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Emulation and Migration Guide

Introduction

Thank you for choosing a Keithley Instruments product. This document provides information about using the DAQ6510 as a drop-in replacement in an existing Keithley Instruments Model 2700 or 2701 test system application.

The DAQ6510 provides greater functionality and improved accuracy over the Model 2700 and 2701. However, established customer test systems can be sustained after replacement without significant reconfiguration and code changes by using emulation mode.

You can use the DAQ6510 SCPI 2700 or SCPI 2701 command set to emulate a Model 2700 or 2701, but you will not have access to the full range of features available in its native mode. In addition, the options that you can set from the front panel are more limited than the front-panel options on the DAQ6510. Emulation mode is intended primarily for remote command operation.

This guide describes:

- How to configure the DAQ6510 for emulation mode.
- The hardware interface differences between the Model 2700 or 2701 and the DAQ6510.
- The software differences between SCPI 2700 or SCPI 2701 on the DAQ6510 and the standard SCPI command set available on the Model 2700 or 2701 product.
- Application examples that provide insight as to what you can expect from the DAQ6510 in the SCPI 2700 or SCPI 2701 emulation mode.

NOTE

The SCPI 2700 and SCPI 2701 command sets are designed to emulate the following instruments and firmware versions:

- **SCPI 2700:** Model 2700, B10
- **SCPI 2701:** Model 2701, B05

If your Model 2700 or 2701 has a previous firmware revision installed, the code examples in this document may not run or could produce unexpected results. Visit tek.com/keithley to download the newest firmware revision.

Comparison of key features

While in emulation mode, the DAQ6510 will mimic the operation of the Model 2700 or Model 2701. You can remotely control the instrument measurement functions using your existing SCPI command programs. More than 90% of the Model 2700 and Model 2701 command set is supported. While new functions and features are supported in native mode, the emulation modes will restrict you to legacy instrument features.



The following table is a comparison of key features between the instruments.

| | DAQ6510 | Model 2700 / Model 2701 |
|--|---|---|
| Resolution | 6 ½ digits | 6 ½ digits |
| DMM input terminals | Front | Front |
| Plug-in module slots and channels | Two slots, up to 80 independent channels | Two slots, up to 80 independent channels |
| Module cards supported | Same | |
| Reading capacity | 7M | 55k |
| Non-volatile memory | No | Yes |
| Basic DCV accuracy | 30 ppm / 1 year; 35 ppm / 2 year | 30 ppm / 1 year |
| Measurements | | |
| DCV, ACV (ranges) | Same | |
| DCI (ranges) | 10 µA, 100 µA, 1 mA, 10 mA, 100 mA, 1 A, 3 A | 20 mA, 100 mA, 1 A, 3 A |
| ACI (ranges) | 100 µA, 1 mA, 10 mA, 100 mA, 1 A, 3 A | 1 A, 3 A |
| Temperature | Same | |
| Diode | 10 V clamp (10 µA, 100 µA, 1 mA, and 10 mA test currents) | N/A |
| Capacitance | 1 nF, 10 nF, 100 nF, 1 µF, 10 µF, 100 µF | N/A |
| Digitizer | Up to 1MS/s voltage or current | N/A |
| Resistance (lowest ranges) | 1 Ω, 10 Ω, 100 Ω | 100 Ω |
| PC interfaces | USB/LAN-LXI (standard) GPIB/RS-232/TSP-Link (optional) | GPIB/RS-232 (Model 2700) LAN/RS-232 (Model 2701) |
| USB flash drive support | Yes | No |
| Max scan rate (w/ 7710 card) | > 800 channels per second (USB) | 180 channels per second (Model 2700, GPIB) 500 channels per second (Model 2701, LAN) |
| Mechanical size (for rack mounting) | 2U, ½ rack | |
| | 14.039 in. (356.6 mm) deep | 14.563 in. (370 mm) deep |
| Measurement accuracy and resolution | The datasheet for each model provides specifications. See the Keithley Instruments (http://www.tek.com/keithley) website. | |
| SCPI compatibility | Greater than 90% coverage of the Model 2700 and Model 2701 standard command set. | |

Select the SCPI command set for emulation mode

To use the DAQ6510 as a drop-in replacement in an existing 2700 or 2701 application, you must use the SCPI 2700 or SCPI 2701 command set. This command set includes most of the commands that are available in the Model 2700 or 2701 product.

You can select the SCPI 2700 or SCPI 2701 command set from the front panel or over the remote interface.

When you change to the SCPI 2700 or SCPI 2701 command set, you must reboot the instrument. You will be prompted by the front panel to reboot, but you will not be prompted if using remote commands.

Using the front panel:

1. Press the **MENU** key.
2. Under System, select **Settings**.
3. Select the button next to Command Set.
4. Select **SCPI 2700** or **SCPI 2701**. You will be prompted to reboot.
5. Select **OK**.

Using SCPI or TSP remote commands:

For SCPI 2700, send the command:

```
*lang SCPI2700
```

For SCPI 2701, send the command:

```
*lang SCPI2701
```

Reboot the instrument.

Front-panel operation with the SCPI 2700 or SCPI 2701 command set

When the SCPI 2700 or SCPI 2701 command set is selected, the options available through the front panel are limited. Emulation mode is intended primarily for remote command operation.

The following topics describe the options that are available when the SCPI 2700 or SCPI 2701 command set is selected.

Home screen display

When the SCPI 2700 or SCPI 2701 command set is selected, the Home screen is the only main screen available. The User, Channel, and Functions swipe screens are also available in the swipe screen area.

The options available on the Home screen are described here.

