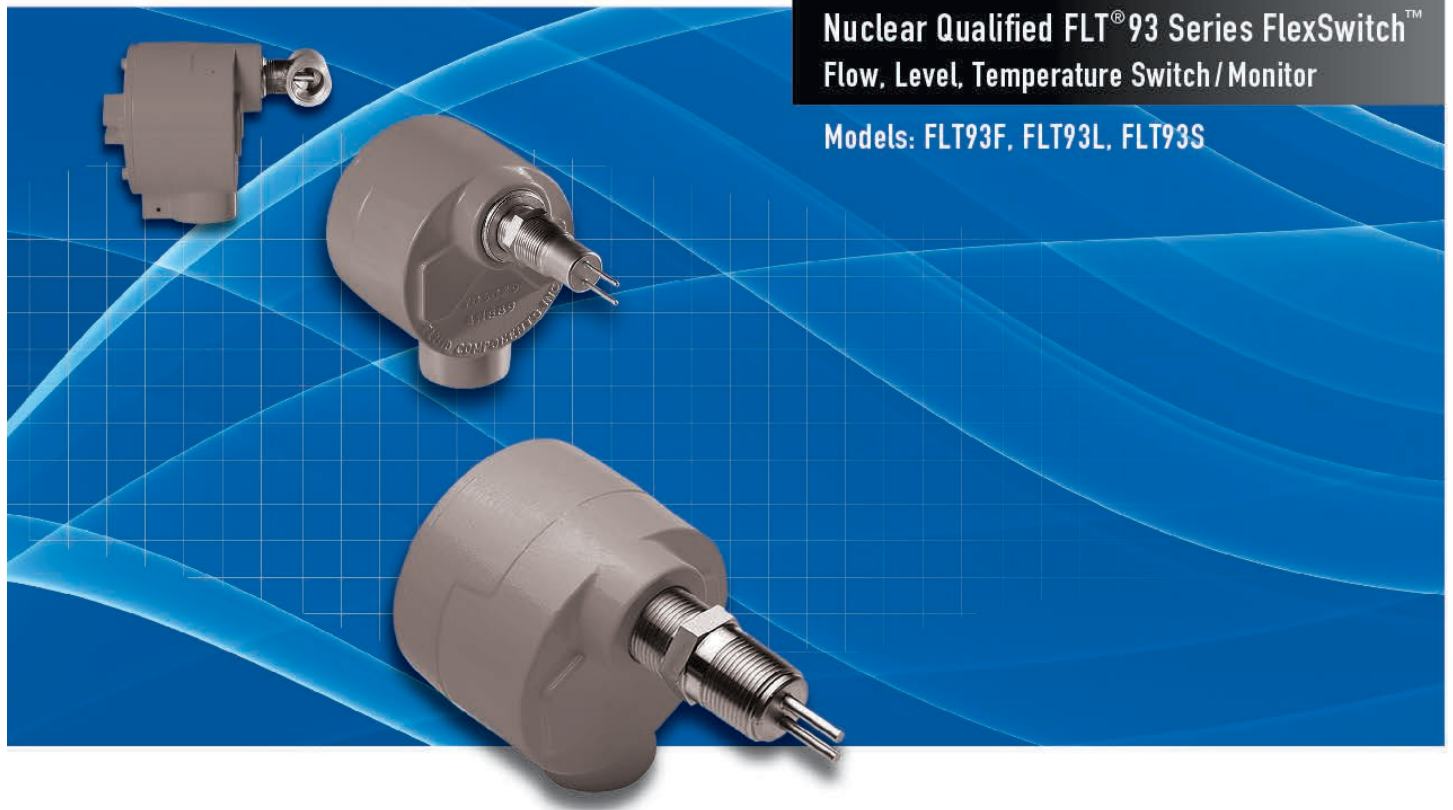


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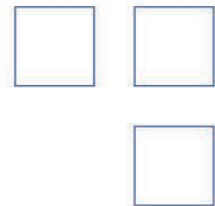
Installation, Operation & Maintenance Manual

Installation, Betrieb und Wartungshandbuch
Manual de Instalación, Operación y Mantenimiento
安装、操作和维护手册



Nuclear Qualified FLT[®] 93 Series FlexSwitch[™]
Flow, Level, Temperature Switch / Monitor

Models: FLT93F, FLT93L, FLT93S



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1 GENERAL

Description

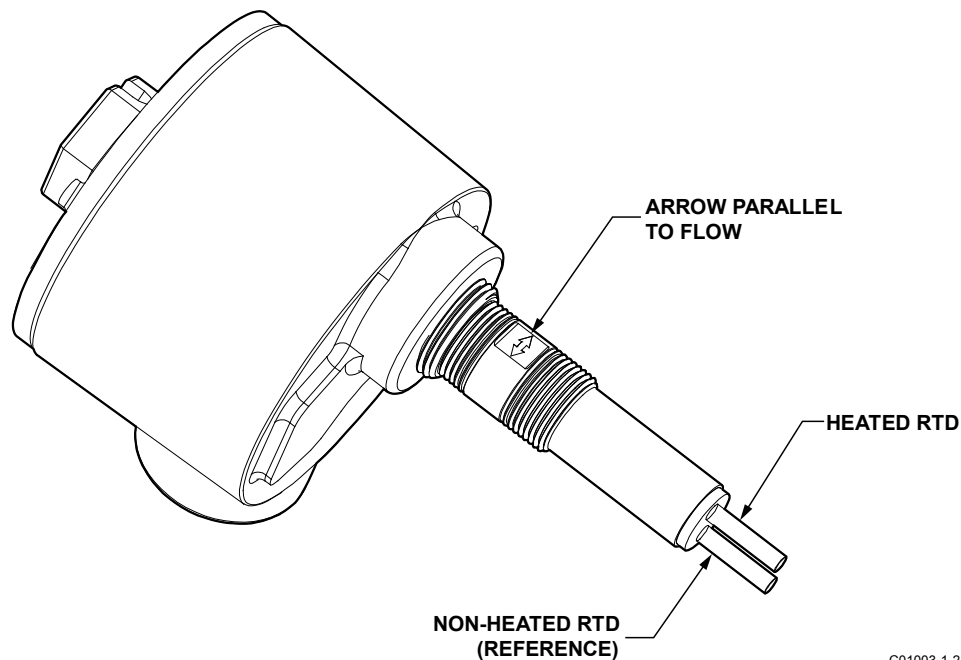
The FLT Series models are multipurpose measurement instruments. The FLT Series models that are included in this manual are FLT93S, FLT93F, FLT93L including high temperature versions. Each model is a single instrument that is capable of detecting fluid flow and temperature. It is also able to detect liquid level or fluid media interfaces. Moreover, the instrument has two field adjustable alarm setpoints, two buffered voltage outputs, as well as a built-in calibration circuit. The alarm setpoints control 6 A relay contacts that can be used to control customer process applications (relays with 10 A contacts, hermetically sealed, and gold-plated contacts optional). 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 sensor element is based on 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.

Sensor Element

The sensor 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. To ensure that the instrument is properly installed the sensor element includes a machined flat area on its threaded portion on which an arrow indicating flow direction is etched. See Figure 1 below for a view of the sensor element.



C01003-1-2

Figure 1 – View of the Sensor Element

Control Module

The control module converts the sensor element's RTD temperature differential into an analog DC voltage signal. Dual comparators monitor the sensor element signal and activate the relay alarm circuits if the signal exceeds an adjustable setpoint.

The control module contains removable jumpers that allow the instrument to be configured for the application.

Technical Specifications

Application

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

Sensor Elements

■ Process Connection

Models S and F

¾" male NPT standard; optional 1" male NPT, 1" BSPT, 1¼" male NPT; flanges, or spool pieces.

Model L

1" male NPT or ¾" female NPT; with orifice, flanges (1" or DIN DN25 Form C) optional.

■ Insertion Length

Models S and F

Available in standard lengths of 1.2" [30 mm], 2" [51 mm], 4" [102 mm], 6" [152 mm], 9" [229 mm], 12" [305 mm], 18" [457 mm] and custom-specified lengths.

Model L

3.375" [86 mm] in-line body length

■ Sensor 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 (FLT93S 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

Sensor 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 Module:

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 Module Features

■ Control Module

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

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	Sensor Element	Power (W)
Gas or Air	S-Style	0.75
	F-Style	0.25
	S-Style	3.0
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 manual for recommendations in your service.

■ Relay Rating

Control Module: Dual SPDT Options – 6 A @ 300 VAC/150 VDC (Epoxy Sealed), 0.5 A @115 VAC, 1 A @28 VDC (Hermetically Sealed), 1 mA to 2 A @1 to 60 VDC (Plastic Sealed).

Aux. Relay Board: DPDT x1 or x2 Options: 10 A @ 120 VAC, 7.5 A @28 VDC (Plastic Cover), Dry to 2 A @115 VAC/28 VDC (Plastic Sealed), 10 A @115 VAC (Plastic Sealed), 0.3 A @115 VAC, 2.0 A @30 VDC (Hermetically Sealed), 0.5 A @115 VAC, 1 A @28 VDC (Hermetically Sealed).

■ 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] 0.25 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 sensor 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%

EMC Testing

Generally, EMC tests are performed per USNRC RG 1.180. For Europe and/or by special request EMC tests can be performed per the CE Mark standards of IEC/EN 61000-6-2 and IEC/EN 61000-6-4. Other tests regimens can be performed subject to test availability.

Nuclear Safety Certification

FLT93 sensor elements are qualified for harsh environment applications under the guidelines of IEEE-323, IEEE-344 and IEEE-382 (FCI Qualification Reports 07EN708676 and 03EN708858).

■ **Radiation Exposure**

Models S and F

2x10⁸ rads

Model S High Temperature (HT)

5x10⁷ rads

Electronics Module [5298] qualified for radiation harsh

5x10⁵ rads

■ **Seismic Level**

Models S and F

Zero Period Acceleration (ZPA) = 3 g

Model L

Required Input Motion (RIM) = 6.4 g

Model S High Temperature (HT)

Zero Period Acceleration (ZPA) = 8 g

■ **Temperature**

Models S and F

40 °F to 175 °F (4.4 °C to 79.4 °C)

Model S High Temperature (HT)

40 °F to 576 °F (4.4 °C to 302 °C)

■ **Qualified Lifetime**

All Models (Sensor Only)

40 years at 150 °F (65.6 °C)

Shipping Weight (approximate), 12-in U-length, NPT process connection)

Integral: 11 lb [5 kg]

Remote: 20 lb [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, on page 49.

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 changed.

Pre-Installation Procedure

Warning: Instrument installation limited to qualified personnel only. 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.

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 module or flow element enclosure is not covered by product warranty.

Observe ESD Precautions

Caution: The instrument contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control module.

Use standard ESD precautions when opening an instrument enclosure or handling the control module. 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 use 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 Sensor 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 against the process location to be sure of a correct fit.

Verify Sensor Element Flow Direction and Placement Orientation (Flow Application)

For flow detection, verify that the sensor element surface marked with direction arrows is parallel to the process flow. The flow can be from either direction.

Mount the sensor 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, locate the sensor element 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).

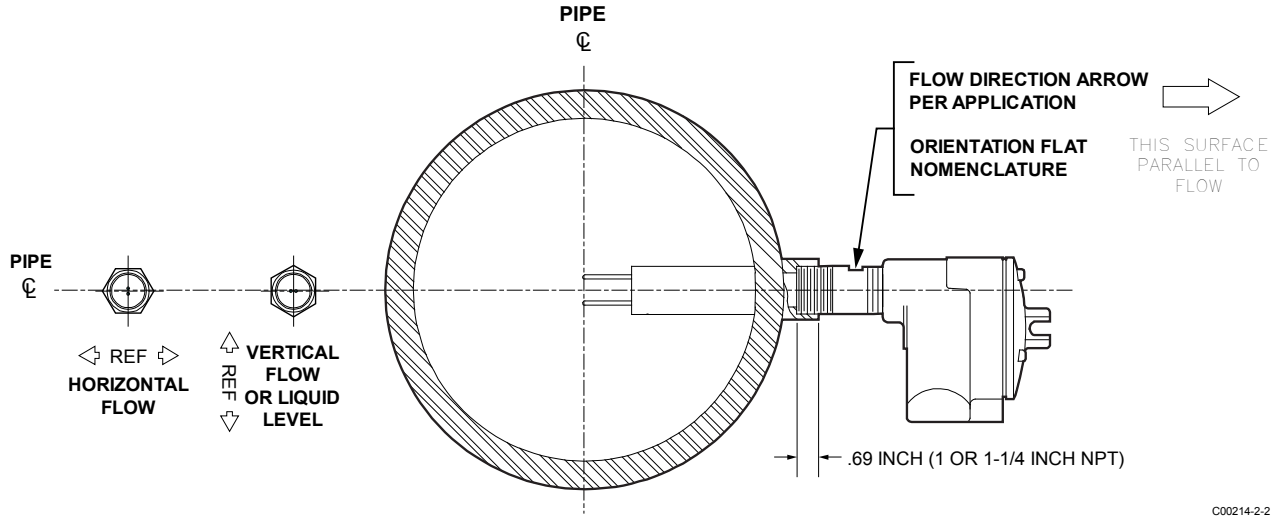
Verify Sensor Element Flow Direction and Placement Orientation (Level Application)

If the sensor element is side-mounted on the process vessel, verify that the surface marked with direction arrows is vertically oriented.
 If the sensor element is top- or bottom-mounted on the process vessel, the orientation of the surface marked with direction arrows does not matter.

