



Metrics ICS Driver Manual

KI4200

Metrics ICS

Version 4.5

Table of Contents

The 4200 SCS Instrument Driver	3
Getting Started: Creating and Executing a Test Setup.....	3
Step 1: Cable the Hardware Connections	4
Step 2: Configure the 4200 for GPIB Control	5
Step 3a: Connect the 4200 Instrument Driver.....	7
Step 3b: Specify the GPIB Address and the Plug-In Module Identities	8
Step 4: Create the Test Setup	9
Step 4A: Specify the Test Setup Name.....	10
Step 4B: Select a Device Schematic Corresponding to the DUT	11
Step 4C: Designate the Source Unit/DUT Connections	11
Step 4D: Specify the Source/Measure Configuration of Each Source	13
Step 5: Insert the DUT Into the Test Fixture	14
Step 6: Execute the Measurement.....	15
Step 7: View the Results	15
Step 8: Create a Plot of the Results.....	16
Step 9: Save the Results into a Project File	17
The 4200 Configuration Dialogue Box.....	18
Source Unit Fields and Labels	18
Configuring the Instrument GPIB Address and Module Identities	19
When to Update the 4200 Configuration Dialogue Box.....	20
Source Unit Availability	22
The Mainframe Setup Dialogue Box	24
Mode	25
Sweep Source Timing Controls	25
Options.....	26
The KI4200 Mainframe Modes	27
Sweep Mainframe Mode.....	28
Spot Mainframe Mode	28
Multi-Sweep Mainframe Mode.....	29
Custom Sweep Mainframe Mode	29
ICS Time Mainframe Mode.....	30
HS Sampling Mainframe Mode	30
Sampling Mainframe Mode	31
Stress Mainframe Mode.....	32
The Measurement Setup Dialogue Box	33
Sweep Controls	35
Bias Mode	35
Stimulus Controls.....	52
Measure Controls	52
Controlling Integration Time	56
Collector Family Setup Conditions.....	57

The 4200 SCS Instrument Driver

Getting Started: Creating and Executing a Test Setup

The Keithley 4200 SCS is a high performance DC parametric measurement instrument. The 4200 SCS is composed of up to eight user-selected plug-in modules. The following 4200 SCS modules are supported by Interactive Characterization Software (ICS):

4200 SCS Instrument

1. 4200 SMU
2. 4200-PA Pre-Amp Modules

This section will walk you through the steps required to create and execute a test setup that measures diode turn-on voltage using the Keithley 4200 SCS. This is a simple measurement, but it will provide you with a general understanding of how ICS and the 4200 SCS are used to measure device characteristics.

Step 1: Cable the Hardware Connections

Cable all the necessary connections between the instrument source units and the test fixture. Connect the required jumpers between the test fixture sockets and personality board. The hardware connections configured in this step will be designated later in ICS' graphic workspace.

The test setup example presented in this section was executed using the 4200 SCS along with a Test Fixture. A schematic of the hardware arrangement is shown below.

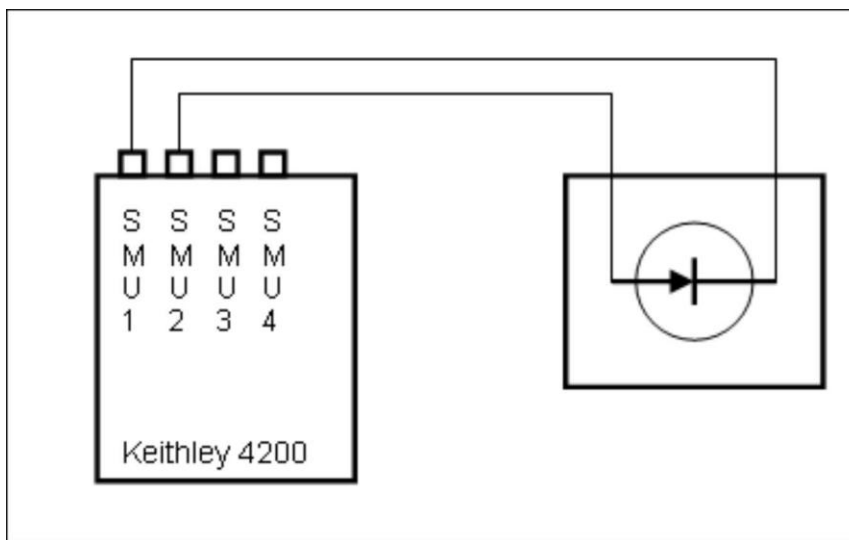


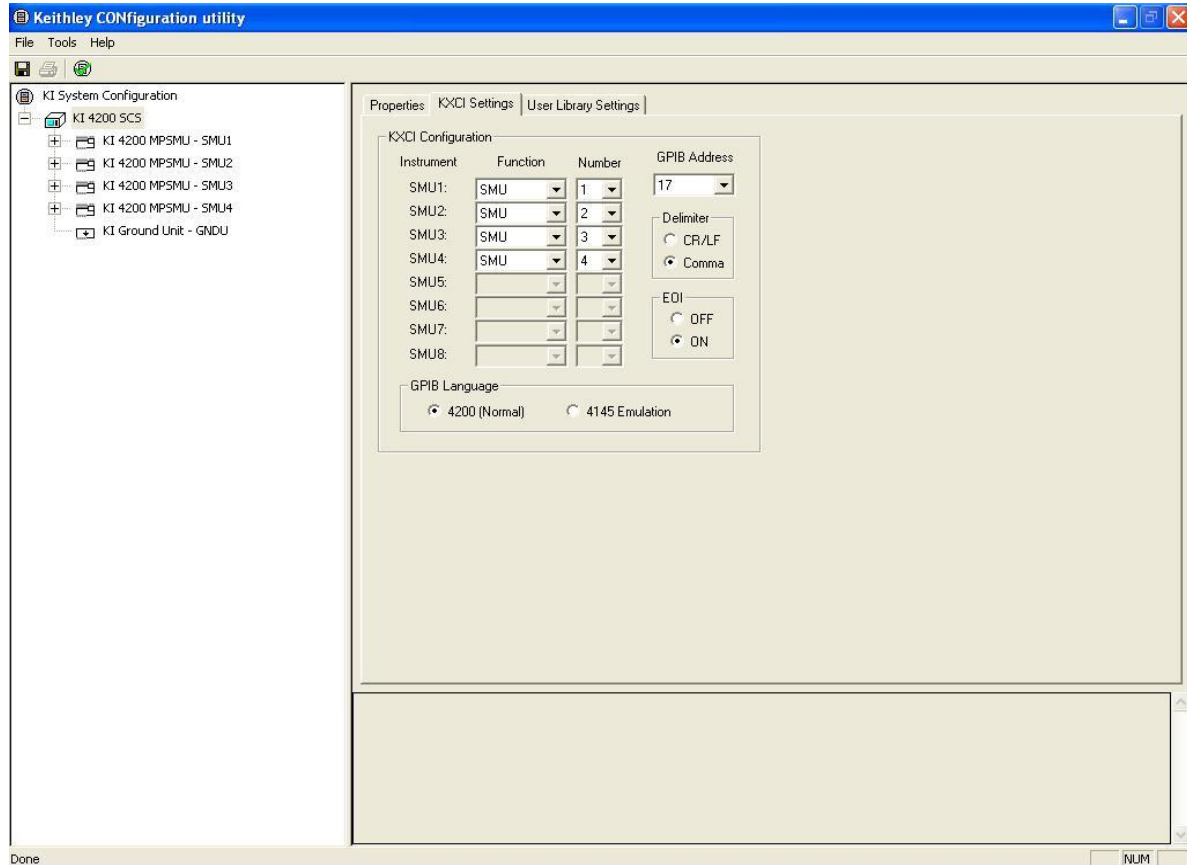
Figure 1: A Schematic of the Hardware Arrangement Used to Measure V_{ON} for an NP Diode.

Step 2: Configure the 4200 for GPIB Control

When turned on, the 4200 SCS boots Windows and then automatically starts the KITE software. The KITE software does not support external control, so you must do the following to allow the 4200 to be externally controlled.

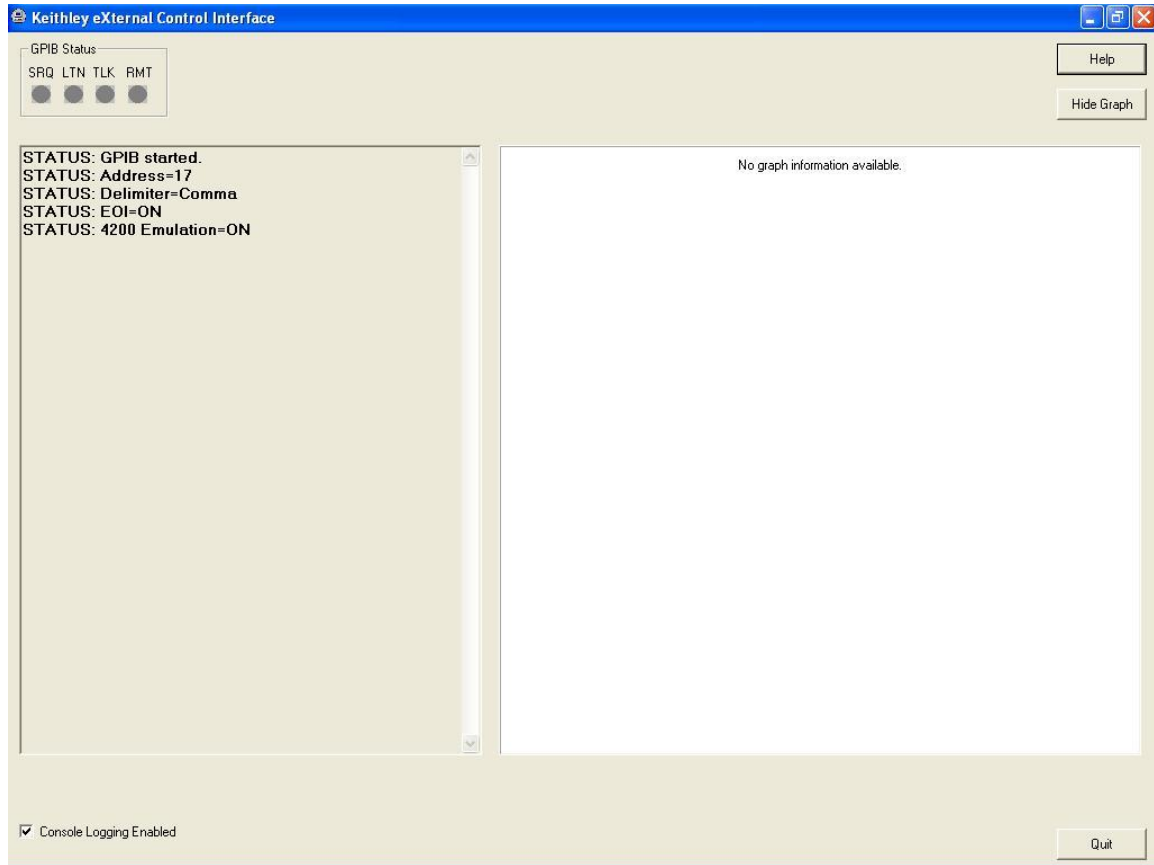
Shut Down KITE Software – you can use it later for manual measurements.

Open the KCON Software – this will allow you to set the GPIB address and options.



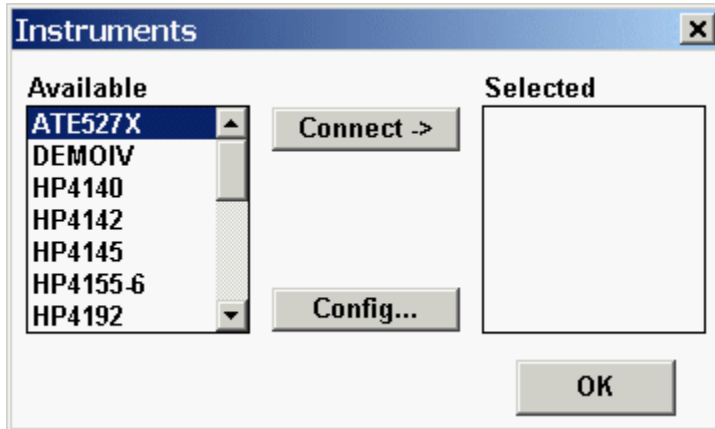
In KCON, click the KI 4200 SCS and select the KXCI Settings tab. Select the GPIB Address. Set the *Delimiter* to be “Comma”, and *EOI* to be “ON”. Set the SMU1, SMU2, etc to Function SMU. Select the GPIB Language to be 4200(Normal). Save the configuration and exit the KCON software.

Start the KXCI Software – this is the software that allows the 4200 SCS to receive and process GPIB commands.



Leave this software running as long as you want to control the 4200 SCS by GPIB.

