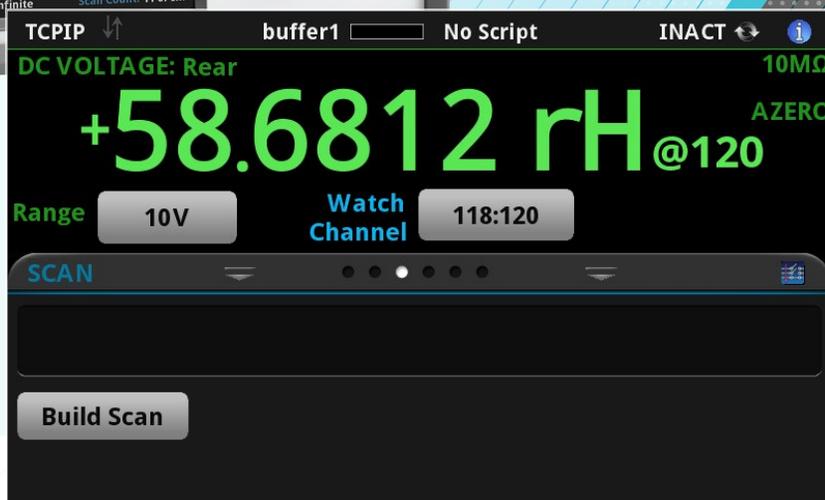
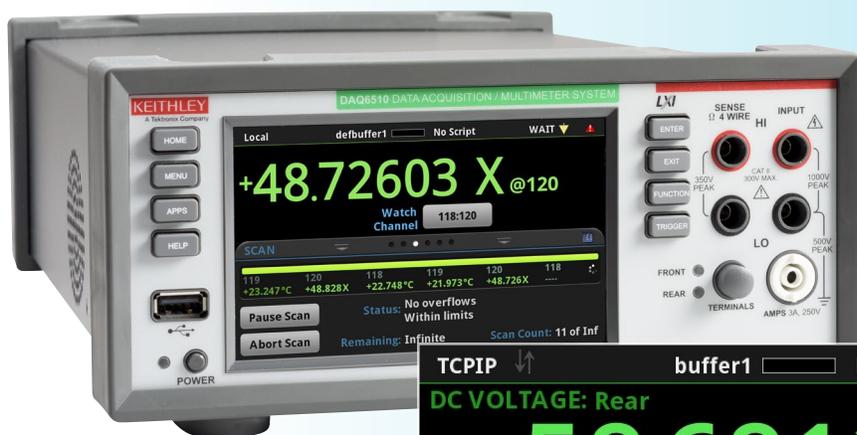


# Adding Relative Humidity Sensing to Temperature Scans on a DAQ6510

## APPLICATION NOTE



**KEITHLEY**  
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## Use Case

Temperature scanning is a common application for data loggers such as the Keithley [DAQ6510 Data Logging Multimeter](#). These scans are run to perform environmental testing on a device of interest or on multiple devices. The scope of this environmental testing can be expanded by adding a relative humidity sensor to the scan, allowing further insight into the operating conditions of the device. The ability to measure temperature and relative humidity together allows for a complete environmental verification of device performance throughout its operating range. While it is sometimes possible to establish communications between a data acquisition system and a given environmental chamber, these connections are cumbersome to configure and require additional programming and cabling. Offloading the relative humidity measuring to the DAQ6510 simplifies the process. Benefits also include localizing the humidity measurements to the device under test (DUT) and conveniently storing both temperature and humidity readings in the same buffer, which can be easily exported for external analysis. The following example demonstrates how an analog relative humidity sensor can be wired into a Series 7700 multiplexer plug-in module. Following these steps is a way to simplify environmental testing and make important measurements on a variety of parameters all from a single instrument.

## Sensor Wiring and Configuration

For this example, we chose to use the HM1500LF humidity transducer from [TE Connectivity](#). This device requires 5VDC and ground inputs, and provides an analog output voltage that corresponds to the humidity detected at the sense point. We leverage the 5V supply and ground pins on the DAQ6510's Digital I/O interface. This requires a communication accessory card to be inserted into the instrument. The three available communications cards ([GPIB](#), [RS-232](#), [TSP-Link®](#)) all include digital I/O, so any card will work for this application. The humidity sensor's voltage supply line is soldered into the pin on a DB9 type connector

corresponding to the digital I/O 5V supply (pin 7). The ground line of the sensor is first split to allow for a common ground between the sensor's signal and supply lines. One ground line is soldered into the pin corresponding to ground on the DB9 connector (pin 9). The signal and second ground line must have around eight to ten inches of slack to allow them to be screwed into the input high and low screw terminals of a Series 7700 multiplexer module. These lines are wired into a given channel on the module and other channels are populated with thermocouple wires to complete the setup.

