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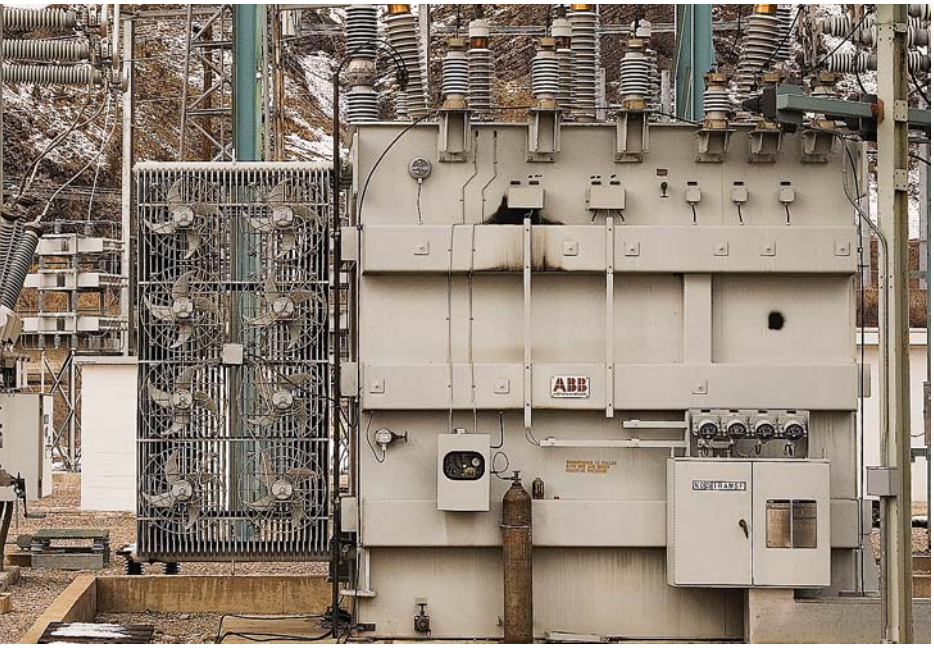
Testing temperature switches using Metrology Wells

Application Note



Customer background

Electrical power substations are responsible for stepping and routing voltages delivered from power plants to consumers. Constant maintenance of a substation is vital because its components age and it is difficult and expensive to replace components.

The loss of a power component can result in power outages for thousands of customers and cost hundreds of thousands of dollars. To properly maintain these components, system operators need consistent and automated testing of control and monitoring systems installed in each substation.

Transformers are generally the largest devices in a power distribution substation. They weigh several tons and are a large investment. Most of these transformers are filled with a heat transfer fluid that helps maintain operating efficiency and safety. The load at which a transformer can safely operate is highly dependent upon the efficiency of the cooling system, and there are significant operational gains that can be achieved with proper sizing of the cooling equipment. Overheating of a multi-million dollar transformer will shorten its life span, wasting the utility's maintenance budget.

The addition of an auxiliary heat exchanger to take more heat out of the heat transfer fluid is a cost effective method of extending the life and capacity of the transformer. All heat exchangers have a simple, yet reliable monitoring system that controls them. Most often, this control system uses a mechanical thermostatic switch. These devices, while reliable mechanically, can have significant drift and if left untested can result in accelerated aging of the transformer, or worse, failure in high demand conditions. Prudent maintenance procedures dictate periodic tests of the temperature switch that controls the heat exchanger.

Basic switch operation

A temperature switch is a device that senses temperature and activates a contact closure based upon the temperature value. The temperature at which the switch activates is called the *set-point* and is an important value that needs to be verified during testing. Another critical value, which is called the *deadband,* determines when the output is active or inactive around the set-point value (see figure 1). Testing and determining the deadband value is imperative to proper and safe operation.

