FLUKE®
Calibration

Improving loop calibration temperature accuracy

Application Note

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 in our 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.

Ignoring the sensor can be a mistake, because temperature sensors are responsible for more than 75% of the output errors in temperature transmitters. You have the option of calibrating the sensor and transmitter together, using either 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.

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

Field Metrology Wells streamline loop calibration

914X Series Field Metrology Wells from Fluke Calibration come in two versions, standard and process. The process versions include everything in the standard version plus tools that streamline loop calibration, so you don't have to pack around a lot of equipment with you on the job. These process tools incorporate technology that powers the loop, measures 4–20 mA transmitter output, measures 2-,3- and 4-wire RTDs, and also measures thermocouples. In addition, there is a jack for a plug-and-play calibrated reference sensor to improve accuracy. Use a reference sensor for more accuracy, and when calibrating shorter sensors that cannot reach the calibration zone of the oven.

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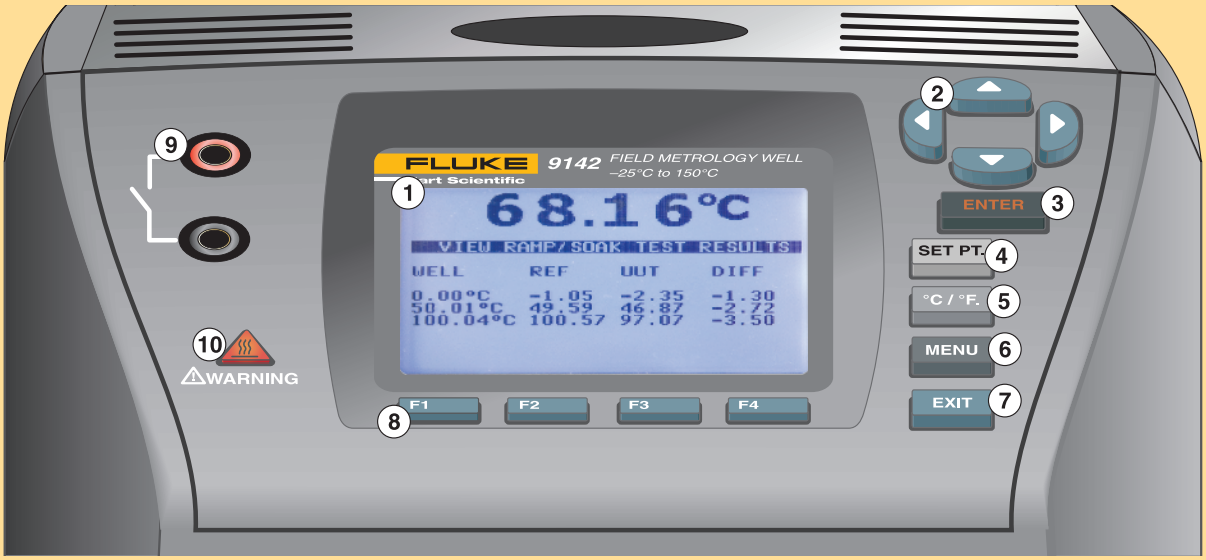
Display panel and buttons for input and process selection



1. *240 x 160 pixel monochrome graphics LCD with backlight.*
2. *Arrow Keys allow you to move the cursor on the display.*
3. *The Enter Key allows you to select menus and accept new values.*
4. *Use SET PT. to heat or cool to a desired temperature.*
5. *Toggle between °C and °F.*
6. *The Menu Key opens the main menu where Soft Keys may be used to access all settings.*
7. *The Exit Key allows you to exit menus and cancel newly entered values.*
8. *Soft Key functions for F1 to F4 are indicated on the display and change depending on the menu selected.*
9. *Connect thermal switches to the Switch Connector posts for calibration.*
10. *Indicator light is lit whenever the block temperature exceeds 50 °C even when power is cut to the unit.*

Setting the temperature on a 914X Series Field Metrology Well is easy.

1. Press the “SET PT.” button.
2. Use the 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 makes 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 24 V loop power, you are able to 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.

Fully automate calibrations of PRTs, thermocouples, and other industrial thermometers with the process version. 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

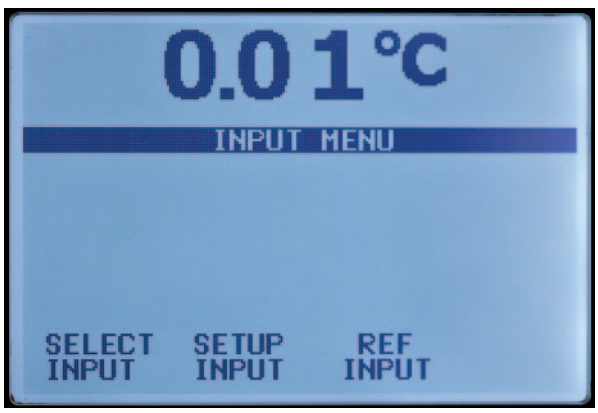
An automated program can be run in three steps.