Figure 1: Home screen when the SCPI 2700 command set is selected



| # | Screen element | Description |
|---|---|--|
| 1 | System status and event indicators | Located at the top of the Home screen. These indicators provide information about the present state of the instrument. Some of the indicators open up a dialog box with more information or a settings menu when selected. |
| 2 | MEASURE view area | Green part of the Home screen; displays the value of the present measurement. |
| 3 | Swipe screen area | Blue part of the Home screen. It displays the User and Functions options. If the rear terminals are selected, Channel options are available. |

Status and error indicators when the SCPI 2700 or SCPI 2701 command set is selected

The indicators at the top of the Home screen contain information about instrument settings and states. Some of the indicators also provide access to instrument settings.

Figure 2: Status and error indicators — SCPI 2700 or SCPI 2701



The communications indicator is at the left. The options you might see here include:

| Indicator | Meaning |
|---------------|--|
| Local | Instrument is controlled from the front panel. |
| GPIB | Instrument is communicating through a GPIB interface. |
| RS-232 | Instrument is communicating through an RS-232 interface. |
| TCPIP | Instrument is communicating through a LAN interface. |
| VXI-11 | Instrument is communicating using VXI-11. |
| USBTMC | Instrument is communicating through a USB interface. |
| Telnet | Instrument is communicating through Telnet. |

The communications indicator displays the type of communications the instrument is using. Select the indicator to display the present communications settings. Select **Change Settings** at the bottom of the dialog box to open the System Communications screen, where you can change the settings.

There is an activity indicator next to the communications indicator. When the instrument is communicating with a remote interface, the up and down arrows flash.

If a service request has been generated, SRQ is displayed to the right of the up and down arrows. You can instruct the instrument to generate a service request (SRQ) when one or more errors or conditions occur. When this indicator is on, a service request has been generated. This indicator stays on until the serial poll byte is read or all the conditions that caused SRQ are cleared.

The system event indicator is on the far right side of the instrument status indicator bar. This indicator changes based on the type of event that occurred.

Press the indicator to open a message screen with a brief description of the error, warning, or event. Press the Event Log button to see the System Events screen, which contains more detailed descriptions of the events and options for controlling the types of error events that are displayed on the front panel.

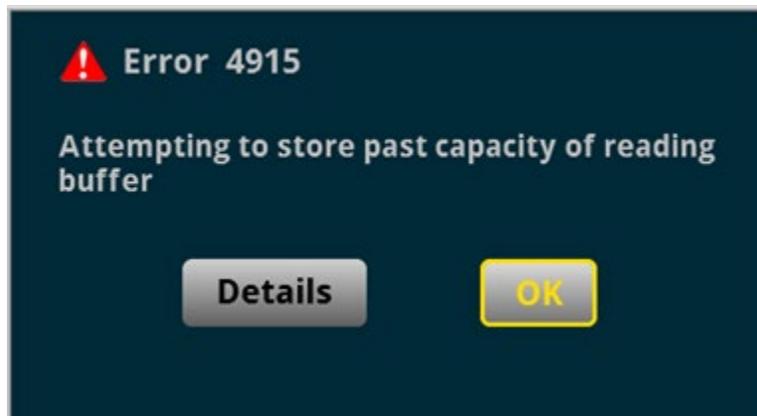
The following table describes the different event indicators and what they mean.

| Icon | Description |
|---|--|
|  | An empty triangle means that no new events were logged in the event log since the last time you viewed the event log. |
|  | A blue circle means that an informational event message was logged. The message is for information only. This indicates status changes or information that may be helpful. If the Log Command option is on, it also includes commands. |
|  | A yellow triangle means that a warning event message was logged. This message indicates that a change occurred that could affect operation. |
|  | A red triangle means that an error event message was logged. This may indicate that a command was sent incorrectly. |

Event messages

During operation and programming, front-panel messages may be displayed. Messages are information, warning, or error notifications.

Figure 3: Example front-panel error message



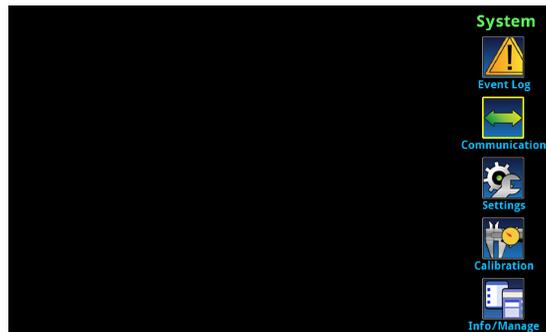
Menus when the SCPI 2700 or SCPI 2701 command set is selected

When the SCPI 2700 or SCPI 2701 command set is selected, the only menu available from the front panel is the System Settings menu.

System Settings menu when the SCPI 2700 or SCPI 2701 command set is selected

The System Settings menu is available when the SCPI 2700 or SCPI 2701 command set is selected. The options are the same as the options when the other command sets are selected, except that the TSP-Link options in the Communication menu are not available.

Figure 4: Main menu when the SCPI 2700 or SCPI 2701 command set is selected



Model 2700 or 2701 to DAQ6510 hardware interface differences

The following topics detail the differences between the hardware connections used for the Model 2700 or 2701 and the interfaces provided for the DAQ6510.

Remote interfaces

The Model 2700 was supplied with both GPIB and RS-232 interfaces, while the Model 2701 supplied Ethernet and RS-232 interfaces.

The DAQ6510 is supplied with USB and Ethernet connectors as standard interfaces. The instrument also supports GPIB, RS-232, and TSP-Link® with optional communication accessory modules.

NOTE

TSP-Link is not supported in SCPI 2700 or SCPI 2701 emulation modes.

