that provides a switching voltage signal instead of relay contacts. The switch voltage is wired from the control circuit socket to the auxiliary relay board actuating the relays.

The auxiliary relay board has several relay options that can be ordered. The options are as follows:

- Dry to 2 amps at 115 Vac or 28Vdc, Dry to 1 amp at 230 Vac (relay is enclosed in a plastic sealed cover).
- 100mA to 10mA at 115 Vac or 28Vdc, 50mA to 3 amps at 230 Vac (relay is enclosed in a plastic sealed cover).
- Dry to 0.5 amps at 115 Vac, hermetically sealed relay.

Make sure that the proper relays have been selected for the intended load. See Appendix A for the auxiliary relay board configuration drawing.

When connecting the relay wiring, do so with complete understanding of what the process requires of the instrument. The instrument has dual DPDT or single 4PDT relay output contacts dependent on the jumper configuration for each alarm switch point. For the relay logic, refer to Figure 2-5. Also refer to Table 3-5 and Table 3-6 in Chapter 3 - Operation. Relay contacts are shown with the relays de-energized. Wire in accordance with the system requirements.

The control circuit can be ordered with switching voltage outputs without ordering a relay board. This can be used with customer supplied relays or any other device that has a differential input. The output voltage is 17 Vdc and will drive a load as low as 1500 ohms. Refer to Figure 2-7 for the output terminals.

### Wiring A Remote Control Circuit To An Auxiliary Relay Board

1. Run a four-conductor cable from the control circuit to the auxiliary relay board if the board was not factory installed. Use the wiring diagram in Figure 2-7 to wire the boards together.
2. Attach the customer wiring as desired using Figure 2-7 as a wiring guide.

Wiring for this configuration is the same as the sensing element wiring to the control circuit on a remote instrument.

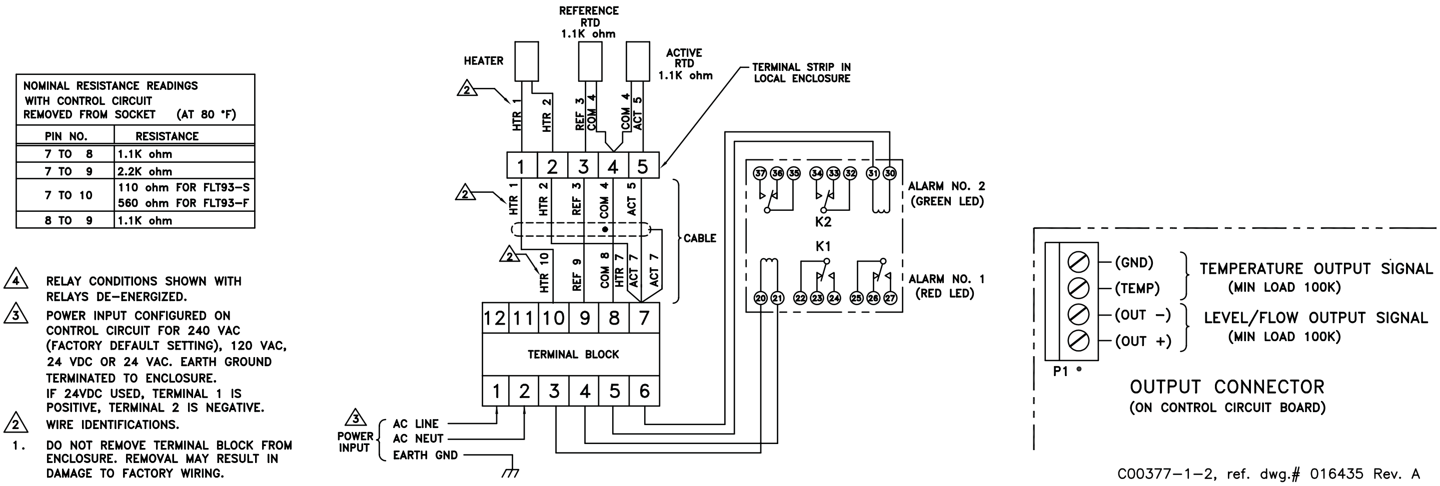


Figure 2-7 Auxilliary Relay Board Wiring Diagram

## Wiring Output Signal Terminals

Two output signals are provided on the control circuit at P1. The signal voltage at positions 1 and 2 represents the process change. The signal voltage at positions 3 and 4 is proportional to the temperature at the sensing element. See Figures 2-5 through 2-7. See also Chapter 3 for the physical layout of the control circuit.

⚠ Caution: Do not ground terminal 2 of P1. (Terminal 2 is the negative lead of the process signal.) This terminal is 9 volts above the control circuit ground. The peripheral using this signal must have a differential input.

These voltages can be used by other peripherals with a minimum load of 100K ohms. The terminal block can be wired with between gauge 26 and 18 wire (22 gauge wire is normally used). The maximum recommended length of wire is 1000 feet. Shielding is required on any length of cable. The shield must be terminated at position 4 on P1.

Early versions of the FLT93 require a connecting harness that was supplied with each instrument. The harness can be ordered if it is missing. The FCI part number is 015664-01. Newer versions of the FLT93 require a supplied terminal plug.

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# 3 OPERATION

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

## Factory Default Jumper Configuration

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

| Input Power | Factory Configured | |
|---|---|---|
| Heater Power | FLT93-S | 0.75 watts for air or liquid level applications. (J13) |
| | FLT93-F | 0.25 watts for air or liquid level applications. (J14) |
| Number of Alarms | Two (J23). Each alarm has one set of SPDT contacts | |
| Alarm No. 1 Red LED<br>Set Point Pot, R26 | Set to monitor flow or level signals (J20). Relay energized at flow or wet (J27) | |
| Alarm No. 2 Green LED<br>Set Point Pot, R25 | Set to monitor temperature signals (J19). Relay energized below temperature (J25).<br>Set point at approximately:<br>250 F (121 C) for standard temperature,<br>500 F (260 C) for medium temperature,<br>850 F (454 C) for high temperature (FLT93-S Only) | |

Table 3-1 Standard Jumper Defaul Configuration

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

If custom factory setup or calibration was not ordered, configure the control circuit using the jumper tables (Tables 3-2 to 3-6) and then follow the set point adjustment section that is appropriate for 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 5298 control circuit has a heater cutoff switch that limits the skin 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 (DT) 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 yellow power indicator LED (DS3) turns on and off with the heater for a visual indication of the heater state. The LED will alternate between on and off until the condition is corrected.

The reason for operating 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.

In some applications it is desirable to set the heater wattage high, even though the sensing element goes into the heater cutoff mode. An example is when the instrument is used to detect the interface of two liquids. These liquids may have viscosities that will have signals very close to each other. In order to have the maximum signal difference between the signals the heater wattage is set to its maximum. If the sensing element detects a dry condition the control circuit will indicate a heater cutoff condition. The sensing element will not be dammaged if it is left dry with the maximum heater wattage. The alarms can be set so one alarm will switch at the interface and one alarm can detect when the element goes dry.

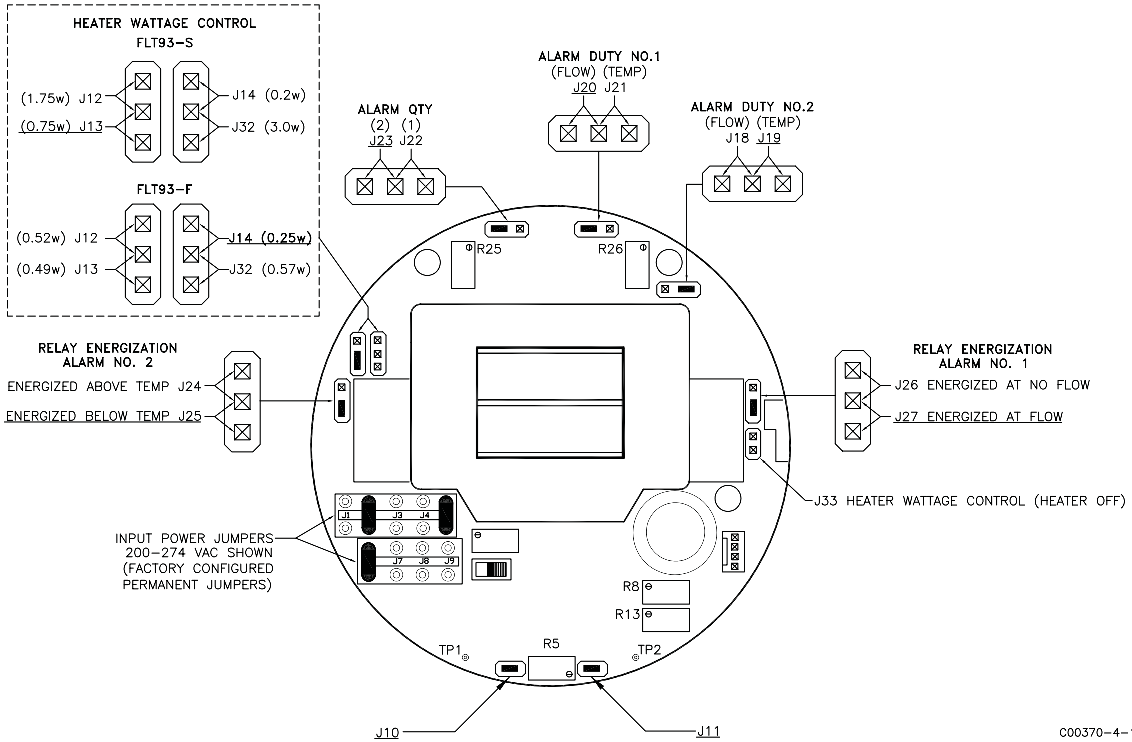


Figure 3-1 5298 Control Circuit Jumper Locations

## Alarm Set Point Adjustments

### Numerical Adjustment Versus Adjustment by Observation

An alarm set point is established using either numerical adjustment or adjustment by observation. The adjustment by observation requires the customer to establish normal process operation and adjust the alarm 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 adjustment by observation requires less time to establish the alarm set point. The numerical adjustment requires control of the process as well as additional time to establish the alarm set point. Use the adjustment procedure that is the most appropriate for the application requirement.

| Jumper | Power Select - Factory Installed | | | |
|---|---|---|---|---|
| | 100-130 VAC | 200-260VAC | 18-26VAC | 21-30VDC |
| J1 | IN | OUT | OUT | OUT |
| J2 | OUT | IN | OUT | OUT |
| J3 | IN | OUT | OUT | OUT |
| J4 | OUT | OUT | IN | OUT |
| J5 | IN | IN | OUT | OUT |
| J6 | OUT | IN | IN | IN |
| J7 | OUT | OUT | OUT | IN |
| J8 | OUT | OUT | OUT | IN |
| J9 | OUT | OUT | IN | OUT |

Table 3-2 Input Power

| Jumper | J32 | J12 | J13 | J14 | J33 |
|---|---|---|---|---|---|
| FLT93-F ELEMENT WATTAGE (560 OHM HTR) | 0.57 WATTS | 0.52 WATTS | 0.49 WATTS | 0.20 WATTS | OFF |
| FLT93-S ELEMENT WATTAGE (110 OHM HTR) | 3 WATTS | 1.75 WATTS | 0.75 WATTS | 0.27 WATTS | OFF |

Table 3-3A Selectable Heater Wattage Control
J13 is standard for FLT93-S and J14 is standard for FLT93-F

| Jumper | J13 | J14 | J33 |
|---|---|---|---|
| FLT93-F ELEMENT WATTAGE (560 OHM HTR) | N.A. | 0.20 WATTS | OFF |
| FLT93-S ELEMENT WATTAGE (110 OHM HTR) | 0.75 WATTS | N.A. | OFF |

Table 3-3B Fixed Heater Wattage Control

| | FLOW/LEVEL | TEMP |
|---|---|---|
| ALARM NO. 1 | J20 | J21 |
| ALARM NO. 2 | J18 | J19 |

Table 3-4 Application

| Jumper | ALARM NO. 1 |
|---|---|
| J27 | RELAY DE-ENERGIZED WITH LOW FLOW, LOW LEVEL (DRY) OR HIGH TEMPERATURE. |
| J26 | RELAY DE-ENERGIZED WITH HIGH FLOW, HIGH LEVEL (WET) OR LOW TEMPERATURE. |
| **Jumper** | **ALARM NO. 2** |
| J25 | RELAY DE-ENERGIZED WITH LOW FLOW, LOW LEVEL (DRY) OR HIGH TEMPERATURE. |
| J24 | RELAY DE-ENERGIZED WITH HIGH FLOW, HIGH LEVEL (WET) OR LOW TEMPERATURE. |

Table 3-5 Relay Energization

| | |
|---|---|
| J23 | DUAL SPDT (ONE RELAY PER ALARM) |
| J22 | SINGLE DPDT (DISABLES ALARM NO. 2) |

Table 3-6 Relay Contact Configuration

## Numerical Alarm Set Point Adjustment

The control circuit has two mutually exclusive alarms; they are identified as Alarm No. 1 and Alarm No. 2. Each has an alarm 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. Use Figure 3-2 to help locate the important setup components (potentiometers, LEDs, etc.)