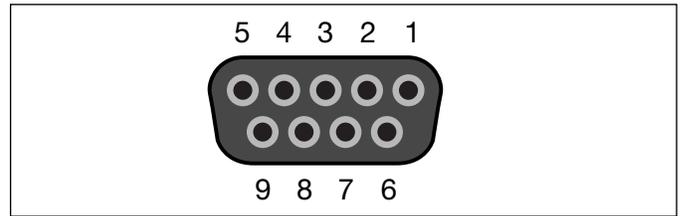


Figure 1: Digital I/O pinout.

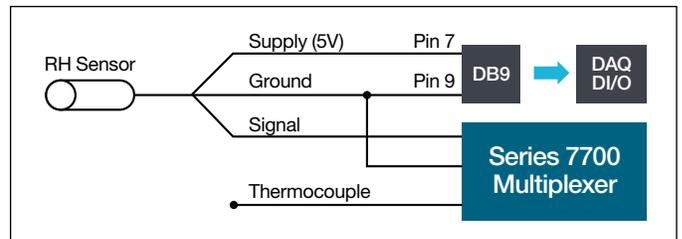


Figure 2: Wiring schematic.

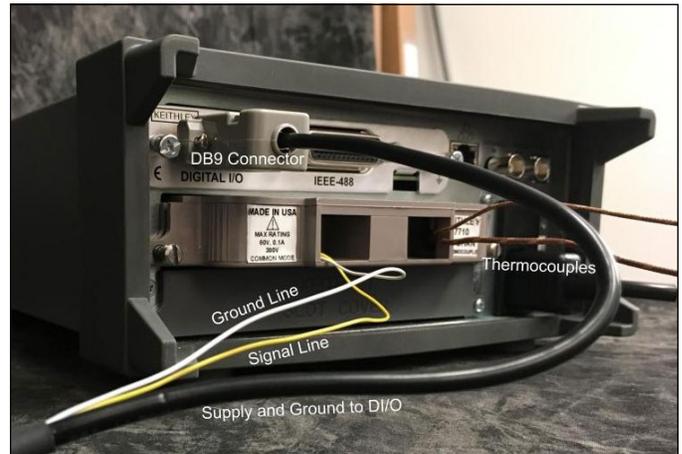


Figure 3: Configured setup.

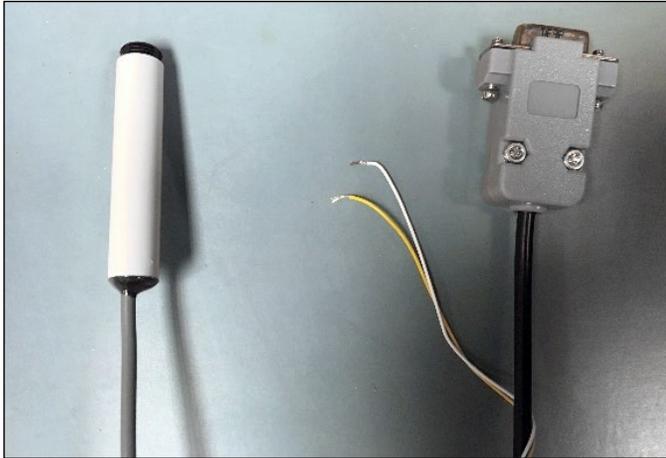


Figure 4: Relative humidity probe to DB9 and card leads.

## Programming the Scan

Because the relative humidity probe is an analog sensor, it outputs a voltage corresponding to the humidity it is measuring. The DAQ6510's built-in  $mx+b$  math function can be used to translate this voltage into a % relative humidity according to the linear equation provided on the sensor's datasheet ( $RH = 38.92 \cdot V_{out} - 42.017$ ). The polynomial fit equation from the datasheet can also be used but requires additional scripting as higher order polynomial equations are not natively supported as a math function. In this example, channels 118 and 119 are wired with type K thermocouple wire and channel 120 is wired with the signal and ground lines from the relative humidity sensor. A scan of relative humidity and temperature is then set up from the front panel using the following steps.

## Front Panel Setup

1. Ensure instrument is set to Rear Terminals.
2. From the Scan swipe screen on the Home screen, press the Build Scan button.
3. Touch the add button (+), and add channels 118 and 119.
4. Select Temperature.
5. On the right side of the screen, ensure Transducer is set to TC, Thermocouple is set to K, and Reference Junction is set to Internal.
6. Touch the add button (+) again, and add channel 120.
7. Select DC Voltage.
8. On the right side of the screen, set measurement range to 10 V.
9. Scroll down and turn on the Math function; touch the settings button to the right.
10. Select  $mx+b$  for Math Format.
11. Set  $m = 38.92$ ,  $b = -42.017$ ; touch OK.
12. Touch the Scan tab on the right side of the screen.
13. Change Scan Count to Infinite.
14. Set Scan to Scan Interval to 5 seconds.
15. Touch the Start button to initiate the scan.
16. Touch View Scan Status.

