

Limit Switches and Limit Switch Applications with the 740 Series DPCs

Application Note

The Fluke 740 Series Documenting Process Calibrators (DPCs) offer many new capabilities. Perhaps the most significant new feature is a built-in test routine for the testing of limit switches. This note discusses the application of limit switches and their calibration using the 740 Series DPCs.

Limit switches

A limit switch is a device that can sense a process or environmental parameter such as temperature or pressure and close a switch contact or change an electrical parameter based on a measurement of that parameter versus the limit switch's *setpoint*.

A simple example of a limit switch is the thermostat on the heater in a house. The *setpoint* is the temperature to which you wish to have the house heated. While the temperature is below the *setpoint*, the thermostat closes a set of switch contacts that engage the heater. A thermostat often has another adjustment that controls the amount of temperature variance from the time the heater turns off to when it turns back on again.

This band of acceptable temperature variance is necessary to ensure that the heater is not cycling on and off at a very fast rate in an attempt to regulate room temperature within too narrow a band about the *setpoint*. If you attempted to regulate the heat in your home too tightly it would: 1) wear out the heater rather quickly and, 2) cause a higher heat bill due to the heater operating in a very inefficient mode. It is not unusual for a heater to vary as much as 2-5 degrees in temperature between the time the heater turns from off to on. The difference between these two temperatures is referred to as the *deadband* of a limit switch.

In the process industries there are many uses for limit switches. One example is simply a thermostat controlling the temperature of a process.

Another is measuring pressure to control a critical process by preventing the pressure from getting too high and causing damage. Other examples include controlling pH level or a chemical concentration in a process.

Testing limit switches

The limit switch in the following example is a temperature limit switch with a type K thermocouple input with a *setpoint* of 20°C. The *set state* for this test is defined as the closure of the limit switch's contacts. The *reset state* is the opening of the limit switch contacts. And the *deadband* is a minimum of 1°C and maximum of 3°C. This device functions in much the same way as the thermostat described earlier. The Low Limit example in Figure 1 illustrates this terminology.

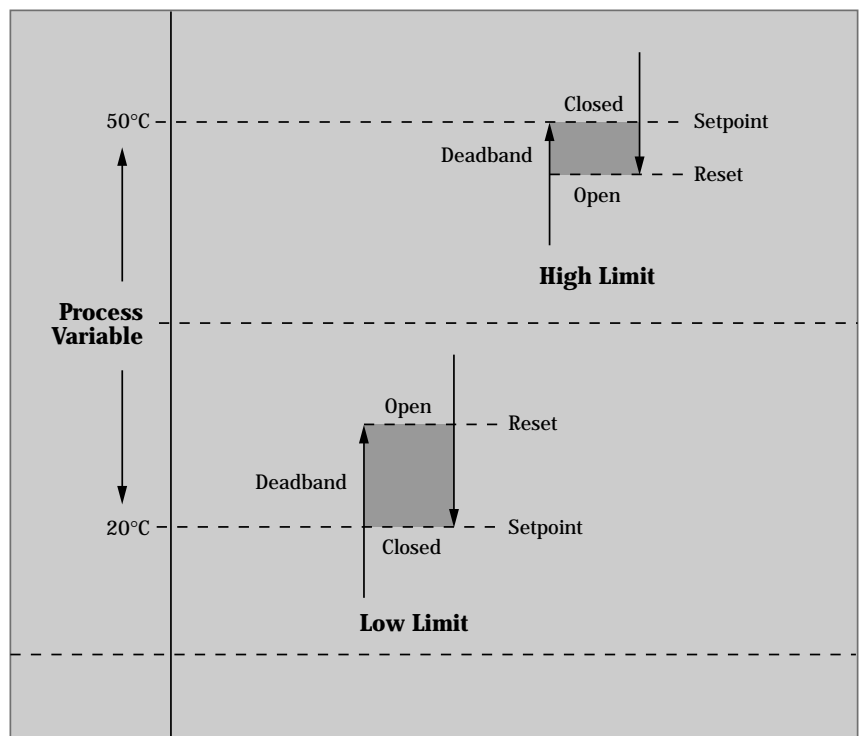


Figure 1. An illustration of a 2-point switch with settings for both a low and a high limit value. The example described in this application note is graphically represented by the low limit section.

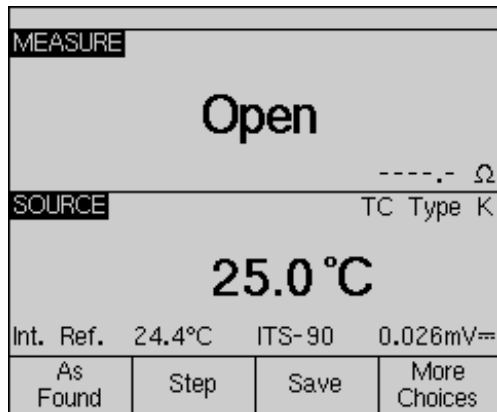


Figure 2.