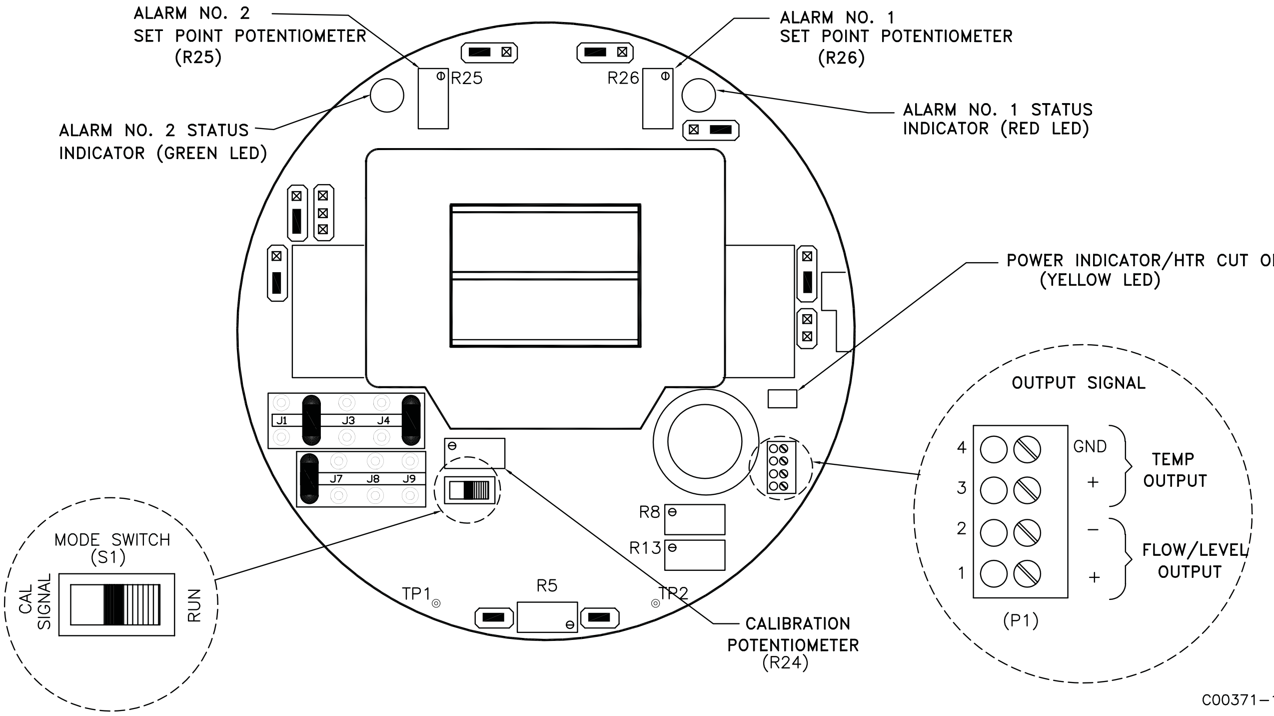


Figure 3-2 5298 Control Circuit Component Locations

### Air/Gas Flow Applications

1. Remove the instrument's enclosure cover.
2. Ensure the configuration jumpers on the control circuit are correct for this application. See Tables 3-3 through 3-6.
3. Check to make sure the input power jumpers match the power to be applied to the instrument. See Table 3-2.
4. Apply power to the instrument. Verify the yellow LED is on and allow the instrument fifteen minutes to warm-up.
5. Verify the mode switch is in the RUN position.
6. Attach a DC voltmeter to the P1 terminal block with the positive (+) lead to position one and the negative (-) lead to position two.

Note: The terminal block can be unplugged from the control circuit to facilitate easy connections.

7. Establish the normal process flow condition and allow the signal to stabilize.

   Note: The output signal at connector P1 will vary inversely with changes in the process flow rate. The output signal level is relative to the type of process media being measured and the heater wattage setting. See Figure 3-3.
8. Record the normal flow signal value.

   Normal Flow Signal = _________ volts DC
9. Follow either the Detecting Decreasing Flow or the Detecting Increasing Flow procedure for each flow application alarm.

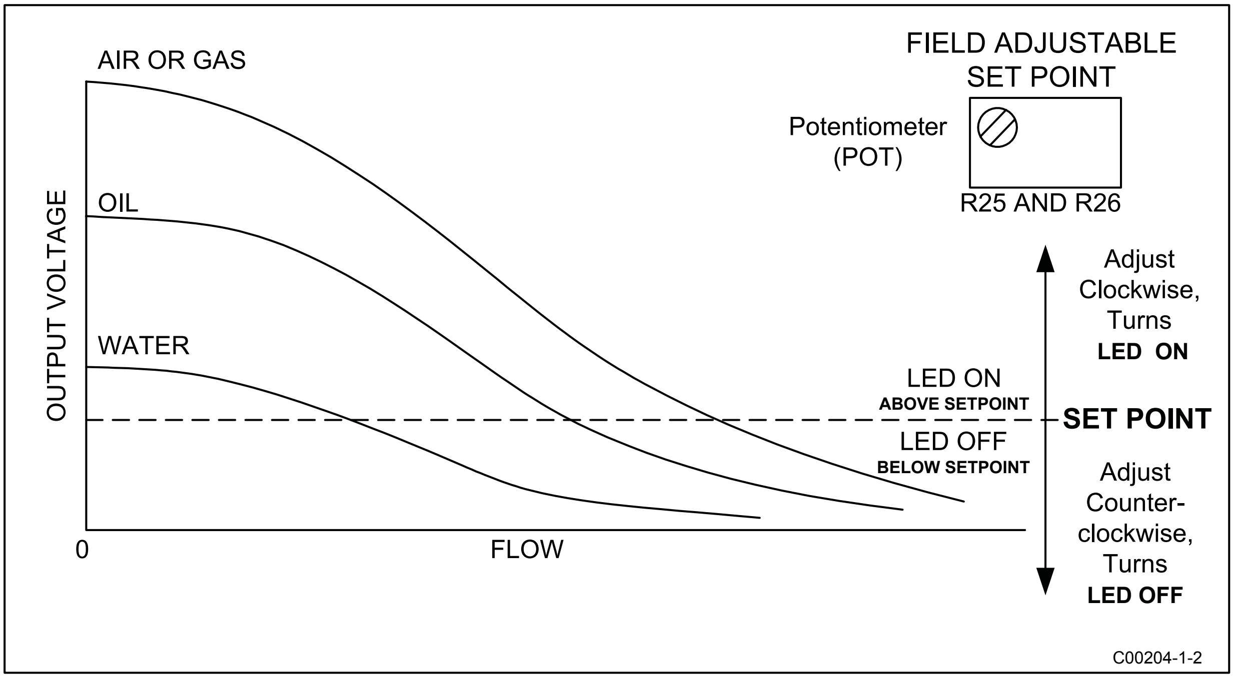


Figure 3-3 Flow Application Signal Output

Detecting Decreasing Flow (low flow alarm)

1. Stop the process flow and allow the signal to stabilize.
2. Record the no-flow signal. (The no-flow signal should be greater than the normal flow signal.)

   No-Flow Signal = _________ volts DC
3. Determine the set point by calculating the average 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.)
4. 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.

5. Slide the mode switch to the CALIBRATE position.
6. Adjust the calibrate potentiometer (R24) until the voltmeter equals the calculated set point.
7. For the appropriate alarm, determine whether the status LED is on or off (red for No. 1 or green for No. 2).
   If the LED is off, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No.2) slowly clockwise just until the LED turns on.

   OR

   If the LED is on, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.
8. If this is the only flow application alarm to be setup, then skip to the Continue With the Air/Gas Flow Procedure.

Detecting Increasing Flow (high flow alarm)

1. Establish the excessive process flow condition and allow the signal to stabilize.
2. Record the high flow signal. (The high flow signal should be less than the normal flow signal.)

   High Flow Signal = _________ volts DC
3. Determine the set point by calculating the average 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.)

4. 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.

5. Slide the mode switch to the CALIBRATE position.
6. Adjust the calibrate potentiometer (R24) until the voltmeter equals the calculated set point.
7. For the appropriate alarm, determine whether the status LED is on or off (red for No. 1 or green for No. 2).
   If the LED is on, turn the set point adjustment potentiometer ( R26 for alarm No. 1 or R25 for alarm No. 2) slowly counterclockwise just until the LED turns off.

   OR

   If the LED is off, turn the set point adjustment potentiometer ( R26 for alarm No. 1 or R25 for alarm No. 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

Continue With the Air/Gas Flow Procedure

1. Slide the mode switch to the RUN position.
2. 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.
3. Establish the process alarm condition and monitor the voltmeter display.
4. 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 change state.
5. Reestablish the normal process flow condition. Both the LED and the relay contacts should reset.
6. Disconnect the voltmeter from P1.
7. Replace the enclosure cover.

Note: The alarm can be set for a specific flow rate. Follow the Air/Gas Flow Application procedure up 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 4 in Detecting Decreasing Flow or Detecting Increasing Flow, respectfully. Enter the specific flow rate value as the set point. Then follow the Continue With the Air / Gas Flow Procedure steps.

The relay logic default configuration is set for the relay coil to be de-energized when the flow signal voltage 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.) A recommendation is to have the relay coils energized when the process condition is normal. This will enable the alarm to close or open the contacts in case of a power failure.

**Wet/Dry Liquid Level Applications**

1. Remove the instrument’s enclosure cover.
2. Ensure the configuration jumpers on the control circuit are correct for this application. See Tables 3-3 through 3-6.
3. Check to make sure the input power jumpers match the power to be applied to the instrument. See Table 3-2.
4. Apply power to the instrument. Verify the yellow LED is on and allow the instrument fifteen minutes to warm-up.
5. Verify the mode switch is in the RUN position.
6. Attach a DC voltmeter to P1 with the positive (+) lead to position one and the negative (-) lead to position two.

Note: The terminal block can be unplugged from the control circuit to facilitate easy connections.

7. Raise the process fluid level so the sensing element is wet.
8. Allow the output signal to stabilize and record the wet condition value.

   Wet Condition Signal = _________ volts DC

Note: The output signal at P1 is relative to the type of process media detected. See Figure 3-4.

9. Lower the process fluid level so the sensing element is dry.
10. 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
11. Determine the set point by calculating the average 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.)
12. Record this value.

    Calculated Set Point = _________ volts DC

Note: The calculated set point must be at least 0.015 volts greater than the wet signal and 0.020 volts less than the dry signal to ensure that the alarm will reset.