Step 3a: Connect the 4200 Instrument Driver



The 4200 Driver is connected using the Connect Instruments dialogue box accessed from the measurement mode menu bar.

How to Connect the 4200 Driver:

1. Click the CONNECT INSTRUMENTS toolbar button or select INSTRUMENTS/SELECT INSTRUMENT from the ICS measurement mode menu bar. This will open the Connect Instruments dialogue box.
2. Highlight the 4200 driver in the AVAILABLE field.
3. Click the CONNECT button.
4. Your choice will be displayed in the SELECTED field.
5. Clicking the OK button would close the Connect Instruments dialogue box and restore control to the ICS desktop. Keep the Connect Instruments dialogue box displayed for now, because the next step requires you to click the Connect Instruments CONFIG button.

Step 3b: Specify the GPIB Address and the Plug-In Module Identities

The 4200 must be connected to your computer with the use of a supported IEEE-488 GPIB card. The GPIB address and the plug-in module identities are specified in the 4200 Configuration dialogue box.

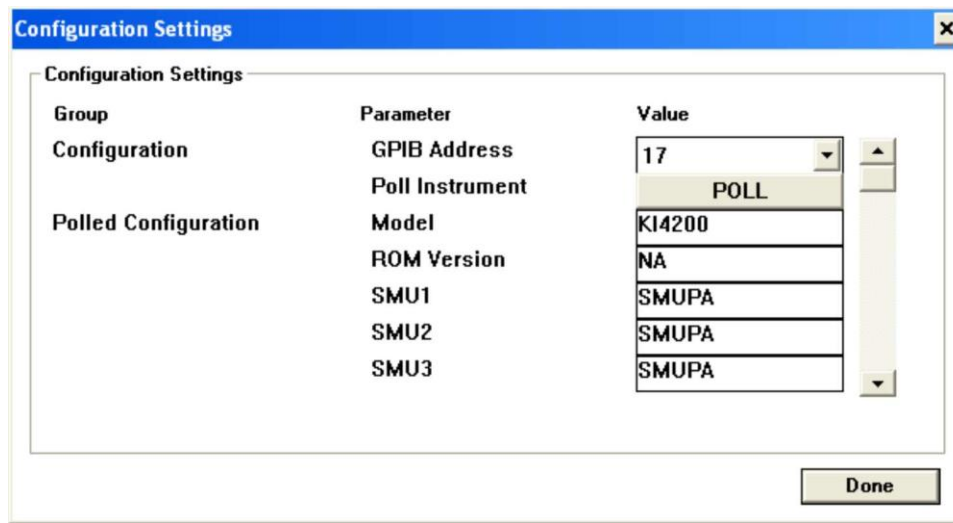


Figure 2: The 4200 Configuration Dialogue Box

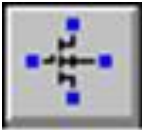
How to Automatically Configure the 4200 Module Identities:

1. If the Connect Instruments dialogue box is no longer displayed from Step 2, click the toolbar CONNECT INSTRUMENTS button or select INSTRUMENT/SELECT INSTRUMENTS from the measurement mode menu bar.
2. Open the 4200 Configuration dialogue box by clicking the CONFIG button at the bottom of the Connect Instruments dialogue box.
3. Designate the instrument GPIB address in the GPIB field. Determine the GPIB address of the instrument by viewing the HP-IB Address on the instrument's front panel. If you wish to change the GPIB setting, please refer to the 4200 Operation Manual from Agilent Technologies.
4. The eight source unit fields displayed in the Configuration dialogue box correspond to the eight module slots in the 4200 mainframe. Each source unit field is referenced by a label displayed in the "Name" column. Each field label identifies the function and slot position of the corresponding module; for example, "SMU1", "SMU2", etc.

6. Each source unit field identifies the type of the instrument module installed at the corresponding mainframe slot. Designate the module identities of all eight source unit fields by clicking the POLL button located in the left-hand corner of the dialogue box. Clicking the POLL button interrogates the instrument and automatically identifies the modules installed at each slot position (for example, "MPSMU") and designates each field label according to the function and slot position of the installed hardware (for example, "SMU1").
7. Any source unit field corresponding to an unoccupied 4200 slot will be designated with an "NA". "NA" stands for "Not Applicable".
8. Click the Done button located at the bottom of the dialogue box. This will close the Configuration dialogue box. Click the OK button in the lower right-hand corner of the Connect Instrument dialogue box to restore control to the ICS desktop.

Step 4: Create the Test Setup

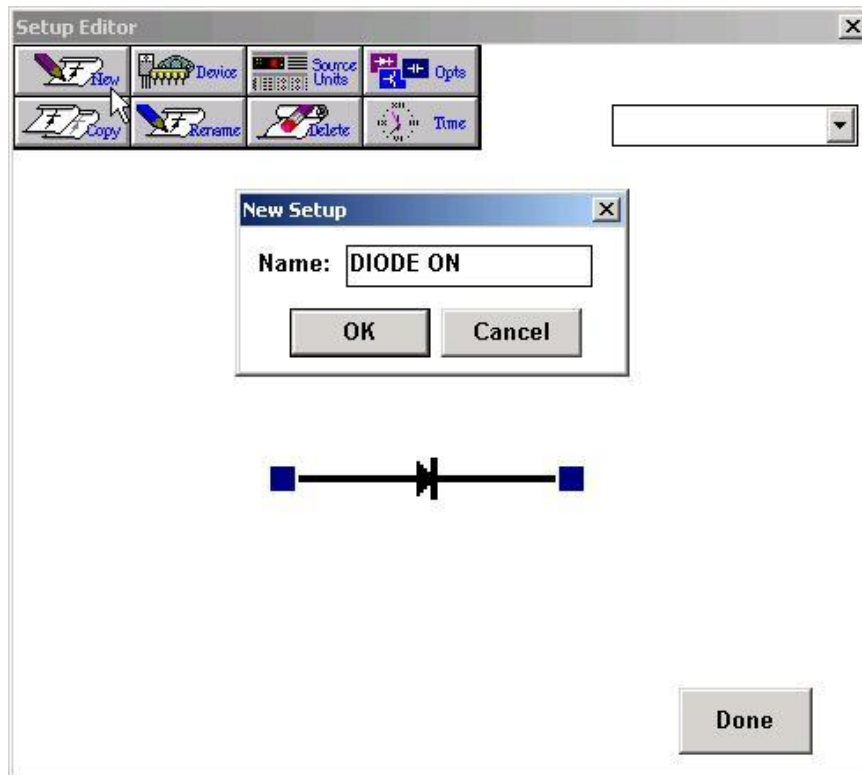
Test setups are created in the Setup Editor. Open the Setup Editor by selecting the SETUP EDITOR toolbar button. In this example, we will create a test setup that measures the forward current of an NP diode with respect to a forward voltage sweep.



Click the corresponding toolbar button to display the Setup Editor.

Step 4A: Specify the Test Setup Name

When creating a new test setup, a test setup name must be specified before any other selections or conditions are designated.



How to Specify the Test Setup Name

1. Click the Setup Editor NEW button. This will open the New Setup dialogue box.
2. At the prompt, specify a test setup name. For this example, type "DiodeOn".
3. Click OK. This will close the New Setup dialogue box.
4. The test setup name will appear in the Setup Editor SETUP window.

Step 4B: Select a Device Schematic Corresponding to the DUT

A device schematic is located at the center of the Setup Editor. The device schematic is designed to provide a graphic image of the test fixture socket.

How to Select a Device Schematic:

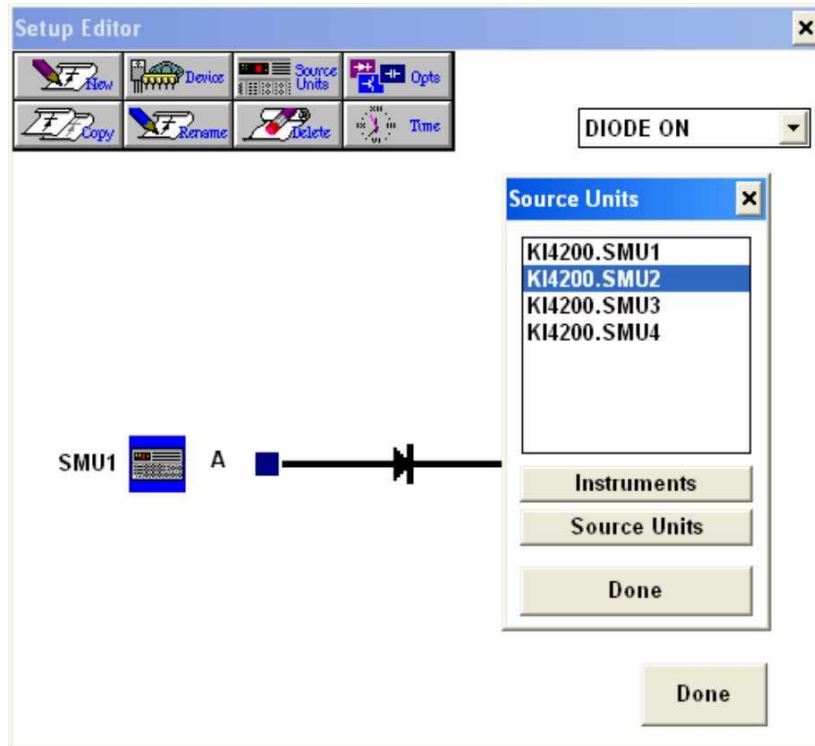
1. Click the Setup Editor DEVICE button. This will open the Device dialogue box.
2. The Device Type window will display a list of available device schematics. Select DIODE. Notice the selected schematic is previewed in the small window to the right of the Device Type window.
3. Some device schematics will display a set of polarity switches when selected. Select the "NP" designation for this example.
4. Click OK. This will close the Device dialogue box and display the diode schematic at the center of the Setup Editor.

Step 4C: Designate the Source Unit/DUT Connections

The Source Unit/DUT connections are designated in the Setup Editor. The Setup Editor display is provided as a tool to document the hardware connections required for the corresponding device measurement. The Source Unit/DUT connections designated in the Setup Editor are a graphic representation of the physical connections between the instrument and the test fixture personality board. The connections designated in the Setup Editor must correspond to the reality of your hardware arrangement.

The Setup Editor displays a device schematic representing the DUT. Connections are designated by first clicking one of the available source units listed in the Source Units dialogue box. After the source unit is selected, click the blue pad next to one of the device schematic pins. Select the blue pad corresponding to the DUT pin that the source unit will be physically connected to. An instrument icon, along with the name of the connected source unit, will appear next to the device schematic pin as a means of indicating the connection. This example will show how to connect a medium power SMU to one end of an NP diode.

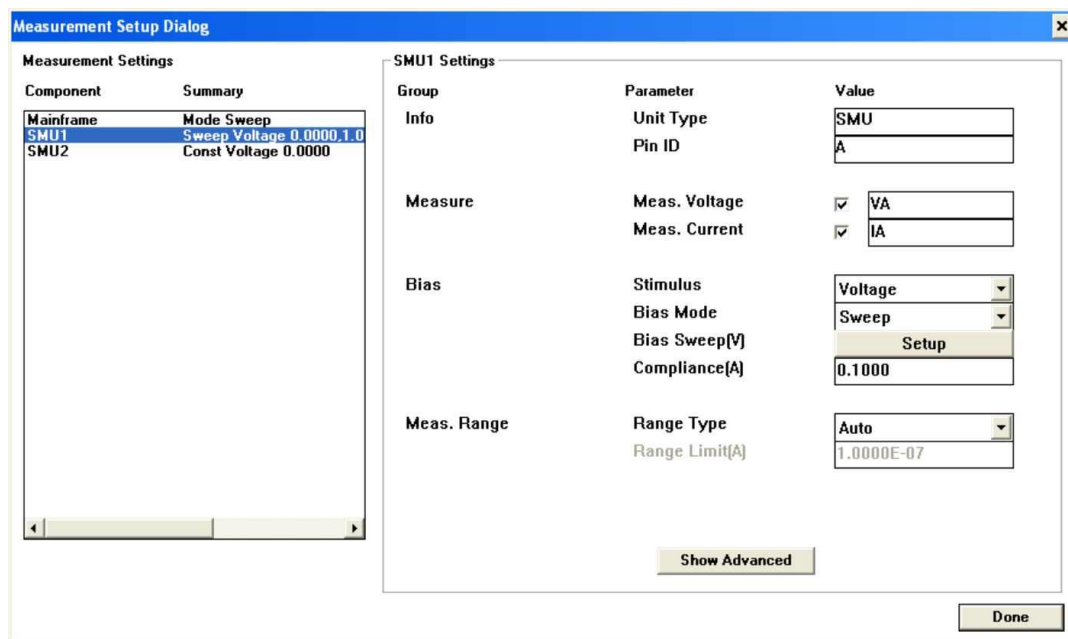
How to Designate the Source Unit/DUT Connections:



Step 4D: Specify the Source/Measure Configuration of Each Source

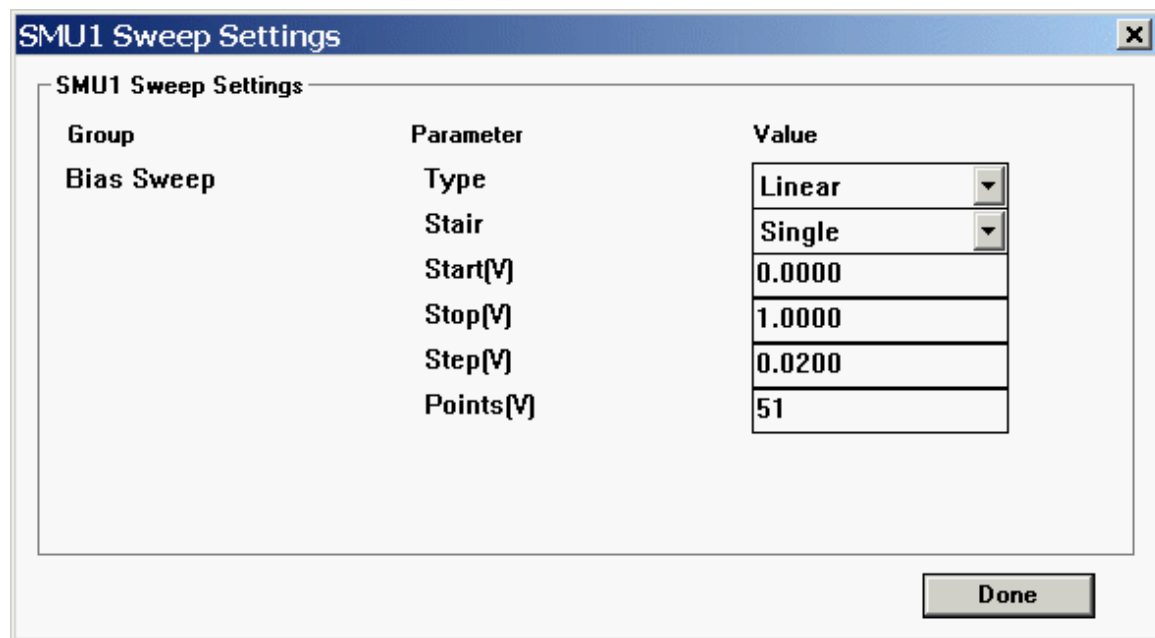
Every available source has its own Source Unit Setup dialogue box. This Source Unit Setup dialogue box is used to specify the source/measure configuration of the respective module. Once a Source Unit/DUT connection is designated, the corresponding Source Unit Setup dialogue box is opened by clicking on the instrument icon displayed beside the respective device schematic location.

In this example, SMU1 (connected to the anode) will source a linear voltage sweep. The sweep will start at 0.0V and stop at 1.0V and consist of 51 data points. SMU1 will measure voltage (V) and current (I). The GNDU will be the ground source for the device.



How to Specify the Source/Measure Configuration of Each Source:

1. Click once on one of the displayed instrument icons to open the Measurement Setup dialogue box corresponding to the connected SMU.
2. Configure the SMU1 controls as shown. Use the mouse or TAB key to move between the different switches and fields in each Source Unit Setup dialogue box.
3. Click the Sweep button to open the SMU1 Sweep Settings dialogue box. Configure the sweep controls as shown and click the Done button to exit the SMU1 Sweep Settings dialogue box.
4. Click Done to close a Source Unit Setup dialogue box. If more than one source unit is added, it is possible to move from the edit fields of each by clicking the correct component from the list on the left-hand side of the Measurement Setup dialogue box.



The image shows a software dialog box titled "SMU1 Sweep Settings". It contains a table with three columns: "Group", "Parameter", and "Value". The "Group" column has one entry, "Bias Sweep". The "Parameter" column lists "Type", "Start[V]", "Stop[V]", "Step[V]", and "Points[V]". The "Value" column shows "Linear" and "Single" as dropdown options, and numerical values "0.0000", "1.0000", "0.0200", and "51" for the other parameters. A "Done" button is located at the bottom right of the dialog.

Group	Parameter	Value
Bias Sweep	Type	Linear
	Stair	Single
	Start[V]	0.0000
	Stop[V]	1.0000
	Step[V]	0.0200
	Points[V]	51

Done

Step 5: Insert the DUT Into the Test Fixture

Insert the DUT into the test fixture personality board according to the Source Unit/DUT connections designated in the Setup Editor.

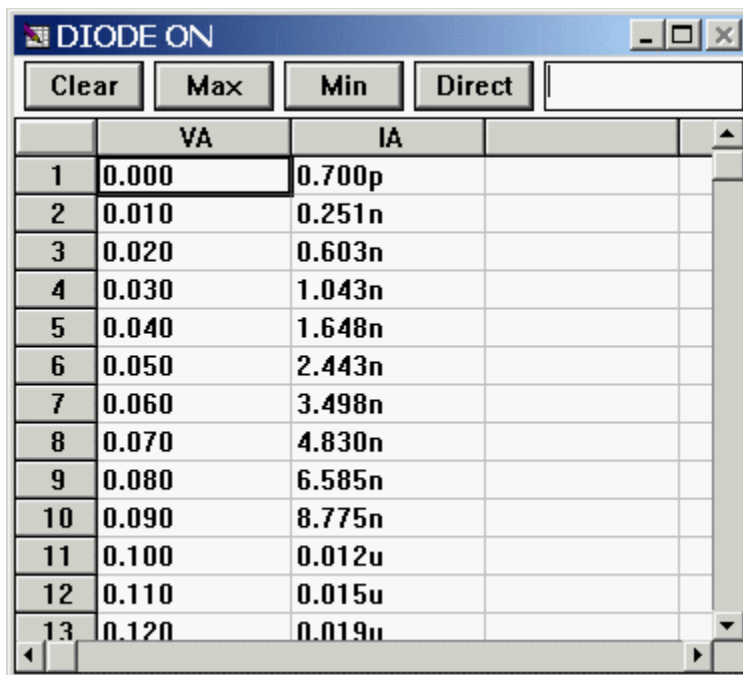
Step 6: Execute the Measurement

Open the Measurement remote control by clicking the toolbar MEASURE button. Run the DIODE ON test by clicking the Single button on the Measurement remote control.

After a few moments, the measurement will complete.

Step 7: View the Results

Data is automatically generated in the corresponding data window spreadsheet each time the measurement is executed. To display the numerical data, double-click on the minimized blue window labeled "DiodeOn" at the bottom of the ICS desktop. The spreadsheet existed before you executed the measurement, but it contained no data.



	VA	IA	
1	0.000	0.700p	
2	0.010	0.251n	
3	0.020	0.603n	
4	0.030	1.043n	
5	0.040	1.648n	
6	0.050	2.443n	
7	0.060	3.498n	
8	0.070	4.830n	
9	0.080	6.585n	
10	0.090	8.775n	
11	0.100	0.012u	
12	0.110	0.015u	
13	0.120	0.019u	

Data window spreadsheets are dynamically linked to the test setup. Each time the corresponding test setup is executed, the spreadsheet data is replaced with the most recently measured data. For this reason, the data window spreadsheet is automatically named the same as the test setup.

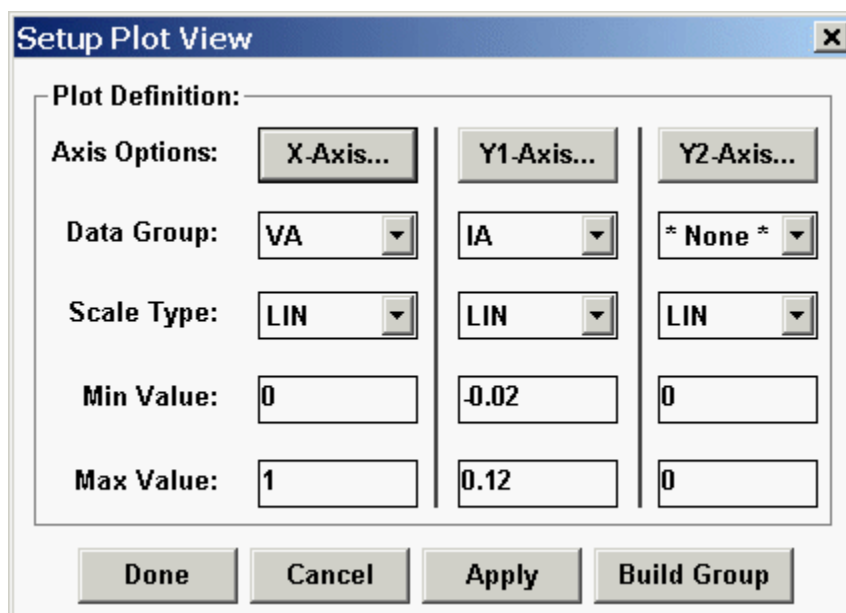
Step 8: Create a Plot of the Results

A plot window is dynamically linked to a corresponding data window spreadsheet. This means that the plot is regenerated any time there is a change to the corresponding spreadsheet data. If the test setup is executed more than once, the plot window is regenerated after each measurement. Up to ten plots can be created from a single data window spreadsheet, and each plot can be independently formatted.

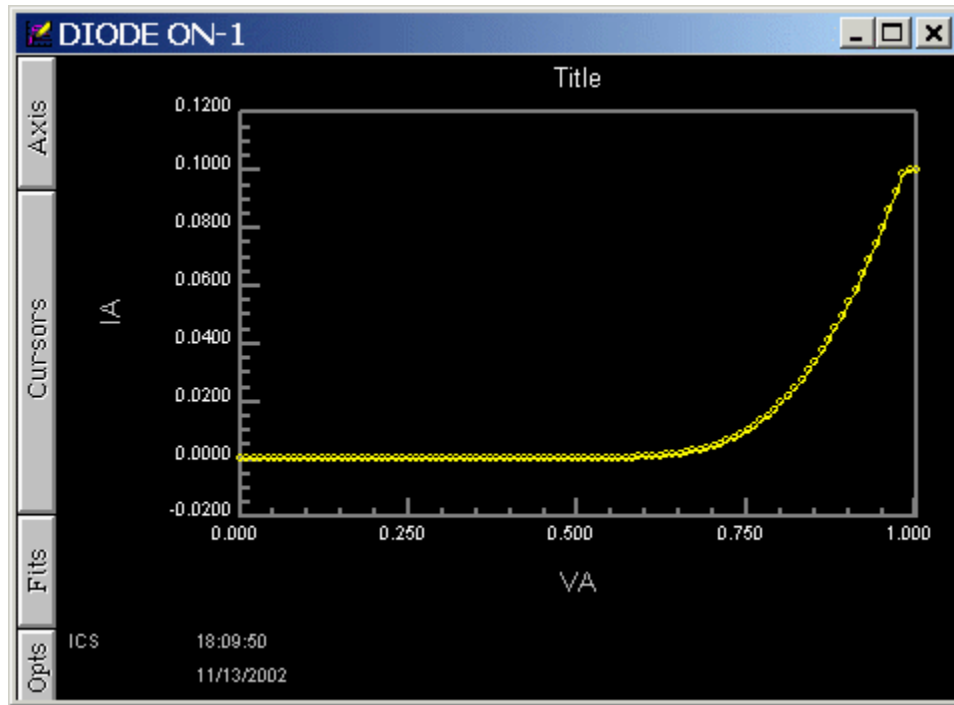
The steps below will show you how to create a plot of diode current with respect to the forward voltage sweep. This plot will correspond to the DiodeOn data.

How to Create a Plot

1. If there is more than one defined test setup, designate the active test setup in one of two ways:
2. Click once on the appropriate data window spreadsheet icon (the data window can be either displayed or minimized).
3. Click the toolbar setup window arrow and select the desired setup from the displayed drop-down list.
4. Click the CREATE PLOT toolbar button. This will open an empty plot window and the Plot Data dialogue box.
5. Designate the x-axis of the plot by selecting the appropriate data vector listed in the Data Group pull-down box. Only two quantities were measured in the DiodeOn test setup, voltage and current. This example will create a plot of current with respect to voltage. Since voltage will be the x-axis, select "V".
6. Designate the first y-axis of the plot (in our case the only y-axis) by selecting the appropriate data vector in the Data Group. For this example, select "I".



- Click the dialogue box APPLY button. This will create the plot but will not close the Plot Data dialogue box. You should notice that at about 0.6V the diode turned on.



- Click the DONE button to close the Plot Data dialogue box.

Step 9: Save the Results into a Project File

A project file includes all of the information necessary to execute a test setup or group of test setups. A single project file includes: 1) the instrument driver selection, 2) any defined test setup(s), and 3) all of the data and plot windows associated with the test setup(s). For more information about project files, refer to *Chapter 1: How ICS Stores Information* in the ICS reference materials.

