

Achieving High Reading Rates Using the Data Buffer on the Keithley Model 2110 5½-Digit Dual-Display Digital Multimeter

The Keithley Model 2110 5½-Digit Dual-Display Digital Multimeter (DMM) is equipped with a data buffer that is unmatched by any other 5½-digit DMM in the market today. When test time is a critical factor in production testing, the bus communication between the instrument and the controlling computer should be minimized. Therefore, storing all the readings in a buffer rather than transferring each reading one at a time during testing can significantly reduce test time. The Model 2110 allows up to 2000 readings to be stored in its volatile memory for all measurement functions, math operations, trigger operations, and reading hold operation.

The data buffer can be accessed from the front panel and the remote interface. When the MEM indicator lights up, readings are stored in the data buffer. **Figure 1** shows a front panel display of the Model 2110 in the data buffer access state.



Figure 1. Storing readings to the data buffer.

Configuring the Data Buffer Size

The Model 2110 powers up to a default data buffer size of 2000 readings; however, it can be user-configured to store any number of readings up to 2000. The number of readings is set through the front panel by pressing SHIFT+CONFIG, then using the ◀ or ▶ button to select TRIG SYS, and finally using the ◀ or ▶ button to select STORE RDGS. The set number is only applicable to the front panel operations such as Auto Triggering and Single Triggering. Readings acquired beyond the set number are displayed but not stored.

Data buffer access through remote operation uses the INIT and FETCh? SCPI (Standard Commands for Programmable Instruments) commands. The data buffer size is automatically determined by the trigger count and the sample count values. For example, if the trigger count is set to 10 and the sample count is set to 2, then the data buffer size is automatically set to 20.

Storing Data in the Data Buffer

Once data buffer size has been configured, STORE must be pressed on the front panel to enable access. As described earlier, the MEM indicator shows the enabled status. Similarly in remote operation, INIT also places the Model 2110 in the Wait-for-Trigger state.

Once a trigger arrives, a single measurement or a set of measurements will be taken and the reading(s) will be stored in the data buffer. Due to the volatile nature of this physical memory, the stored readings will clear whenever the Model 2110 DMM powers down.

Recalling Stored Readings

Stored readings can be recalled by pressing the SHIFT + STORE buttons. The Model 2110 will display the first reading in the data buffer. The ◀ or ▶ buttons are used to scroll through the remaining readings in the buffer. **Figure 2** illustrates a Model 2110 recalling reading number 2 of the 45 stored readings.



Figure 2. Recalling readings from the data buffer.

Likewise, the FETCh? SCPI command is used to retrieve readings in the data buffer in remote operation. All the readings are returned at once in ASCII characters separated by commas.

Example 1 - Front Panel Single Triggering and Buffering

The following example demonstrates the use of Model 2110 data buffer using the front panel controls. This example configures a Model 2110 to measure a DC current at the default setting using the single triggering mode. A total of 15 readings are to be stored in the data buffer and can be recalled.

-Configure measurement type

1. Press SHIFT + DCV to select the DCI measurement function

-Configure Single Triggering Mode

2. Press TRIGGER to select the single triggering mode

-Configure data buffer size

3. Press SHIFT + CONFIG to enter the main menu
4. Press <|> buttons to select TRIG SYS
5. Press ENTER to enter the submenu
6. Press <|> buttons to select STORE RDGS
7. Press ENTER
8. Press $\Delta \nabla$ and <|> buttons to set the number of readings to 15
9. Press ENTER to set it.

-Enable data storage in the data buffer

10. Press STORE to initiate data storage

-Take measurement

11. Press TRIGGER 15 times to collect 15 readings

-Recall readings

12. Press SHIFT+STORE to display the first reading taken
13. Press <|> buttons to scroll through the remaining readings

SCPI command sequence that configures a software-, or BUS-, triggered DC voltage measurement at a trigger count of 2 and a sample count of 20. A trigger delay of one second is inserted before sampling each measurement. Each measurement takes an integration time of 0.006 power line cycles. A total of 40 readings will be stored in the data buffer.

-Reset the instrument

*RST

-Configure Trigger Source

TRIG:SOUR BUS

-Configure Trigger Delay

TRIG:DEL 1

-Configure trigger count and sample count

TRIG:COUN 2

SAMP:COUN 20

-Arm the multimeter in Wait-for-Trigger state

INIT

-Software triggers the first 20 samples of readings

*TRG

-Wait for the multimeter complete its measurements

-Software triggers the second 20 samples of readings

*TRG

-Wait for the multimeter complete its measurements

-Recall the readings from the buffer

FETC?

Example 2 Remote Interface BUS Triggering and Buffering

The Model 2110's data buffering operation can achieve over 30000 readings/second at $4\frac{1}{2}$ digits. Reading rates are determined by a number of factors such as range change, integration time (NPLC or Number of Power Line Cycles), auto delay, auto zero, etc. The following example illustrates the

The Keithley Model 2110 $5\frac{1}{2}$ -Digit Dual-Display Digital Multimeter features rich capabilities, high accuracy, and high speed for a broad range of applications from production to laboratory research. Combined with a value price, the Model 2110 is unbeatable in today's digital multimeter market.

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