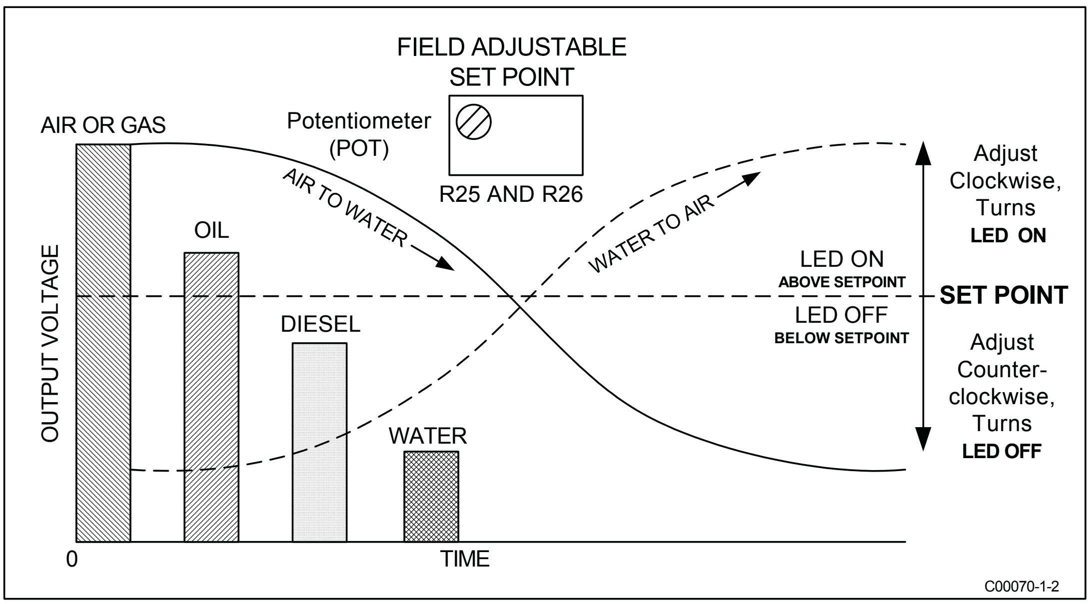


Figure 3-4 Level Application Signal Output

13. Slide the mode switch to the CALIBRATE position.
14. Adjust the calibrate potentiometer (R24) until the voltmeter equals the calculated set point.
15. For the appropriate alarm, determine whether the status LED is on or off (red for No. 1 or green for No. 2).
16. Follow either the Detecting Dry Condition or the Detecting Wet Condition for each level application alarm.

Detecting Dry Condition (low level alarm)

If the status LED is off, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) slowly clockwise just until the LED turns on.

OR

If the status LED is on, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.

Detecting Wet Condition (high level alarm)

If the status LED is on, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) slowly counterclockwise just until the LED turns off.

OR

If the status LED is off, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

17. 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.
18. 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 change state.
19. Reestablish the normal level condition. Both the LED and relay contacts should reset.
20. Disconnect the voltmeter from P1.
21. Replace the enclosure cover.

✎ 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.) A recommendation is to have the relay coils energized when the process condition is normal. This will enable the alarm to close or open the contacts in case of a power failure.

**Liquid Flow Applications**

1. Remove the instrument's enclosure cover.
2. Check to make sure the input power jumpers match the power to be applied to the instrument. See Table 3-2.
3. As necessary, set the following control circuit configuration jumpers. See Tables 3-3 through 3-6.
   Application: J20 or J18 (Flow/Level) for alarm No. 1 or No. 2, respectively.
   Heater Power: J32 (3 watts for FLT93-S or 0.57 watts for FLT93-F).
4. Apply power to the instrument. Verify the yellow LED is on. Allow the instrument fifteen minutes to warm-up.
5. Verify the mode switch is in the RUN position.
6. Attach a DC voltmeter to P1 connector with the positive (+) lead to position one and the negative (-) lead to position two.

✎ Note: The terminal block can be unplugged from the control circuit to facilitate easy connections.

The output signal at connector P1 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.

7. Establish the normal process flow condition and allow the signal to stabilize.
8. Record the normal flow signal value.

   Normal Flow Signal = _________ volts DC
9. Follow either the Detecting Decreasing Flow or Detecting Increasing Flow procedure for each Liquid flow application alarm.

Detecting Decreasing Flow (low flow alarm)

1. Stop the process flow and allow the signal to stabilize.
2. Record the no-flow signal. (The no-flow signal should be greater than the normal flow signal.)

   No-Flow Signal = _________ volts DC
3. Determine the set point by calculating the average 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.)
4. 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.

5. Slide the mode switch to the CALIBRATE position.
6. Adjust the calibrate potentiometer (R24) until the voltmeter equals the calculated set point.
7. For the appropriate alarm, determine whether the status LED is on or off (red for No. 1 or green for No. 2).

   If the LED is off, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) slowly clockwise just until the LED turns on.

   OR

   If the LED is on, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.
8. If this is the only flow application alarm to be setup, then skip to Continue With the Liquid Flow Applications procedure.

<u>Detecting Increasing Flow Rate (high flow alarm)</u>

1. Establish the excessive flow condition and allow the signal to stabilize.
2. Record the high flow signal. (The high flow signal should be less than the normal flow signal.)

   High Flow Signal = _________ volts DC
3. Determine the set point by calculating the average 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.)
4. 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.

5. Slide the mode switch to the CALIBRATE position.
6. Adjust the calibrate potentiometer (R24) until the voltmeter equals the calculated set point.
7. For the appropriate alarm, determine whether the status LED is on or off (red for No. 1 or green for No. 2).
8. If the LED is on, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) slowly counterclockwise just until the LED turns off.

   OR

   If the LED is off, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

<u>Continue With the Liquid Flow Applications</u>

1. Slide the mode switch to the RUN position.
2. 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.
3. Establish the process alarm condition and monitor the voltmeter display.

   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 change state.
4. Reestablish the normal process flow condition. Both the LED and the relay contacts should reset.
5. Disconnect the voltmeter from P1.
6. Replace the enclosure cover.

Note: The alarm can be set for a specific flow rate. Follow the Air/Gas Flow Application procedure up 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 4 in Detecting Decreasing Flow or Detecting Increasing Flow, respectfully. Enter the specific flow rate value as the set point. Then follow the Continue With the Air / Gas Flow Procedure steps.

The relay logic default configuration is set for the relay coil to be de-energized when the flow signal voltage 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.) A recommendation is to have the relay coils energized when the process condition is normal. This will enable the alarm to close or open the contacts in case of a power failure.

## Adjustment by Observation

Note: The control circuit has two mutually exclusive alarms; they are identified as Alarm No. 1 and Alarm No. 2 and each has a set point adjustment potentiometer and LED indicator. Each alarm 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 RUN position. Use Figure 3-2 to help locate the adjustment potentiometers and LEDs.

### 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. Apply power to the instrument and allow fifteen minutes for the sensing element to become active and stabilize.
3. Flow the pipeline at the normal or expected rate. Remove the enclosure cover to allow access to the control circuit to make adjustments.

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 hysteresis, 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 hysteresis, therefore, if the mark is overshot, the procedure should be repeated.

Signal Output for Flow Applications

The output signal at connector P1 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. Apply power to the instrument and allow fifteen minutes for the sensing element to become active and stabilize.
3. Remove the enclosure cover to allow access to the control circuit to make adjustments.

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 hystereses, therefore, if the mark is overshot, the procedure should be repeated.

Detecting Wet Condition (adjustment with sensing element dry)

Caution: Give consideration to the fact that air or gas flowing over the sensing element may decrease the output signal resulting in a false alarm. If the sensing element is exposed to air or gas flow in the dry condition, or where the process media is highly viscous, make set point adjustments 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 1 turn past the point at which the LED just goes on. The potentiometer may have up to one-quarter turn of hysteresis, therefore, if the mark is overshot, the procedure should be repeated.

Signal Output for Level Applications

The output signal at P1 is lowest in water and highest in air. See Figure 3-4.

**Temperature Applications**

For temperature versus voltage values, see Table 3-7 located at the rear of this chapter. These values have an accuracy of ±5°F (2.78°C). There is also a conversion formula later in this chapter to convert the temperature output voltage to degrees fahrenheit. 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.

Note: It is reccommended not to use the instrument for a dual flow and temperature application in air or gas unless the flow rate is greater than 1.0 SFPS. (The instrument may be used for a dual flow and temperature application in liquids at any flow rate.)

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 in still air.

Turn the heater off for temperature only applications. To turn off the heater remove the heater control jumper from the heater, control header. The jumper may be stored on the control circuit by plugging it across J12 and J14. Placing the jumper here will not turn on the heater.

1. Remove the instrument's enclosure cover.
2. Ensure the configuration jumpers on the control circuit are correct for this application. See Tables 3-3 through 3-6.
3. Check to make sure the input power jumpers match the power to be applied to the instrument. See Table 3-2.
4. Apply power to the instrument. Verify the yellow LED is on. Allow the instrument fifteen minutes to warm-up.
5. Verify the mode switch is in the RUN position.
6. Attach a DC voltmeter to P1 with the positive (+) lead to position 3 and the negative (-) lead to position 4.

Note: The terminal block can be unplugged from the control circuit to facilitate easy connections.

7. Establish the normal process temperature condition and allow the signal to stabilize.
8. Record the normal temperature signal value.

   Normal Temperature Signal = _________ volts DC

Note: The output signal at connector P1 will vary proportionally with the process temperature.

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

Detecting Increasing Temperature (high temperature alarm)

1. Slide the mode switch to the CALIBRATE position.
2. Adjust the calibrate potentiometer (R24) until the voltmeter equals the desired temperature signal in Table 3-7.
3. For the appropriate alarm, determine whether the status LED is on or off (red for No. 1 or green for No. 2).

   If the LED is off, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) slowly clockwise just until the LED turns on.

OR

   If the LED is on, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) counterclockwise until the LED turns off and then slowly clockwise just until the LED turns on.

If this is the only temperature application alarm to be setup, then skip to the Continue With the Temperature Application procedure.

Detecting Decreasing Temperature (low temperature alarm)

1. Slide the mode switch to the CALIBRATE position.
2. Adjust the calibrate potentiometer (R24) until the voltmeter equals the normal temperature signal.
3. For the appropriate alarm, determine whether the status LED is on or off (red for No. 1 or green for No. 2).

   If the LED is on, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) slowly counterclockwise just until the LED turns off.

OR

   If the LED is off, turn the set point adjustment potentiometer (R26 for alarm No. 1 or R25 for alarm No. 2) clockwise until the LED turns on and then slowly counterclockwise just until the LED turns off.

Continue With the Temperature Applications

1. Slide the mode switch to the RUN position.
2. Establish the normal process temperature condition. For the high temperature alarm setups, the status LED should be off at normal temperatures. For the low temperature alarm setups, the status LED should be on at normal temperatures.
3. Establish the process alarm condition and monitor the voltmeter display.
4. 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 change state.
5. Reestablish the normal process temperature condition. The LED and relay contacts should reset.
6. Disconnect the voltmeter from P1.
7. Replace the enclosure cover.

✎ 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.)

**Converting Temp Out Voltage to Temperature in Degrees F or Degrees C**

This formula is useful when monitoring the temperature output voltage with a data acquisition system where the formula can be used in the program.

Use the following formula to determine what the temperature is in degrees Fahrenheit, if the FLT temperature output voltage is known.

$$y = a + b(x / .0002) + c(x / 0.002)^2$$

Where:

y = Temperature in Degrees F

x = FLT Temperature Output Voltage

a = -409.3253

b = 0.42224

c = .00001904

Use the following equation to convert the temperature from degrees Fahrenheit to Celsius:

$$C = (F - 32) \times 5/9$$

| 0.00385 OHMS/OHMS/°C 1000 OHM PLATINUM SENSORS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93 | | | | | | | | | | | |
| Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C |
| 1.400 | -104 | -76 | 1.600 | -59 | -51 | 1.800 | -14 | -25 | 2.000 | 32 | 0 |
| 1.405 | -103 | -75 | 1.605 | -58 | -50 | 1.805 | -13 | -25 | 2.005 | 33 | 1 |
| 1.410 | -102 | -75 | 1.610 | -57 | -49 | 1.810 | -12 | -24 | 2.010 | 34 | 1 |
| 1.415 | -101 | -74 | 1.615 | -56 | -49 | 1.815 | -10 | -24 | 2.015 | 35 | 2 |
| 1.420 | -100 | -73 | 1.620 | -55 | -48 | 1.820 | -9 | -23 | 2.020 | 37 | 3 |
| 1.425 | -99 | -73 | 1.625 | -54 | -48 | 1.825 | -8 | -22 | 2.025 | 38 | 3 |
| 1.430 | -98 | -72 | 1.630 | -53 | -47 | 1.830 | -7 | -22 | 2.030 | 39 | 4 |
| 1.435 | -97 | -71 | 1.635 | -51 | -46 | 1.835 | -6 | -21 | 2.035 | 40 | 4 |
| 1.440 | -95 | -71 | 1.640 | -50 | -46 | 1.840 | -5 | -20 | 2.040 | 41 | 5 |
| 1.445 | -94 | -70 | 1.645 | -49 | -45 | 1.845 | -4 | -20 | 2.045 | 42 | 6 |
| 1.450 | -93 | -70 | 1.650 | -48 | -44 | 1.850 | -2 | -19 | 2.050 | 43 | 6 |
| 1.455 | -92 | -69 | 1.655 | -47 | -44 | 1.855 | -1 | -19 | 2.055 | 45 | 7 |
| 1.460 | -91 | -68 | 1.660 | -46 | -43 | 1.860 | 0 | -18 | 2.060 | 46 | 8 |
| 1.465 | -90 | -68 | 1.665 | -45 | -43 | 1.865 | 1 | -17 | 2.065 | 47 | 8 |
| 1.470 | -89 | -67 | 1.670 | -43 | -42 | 1.870 | 2 | -17 | 2.070 | 48 | 9 |
| 1.475 | -88 | -66 | 1.675 | -42 | -41 | 1.875 | 3 | -16 | 2.075 | 49 | 10 |
| 1.480 | -86 | -66 | 1.680 | -41 | -41 | 1.880 | 4 | -15 | 2.080 | 50 | 10 |
| 1.485 | -85 | -65 | 1.685 | -40 | -40 | 1.885 | 6 | -15 | 2.085 | 52 | 11 |
| 1.490 | -84 | -65 | 1.690 | -39 | -39 | 1.890 | 7 | -14 | 2.090 | 53 | 12 |
| 1.495 | -83 | -64 | 1.695 | -38 | -39 | 1.895 | 8 | -13 | 2.095 | 54 | 12 |
| 1.500 | -82 | -63 | 1.700 | -37 | -38 | 1.900 | 9 | -13 | 2.100 | 55 | 13 |
| 1.505 | -81 | -63 | 1.705 | -36 | -38 | 1.905 | 10 | -12 | 2.105 | 56 | 13 |
| 1.510 | -80 | -62 | 1.710 | -34 | -37 | 1.910 | 11 | -12 | 2.110 | 57 | 14 |
| 1.515 | -79 | -61 | 1.715 | -33 | -36 | 1.915 | 12 | -11 | 2.115 | 58 | 15 |
| 1.520 | -77 | -61 | 1.720 | -32 | -36 | 1.920 | 14 | -10 | 2.120 | 60 | 15 |
| 1.525 | -76 | -60 | 1.725 | -31 | -35 | 1.925 | 15 | -10 | 2.125 | 61 | 16 |
| 1.530 | -75 | -60 | 1.730 | -30 | -34 | 1.930 | 16 | -9 | 2.130 | 62 | 17 |
| 1.535 | -74 | -59 | 1.735 | -29 | -34 | 1.935 | 17 | -8 | 2.135 | 63 | 17 |
| 1.540 | -73 | -58 | 1.740 | -28 | -33 | 1.940 | 18 | -8 | 2.140 | 64 | 18 |
| 1.545 | -72 | -58 | 1.745 | -26 | -32 | 1.945 | 19 | -7 | 2.145 | 65 | 19 |
| 1.550 | -71 | -57 | 1.750 | -25 | -32 | 1.950 | 20 | -6 | 2.150 | 67 | 19 |
| 1.555 | -70 | -56 | 1.755 | -24 | -31 | 1.955 | 22 | -6 | 2.155 | 68 | 20 |
| 1.560 | -68 | -56 | 1.760 | -23 | -31 | 1.960 | 23 | -5 | 2.160 | 69 | 20 |
| 1.565 | -67 | -55 | 1.765 | -22 | -30 | 1.965 | 24 | -5 | 2.165 | 70 | 21 |
| 1.570 | -66 | -55 | 1.770 | -21 | -29 | 1.970 | 25 | -4 | 2.170 | 71 | 22 |
| 1.575 | -65 | -54 | 1.775 | -20 | -29 | 1.975 | 26 | -3 | 2.175 | 72 | 22 |
| 1.580 | -64 | -53 | 1.780 | -18 | -28 | 1.980 | 27 | -3 | 2.180 | 74 | 23 |
| 1.585 | -63 | -53 | 1.785 | -17 | -27 | 1.985 | 28 | -2 | 2.185 | 75 | 24 |
| 1.590 | -62 | -52 | 1.790 | -16 | -27 | 1.990 | 30 | -1 | 2.190 | 76 | 24 |
| 1.595 | -60 | -51 | 1.795 | -15 | -26 | 1.995 | 31 | -1 | 2.195 | 77 | 25 |

Table 3-7. Temperature versus Voltage Output - Page 1

| 0.00385 OHMS/OHMS/°C 1000 OHM PLATINUM SENSORS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93 | | | | | | | | | | | |
| Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C |
| 2.200 | 78 | 26 | 2.400 | 125 | 52 | 2.600 | 172 | 78 | 2.800 | 219 | 104 |
| 2.205 | 79 | 26 | 2.405 | 126 | 52 | 2.605 | 173 | 78 | 2.805 | 220 | 105 |
| 2.210 | 80 | 27 | 2.410 | 127 | 53 | 2.610 | 174 | 79 | 2.810 | 221 | 105 |
| 2.215 | 82 | 28 | 2.415 | 128 | 53 | 2.615 | 175 | 80 | 2.815 | 223 | 106 |
| 2.220 | 83 | 28 | 2.420 | 129 | 54 | 2.620 | 176 | 80 | 2.820 | 224 | 107 |
| 2.225 | 84 | 29 | 2.425 | 131 | 55 | 2.625 | 178 | 81 | 2.825 | 225 | 107 |
| 2.230 | 85 | 30 | 2.430 | 132 | 55 | 2.630 | 179 | 82 | 2.830 | 226 | 108 |
| 2.235 | 86 | 30 | 2.435 | 133 | 56 | 2.635 | 180 | 82 | 2.835 | 227 | 109 |
| 2.240 | 87 | 31 | 2.440 | 134 | 57 | 2.640 | 181 | 83 | 2.840 | 229 | 109 |
| 2.245 | 89 | 31 | 2.445 | 135 | 57 | 2.645 | 182 | 84 | 2.845 | 230 | 110 |
| 2.250 | 90 | 32 | 2.450 | 136 | 58 | 2.650 | 184 | 84 | 2.850 | 231 | 111 |
| 2.255 | 91 | 33 | 2.455 | 138 | 59 | 2.655 | 185 | 85 | 2.855 | 232 | 111 |
| 2.260 | 92 | 33 | 2.460 | 139 | 59 | 2.660 | 186 | 86 | 2.860 | 233 | 112 |
| 2.265 | 93 | 34 | 2.465 | 140 | 60 | 2.665 | 187 | 86 | 2.865 | 235 | 113 |
| 2.270 | 94 | 35 | 2.470 | 141 | 61 | 2.670 | 188 | 87 | 2.870 | 236 | 113 |
| 2.275 | 96 | 35 | 2.475 | 142 | 61 | 2.675 | 189 | 87 | 2.875 | 237 | 114 |
| 2.280 | 97 | 36 | 2.480 | 144 | 62 | 2.680 | 191 | 88 | 2.880 | 238 | 115 |
| 2.285 | 98 | 37 | 2.485 | 145 | 63 | 2.685 | 192 | 89 | 2.885 | 239 | 115 |
| 2.290 | 99 | 37 | 2.490 | 146 | 63 | 2.690 | 193 | 89 | 2.890 | 241 | 116 |
| 2.295 | 100 | 38 | 2.495 | 147 | 64 | 2.695 | 194 | 90 | 2.895 | 242 | 117 |
| 2.300 | 101 | 39 | 2.500 | 148 | 65 | 2.700 | 195 | 91 | 2.900 | 243 | 117 |
| 2.305 | 103 | 39 | 2.505 | 149 | 65 | 2.705 | 197 | 91 | 2.905 | 244 | 118 |
| 2.310 | 104 | 40 | 2.510 | 151 | 66 | 2.710 | 198 | 92 | 2.910 | 245 | 119 |
| 2.315 | 105 | 41 | 2.515 | 152 | 67 | 2.715 | 199 | 93 | 2.915 | 247 | 119 |
| 2.320 | 106 | 41 | 2.520 | 153 | 67 | 2.720 | 200 | 93 | 2.920 | 248 | 120 |
| 2.325 | 107 | 42 | 2.525 | 154 | 68 | 2.725 | 201 | 94 | 2.925 | 249 | 121 |
| 2.330 | 108 | 42 | 2.530 | 155 | 68 | 2.730 | 202 | 95 | 2.930 | 250 | 121 |
| 2.335 | 110 | 43 | 2.535 | 156 | 69 | 2.735 | 204 | 95 | 2.935 | 251 | 122 |
| 2.340 | 111 | 44 | 2.540 | 158 | 70 | 2.740 | 205 | 96 | 2.940 | 253 | 123 |
| 2.345 | 112 | 44 | 2.545 | 159 | 70 | 2.745 | 206 | 97 | 2.945 | 254 | 123 |
| 2.350 | 113 | 45 | 2.550 | 160 | 71 | 2.750 | 207 | 97 | 2.950 | 255 | 124 |
| 2.355 | 114 | 46 | 2.555 | 161 | 72 | 2.755 | 208 | 98 | 2.955 | 256 | 124 |
| 2.360 | 115 | 46 | 2.560 | 162 | 72 | 2.760 | 210 | 99 | 2.960 | 257 | 125 |
| 2.365 | 117 | 47 | 2.565 | 164 | 73 | 2.765 | 211 | 99 | 2.965 | 258 | 126 |
| 2.370 | 118 | 48 | 2.570 | 165 | 74 | 2.770 | 212 | 100 | 2.970 | 260 | 126 |
| 2.375 | 119 | 48 | 2.575 | 166 | 74 | 2.775 | 213 | 101 | 2.975 | 261 | 127 |
| 2.380 | 120 | 49 | 2.580 | 167 | 75 | 2.780 | 214 | 101 | 2.980 | 262 | 128 |
| 2.385 | 121 | 50 | 2.585 | 168 | 76 | 2.785 | 216 | 102 | 2.985 | 263 | 128 |
| 2.390 | 122 | 50 | 2.590 | 169 | 76 | 2.790 | 217 | 103 | 2.990 | 264 | 129 |
| 2.395 | 124 | 51 | 2.595 | 171 | 77 | 2.795 | 218 | 103 | 2.995 | 266 | 130 |