The following communication accessory modules are available for the DAQ6510. These modules are designed for user installation, and do not require the DAQ6510 to be shipped to Keithley Instruments for service or adjustment.

- KTTI-GPIB – Communication and Digital I/O Accessory
- KTTI-RS232 – Communication and Digital I/O Accessory
- KTTI-TSP – Communication and Digital I/O Accessory

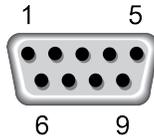
For more information about the communication accessory cards (such as configuration through the front panel and over the remote interface), visit tek.com/keithley.

Digital I/O interface

The Model 2700 and 2701 provide six digital I/O lines on a standard DB-9 connector on the rear panel of the instrument. The port is output-only in standard mode and also when you use the SCPI 2700 and SCPI 2701 command sets.

The following graphic and table details the digital I/O pinouts.

Figure 5: Model 270x digital I/O pin layouts



| Pin | 2700 and 2701 functionality |
|-----|----------------------------------|
| 1 | Digital output #1 (low limit 1) |
| 2 | Digital output #2 (high limit 1) |
| 3 | Digital output #3 (low limit 2) |
| 4 | Digital output #4 (high limit 2) |
| 5 | Digital output #5 (master limit) |
| 6 | External trigger (input) |
| 7 | Diode clamp |
| 8 | Hardware interlock (input) |
| 9 | Digital ground (chassis) |

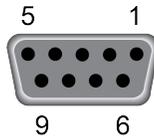
The DAQ6510 does not directly provide this interface. However, the same interface is available if you install one of the KTTI communications accessory cards (see [Remote interfaces](#) (on page 6)).

If you use the SCPI 2700 or SCPI 2701 command set with the DAQ6510 and a KTTI card, the I/O pin mapping and functionality will match that of the 2700 or 2701, with two exceptions:

- Pin 6 is not physically linked to the external trigger line of the trigger link connection, but pin 6 will accept the external trigger signal from an outside source.
- Pin 8 will not enable or disable the external trigger line of the trigger link connection, but pin 8 will still enable and disable the triggering capability of pin 6.

The following graphic and table details the DAQ6510 digital I/O pinouts when a KTTI communication accessory card is installed. The DAQ6510 is output-only when used with the SCPI 2700 or SCPI 2701 command sets. However, the DAQ6510 standard command set supports six dedicated I/O input and output control lines.

Figure 6: DAQ6510 digital I/O pin layouts

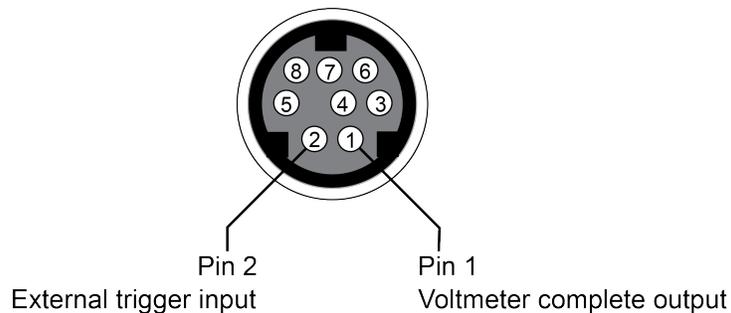


| Pin | DAQ6510 functionality (with KITT card installed) |
|-----|--|
| 1 | I/O line #1 |
| 2 | I/O line #2 |
| 3 | I/O line #3 |
| 4 | I/O line #4 |
| 5 | V _{ext} line (relay flyback diode protection; maximum 33 V) |
| 6 | I/O line #5 |
| 7 | +5 V line. Use this pin to drive external logic circuitry. Maximum current output is 500 mA. This line is protected by a self-resetting fuse (one-hour recovery time). |
| 8 | I/O line #6 |
| 9 | Ground |

Trigger Link and external trigger and voltmeter support

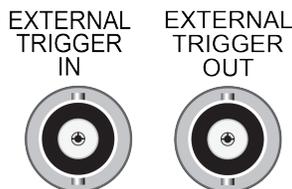
An 8-pin, micro-DIN connector is provided on the rear panel of the Model 2700 and 2701 for sending and receiving trigger pulses. The voltmeter complete output and external trigger input signals are supported by pin 1 and pin 2, respectively. See the next figure.

Figure 7: Model 2700 and 2701 external trigger connections



The DAQ6510 also supports the external trigger input and voltmeter complete signals, but each trigger line is routed to a dedicated BNC connection on the rear panel of the DAQ6510.

Figure 8: DAQ6510 external trigger connections



When using the SCPI 2700 or SCPI 2701 command set, the DAQ6510 trigger signal for voltmeter complete output is sent to the EXTERNAL TRIGGER OUT connector. External trigger input signals are received through the EXTERNAL TRIGGER IN connector.

Scan card support

The Model 2700 or 2701 primary use case is scanning multiple channels using any of the twelve module cards available from Keithley Instruments. All twelve module cards are supported by the DAQ6510 in both emulation and standard modes. These module cards are as follows:

- Model 7700: 20-channel Differential Multiplexer Module
- Model 7701: 32-channel Differential Multiplexer Module
- Model 7702: 40-channel Differential Multiplexer Module
- Model 7703: 32-channel High Speed Differential Multiplexer Module
- Model 7705: 40-channel Single-pole Control Module
- Model 7706: 20-channel Differential Multiplexer with Automatic CJC, 16 Digital Outputs, 2 Analog Outputs, and Counter/Totalizer
- Model 7707: 32-channel Digital I/O Module with 10-channel Differential Multiplexer
- Model 7708: 40-channel Differential Multiplexer Module with Automatic CJC
- Model 7709: 6x8 Matrix Module
- Model 7710: 20-channel Solid-state Differential Multiplexer with Automatic CJC
- Model 7711: 2 GHz 50 Ω RF Module
- Model 7712: 3.5 GHz 50 Ω RF Module

Visit tek.com/keithley for more information on these switching modules.