## Equivalent Setup Using TSP® Scripts

The same scan setup can be achieved using TSP scripts using the following code.

```

reset ()
-- set up DMM
channel.setdmm("118", dmm.ATTR_MEAS_FUNCTION, dmm.FUNC_TEMPERATURE,
  dmm.ATTR_MEAS_THERMOCOUPLE, dmm.THERMOCOUPLE_K,
  dmm.ATTR_MEAS_REF_JUNCTION, dmm.REFJUNCT_INTERNAL)
channel.setdmm("119", dmm.ATTR_MEAS_FUNCTION, dmm.FUNC_TEMPERATURE,
  dmm.ATTR_MEAS_THERMOCOUPLE, dmm.THERMOCOUPLE_K,
  dmm.ATTR_MEAS_REF_JUNCTION, dmm.REFJUNCT_INTERNAL)
channel.setdmm("120", dmm.ATTR_MEAS_FUNCTION, dmm.FUNC_DC_VOLTAGE,
dmm.ATTR_MEAS_RANGE, 10, dmm.ATTR_MEAS_RANGE_AUTO, dmm.OFF, dmm.ATTR_MEAS_MATH_ENABLE, dmm.ON)
channel.setdmm("120", dmm.ATTR_MEAS_MATH_FORMAT, dmm.MATH_MXB, dmm.ATTR_MEAS_MATH_MXB_BF,
-42.017, dmm.ATTR_MEAS_MATH_MXB_MF, 38.92)
display.watchchannels = '118:120'

-- set up Scan
scan.add("118,119,120")
scan.scancount = 0 -- sets scan count to infinite
scan.scaninterval = 5
-- set up trigger model
trigger.model.initiate()

```



Figure 5: Screen showing scan status and %RH measurement.

## Advanced TSP Example

A more advanced TSP example is shown below. The following code allows for units rH to be displayed on the instrument's display. This is achieved using custom units, which can be attached to readings in a writable buffer. To do this, each measurement must first be taken into a reading buffer then written to the writable buffer. This requires leveraging of the built-in Lua scripting supported by the DAQ6510 to create a “for” loop to mimic a scan of the channels. This method also allows implementation of the higher order polynomial equation for voltage to %RH conversion. The user can switch between the two methods of conversion, linear and polynomial, by selectively commenting out the relevant lines in the following script.

```

--Scanning Temperature and Relative Humidity on the DAQ6510
reset ()
-- set up DMM
channel.setdmm("118", dmm.ATTR_MEAS_FUNCTION, dmm.FUNC_TEMPERATURE,
  dmm.ATTR_MEAS_THERMOCOUPLE, dmm.THERMOCOUPLE_K,
  dmm.ATTR_MEAS_REF_JUNCTION, dmm.REFJUNCT_INTERNAL)
channel.setdmm("119", dmm.ATTR_MEAS_FUNCTION, dmm.FUNC_TEMPERATURE,
  dmm.ATTR_MEAS_THERMOCOUPLE, dmm.THERMOCOUPLE_K,
  dmm.ATTR_MEAS_REF_JUNCTION, dmm.REFJUNCT_INTERNAL)

```

```

channel.setdmm("120", dmm.ATTR_MEAS_FUNCTION, dmm.FUNC_DC_VOLTAGE,
    dmm.ATTR_MEAS_RANGE, 10, dmm.ATTR_MEAS_RANGE_AUTO, dmm.OFF)
display.watchchannels = '118:120'

buffer1 = buffer.make(1000000, buffer.STYLE_WRITABLE)
buffer.unit(buffer.UNIT_CUSTOM1, "dC")
buffer.unit(buffer.UNIT_CUSTOM2, "rH")
scanCount = 10
channelDelay = 1

channel.open("allslots")

for i = 1,scanCount do
    --take one measurement per channel closure
    dmm.measure.count = 1
    channel.close("118")
    --read measurement from default buffer
    reading, seconds, fractional = dmm.measure.readwithtime(defbuffer1)
    --establishes settings for custom buffer
    buffer.write.format(buffer1, buffer.UNIT_CUSTOM1, buffer.DIGITS_5_5)
    --writes reading to custom buffer
    buffer.write.reading(buffer1, reading, seconds, fractional, 0, "118")
    channel.open("118")
    delay(channelDelay)

    channel.close("119")
    reading, seconds, fractional = dmm.measure.readwithtime(defbuffer1)
    buffer.write.format(buffer1, buffer.UNIT_CUSTOM1, buffer.DIGITS_5_5)
    buffer.write.reading(buffer1, reading, seconds, fractional, 0, "119")
    channel.open("119")
    delay(channelDelay)

    channel.close("120")
    reading, seconds, fractional = dmm.measure.readwithtime(defbuffer1)
    --performs math on channel to convert DCV to %RH
    reading = reading * 1000
    --comment out one of the following "reading =" functions to switch methods
    reading = -1.91E-9 * (reading)^3 + 1.33E-5 * (reading)^2 + 9.56E-3 *
    (reading) - 2.16E+1
    --reading = 0.03892 * reading - 42.017
    buffer.write.format(buffer1, buffer.UNIT_CUSTOM2, buffer.DIGITS_5_5)
    buffer.write.reading(buffer1, reading, seconds, fractional, 0, "120")
    channel.open("120")
    delay(channelDelay)
end

```



Figure 6: Relative humidity measurement with custom units shown.

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