

Appendix D. Temperature Compensation

Introduction

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

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



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

Factory Temperature Compensation Settings

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

Restoring Temp Comp Adjustments

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

Equipment Required

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

Adapter cable FCI part number 015664-01 for older version of the control circuit.

Flat screw driver, capable of adjusting control circuit potentiometers.

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

Insulating varnish or equivalent to reseal the potentiometers.



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

Procedure

1. Turn off the instrument power. Remove the control circuit from the socket.
2. Write down where the heater wattage control jumper is located in the area of the upper left hand side of the control circuit. Remove the heater wattage control jumper and set it aside. Refer to Figure 3-1 for the jumper location.
3. Remove jumpers J10 and J11 at the lower side of the control circuit and set them aside.
4. Connect the DMM from TP1 (by J10), to the left jumper post of J10. Set the DMM to ohms. See Figure 3-2 for component placement.
5. Adjust potentiometer R5 (bottom center of the control circuit) until the DMM reads the ohm value for R5 as shown on the Temp Comp calibration sheet that is in the plastic page protector in the back of this manual.
6. Remove the DMM, and reconnect it between TP2 (by J11), and the right jumper post of J11. Figure 3-1 shows jumper post location.
7. Adjust pot R8 (below the yellow LED) until the ohm value for R8 is as shown on the Temp Comp Cal sheet.
8. Remove the DMM and reinstall jumpers J10 and J11. (Leave the heater jumper removed.)



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

9. Connect the DMM to P1 (the adapter cable on older control circuits) with the positive lead connected to position 2 (red wire on older control circuits) and the negative lead connected to position 2 (blue wire on older control circuits). Re-install the control circuit on the socket. Set the DMM to volts DC.
10. Turn on the instrument power and wait fifteen minutes for the instrument to stabilize. During this time make sure that the process media is flowing or the sensing elements are submerged. Do not make the following adjustment in still gas.
11. Adjust potentiometer R13 (next to R8) until the DMM reads 0 volts $\pm 5\text{mV}$.
12. Turn off the instrument power and remove the DMM. Re-install the heater jumper in its original position.

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

Field Temp Comp Calibration

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

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

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

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

Equipment Required

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

Procedure

1. Turn off the instrument power.
2. Install the instrument into the pipe or a test stand where it can be calibrated. Start the process media flowing at a normal rate. Cool the process media to the lowest temperature in the expected operating range.
3. Remove the control circuit. Disconnect the wires on terminals 6 through 10. Removal of the socket from the enclosure may be necessary for access to the wires.
4. Connect the DMM's and the power supply to the sensing element as shown in Figure D-1.
5. Set the power supply voltage to the proper voltage as shown in Table D-1. Turn on the power supply and check the voltage setting.