Install the Sensor Element

Male NPT Mounting

When mounting the sensor 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. Firmly tighten all connections. To avoid leaks, do not overtighten or cross-thread connections. See Figure 2 below for proper mounting.

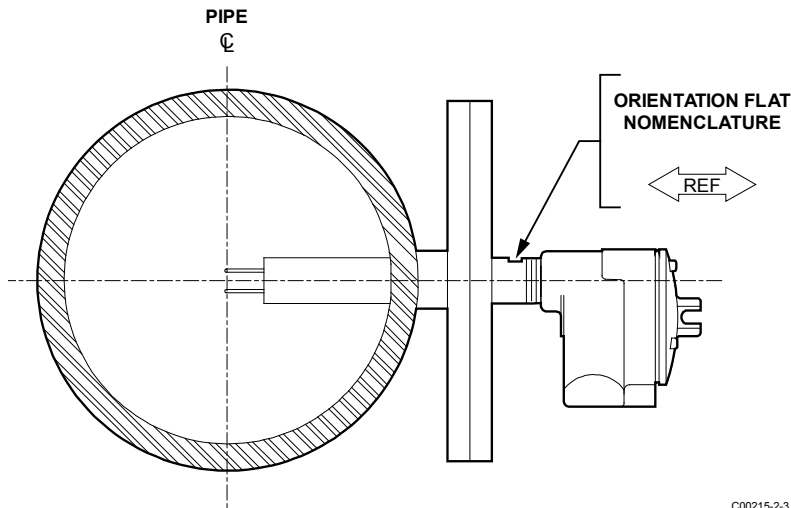


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Figure 2 – NPT Pipe Thread Mount

Flange Mounting

For flange mounted sensor elements, attach the process mating flange with care. The correct orientation of the sensor element must be maintained to ensure optimum performance or calibration. See Figure 3 below.



C00215-2-3

Figure 3 – Flange Mount

In-line NPT Assembly (FLT93L)

Check the in-line assembly’s body length to make sure it fits into the process line. The direction of flow is important for proper operation. Orient the assembly so that the flow direction arrow points in the same direction as the process media flow. See Figure 4 below for an example of correct orientation.

If the instrument is a butt weld assembly, be sure to remove the control module first and properly ground the flow element before welding (GTAW is highly recommended).

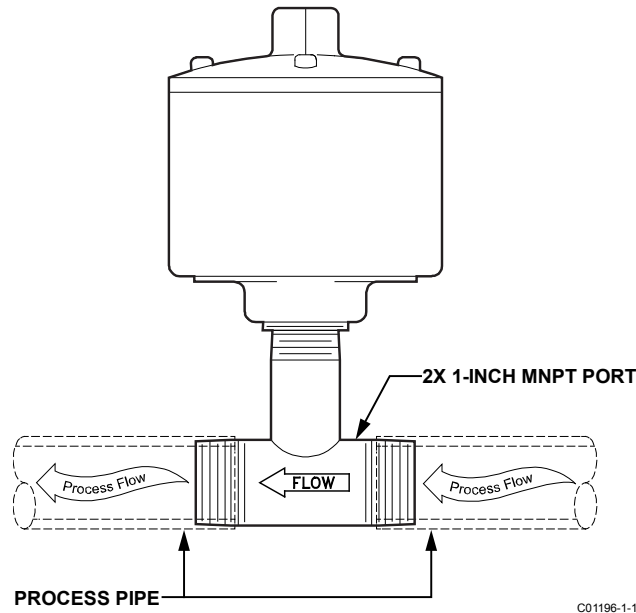


Figure 4 – FLT93L In-Line Flow Element (Shown with 1-Inch MNPT Ports)

Enclosure Wiring, General

Caution: In applications where the sensor element is located in an explosive environment, isolate the conduit before it leaves the environment. A silicone encapsulant/potting compound can be used to provide the isolation.

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

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

Minimum Wire Size

Table 1 below shows the smallest (maximum AWG number) copper wire that can be used for various lengths of cables. Contact FCI concerning greater distances than those listed in the table. The sensor 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.

Table 1 – Interconnecting Cable Minimum Conductor Size (Maximum AWG Number)

Connection	Maximum Distance for AWG ¹					
	10 ft. (3 m)	50 ft (15 m)	100 ft. (31 m)	250 ft. (76 m)	500 ft. (152 m)	1000 ft. (305 m)
AC/DC Power	22	22	22	20	18	16
Relay (6 A)	28	22	20	16	12	10
Relay (10 A)	22	16	12	8	6	Not Recommended
Flow Element Wires ²	22	20	20	18	18	18

Note: 1. Ensures a maximum 2-volt drop over the cable length. Use a lower (heavier) gauge for less voltage drop.

2. Requires a shielded cable with the shield wire connected to the control socket only.

Enclosure Covers

All enclosure covers must be in place and securely closed to achieve environmental and safety classifications. Tighten all circular thread-on covers about 1 full turn past hand-tight.

For applications in hazardous/harsh environments, make sure that cover locks are in place and secure.

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

A Viton O-ring [400 °F (204 °C) max. temp.] is available for the thread-on covers.

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)
- Other materials available at request

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, including conduit plugs, must meet or exceed the area approval where the unit is being installed.

Wiring the Local Enclosure

This procedure is for instruments with the control module located in same enclosure as the sensor element (i.e., integral FLT93 units).

Input Power and Alarm Relay Wiring

1. Unscrew enclosure lid.
2. Remove the control module from its socket. Do not remove the control module socket. Removal of the control module socket may cause damage to the instrument.
3. 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.

4. Wire AC Hot/DC+ and AC Neutral/DC- directly to control module socket screw terminals 1 and 2 respectively. Attach earth ground lead to enclosure grounding screw. See [Figure 5](#) wiring diagram below. Refer to [Table 1](#) on page 7 for minimum wire gauge recommendations.
5. Wire the relay contacts using the control module socket screw terminals indicated in the wiring diagram in [Figure 5](#) below. When connecting the relay wiring, do so with complete understanding of what the process requires of the instrument. The instrument has dual SPDT relay output contacts for each alarm switch point. For the relay logic, refer to [Figure 5](#). Also refer to the jumper configuration tables in [OPERATION](#) starting on page 15. Relay contacts are shown with the relays de-energized. Wire in accordance with the system requirements.
6. Wire the output signal(s) as required for the application. Refer to [Wiring Output Signal Terminals](#), page 12 for details.

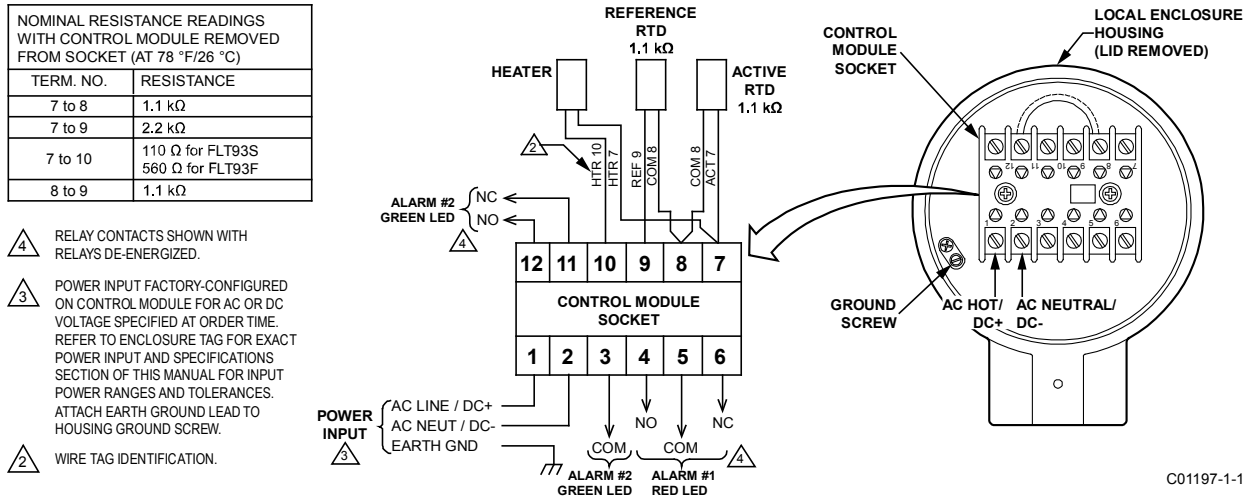


Figure 5 – Local Wiring Diagram

Power Fuse

Input power overload protection is provided by a soldered-on fuse on the control module. Refer to [Power Fuse Replacement](#), page 34 for fusing details.

Wiring the Remote Enclosure

This procedure is for instruments with the control module located remotely from the sensor element.

Locate the Remote Hardware Location

Select a location for the remote enclosure within 1000 feet (305 m) of the sensor element. Do not locate pigtail sensor elements more than 10 feet (3 m) from the enclosure unless the pigtail is extended with the proper size cable as listed in [Table 1](#), page 7. If the cable is extended use a junction box with a 6-position terminal block for the cable connections. All 5 conductors and the shield must have its own termination. Make sure the remote enclosure location has adequate clearance to fully open the enclosure door. Secure the remote enclosure solidly to a vertical surface capable of providing support. Use appropriate hardware to secure the enclosure.

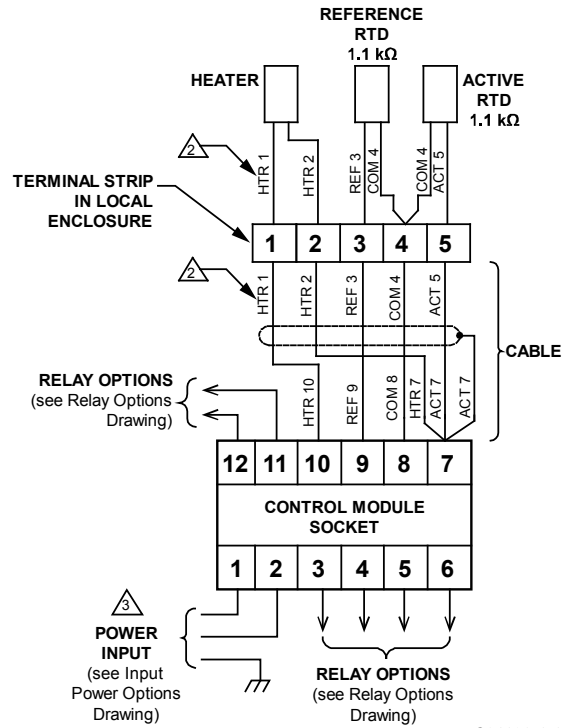
Sensor Wiring

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

1. Remove control module from remote enclosure.
2. Run a five-conductor, shielded cable from sensor’s local enclosure to remote enclosure’s control module socket screw terminals. See [Figure 6](#) below. Refer to [Table 1](#) on page 7 for minimum wire gauge recommendations.

NOMINAL RESISTANCE READINGS WITH CONTROL MODULE REMOVED FROM SOCKET (AT 78 °F/26 °C)	
TERM. NO.	RESISTANCE
7 to 8	1.1 kΩ
7 to 9	2.2 kΩ
7 to 10	110 Ω for FLT93S 560 Ω for FLT93F
8 to 9	1.1 kΩ

- ⚠️ 3 POWER INPUT FACTORY-CONFIGURED ON CONTROL MODULE FOR AC OR DC VOLTAGE SPECIFIED AT ORDER TIME. REFER TO ENCLOSURE TAG FOR EXACT POWER INPUT AND SPECIFICATIONS SECTION OF THIS MANUAL FOR INPUT POWER RANGES AND TOLERANCES. EARTH GROUND IS TERMINATED TO THE HOUSING.
- ⚠️ 2 WIRE TAG IDENTIFICATION.
- 1. DO NOT REMOVE TERMINAL BLOCK FROM FACTORY ASSEMBLED SENSOR HOUSING. REMOVAL MAY RESULT IN DAMAGE TO SENSING ELEMENT LEADS.