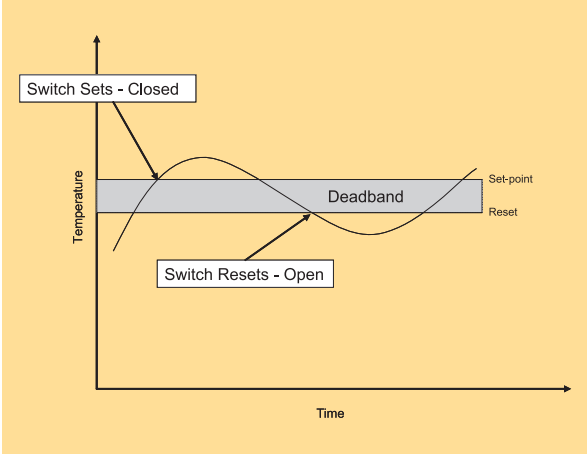


Figure 1 Schematic diagram showing the deadband in a temperature switch as it closes and opens with temperature changes.

Figure 2 Location of the switch terminals on a Metrology Well.

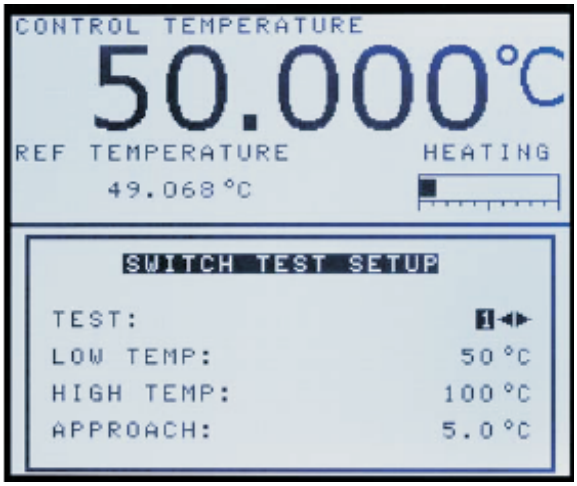


Figure 3 SWITCH TEST SETUP menu

Using Metrology Wells to perform automated switch testing

The 9170 Series Metrology Wells have built-in routines that can be configured to automate the testing of temperature switches. Four individual tests can be pre-configured and stored into the memory for quick and easy recall. The built-in routines zero in on and provide actual measurements of set-point and deadband values.

First, connect the thermostatic switch to the terminals located on the front of the Metrology Well (see Figure 2) and insert the switch into the thermal well.

To access the switch test menu, press the menu button located left of the arrow keys, then press "PROG MENU" (F3), then press "SWITCH MENU" (F4), and then press "SETUP" (F2).

In the SWITCH TEST SETUP menu (see Figure 3), each of the four available tests can be configured and customized by the user. Below is a description of the parameters in the Switch Test Setup menu.

TEST

This parameter allows the user to select which of the four stored tests are to be configured.

LOW TEMP

This is the initial temperature at which the Metrology Well will start the first test cycle. The value of LOW TEMP must be less than the value of HIGH TEMP.

HIGH TEMP

This is the initial temperature at which the Metrology Well will start to cool during the first test cycle. The value of HIGH TEMP must be greater than LOW TEMP.

APPROACH

The APPROACH parameter is a temperature value used to change the heating or cooling rate of the Metrology Well when it approaches the switch's set-point. This is used to slow the rate of the Metrology Well so that the switch temperature can come within thermal equilibrium with the block temperature. Typically, an acceptable approach temperature is 3 °C to 5 °C.

RAMP RATE

The ramp rate is the rate at which a Metrology Wells heats or cools once it has reached the approach temperature. This is useful because there will be a lag time between the switch temperature and the block temperature.

CYCLES

This parameter determines the number of heating and cooling cycles performed during the test. Multiple cycles allows the Metrology Well to zero in on the actual set-point and deadband values. The initial cycle uses the high and low temp values as configured. After the first cycle, the Metrology Well resets the high and low temp values based upon measurements from the previous cycle.