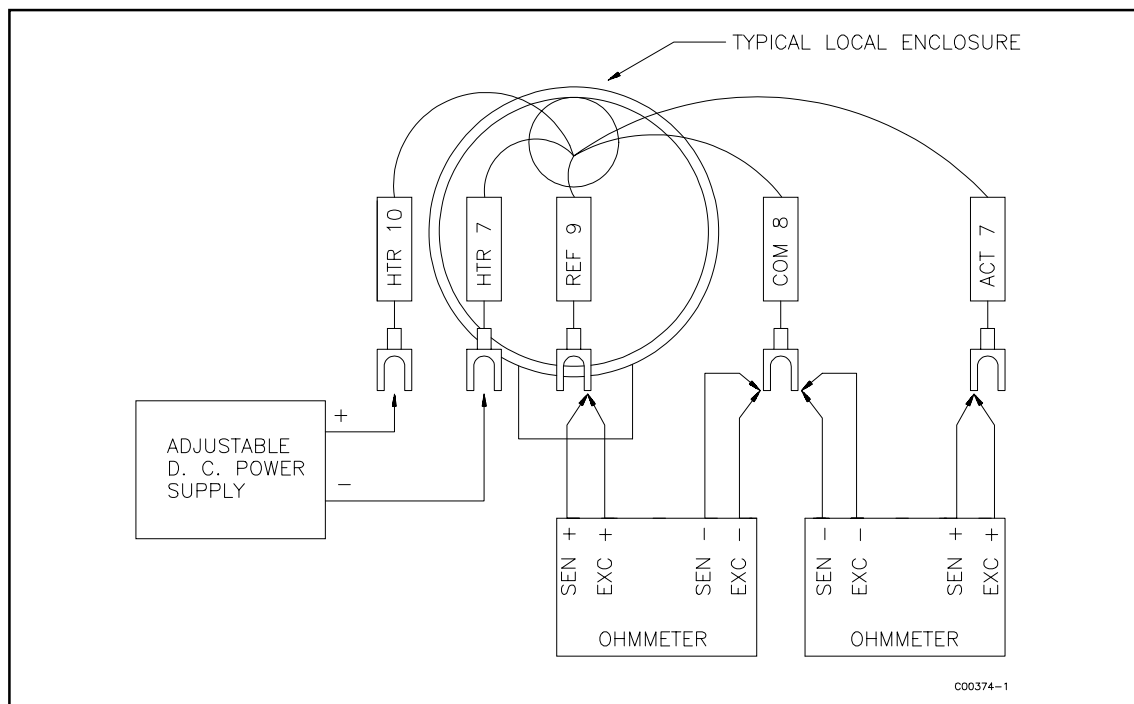


Figure D-1. Sensing Element Calibration Connections

Table D-1. Heater Voltage Settings

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

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

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

The Temp Comp factor is not to exceed ± 0.041 .

13. If the Temp Comp factor is within tolerance, turn off the power to the instrument and stop the process media if needed. Disconnect the DMM's and the power supply from the instrument. Reconnect the sensing element wires to the control circuit socket and reinstall the socket in the enclosure if it was previously removed. Do not pinch the wires between the socket and the enclosure.
14. Look up the resistance values to adjust potentiometers R5 and R8 in the Temp Comp Factor table (Table D-2). Follow the procedure in the Restoring Temp Comp adjustment section using the values found in the table below.
15. If the calculated Temp Comp factor exceeds the allowable tolerance by a small amount (± 0.01), using the maximum Temp Comp factor may make the instrument perform satisfactorily. However, if the factor is out of tolerance by more than ± 0.01 then it will be necessary to repeat the calibration to verify the result. Continue with the adjustment procedure if the second result is within tolerance.

Table D-2. Temp Comp Factor Table

TEMP			TEMP			TEMP		
COMP	R5	R8	COMP	R5	R8	COMP	R5	R8
FACTOR	K OHMS	K OHMS	FACTOR	K OHMS	K OHMS	FACTOR	K OHMS	K OHMS
0.042	119.75	263.16	0.013	123.38	149.25	-0.016	127.00	104.17
0.041	119.88	256.41	0.012	123.50	147.06	-0.017	127.13	103.09
0.040	120.00	250.00	0.011	123.63	144.93	-0.018	127.25	102.04
0.039	120.13	243.90	0.010	123.75	142.86	-0.019	127.38	101.01
0.038	120.25	238.10	0.009	123.88	140.85	-0.020	127.50	100.00
0.037	120.38	232.56	0.008	124.00	138.89	-0.021	127.63	99.01
0.036	120.50	227.27	0.007	124.13	136.99	-0.022	127.75	98.04
0.035	120.63	222.22	0.006	124.25	135.14	-0.023	127.88	97.09
0.034	120.75	217.39	0.005	124.38	133.33	-0.024	128.00	96.15
0.033	120.88	212.77	0.004	124.50	131.58	-0.025	128.13	95.24
0.032	121.00	208.33	0.003	124.63	129.87	-0.026	128.25	94.34
0.031	121.13	204.08	0.002	124.75	128.21	-0.027	128.38	93.46
0.030	121.25	200.00	0.001	124.88	126.58	-0.028	128.50	92.59
0.029	121.38	196.08	0.000	125.00	125.00	-0.029	128.63	91.74
0.028	121.50	192.31	-0.001	125.13	123.46	-0.030	128.75	90.91
0.027	121.63	188.68	-0.002	125.25	121.95	-0.031	128.88	90.09
0.026	121.75	185.19	-0.003	125.38	120.48	-0.032	129.00	89.29
0.025	121.88	181.82	-0.004	125.50	119.05	-0.033	129.13	88.50
0.024	122.00	178.57	-0.005	125.63	117.65	-0.034	129.25	87.72
0.023	122.13	175.44	-0.006	125.75	116.28	-0.035	129.38	86.96
0.022	122.25	172.41	-0.007	125.88	114.94	-0.036	129.50	86.21
0.021	122.38	169.49	-0.008	126.00	113.64	-0.037	129.63	85.47
0.020	122.50	166.67	-0.009	126.13	112.36	-0.038	129.75	84.75
0.019	122.63	163.93	-0.010	126.25	111.11	-0.039	129.88	84.03
0.018	122.75	161.29	-0.011	126.38	109.89	-0.040	130.00	83.33
0.017	122.88	158.73	-0.012	126.50	108.70	-0.041	130.13	82.64
0.016	123.00	156.25	-0.013	126.63	107.53	-0.042	130.25	81.97
0.015	123.13	153.85	-0.014	126.75	106.38			
0.014	123.25	151.52	-0.015	126.88	105.26			