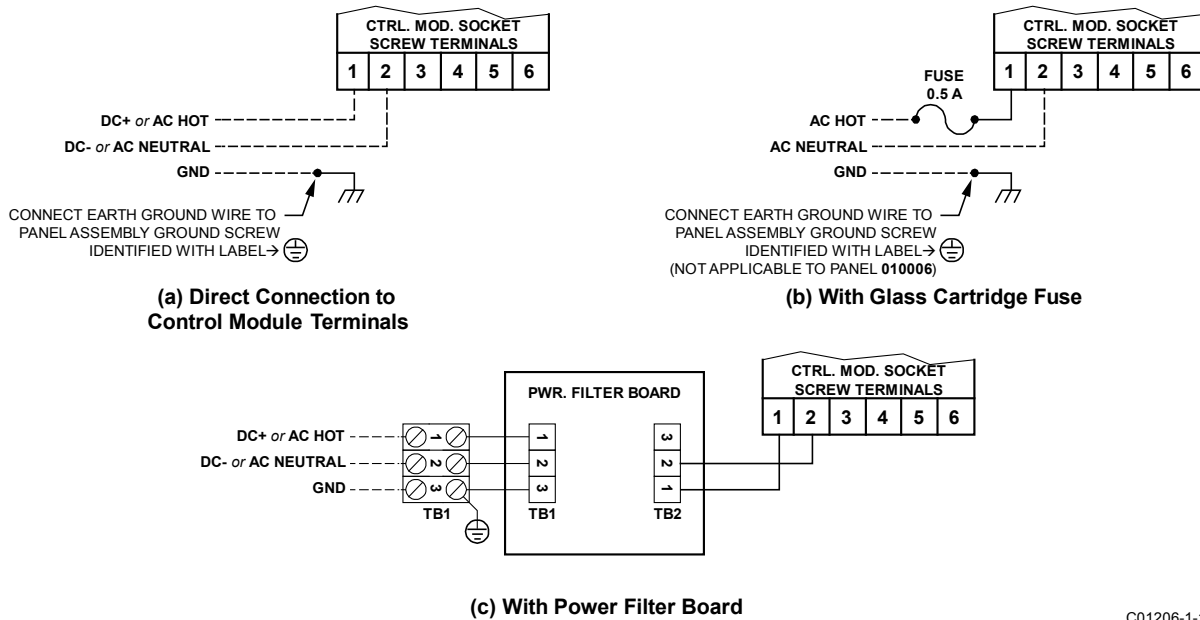
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Figure 6 – Remote Wiring Diagram, Sensor

Input Power Wiring

There are three possible ways to wire input power depending on the remote unit’s panel assembly type. Wire input power according to your hardware. See remote unit’s enclosure tag for exact power requirements.

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



C01206-1-1

Figure 7 – Remote Wiring Diagram, Input Power Options

Panel Assembly, 12-Pin Socket and Auxiliary Relay Board, No Fuse (018247)

1. Remove control module from remote enclosure socket.
2. Wire AC Hot or DC+ and AC Neutral or DC- directly to control module socket screw terminals 1 and 2 respectively. Attach earth ground lead to panel's grounding screw, which is labeled with ground symbol. See [Figure 7](#) wiring diagram above. Refer to [Table 1](#) on page 7 for minimum wire gauge recommendations.

Panel Assembly, 12-Pin Socket and Glass Cartridge Fuse (010006 & 000469)

1. Remove control module from remote enclosure socket.
2. Wire AC Hot to open screw terminal of fuse clip (other end of fuse clip is already connected to control module socket terminal 1). Wire AC Neutral to control module socket screw terminal 2. Attach earth ground lead to panel's grounding screw, which is labeled with ground symbol. See [Figure 7](#) wiring diagram above and [Figure 20](#), page 35. Refer to [Table 1](#) on page 7 for minimum wire gauge recommendations.

Note: Earth ground connection not applicable to panel assembly 010006.

Panel Assembly, 12-Pin Socket and Power Supply Filter (022436, 023048 & 024065)

1. Wire AC Hot or DC+, AC Neutral or DC- and GND power leads directly to 3-position terminal block TB1, terminals 1, 2 and 3 respectively. The TB1 input power terminal block is a standalone piece that is wired to the power filter board. Remove TB1's snap-on plastic cover to access the screw terminals. For panel assemblies 022436 and 023048 the TB1 terminal block is mounted on a riser (upper tier of assembly). See [Figure 7](#) wiring diagram above and [Figure 20](#), page 35. Refer to [Table 1](#) on page 7 for minimum wire gauge recommendations.

Power Fuse

Input power overload protection is provided by a soldered-on fuse on the control module. Remote units have additional fuse options that vary depending on the type panel assembly used. Refer to [Power Fuse Replacement](#), page 34 for fusing details.

Alarm Relay Wiring

Alarm relays are provided by the on-board control module relays or via an auxiliary relay board. For remote units using the control module's on-board relays, remove the control module from its socket and wire the relay contacts using the control module socket screw terminals indicated in the wiring diagram in [Figure 8](#) below.

Remote units with the auxiliary relay board have the control module and auxiliary relay board mounted on the same panel and wired together at the factory. This configuration is available without an enclosure (for use with a customer-supplied enclosure). Wire the alarm relay contacts on the auxiliary relay board using its TB1/TB2 screw terminals. [Table 2](#) below summarizes the available relay configurations.

Table 2 – Alarm Relay Configurations

Type	Contact Config.	Contact Rating (Relay Ref. Designator)	Case	Config. Code
On-board Relays (on 5298 Control Module)	SPDT x2	6 A @ 300 VAC/150 VDC (K1, K2)	Epoxy Sealed	5298-x1xxxxxx
		0.5 A @115 VAC, 1 A @28 VDC (K1, K2)	Herm. Sealed	5298-x3xxxxxx
		1 mA to 2 A @1 to 60 VDC (K1, K2)	Plastic Sealed	5298-x4xxxxxx
Auxiliary Relays (on 705649 Aux. Relay Board)	DPDT x1 or x2	10 A @ 120 VAC, 7.5 A @28 VDC (K1, K2)	Plastic Cover	705649-01/02
		Dry to 2 A @115 VAC/28 VDC (K1, K2)	Plastic Sealed	705649-03/04
		10 A @115 VAC (K1, K2)	Plastic Sealed	705649-05/06
		0.3 A @115 VAC, 2.0 A @30 VDC (K3, K4)	Herm. Sealed	705649-07/08
		0.5 A @115 VAC, 1 A @28 VDC (K5, K6)	Herm. Sealed	705649-09/10

Caution: For remote units with the auxiliary relay board, do not connect any loads to the control module socket. Damage will occur to the control module if the alarm circuit is energized.

The auxiliary relay configuration uses a control module that provides a switching voltage signal instead of relay contacts. The switch voltage is wired from the control module socket to the auxiliary relay board to energize/de-energize the relay coils.

When connecting the relay wiring, do so with complete understanding of what the process requires of the instrument. The instrument has single or dual DPDT relay output contacts depending on the application. For the relay logic, refer to [Figure 8](#) below. Relay contacts are shown with the relays de-energized. Also refer to the jumper configuration tables starting on page 15. Wire in accordance with the system requirements.

The control module can be ordered with switching voltage outputs and no auxiliary relay board. This can be used with customer-supplied relays or any other device that has a differential input. The 17 VDC output drives loads as low as 1500 Ω. Refer to Figure 8 below for the output terminals.

Wiring a Remote Control Module to an External Auxiliary Relay Board

1. Run a four-conductor cable from the control module to the external (i.e., not the factory-installed auxiliary relay board) auxiliary relay coils. Use the wiring diagram in Figure 8 below as a guide to wire the boards together.
2. Attach the customer wiring to the external relay contacts.

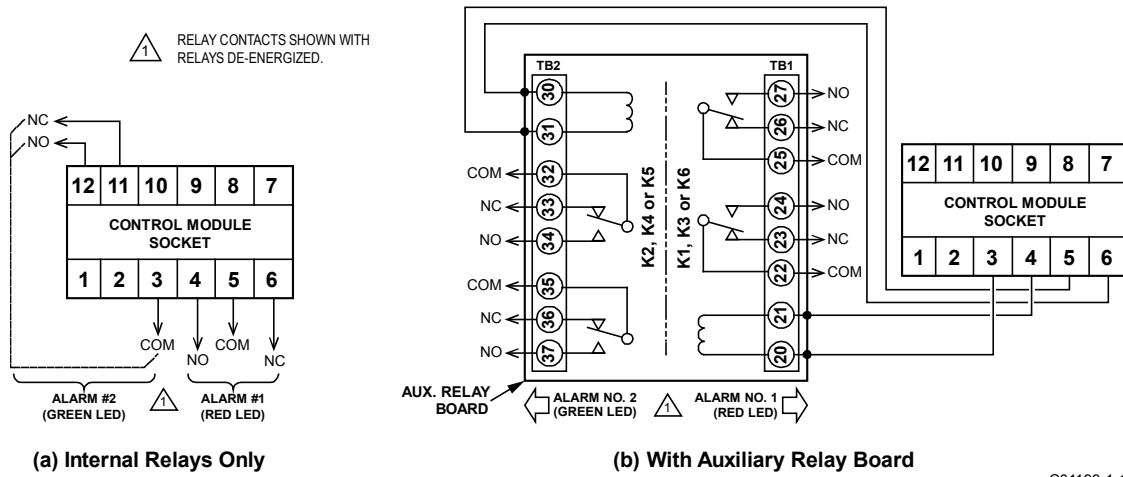


Figure 8 – Remote Wiring Diagram, Relay Options

Wiring Output Signal Terminals

Two buffered output signals are provided by the control module at P1, a 4-position terminal block. 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 sensor element. See Figure 9 below.

Caution: Do not ground P1-2, which is the negative lead of the process signal. This terminal is 9 volts above the control module ground. The peripheral using this signal must have a differential input.

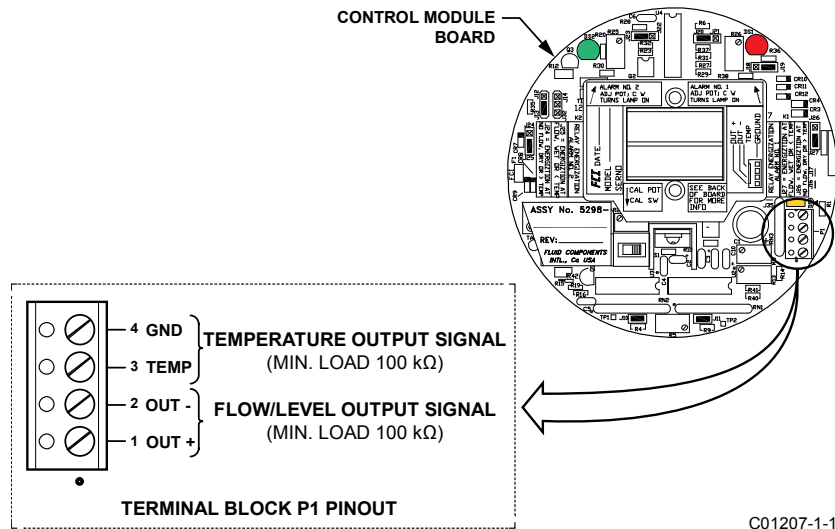


Figure 9 – Output Signal Connections, Terminal Block P1

These voltages can be used by other peripherals with a minimum load of 100K ohms. The terminal block accepts 16-28 AWG wire (22 gauge wire is typically used). The maximum recommended length of wire is 1000 feet. Shielding is required on any length of cable. Terminate the shield at P1-4. To ease wiring, the terminal block can be removed from the module (pull straight up).

Interface Cabling Terminations

Power, output signal and sensor probe cabling can be attached to the remote electronics/probe using cable glands and/or quick disconnect connectors (QDC). Refer to the appropriate information below as it applies to your installation.

Cable Gland

A cable gland provides cable strain relief as well as a barrier against moisture. Follow the instructions below for cable gland installation.

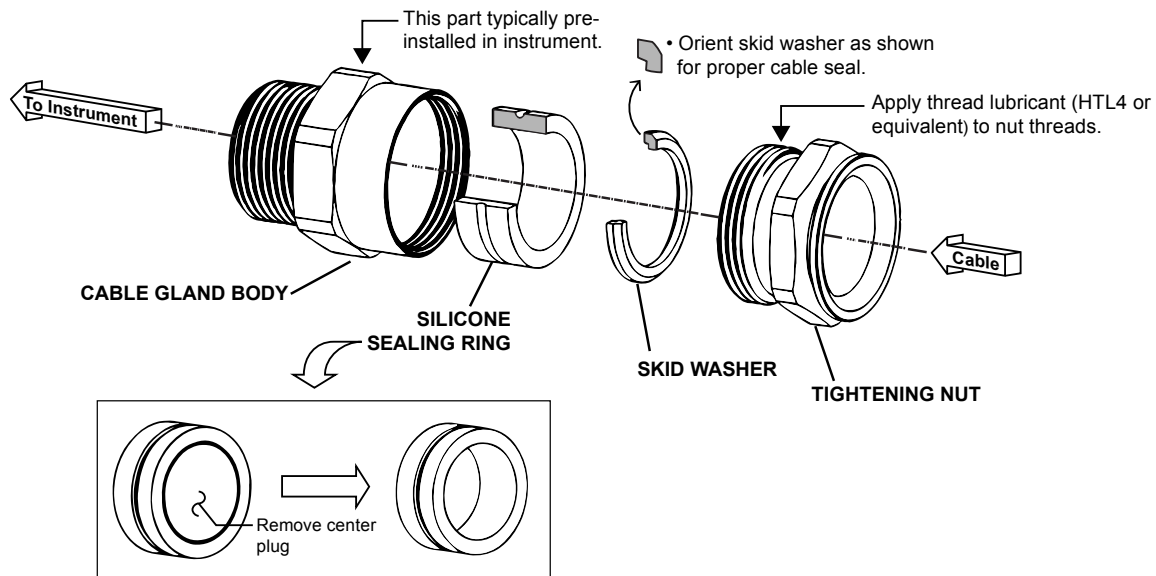
Note: The following applies to applications using the Capri ADE 1F2 model cable gland with NPT thread and 316L stainless steel construction.

