



## Improving loop calibration temperature accuracy

### Topics Covered

Sensor contribution to loop accuracy  
Streamlined calibration with Field Metrology Wells  
Innovations in dry-block performance

### Introduction

Nearly everyone has experienced the frustration of inconsistent calibration results at one time or another. Today's complex processes are hard enough to trouble shoot without the added headache of a broken calibration process. We use calibration to eliminate variables not add to them, and the tools and the processes we use are some of the things we have the power to control.

### Don't forget the sensor

Process instrumentation requires periodic calibration and maintenance to ensure that it is operating correctly. When field testing and calibrating loop powered two-wire temperature transmitters it is common to disconnect the temperature sensor and use a simulator in its place. The simulator might be a decade box or a loop calibrator. It provides the input signal to the transmitter so the technician can evaluate zero, span and linearity errors in the transmitter. This achieves some performance improvement, but it leaves out the sensor.

You may be surprised to learn that temperature sensors are responsible for more than 75% of output errors in temperature transmitters. With limited resources, we have to decide where to focus our energy. The best choice is to focus on the approach resulting in the greatest impact.

The sensor and transmitter can be calibrated together using a constant temperature bath or oven (dry-block calibrator) as a temperature source. Just place the sensor in the temperature source and measure the output of the transmitter. Compare the reading to the indicated temperature on the display of the temperature source, or for more accuracy, compare the reading to a reference thermometer.

One difficulty with this approach in the past has been that it requires many pieces of equipment. At a minimum, you need a calibrator, a device to measure 4–20 mA and power the loop, and potentially a reference thermometer too.



**9142**



## Field Metrology Wells streamline loop calibration

Field Metrology Wells come in two versions. There are the standard versions and the process versions. The process versions come with tools that streamline loop calibration, so that you don't have to pack around a lot of stuff with you on the job. The process version comes with everything in the standard version plus technology that powers the loop, measures 4-20 mA transmitter output, measures 2,3 and 4-wire RTD's, and also measures thermocouples. In addition, there is a jack for a plug and play calibrated reference sensor to improve accuracy. Also, use a reference sensor whenever calibrating shorter sensors that cannot reach the calibration zone of the oven.

Setting the temperature is easy.

1. Press "SET PT." button
2. Use arrow keys to enter temperature
3. Press "ENTER"

Visual and audible alarms alert you when the instrument has a stable temperature and is ready for measurement.

The process option of Field Metrology Wells make transmitter loop calibrations easy. Place the temperature sensor in the well with transmitter electronics and reference PRT (if used) connected to the front panel of the instrument. With 24V loop power, you are able power and measure the transmitter current while sourcing and measuring temperature in the Field Metrology Well. This allows for the measurement of as-found and as-left data in one self-contained calibration tool.

With the process version, fully automate calibrations of PRTs, thermocouples, and other industrial thermometers. After configuring your sequence of measurements, you can walk away and come back to your documented results. This increases productivity in field calibration work because technicians no longer need to babysit a test and ensure that it moves on to each new step while manually recording all of the data. The process version stores data for up to 20 tests. Easily export the data using the included 9930 Interface-it software.

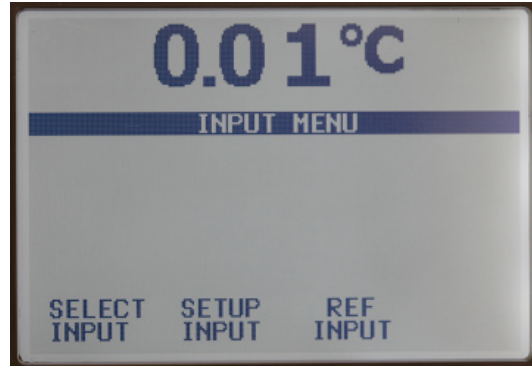
### Automated Program

An automated program can be run in 3 steps.

Step 1: Configure to measure RTD, Thermocouple or Transmitter

Begin with the reference PRT (if a reference is being used) and the unit under test connected to the Field Metrology Well inputs and the sensors placed in the well for calibration.