The 4200 Configuration Dialogue Box

The 4200 Configuration dialogue box identifies the instrument GPIB address and the model number and position of each plug-in module installed in the 4200 mainframe.

The 4200 Driver must be connected to ICS before the Configuration dialogue box can be opened. If necessary, refer to *Step #3, Connecting the 4200 Instrument Driver*. After connecting the 4200 Driver, the 4200 Configuration dialogue box can be opened from the Connect Instruments dialogue box.

Open the Connect Instruments dialogue box by clicking the corresponding toolbar button. Open the 4200 Configuration dialogue box from the Connect Instruments dialogue box by clicking the Connect Instruments CONFIG button.

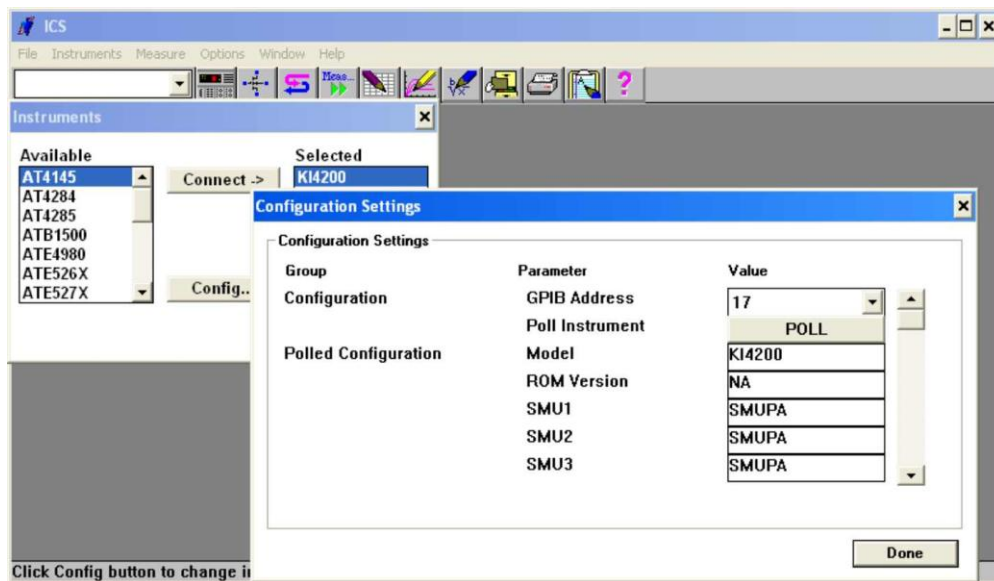


Figure 3: Open the 4200 Configuration Dialogue Box from the Connect Instruments Dialogue Box.

Source Unit Fields and Labels

The 4200 Configuration dialogue box includes eight source unit fields corresponding to the eight slots available in the 4200 mainframe. Each source unit field is used to identify the hardware installed at the corresponding mainframe slot. When a user designates source units later in the application, each instrument module will be identified by the corresponding "SMU" label designated in the "Parameter" column of the 4200 Configuration dialogue box. Instrument modules are identified by "SMU" labels instead of the model numbers configured in the source unit fields. This eliminates confusion when two or more identical modules are installed in the 4200.

Configuring the Instrument GPIB Address and Module Identities

When reviewing the 4200 Configuration dialogue box, the user must be certain that the specified configuration agrees with the physical installation of the hardware modules. The mainframe slot position corresponding to each source unit field is identified in the dialogue box "Parameter" column. Since this slot holds an SMU, the value will not be labeled "NA".

The 4200 Configuration dialogue box is configured by first designating the instrument GPIB address and then clicking the POLL button at the top of the dialogue box. The POLL function interrogates the instrument and automatically identifies the modules installed at each slot position (for example, "SMUPA") and designates the name of each field according to the installed hardware (for example, "SMU1").

Group	Parameter	Value
Configuration	GPIB Address	17
	Poll Instrument	POLL
Polled Configuration	Model	KI4200
	ROM Version	NA
	SMU1	SMUPA
	SMU2	SMUPA
	SMU3	SMUPA

Figure 4: The 4200 Configuration Dialogue Box.

Any source unit field corresponding to an unoccupied mainframe slot must be designated with the "NA" selection. "NA" stands for "Not Applicable".

Configuring Module Identities Automatically

The 4200 Driver includes a Poll function that will automatically arrange the 4200 Configuration dialogue box. The Poll function is activated by first designating the instrument GPIB address and then clicking the POLL button at the top of the dialogue box. The POLL function interrogates the instrument and automatically identifies the modules installed at each slot position and designates the name of each field according to

the installed hardware. Empty mainframe slots will be designated as "NA" (Not Applicable).

Detailed instructions outlining how to automatically configure the 4200 Configuration dialogue box are presented in *Step 3: Specify the GPIB Address and the Plug-In Module Identities* earlier in this chapter.

Polling Errors and Warnings

ICS will display a short sequence of error messages if the GPIB card times-out after attempting to locate the instrument on the GPIB bus. (The time-out limit is designated in the GPIB Setup dialogue box. The GPIB Setup dialogue box is opened by selecting INSTRUMENTS/GPIB SETUP from the measurement mode menu bar.) The GPIB card will time-out if the instrument is OFF or if the instrument is not connected to the GPIB cable. If the instrument is connected to your computer through a daisy-chain of GPIB cable connections, each instrument in the cable path must be turned ON.

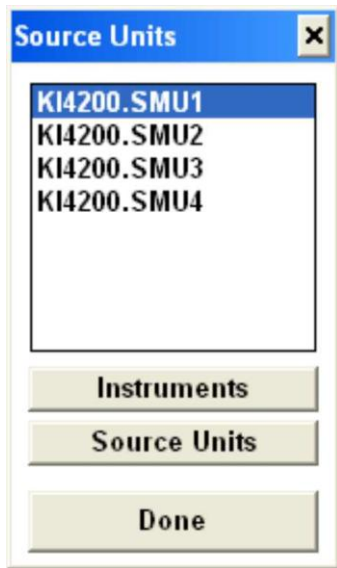
When to Update the 4200 Configuration Dialogue Box

It is only necessary to configure or update the 4200 Configuration dialogue box when either of two situations occur:

1. The 4200 Driver is connected to ICS for the first time.
2. The 4200 module configuration is altered or the instrument GPIB address is changed.

The information displayed in the 4200 Configuration dialogue box is stored in memory when the user manually specifies the box contents or after the user polls the instrument. The 4200 configuration is written to the ICS35.INI file as soon as the OK button is selected in the Configuration dialogue box. The 4200 Driver connection is documented in the corresponding project file when FILE/SAVE or FILE/SAVE AS is selected. When the project file is opened, ICS will automatically connect the 4200 Driver and arrange the 4200 Configuration dialogue box according to the designations recorded in the ICS.INI file. This eliminates the need to repeatedly connect the 4200 Driver or arrange the Configuration dialogue box each time an 4200 project file is opened. After initially arranging the 4200 Configuration dialogue box, there is no need for the user to review the dialogue box unless the module configuration is altered or the instrument GPIB address is changed.

Source Unit Availability



The SOURCE UNITS dialogue box contains a list of available instrument modules that can be used to build a test setup. The contents of this dialogue box represent the instrument modules installed in the 4200 and designated in the 4200 Configuration dialogue box.

It is possible to open a project file that was created with a mainframe configuration that does not match the configuration of the instrument presently available. This is called a hardware mismatch. A hardware mismatch is more precisely defined in the paragraphs that follow.

When a test setup is created, the association between the module identity and the source unit field label (for example, "SMU1") is stored as part of the test setup. This association is obtained from the 4200 configuration defined in memory when the test setup is created. Test setups are stored in project files, thus the 4200 configuration associated with each test setup is recorded in the corresponding project file. After the project file is created, the user may alter the 4200 configuration. The user may change the GPIB address, or the user may add new modules or move existing modules to new slot positions. Any one or more of these situations will alter the 4200 configuration. If the 4200 configuration changes, the user must update the 4200 Configuration dialogue box. Failing to do so will generate a hardware mismatch error when the user attempts to execute a test setup. The user can update the 4200 Configuration dialogue box by using the Poll function. As soon as the 4200 Configuration dialogue box is updated, the new 4200 configuration is stored in memory. The new 4200 configuration is written to the ICS35.INI file as soon as the OK button is selected in the Configuration dialogue box.

When a user opens a project file, ICS will verify that the correspondence between the test setup source unit labels and the module identities agree with the 4200 configuration stored in memory. If there is a disagreement, ICS will identify the inconsistency but will not display a hardware mismatch error until the respective test setup is executed.

When the user selects a test setup and clicks the toolbar MEASURE button, ICS will do two things. First, ICS will display an error message reporting any hardware inconsistencies that were detected when the project file was opened. If there were none, ICS will then interrogate the instrument and insure that the correspondence between the module identities and slot positions reported by the instrument agrees with the 4200 configuration stored in memory. This verification detects inconsistencies that result when the user changes the 4200 configuration but fails to update the 4200 Configuration

dialogue box. If this comparison agrees, ICS will execute the test setup. If it does not, ICS will display a hardware mismatch error.

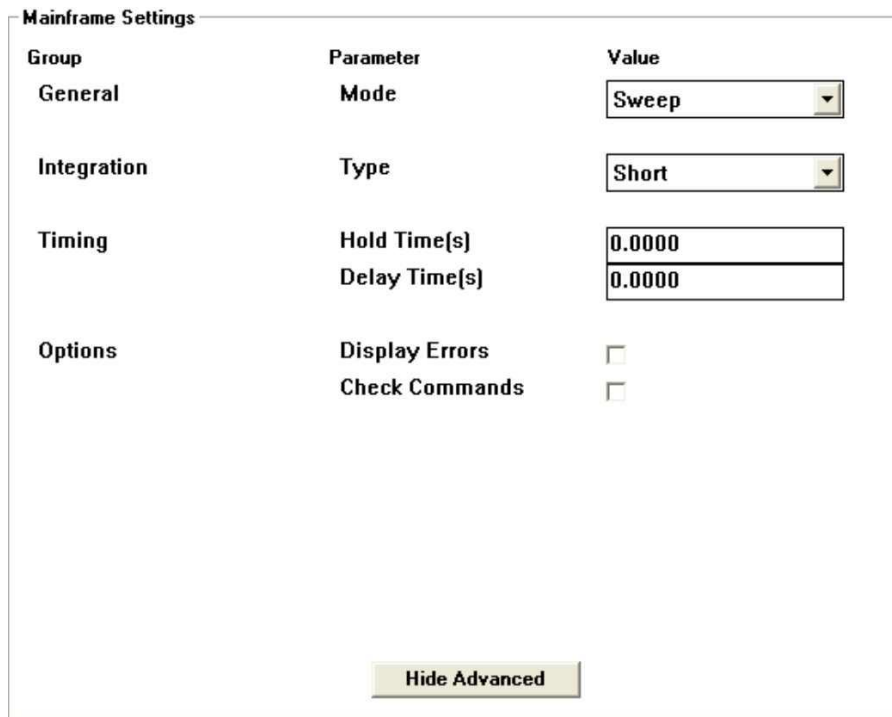
When the user attempts to execute a test setup that includes a hardware mismatch, ICS will display a message box informing the user of the problem. The message box will identify the source unit label (which also identifies the slot position) corresponding to the error. The message box will also list the module identity stored in memory followed by the module identity returned from the corresponding mainframe position.

The user has two options when a hardware mismatch is encountered:

1. Delete the test setup and create a new test setup using the active 4200 configuration.
2. Restore the mainframe configuration to the original configuration reported by the error message(s).

The Mainframe Setup Dialogue Box

Clicking the OPTIONS button in the Setup Editor will open the 4200 Mainframe Setup dialogue box. The 4200 Mainframe Setup dialogue box includes the controls necessary to specify the mode, timing, integration, and options.

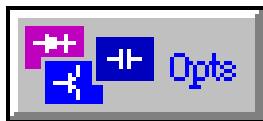


The Mainframe Settings dialog box is titled "Mainframe Settings". It contains a table with three columns: "Group", "Parameter", and "Value".

Group	Parameter	Value
General	Mode	Sweep
Integration	Type	Short
Timing	Hold Time[s]	0.0000
	Delay Time[s]	0.0000
Options	Display Errors	<input type="checkbox"/>
	Check Commands	<input type="checkbox"/>

At the bottom of the dialog box is a button labeled "Hide Advanced".

The contents of the 4200 Mainframe Setup dialogue box are global to every module in the test setup. The 4200 mainframe options are only applied to the test setup in which they were specified. Once a new test setup is defined, the mainframe options can be re-specified without changing the configuration of the mainframe options in a previously defined test setup.



The 4200 Mainframe Setup dialogue box is displayed by clicking the Setup Editor OPTIONS button after first designating at least one Source Unit/DUT connection.