1. Remove perforated center of sealing ring, shown in Figure 10 below, by pushing through with a blunt object. Do not use cable to remove silicone center as this may damage cable or cable gland assembly. Cable gland may be completely assembled during this step.
2. Loosen cable gland and apply plant approved thread lubricant to tightening nut threads as shown in Figure 10 below. FCI recommends use of HTL4 or similar thread lubricant. Use sparingly.
3. Ensure correct orientation of skid washer shown in Figure 10 detail below. This is necessary for proper seal on cable.
4. Hand thread tightening nut but do not tighten fully.
5. Clean and degrease cable gland assembly with plant approved cleaning solution/solvent so that all outer surfaces are free of any lubricant or grease.
6. Thread cable through cable gland.

Note: Some installations require the use of heat shrink tubing: One length covers a small length of cable up to the tightening nut and another (larger diameter) length covers the entire cable gland. If applicable, thread the cable through these two heat shrink tubing pieces before the cable goes through the cable gland.

7. Ensure an adequate length of cable wires are within the enclosure, then tighten cable gland finger-tight.
8. After all enclosure connections are made, torque cable gland tightening nut as listed in Table 3 below.
9. Clean off any excess lubricant.

Note: If applicable, shrink the heat shrink tubing pieces in place after tightening the nut (smaller diameter first, followed by the larger one).



DETAIL: SILICONE SEALING RING
 • Remove perforated center plug using flat blade screwdriver or similar blunt tool.

C01211-1-1

Figure 10 – Cable Gland Installation

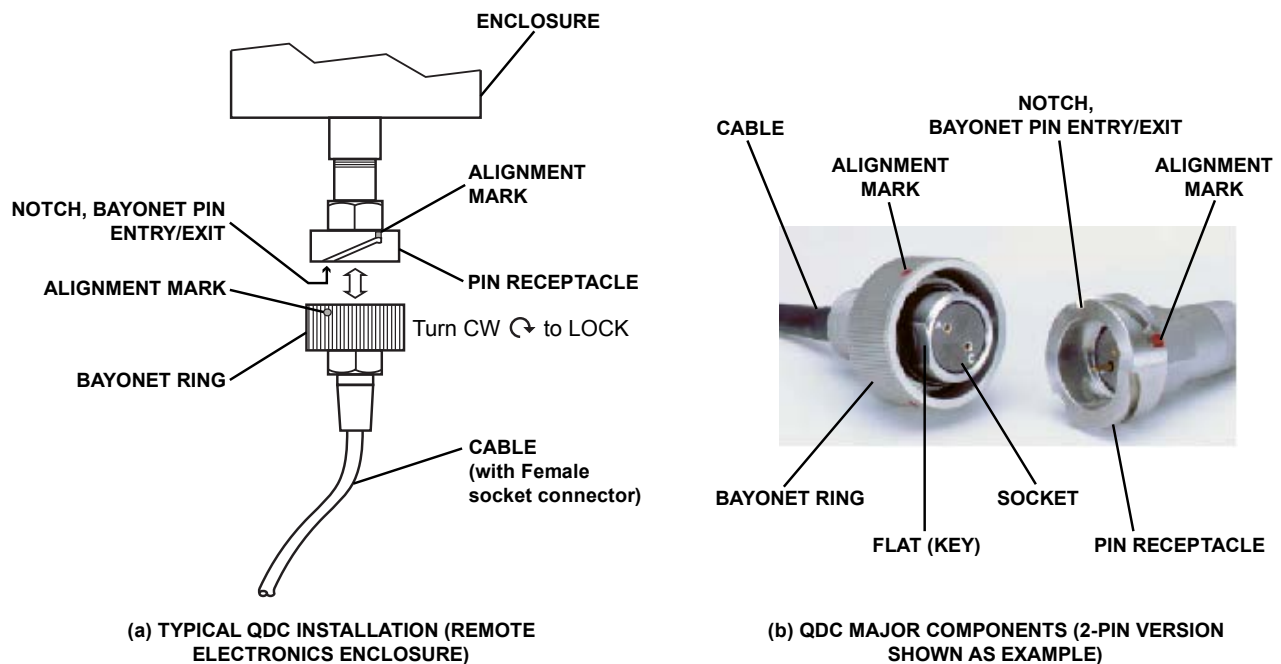
Table 3 – Cable Gland Tightening Nut Torque Chart

Cable Gland Size	Torque
06 (½" or ¾" NPT)	45 in-lb (5 N-m)
07 (¾" NPT)	45 in-lb (5 N-m)
08 (1" NPT)	66 in-lb (7.5 N-m)

Quick Disconnect Connector

The FLT93 quick disconnect connector (QDC) cable uses a bayonet style connector for quick and secure connections. Follow these steps to make a QDC connection (refer to Figure 11 below):

1. Insert cable’s female socket to enclosure pin receptacle then push in. (Connector flat ensures cable goes in one way only.)
2. Engage bayonet pins (inside bayonet ring) to notches at bottom of pin receptacle.
3. Twist bayonet ring fully clockwise until connector clicks into place (approximately 1/3 turn) The cable is fully seated and locked when red dots on the bayonet ring line up with red marks on pin receptacle.



C01212-1-1

Figure 11 – Quick Disconnect Connector (QDC)

3 OPERATION

Caution: The control module contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control module. Refer to [Observe ESD Precautions](#), page 5 for ESD details.

Configuration Jumpers

The control module configuration jumpers are set by the 5298 control module callout which is specified on the top assembly for the particular customer order (CO). The information in the tables below and in [Figure 12](#) on page 16 is for reference only. See [APPENDIX A](#) on page 41 for an example of a control module callout.

Table 4 – Jumpers, Selectable Heater Wattage Control

Jumper	J32	J12	J13	J14	J33
FLT93F Element Wattage, 560 Ω Heater	0.57 W	0.52 W	0.49 W	0.25 W	OFF
FLT93S Element Wattage, 110- Ω Heater	3 W	1.75 W	0.75 W	0.21 W	OFF

Table 5 – Jumpers, Fixed Heater Wattage Control

Jumper	J13	J14	J33
FLT93F Element Wattage, 560 Ω Heater	N.A.	0.21 W	OFF
FLT93S Element Wattage, 110- Ω Heater	0.75 W	N.A.	OFF

Table 6 – Jumpers, Alarm Application

Alarm	Flow/Level	Temp
Alarm No. 1	J20	J21
Alarm No. 2	J18	J19 [†]

Table 7 – Jumpers, Relay Energization

Jumper	Alarm No. 1
J26	Relay Energized With Low Flow, Low Level (Dry) Or High Temperature.
J27	Relay Energized With High Flow, High Level (Wet) Or Low Temperature.
Jumper	Alarm No. 2
J24	Relay Energized With Low Flow, Low Level (Dry) Or High Temperature.
J25	Relay Energized With High Flow, High Level (Wet) Or Low Temperature.

Table 8 – Jumpers, Relay Contact Configuration

Jumper	Relay Contact Configuration
J23	Dual SPDT (One Relay Per Alarm)
J22	Single DPDT (Disables Alarm No. 2)

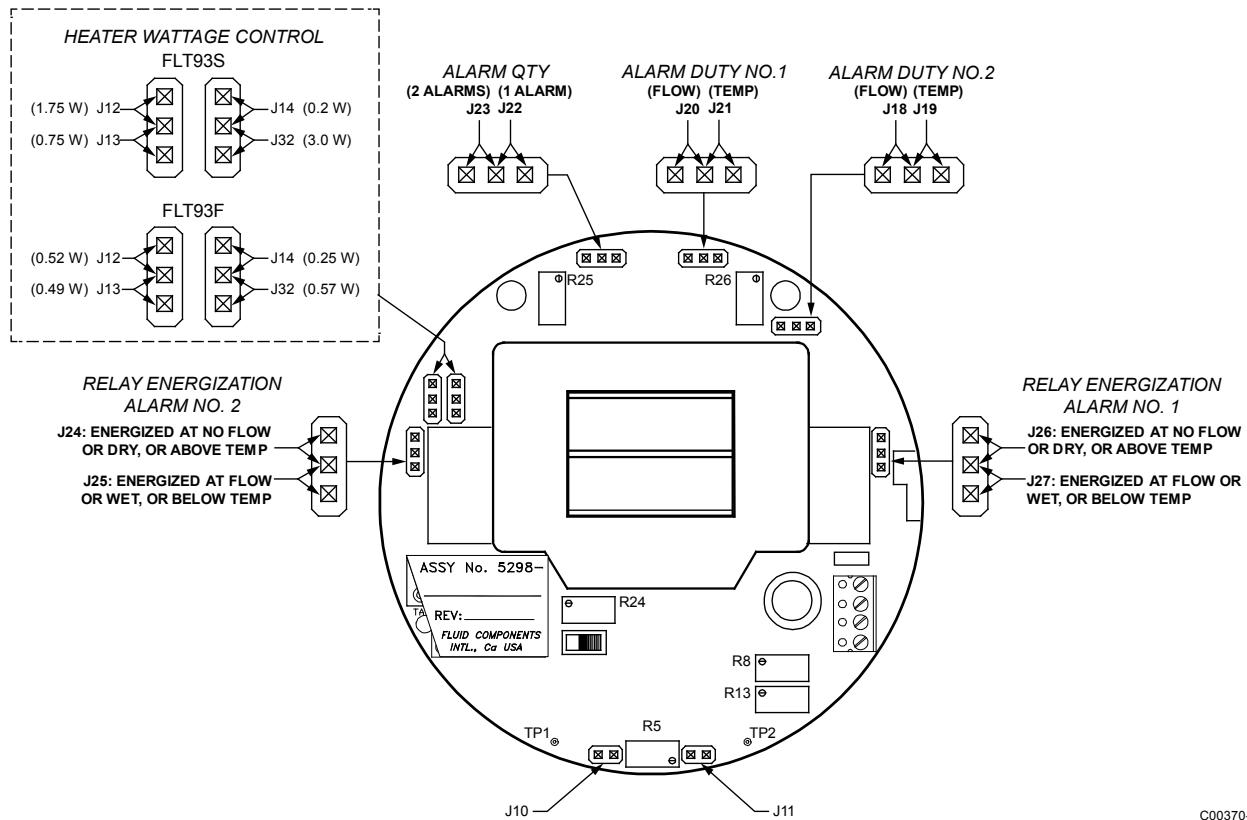


Figure 12 – 5298 Control Module Jumper Locations

Heater Cut-Off

The 5298 control module has a heater cutoff switch that limits the skin temperature of the sensor element to a temperature differential of approximately 150 °F (66 °C) above the process temperature. In the case where the instrument is used as a gas flow switch, and the heater wattage is set too high, the temperature differential (ΔT) between the RTDs may exceed the usable input range of the control module. 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 sensor 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 alternates between on and off until the heater cycling 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 setpoint 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 sensor 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 sensor element detects a dry condition the control module will indicate a heater cutoff condition. The sensor element will not be damaged 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.

Alarm Setpoint Adjustments: Numerical Adjustment vs. Adjustment by Observation

An alarm setpoint 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 setpoint 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 setpoint. The numerical adjustment requires control of the process as well as additional time to establish the alarm setpoint. Use the adjustment procedure that is the most appropriate for the application requirement.

Numerical Alarm Setpoint Adjustment

The control module has two mutually exclusive alarms identified as Alarm No. 1 and Alarm No. 2. Each has an alarm setpoint adjustment potentiometer and LED indicator. Both alarms can be set up 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. Refer to [Figure 13](#) below for the location of key control module components (potentiometers, LEDs, switch, etc.).

