Section 5

Scanning temperature using thermocouples

In this section:

Introduction

This application example demonstrates how to use the DAQ6510 to log thermocouple-based temperature measurement scans, using internal cold-junction compensation (CJC) correction, over a 24-hour period.

This type of test is typically performed when a device under test (DUT) is placed in an environmental chamber and exposed to extreme conditions. The system captures data at different locations on the DUT. The data is then exported from the DAQ6510 to a computer where a thermal profile is generated. This thermal profile provides designers and consumers with a thorough understanding of the thermal operating characteristics of their device or product.

Equipment required

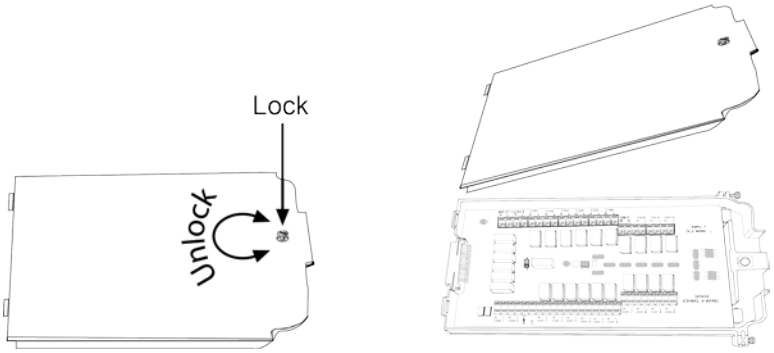
- One DAQ6510
- One Model 7700 20-channel differential multiplexer module
- One computer setup for communication with the instrument
- 10 Type K Thermocouples
- One USB flash drive
- One device or component to be tested

Device connections

Connecting thermocouples to the instrument

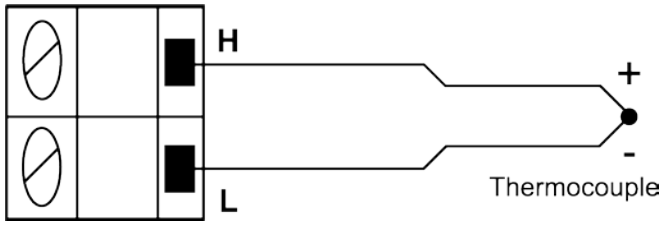
1. Power off the DAQ6510.
2. Remove the 7700 from the DAQ6510.
3. Remove the top cover from the 7700.

Figure 30: Screw terminal access



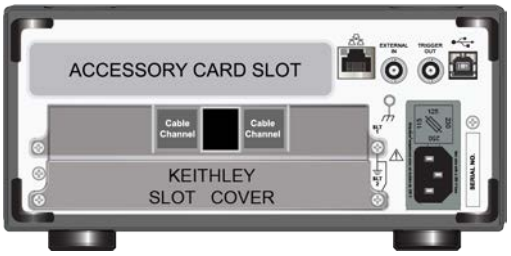
4. Connect ten Type K thermocouples to each channel as shown.

Figure 31: 7700 multiplexer module thermocouple connections



5. Route the cables out through the channels in the 7700 and secure the top cover.
6. Ensure that the DAQ6510 power is turned off.
7. Insert the 7700 into a slot on the rear of the DAQ6510.

Figure 32: DAQ6510 with 7700 multiplexer module



8. Press the **POWER** switch on the front panel to turn on the instrument.
9. Set the TERMINALS switch to rear.
10. Plug the USB flash drive into the port on the front of the instrument.

The remaining connections are the thermocouples to the DUT, which typically use soldering, thermal compound, polyimide tape, or conductive epoxy.

⚠ WARNING

To prevent electric shock, test connections must be configured such that the user cannot come in contact with test leads or any device under test (DUT) that is in contact with the conductors. It is good practice to disconnect DUTs from the instrument before powering the instrument. Safe installation requires proper shields, barriers, and grounding to prevent contact with test leads.

There is no internal connection between protective earth (safety ground) and the LO terminals of the DAQ6510. Therefore, hazardous voltages (more than 30 V_{rms}) can appear on LO terminals. This can occur when the instrument is operating in any mode. To prevent hazardous voltage from appearing on the LO terminals, connect the LO terminal to protective earth (safety ground) if your application allows it. You can connect the LO terminal to the chassis ground terminal on the front panel or the chassis ground screw terminal on the rear panel. Note that the front-panel terminals are isolated from the rear-panel terminals. Therefore, if you are using the front-panel terminals, ground to the front-panel LO terminal. If using the rear-panel terminals, ground to the rear panel LO terminal. Failure to follow these guidelines can result in injury, death, or instrument damage.

Thermocouple temperature scanning

This application demonstrates how to use the DAQ6510 to measure temperature at ten different points on a DUT every minute over a 24-hour period. During this test, all scan data is automatically written to a USB flash drive connected to the port on the instrument.