Mode

Group	Parameter	Value
General	Mode	<div>Sweep ▼</div>

The Mode setting allows the user to select the way that the instrument will be used. Selecting the Mode allows the driver to simplify the SMU configuration windows.

Sweep Source Timing Controls

Timing	Hold Time[s]	<div>0.0000</div>
	Delay Time[s]	<div>0.0000</div>

The Sweep Source Timing Controls specify the timing configurations of any sweep mode sourcing signal. Values entered in the sweep source timing fields are interpreted in units of seconds.

Hold Time

The hold time is the length of time the 4200 will wait while allowing the starting value of the sweep signal to settle. The hold time is only applicable to the initial application of the sweep signal. After the sweep signal starts to increment, the delay time is the only parameter used to accommodate settling times. When applying a sweep source, the total delay prior to measuring the starting magnitude of the sweep signal is actually the sum of the hold time and delay time. The sweep source hold time specification is independent of the pulsed source hold time.

Delay Time

The delay time is the length of time between the sweep signal magnitude increment and the point at which an SMU obtains a measurement. The delay time allows the output at each sweep increment to settle before a measurement is made.

Options

Options	Display Errors	<input type="checkbox"/>
	Check Commands	<input type="checkbox"/>

The Options Group contains specialized functions for the 4200 mainframe. The options are listed below.

Display Errors

This option when selected will force the software to report any error condition reported by the instrument, including Compliance.

Check Commands

This option forces the software to make a secondary verification of all commands sent. This is accomplished by sending GPIB commands to check for errors after EVERY GPIB command. This will slow the instrument performance down and is recommended only when working with Metrics Technology to resolve an instrument error.

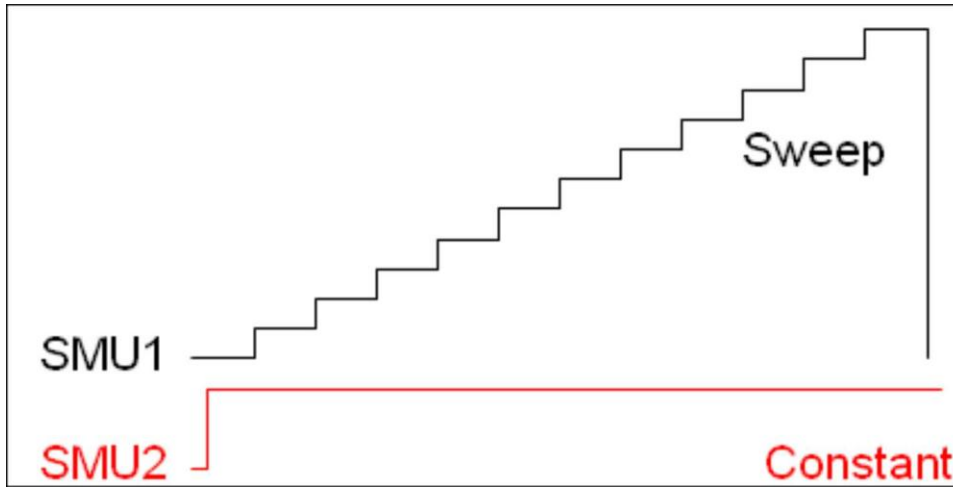
The KI4200 Mainframe Modes

The KI4200 driver allows the setup of the instrument into specific modes. These modes allow for easier setup of the test by removing options that are not applicable for a specific test method. This section of the manual describes the Mainframe Modes and the SMU setups allowed, respectively.

Mainframe Mode	SMU Bias Mode								
		Const	Step	Sync	Sweep	Multi-Sweep	Custom Step	Custom Sync	Custom Sweep
	Sweep Mode	*	*	*	*		*		
	Spot Mode	*							
	Multi-Sweep Mode	*	*		*	*	*		
	Custom Sweep Mode	*	*				*	*	*
	ICS Time Mode	*							
	HS Sampling Mode	*							
	Sampling Mode	*							
	Stress Mode	*							

Sweep Mainframe Mode

The Sweep Mainframe mode is the mode for most measurements that require the sweep of one of the device terminals. One of the SMUs must be set in Sweep Mode and the remaining can be setup in Constant, Step, Sync, or Custom Step Bias Mode.

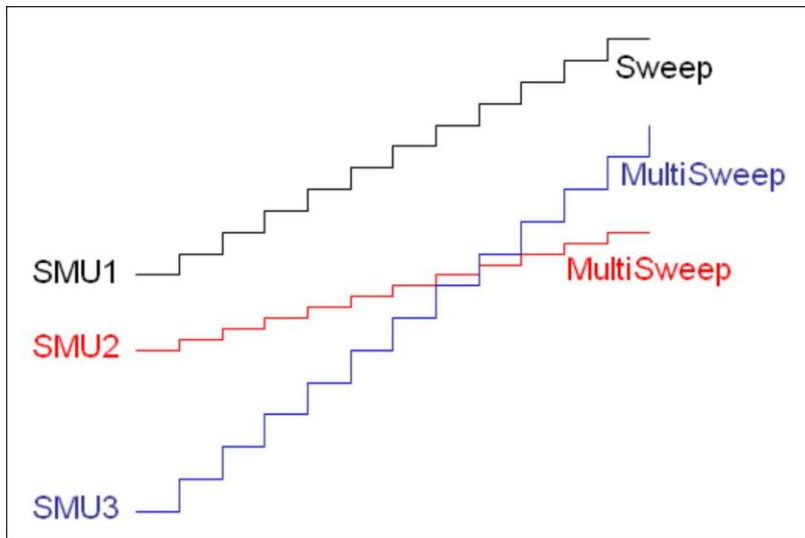


Spot Mainframe Mode

The Spot Mainframe mode is the mode for measurements that test only a single bias point of the device terminals. All of the SMUs must be set in Constant Mode.

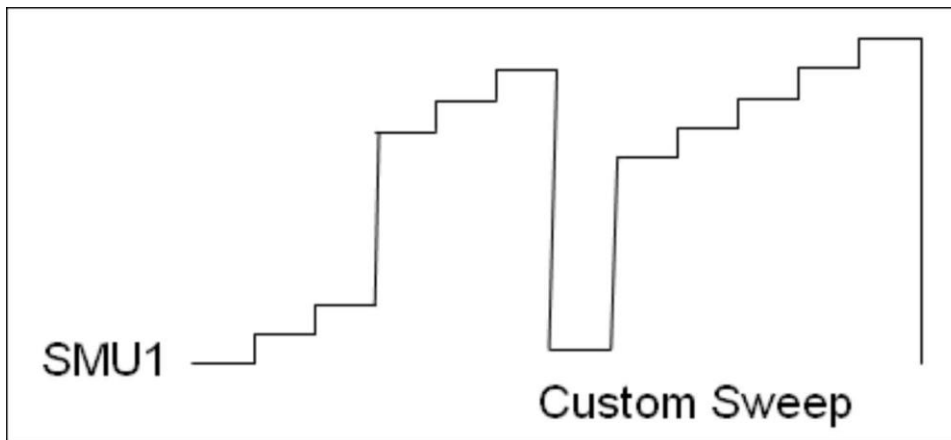
Multi-Sweep Mainframe Mode

The Multi-Sweep Mainframe mode is the mode for parallel measurements of several devices at the same time by sweeping several SMUs simultaneously. One of the SMUs must be set in Sweep Mode and other SMUs to be swept are set to Multi-Sweep mode and the remaining can be setup in Constant, Step, Custom Step Bias Mode.



Custom Sweep Mainframe Mode

The Custom Sweep Mainframe mode is the mode for applying a sweep that is a non-standard set of points that cannot be simply defined as Start, Stop, and Number of Steps. One of the SMUs must be set in Custom Sweep Mode and the remaining can be setup in Constant, Step, Custom Step, and Custom Sync Bias Mode.



ICS Time Mainframe Mode

The ICS Time Mainframe mode allows the test setup to be created exactly like the older versions of ICS. If you are not using an old project, use the HS Sampling or Sampling Modes instead. A constant bias is applied while the DUT is measured at specified time intervals. All of the SMUs must be set in Const Mode.

HS Sampling Mainframe Mode

The HS Sampling Mainframe mode allows the test setup to use the internal sampling capability of the instrument. The internal sampling is the fastest possible sampling mode for the instrument. A constant bias is applied while the DUT is measured at specified time intervals that are set in the “Timing” Mainframe Setting. All of the SMUs must be set in Const Mode.

The image shows a software window titled "Measurement Setup Dialog". It is divided into two main sections: "Measurement Settings" on the left and "Mainframe Settings" on the right.

Measurement Settings: This section contains a table with two columns: "Component" and "Summary".

Component	Summary
Mainframe	Mode HS Sampling
SMU1	Const Voltage 0.0000
SMU2	Const Voltage 0.0000
SMU3	Const Voltage 0.0000
SMU4	Const Voltage 0.0000

Mainframe Settings: This section is a form with several groups of settings.

Group	Parameter	Value
General	Mode	HS Sampling
	Integration	Type
Timing	Hold Time[s]	0.0000
	Sampling	Type
Sampling	Interval[s]	1.0000
	No. Samples	2
	Tot. Time[s]	1.0000
Options	Display Errors	<input type="checkbox"/>
	Check Commands	<input type="checkbox"/>

At the bottom of the "Mainframe Settings" section, there is a button labeled "Hide Advanced". At the bottom right of the entire dialog, there is a button labeled "Done".

Sampling Mainframe Mode

The Sampling Mainframe mode allows the test setup to use the external sampling capability of the instrument. The external sampling is a slower sampling mode for any instrument as the samples are triggered externally. A constant bias is applied while the DUT is measured at specified time intervals that are set in the “Timing” Mainframe Setting. All of the SMUs must be set in Const Mode.

The image shows a software window titled "Measurement Setup Dialog". It is divided into two main sections: "Measurement Settings" on the left and "Mainframe Settings" on the right.

Measurement Settings: This section contains a table with two columns: "Component" and "Summary".

Component	Summary
Mainframe	Mode Sampling
SMU1	Const Voltage 0.0000
SMU2	Const Voltage 0.0000
SMU3	Const Voltage 0.0000
SMU4	Const Voltage 0.0000

Mainframe Settings: This section is further divided into groups: General, Integration, Timing, Sampling, and Options. Each group has specific parameters and values.

Group	Parameter	Value
General	Mode	Sampling
	Type	Short
Timing	Hold Time[s]	0.0000
	Type	Linear
Sampling	Interval[s]	1.0000
	No. Samples	2
	Tot. Time[s]	1.0000
Options	Display Errors	<input type="checkbox"/>
	Check Commands	<input type="checkbox"/>
	Stop Cond	Continue On Any

At the bottom of the "Mainframe Settings" section, there is a button labeled "Hide Advanced". At the bottom right of the entire dialog, there is a button labeled "Done".

Stress Mainframe Mode

The Stress Mainframe mode allows the test setup to stress a device for a set period of time. The selected terminals are measured at the beginning and end of the stress period. All of the SMUs must be set in Const Mode.

The image shows a software window titled "Measurement Setup Dialog". It is divided into two main sections: "Measurement Settings" on the left and "Mainframe Settings" on the right.

Measurement Settings: This section contains a table with two columns: "Component" and "Summary".

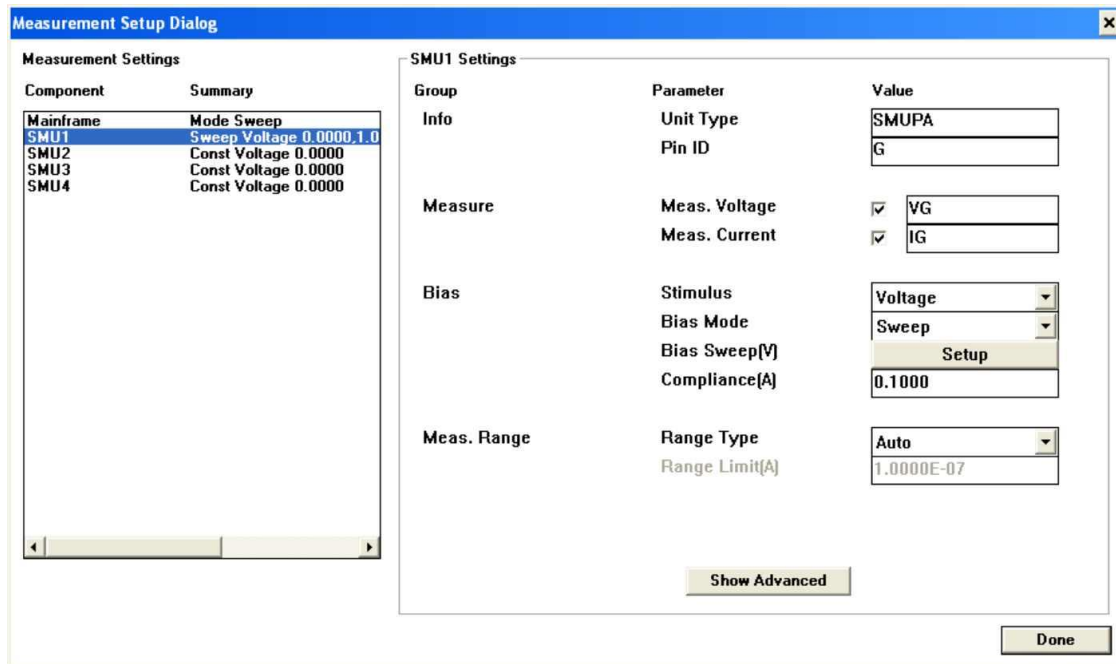
Component	Summary
Mainframe	Mode Stress
SMU1	Const Voltage 0.0000
SMU2	Const Voltage 0.0000
SMU3	Const Voltage 0.0000
SMU4	Const Voltage 0.0000

Mainframe Settings: This section is further divided into three groups: "General", "Stress", and "Options".