Table 3-7. Temperature versus Voltage Output - Page 2

| 0.00385 OHMS/OHMS/ºC 1000 OHM PLATINUM SENSORS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93 | | | | | | | | | | | |
| Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C |
| 3.000 | 267 | 130 | 3.200 | 315 | 157 | 3.400 | 363 | 184 | 3.600 | 412 | 211 |
| 3.005 | 268 | 131 | 3.205 | 316 | 158 | 3.405 | 365 | 185 | 3.605 | 414 | 212 |
| 3.010 | 269 | 132 | 3.210 | 317 | 159 | 3.410 | 366 | 186 | 3.610 | 415 | 213 |
| 3.015 | 270 | 132 | 3.215 | 319 | 159 | 3.415 | 367 | 186 | 3.615 | 416 | 213 |
| 3.020 | 272 | 133 | 3.220 | 320 | 160 | 3.420 | 368 | 187 | 3.620 | 417 | 214 |
| 3.025 | 273 | 134 | 3.225 | 321 | 161 | 3.425 | 370 | 188 | 3.625 | 419 | 215 |
| 3.030 | 274 | 134 | 3.230 | 322 | 161 | 3.430 | 371 | 188 | 3.630 | 420 | 215 |
| 3.035 | 275 | 135 | 3.235 | 323 | 162 | 3.435 | 372 | 189 | 3.635 | 421 | 216 |
| 3.040 | 276 | 136 | 3.240 | 325 | 163 | 3.440 | 373 | 190 | 3.640 | 422 | 217 |
| 3.045 | 278 | 136 | 3.245 | 326 | 163 | 3.445 | 374 | 190 | 3.645 | 423 | 217 |
| 3.050 | 279 | 137 | 3.250 | 327 | 164 | 3.450 | 376 | 191 | 3.650 | 425 | 218 |
| 3.055 | 280 | 138 | 3.255 | 328 | 165 | 3.455 | 377 | 192 | 3.655 | 426 | 219 |
| 3.060 | 281 | 138 | 3.260 | 330 | 165 | 3.460 | 378 | 192 | 3.660 | 427 | 220 |
| 3.065 | 282 | 139 | 3.265 | 331 | 166 | 3.465 | 379 | 193 | 3.665 | 428 | 220 |
| 3.070 | 284 | 140 | 3.270 | 332 | 167 | 3.470 | 381 | 194 | 3.670 | 430 | 221 |
| 3.075 | 285 | 140 | 3.275 | 333 | 167 | 3.475 | 382 | 194 | 3.675 | 431 | 222 |
| 3.080 | 286 | 141 | 3.280 | 334 | 168 | 3.480 | 383 | 195 | 3.680 | 432 | 222 |
| 3.085 | 287 | 142 | 3.285 | 336 | 169 | 3.485 | 384 | 196 | 3.685 | 433 | 223 |
| 3.090 | 288 | 142 | 3.290 | 337 | 169 | 3.490 | 385 | 196 | 3.690 | 435 | 224 |
| 3.095 | 290 | 143 | 3.295 | 338 | 170 | 3.495 | 387 | 197 | 3.695 | 436 | 224 |
| 3.100 | 291 | 144 | 3.300 | 339 | 171 | 3.500 | 388 | 198 | 3.700 | 437 | 225 |
| 3.105 | 292 | 144 | 3.305 | 340 | 171 | 3.505 | 389 | 198 | 3.705 | 438 | 226 |
| 3.110 | 293 | 145 | 3.310 | 342 | 172 | 3.510 | 390 | 199 | 3.710 | 439 | 226 |
| 3.115 | 294 | 146 | 3.315 | 343 | 173 | 3.515 | 392 | 200 | 3.715 | 441 | 227 |
| 3.120 | 296 | 146 | 3.320 | 344 | 173 | 3.520 | 393 | 200 | 3.720 | 442 | 228 |
| 3.125 | 297 | 147 | 3.325 | 345 | 174 | 3.525 | 394 | 201 | 3.725 | 443 | 228 |
| 3.130 | 298 | 148 | 3.330 | 346 | 175 | 3.530 | 395 | 202 | 3.730 | 444 | 229 |
| 3.135 | 299 | 149 | 3.335 | 348 | 175 | 3.535 | 396 | 202 | 3.735 | 446 | 230 |
| 3.140 | 301 | 149 | 3.340 | 349 | 176 | 3.540 | 398 | 203 | 3.740 | 447 | 230 |
| 3.145 | 302 | 150 | 3.345 | 350 | 177 | 3.545 | 399 | 204 | 3.745 | 448 | 231 |
| 3.150 | 303 | 151 | 3.350 | 351 | 177 | 3.550 | 400 | 205 | 3.750 | 449 | 232 |
| 3.155 | 304 | 151 | 3.355 | 353 | 178 | 3.555 | 401 | 205 | 3.755 | 451 | 233 |
| 3.160 | 305 | 152 | 3.360 | 354 | 179 | 3.560 | 403 | 206 | 3.760 | 452 | 233 |
| 3.165 | 307 | 153 | 3.365 | 355 | 179 | 3.565 | 404 | 207 | 3.765 | 453 | 234 |
| 3.170 | 308 | 153 | 3.370 | 356 | 180 | 3.570 | 405 | 207 | 3.770 | 454 | 235 |
| 3.175 | 309 | 154 | 3.375 | 357 | 181 | 3.575 | 406 | 208 | 3.775 | 455 | 235 |
| 3.180 | 310 | 155 | 3.380 | 359 | 181 | 3.580 | 407 | 209 | 3.780 | 457 | 236 |
| 3.185 | 311 | 155 | 3.385 | 360 | 182 | 3.585 | 409 | 209 | 3.785 | 458 | 237 |
| 3.190 | 313 | 156 | 3.390 | 361 | 183 | 3.590 | 410 | 210 | 3.790 | 459 | 237 |
| 3.195 | 314 | 157 | 3.395 | 362 | 183 | 3.595 | 411 | 211 | 3.795 | 460 | 238 |

Table 3-7. Temperature versus Voltage Output - Page 3

| 0.00385 OHMS/OHMS/°C 1000 OHM PLATINUM SENSORS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93 | | | | | | | | | | | |
| Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C |
| 3.800 | 462 | 239 | 4.000 | 511 | 266 | 4.200 | 561 | 294 | 4.400 | 612 | 322 |
| 3.805 | 463 | 239 | 4.005 | 513 | 267 | 4.205 | 563 | 295 | 4.405 | 613 | 323 |
| 3.810 | 464 | 240 | 4.010 | 514 | 268 | 4.210 | 564 | 295 | 4.410 | 614 | 323 |
| 3.815 | 465 | 241 | 4.015 | 515 | 268 | 4.215 | 565 | 296 | 4.415 | 616 | 324 |
| 3.820 | 467 | 241 | 4.020 | 516 | 269 | 4.220 | 566 | 297 | 4.420 | 617 | 325 |
| 3.825 | 468 | 242 | 4.025 | 518 | 270 | 4.225 | 568 | 298 | 4.425 | 618 | 326 |
| 3.830 | 469 | 243 | 4.030 | 519 | 270 | 4.230 | 569 | 298 | 4.430 | 619 | 326 |
| 3.835 | 470 | 244 | 4.035 | 520 | 271 | 4.235 | 570 | 299 | 4.435 | 621 | 327 |
| 3.840 | 472 | 244 | 4.040 | 521 | 272 | 4.240 | 571 | 300 | 4.440 | 622 | 328 |
| 3.845 | 473 | 245 | 4.045 | 523 | 273 | 4.245 | 573 | 300 | 4.445 | 623 | 328 |
| 3.850 | 474 | 246 | 4.050 | 524 | 273 | 4.250 | 574 | 301 | 4.450 | 624 | 329 |
| 3.855 | 475 | 246 | 4.055 | 525 | 274 | 4.255 | 575 | 302 | 4.455 | 626 | 330 |
| 3.860 | 477 | 247 | 4.060 | 526 | 275 | 4.260 | 576 | 302 | 4.460 | 627 | 331 |
| 3.865 | 478 | 248 | 4.065 | 528 | 275 | 4.265 | 578 | 303 | 4.465 | 628 | 331 |
| 3.870 | 479 | 248 | 4.070 | 529 | 276 | 4.270 | 579 | 304 | 4.470 | 629 | 332 |
| 3.875 | 480 | 249 | 4.075 | 530 | 277 | 4.275 | 580 | 305 | 4.475 | 631 | 333 |
| 3.880 | 481 | 250 | 4.080 | 531 | 277 | 4.280 | 581 | 305 | 4.480 | 632 | 333 |
| 3.885 | 483 | 250 | 4.085 | 533 | 278 | 4.285 | 583 | 306 | 4.485 | 633 | 334 |
| 3.890 | 484 | 251 | 4.090 | 534 | 279 | 4.290 | 584 | 307 | 4.490 | 635 | 335 |
| 3.895 | 485 | 252 | 4.095 | 535 | 279 | 4.295 | 585 | 307 | 4.495 | 636 | 335 |
| 3.900 | 486 | 252 | 4.100 | 536 | 280 | 4.300 | 586 | 308 | 4.500 | 637 | 336 |
| 3.905 | 488 | 253 | 4.105 | 538 | 281 | 4.305 | 588 | 309 | 4.505 | 638 | 337 |
| 3.910 | 489 | 254 | 4.110 | 539 | 282 | 4.310 | 589 | 309 | 4.510 | 640 | 338 |
| 3.915 | 490 | 255 | 4.115 | 540 | 282 | 4.315 | 590 | 310 | 4.515 | 641 | 338 |
| 3.920 | 491 | 255 | 4.120 | 541 | 283 | 4.320 | 592 | 311 | 4.520 | 642 | 339 |
| 3.925 | 493 | 256 | 4.125 | 543 | 284 | 4.325 | 593 | 312 | 4.525 | 643 | 340 |
| 3.930 | 494 | 257 | 4.130 | 544 | 284 | 4.330 | 594 | 312 | 4.530 | 645 | 340 |
| 3.935 | 495 | 257 | 4.135 | 545 | 285 | 4.335 | 595 | 313 | 4.535 | 646 | 341 |
| 3.940 | 496 | 258 | 4.140 | 546 | 286 | 4.340 | 597 | 314 | 4.540 | 647 | 342 |
| 3.945 | 498 | 259 | 4.145 | 548 | 286 | 4.345 | 598 | 314 | 4.545 | 649 | 343 |
| 3.950 | 499 | 259 | 4.150 | 549 | 287 | 4.350 | 599 | 315 | 4.550 | 650 | 343 |
| 3.955 | 500 | 260 | 4.155 | 550 | 288 | 4.355 | 600 | 316 | 4.555 | 651 | 344 |
| 3.960 | 501 | 261 | 4.160 | 551 | 288 | 4.360 | 602 | 316 | 4.560 | 652 | 345 |
| 3.965 | 503 | 261 | 4.165 | 553 | 289 | 4.365 | 603 | 317 | 4.565 | 654 | 345 |
| 3.970 | 504 | 262 | 4.170 | 554 | 290 | 4.370 | 604 | 318 | 4.570 | 655 | 346 |
| 3.975 | 505 | 263 | 4.175 | 555 | 291 | 4.375 | 605 | 319 | 4.575 | 656 | 347 |
| 3.980 | 506 | 264 | 4.180 | 556 | 291 | 4.380 | 607 | 319 | 4.580 | 657 | 347 |
| 3.985 | 508 | 264 | 4.185 | 558 | 292 | 4.385 | 608 | 320 | 4.585 | 659 | 348 |
| 3.990 | 509 | 265 | 4.190 | 559 | 293 | 4.390 | 609 | 321 | 4.590 | 660 | 349 |
| 3.995 | 510 | 266 | 4.195 | 560 | 293 | 4.395 | 610 | 321 | 4.595 | 661 | 350 |

Table 3-7. Temperature versus Voltage Output - Page 4

| 0.00385 OHMS/OHMS/°C 1000 OHM PLATINUM SENSORS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMPERATURE VERSUS VOLTAGE OUTPUT, FLT93 | | | | | | | | | | | |
| Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C | Temp Output Voltage | °F | °C |
| 4.600 | 663 | 350 | 4.800 | 714 | 379 | 5.000 | 765 | 407 | 5.200 | 817 | 436 |
| 4.605 | 664 | 351 | 4.805 | 715 | 379 | 5.005 | 767 | 408 | 5.205 | 818 | 437 |
| 4.610 | 665 | 352 | 4.810 | 716 | 380 | 5.010 | 768 | 409 | 5.210 | 820 | 438 |
| 4.615 | 666 | 352 | 4.815 | 718 | 381 | 5.015 | 769 | 410 | 5.215 | 821 | 438 |
| 4.620 | 668 | 353 | 4.820 | 719 | 382 | 5.020 | 770 | 410 | 5.220 | 822 | 439 |
| 4.625 | 669 | 354 | 4.825 | 720 | 382 | 5.025 | 772 | 411 | 5.225 | 824 | 440 |
| 4.630 | 670 | 355 | 4.830 | 721 | 383 | 5.030 | 773 | 412 | 5.230 | 825 | 441 |
| 4.635 | 671 | 355 | 4.835 | 723 | 384 | 5.035 | 774 | 412 | 5.235 | 826 | 441 |
| 4.640 | 673 | 356 | 4.840 | 724 | 384 | 5.040 | 776 | 413 | 5.240 | 828 | 442 |
| 4.645 | 674 | 357 | 4.845 | 725 | 385 | 5.045 | 777 | 414 | 5.245 | 829 | 443 |
| 4.650 | 675 | 357 | 4.850 | 727 | 386 | 5.050 | 778 | 415 | 5.250 | 830 | 443 |
| 4.655 | 677 | 358 | 4.855 | 728 | 387 | 5.055 | 779 | 415 | 5.255 | 832 | 444 |
| 4.660 | 678 | 359 | 4.860 | 729 | 387 | 5.060 | 781 | 416 | 5.260 | 833 | 445 |
| 4.665 | 679 | 360 | 4.865 | 730 | 388 | 5.065 | 782 | 417 | 5.265 | 834 | 446 |
| 4.670 | 680 | 360 | 4.870 | 732 | 389 | 5.070 | 783 | 417 | 5.270 | 835 | 446 |
| 4.675 | 682 | 361 | 4.875 | 733 | 389 | 5.075 | 785 | 418 | 5.275 | 837 | 447 |
| 4.680 | 683 | 362 | 4.880 | 734 | 390 | 5.080 | 786 | 419 | 5.280 | 838 | 448 |
| 4.685 | 684 | 362 | 4.885 | 736 | 391 | 5.085 | 787 | 420 | 5.285 | 839 | 449 |
| 4.690 | 686 | 363 | 4.890 | 737 | 392 | 5.090 | 789 | 420 | 5.290 | 841 | 449 |
| 4.695 | 687 | 364 | 4.895 | 738 | 392 | 5.095 | 790 | 421 | 5.295 | 842 | 450 |
| 4.700 | 688 | 364 | 4.900 | 739 | 393 | 5.100 | 791 | 422 | 5.300 | 843 | 451 |
| 4.705 | 689 | 365 | 4.905 | 741 | 394 | 5.105 | 792 | 422 | 5.305 | 845 | 451 |
| 4.710 | 691 | 366 | 4.910 | 742 | 394 | 5.110 | 794 | 423 | 5.310 | 846 | 452 |
| 4.715 | 692 | 367 | 4.915 | 743 | 395 | 5.115 | 795 | 424 | 5.315 | 847 | 453 |
| 4.720 | 693 | 367 | 4.920 | 745 | 396 | 5.120 | 796 | 425 | 5.320 | 849 | 454 |
| 4.725 | 694 | 368 | 4.925 | 746 | 397 | 5.125 | 798 | 425 | 5.325 | 850 | 454 |
| 4.730 | 696 | 369 | 4.930 | 747 | 397 | 5.130 | 799 | 426 | 5.330 | 851 | 455 |
| 4.735 | 697 | 369 | 4.935 | 748 | 398 | 5.135 | 800 | 427 | 5.335 | 852 | 456 |
| 4.740 | 698 | 370 | 4.940 | 750 | 399 | 5.140 | 802 | 428 | 5.340 | 854 | 457 |
| 4.745 | 700 | 371 | 4.945 | 751 | 399 | 5.145 | 803 | 428 | 5.345 | 855 | 457 |
| 4.750 | 701 | 372 | 4.950 | 752 | 400 | 5.150 | 804 | 429 | 5.350 | 856 | 458 |
| 4.755 | 702 | 372 | 4.955 | 754 | 401 | 5.155 | 805 | 430 | 5.355 | 858 | 459 |
| 4.760 | 703 | 373 | 4.960 | 755 | 402 | 5.160 | 807 | 430 | 5.360 | 859 | 459 |
| 4.765 | 705 | 374 | 4.965 | 756 | 402 | 5.165 | 808 | 431 | 5.365 | 860 | 460 |
| 4.770 | 706 | 374 | 4.970 | 757 | 403 | 5.170 | 809 | 432 | 5.370 | 862 | 461 |
| 4.775 | 707 | 375 | 4.975 | 759 | 404 | 5.175 | 811 | 433 | 5.375 | 863 | 462 |
| 4.780 | 709 | 376 | 4.980 | 760 | 404 | 5.180 | 812 | 433 | 5.380 | 864 | 462 |
| 4.785 | 710 | 377 | 4.985 | 761 | 405 | 5.185 | 813 | 434 | 5.385 | 866 | 463 |
| 4.790 | 711 | 377 | 4.990 | 763 | 406 | 5.190 | 815 | 435 | 5.390 | 867 | 464 |
| 4.795 | 712 | 378 | 4.995 | 764 | 407 | 5.195 | 816 | 435 | 5.395 | 868 | 465 |