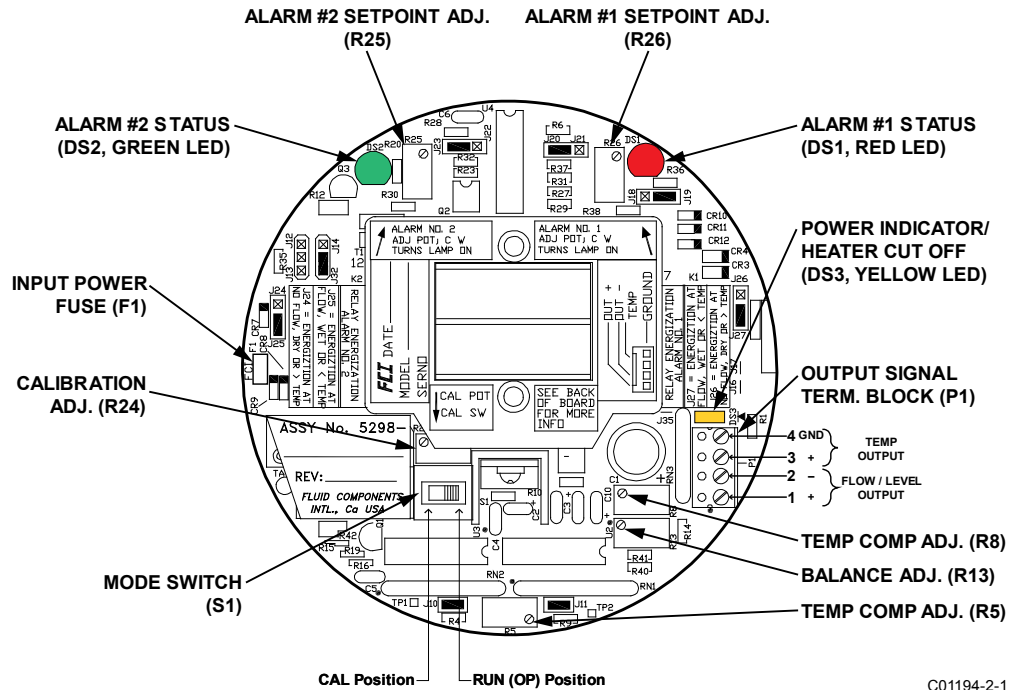


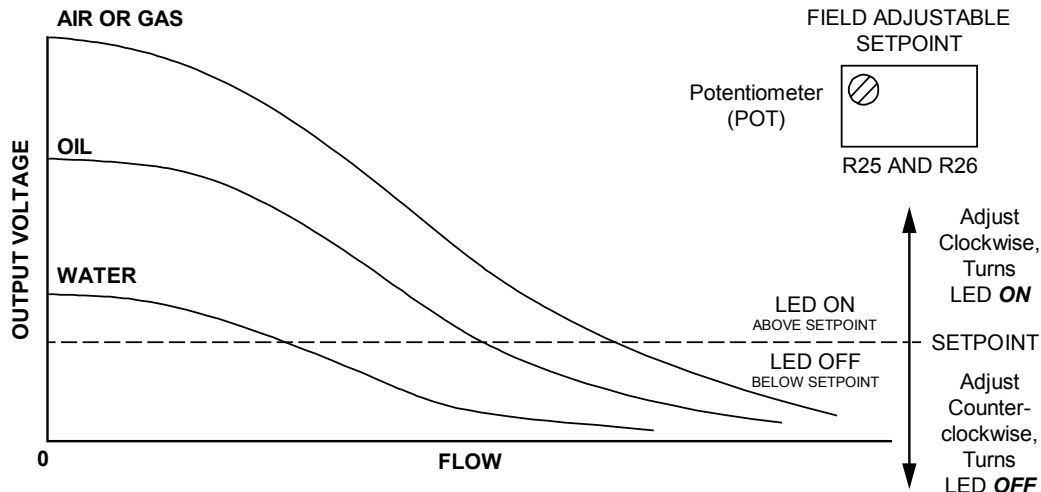
Figure 13 – 5298 Control Module Component Locations

Air/Gas Flow Applications

1. Remove instrument's enclosure cover (integral) or open enclosure door (remote).
2. Turn instrument power ON. Verify yellow LED is ON. Allow fifteen minutes warm-up time.
3. Verify mode switch is in RUN position.
4. Attach DC voltmeter to P1 terminal block: Positive (+) lead on terminal 1 and negative (-) lead on terminal 2.

Note: Terminal block P1 can be unplugged from the control module to make connections easier (pull block straight up).
5. Establish normal process flow condition and allow signal to stabilize.

Note: The output signal at terminal block P1 varies 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 14](#) below.
6. Record normal flow signal value:
Normal Flow Signal = _____ volts DC
7. Follow either *Detecting Decreasing Flow* or *Detecting Increasing Flow* procedure below for each air/gas flow application alarm.



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Figure 14 – Flow Application Signal Output

Detecting Decreasing Flow (Low Flow Alarm)

1. Stop process flow and allow signal to stabilize.
2. Record no-flow signal: (Observe that no-flow signal is greater than normal flow signal.)
No-Flow Signal = _____ volts DC
3. Determine setpoint by calculating average of normal and no-flow output signals (i.e., if normal signal is 2.000 volts and no-flow signal is 5.000 volts, then calculated setpoint would be 3.500 volts). Record this value:
Calculated Setpoint = _____ volts DC

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

4. Slide mode switch to CAL position.
5. Adjust calibrate potentiometer R24 until voltmeter displays calculated setpoint.
6. For appropriate alarm, determine whether status LED is ON or OFF (red for alarm #1 or green for alarm #2). If LED is OFF, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) slowly clockwise just until LED turns ON.

OR

If LED is ON, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) counterclockwise until LED turns OFF, and then slowly turn pot clockwise just until LED turns ON.

7. If this is the only flow application alarm to be set up, skip to *Air/Gas Flow Procedure, Continued*.

Detecting Increasing Flow (High Flow Alarm)

1. Establish excessive process flow condition and allow signal to stabilize.
2. Record high flow signal. (Observe that high flow signal is less than normal flow signal.)
High Flow Signal = _____ volts DC
3. Determine setpoint by calculating average of normal and high flow output signals (i.e., if normal signal is 2.000 volts and high flow signal is 1.000 volts, then calculated setpoint would be 1.500 volts). Record this value:
Calculated Setpoint = _____ volts DC

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

4. Slide mode switch to CAL position.
5. Adjust calibrate potentiometer R24 until voltmeter displays calculated setpoint.
6. For appropriate alarm, determine whether status LED is ON or OFF (red for alarm #1 or green for alarm #2). If LED is ON, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) slowly counterclockwise just until LED turns OFF.

OR

If the LED is OFF, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) clockwise until LED turns ON and then slowly turn pot counterclockwise just until LED turns OFF.

7. If this is the only flow application alarm to be set up, skip to *Air/Gas Flow Procedure, Continued*.

Air/Gas Flow Procedure, Continued

1. Slide mode switch to RUN position.
2. Establish normal process flow condition. For low-flow alarm setups, observe that status LED is OFF. For high flow alarm setups, observe that status LED is ON.
3. Establish process alarm condition and monitor voltmeter display.
4. When output signal passes through calculated setpoint value, verify that status LED turns ON for low-flow alarm or OFF for high flow alarm, and that relay contacts change state.
5. Reestablish normal process flow condition. Verify that both LED and relay contacts reset.
6. Disconnect voltmeter from P1.
7. Replace enclosure cover (integral)/close enclosure door (remote).

Note: The alarm can be set for a specific flow rate. Follow the *Air/Gas Flow Applications* procedure up to step 5 except establish the specific flow rate rather than the normal flow. The output signal will be the setpoint value. Determine whether the alarm should actuate with decreasing or increasing flow and skip to the appropriate step 3 in *Detecting Decreasing Flow* or *Detecting Increasing Flow*, respectfully. Enter the specific flow rate value as the setpoint. 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 setpoint value. 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. It is recommended that the relay coils be energized when the process condition is normal. This enables the alarm to close or open the contacts in case of a power failure.

Wet/Dry Liquid Level Applications

1. Remove instrument's enclosure cover (integral) or open enclosure door (remote).
2. Turn instrument power ON. Verify yellow LED is ON. Allow fifteen minutes warm-up time.
3. Verify mode switch is in RUN position.
4. Attach DC voltmeter to P1 terminal block: Positive (+) lead to terminal 1 and negative (-) lead to terminal 2.

Note: Terminal block P1 can be unplugged from the control module to make connections easier (pull block straight up).

5. Raise process fluid level so that sensor element is wet.
6. Allow output signal to stabilize and record wet condition value.

Wet Condition Signal = _____ volts DC

Note: The output signal at terminal block P1 is relative to the type of process media detected. See [Figure 15](#) below.

7. Lower process fluid level so that sensor element is dry.
8. Allow output signal to stabilize and record dry condition value. (Dry signal should be greater than wet signal.)
9. Determine setpoint by calculating average of wet and dry output signals (i.e., if wet signal is 0.200 volts and dry signal is 4.000 volts, then calculated setpoint would be 2.100 volts). Record this value:

Calculated Setpoint = _____ volts DC

Note: The calculated setpoint 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.

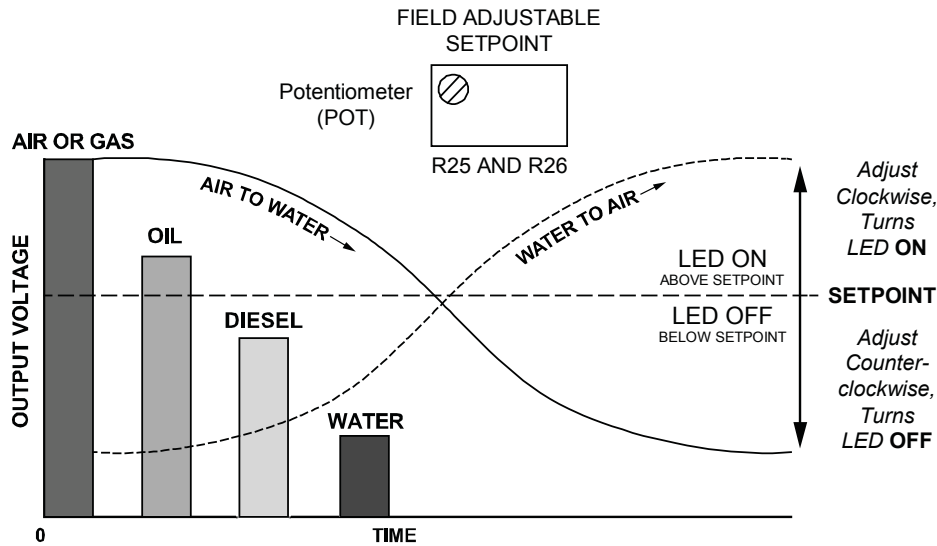


Figure 15 – Level Application Signal Output

10. Slide mode switch to CAL position.
11. Adjust calibrate potentiometer R24 until voltmeter equals calculated setpoint.
12. For appropriate alarm, determine whether status LED is ON or OFF (red for alarm #1 or green for alarm #2).
13. Follow either *Detecting Dry Condition* or the *Detecting Wet Condition* procedure below for each level application alarm.

Detecting Dry Condition (Low Level Alarm)

1. If status LED is OFF, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) slowly clockwise just until LED turns ON.
OR
If status LED is ON, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) counterclockwise until LED turns OFF and then slowly turn pot clockwise just until LED turns ON.
2. If this is the only level application alarm to be set up, skip to *Wet/Dry Liquid Level Procedure, Continued*.

Detecting Wet Condition (High Level Alarm)

1. If the status LED is on, turn the setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) slowly counterclockwise just until the LED turns off.
OR
If the status LED is off, turn the setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) clockwise until the LED turns on and then slowly turn pot counterclockwise just until the LED turns off.
2. If this is the only level application alarm to be set up, skip to *Wet/Dry Liquid Level Procedure, Continued*.

Wet/Dry Liquid Level Procedure, Continued

1. Slide mode switch to RUN position. Observe that status LED is ON if sensor element is dry and OFF if sensor element is wet.
2. Monitor voltmeter display while raising or lowering process fluid level. When output signal passes through setpoint, verify that status LED and relay contacts change state.
3. Reestablish normal level condition. Verify that both LED and relay contacts reset.
4. Disconnect voltmeter from P1.
5. Replace enclosure cover (integral)/close enclosure door (remote).

Note: The relay logic default configuration is set for the relay coil to be de-energized when the level signal is greater than the setpoint value (i.e., the relay coil is de-energized when the sensor element is dry). It is recommended that alarms be configured so that relay coils are energized when the process condition is normal. This lets the alarm relay contacts indicate an alarm in the event of a power failure.

Liquid Flow Applications

1. Remove instrument's enclosure cover (integral) or open enclosure door (remote).
2. Turn instrument power ON. Verify yellow LED is ON. Allow fifteen minutes warm-up time.
3. Verify mode switch is in RUN position.
4. Attach DC voltmeter to P1 terminal block: Positive (+) lead to terminal 1 and negative (-) lead to terminal 2.

Note: Terminal block P1 can be unplugged from the control module to make connections easier (pull block straight up).
The output signal at connector P1 varies inversely with changes in the process flow rate. The output signal level is relative to the type of process media being measured. See [Figure 14](#), page 18.

5. Establish the normal process flow condition and allow the signal to stabilize.
6. Record normal flow signal value:
Normal Flow Signal = _____ volts DC
7. Follow either *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 no-flow signal: (Observe that no-flow signal is greater than normal flow signal.)
No-Flow Signal = _____ volts DC
3. Determine setpoint by calculating average of normal and no-flow output signals. (i.e.; If normal signal is 0.080 volts and the no-flow signal is 0.300 volts, then calculated setpoint would be 0.190 volts.) Record this value:
Calculated Setpoint = _____ volts DC

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

4. Slide mode switch to CAL position.
5. Adjust calibrate potentiometer R24 until voltmeter displays calculated setpoint.
6. For appropriate alarm, determine whether status LED is ON or OFF (red for alarm #1 or green for alarm #2). If LED is OFF, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) slowly clockwise just until LED turns ON.
OR
If LED is ON, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) counterclockwise until LED turns OFF, and then slowly turn pot clockwise just until LED turns ON.
7. If this is the only flow application alarm to be set up, skip to *Liquid Flow Procedure, Continued*.

Detecting Increasing Flow (High Flow Alarm)

1. Establish excessive flow condition and allow signal to stabilize.
2. Record high flow signal. (Observe that high flow signal is less than normal flow signal.)
High Flow Signal = _____ volts DC
3. Determine setpoint by calculating average of normal and high flow output signals. (i.e., if normal signal is 0.080 volts and high flow signal is 0.030 volts, then the calculated setpoint would be 0.055 volts). Record this value.
Calculated Setpoint = _____ volts DC

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

4. Slide mode switch to CAL position.
5. Adjust calibrate potentiometer R24 until voltmeter displays calculated setpoint.
6. For appropriate alarm, determine whether status LED is ON or OFF (red for alarm #1 or green for alarm #2). If LED is ON, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) slowly counterclockwise just until LED turns OFF.
OR

If the LED is OFF, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) clockwise until LED turns ON and then slowly turn pot counterclockwise just until LED turns OFF.

