3. Operation

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

Factory Default Jumper Configuration

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

Table 3-1. Standard Jumper Default Configuration

Input Power	230 Vac (J2, J5 and J6).	
Heater Power	FLT93-S	0.75 watts for air or liquid level applications. (J13)
	FLT93-F	0.25 watts for air or liquid level applications. (J14)
Number of Alarms	Two (J23). Each alarm has one set of SPDT contacts.	
Alarm No. 1 Red LED Set Point Pot. R26	Set to monitor flow or level signals (J20). Relay energized at flow or wet (J27).	
Alarm No. 2 Green LED Set Point Pot. R25	Set to monitor temperature signals (J19). Relay energized below temperature (J25). Set point at approximately: 250 F (121 C) for standard temperature, 500 F (260 C) for medium temperature, 850 F (454 C) for high temperature (FLT93-S Only).	

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

If custom factory setup or calibration was not ordered, configure the control circuit using the jumper tables (Tables 3-2 to 3-6) and then follow the set point adjustment section that is appropriate for the application.

Configuration Jumpers

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

Heater Cut-Off

The 5294 control circuit has a heater cutoff switch that limits the skin temperature of the sensing element to a temperature differential of approximately 150°F (66°C) above the process temperature. In the case where the instrument is used as a gas flow switch, and the heater wattage is set too high, the temperature differential (DT) between the RTDs may exceed the usable input range of the control circuit. The usable input range can also be exceeded in the case where the instrument is used in liquid flow applications where the heater wattage is set at the highest value, and when the sensing elements go dry. When the temperature differential is less than 150°F (66°C) the heater automatically turns back on. The yellow power indicator LED (DS3) turns on and off with the heater for a visual indication of the heater state. The LED will alternate between on and off until the condition iss corrected.