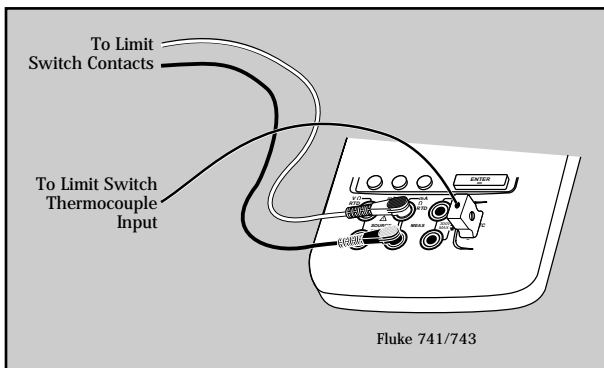


Figure 3.

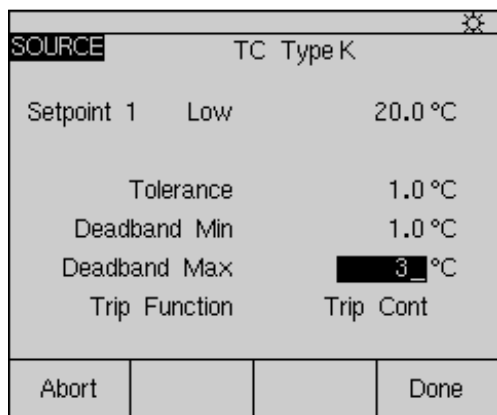


Figure 4.

To set up the 740 Series DPC to calibrate the limit switch described previously, follow these step-by-step instructions. Keystroke entries for the DPC are surrounded by quotation marks.

1. Beginning in the power up state of the calibrator, or Measure mode, depress the "ohms/continuity" key twice to enable continuity mode.
2. Depress the "MEAS/SOURCE" key once to obtain the Source mode, depress the "TC/RTD" key, move the cursor with the "↓" key to "K" and depress "ENTER" to select a type K thermocouple. Depress "ENTER" again to select "Linear T." Next, enter a temperature output of "25" and depress "ENTER." Depress the "MEAS/SOURCE" key to obtain the split screen display. The display of the 74X should be as per Figure 2.
3. Next, hook up the DPC per Figure 3.
4. Select the "As Found" softkey. Move the cursor to "1 Pt. Switch Test" with the "↓" key and depress "ENTER." You should now see the switch test setup screen.
5. Depress "Enter" and enter a *setpoint* of "20"°C and depress "ENTER." The *Setpoint Type* is set for low and the *Set State* is a short by default, perfect for this particular test. (If these conditions were different, we would change them here.) These setup conditions describe a limit switch that has *setpoint* of 20°C and closes a set of contact as long as the input temperature to the switch is below 20°C. Depress the "Done" softkey.
6. Move the cursor to tolerance and enter a *setpoint tolerance* of "1"°C. Move the cursor to Deadband Min and enter a *minimum deadband* of "1"°C. Move the cursor to Deadband Max and enter a *maximum deadband* value of 3°C. The test setup screen should now be as per Figure 4. Depress the "Done" softkey.
7. You should now be presented with the split screen in Figure 5. Select the "Auto Test" softkey and the "Continue" softkey. The DPC will now ramp the simulated thermocouple potential into the limit switch back and forth past the nominal *setpoint* and record the sourced temperature values for the actual *setpoint* and show that value in the upper lefthand corner of the DPC display. Once that is done, the DPC will then test the *reset* point of the limit switch by ramping the simulated thermocouple potential into the limit switch back and forth past the nominal (21°C-23°C) expected reset value. Once that value is recorded you should be presented with a post test summary similar to Figure 6. Errors exceeding test tolerance are recorded in inverse video.
8. Depress the "Done" softkey and enter the Tag information for your test. Depress the "Done" softkey when tag entry is complete.