- General:** Contains a "Mode" parameter with a dropdown menu set to "Stress".
- Stress:** Contains a "Type" parameter with a dropdown menu set to "Duration", and a "Duration(s)" parameter with a text box containing "0.0000".
- Options:** Contains three checkboxes: "Display Errors" (unchecked), "Check Commands" (unchecked), and "Stop Cond" (checked). The "Stop Cond" checkbox is accompanied by a dropdown menu set to "Continue On Any".

At the bottom of the "Mainframe Settings" section, there is a "Hide Advanced" button. At the bottom right of the entire dialog, there is a "Done" button.

The Measurement Setup Dialogue Box



The setup conditions of each source unit are independently controlled with the Measurement Setup dialogue box. There is a Settings dialogue box that corresponds to each 4200 module. The 4200's Measurement Setup dialogue box is accessed from the Setup Editor.

Once the Measurement Setup Dialogue box is opened, all features of the instrument (including Mainframe options) can be accessed. This is different from other ICS drivers which require the opening of several dialogue boxes to perform these functions.

How to Display the Measurement Setup Dialogue Box:

In order to display the Measurement Setup dialogue box, the corresponding source must be assigned to a DUT pin represented by the device schematic.

1. Click once on the instrument icon to open the Measurement Setup dialogue box.
2. Click once on the desired source unit listed in the Measurement Settings area of the Measurement Setup Dialogue box.
3. The settings for the selected SMU will appear in the right side of the Measurement Setup Dialogue box.

The Measurement Setup dialogue box is used to specify the source/measure configuration of each 4200 module. The contents of Measurement Setup dialogue box are outlined below:

1. **Measurement Settings:** This field displays the selected SMUs as well as the Mainframe mode.
2. **SMU Settings Field:** This field contains the setup for the corresponding SMU.
3. **Unit Type Field:** This field displays the smu designation for the corresponding 4200 module.
4. **Pin ID Field:** This field contains the name of the device pin it is attached to in the Setup Editor.
5. **Meas. Voltage Field:** This field allows the selection of the Voltage values to be returned to the Data Spreadsheet.
6. **Meas. Current Field:** This field allows the selection of the Current values to be returned to the Data Spreadsheet.
7. **Stimulus Field:** This field consists a pull-down menu used to identify whether the sourcing signal is a voltage or a current.
8. **Bias Mode Field:** This field consists of a pull-down menu that allows the selection of the sourced signal type (Const, Sweep, Step, etc.).
9. **Bias Field:** This field allows the setup of the bias value. In the case of a sweep source the field will contain a button to open the source configuration.
10. **Compliance Field:** This field allows the setting of the Source compliance level.
11. **Meas. Range Type Field:** This field allows the selection of the type of measurement ranging control via a pull-down menu.
12. **Meas. Range Limit Field:** This field allows the setting of the measurement range value.

At the bottom of the setup box is a button labeled **Show Advanced**. This button allows additional settings to be displayed. The additional settings are listed below. Clicking the **Hide Advanced** button will hide these options.

- 1. **Output Range Type Field:** This field allows the selection of the type of Output ranging control via a pull-down menu.
- 2. **Output Range Limit Field:** This field allows the setting of the Output range value.

Sweep Controls

Sweep controls are used to specify the shape and boundaries of the sourcing signal, as well as the sourcing signal's compliance limit. Timing and averaging configurations are defined in the KI4200 Mainframe Setup dialogue box.

The type of Sweep Controls available for selection is dependent upon the Mainframe Mode that is selected. More information about the Mainframe Mode is presented later in the *Mainframe Options* section of this manual.

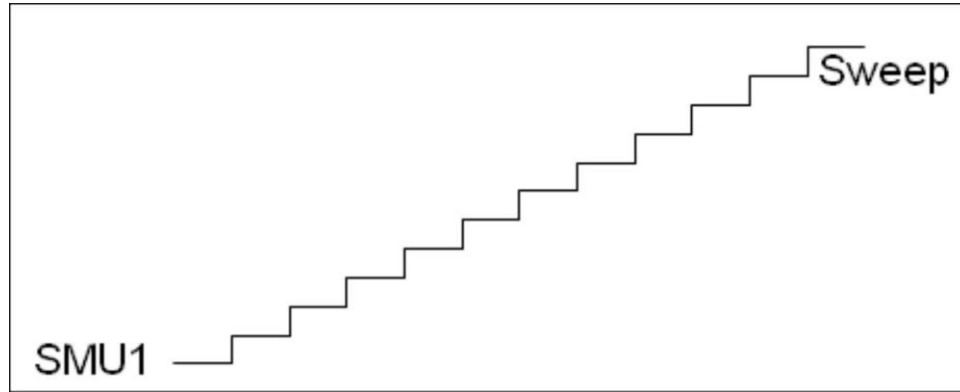
Bias Mode

The sourcing signal shape is selected from a list of signal shapes available in the BIAS MODE field. The sourcing signal may be characterized as a sweep, synchronized sweep, step, constant supply, custom step, custom sweep, custom sync, or multi-sweep. To select the desired bias mode, use the pull-down menu in the BIAS MODE field. Click on the desired mode.

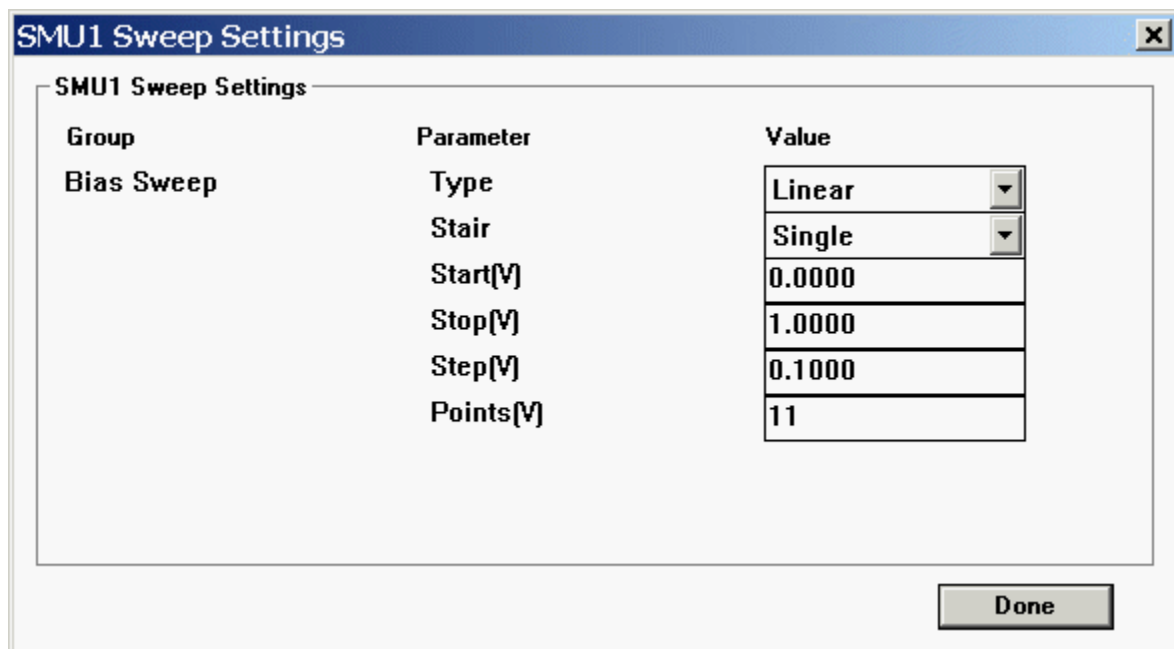
For an explanation of the bias modes used in conjunction with the pulse option, please refer to the *Pulse Configuration* section of this chapter.

Bias	Stimulus	<div>Voltage</div>
	Bias Mode	<div>Sweep</div>
	Bias Sweep[V]	<div>Setup</div>
	Compliance[A]	<div>0.1000</div>

Sweep Mode



The sweep mode generates either a linear or logarithmic staircase sweep signal between two specified boundary values. The settings are configured by clicking the **Setup** button.



The image shows a dialog box titled "SMU1 Sweep Settings". It contains a table with three columns: "Group", "Parameter", and "Value". The "Group" is "Bias Sweep". The "Parameters" are "Type", "Stair", "Start[V]", "Stop[V]", "Step[V]", and "Points[V]". The "Values" are "Linear", "Single", "0.0000", "1.0000", "0.1000", and "11" respectively. There is a "Done" button at the bottom right.

Group	Parameter	Value
Bias Sweep	Type	Linear
	Stair	Single
	Start[V]	0.0000
	Stop[V]	1.0000
	Step[V]	0.1000
	Points[V]	11

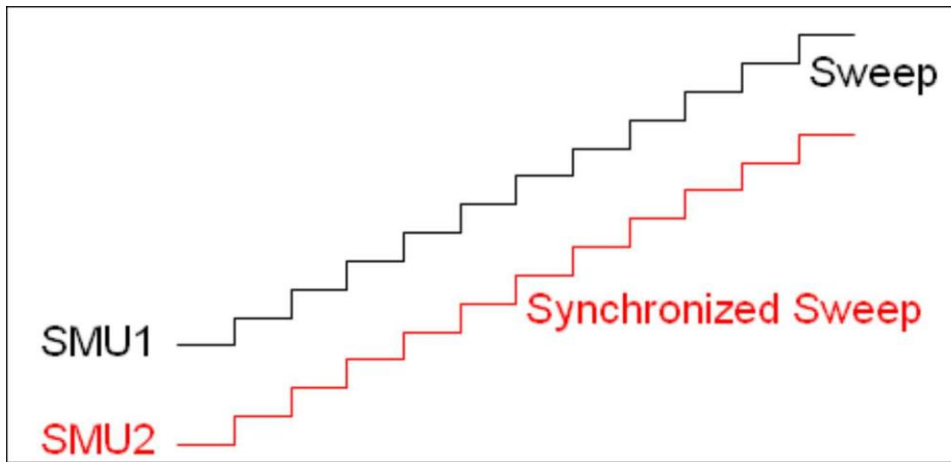
Done

When creating a test setup that includes a second, synchronized sweep signal, the sweep application described in this section is the primary sweep signal. Double sweeps consisting of ascending and descending sweep directions are supported by this driver.

How to Source a Sweep Signal:

1. Select the Mainframe Settings and verify that the Mode is set to SWEEP.
2. Select the SMU component that is to be the sweep source.
3. Select the "SWEEP" designation from the available options listed in the BIAS MODE field.
4. Click the **Setup** button to open the Sweep Settings dialogue box.
5. The data point distribution of the sweep signal can be either linearly or logarithmically distributed between the START and STOP values specified. Select between a linear or logarithmic distribution by selecting the appropriate designation in the TYPE field.
6. Specify if the sweep will be a Single or Double (consisting of ascending and descending sweep directions) type.
7. Specify the sweep signal boundary values in the START and STOP fields.
8. Enter the number of data points that will comprise the sweep signal in the POINTS field.
9. If a linear sweep type is selected, the Sweep controls will include a STEP field. The STEP field will be calculated automatically after a value is entered in the POINTS field and the cursor is moved to another location (or OK is selected). If desired, the calculated STEP can be updated by the user. If a new value is entered in the STEP field, the POINTS field will be updated to accommodate the new STEP value. If any of the other fields are edited, the STEP field will be automatically updated to accommodate the change.