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 – SETUP INPUT



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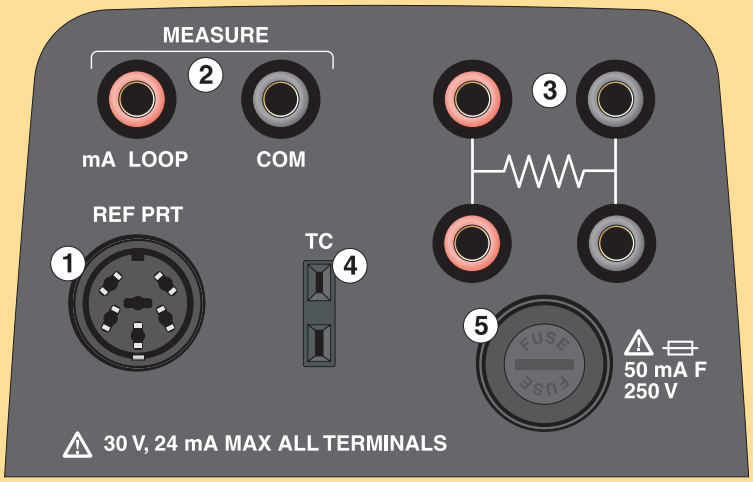
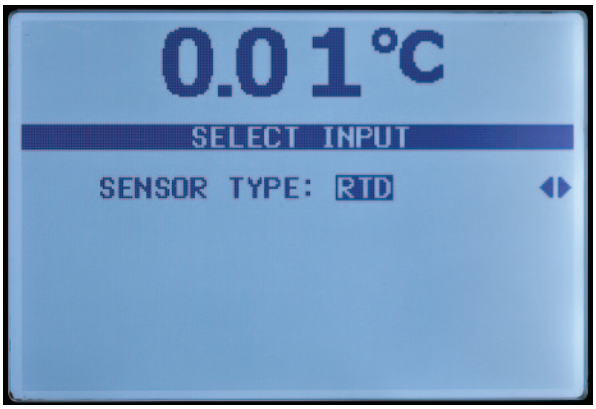
Process version panel for probe connections



1. *PRT Reference Thermometer 6-pin DIN Smart connector*
2. *4–20 mA connector allows current and/or voltage probes to be connected for measurement.*
3. *PRT/RTD connector for 4-,3-, and 2- wire measurement*
4. *Thermocouple connector (subminiature)*
5. *Fuse for the 4–20 mA circuit*

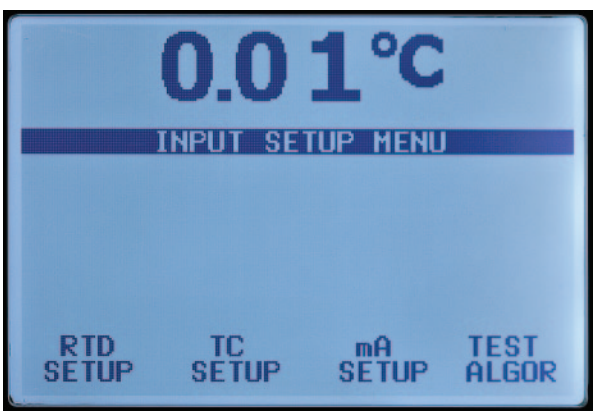
Press F1 – SELECT INPUT



Use arrow keys to select mA (for transmitter), 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."

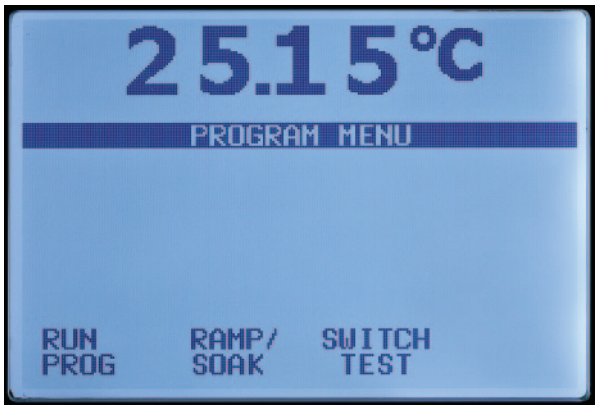
F2 – TC SETUP to select the thermocouple type and press "ENTER."

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

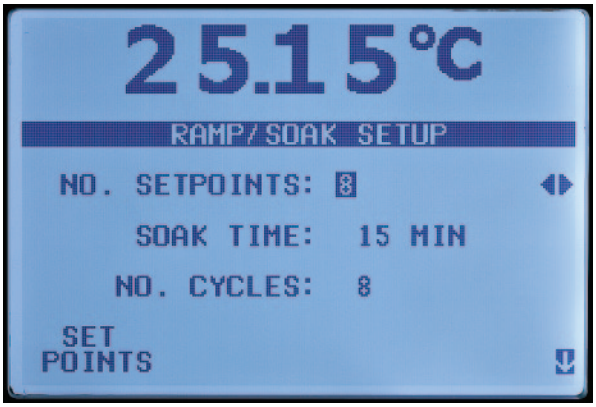
Step 2: Configure the test program.

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

With five patents pending, the 914X is one of Fluke Calibration'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 meet 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.

Summary

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

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 to 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.

Fluke Calibration. *Precision, performance, confidence.*™

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