- If this is the only flow application alarm to be set up, skip to *Liquid Flow Procedure, Continued*.

Liquid Flow Procedure, Continued

- Slide mode switch to RUN position.
- Establish normal process flow condition. For low-flow alarm setups, observe that status LED is OFF. For high flow alarm setups, observe that status LED is ON.
- Establish process alarm condition and monitor voltmeter display.
- When output signal passes through calculated setpoint value, verify that status LED turns ON for low-flow alarm or OFF for high flow alarm, and that relay contacts change state.
- Reestablish normal process flow condition. Verify that both LED and relay contacts reset.
- Disconnect voltmeter from P1.
- Replace enclosure cover (integral)/close enclosure door (remote).

Note: The alarm can be set for a specific flow rate. Follow the *Liquid Flow Applications* procedure up to step 5 except establish the specific flow rate rather than the normal flow. The output signal will be the setpoint value. Determine whether the alarm should actuate with decreasing or increasing flow and skip to the appropriate step 3 in *Detecting Decreasing Flow* or *Detecting Increasing Flow*, respectfully. Enter the specific flow rate value as the setpoint. Then follow the *Liquid Flow Procedure, Continued* 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 setpoint value. 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. It is recommended that the relay coils be energized when the process condition is normal. This enables the alarm to close or open the contacts in case of a power failure.

Adjustment by Observation

Note: The control module has two mutually exclusive alarms identified as Alarm No. 1 and Alarm No. 2. Each alarm has a setpoint adjustment potentiometer and an LED indicator. Each alarm can be set up 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. Refer to [Figure 13](#) on page 17 to locate the adjustment potentiometers and LEDs.

Flow Applications

- Ensure that the instrument has been properly installed in the pipeline. Fill the pipeline so the sensor element is surrounded by the process medium.
- Apply power to the instrument and allow fifteen minutes for the sensor element to stabilize.
- Flow the pipeline at the normal or expected rate. Remove the enclosure cover to allow access to the control module to make adjustments.

Detecting Decreasing Flow (Low Flow Alarm)

If the status LED is OFF, turn the setpoint 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 overshoot, repeat the procedure.

Detecting Increasing Flow (High Flow Alarm)

If the status LED is ON, turn the setpoint 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 overshoot, repeat the procedure.

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. Refer to [Figure 14](#), page 18.

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 sensor element to become active and stabilize.
3. Remove the enclosure cover (integral)/open the enclosure door (remote) to access the control module for adjustments.

Detecting Dry Condition (Adjustment with sensor Element Wet)

Verify that the sensor element is wet. If the status LED is OFF, turn the setpoint 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, repeat the procedure.

Detecting Wet Condition (Adjustment with Sensor Element Dry)

Caution: Give consideration to the fact that air or gas flowing over the sensor element may decrease the output signal resulting in a false alarm. If the sensor element is exposed to air or gas flow in the dry condition, or where the process media is highly viscous, make setpoint adjustments in the wet condition only.

Perform field adjustments made in the dry condition 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 sensor element. If the status LED is ON, turn the setpoint 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, repeat the procedure.

Signal Output for Level Applications

The output signal at P1 is lowest in water and highest in air. Refer to [Figure 14](#), page 18.

Temperature Applications

For temperature versus voltage values, see [Table 9](#) on page 25. These values have an accuracy of ± 5 °F (2.78 °C). There is also a conversion formula later in this section 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 recommended 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 sensor 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 pins. Store the jumper on the control module by plugging it across J12 and J14. Placing the jumper here will not turn on the heater.

1. Remove instrument's enclosure cover (integral) or open enclosure door (remote).
2. Turn instrument power ON. Verify yellow LED is ON. Allow fifteen minutes warm-up time.
3. Verify mode switch is in RUN position.
4. Attach DC voltmeter to P1 terminal block: Positive (+) lead to terminal 3 and negative (-) lead to terminal 4.

Note: Terminal block P1 can be unplugged from the control module to make connections easier (pull block straight up).

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

Normal Temperature Signal = _____ volts DC

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

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

Detecting Increasing Temperature (High Temperature Alarm)

1. Slide mode switch to CAL position.
2. Adjust calibrate potentiometer R24 until voltmeter displays desired temperature signal in [Table 9](#), page 25.
3. For appropriate alarm, determine whether status LED is ON or OFF (red for alarm #1 or green for alarm #2). If LED is OFF, turn setpoint adjustment potentiometer (R26 for alarm # 1 or R25 for alarm # 2) slowly clockwise just until LED turns ON.

OR

If LED is ON, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) counterclockwise until LED turns OFF and then slowly turn pot clockwise just until LED turns ON.

4. If this is the only temperature application alarm to be set up, skip to *Temperature Procedure, Continued*.

Detecting Decreasing Temperature (Low Temperature Alarm)

1. Slide switch to CAL position.
2. Adjust calibrate potentiometer R24 until voltmeter displays normal temperature signal.
3. For appropriate alarm, determine whether status LED is ON or OFF (red for alarm #1 or green for alarm #2). If the LED is ON, turn the setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) slowly counterclockwise just until the LED turns OFF.

OR

If the LED is OFF, turn setpoint adjustment potentiometer (R26 for alarm #1 or R25 for alarm #2) clockwise until LED turns ON and then slowly turn pot counterclockwise just until LED turns OFF.

4. If this is the only temperature application alarm to be set up, skip to *Temperature Procedure, Continued*.

Temperature Procedure, Continued

1. Slide mode switch to RUN position.
2. Establish normal process temperature condition. For high temperature alarm setups, observe that status LED is OFF at normal temperatures. For low temperature alarm setups, observe that status LED is ON at normal temperatures.
3. Establish process alarm condition and monitor voltmeter display.
4. When output signal passes through setpoint value, verify that status LED turns ON for high temperature alarms or OFF for low temperature alarms, and that relay contacts change state.
5. Reestablish normal process temperature condition. Verify that both LED and relay contacts reset.
6. Disconnect voltmeter from P1.
7. Replace enclosure cover (integral)/close enclosure door (remote).

Note: The relay logic default configuration is set for the relay coil to be de-energized when the temperature signal is greater than the setpoint value (i.e., the relay coil is de-energized when the temperature exceeds setpoint). It is recommended that alarms be configured so that relay coils are energized when the process condition is normal. This lets the alarm relay contacts indicate an alarm in the event of a power failure.

Converting Temperature Output Voltage to °F/°C Temperature

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 for a known FLT temperature output voltage.

$$y = a + b \left(\frac{x}{0.002} \right) + c \left(\frac{x}{0.002} \right)^2$$

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:

$$C = (F - 32) \times \frac{5}{9}$$

Table 9 – 0.00385 ohms/ohms/°C 1000-ohm Platinum Sensors, Temperature vs. Voltage Output

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

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

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

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

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

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 install the following jumpers: J18, J20, J23, J24, J27.

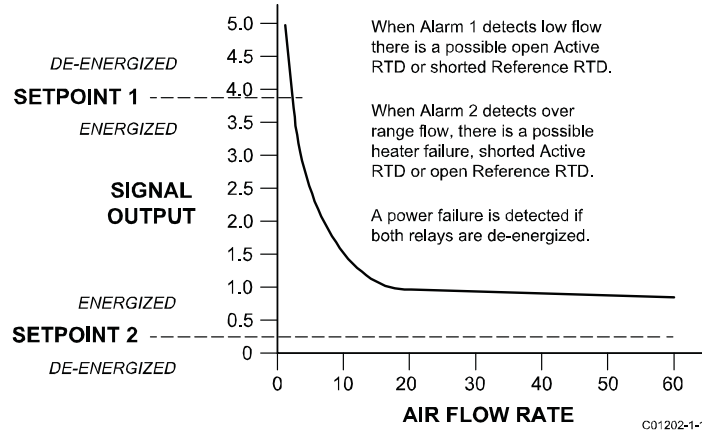


Figure 16 – Low Flow Fail-Safe Alarm

The following information is assumed:

- Relay is de-energized in the ALARM condition.
- Alarm #1 setpoint is adjusted for desired low flow alarm velocity or signal.
- Alarm #2 setpoint is adjusted slightly below minimum signal output (over range flow).

High Flow Alarm Settings

For the high flow fail safe setup install the following jumpers: J18, J20, J23, J25, J26.

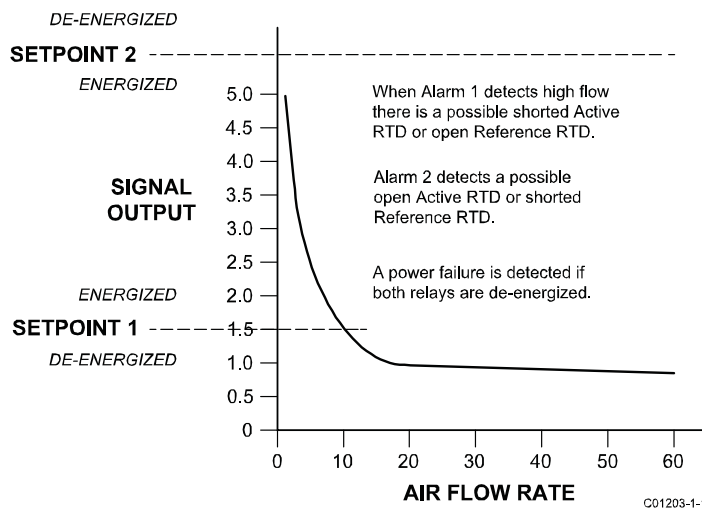


Figure 17 – High Flow Fail-Safe Alarm

The following information is assumed:

- Relay is de-energized in the ALARM condition.
- Alarm #1 setpoint is adjusted for desired high flow alarm velocity or signal.
- Alarm #2 setpoint is adjusted above maximum signal output (under range flow not to exceed 7.0 volts).

Low Level Alarm Settings (Sensor Element Normally Wet)

For the low level fail safe setup install the following jumpers: J18, J20, J23, J24, J27.

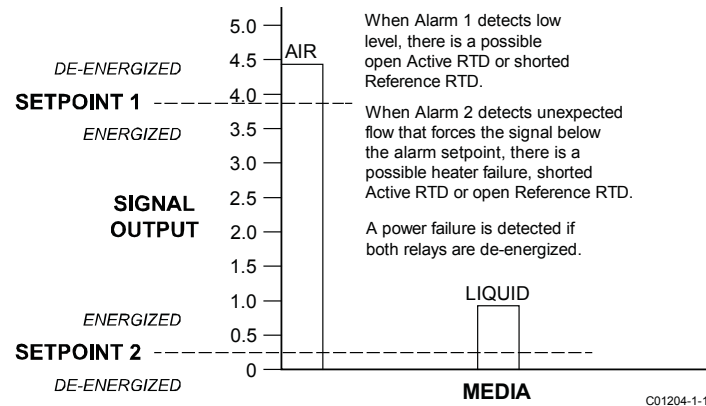


Figure 18 – Low Level Fail-Safe Alarm

The following information is assumed:

- Relay is de-energized in the ALARM condition.
- Alarm #1 setpoint is adjusted for the mean value between the air and liquid signals.
- Alarm #2 setpoint is adjusted to approximately half of the liquid signal. (A lower setting might be needed if the liquid is moving.)

High Level Alarm Settings (Sensor Element Normally Dry)

For the high level fail safe setup install the following jumpers: J18, J20, J23, J25, J26.

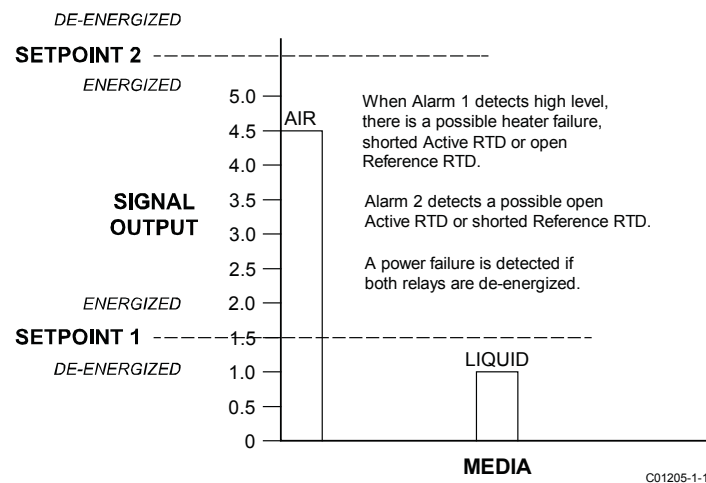


Figure 19 – High Level Fail-Safe Alarm

The following information is assumed:

- Relay is de-energized in the ALARM condition.
- Alarm #1 setpoint is adjusted for the mean value between the air and liquid signals.
- Alarm #2 setpoint is adjusted above maximum signal output for air (not to exceed 7.0 volts).

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4 MAINTENANCE

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

Caution: The instrument contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control module. Refer to [Observe ESD Precautions](#) on page 5 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. Refer to [APPENDIX C](#), page 45.