Model 2700 and 2701 to DAQ6510 software differences

You can use existing code from a Model 2700 or 2701 application with a DAQ6510 — many of the commands are the same. Apart from the exceptions noted in this section, Model 2700 emulation for the DAQ6510 supports all SCPI commands that are supported by the Model 2700. Model 2701 emulation for the DAQ6510 supports all SCPI commands that are supported by the Model 2701.

Details about these differences and other commands that operate differently are described in the following sections.

If a command is not listed in this section, you can use the command in the same way that you did for the previous Model 2700 and 2701 products. The descriptions of the commands are provided in the *Model 2700 or Model 2701 User's Manual*.

SCPI 2700 and SCPI 2701 overview and general exceptions

When you apply the SCPI 2700 or SCPI 2701 command set, the DAQ6510 operation matches Model 2700 or 2701 operation. Commands run as described and have the same defaults as listed in the original *Model 2700 or Model 2701 User Manual*. However, the following exceptions may affect your test system performance:

- Commands run faster than on the Model 2700 and Model 2701.
- Measurements are acquired at the same speed or faster than on a Model 2700 or Model 2701.
- Error numbers generated in emulation mode (using the SCPI 2700 or SCPI 2701 command set) may not match the original product.
- Autorange may use ranges not available on the original product.

The following items are the general exceptions when you select the SCPI 2701 or SCPI 2700 command set.

| Item | Exception |
|--------------------------------------|--|
| Auto scan | Non-volatile auto scan is not supported. |
| Buffer | The minimum reading buffer size is 10. The TRAC:POIN command will accept values less than 10, and you can scan less than 10 channels, but the buffer size will be adjusted to 10. The Model 2700 and 2701 product default is 2. |
| AC aperture | The DAQ6510 has a fixed aperture for AC voltage and AC current measurements regardless of the detector bandwidth setting. The Model 2700 and 2701 allowed NPLC and aperture settings with the detector bandwidth set to 300 Hz. |
| Frequency and period aperture | The DAQ6510 will only accept values up to 250 ms. The Model 2700 and 2701 product default is 1 s. |
| Integration time (NPLC) | At a 60 Hz line frequency, NPLC values up to 15 are supported. At a 50 Hz line frequency, NPLC values up to 12 are supported. Larger values will be accepted and stored, but the DAQ6510 will use 15 (60 Hz) or 12 (50 Hz). |
| Auto delay | The auto delay times are derived from hardware design and therefore may not be the same as on the Model 2700 and Model 2701. Querying the auto delay duration is not supported, and will return zero seconds. |
| Key clicks and presses | Not supported. |
| Frequency and period threshold range | The Model 2700 and Model 2701 maximum range value is 1010 V. The DAQ6510 maximum is 700V. |
| Calibration | Not supported. You must change the command set to use SCPI or TSP to perform calibration. |
| Front panel defaults | The DAQ6510 does not support front panel defaults that differ from remote bus command defaults. |
| Display text data | When selected, this will appear on the User swipe screen of the Home screen. |
| Status model | The following bits are not supported: <ul style="list-style-type: none"> ▪ User Request (URQ) ▪ Device-Dependent Error (DDE) ▪ Hardware Limit Event (HL) ▪ Calibration Summary (Cal) ▪ Command Warning (Warn) ▪ Temperature Summary (Temp) |
| Limits | The beeper is not supported for limit testing. Limit annunciators (indicators on the front panel display) are not implemented. |

| | |
|--------------|--|
| Annunciators | <p>The following annunciators are not supported:</p> <ul style="list-style-type: none"> ▪ HIGH (Reading has reached or exceeded the enabled high limit) ▪ LOW (Reading has reached or exceeded the enabled low limit) ▪ MATH (mX+b, percent, or reciprocal (1/X) calculation enabled) |
|--------------|--|

SCPI 2700 and SCPI 2701 command set exceptions

The following are command set exceptions for the SCPI 2700 command set when used on the DAQ6510.

| Model 2700 command | Exceptions |
|--|--|
| *TST? | Not supported. This command will return 0 (passed). |
| [[:SENSE[1]]:FREQUency:THReshold: VOLTage:RANGe <n> [,<clist>] | The maximum range is 700 V. Will accept higher values, but the range will be set to 700 V. The set value is accepted and stored for later query. |
| [[:SENSE[1]]:PERiod:THReshold: VOLTage:RANGe <n> [,<clist>] | The maximum range is 700 V. Will accept higher values, but the range will be set to 700 V. The set value is accepted and stored for later query. |
| [[:SENSE[1]]:VOLTage:AC: REFerence <n> [,<clist>] | The maximum range is ± 700 V. Will accept higher values, but the range will be set to ± 700 V. The set value is accepted and stored for later query. The Model 2700 and 2701 product maximum is ± 757.5 V. |
| [[:SENSE[1]]:VOLTage:AC:RANGe [:UPPer] <n> [,<clist>] | The maximum range is 700 V. Will accept higher values, but the range will be set to 700 V. The set value is accepted and stored for later query. The Model 2700 and 2701 product maximum range is 757.5 V. |
| DISPlay:TEXT:DATA <a> DISPlay:TEXT:STATe ON OFF | When enabled, text will appear on line 1 of the user swipe screen. |
| FORM:ELEM? | The Model 2700 returns extra commas when less than the maximum elements is set. The DAQ6510 will not return commas unless more than one element is set. |
| ROUTE:CLOSE:COUNT:INTerval | Rounds values to the nearest of 10, 15, 30, 60, or 1440 |
| ROUTE:OPEN:ALL | If you do not have a switch or control module installed, this command generates an error. |
| ROUTE:SCAN:BBMake | Not supported. |
| ROUTE:SCAN:NVOLatile ROUTE:SCAN:NVOLatile? | Non-volatile auto scan is not supported. Returns 0 (disabled) when queried. |
| SYSTEM:KCLick SYSTEM:KCLick? | The set value is accepted and stored for later query, but is not supported. You can configure key click only from the front panel. |
| SYSTEM:KEY <NRf> SYSTEM:KEY? | Not supported. The query will return -1. |
| SYSTEM:RWLock | Not supported. |