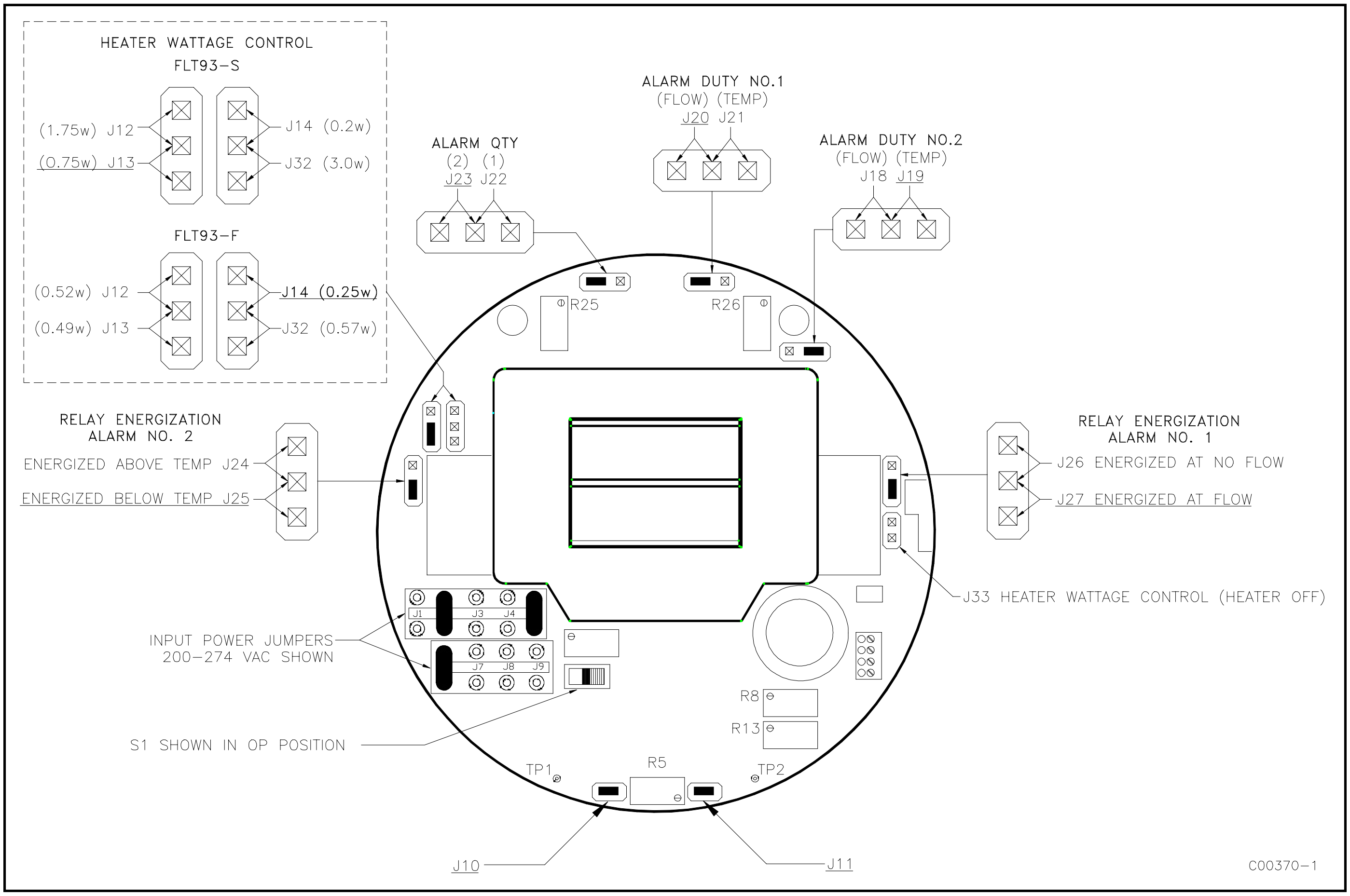

Figure 3-1. 5294 Control Circuit Jumper Locations

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

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

Alarm Set Point Adjustments

Numerical Adjustment Versus Adjustment by Observation

An alarm set point is established using either numerical adjustment or adjustment by observation. The adjustment by observation requires the customer to establish normal process operation and adjust the alarm set point relative to this condition. The numerical approach requires measuring normal and alarm process conditions with a voltmeter and setting up the instrument in the calibrate mode based on these values. The adjustment by observation requires less time to establish the alarm set point. The numerical adjustment requires control of the process as well as additional time to establish the alarm set point. Use the adjustment procedure that is the most appropriate for the application requirement.

Table 3-2. Input Power

JUMPER	POWER SELECT			
	100-130 VAC	200-260VAC	18-26VAC	21-30VDC
J1	IN	OUT	OUT	OUT
J2	OUT	IN	OUT	OUT
J3	IN	OUT	OUT	OUT
J4	OUT	OUT	IN	OUT
J5	IN	IN	OUT	OUT
J6	OUT	IN	IN	IN
J7	OUT	OUT	OUT	IN
J8	OUT	OUT	OUT	IN
J9	OUT	OUT	IN	OUT

Table 3-3A. Selectable Heater Wattage Control

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

*J13 is standard for FLT93-S and
J14 is standard for FLT93-F.

Table 3-3B. Fixed Heater Wattage Control

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

Table 3-4. Application

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

Table 3-5. Relay Energization

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

Table 3-6. Relay Contact Configuration

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

Numerical Alarm Set Point Adjustment

The control circuit has two mutually exclusive alarms; they are identified as Alarm No. 1 and Alarm No. 2. Each has an alarm set point adjustment potentiometer and LED indicator. Both alarms can be setup for one of three applications; flow, level/interface, or temperature. The following application specific adjustment procedures are generic and can be used for setting either or both alarms. Use Figure 3-2 to help locate the important setup components (potentiometers, LEDs, etc.).