Table 3-7. Temperature versus Voltage Output - Page 5

## Fail Safe Alarm Setting

These procedures set the second relay to detect component failure (fail-safe).

### Low Flow Alarm Settings

For the low flow fail safe setup the following jumpers are to be installed: J18, J20, J23, J24, J27.

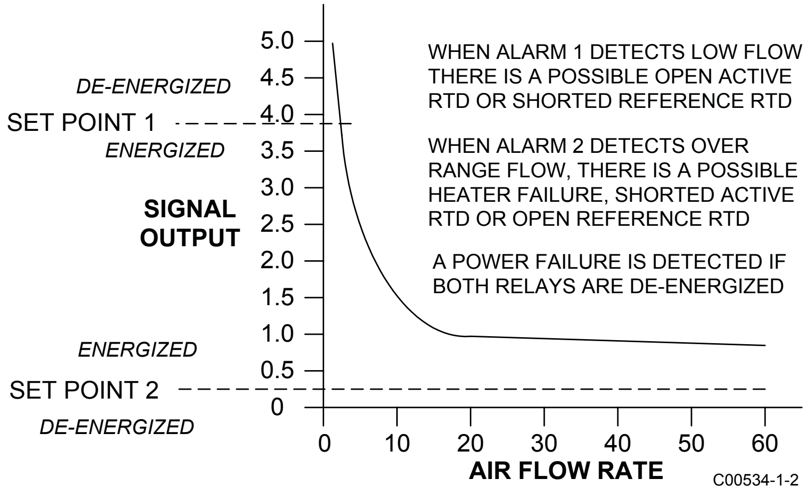


Figure 3-5. Low Flow Fail Safe Alarm

The following information is assumed:

Relay is de-energized in the ALARM condition.

Alarm 1 set point is adjusted for desired low flow alarm velocity or signal.

Alarm 2 set point is adjusted slightly below minimum signal output (over range flow).

### High Flow Alarm Settings

For the high flow fail safe setup the following jumpers are to be installed: J18, J20, J23, J25, J26.

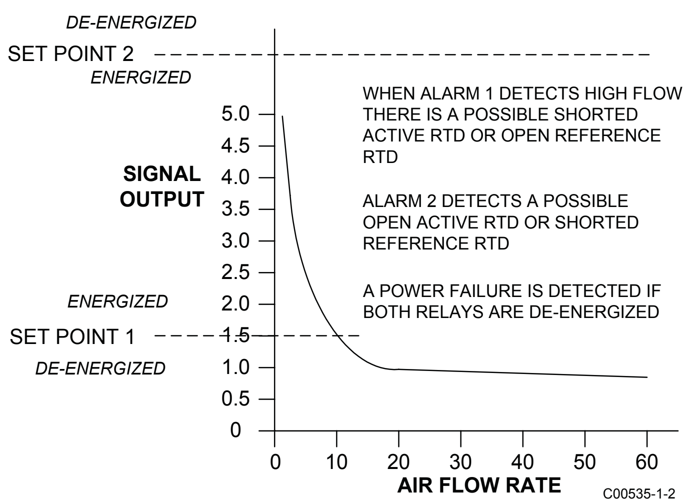


Figure 3-6. High Flow Fail Safe Alarm

The following information is assumed:

Relay is de-energized in the ALARM condition.

Alarm 1 set point is adjusted for desired high flow alarm velocity or signal.

Alarm 2 set point is adjusted above maximum signal output (under range flow not to exceed 7.0 volts).

**Low Level Alarm Settings (Sensing Element Normally Wet)**

For the low level fail safe setup the following jumpers are to be installed: J18, J20, J23, J24, J27.

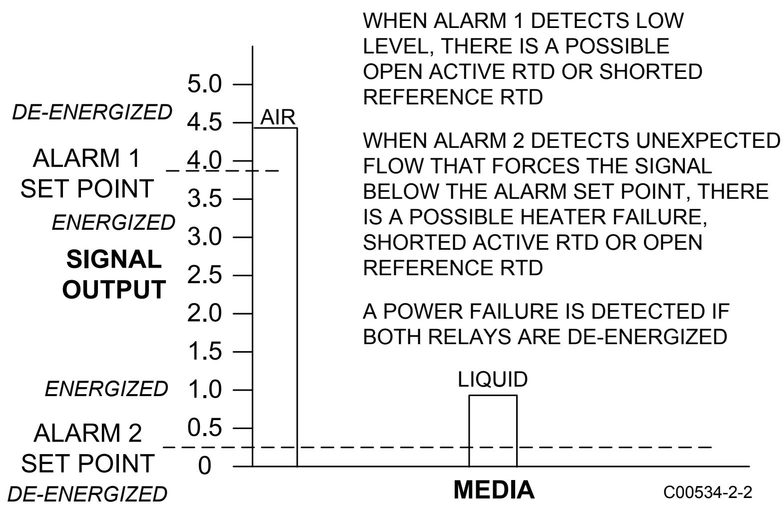


Figure 3-7. Low Level Fail Safe Alarm

The following information is assumed:

Relay is de-energized in the ALARM condition.

Alarm 1 set point is adjusted for the mean value between the air and liquid signals.

Alarm 2 set point is adjusted to approximately half of the liquid signal. (A lower setting might be needed if the liquid is moving.)

**High Level Alarm Settings (Sensing Element Normally Dry)**

For the high level fail safe setup the following jumpers are to be installed: J18, J20, J23, J25, J26.

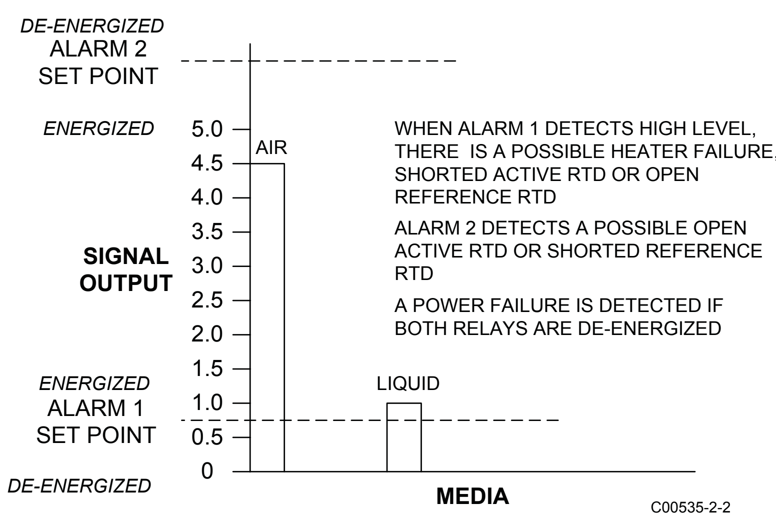


Figure 3-8. High Flow Fail Safe Alarm

The following information is assumed:

Relay is de-energized in the ALARM condition.

Alarm 1 set point is adjusted for the mean value between the air and liquid signals.

Alarm 2 set point is adjusted above maximum signal output for air (not to exceed 7.0 volts).

# 4 MAINTENANCE

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

Caution: The insturment contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control circuit. See Chapter 2, Operation, for ESD details.

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

## Maintenance

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

### Calibration

Periodically verify the calibration of the output and re-calibrate if necessary. See Chapter 3 for instructions.

### Electrical Connections

Periodically inspect cable connections on terminal strips and terminal blocks. Verify that terminal connections are tight and in good condition with no sign of corrosion.

### Remote Enclosure

Verify that the moisture barriers and seals protecting the electronics in the local and remote enclosures are adequate and that no moisture is entering those enclosures.

### Electrical Wiring

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

### Sensing Element Connections

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

### Sensing Element Assembly

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

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# 5 TROUBLESHOOTING

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

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

**Tools Needed**

Digital Multimeter (DMM)
Small standard screwdriver
Small phillips head screwdriver

**Quick Check**

- Verify that the control circuit is seated firmly.
- LED DS3 should be lit when power is applied and in most cases it should not be blinking.
- Ensure that the jumpers are in the correct position. See Chapter 3 for the correct positions. (The power is factory preset for 220 Vac, the customer may need to reset jumpers for other power input.)
- Ensure that the CALIBRATE - RUN switch is in the RUN position (switch S1 positioned toward the heat sink).
- If LED DS3 flashes the heater power is set to high for most applications.
- Check any customer supplied fuses.
- See the troubleshooting chart in Figure 5-1 at the end of this chapter.

**Non-maintenance Observations**

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

**Check Serial Numbers**

Verify that the serial number of the sensing element and the control circuit are the same number. The sensing element and the control circuit are a matched set and cannot be operated independently of each other. The exception to this is if a removal and replacement have been done for repair purposes. All calibrations and jumpers must have been done and set.

**Check Input Power**

Verify that the correct power source is turned on and connected. Verify that the power jumpers are correct for the application. See Chapter 3 for the correct positions.

**Check the Instrument Installation**

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

**Check for Moisture**

Check for moisture on the control circuit or in the sensor , or control circuit enclosure. Moisture on the control circuit may cause intermittent operation.

**Check Application Design Requirements**

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

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

If conditions and specifications are satisfactory, then refer to the troubleshooting chart in the back of this chapter for troubleshooting suggestions.

## Troubleshooting the Flow Element

Use Tables 5-1 and 5-2 to determine if the flow element is wired correctly or has failed. Turn off the input power to the instrument. Unplug the control circuit from its socket and measure the resistances below from the terminal block socket.

If the instrument is set up in remote configuration (flow element enclosure seperate from the control circuit enclosure), and the ohm readings are incorrect, disconnect the flow element cable at the local (flow element) enclosure. Measure the resistance as shown in Table 5-2. If the resistances are correct then the cable between the enclosures is probably bad or not connected properly (loose, corroded, or connected to the wrong terminals).