For this application, you will:

- Configure the instrument for ten channels of Type K thermocouple measurement using internal cold junction correction (CJC).
- Enable detection of open leads and offset compensation for more accurate readings.
- Configure the instrument to scan all channels (1 to 10) once a minute for 24 hours.
- Automatically export the data to a USB flash drive for each completed scan.
- Enable the auto-restart feature to ensure the continuation of progress in the event of power failure.
- Check the status of the scan progress as it is running.
- Pause the scan and move the data to a computer to begin analysis, prior to scan completion.
- Analyze graphical data of the scan in progress.
- Learn how to program the instrument through the front panel user interface.
- Learn how to program the instrument using a remote communications interface with SCPI and TSP code commands.

Using the front panel

To set up the application from the front panel:

1. Press the **POWER** switch on the front panel to turn on the instrument.
2. Press the **MENU** key.
3. Under Channel, select **Scan**.
4. Select the **+** button to add a group of channels (101 to 110), and select **OK**.
5. Select **Temperature** on the Measure Functions screen.
6. Select Thermocouple, select **K.**
7. Scroll down and set the Reference Junction to **Internal**.
8. Select the Scan tab, set the Scan Count to 1440, and select **OK.** (One scan every minute for 24 hours = 24 hours * 60 minutes = 1440).
9. Set the Interval Between Scans to **60 s** and select **OK**.
10. Scroll down on the Scan tab to Export to a USB flash drive. Choose **After Each Scan** from the list of options.
11. Select Filename, enter **scan24hr,** and select **OK** to accept.
12. Select **OK** to accept the remaining File Content settings.
13. Select **Power Loss Restart** and select **On**.
14. You can now start your scan in one of two ways:
    a. Select the **Start** icon on the SCAN screen.
    b. Press the **TRIGGER** key and select a measurement state. Choose **Initiate Scan** to start the scan.
15. Select **View Scan Status** to go to the SCAN swipe on the HOME screen.

Using SCPI commands

This sequence of SCPI commands makes a thermocouple-based temperature scan.

You may need to make changes so that this code will run in your programming environment.

Send the following commands for this example application:

Commands	Descriptions
`*RST`	• Reset the DAQ6510
`:FUNCtion 'TEMPerature',(@101:110)`	• Set up channel settings for Slot 1
`:SENSe:TEMPerature:TRANsducer TCouple, (@101:110)`	
`:SENSe:TEMPerature:TCouple:TYPE K, (@101:110)`	
`:SENSe:TEMPerature:TCouple:RJUNction: RSELect INTernal, (@101:110)`	
`:SENSe:TEMPerature:ODETector ON, (@101:110)`	
`:ROUTe:SCAN:CREate (@101:110)`	• Set up Scan
`:ROUTe:SCAN:COUNt:SCAN 1440`	• Set the scan count to 24 hrs * 60 min/hr = 1440
`:ROUTe:SCAN:INTerval 60.0`	• Set the time between scans to 60 s
`:ROUTe:SCAN:EXPORT "/usb1/scan24hr.csv", SCAN, ALL`	• Ensure data gets written to a USB drive after each scan
`:ROUTe:SCAN:RESTart ON`	• Enable scan restart after power failure
`:INIT`	• Trigger to start scan
`:DISPlay:SCReen SWIPE_SCAN`	• Sends user to the SCAN swipe screen

Using TSP commands

NOTE

The following TSP code is designed to be run from Keithley Instruments Test Script Builder (TSB). TSB is a software tool that is available from the Keithley webpage on the Tektronix website (tek.com/keithley). You can install and use TSB to write code and develop scripts for TSP-enabled instruments. Information about how to use TSB is in the online help for TSB and in the "Introduction to TSP operation" section of the *DAQ6510 Reference Manual*.

To use other programming environments, you may need to make changes to the example TSP code.

By default, the DAQ6510 uses the SCPI command set. You must select the TSP command set before sending TSP commands to the instrument.

To enable TSP commands:

1. Press the **MENU** key.
2. Under System, select **Settings**.
3. For Command Set, select **TSP**.
4. At the prompt to reboot, select **Yes**.

This sequence of TSP commands makes a series of temperature measurements. After the code executes, the data is displayed in the Instrument Console of Test Script Builder.

Send the following commands for this example application:

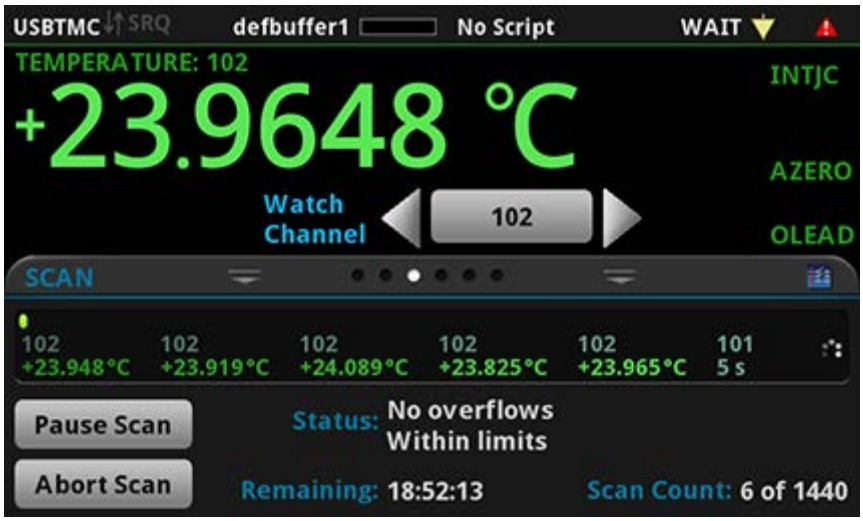
```
-- Reset the instrument to the default settings
reset()
-- Set up channel settings for Slot 1
channel.setdmm("101:110", dmm.ATTR_MEAS_FUNCTION, dmm.FUNC_TEMPERATURE)
channel.setdmm("101:110", dmm.ATTR_MEAS_TRANSDUCER, dmm.TRANS_THERMOCOUPLE)
channel.setdmm("101:110", dmm.ATTR_MEAS_THERMOCOUPLE, dmm.THERMOCOUPLE_K)
channel.setdmm("101:110", dmm.ATTR_MEAS_REF_JUNCTION, dmm.REFJUNCT_INTERNAL)
channel.setdmm("101:110", dmm.ATTR_MEAS_OPEN_DETECTOR, dmm.ON)
-- set up Scan
scan.create("101:110")
-- Set the scan count to 24hrs * 60min/hr = 1440
scan.scancount = 1440
-- Set the time between scans to 60s
scan.scaninterval = 6.000e+01
-- Ensure data gets written to a connected USB drive after each scan
scan.export("/usb1/scan24hr.csv", scan.WRITE_AFTER_SCAN, buffer.SAVE_RELATIVE_TIME)
-- Enable scan restart after power failure
scan.restart = scan.ON
-- Trigger to start the scan...
trigger.model.initiate()
-- Ensure that the display shows the SCAN swipe and carousel
display.changescreen(display.SCREEN_SCAN_SWIPE)
```

Test results

The following figures show sample results and final test measurements for this application.

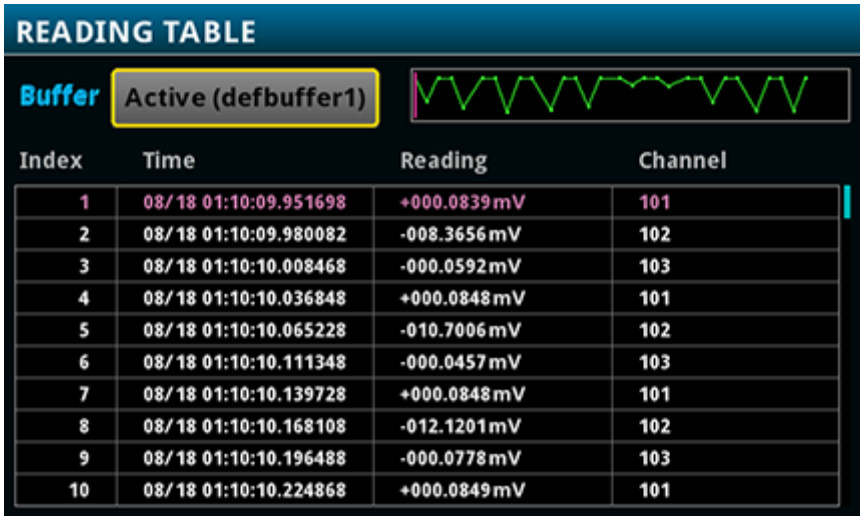
1. The horizontal progress bar is completely green when the connections at the screw terminals and at the DUT are secure. The SCAN swipe screen provides the time remaining (in seconds) and the scan countdown.

Figure 33: DAQ6510 scan start screen



2. If you have data on the USB flash drive and want to review it prior to completion, pause the scan, remove the drive, copy the data file to your PC, return the drive to the DAQ6510, and resume the scan.

Figure 34: Temperature scan results



Index	Time	Reading	Channel
1	08/18 01:10:09.951698	+000.0839mV	101
2	08/18 01:10:09.980082	-008.3656mV	102
3	08/18 01:10:10.008468	-000.0592mV	103
4	08/18 01:10:10.036848	+000.0848mV	101
5	08/18 01:10:10.065228	-010.7006mV	102
6	08/18 01:10:10.111348	-000.0457mV	103
7	08/18 01:10:10.139728	+000.0848mV	101
8	08/18 01:10:10.168108	-012.1201mV	102
9	08/18 01:10:10.196488	-000.0778mV	103
10	08/18 01:10:10.224868	+000.0849mV	101

3. Once the scan is complete, the SCAN swipe screen provides you with additional options. You can select different tabs that provide graphical data analysis options. The following figure shows a sample graph for this application.

Figure 35: DAQ6510 graph UI four views.png