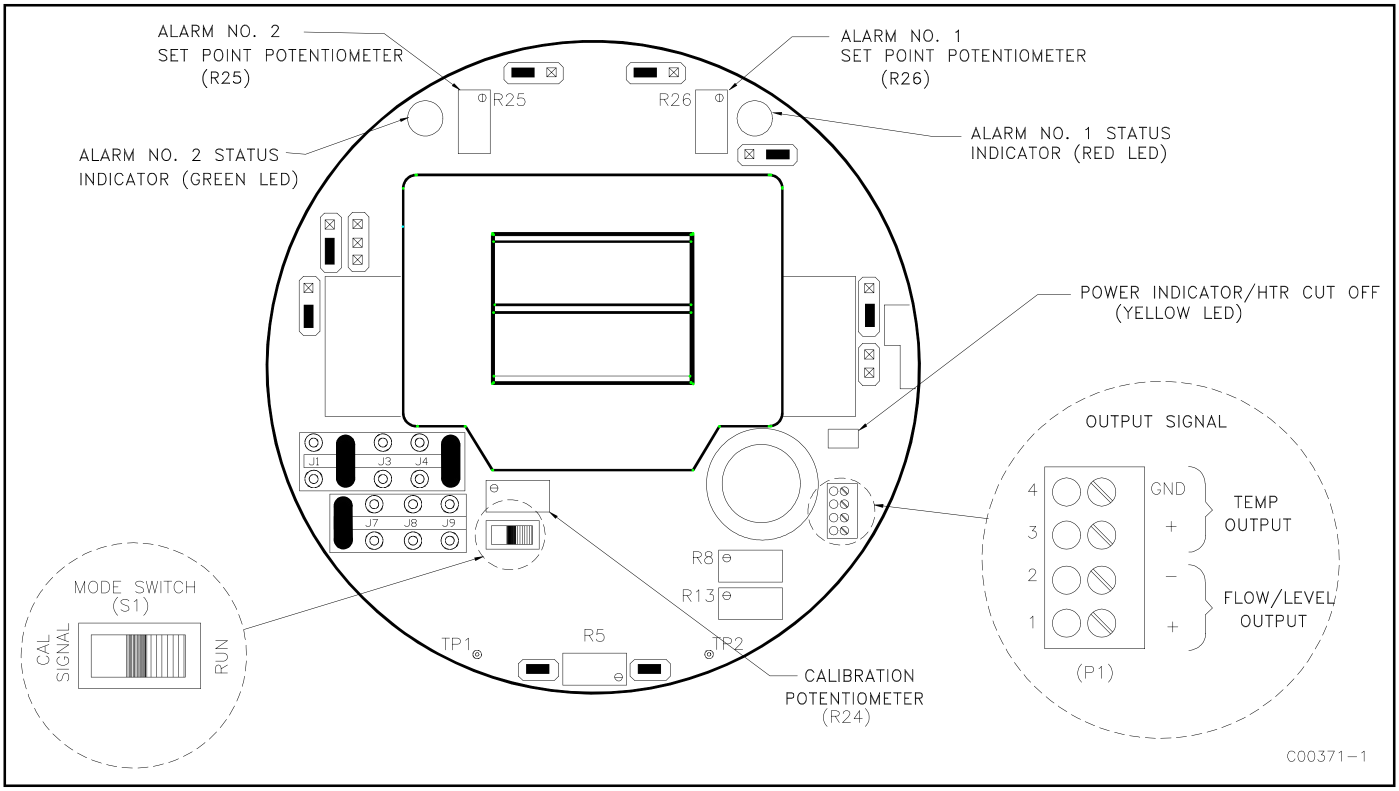

Figure 3-2. 5294 Control Circuit Component Locations

Air/Gas Flow Applications

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

Note: The terminal block can be unplugged from the control circuit to facilitate easy connections. The terminal block is used in late production instruments. Early production instruments used a mating cable and connector. If a cable and connector are required use FCI part number 015664-01 to order.