For normally dry conditions check for moisture on the sensing element. If a component of the process media is near its saturation temperature it may condense on the sensing element. Place the sensing element where the process media is well above the saturation temperature of any of the process gases.

| NOMINAL CONTROL CIRCUIT RESISTANCE | |
|---|---|
| LUG NUMBER | RESISTANCE |
| 7 TO 8 | 1.1 K OHM* |
| 7 TO 9 | 2.2 K OHM* |
| 7 TO 10 | 110-120 OHM FOR FLT93-S<br>548-620 OHM FOR FLT93-F |
| 8 TO 9 | 1.1 K OHM* |

Table 5-1. Resistance at Control Circuit Terminal Block Socket

| NOMINAL RESISTANCE AT LOCAL ENCLOSURE TERMINAL BLOCK | |
|---|---|
| TERMINAL NO. | RESISTANCE |
| 1 TO 2 | 110-120 OHM FOR FLT93-S<br>548-620 OHM FOR FLT93-F |
| 3 TO 4 | 1.1 K OHM* |
| 3 TO 5 | 2.2 K OHM* |
| 4 TO 5 | 1.1 K OHM* |
| SHIELD CONNECTED TO CONTROL CIRCUIT SOCKET ONLY. NO CONNECTION TO LOCAL ENCLOSURE OR ITS TERMINAL BLOCK** | |

Table 5-2. Resistance at Flow Element enclosure Terminal Block (Remote Applications Only)

* Approximate at 80°F process temperature.

** Reference wiring diagrams in the Installation section of the manual.

## Troubleshooting the Flow Transmitter

With power applied measure 9 volts DC ±2% (8 to 10 volts) from Plug P1 Pin 1 to Pin 4. See Figure 3-2 for the location of P1.

| | | |
|---|---|---|
| 1 | Is the Yellow LED ON, OFF or BLINKING | **LED ON**<br>Although the LED is on, it may appear dim. This is usually caused by the unit being supplied with 115 Vac and the Input Power Jumper Configuration set to the default setting of 230 Vac.<br>Check Input power and the input power jumper configuration:<br>OK: See Step 2.<br>NOT OK: Supply power will need to be changed to work with the control circuit or the control circuit must be returned to FCI for reconfiguration.<br><br>**LED OFF**<br>Check the Input Power Jumper Configuration setting and verify the input power.<br>OK: See Step 4<br>NOT OK: Supply power will need to be changed to work with the control circuit or the control circuit must be returned to FCI for reconfiguration. Reinstall the control circuit and restart the system and check for proper operation. If LED is still off go to Step 4.<br><br>**LED BLINKING**<br>For Liquid Flow Applications: Line is DRY. Make sure the line is packed.<br>For Gas Flow Applications: Heater power set too high. Set to lower value.<br>For Liquid level Applications: Heater power set too high. Set to lower value.<br>For Liquid Interface Applications: In some cases it is necessary to set the heater power to the maximum value to achieve the maximum signal difference between the two liquids. For this application it is normal for the LED to blink if the element goes dry. Go to Step 2. |
| 2 | Mode Switch | Make sure the mode switch is in the "RUN" position.<br>OK: See Step 3. |
| 3 | Signal Voltage Observation | Remove the Heater Wattage Control jumper. With a voltmeter measure the signal voltage at P1 Terminals 1 and 2.<br>**a) The voltage is 0 volts ± 25 mV: OK,**<br>Reinstall the jumper and wait 5 minutes. Go to c) or d) which ever is applicable.<br>**b) The voltage is out of tolerance: NOT OK,**<br>Make sure that the serial numbers on the control board and the sensing element match. If the serial numbers are OK then go to the "Restoring Temp Comp Adjustments" procedure in Appendix C then go to c) or d) which ever is applicable.<br>**c) The Voltage is between 0.1 and 6 volts and changes with flow or level changes:**<br>OK. See Step 9.<br>**d) The voltage is still about 0 volts: or the voltage is over ± 7 volts: or the voltage is negative, between -1 and -6 volts and changes with flow or level changes: Not OK,**<br>Sensing element may be miswired or is defective. Miswiring is more common on remote installations at the initial installation. See Step 6 for integral installation, Step 7 for remote installations. |
| 4 | Power Supply Check | Measure the voltage at P1 terminals 2 to 4.<br>**Voltage is 9 volts ± .2V: OK.** See Step 6 for integral installation, Step 7 for remote installations.<br>**NOT OK.** See Step 5. |

| | | |
|---|---|---|
| 5 | Fuse Check | Turn off the power to the FLT and remove the control circuit. With an ohmmeter, measure the continuity of the fuse F1.<br>**Fuse has no continuity: NOT OK** Replace the fuse and restart the system.<br>Check for proper operation. Call the factory if the fuse fails again.<br>**Fuse has continuity: OK** Control circuit is defective. Replace it with a control circuit that has the temp comp adjusted for the particular sensing element. Follow the "Restoring temperature compensation settings" procedure in Appendix C and restart the system. |
| 6 | Sensor Element Check for Integral Installation | Turn off the power and remove the control circuit. Follow the "Troubleshooting the Flow Element" procedure in this chapter.<br>**Sensor Failure:** Call the Factory<br>**Sensors are OK:** See Step 8. |
| 7 | Sensor Element Check for Remote Installation | Turn off the power and remove the control circuit. Follow the "Troubleshooting the Flow Element" procedure in this chapter.<br>**Remote cable miswired or damaged:** Repair and restart the system.<br>**Sensor Failure:** Call the Factory<br>**Sensors are OK:** See Step 8. |
| 8 | Sensor Balance and Temp Comp Settings Check | Turn off the power and remove the control circuit. Follow the procedure in Appendix C to check the temp comp settings and balance adjustment.<br>**Temp Comp Settings are Wrong:** Perform the "Restore Temp Comp" Procedure. Then perform the sensor Balancing procedure.<br>**Temp Comp Settings are OK:** Perform the Balancing procedure. Restart the system for proper operation. See Step 9. |
| 9 | Alarm Switch Point Settings | Make sure that the jumpers are set correctly. The related settings are the "Alarm Duty", "Alarm Quantity" and the "Energization". Refer to the charts in chapter 3 or the bottom of the control circuit.<br>Using the Mode Switch set to Cal, check and record the alarm settings. Compare these setting to the signals generated by the process and make adjustment if necessary. Refer to the Operation chapter for guidelines on setting a switch point in your particular application. |

Figure 5-1. Trouble Shooting Chart

### Spares

FCI recommends at least one control circuit to be kept as a spare. Depending on the number of units the customer has installed and if the switches are critical then an entire spare switch assembly should be kept on hand. The control circuit part number is 5298-A1A1A1B2. The dash number can be found on the control circuit, the enclosure and on the ordering paper work.

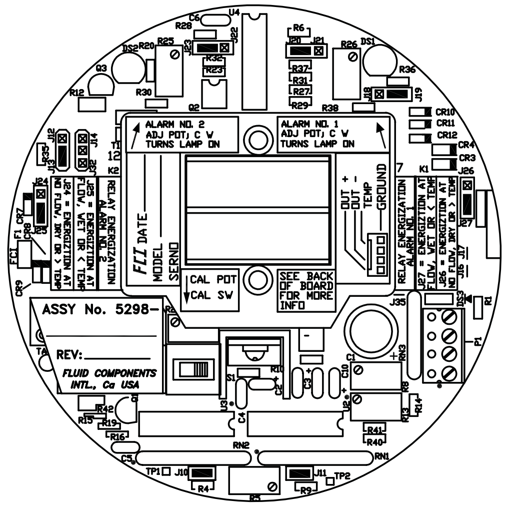
### Defective Parts

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

### Customer Service

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

# APPENDIX A DRAWINGS




⚠1 FIGURE 1
COMPONENT SIDE

5298– A 1 A 1 A 1 B 2

| PART NUMBER | INPUT POWER CONFIGURATION BLOCK ⚠3 | DES |
|---|---|---|
| 017494–01 | 120 VAC | A |
| 017495–01 | 240 VAC | B |
| 017496–01 | 24 VDC | C |
| 017497–01 | 24 VAC | D |
| 017498–01 | 100 VAC | E |
| 017499–01 | 200 VAC | F |

| PART NUMBER | RELAY CONTACT RATING CONFIGURATION BLOCK ⚠5 | DES |
|---|---|---|
| 015334–01 | STD: 6 AMP AT 120 VAC EPOXY SEALED | 1 |
| 015336–01 | EXTERNAL RELAYS 18 VDC SIGNAL OUTPUT ⚠4 | 2 |
| 017503–01 | 0.5 AMP AT 120 VAC HERMETICALLY SEALED | 3 |

| PART NUMBER | HEATER WATTAGE CONTROL | DES |
|---|---|---|
| 000456–01 | "S" ELEMENT: 3 WATTS "F" ELEMENT: 0.57 WATTS (J32) | A |
| 000456–01 | "S" ELEMENT: 1.75 WATTS "F" ELEMENT: 0.52 WATTS (J12) | B |
| 000456–01 | "S" ELEMENT: 0.75 WATTS "F" ELEMENT: 0.49 WATTS (J13) | C |
| 000456–01 | "S" ELEMENT: 0.21 WATTS "F" ELEMENT: 0.25 WATTS (J14) | D |
| 000456–01 | "S" ELEMENT: OFF "F" ELEMENT: OFF BETWEEN (J12 & J14) | E |

| DES | RELAY ENERGIZATION ALARM NO. 2 | PART NUMBER |
|---|---|---|
| 1 | ENERGIZED AT FLOW, WET OR BELOW TEMP (J25) | 000456–01 |
| 2 | ENERGIZED AT NO FLOW, DRY OR ABOVE TEMP (J24) | 000456–01 |

| DES | RELAY ENERGIZATION ALARM NO. 1 | PART NUMBER |
|---|---|---|
| A | ENERGIZED AT FLOW, WET OR BELOW TEMP (J27) | 000456–01 |
| B | ENERGIZED AT NO FLOW, DRY OR ABOVE TEMP (J26) | 000456–01 |

| DES | ALARM NO. 2 APPLICATION | PART NUMBER |
|---|---|---|
| 1 | FLOW / LEVEL (J18) | 000456–01 |
| 2 | TEMPERATURE (J19) | 000456–01 |

| DES | ALARM NO. 1 APPLICATION | PART NUMBER |
|---|---|---|
| A | FLOW / LEVEL (J20) | 000456–01 |
| B | TEMPERATURE (J21) | 000456–01 |

| DES | ALARM QUANTITY | PART NUMBER |
|---|---|---|
| 1 | TWO ALARMS (J23) | 000456–01 |
| 2 | ONE ALARM (J22) | 000456–01 |

C01009–1–1, ref dwg. 5298 Rev. A

⚠3 SUB ASSEMBLY 017500–01 INCLUDED AS PART OF THIS OPTION.

2 ALL PLUGABLE JUMPERS ARE SHOWN IN THE DEFAULT POSITIONS.
DEFAULT SETTINGS ARE AS FOLLOWS:
INPUT POWER = 240 VAC (J2, J5, J6)
HEATER WATTAGE CONTROL = 0.75 WATTS (J13) FOR THE FLT–S ELEMENT;
0.25 WATTS (J14) FOR THE F.R. ELEMENT.
ALARM NO. 1 SET TO MONITOR FLOW OR LEVEL SIGNAL (J20)
ALARM NO. 2 SET TO MONITOR TEMPERATURE SIGNAL (J19)
ALARM NO. 1 RELAY ENERGIZED AT FLOW OR WET (J27)
ALARM NO. 2 RELAY ENERGIZED AT BELOW TEMPERATURE (J25)
ALARM QUANTITY JUMPER SET FOR 2 EA (J23)

⚠1 SEE FIGURE ONE FOR CLARIFICATION OF THE REFERENCE DESIGNATOR LOCATIONS OF THE SUB LEVEL PARTS LISTS.

7 SCHEMATIC NO. 017551–01.

6 SEE THE OP SHEET FOR ASSEMBLY INSTRUCTIONS.

⚠5 RELAYS ARE RATED FOR RESISTIVE LOADS ONLY.

⚠4 FOR USE WITH A SEPARATELY MOUNTED RELAY ASSEMBLY (P/N 705649)
THE CONTROL CIRCUIT PROVIDES A SWITCHING VOLTAGE AT TERMINALS 3 & 4
FOR ALARM NO. 1 AND 5 & 6 FOR ALRAM NO. 2
THE RELAYS ASSEMBLY HAS 2 EA DPDT RELAY WITH A CHOICE OF RATINGS.
PLASTIC CASE 2 AMP AT 115 VAC OR 10 AMPS AT 115 VAC RESISTIVE.
HERMETICALLY SEALED RELAYS ARE 0.5 AMP AT 115 VAC.