Switch test example

The temperature switch in the following example has a set-point of 35 °C. Above this temperature, the output contacts are closed, turning the heat exchanger on. The deadband needs to be at least 1 °C but no more than 3 °C. Below are the parameters that are programmed into the Metrology Well for this example:

LOW TEMP: 28 °C
HIGH TEMP: 42 °C
APPROACH: 3 °C
RAMP RATE: 0.25 °C
CYCLES: 3

The low and high temp values are chosen to provide a window around the actual expected set-point. Some switches

may require a wider window. The chosen window gives the instrument an approximation of where the switch will open and close. If the window is too narrow, the switch test may abort before determining the characteristics of the switch.

Figure 4 shows a diagram of how this test might progress. The Metrology Well will set its set-point temperature to the HIGH TEMP parameter in the setup above and heat the well at the system scan rate until the switch activates and closes. The Metrology Well will then change its set-point to the LOW TEMP parameter and cool using the system scan rate until the switch resets and opens. This is the end of the first cycle.

For the second cycle, the Metrology Well will change its set-point to the switch activation temperature measured in cycle one, and start to heat. When the switch activates, the Metrology Well will change its set-point to the switch reset temperature measured in the first cycle and start cooling.

As the Metrology Well heats in the third cycle, it reaches the approach temperature (HIGH TEMP 3 minus APPROACH parameter), and the instrument changes its scan rate to the RAMP RATE parameter (0.25 °C/min in this example). When the switch activates, the instrument sets its set-point to the reset temperature measured in the second cycle, and the instrument starts to cool. When the instrument temperature reaches the approach temperature (LOW TEMP 3 plus approach parameter) it changes the scan rate to the RAMP RATE parameter.

When the switch resets, the test completes and the values of the SWITCH OPEN, SWITCH CLOSE and SWITCH BAND are displayed for the user to record.

Equipment needed

Application will work with any of the Metrology Wells listed in Table 1.

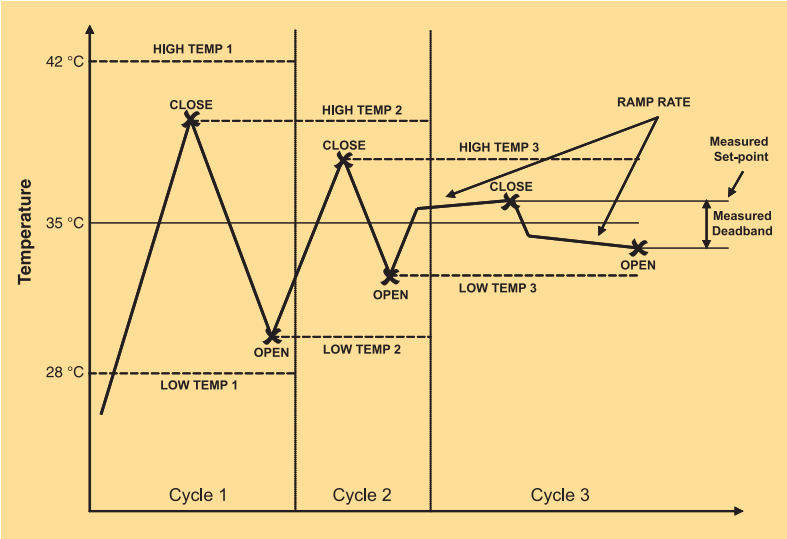


Figure 4 Progression of a switch test through a three-cycle test.

Table 1 Metrology Well models supporting automated switch test functions.

Model		Temperature Range
9170	Metrology Well	–45 °C to 140 °C
9170-R	Metrology Well with Built-in Reference Thermometer	–45 °C to 140 °C
9171	Metrology Well	–30 °C to 155 °C
9171-R	Metrology Well with Built-in Reference Thermometer	–30 °C to 155 °C
9172	Metrology Well	35 °C to 425 °C
9172-R	Metrology Well with Built-in Reference Thermometer	35 °C to 425 °C
9173	Metrology Well	50 °C to 700 °C
9173-R	Metrology Well with Built-in Reference Thermometer	50 °C to 700 °C

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