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

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

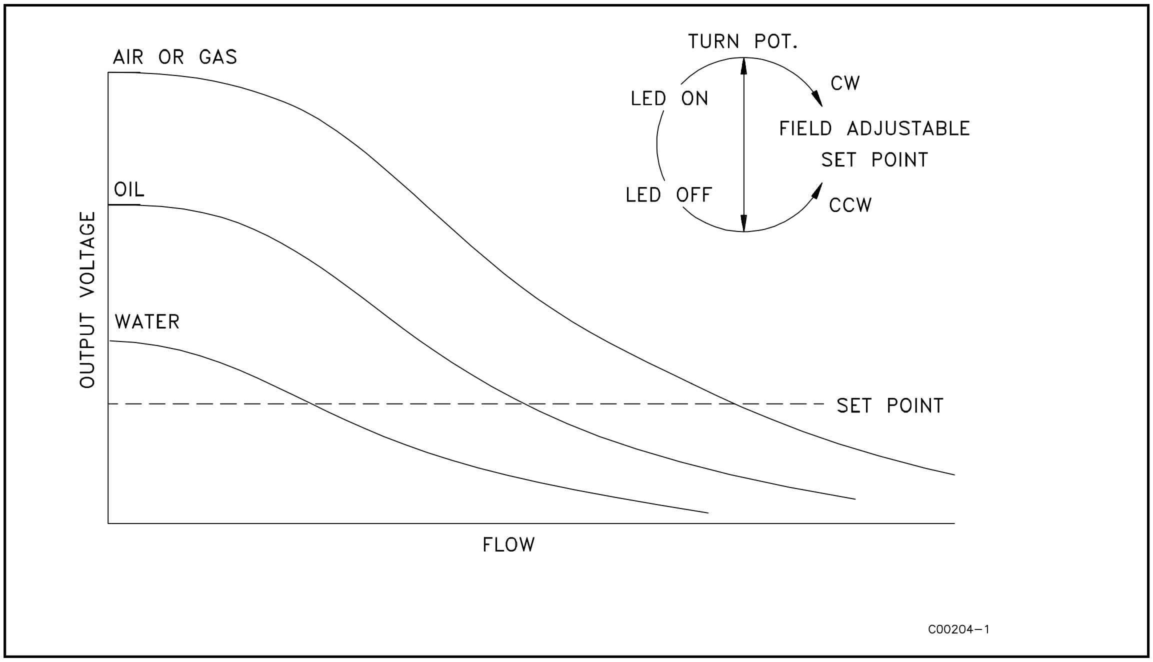

Figure 3-3. Flow Application Signal Output

8. Record the normal flow signal value.

   Normal Flow Signal = ________ volts DC

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

Detecting Decreasing Flow (low flow alarm)

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

   No-Flow Signal = ________ volts DC

3. Determine the set point by calculating the average of the normal and no-flow output signals. (i.e.; If the normal signal is 2.000 volts and the no-flow signal is 5.000 volts, then the calculated set point would be 3.500 volts.)
4. Record this value.

   Calculated Set Point = ________ volts DC

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

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

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

OR

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

8. If this is the only flow application alarm to be setup, then skip to the Continue With the Air/Gas Flow Procedure.

Detecting Increasing Flow (high flow alarm)

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

   High Flow Signal = ________ volts DC
3. Determine the set point by calculating the average of the normal and high flow output signals. (i.e., If the normal signal is 2.000 volts and the high flow signal is 1.000 volts, then the calculated set point would be 1.500 volts.)
4. Record this value.

   Calculated Set Point = ________ volts DC

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

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

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

OR

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

Continue With the Air/Gas Flow Procedure

1. Slide the mode switch to the RUN position.
2. Establish the normal process flow condition. For low-flow alarm setups, the status LED should be off. For high flow alarm setups, the status LED should be on.
3. Establish the process alarm condition and monitor the voltmeter display.
4. When the output signal passes through the calculated set point value, the status LED should turn on for low-flow alarms, off for high flow alarms, and the relay contacts should change state.
5. Reestablish the normal process flow condition. Both the LED and the relay contacts should reset.
6. Disconnect the voltmeter from P1.
7. Replace the enclosure cover.

Note: The alarm can be set for a specific flow rate. Follow the Air/Gas Flow Application procedure up to step 7 except establish the specific flow rate rather than the normal flow. The output signal will be the set point value. Determine whether the alarm should actuate with decreasing or increasing flow and skip to the appropriate step 4 in Detecting Decreasing Flow or Detecting Increasing Flow, respectfully. Enter the specific flow rate value as the set point. Then follow the Continue With the Air /Gas Flow Procedure steps.

The relay logic default configuration is set for the relay coil to be de-energized when the flow signal voltage is greater than the set point value. (i.e., Assume that the normal process flow condition has been established. In this state, the relay coil will be energized if the alarm has been set for low-flow detection and de-energized if the alarm has been set for high flow detection.) A recommendation is to have the relay coils energized when the process condition is normal. This will enable the alarm to close or open the contacts in case of a power failure.

Wet/Dry Liquid Level Applications

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

Note: The terminal block can be unplugged from the control circuit to facilitate easy connections. The terminal block is used in late production instruments. Early production instruments used a mating cable and connector. If a cable and connector are required use FCI part number 015664-01 to order.