9. If the limit switch failed any of the test parameters it is necessary to adjust the set and/or reset points. To perform that test select the "adjust" softkey. Depress the "Step Size" softkey, enter a step size of ".1"°C, and depress the "Done" softkey. Depress the "↓" key until the DPC source value is 20°C (the setpoint). Slowly adjust the setpoint on the limit switch until the measure screen toggles to Reset. Depress the "↑" key until the DPC measure screen toggles to Reset. If the DPC toggles from set to reset between 21°C and 23°C, the deadband should be correctly set. If it does not toggle properly, adjust the reset point until it toggles within that band. Verify the set and reset points toggle correctly by depressing the "↓" and "↑" keys to slew the DPC source temperature across the set and reset values. Once that is complete, depress the "Done" softkey.
10. Depress the "As Left" softkey, confirm the test settings, depress the "Done", "Auto Test" and "Continue" softkeys. Monitor the DPC as it performs the As Left evaluation. Once the post test summary is displayed, review the results. If all results are in normal video (as in Figure 7), the As Left test passes. Depress the "Done" softkey, and "Done" again to save the Tag information. If there were inverse video indications of a failure, repeat the adjustments performed in Step 9 until a passing result is obtained.
11. To review results in memory, depress the "Done" and "Review Memory" softkeys. Move the cursor to the tag entry associated with this test and depress "ENTER." Move the cursor to the As Found entry and depress "Enter" to review your As Found result. Depress the "Done" softkey, move the cursor to the As Left entry and depress "Enter" to review that result. Depress the "Done" softkey, then depress the "Tag" softkey to review your Tag information.

Other Limit Switch Tests

In the preceding step by step description, the limit switch has been removed from its operational circuit and the switch contact closure is monitored to determine state change. This test can also be performed with the switch installed in its circuit. In this instance, the switch contacts will open and close and make available a switched voltage the 740 Series DPC can toggle on to determine state change. A typical example would be toggling from 0-120 VAC, measuring the voltage applied to a heater as controlled by the output of the limit switch. The 740 series DPCs can toggle with dc Voltage in addition to the continuity and ac voltage examples previously described. Pressure limit switch tests are similar to temperature limit switch tests. You need to use a hand pump to source pressure into both a pressure module and the limit switch applying pressure above and below the set and reset points. After repeating the test several times, the results are documented by manually depressing the "Accept Point" soft key when the test has been completed.

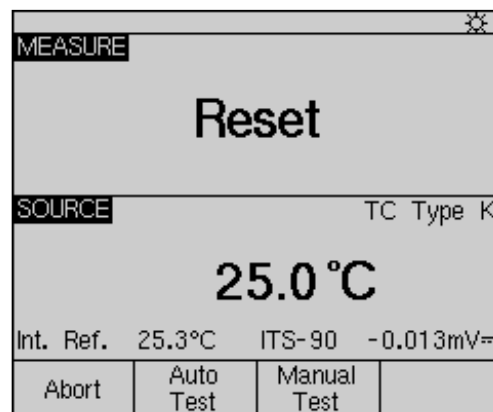


Figure 5.

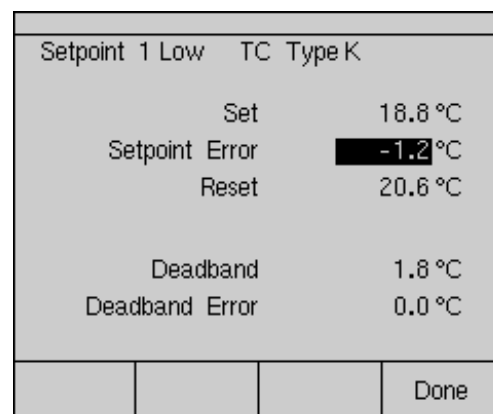


Figure 6.

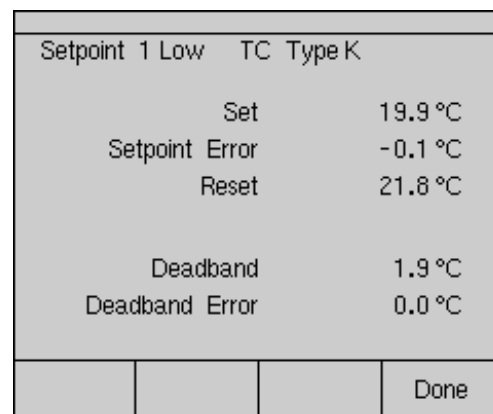


Figure 7.

This application note was prepared by Jim Shields, Sr. Product Specialist for Process Tools and Data Acquisition products. With Fluke Corporation since 1976 in engineering and manufacturing positions, Jim is a certified electronic technician and member of the Instrumentation Society of America, Northwest chapter.
Fax: (425) 356-5992
email: jimbo@tc.fluke.com

Fluke Corporation

PO Box 9090, Everett, WA USA 98206

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
U.S.A. (800) 443-5853 or
Fax (425) 356-5116
Europe (31 40) 2 678 200 or
Fax (31 40) 2 678 222
Canada (905) 890-7600 or
Fax (905) 890-6866

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Fax (425) 356-5116
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