Synchronized Sweep Mode



Bias

Stimulus

Bias Mode

Bias Sweep[V]

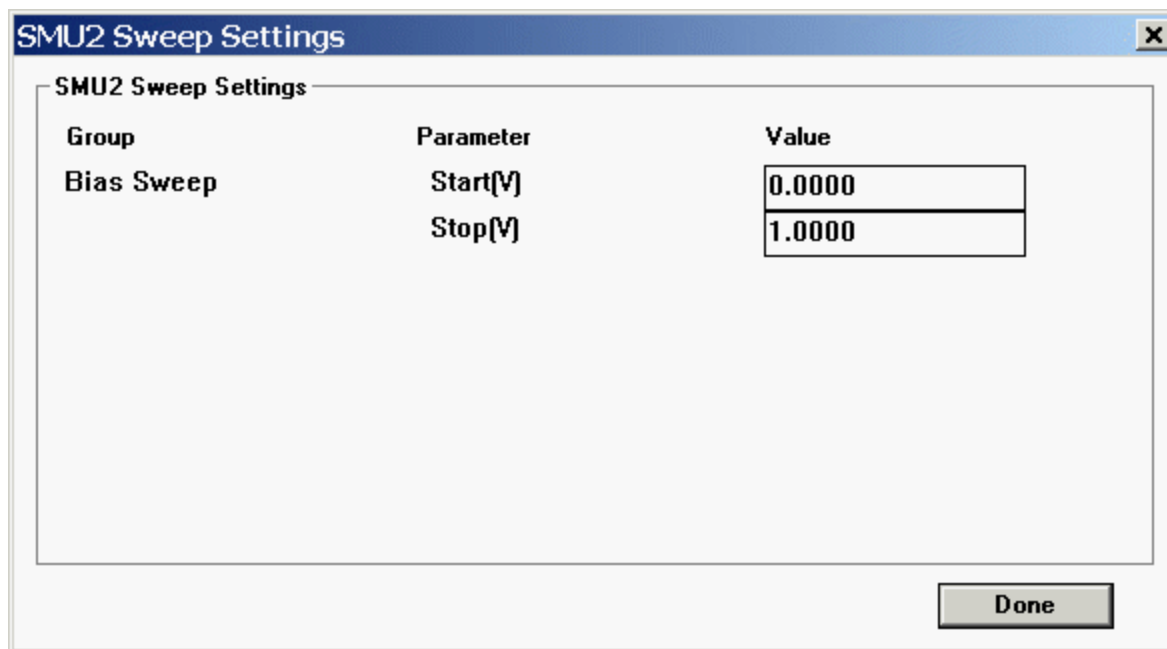
Compliance[A]

Voltage	▼
Sync	▼
Setup	
0.1000	

A synchronized sweep is a linear sweep signal that is synchronized in time with a primary sweep signal applied by another source unit.

A source unit can force a synchronized output only when the output of another source unit in the test setup is configured in a sweep mode. If a synchronized sweep mode is designated in a test setup that does not include a primary linear sweep signal, ICS will display an error message when the user attempts to exit the Measurement Setup.

The stimulus of the synchronized sweep signal must match the stimulus of the primary sweep. In other words, if the primary sweep is a voltage output, the synchronized sweep must be a voltage output also. If the stimulus modes of the primary and synchronous outputs disagree, ICS will generate an error message when the user attempts to exit the Measurement Setup.



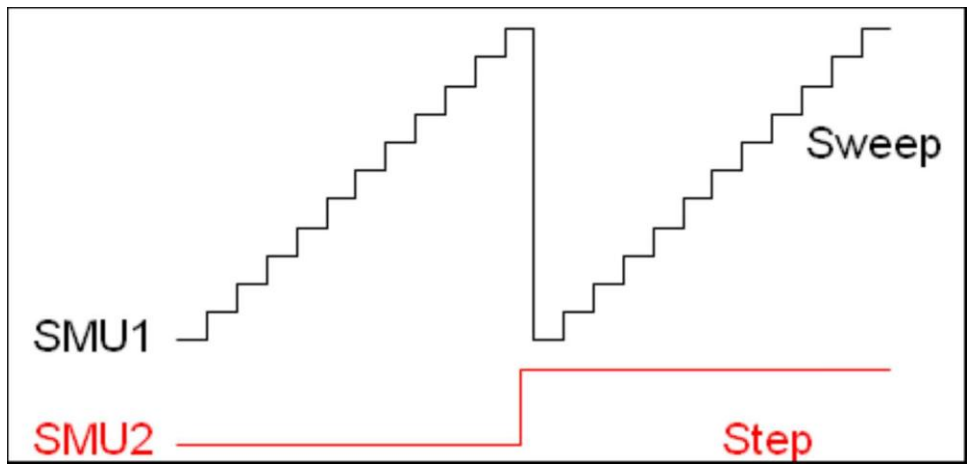
While the *timing* of the primary and secondary sweep signals is synchronized, the magnitudes can differ. The magnitude of the synchronized sweep signal is specified by designating a start and stop value. The sync source will automatically have the same number of POINTS.

How to Source a Synchronized Sweep Signal:

A synchronized sweep signal is functional only when a linear sweep signal is forced by another source unit.

1. Select the "SYNC" designation from the available options listed in the BIAS MODE field.
2. Make certain that the selected Stimulus switch (VOLTAGE or CURRENT) matches the output stimulus type of the primary sweep signal. If the stimulus mode of the output signals do not match, ICS will generate an error message when the user attempts to exit the Measurement setup.
3. Click the Setup button.
4. Specify the START and STOP values.
5. Click the Done button.

Step Mode



Bias

Stimulus
Bias Mode
Bias Sweep(V)
Compliance(A)

Voltage	▼
Step	▼
Sweep	
0.1000	

The step mode forces a constant output while another source unit in the test setup forces a sweep signal. The step mode is functional only in test setups that include a second source unit configured in sweep mode.

The step mode generates a constant output signal while a second source unit generates a staircase sweep signal. After the staircase sweep signal reaches the specified STOP value, the magnitude of the step output is incremented by the STEP value and the staircase sweep signal is triggered again. This process continues until the STOP value of the step signal is reached.

SMU2 Sweep Settings

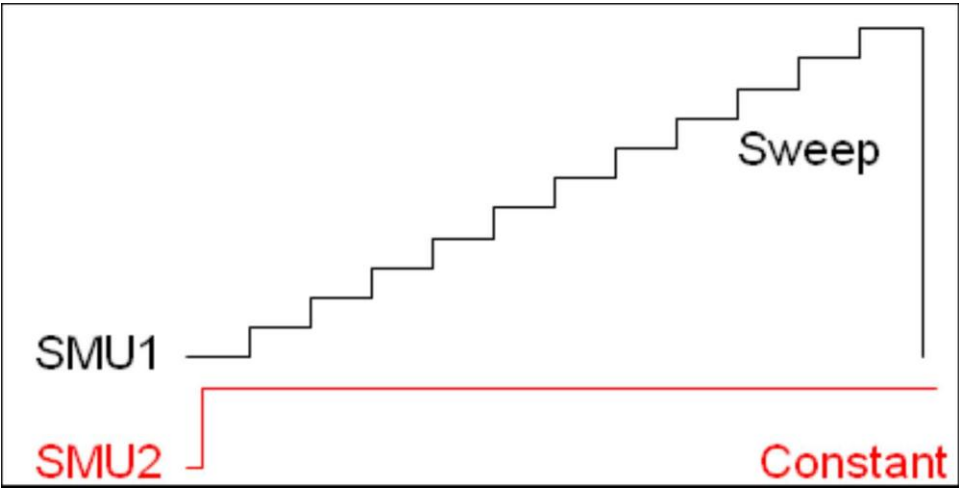
Group	Parameter	Value
Bias Sweep	Type	Linear
	Start[V]	0.0000
	Stop[V]	1.0000
	Step[V]	0.2500
	Points[V]	5

Done

How to Source a Step Signal:

1. Select the "STEP" designation from the available options listed in the BIAS MODE field.
2. The step sequences can be either linearly or logarithmically calculated between the START and STOP values specified in Step #3. Select between either a linear or logarithmic step sequences by specifying the appropriate designation in the TYPE field.
3. Specify the range of the step signal in the START and STOP fields.
4. Specify the increment quantity in the POINTS field.
5. If a linear step sequence is configured in the TYPE field, the increment size will be displayed in the STEP field. After a value is entered in the POINTS field and the cursor is moved to another location (or OK is selected), the STEP field will be calculated automatically. If desired, the calculated STEP can be updated by the user. If a logarithmic step sequence is configured in the TYPE field, the STEP field will not be displayed.

Constant Mode



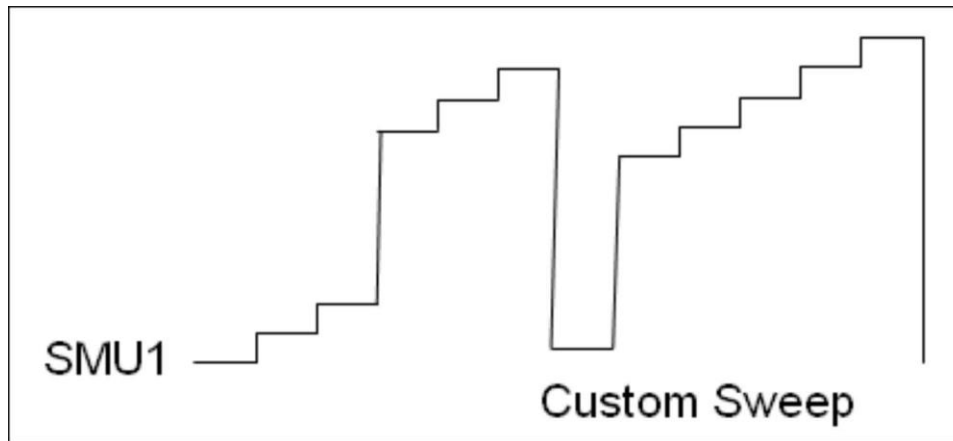
Bias	Stimulus	Voltage ▼
	Bias Mode	Const ▼
	Bias Value[V]	0.0000
	Compliance[A]	0.1000

The constant mode generates a signal that remains at a constant magnitude throughout the duration of the test setup. Constant is typically kept on an SMU in conjunction with a second SMU performing a Sweep of some type.

How to Source a Constant Signal:

1. Select the "CONST" designation from the available options listed in the BIAS MODE field.
2. Specify the signal magnitude in the BIAS VALUE field.

Custom Sweep Mode



Bias

Stimulus

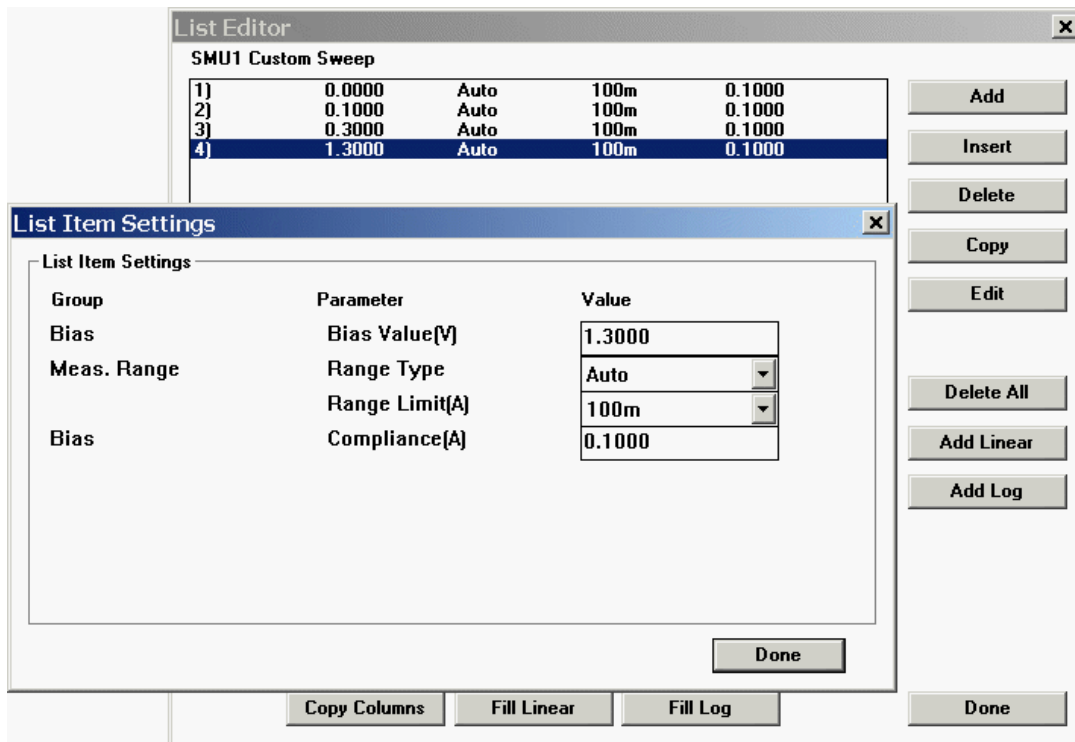
Bias Mode

Bias List[V]

Voltage	▼
Custom Sweep	▼
Setup	

The custom sweep mode generates user-defined sweep signal between two specified boundary values. The settings are configured by clicking the **Setup** button.