| | |
|--|---|
| SYSTem:TIME <hr, min, sec> | The minimum second specification is 1 s. Hours can be set to 23. The maximum second and minute specification is 59. The Model 2700 and 2701 default is 0.01 s resolution, 24 maximum hours, and 60 maximum minutes and seconds. |
| TRACe:POINts <Nrf> | Minimum buffer size is 10. The Model 2700 and 2701 product minimum is 2. |
| TRIGger[:SEQuence[1]]:SOURce MANual | Not supported. |
| UNIT:VOLTage:AC:DB:REFerence <n> | Maximum reference is 700. The Model 2700 and 2701 product maximum is 1000. |

The following are command set exceptions for the SCPI 2701 command set when used on the DAQ6510.

| Model 2701 command | Exceptions |
|---|---|
| SYSTem:BATTery:PRESent? SYSTem:BATTery:STATus? | The battery present query will return 0 (not present). The battery status query will always return "MEMORY LOST". |
| SYSTem:BOARd:SNUMber? SYSTem:BOARd:REVision? | Not supported. The query will return "UNKNOWN". |
| SYSTem:COMMunicate:SERial :CONTrol:RTS <name> | Enabling or disabling the RTS/CTS hardware handshaking will turn off the Xon/Xoff flow control. |
| SYSTem:COMMunicate:SERial :ENTer? | Read data from serial port is not supported. |
| SYSTem:COMMunicate:SERial :PACE <name> | Turning the Xon/Xoff flow control on or off will disable the RTS/CTS hardware handshaking. |
| SYSTem:COMMunicate:SERial :SEND <data> | Not supported. |
| SYSTem:PASSword :CDISable <password> [:CENable] <password> [:CENable]:STATe? | Not supported. Querying the state of protected commands will return 1 (enabled). |
| SYSTem:PASSword :ENABle :ENABle? | Not supported. The query will return 0 (disabled). |
| SYSTem:PASSword :NEW <password> | Not supported. |
| TRIGger[:SEQuence[1]]:SOURce MANual | Not supported. |

Trigger model and status model

The DAQ6510 will emulate the trigger model of either the Model 2700 or Model 2701, depending on the selected SCPI command emulation mode. For details on trigger model behavior in either of these modes, refer to the trigger model information in the Model 2700 or Model 2701 User's Manual.

The DAQ6510 will also emulate a portion of the status model operation for either the Model 2700 or Model 2701, depending on the selected SCPI command emulation mode. See the previous topics in this section for more information. For details on the status model behavior in either of these modes, refer to the status model information in the *Model 2700 or Model 2701 User's Manual*.

DAQ6510 application examples using SCPI 2700 and SCPI 2701 emulation

The following series of examples use the DAQ6510 in either SCPI 2700 or SCPI 2701 emulation mode. These applications were designed using commands in the Model 2700 and 2701 User Manuals.

You may need to make changes so that this code will run in your programming environment. In the following command tables, the SCPI commands have a light gray background. The light green shaded code represents pseudocode that will vary depending on the programming environment you use.

Example 1 - Single-point DC voltage measurement

NOTE

This example uses only SCPI 2700 commands.

This example performs the following operations:

- Resets the instrument
- Places the instrument in DC voltage measurement mode in the fixed 10 V range using a lengthy integration time
- Displays 3 ½ digits on the front panel and returns the reading with units and the timestamp
- Extracts readings with the `READ?` command (which triggers and retrieves the measurement), then uses the `INIT + FETCH?` combination for trigger and measurement extraction

| Model 2700 commands executed on the DAQ6510 | Description |
|---|---|
| *RST | Place the instrument into a known state |
| SENS:FUNC 'VOLT:DC' | Set function to DC volts |
| SENS:VOLT:RANG 10 | Set fixed range of 10 V |
| SENS:VOLT:DIG 4 | Set display digits (range of 4 to 7) |
| SENS:VOLT:NPLC 10 | Set slow integration rate |
| FORM:ELEM READ, TST, UNIT, RNUM | Return readings and timestamps with units |
| TRAC:CLE | Clear the reading buffer |
| READ? | Trigger and return a single reading |
| Delay 5000 | Wait 5 s to change source voltage |
| INIT | Initiate the trigger model |
| FETCH? | Return the latest reading |

Example 2 - Scanning temperature using thermocouples (long-term test)

NOTE

This example uses only SCPI 2700 commands.

This example demonstrates how to use the DAQ6510 in SCPI 2700 or SCPI 2701 emulation mode to scan a set of channels, measure temperature at fixed time intervals, and send the data back to the controlling computer in real time.