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 sensor element wiring on a common sense basis related to the application environment. Periodically inspect the conductors for corrosion as well as the cable insulation for signs of deterioration.

Sensor 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.

Sensor Element Assembly

Periodically remove the sensor 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 sensor element with a soft brush and available solvents that are compatible with the instruments wetted metal.

Power Fuse Replacement

Table 10 below summarizes the power fuses used in FLT93 Series instruments.

Table 10 – Power Fuse Summary

Qty	FCI Assembly P/Ns	Description	Fuse Mfgr P/N	FCI Fuse P/N
1	5298-xxxxxxx (Control Module)	Subminiature, axial lead fuse, Littelfuse 473 Series, 1.5 A/125 V slo-blo	0473-01.5	015699-01
1	010006 (Pnl Assy, 12-pin Socket & Aux Relay) 000469 (Pnl Assy & 12-pin Socket)	Glass cartridge fuse, Bussman AGX Series, 1.5 A/250 V, normal/fast blow	AGX-1-½	010047-01
2	023313-01 (DC Power Filter Board) 022326-01 (AC Power Filter Board)	Radial lead fuse, Littelfuse TR5 Series 374, 4.0 A/250 V, time-lag	37414000410	019933-05

Control Module Fuse

The control module is provided with a subminiature, axial lead 1.5 A/125 V slo-blo fuse (F1) soldered onto the board. See Figure 13 on page 17 for the location of the fuse. To check the integrity of the control module fuse turn instrument power OFF and unplug control module from its socket. Measure the resistance across F1. Any reading other than a short indicates a blown fuse. Replace with Littelfuse 473 Series p/n 0473-01.5. This part is available from FCI (p/n 015699-01). Alternatively, the module can be returned to FCI for fuse replacement/repair (refer to APPENDIX D, page 49 for customer service procedures).

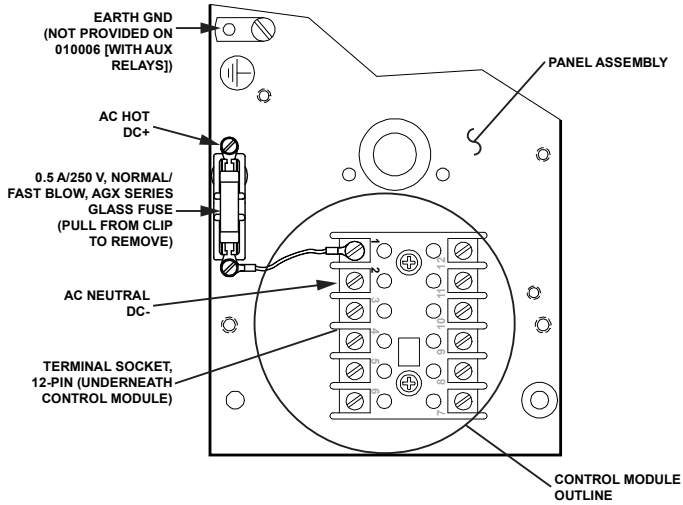
Remote Unit Fuse(s)

Remote units have additional fuse options that vary depending on the type panel assembly used. Figure 20 below shows the remote unit panel assemblies and the fuse(s) used in each type.

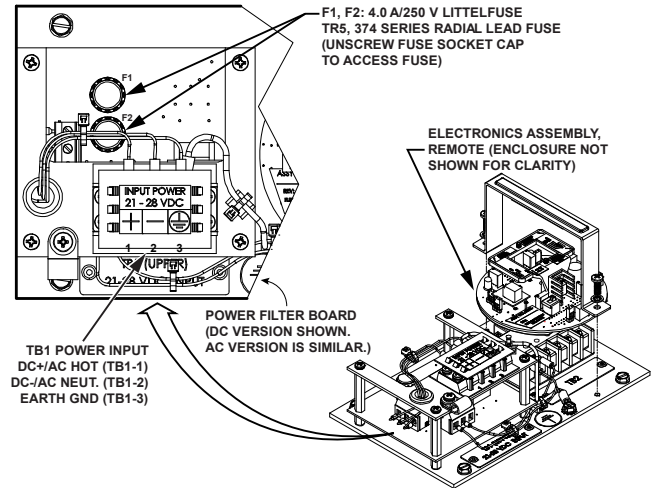
Note: Panel assembly 018247 (with auxiliary relay board) provides no additional fusing (control module fuse only).

Remote Panel Assembly with Glass Fuse -- Input power overload protection is provided by a 0.5 A/250 V, normal/fast blow, 0.250" x 1" glass cartridge fuse (AGX series). The fuse is installed on a clip-on fuse holder on the metal panel assembly. Replace a blown fuse with the same type fuse.

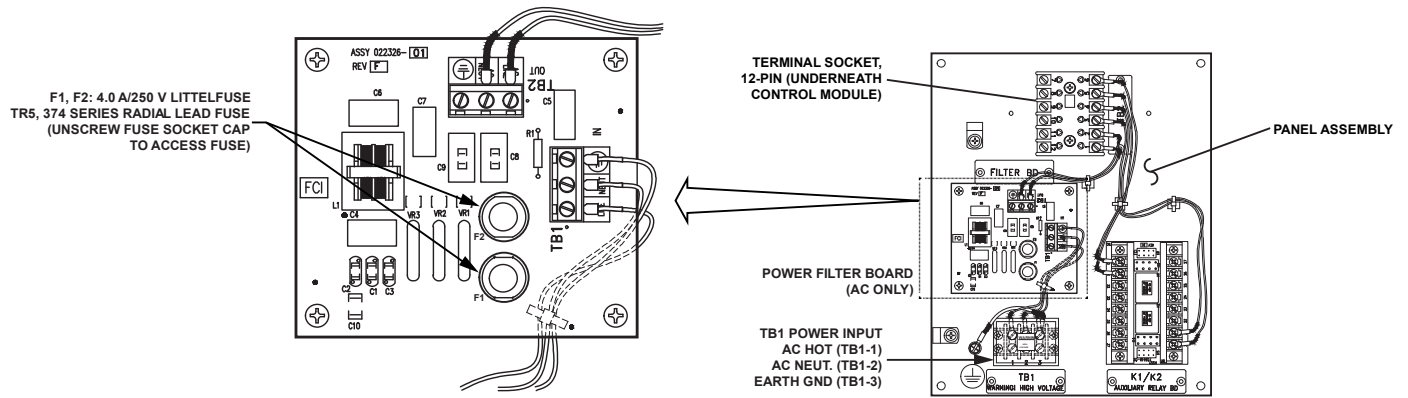
Remote Panel Assembly with Power Filter Board -- Input power overload protection is provided by two (2) 4 A/250 V socketed radial lead fuses on the power filter board. To check the integrity of a radial lead fuse first turn instrument power OFF. Unscrew the fuse socket's clear plastic cap and pull out the fuse. Measure the fuse resistance. Any reading other than a short (i.e., open circuit) indicates a blown fuse. Replace with Littelfuse TR5, Series 374 fuse, part no. 37414000410.



(a) Panel Assy. With/Without (010006/000469) Aux. Relay Board, Glass Fuse



(b) Panel Assy. With AC/DC (022436/023048) Power Filter, No Aux. Relay Board



(c) Panel Assembly 024065 With AC Power Filter Board and Aux. Relay Board

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Figure 20 – Remote Panel Assembly Fusing and Input Power Summary

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5 TROUBLESHOOTING

Warning: Testing of this instrument is limited to qualified personnel only. The operator assumes all responsibilities for safe practices while troubleshooting.

Caution: The instrument contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control module. Refer to [Observe ESD Precautions](#) on page 5 for ESD details.

Tools Needed

- Digital multimeter (DMM)
- Small standard screwdriver
- Small phillips head screwdriver

Quick Check

- Verify that the control module is seated firmly.
- Verify that amber LED DS3 is ON when power is applied. In most cases this LED is ON steady. If LED DS3 is blinking the heater power is set too high for most applications.
- Verify correct jumper placement for the desired configuration. See [OPERATION](#) starting on page 15 for jumper information.
- Ensure that control module mode switch is in the RUN position (switch S1 positioned toward the heat sink).
- Check any customer supplied fuses.
- See the troubleshooting matrix [Table 13](#), page 39.

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 sensor element and the control module are the same number. The sensor element and the control module are a matched set and cannot be operated independently of each other. The exception to this is if a removal and replacement was done for repair purposes. All jumper configurations and calibrations are normally set at the factory.

Check Input Power and Module Configuration

Verify that the correct power source is turned on and connected. Verify that the control module's configuration jumpers are correct for the application. See [Configuration Jumpers](#) on page 15 for the correct positions.

Check the Instrument Installation

Review the instrument installation information in [INSTALLATION](#), page 5 to verify correct mechanical and electrical installation.

Check for Moisture

Check for moisture on the control module or in the sensor, or control module enclosure. Moisture on the control module 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 matrix [Table 12](#), page 39 for troubleshooting suggestions.

Troubleshooting the Sensor Element

Determine if the sensor element is wired correctly or has failed by performing resistance checks. Turn off the input power to the instrument. Unplug the control module from its socket and measure the resistances at the terminal block socket as indicated in [Table 11](#) below.

If the ohm readings are incorrect and the instrument is a remote unit (sensor element enclosure separate from the control module enclosure), disconnect the sensor element cable at the local (sensor element) enclosure. Measure the resistance as shown in [Table 12](#) below. If the resistances are correct then the cable between the enclosures is probably bad or not connected properly (i.e., loose, corroded, or connected to the wrong terminals).

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

Table 11 – Nominal Resistance at Control Module Terminal Block Socket

Socket Number	Resistance
7 to 8	1.1 kΩ ¹
7 to 9	2.2 kΩ ¹
7 to 10	110-120 Ω FOR FLT93S 548-620 Ω FOR FLT93F
8 to 9	1.1 kΩ ¹

Note: 1. Approximate resistance with sensor at 78 °F/26 °C temperature.

Table 12 – Nominal Resistance at Sensor Element Enclosure Terminal Block (Remote Applications Only)

Terminal No.	Resistance
1 to 2	110-120 Ω FOR FLT93S 548-620 Ω FOR FLT93F
3 to 4	1.1 kΩ ¹
3 to 5	2.2 kΩ ¹
4 to 5	1.1 kΩ ¹
Shield connected to control module socket only. No connection to local enclosure or its terminal block. ²	

Note: 1. Approximate resistance with sensor at 78 °F/26 °C temperature.

2. Refer to wiring diagram [Figure 6](#), page 10.

Troubleshooting the Transmitter

When following the below steps refer to [Figure 13](#) on page [17](#) for the location of control module components.

Table 13 – Troubleshooting Matrix

Step	Area to Check	Observations
1	Yellow LED Status: ON, OFF or BLINKING	<p>LED ON – 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 230 VAC. Check for proper input power: OK: See Step 2. NOT OK: Supply power will need to be changed to work with the control module or the control module must be returned to FCI for reconfiguration (power jumpers fixed at the factory).</p> <p>LED OFF – Verify input power ON and of proper voltage. OK: See Step 4 NOT OK: Supply power will need to be changed to work with the control module or the control module must be returned to FCI for reconfiguration. Reinstall the control module and restart the system and check for proper operation. If LED is still off go to Step 4.</p> <p>LED BLINKING – For Liquid Flow Applications: Line is DRY. Make sure the line is packed. For Gas Flow Applications: Heater power set too high. Set to lower value. For Liquid level Applications: Heater power set too high. Set to lower value. 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.</p>
2	Mode Switch	<p>Make sure the mode switch is in the “RUN” position. OK: See Step 3.</p>
3	Signal Voltage Observation	<p>Remove the Heater Wattage Control jumper. With a voltmeter measure the signal voltage at P1-1 and P1-2. a) The voltage is 0 volts ± 25 mV: OK, Reinstall the jumper and wait 5 minutes. Go to c) or d) as applicable. b) The voltage is out of tolerance: NOT OK, Make sure that the serial numbers on the control board and the sensor element match. If the serial numbers are OK then go to <i>Restoring Temp Comp Adjustments</i> procedure in Appendix C then go to c) or d) as applicable. c) The voltage is between 0.1 and 6 volts and changes with flow or level changes: OK. See Step 9. 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, Sensor element may be miswired or is defective. Miswiring is more common on remote installations at the initial installation. See Step 6 for integral installation or Step 7 for remote installation.</p>
4	Power Supply Check	<p>Measure the voltage at P1-2 and P1-4 (Gnd). Voltage is 9 volts ±2% (8.8-9.2 VDC): OK. See Step 6 for integral installation or Step 7 for remote installation. NOT OK. See Step 5.</p>

Step	Area to Check	Observations
5	Fuse Check	<p>Turn off the power to the FLT and remove the control module. With an ohmmeter, measure the continuity of fuse F1. See Control Module Fuse on page 34 for details.</p> <p>Fuse has no continuity: NOT OK Replace the fuse and restart the system. Check for proper operation. Call the factory if the fuse fails again.</p> <p>Fuse has continuity: OK Remote unit only: Check panel assembly fuse(s). See Remote Unit Fuse(s), page 34 for details. Replace any blown fuses. If panel fuse(s) OK or if panel fuse not used, control module is defective. Replace it with a control module that has the temp comp adjusted for the particular sensor element. Follow the procedure in Restoring Temp Comp Adjustments in APPENDIX C and restart the system.</p>
6	Sensor Element Check for Integral Installation	<p>Turn off the power and remove the control module. Follow the Troubleshooting the Sensor Element procedure in this section (page 38).</p> <p>Sensor Failure: Call the Factory</p> <p>Sensors are OK: See Step 8.</p>
7	Sensor Element Check for Remote Installation	<p>Turn off the power and remove the control module. Follow the Troubleshooting the Sensor Element procedure in this section (page 38).</p> <p>Remote cable miswired or damaged: Repair and restart the system.</p> <p>Sensor Failure: Call the Factory</p> <p>Sensors are OK: See Step 8.</p>
8	Sensor Balance and Temp Comp Settings Check	<p>Turn off the power and remove the control module. Follow the procedure in Appendix C to check the temp comp settings and balance adjustment.</p> <p>Temp Comp Settings are Wrong: Perform the “Restore Temp Comp” Procedure. Then perform the sensor balancing procedure.</p> <p>Temp Comp Settings are OK: Perform the Balancing procedure. Restart the system for proper operation. See Step 9.</p>
9	Alarm Switch Point Settings	<p>Make sure that the jumpers are set correctly. The relevant settings are “Alarm Duty”, “Alarm Quantity” and “Energization”. Refer to the tables in Section 3 or the information at the bottom of the control module.</p> <p>Set mode switch set to CAL and check and record the alarm settings. Compare these setting to the signals generated by the process and make adjustment if necessary. Refer to OPERATION, page 15 for guidelines on setting a switch point in your particular application.</p>

Spares

FCI recommends at least one control module to be kept as a spare. Depending on the number of units the customer has installed and if the switches are critical, it is recommended that an entire spare switch assembly be kept as a spare. The control module part number is 5298-xxxxxxx. The dash number can be found on the control module, or by contacting FCI.