Press the "MENU" button  
Press F4 – INPUT SETUP

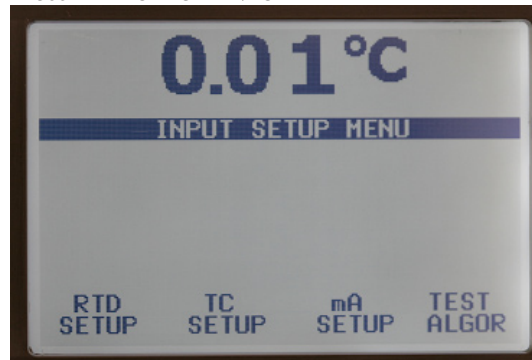


Press F1 – SELECT INPUT



Use arrow keys to select mA (for transmitter) or TC (for thermocouple) or RTD

Press "Enter" to go to the INPUT MENU screen  
Press F2 – SETUP INPUT



Choose the appropriate device to be measured.

F1 – RTD SETUP to select the RTD type and press "ENTER."

F2 – TC SETUP to select the thermocouple type and press "ENTER."

F3 – mA SETUP and enable the 24V loop power and press "ENTER".



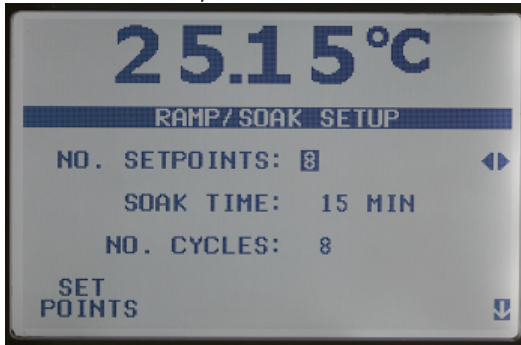
**Step 2:** Configure the test program

Press the "MENU" button

Press F2 – PROG MENU



Press F2 – RAMP/SOAK



Enter the following information:

**NO. SETPOINTS:** (How many temperatures do you want to test?)

**SOAK TIME:** (How long do you want to wait before making a measurement when stable?)

**NO. CYCLES:** (How many times do you want the test to repeat?)

**DIRECTION:** (Do you want to sequence temperatures in order, reverse order or forward and then reverse?)

**PASS TOLERANCE:** (What is the allowable error for the unit under test?)

Press F1 – SET POINTS

Press "ENTER" after entering the set points

**Step 3:** Start the program

"EXIT" to the PROGRAM MENU screen

Press F1 – RUN PROG

**Enter the following information:**

**TEST STATUS:** (Choose Run to start the program)

**RUN TEST:** (Choose Ramp/Soak)

**RECORD DATA:** (Yes to record data, or No to not record data)

**TEST ID:** (Identify the test so you can collect the data later.)

Return to the main screen

Please note that as the test is running the screen will display the step you are on (step 1 out of 2 for example) and the soak time will begin its count down once the temperature meets the stability requirement.

When the test is complete Press the "MENU" button

Press F2 – PROG MENU

Press F4 – TEST RESULT

Press F1 – VIEW TESTS and use the arrow buttons to find the selected test, then push "ENTER" to view the test results

Note: To calibrate the transmitter adjust the trim pots on the top of the transmitter, or for digital transmitters use a communication device to make the adjustments. If the transmitter is set to a range of 0°C to 200°C, then the expected mA current values would follow the table below.

Model	Set Point	mA
9142	0°C	4 mA
	100°C	12 mA
	200°C	20 mA

**Innovations in dry-block performance**

Many companies measure innovation by the number of patents they possess. By that standard, with five patents pending, the 914X is one Hart Scientific's most innovative products yet. From innovations in keypad design and automation of thermal switch tests to a unique vertical gradient compensation design that compensates for a wide range of ambient temperatures, the 914X received great attention to detail. By compensating for ambient temperature levels, the Field Metrology Wells meets specifications from 13°C to 33°C, an unprecedented range. Another pending patent redirects airflow from the unit to keep probe handles cool even when calibrating at 660°C. This makes the product safer to use and improves the quality of calibrations at the same time. Yet another pending patent improves performance by compensating for deviations in line voltage levels. By any standard, Field Metrology Wells are truly innovative and drive better performance in demanding applications.



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## Summary

Forgetting to calibrate the temperature sensor can undermine these efforts. The best approach is to get each piece of the system under control to the most reasonable extent possible. Making predictions about complex systems can be difficult. Searching for the root cause is many times fruitless.

Loop calibrations with Field Metrology Wells include the sensor in the calibration and streamline the process through automation and by reducing the amount of equipment required. They verify and help optimize the entire measurement system. In this way, the unique characteristics of both the sensing element and the measurement electronics are included in the calibration. This achieves bigger performance gains than the alternative of focusing on the measurement electronics alone.

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