This example performs the following operations:

- Clears the buffer and disable continuous trigger
- Sizes the buffer for a target number of points
- Sets the data format to ASCII and returns readings, channel numbers, and units for each channel measurement
- Enables a timer to trigger a scan of 10 channels every 10 seconds for one hour.
- Measures temperature across channels 101 through 110 using Type K thermocouples, uses the internal CJC (dependent on module card model), and enables open lead detection.
- Sets the display digits on the front panel to 4 ½ digits and uses an integration time of 1 PLC
- Incrementally extracts the scanned readings for each triggered scan

| Model 2700 commands executed on the DAQ6510 | Result |
|---|---|
| <pre>int chunkSize = 1 string dudCntr = "" string rcvBuffer int accumVals = 0 int bufferSize = 3600</pre> | Set the data extraction size to one reading Create a variable to store the counter for the loop Create a variable to store the receive buffer Create a variable to hold the accumulated values 10 channels x 360 scans = 3600 samples |
| *RST | Place the instrument into a known state |
| TRAC:CLE | Clear the reading buffer |
| INIT:CONT OFF | Disable continuous triggering |
| TRAC:POIN 3600 | Set the buffer size |
| FORM:DATA ASCII | Format data as an ASCII character string |
| FORM:ELEM READ, CHAN, UNIT | Include units and channel numbers with the reading |
| TRIG:COUN 360 | Set to respond to 360 trigger events |
| SAMP:COUN 10 | Capture 10 channels for each triggered scan |
| TRIG:SOUR TIM | Set the trigger source as based on the timer |
| TRIG:TIM 10.0 | Set the timer event to issue every 10 seconds |
| ROUT:SCAN:TSO IMM | Set the scan trigger source to immediate |
| FUNC 'TEMP', (@101:110) | Set function to temperature |
| TEMP:TRAN TC, (@101:110) | Set transducer to thermocouples |
| TEMP:TC:TYPE K, (@101:110) | Set thermocouples to Type K |
| TEMP:TC:ODET ON | Turn on open thermocouple detector |
| TEMP:RJUN:RSEL INT, (@101:110) | Set reference junction to internal |
| TEMP:DIG 5, (@101:110) | Set display digits |

| | |
|---|---|
| TEMP:NPLC 1, (@101:110) | Set integration rate |
| ROUT:SCAN (@101:110) | Set the scan list |
| ROUT:SCAN:LSEL INT | Enable the scan |
| *OPC? | Check that operations complete |
| INIT | Initiate the scan |
| Delay 10000 | Pause for 10 seconds to allow for the interval delay |
| while accumVals < bufferSize | Begin "while" loop |
| dudCntr = TRAC:NEXT? | Check for the last buffer reading |
| Delay 50 if (dudCntr - accumVals > chunkSize) OR (dudCntr = 0) dudCntr = "" | Allow readings to accumulate Check that there is a reading to print to the console window |
| rcvBuffer = TRAC:DATA:SEL? accumVals, chunksize | Return reading for each individual scan performed over the test period |
| Print rcvBuffer accumVals = accumVals + chunkSize rcvBuffer = "" END if END while | Print the contents of the receive buffer to the console window Increment indexes End the "while" loop |
| *OPC? | Hold for the operations to complete |
| ROUT:SEL:LSEL NONE | Disable scanning |

Example 3 - High-speed scanning with the Model 7710 Solid State Multiplexer Module

NOTE

This example uses only SCPI 2701 commands.

This example demonstrates how to increase scanning speed by disabling features such as autozero and background filtering.

Using a Model 7710 20-channel scanning card populated with 13 kΩ resistors, all channels are configured for the fastest possible NPLC (on the Model 2701). A fixed range is used to further increase the scanning speed.

This application is useful for when you want to prioritize measurement collection speed over measurement noise and accuracy.

This example performs the following operations:

- Sets the data format to ASCII and returns only readings
- Scans 2-wire resistance across channels 101 through 110 one hundred times on a fixed range, with a fast integration time (0.01 NPLC)
- Disables autodelay, autozero, the front-panel display, trigger delay, math calculations, and limits checking
- Extracts the data 50 readings at a time as measurements are made
- Re-enables the display once the scanning and data extraction is complete

| Model 2701 SCPI commands executed on the DAQ6510 | Description |
|--|--|
| <pre>int chunkSize = 50 string dudCntr = "" string rcvBuffer int accumVals = 0 int bufferSize = 1000</pre> | Set the data extraction size to one reading Create a variable to store the counter for the loop Create a variable to hold the receive buffer Create a variable to hold the accumulated values 10 channels x 100 scans = 1000 samples |
| *RST | Put the instrument in a known state |
| TRAC:POIN 1000 | Set the buffer size |
| FORM:DATA ASCII | Format data as an ASCII string |
| FORM:ELEM READ | Return the reading with units |
| SAMP:COUN 1000 | Take 1000 readings |
| FUNC "RES", (@101:110) | Set function to 2-wire resistance |
| RES:RANG 10e3, (@101:110) | Set fixed range at 10kΩ |
| RES:NPLC 0.01, (@101:110) | Set fast integration rate |
| RES:DIG 5, (@101:110) | Set significant digits |
| DISP:ENAB OFF | Turn off display |
| TRIG:DEL:AUTO OFF | Turn off auto-delay |
| TRIG:DEL 0 | Set trigger delay to 0 seconds |
| RES:AVER:STAT OFF, (@101:110) | Disable background statistics/filtering |
| CALC3:OUTP OFF | Turn off limit test |
| SYST:LSYN OFF | Turn off line-sync |

| | |
|---|---|
| SYST:AZER:STAT OFF | Turn off auto-zero |
| CALC3:LIM1:STAT OFF, (@101:110) | Turn off limits |
| TRAC:CLE | Clear the reading buffer |
| ROUT:SCAN (@101:110) | Set the scan list |
| ROUT:SCAN:LSEL INT | Enable the scan |
| *OPC? | Check that operations complete |
| INIT | Initiate the scan |
| Delay 150 | Delay to allow readings to accumulate |
| while accumVals < 1000 | Begin while loop |
| dudCntr = TRAC:NEXT? | Check for the last buffer reading |
| If (dudCntr - accumVals > chunkSize) OR (dudCntr = 0) DudCntr = "" | Check that there are enough readings to print to the console |
| rcvBuffer = TRAC:DATA:SEL? accumVals, chunkSize | Return readings in chunks of 50 |
| Print rcvBuffer accumVals = accumVals + chunkSize END if END while | Print the contents of the receive buffer to the console window Increment indexes End loop |
| *OPC? | Hold for the operations to complete |
| ROUT:SCAN:LSEL NONE | Disable scanning |
| DISP:ENAB ON | Turn the display back on |