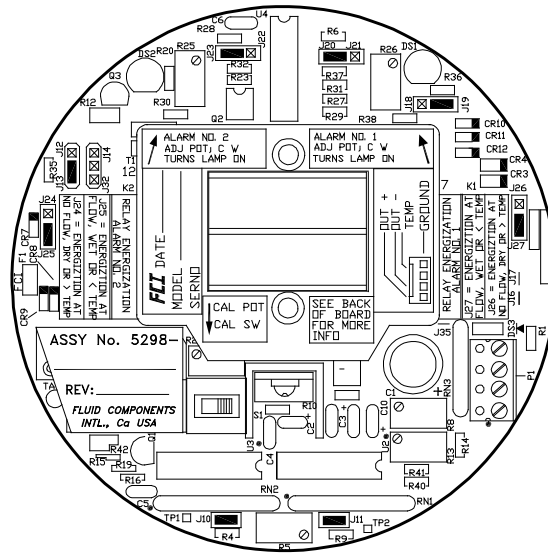
Defective Parts

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

Customer Service

1. In the event of problems or inquiries regarding the instrument, contact an authorized FCI field agent for the region or country. Refer to the FCI website: <http://www.fluidcomponents.com/> for a list of field service representatives (which includes phone and email contact information) and a list of service centers around the world.
2. Before contacting the FCI representative, be sure that all the applicable information is nearby so that a more effective, efficient and timely response can be provided.
3. Refer to [APPENDIX D](#), page 49 for specific customer service policy provisions.

APPENDIX A DRAWINGS



5298 CONTROL MODULE LAYOUT DRAWING, COMPONENT SIDE △ 1

Example Callout → 5298 - B 1 C 1 A 2 A 1

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
023797-01	1 mA to 2 A, 1 to 60 V, 30 WATT MAX, GOLD CONTACTS	4

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 (BETWEEN J12 & J14) "F" ELEMENT: OFF	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

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

2. ALL PLUGGABLE 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 FLTS 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 DRAWING ABOVE 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 ALARM NO. 2. THE RELAY 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.

C01009-1-3

Figure 21 – PWB 5298 Control Module, Dual Alarm

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APPENDIX B GLOSSARY

Abbreviations

Delta-R (ΔR)	Resistance differential
Delta-T (ΔT)	Temperature differential
Delta-V (ΔV)	Voltage differential
DMM	Digital Multimeter
DPDT	Double-Pole, Double-Throw
ESD	Electrostatic Discharge
FCI	Fluid Components International
GND	Ground
HTR	Heater
LED	Light Emitting Diode
RTD	Resistance Temperature Detector
SFPS	Standard Feet per Second
SPDT	Single-Pole, Double-Throw

Definitions

Active RTD	The sensor 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).
Resistance Differential Delta-R (ΔR)	The difference in resistance between the active and reference RTDs.
Temperature Differential Delta-T (ΔT)	The difference in temperature between the active and reference RTDs.
Heater (HTR)	The part of the sensor element that heats the active RTD.
Local enclosure	The enclosure attached to the sensor element. (Usually contains the control module and mounting socket.)
Reference RTD	The part of the sensor element that senses the process media temperature.
Remote enclosure	An optional protective enclosure for the control module. Used when the control module must be located away from the sensor element.
Resistance Temperature Detector (RTD)	A sensor whose resistance changes proportionally to temperature changes.
Sensor element	The transducer portion of the instrument. The sensor 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 sensor element that protects the heater and RTDs from the process fluid.
Turndown	The ratio of minimum flow rate to maximum flow rate.

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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 that 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: To properly adjust the Temp Comp certain parameters must be measured and calculated. All temperature measurements are to be converted to degrees Fahrenheit before a temperature differential is found. These parameters and measurements are 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 module is replaced or if the Temp Comp potentiometers are accidentally moved the adjustments must be restored. There are three adjustments that need to be made on the control module 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 included in the instrument's documentation. The calibration values are listed by the instrument serial number.

Equipment Required

- 5-½ digit digital multimeter (DMM). (Small clip leads are desirable.)
- Adapter cable FCI part number 015664-01 for older version of the control module.
- Trimpot adjusting tool, for adjusting control module potentiometers.
- Temp Comp calibration data sheet (included in instrument documentation)
- 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 module. See [Observe ESD Precautions](#), page 5 for details.

Procedure

Note: The component locations described in the following steps assume the board is oriented as shown in [Figure 12](#) (jumper/test-point locations, page 16) and [Figure 13](#) (component locations, page 17). Refer to these figures when performing the steps.

1. Turn OFF instrument power. Remove control module from socket.
2. Write down where the heater wattage control jumper is located in the area of the upper left hand side of the control module. Remove the heater wattage control jumper and set it aside.
3. Remove jumpers J10 and J11 at the lower side of the control module and set them aside.
4. Connect the DMM (set to ohms) from TP1 (by J10), to the left jumper post of J10.
5. Adjust potentiometer R5 (bottom center of the control module) until the DMM reads the ohm value for R5 as shown on the Temp Comp calibration sheet that is included in the instrument's documentation.
6. Remove the DMM, and reconnect it between TP2 (by J11), and the right jumper post of J11.

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 9 through 12 make up the flow element balance procedure required to complete the Temp Comp restoration.
9. Connect the DMM (set to volts) positive lead to P1-1 (adapter cable red wire on older control module) and the negative lead to P1-2 (adapter cable blue wire on older control module). Re-install the control module on the socket.
10. Turn ON instrument power and wait fifteen minutes for the instrument to stabilize. During this time make sure that the process media is flowing or the sensor 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 ± 5 mV.
12. Turn OFF instrument power and remove DMM. Re-install heater jumper in its original position.

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

Field Temp Comp Calibration

A change in instrument application usually requires a Temp Comp recalibration. For example: The process media is gas, the factory-set Temp Comp is 40 to 140 °F. The instrument is then placed in a new application with a 300-400 °F temperature range. In this case a Temp Comp recalibration over the new temperature range ensures instrument accuracy in the new application.

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 instrument's rated maximum temperature.
- The flow rate at which the switch will alarm needs to be known.
- Data must be collected with the alarm flow rate held constant at both the low and high temperature. For gases, the flow rate must be held constant in terms of volumetric flow rate (SCFM, NCMH, etc.).

Equipment Required

- DC Power Supply, 0 to 20 VDC minimum, at 0.5 A
- 5-½ digit digital multimeter (DMM) with 4 wire clip leads, qty. 2
- #1 Phillips screwdriver
- #1 flat-blade screwdriver
- Trimpot adjusting tool, for adjusting control module potentiometers
- Insulating varnish or equivalent to reseal the potentiometers

Procedure

1. Turn OFF 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 module. 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 DMMs and the power supply to the sensor element as shown in [Figure 22](#) below.
5. Set the power supply voltage to the proper voltage as shown in [Table 14](#), page 48. 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 sensor 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 RTDs at the low temperature.
10. Raise the temperature of the process media to the maximum expected temperature. The difference between the low and the high temperature is not to exceed 100 °F.
11. Set the flow rate to the same value used for the low temperature.

Note: The flow rate must be the same at both the low and high temperature. For gases, the flow rate must be held constant in terms of volumetric flow rate (SCFM, NCMH, etc.).

12. With the instrument power on, let the instrument stabilize for fifteen minutes.
13. Record the resistance values of the active and reference RTDs for the high temperature.
14. Calculate the Temp Comp factor with the formula shown below.

$$\text{Temp Comp Factor} = \frac{\Delta R \text{ Low Temperature} - \Delta R \text{ High Temperature}}{(R \text{ Reference High Temperature}) - (R \text{ Reference Low Temperature})}$$

The Temp Comp factor is not to exceed ±0.041.

15. 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 sensor element wires to the control module socket and reinstall the socket in the enclosure if it was previously removed. Do not pinch the wires between the socket and the enclosure.
16. Look up the resistance values to adjust potentiometers R5 and R8 in the Temp Comp Factor table (Table 15, page 48). Follow the procedure in the Restoring Temp Comp adjustment section using the values found in Table 15.
17. 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.

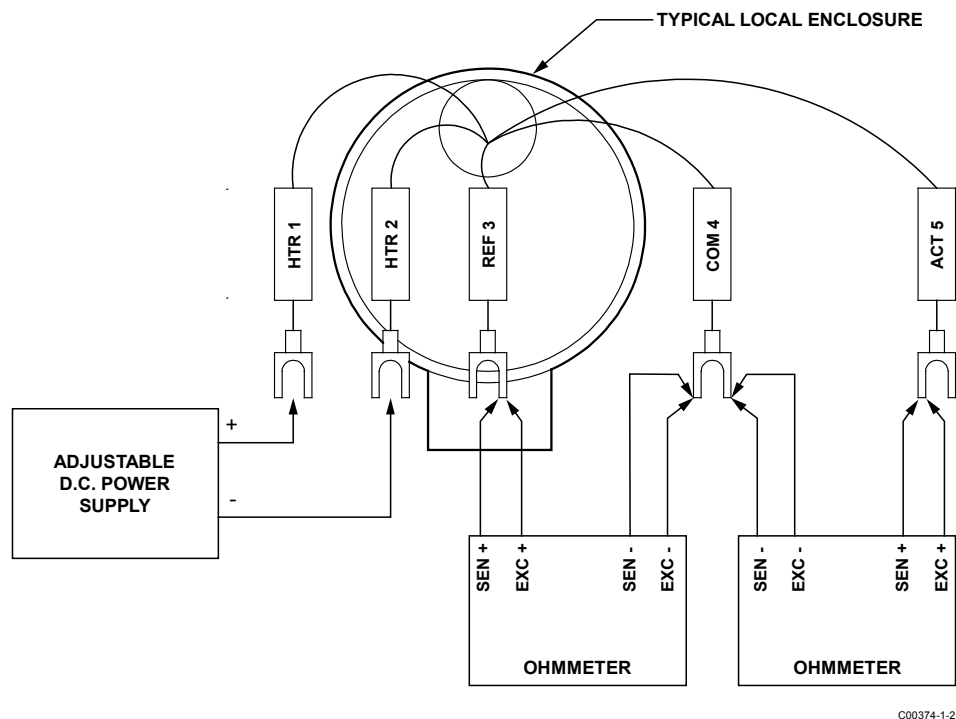


Figure 22 – Sensor Element Calibration Connections

Table 14 – Power Supply Heater Voltage Settings

FLT93S	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
FLT93F	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 15 – Temp Comp Factor Table

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

APPENDIX 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, 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. 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 Email

FCI Customer Service can be contacted by email at: techsupport@fluidcomponents.com.

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

International Support

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

After Hours Support

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

Point of Contact

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

Warranty Repairs or Returns

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

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

Non-Warranty Repairs or Returns

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

Extended Warranty

An extended warranty is available. Contact the factory for information.

Return to Stock Equipment

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

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

Field Service Procedures

Contact an FCI field representative to request field service.

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

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

Field Service Rates

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

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



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  

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

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

FCI Document No. 05CS000004D [U]



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.

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

<p>*** Decontamination Statement *** This Section Must Be Completed ***</p>
<p>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.</p>
<p><u>Certification Of Decontamination</u></p>
<p>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.</p>
<p>This certification must be signed by knowledgeable personnel responsible for maintaining or managing the safety program at your facility.</p>
<p>Process Flow Media _____</p>
<p>Product was or may have been exposed to the following substances: _____</p>
<p>Print Name _____</p>
<p>Authorized Signature _____ Date _____</p>
<p>Company Title _____</p>

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



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