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

   Wet Condition Signal = ________ volts DC

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

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

    Dry Condition Signal = ________ volts DC

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

    Calculated Set Point = ________ volts DC

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

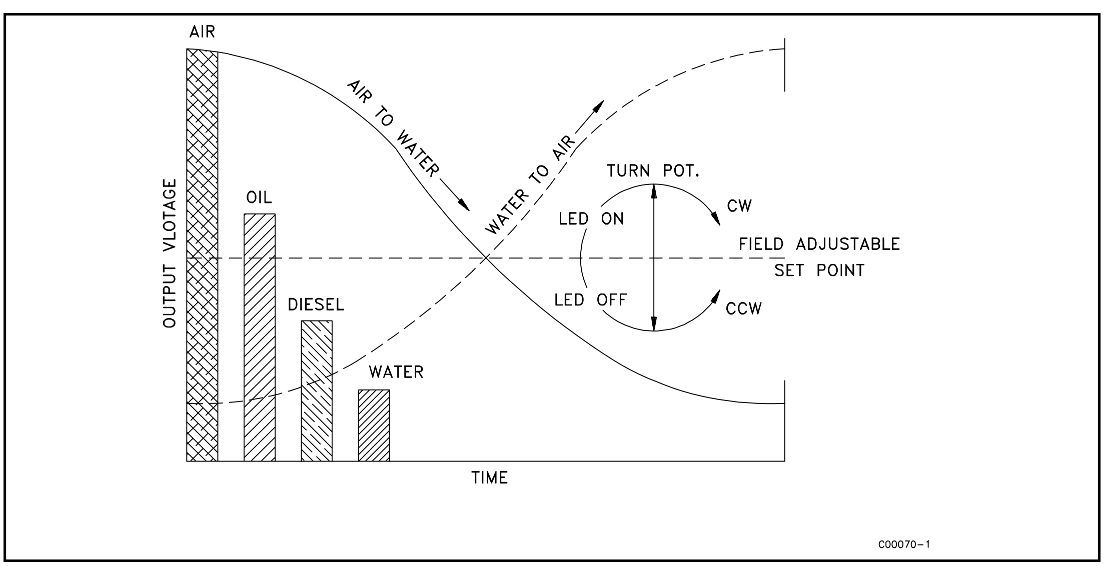

Figure 3-4. Level Application Signal Output

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

Detecting Dry Condition (low level alarm)

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

OR

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

Detecting Wet Condition (high level alarm)

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

OR

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

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

Note: The relay logic default configuration is set for the relay coil to be de-energized when the level signal is greater than the set point value. (i.e., The relay coil will be de-energized when the sensing element is dry.) A recommendation is to have the relay coils energized when the process condition is normal. This will enable the alarm to close or open the contacts in case of a power failure.

Temperature Applications

For temperature versus voltage values, see Table 3-7 located at the rear of this chapter. These values have an accuracy of ±5°F (2.78°C). There is also a conversion formula later in this chapter to convert the temperature output voltage to degrees fahrenheit. If a factory calibration chart was ordered look for it in the plastic page protector at the back of this manual. Make sure the serial number of the chart matches the instrument to be adjusted.

1. Remove the instrument's enclosure cover.
2. Ensure the configuration jumpers on the control circuit are correct for this application. See Tables 3-3 through 3-6.

Caution: If both alarms are to be used for temperature, then remove the heater control jumper from the heater, control header. The jumper may be stored on the control circuit by plugging it across J12 and J14. Placing the jumper here will not turn on the heater. If one alarm is for temperature and the other is for flow or level, then set the heater power according to the application. Use alarm No. 2 for the temperature alarm. See Table 3-3.

3. Check to make sure the input power jumpers match the power to be applied to the instrument. See Table 3-2.
4. Apply power to the instrument. Verify the yellow LED is on. Allow the instrument fifteen minutes to warm-up.
5. Verify the mode switch is in the RUN position.
6. Attach a DC voltmeter to P1 with the positive (+) lead to position 3 and the negative (-) lead to position 4.

Note: The terminal block can be unplugged from the control circuit to facilitate easy connections. The terminal block is used in late production instruments. Early production instruments used a mating cable and connector. If a cable and connector are required use FCI part number 015664-01 to order.

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

   Normal Temperature Signal = ________ volts DC

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

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

Detecting Increasing Temperature (high temperature alarm)

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

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

OR

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

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

Detecting Decreasing Temperature (low temperature alarm)

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

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

OR

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

Continue With the Temperature Applications

1. Slide the mode switch to the RUN position.
2. Establish the normal process temperature condition. For the high temperature alarm setups, the status LED should be off at normal temperatures. For the low temperature alarm setups, the status LED should be on at normal temperatures.