The following table lists the overall command execution time as well as the throughput results in units of readings per second. This can help you determine how many measurements you can expect to be returned to the test program using each instrument. Commands generally run faster in emulation mode on the DAQ6510.

| Instrument | Run time at data acquisition rate (readings per second) | |
|---------------------------------|---|---------------|
| | 0.01 PLC | 0.002 PLC |
| Model 2701 | 3.06 @ 326.88 | 3.05 @ 327.23 |
| Model 2701 emulation on DAQ6510 | 2.04 @ 488.52 | 1.94 @ 513.08 |
| Model 2700 | 13.56 @ 73.71 | - |
| Model 2700 emulation on DAQ6510 | 1.80 @ 555.56 | - |

Updating your code to use DAQ6510 SCPI commands

The DAQ6510 standard SCPI command set lets you access new measurement functions, ranges, and data analysis tools. However, these new features are not available when using the SCPI 2700 or SCPI 2701 command set, and you cannot run more than one command set at once.

To access these new features, you can modify your existing SCPI code to use the DAQ6510 standard mode SCPI commands. The examples in this section detail the code changes you can make to the SCPI 2700 or SCPI 2701 command set applications in the previous section.

You may need to make changes so that this code will run in your programming environment. In the following command tables, the SCPI commands have a light gray background. The light green shaded code represents pseudocode that will vary depending on the programming environment you use.

For more information on the functions and features available on the DAQ6510, see the DAQ6510 specification, available from tek.com/keithley.

Example 1 - Single-point DC voltage measurement

NOTE

This example uses only SCPI 2700 commands.

This example performs the following operations:

- Resets the instrument
- Places the instrument in DC voltage measurement mode in the fixed 10 V range using a lengthy integration time
- Displays 3 ½ digits on the front panel and returns the reading with units and the timestamp
- Extracts readings with the READ? command (which triggers and retrieves the measurement), then uses the INIT + FETCH? combination for trigger and measurement extraction

| DAQ6510 SCPI commands | Model 2700 SCPI commands |
|-----------------------|---------------------------------|
| *RST | *RST |
| SENS:FUNC "VOLT:DC" | SENS:FUNC 'VOLT:DC' |
| SENS:VOLT:RANG 10 | SENS:VOLT:RANG 10 |
| DISP:VOLT:DIG 4 | SENS:VOLT:DIG 4 |
| SENS:VOLT:NPLC 10 | SENS:VOLT:NPLC 10 |
| | FORM:ELEM READ, TST, UNIT, RNUM |
| TRAC:CLE | TRAC:CLE |
| READ? | READ? |
| Delay 5000 | |
| INIT | INIT |
| FETCH? | FETCH? |

Example 2 - Scanning temperature using thermocouples (long-term test)

NOTE

This example uses only SCPI 2700 commands.

This example performs the following operations:

- Clears the buffer and disable continuous trigger.
- Sizes the buffer for a target number of points.
- Sets the data format to ASCII and returns readings, channel numbers, and units for each channel measurement.
- Enables a timer to trigger a scan of 10 channels every 10 seconds for one hour.
- Measures temperature across channels 101 through 110 using Type K thermocouples, uses the internal CJC, and enables open lead detection.
- Sets the display digits on the front panel to 4 ½ digits and uses an integration time of 1 PLC.
- Incrementally extracts the scanned readings for each triggered scan.

| DAQ6510 SCPI Commands | Model 2700 SCPI Commands |
|---|---|
| int chunkSize = 1 string dudCntr = "" string rcvBuffer int accumVals = 0 int startIndex int endIndex int bufferSize = 360 | int chunkSize = 1 string dudCntr = "" string rcvBuffer int accumVals = 0 int bufferSize = 360 |
| *RST | *RST |
| TRAC:CLE | TRAC:CLE |
| | INIT:CONT OFF |
| TRAC:POIN 360, "defbuffer1" | TRAC:POIN 360 |
| FORM:DATA ASCII | FORM:DATA ASCII |
| | FORM:ELEM READ, CHAN, UNIT |
| FORM:ASC:PREC 4 | |
| ROUT:SCAN:COUN:SCAN 36 | TRIG:COUN 36 |
| | SAMP:COUN 10 |
| | TRIG:SOUR TIM |
| ROUT:SCAN:INT 10 | TRIG:TIM 10.0 |
| | ROUT:SCAN:TSO IMM |
| FUNC "TEMP", (@101:110) | FUNC 'TEMP', (@101:110) |
| TEMP:TRAN TC, (@101:110) | TEMP:TRAN TC, (@101:110) |
| TEMP:TC:TYPE K, (@101:110) | TEMP:TC:TYPE K, (@101:110) |
| TEMP:ODET ON | TEMP:TC:ODET ON |
| TEMP:TC:RJUN:RSEL INT, (@101:110) | TEMP:RJUN:RSEL INT, (@101:110) |
| DISP:TEMP:DIG 4, (@101:110) | TEMP:DIG 4, (@101:110) |
| TEMP:NPLC 1, (@101:110) | TEMP:NPLC 1, (@101:110) |
| ROUT:SCAN:CRE (@101:110) | ROUT:SCAN (@101:110) |
| | ROUT:SCAN:LSEL INT |

