Application Bulletin

Calibration of Thermocouples and RTD's with Portable Dry Block Calibrators

TEMPERATURE & PROCESS INSTRUMENTS INC

Temperature Calibration with Portable Dry Block Calibrators

Warning and Caution
This guide is intended for use by experienced technicians and engineers who are familiar with the principles of calibration and the use of temperature instrumentation.

Always use the appropriate personal protective equipment when working with temperature instrumentation, as high temperatures can be present. Use of Dry block temperature calibrators

Portable or Benchtop Dry Block Temperature Calibrators

Several companies manufacture dry block temperature calibrators. The use of each will vary slightly from this procedure, but the overall principles remain the same. As many types of instrumentation exist for measuring the output of the sensor under test, we will only cover basic block calibrator use here. Having read the manufacturer's instructions and being familiar with the specific calibrator you will need to perform the following items:

- **Change or select the engineering units used by the display.**
- **Set or enter the required temperature setpoint or**
- **Program a set of ramp and dwell steps corresponding to your calibration points.**
- **Connect the probe interface module and select the appropriate sensor type to be tested if applicable.**
- **Use of PC software to remotely create programs, certificates and graphical data analysis as needed.**

Note: If your procedure requires that "as received" and "as left" readings be obtained remember to acquire all "as received" results before making any adjustments to sensors or instrumentation.

Probe Interface Module

Most dry block calibrator manufacturers offer probe interface modules that plug into the block calibrator electronics. These modules allow the user to remove the sensor to be checked or calibrated from the process for insertion into the calibrator and when connected directly to the module, convert the signal for display of temperature on the calibrator indicator. The module should allow for connection of various types of sensors including thermocouples, RTD's and transmitters. With a block calibrator that is programmable, and retains both block and sensor data, the benefit of a fully automated, unattended calibration can be realized.

Basic calibration steps

A. Selecting the block insert

Select a block insert with the proper hole diameter and depth for the sensor under test. (See the note below regarding sensor immersion depth.) The sensor should fit into the hole fairly snug, with little lateral movement. A loose fit may give erroneous calibration results. In addition, it is highly recommended that dry block calibrators be used dry without any oils or thermal greases. Despite popular belief, thermal fluids used in and around the block and sensor under test do not improve the heat transfer. Use of oils and greases can degrade performance and/or damage critical block components including heaters, block sensing PRT's, peltier devices and cooling fans. In either case, simply allowing at least 10 minutes for the block to become stabile and equalize out before taking readings will give good results.

I. Sensor Immersion Depth

Many block calibrators offer as standard a 4 to 6 inch immersion depth. In order to eliminate stem losses a general rule of thumb is as follows: at temperatures up to 350ºC (660ºF) the immersion depth should be ten times the outside diameter of the sensor and fifteen times the outside diameter for temperatures above 350ºC(660ºF). Example: a sensor OD of 5/16" should have a nominal immersion of 3.125" at a temperature below 350ºC. This is to be used as a guideline only as the optimum immersion may be more or less depending on required accuracy.

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Selecting the method of comparison calibration

There are primarily three methods of calibration using a dry block calibrator.

I. The first and most simple is by direct comparison to the block calibrator display. In this method a calibrator block insert with one hole will suffice. Here the user places the sensor under test into the insert of the block and relies on the display accuracy of the calibrator for results. The display accuracy should be clearly stated on the calibration certificate or in the instruction manual. The user can then make adjustments to the sensor under test indicator or loop display to correct for out of tolerance results. If traceability is required for the calibration then have the manufacturer include a NIST certificate with the block calibrator. With normal use most manufacturers recommend an annual re-calibration of the calibrator.

TCS Block Calibrators

II. Method number two is by comparing your reference or primary thermometer to the sensor under test directly in the block calibrator insert. A block insert with at least two holes of the required sensor size will be needed. A traceable reference thermometer and indicator with a total system accuracy of at least 4 times better than that of the sensor being calibrated would be necessary to meet today's quality standards. This method of calibration can give the most accurate results, but may be cost prohibitive because of the need for a reference grade sensor and digital thermometer. A traceable calibration certificate for the block calibrator would not necessarily be required for this calibration method.

III. Last employing a block calibrator with a probe interface module tends to be the easiest and can save labor hours if the system can be run unattended. The probe module should be capable of converting and displaying various thermocouple types, RTD's and transmitters directly on the calibrator display and have accuracy's meeting your requirements. Place the sensor under test into the insert and make the connection to the probe interface module. Taking advantage of a programmable block with on board storage of calibration results including both block temperatures and corresponding sensor under test readings, a fully automatic calibration can be appreciated. Many of today's block calibrators offer good windows PC programs for transferring your data to file for graphic analysis of trends, drift, and failures which could give an added advantage to this method of calibration.

A. Finishing Up

Method I and II

After acquiring all "as received" readings, fill in the sensor calibration data on your sheet or PC. As specified in the manufacturers specification or your procedure, if the "as received" readings are out, start by adjusting your zero reading and then go up to adjust the span. To achieve more linear results you may have to repeat adjustments more than once. When in specification proceed with obtaining the "as left" results and entering them on your data sheet or PC.

Method III

The user probe interface will automatically run through your programmed set temperatures and acquire sensor readings. With the data you should be able to create a calibration certificate or graph and make comparisons to previous results. The printed results and/or those acquired in a PC should be saved to maintain a historic record for the sensor. If at each calibration interval you find that an adjustment is required you might do one of the following: investigate the reason for excessive drift, shorten the calibration interval, loosen the specs or replace the sensor. With the calibration complete, install the sensor back into the process and reconnect all wiring.

The Thermcal 400 calibrator can easily mathed with the DMC-1410 Documenting Calibrator as a comple calibration system.

Summary

Calibration of temperature sensors is an important part of your manufacturing process to maintain product quality and process performance. It can also save you money, in both product reject due to inrrect process temperature and utility bills as you have a better understanding of the process temperature and are running at maximum efficiency.

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