3. Establish the process alarm condition and monitor the voltmeter display.
4. When the output signal passes through the set point value, the status LED should turn on for high temperature alarms, off for low temperature alarms, and the relay contacts should change state.
5. Reestablish the normal process temperature condition. The LED and relay contacts should reset.
6. Disconnect the voltmeter from P1.
7. Replace the enclosure cover.

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

Liquid Flow Applications

1. Remove the instrument's enclosure cover.
2. Check to make sure the input power jumpers match the power to be applied to the instrument. See Table 3-2.
3. As necessary, set the following control circuit configuration jumpers. See Tables 3-3 through 3-6.

   Application: J20 or J18 (Flow/Level) for alarm No. 1 or No. 2, respectively.

   Heater Power: J32 (3 watts for FLT93-S or 0.57 watts for FLT93-F).
4. Apply power to the instrument. Verify the yellow LED is on. Allow the instrument fifteen minutes to warm-up.
5. Verify the mode switch is in the RUN position.
6. Attach a DC voltmeter to P1 connector with the positive (+) lead to position one and the negative (-) lead to position two.

Note: The terminal block can be unplugged from the control circuit to facilitate easy connections. The terminal block is used in late production instruments. Early production instruments used a mating cable and connector. If a cable and connector are required use FCI part number 015664-01 to order.

The output signal at connector P1 will vary inversely with changes in the process flow rate. The output signal level is also relative to the type of process media being measured. See Figure 3-3.

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

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

Detecting Decreasing Flow (low flow alarm)

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

   No-Flow Signal = ________ volts DC
3. Determine the set point by calculating the average of the normal and no-flow output signals. (i.e.; If the normal signal is 0.080 volts and the no-flow signal is 0.300 volts, then the calculated set point would be 0.190 volts.)
4. Record this value.

   Calculated Set Point = ________ volts DC

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

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

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

OR

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

8. If this is the only flow application alarm to be setup, then skip to Continue With the Liquid Flow Applications procedure.

Detecting Increasing Flow Rate (high flow alarm)

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

   High Flow Signal = ________ volts DC

3. Determine the set point by calculating the average of the normal and high flow output signals. (i.e.; If the normal signal is 0.080 volts and the high flow signal is 0.030 volts, then the calculated set point would be 0.055 volts.)
4. Record this value.

Calculated Set Point = ________ volts DC

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

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

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

OR

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

Continue With the Liquid Flow Applications

1. Slide the mode switch to the RUN position.
2. Establish the normal process flow condition. For low-flow alarm setups, the status LED should be off. For high flow alarm setups, the status LED should be on.
3. Establish the process alarm condition and monitor the voltmeter display.
4. When the output signal passes through the calculated set point value, the status LED should turn on for low-flow alarms, off for high flow alarms, and the relay contacts should change state.
5. Reestablish the normal process flow condition. Both the LED and the relay contacts should reset.

6. Disconnect the voltmeter from P1.
7. Replace the enclosure cover.

Note: The alarm can be set for a specific flow rate. Follow the Liquid Flow Application Procedure above to establish the specific flow rate rather than the normal flow. The output signal will be the set point value. Determine whether the alarm should actuate with decreasing or increasing flow and skip to the appropriate step, 4 of either Decreasing Flow Rate or Increasing flow rate. Enter the specific flow rate value as the set point and then follow the Continue With the Liquid Flow Application procedure steps.

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

Adjustment by Observation

Note: The control circuit has two mutually exclusive alarms; they are identified as Alarm No. 1 and Alarm No. 2 and each has a set point adjustment potentiometer and LED indicator. Each alarm can be setup for one of three applications: flow, level/interface, or temperature. The following application specific adjustment procedures are generic and can be used for setting either or both alarms. The mode switch must be in the RUN position. Use Figure 3-2 to help locate the adjustment potentiometers and LEDs.

Flow Applications

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

Detecting Decreasing Flow (low flow alarm)

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

Detecting Increasing Flow (high flow alarm)

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

Signal Output for Flow Applications

The output signal at connector P1 varies inversely with flow rate. The output signal level is also relative to the type of process media, see Figure 3-3.