| | |
|---|---|
| *OPC? | *OPC? |
| INIT | INIT |
| Delay 10000 | Delay 10000 |
| while accumVals != 1000 | while accumVals < bufferSize |
| dudCntr = TRACe:ACTual:END? | dudCntr = TRAC:NEXT? |
| Delay 50 If (dudCntr - accumVals) >= chunkSize | Delay 50 if (dudCntr - accumVals > chunkSize) OR (dudCntr = 0) dudCntr = "" |
| rcvBuffer = TRAC:DATA? startIndex, endIndex, "debuffer1", READ | rcvBuffer = TRAC:DATA:SEL? accumVals, chunksize |
| Print rcvBuffer accumVals = accumVals + chunkSize startIndex = startIndex + chunkSize; endIndex = startIndex + (chunkSize - 1); END if END while | Print rcvBuffer accumVals = accumVals + chunkSize rcvBuffer = "" END if END while |
| *OPC? | *OPC? |
| | ROUT:SEL:LSEL NONE |

Example 3 - High-speed scanning with the Model 7710 Solid State Multiplexer Module

NOTE

This example uses only SCPI 2701 commands.

This example performs the following operations:

- Sets the data format to ASCII and returns only readings
- Scans 2-wire resistance across channels 101 through 110 one hundred times on a fixed range, with a fast integration time (0.01 NPLC)
- Disables autodelay, autozero, the front-panel display, trigger delay, math calculations, and limits checking
- Extracts the data 50 readings at a time as measurements are made
- Re-enables the display once the scanning and data extraction is complete

| DAQ6510 SCPI commands | Model 2700 SCPI commands |
|---|---|
| int chunkSize = 50 string dudCntr = "" string rcvBuffer int accumVals = 0 int startIndex int endIndex int bufferSize = 1000 | int chunkSize = 50 string dudCntr = "" string rcvBuffer int accumVals = 0 int bufferSize = 1000 |
| *RST | *RST |
| FORM:DATA ASCII | FORM:DATA ASCII |
| | FORM:ELEM READ |

| | |
|--|---|
| ROUT:SCAN:COUN:SCAN 100 | SAMP:COUN 1000 |
| FUNC "RES", (@101:110) | FUNC "RES", (@101:110) |
| RES:RANG 10e3, (@101:110) | RES:RANG 10e3, (@101:110) |
| RES:NPLC 0.01, (@101:110) | RES:NPLC 0.01, (@101:110) |
| DISP:RES:DIG 5, (@101:110) | RES:DIG 5, (@101:110) |
| DISP:LIGH:STAT OFF | DISP:ENAB OFF |
| RES:DEL:AUTO OFF | TRIG:DEL:AUTO OFF |
| ROUT:SCAN:INT 0 | TRIG:DEL 0 |
| ROUT:CHAN:DEL 0, (@101,110) | |
| RES:AVER:STAT OFF, (@101:110) | RES:AVER:STAT OFF, (@101:110) |
| CALC2:RES:LIM1:STAT OFF, (@101:110) | CALC3:LIM1:STAT OFF, (@101:110) |
| CALC2:RES:LIM2:STAT OFF, (@101:110) | |
| | CALC3:OUTP OFF |
| RES:LINE:SYNC OFF, (@101:110) | SYST:LSYN OFF |
| RES:AZER:STAT OFF, (@101:110) | SYST:AZER:STAT OFF |
| TRAC:CLE | TRAC:CLE |
| TRAC:POIN 1000, "defbuffer1" | TRAC:POIN 1000 |
| ROUT:SCAN:CRE (@101:110) | ROUT:SCAN (@101:110) |
| | ROUT:SCAN:LSEL INT |
| *OPC? | *OPC? |
| INIT | INIT |
| | Delay 150 |
| while accumVals != 1000 | while accumVals < 1000 |
| dudCntr = TRACe:ACTual:END? | dudCntr = TRAC:NEXT? |
| If (dudCntr - accumVals) >= chunkSize | If (dudCntr - accumVals > chunkSize) OR (dudCntr = 0) DudCntr = "" |
| rcvBuffer = TRAC:DATA? startIndex, endIndex, "debuffer1", READ | rcvBuffer = TRAC:DATA:SEL? accumVals, chunkSize |
| Print rcvBuffer accumVals = accumVals + chunkSize startIndex = startIndex + chunkSize; endIndex = startIndex + (chunkSize - 1); END if END while | Print rcvBuffer accumVals = accumVals + chunkSize END if END while |
| *OPC? | *OPC? |
| | ROUT:SCAN:LSEL NONE |
| DISP:LIGH:STAT ON | DISP:ENAB ON |

The following table lists the overall command execution time as well as the throughput results in units of readings per second. This can help you determine how many measurements you can expect to be returned to the test program using each instrument. Commands generally run faster in emulation mode on the DAQ6510.

| Instrument | Run time at data acquisition rate (readings/second) | |
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| | 0.01 PLC | 0.002 PLC |
| Model 2701 | 3.06 @ 326.88 | 3.05 @ 327.23 |
| Model 2701 emulation on DAQ6510 | 2.04 @ 488.52 | 1.94 @ 513.08 |
| Model 2700 | 13.56 @ 73.71 | - |
| Model 2700 emulation on DAQ6510 | 1.80 @ 555.56 | - |
| DAQ6510 | 0.97 @ 1025.64 | 1.02 @ 974.66 |