PWB Module 5298 - Dual Alarm

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# 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 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. (Usually contains the control circuit and mounting socket.) |
| **Reference RTD** | The part of the sensing element that senses the process media temperature. |
| **Remote enclosure** | An optional protective enclosure for the control circuit. Used when the control circuit must be located away from the sensing element. |
| **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. |

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# APPENDIX C 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 (DT). For example; with constant temperature, flow rate, process media and heater power, the DT is reduced and reaches a stable value. If the process media temperature goes up and all other conditions stay the same, the DT 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 DT.

✎ 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 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 015664-01 for older version of the control circuit.
- 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.

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

### Procedure

1. Turn off the instrument power. Remove the control circuit form the socket.
2. Write down where the heater wattage control jumper is located in the area of the upper left hand side of the control circuit. Remove the heater wattage control jumper and set it aside. Refer to Figure 3-1 for the jumper location.
3. Remove jumpers J10 and J11 at the lower side of the control circuit and set them aside.
4. Connect the DMM from TP1 (by J10), to the left jumper post of J10. Set the DMM to ohms. See Figure 3-2 for component placement.
5. Adjust potentiometer R5 (bottom center of the control circuit) until the DMM reads the ohm value for R5 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 reconnect it between TP2 (by J11), and the right jumper post of J11. Figure 3-1 shows jumper post location.

7. Adjust pot R8 (below the yellow LED) until the ohm value for R8 is as shown on the Temp Comp Cal sheet.
8. Remove the DMM and reinstall jumpers J10 and J11. (Leave the heater jumper removed.)

Note: Steps 10 through 13 are the flow element balance procedure required to complete the Temp Comp restoration.

9. Connect the DMM to P1 (the adapter cable on older control circuits) with the positive lead connected to position 2 (red wire on older control circuits) and the negative lead connected to position 2 (blue wire on older control circuits). Re-install the control circuit on the socket. Set the DMM to volts DC.
10. 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.
11. Adjust potentiometer R13 (next to R8) until the DMM reads 0 volts ±5mV.
12. Turn off the instrument power and remove the DMM. Re-install the heater jumper in its 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 range 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.

<u>Equipment Required</u>

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.

<u>Procedure</u>

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. Remove the control circuit. Disconnect the wires on terminals 6 through 10. Removal of the socket 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-1.
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.
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 (DR). If DR does not exceed the maximum DR of 280 ohms then proceed with the calibration. If the DR is above 280 ohms use the next lower heater wattage setting and let the instrument stabilize. Recheck the DR

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 R5 and R8 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.

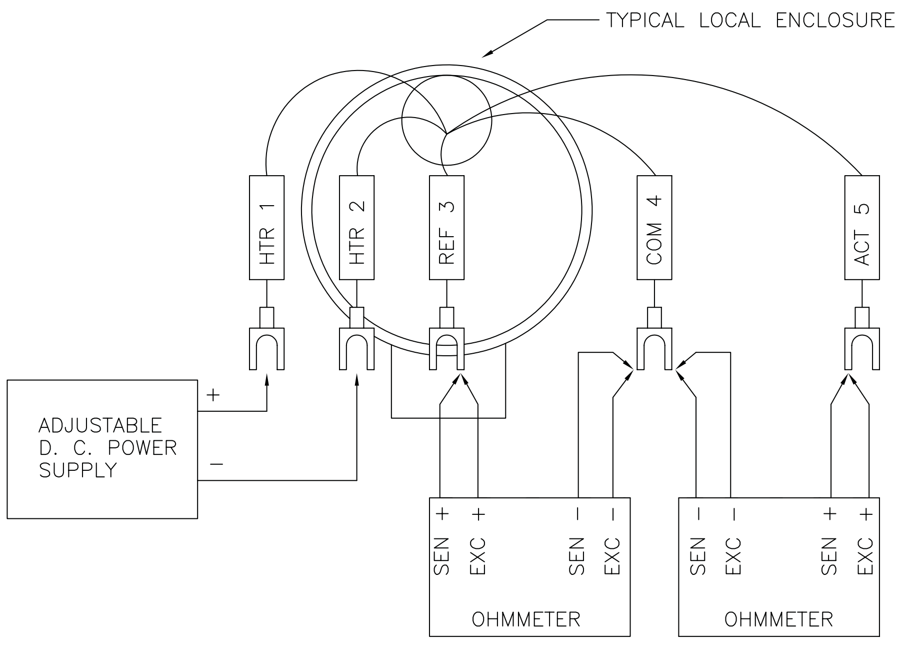


Figure D-1. Sensing Element Calibration Connections

| POWER SUPPLY SETTINGS | | | | |
|---|---|---|---|---|
| FLT93-S | 3 Watts | 1.75 Watts | 0.75 Watts | 0.21 Watts |
| | Set For 18.0 Vdc | Set For 13.8 Vdc | Set For 9.0 Vdc | Set For 4.9 Vdc |
| FLT93-F | 0.57 Watts | 0.52 Watts | 0.40 Watts | 0.25 Watts |
| | Set For 18.0 Vdc | Set For 17.0 Vdc | Set For 15.0 Vdc | Set For 11.8 Vdc |

Table D-1. Heater Voltage Settings

| TEMP COMP FACTOR | R5 K OHMS | R8 K OHMS |
|---|---|---|
| 0.042 | 119.75 | 263.16 |
| 0.041 | 119.88 | 256.41 |
| 0.04 | 120.00 | 250.00 |
| 0.039 | 120.13 | 243.9 |
| 0.038 | 120.25 | 238.10 |
| 0.037 | 120.38 | 232.56 |
| 0.036 | 120.5 | 227.27 |
| 0.035 | 120.63 | 222.22 |
| 0.034 | 120.75 | 217.39 |
| 0.033 | 120.88 | 212.77 |
| 0.032 | 121.00 | 208.33 |
| 0.031 | 121.13 | 204.08 |
| 0.030 | 121.25 | 200.00 |
| 0.029 | 121.38 | 196.08 |
| 0.028 | 121.5 | 192.31 |
| 0.027 | 121.63 | 188.68 |
| 0.026 | 121.75 | 185.19 |
| 0.025 | 121.88 | 181.82 |
| 0.024 | 122.00 | 178.57 |
| 0.023 | 122.13 | 175.44 |
| 0.022 | 122.25 | 172.41 |
| 0.021 | 122.38 | 169.49 |
| 0.020 | 122.5 | 166.67 |
| 0.019 | 122.63 | 163.93 |
| 0.018 | 122.75 | 161.29 |
| 0.017 | 122.88 | 158.73 |
| 0.016 | 123.00 | 156.25 |
| 0.015 | 123.13 | 153.85 |
| 0.014 | 123.25 | 151.52 |
| 0.013 | 123.38 | 149.25 |
| 0.012 | 123.50 | 147.06 |
| 0.011 | 123.63 | 144.93 |
| 0.010 | 123.75 | 142.86 |
| 0.009 | 123.88 | 140.85 |
| 0.008 | 124.00 | 138.89 |
| 0.007 | 124.13 | 136.99 |
| 0.006 | 124.25 | 135.14 |
| 0.005 | 124.38 | 133.33 |
| 0.004 | 124.50 | 131.58 |
| 0.003 | 124.63 | 129.87 |
| 0.002 | 124.75 | 128.21 |
| 0.001 | 124.88 | 126.58 |
| 0.000 | 125.00 | 125.00 |
| -0.001 | 125.13 | 123.46 |
| -0.002 | 125.25 | 121.95 |
| -0.003 | 125.38 | 120.48 |
| -0.004 | 125.50 | 119.05 |
| -0.005 | 125.63 | 117.65 |
| -0.006 | 125.75 | 116.28 |
| -0.007 | 125.88 | 114.94 |
| -0.008 | 126.00 | 113.64 |
| -0.009 | 126.13 | 112.36 |
| -0.010 | 126.25 | 111.11 |
| -0.011 | 126.38 | 109.89 |
| -0.012 | 126.50 | 108.70 |
| -0.013 | 126.63 | 107.53 |
| -0.014 | 126.75 | 106.38 |
| -0.015 | 126.88 | 105.26 |
| -0.016 | 127.00 | 104.17 |
| -0.017 | 127.13 | 103.09 |
| -0.018 | 127.25 | 102.04 |
| -0.019 | 127.38 | 101.01 |
| -0.020 | 127.50 | 100.00 |
| -0.021 | 127.63 | 99.01 |
| -0.022 | 127.75 | 98.04 |
| -0.023 | 127.88 | 97.09 |
| -0.024 | 128.00 | 96.15 |
| -0.025 | 128.13 | 95.24 |
| -0.026 | 128.25 | 94.34 |
| -0.027 | 128.38 | 93.46 |
| -0.028 | 128.50 | 92.59 |
| -0.029 | 128.63 | 91.74 |
| -0.030 | 128.75 | 90.91 |
| -0.031 | 128.88 | 90.09 |
| -0.032 | 129.00 | 89.29 |
| -0.033 | 129.13 | 88.50 |
| -0.034 | 129.25 | 87.72 |
| -0.035 | 129.38 | 86.96 |
| -0.036 | 129.50 | 86.21 |
| -0.037 | 129.63 | 85.47 |
| -0.038 | 129.75 | 84.75 |
| -0.039 | 129.88 | 84.03 |
| -0.040 | 130.00 | 83.33 |
| -0.041 | 130.13 | 82.64 |
| -0.042 | 130.25 | 81.97 |

Table D-2. Temp Comp Factor Table

# APPENDIX D CUSTOMER SERVICE

### Customer Service/ Technical Support

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

*By Mail*

Fluid Components International LLC

1755 La Costa Meadows Dr.

San Marcos, CA 92078-5115 USA

Attn: Customer Service Department

*By Phone*

Contact the area FCI regional representative. If a field representative is unable to be contacted or if a situation is unable to be resolved, contact the FCI Customer Service Department toll free at

1 (800) 854-1993.

*By Fax*

To describe problems in a graphical or pictorial manner, send a fax including a phone

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

*By E-Mail*

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

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

*International Support*

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

*After Hours Support*

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

*Point of Contact*

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

### Warranty Repairs or Returns

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

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

### Non-Warranty Repairs or Returns

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

**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**

Contact an FCI field representative to request field service.

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

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

**Field Service Rates**

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

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

**RA #________________**

# Return Authorization Request

1. **Return Customer Information**

Returning Company's Name:______________________________ Phone# ______________________________

Return Contact Name:______________________________ Fax # ______________________________

Email Address: ____________________________________________________________

2. **Return Address**

Bill To: ______________________________ Ship To: ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

3. **Mandatory End User Information**

Contact: ____________________ Company: ______________________________ Country: ______________

4. **Return Product Information**

Model No: ______________________________ Serial No(s):______________________________

Failure Symptoms *(Detailed Description Required)*: ______________________________________________

____________________________________________________________

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

____________________________________________________________

FCI Factory Technical Service Contact: ______________________________________________

5. **Reason For Return**

- ❑ Sensor Element
- ❑ Electronics
- ❑ As Found Testing
- ❑ Credit
- ❑ Recalibrate (New Data)
- ❑ Recalibrate (Most Recent Data)
- ❑ Other

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

6. **Payment Via**

- ❑ Faxed Purchase Order
- ❑ VISA
- ❑ MasterCard

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

Factory Return Shipping Address:

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

FLUID COMPONENTS INTERNATIONAL LLC

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

Packing Procedures

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

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

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

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

### Certification Of Decontamination

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

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

Process Flow Media ____________________

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

Print Name____________________

Authorized Signature____________________ Date ____________________

Company Title ____________________

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

FCI Document No. 05CS000004D [U]

## WARRANTIES

Goods furnished by the Seller are to be within the limits and of the sizes published by the Seller and subject to the Seller's standard tolerances for variations. All items made by the Seller are inspected before shipment, and should any of said items prove defective due to faults in manufacture or performance under Seller approved applications, or fail to meet the written specifications accepted by the Seller, they will be replaced or repaired by Seller at no charge to Buyer provided return or notice of rejection of such material is made within a reasonable period but in no event longer than three (1) 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.


**FCI's Complete Customer Commitment. Worldwide**
**ISO 9001 and AS9100 Certified**

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