Level Applications

1. Ensure that the instrument has been properly installed in the vessel.
2. Apply power to the instrument and allow fifteen minutes for the sensing element to become active and stabilize.
3. Remove the enclosure cover to allow access to the control circuit to make adjustments.

Detecting Dry Condition (adjustment with sensing element wet)

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

Detecting Wet Condition (adjustment with sensing element dry)

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

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

With the LED off, slowly turn the potentiometer clockwise 1 turn past the point at which the LED just goes on. The potentiometer may have up to one-quarter turn of hysteresis, therefore, if the mark is overshot, the procedure should be repeated.

Signal Output for Level Applications

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

Temperature Applications

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

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

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

1. Ensure that the instrument has been properly installed. Apply power the instrument and allow fifteen minutes for the sensing element to become active and stabilize.
3. Establish the normal or expected temperature. Remove the enclosure cover to allow access to the control circuit. Perform either the detecting increasing temperature or detecting decreasing temperature procedure shown below.

Detecting Increasing Temperature (high temperature alarm)

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

Detecting Decreasing Temperature (low temperature alarm)

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

Table 3-7. Temperature Versus Voltage Output (sheet 1 of 5)

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

Table 3-7. Temperature Versus Voltage Output (sheet 2 of 5)

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

Table 3-7. Temperature Versus Voltage Output (sheet 3 of 5)

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

Table 3-7. Temperature Versus Voltage Output (sheet 4 of 5)

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

Table 3-7. Temperature Versus Voltage Output (sheet 5 of 5)

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

Converting Temp Out Voltage to Temp in Degrees F

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

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

$$y = a + bx + c/x + dx^2 + e/x^2 + fx^3 + g/x^3$$

Where: y = Temperature in Degrees F

x = FLT Temperature Output Voltage

a = -533.998303

b = 251.-092242

c = 218.4101830

d = -1.25664666

e = -225.492653

f = 0.522817769

g = 95.41271936

Fail Safe Alarm Setting

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

Low Flow Alarm Settings

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

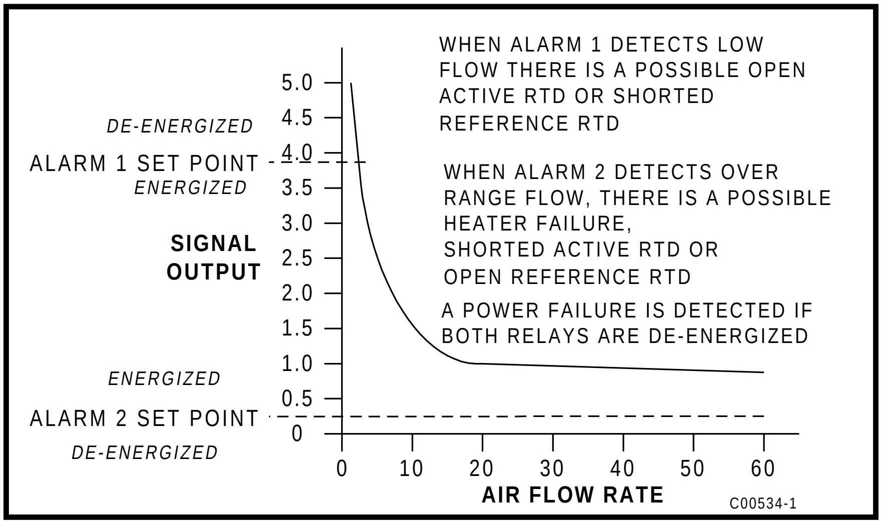

Figure 3-5. Low Flow Fail Safe Alarm

The following information is assumed:

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

High Flow Alarm Settings

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

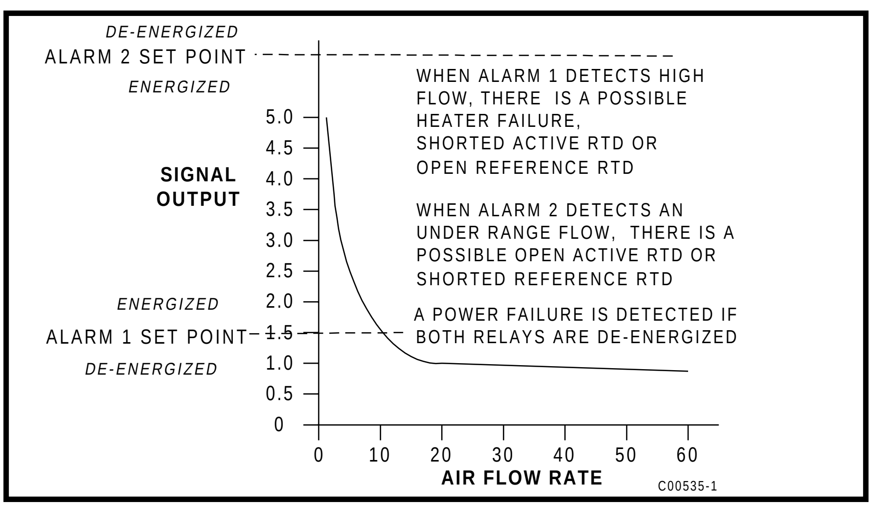

Figure 3-6. High Flow Fail Safe Alarm

The following information is assumed:

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

Low Level Alarm Settings (Sensing Element Normally Wet)

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

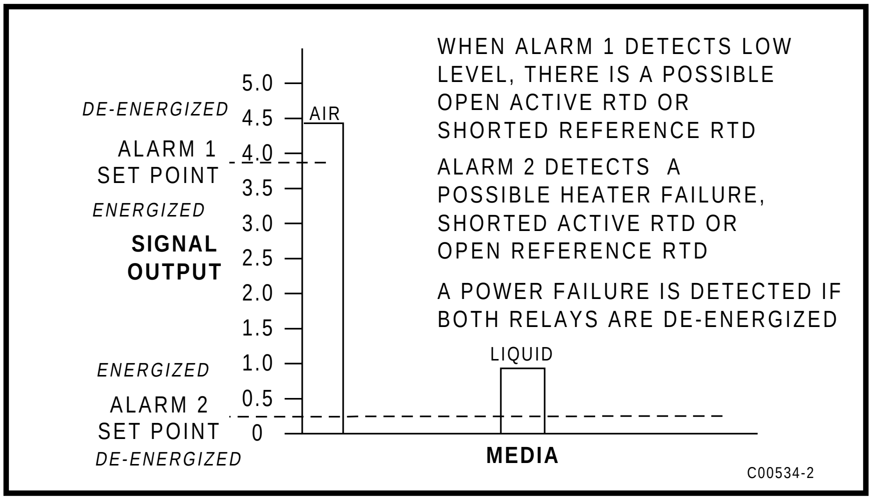

Figure 3-7. Low Level Fail Safe Alarm

The following information is assumed:

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

High Level Alarm Settings (Sensing Element Normally Dry)

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

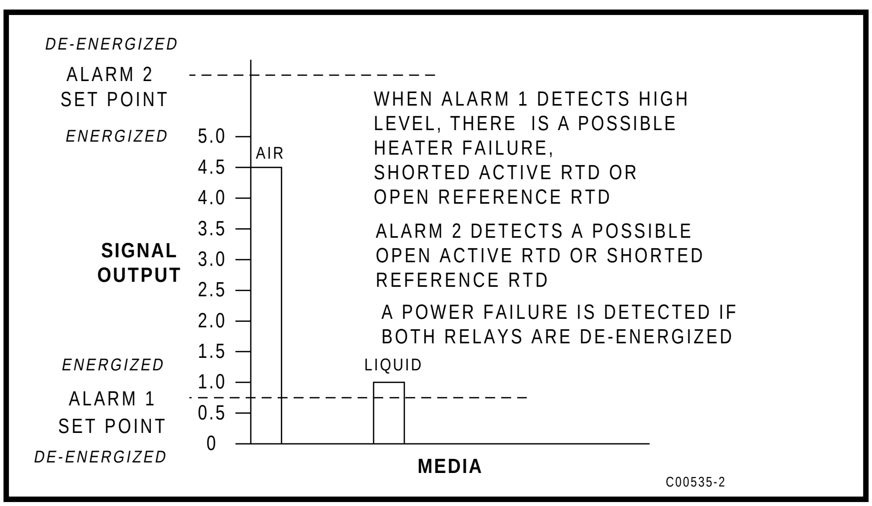

Figure 3-8. High Flow Fail Safe Alarm

The following information is assumed:

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