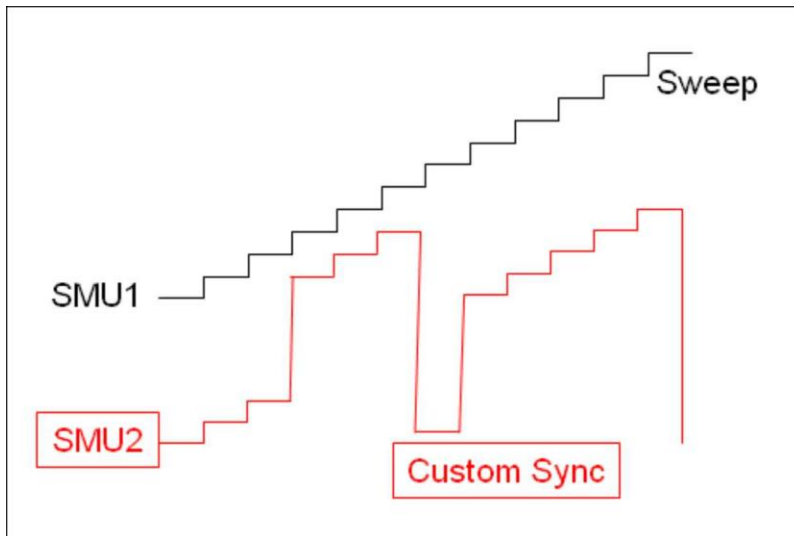
When creating a Custom Sweep the Mainframe Mode must be selected as CUSTOM SWEEP.



How to Source a Custom Sweep Signal:

1. Select the Mainframe Settings and verify that the Mode is set to CUSTOM SWEEP.
2. Select the SMU component that is to be the custom sweep source.
3. Select the "CUSTOM SWEEP" designation from the available options listed in the BIAS MODE field.
4. Click the **Setup** button to open the Sweep Settings dialogue box.
5. Each sweep point is added to a list. The list is created by clicking ADD and specifying the sweep point.
6. After creating the list of points, click the DONE button.

Custom Sync Mode



Bias

Stimulus

Bias Mode

Bias List[V]

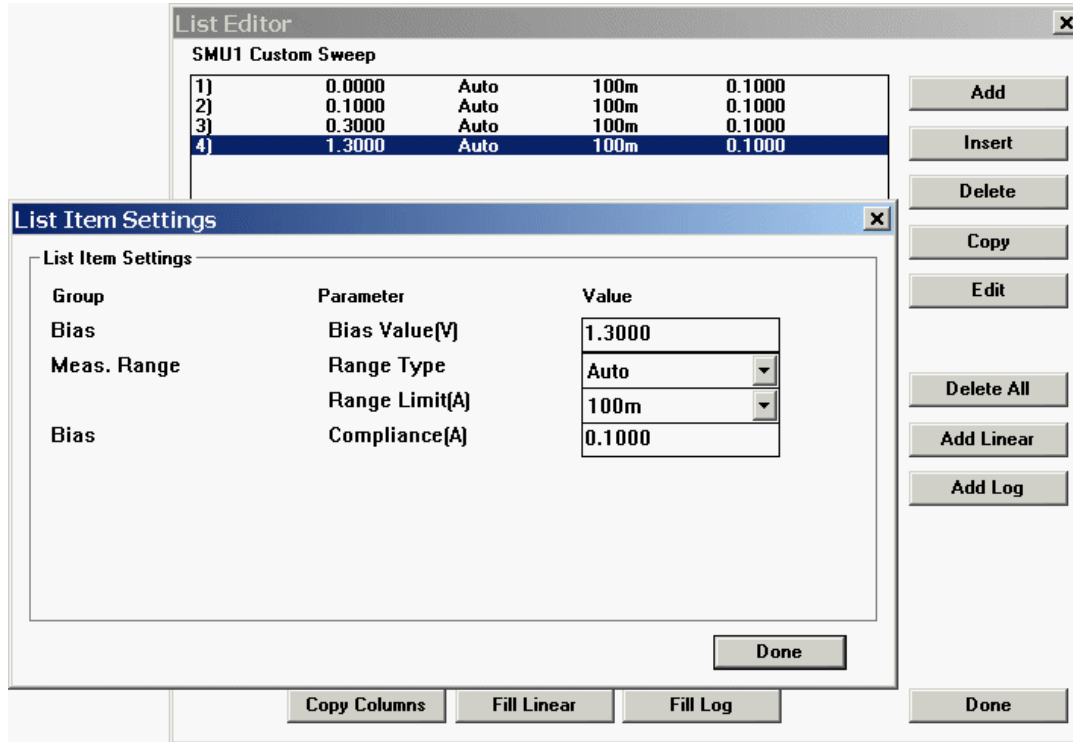
Voltage	▼
Custom Sync	▼
Setup	

The custom sync mode generates user-defined sweep signal. The settings are configured by clicking the **Setup** button.

The Custom Sync mode is only available when the Mainframe Mode is CUSTOM SWEEP.

A source unit can force a custom synchronized output only when the output of another source unit in the test setup is configured in a custom sweep mode. If a custom sync mode is designated in a test setup that does not include a primary custom sweep signal, ICS will display an error message when the user attempts to exit the Measurement Setup.

The stimulus of the custom sync sweep signal must match the stimulus of the primary sweep. In other words, if the primary sweep is a voltage output, the synchronized sweep must be a voltage output also. If the stimulus modes of the primary and synchronous outputs disagree, ICS will generate an error message when the user attempts to exit the Measurement Setup.

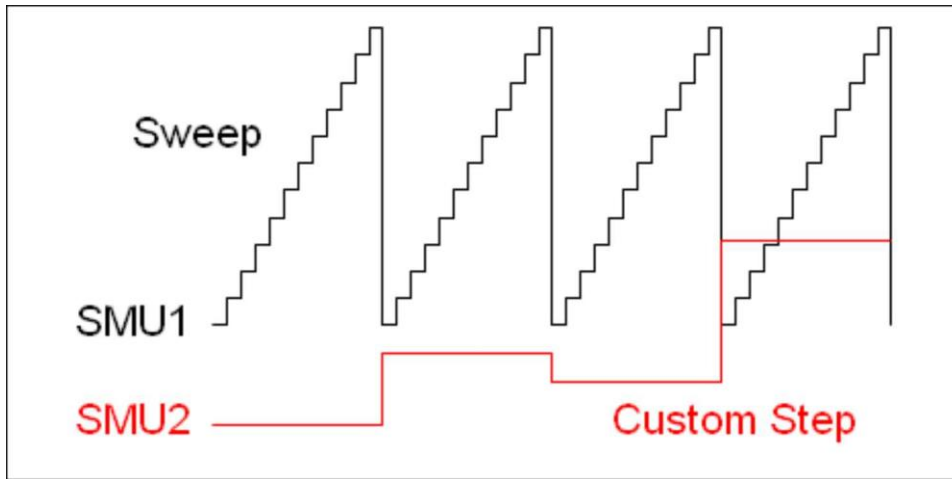


While the *timing* of the primary and secondary sweep signals are synchronized, the magnitudes can differ. The magnitude of the synchronized sweep signal is specified at each individual sweep value. The custom sync source **MUST** have the same number of POINTS.

How to Source a Custom Sync Sweep Signal:

1. A custom sync sweep signal is functional only when a custom sweep signal is forced by another source unit.
2. Select the "CUSTOM SYNC" designation from the available options listed in the BIAS MODE field.
3. Make certain that the selected Stimulus switch (VOLTAGE or CURRENT) agrees with the output stimulus of the primary sweep signal. If the stimulus mode of the output signals disagree, ICS will generate an error message when the user attempts to exit the Measurement setup.
4. Click the Setup button.
5. Each sweep point is added to a list. The list is created by clicking ADD and specifying the sweep point.
6. After creating the list of points, click the DONE button.

Custom Step Mode



Bias

Stimulus

Bias Mode

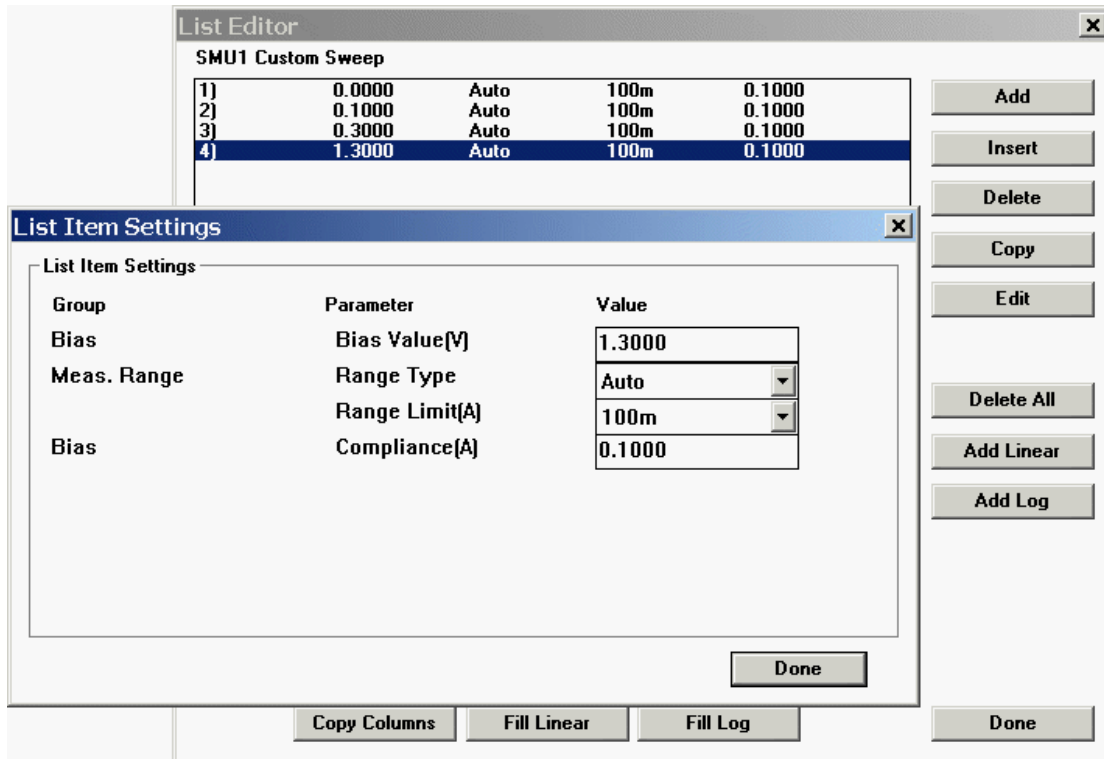
Bias List[V]

Voltage	▼
Custom Step	▼
Setup	

The custom step mode forces a constant output while another source unit in the test setup forces a sweep signal. The custom step mode is functional only in test setups that include a second source unit configured in sweep mode.

The Custom Step mode is only available when the Mainframe Mode is SWEEP, CUSTOM SWEEP, or MULTISWEEP.

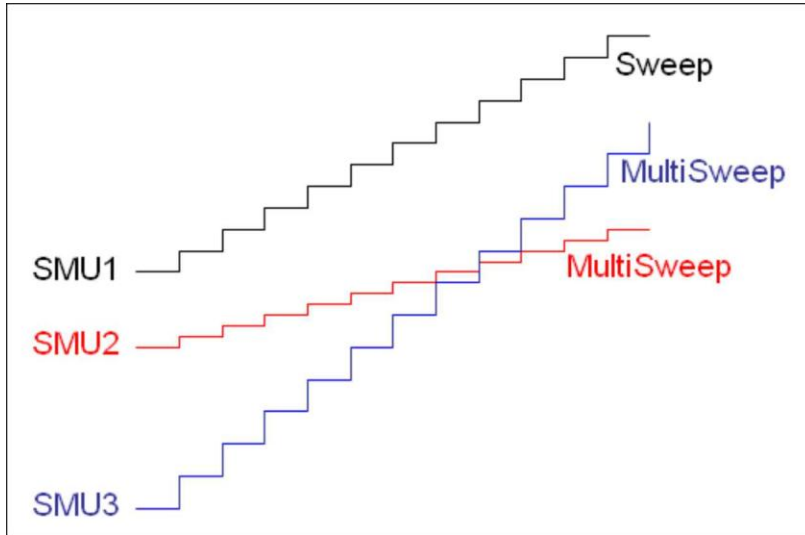
The custom step mode generates a constant output signal while a second source unit generates a staircase sweep signal. After the staircase sweep signal reaches the specified STOP value, the magnitude of the step output is incremented to the next value and the staircase sweep signal is triggered again. This process continues until the last value of the step signal is reached.



How to Source a Custom Step Signal:

7. Select the "CUSTOM STEP" designation from the available options listed in the BIAS MODE field.
8. Click the Setup button.
9. Each sweep point is added to a list. The list is created by clicking ADD and specifying the sweep point.
10. After creating the list of points, click the DONE button.

Multi-Sweep Mode



Bias

Stimulus

Bias Mode

Bias Sweep[A]

Compliance[V]

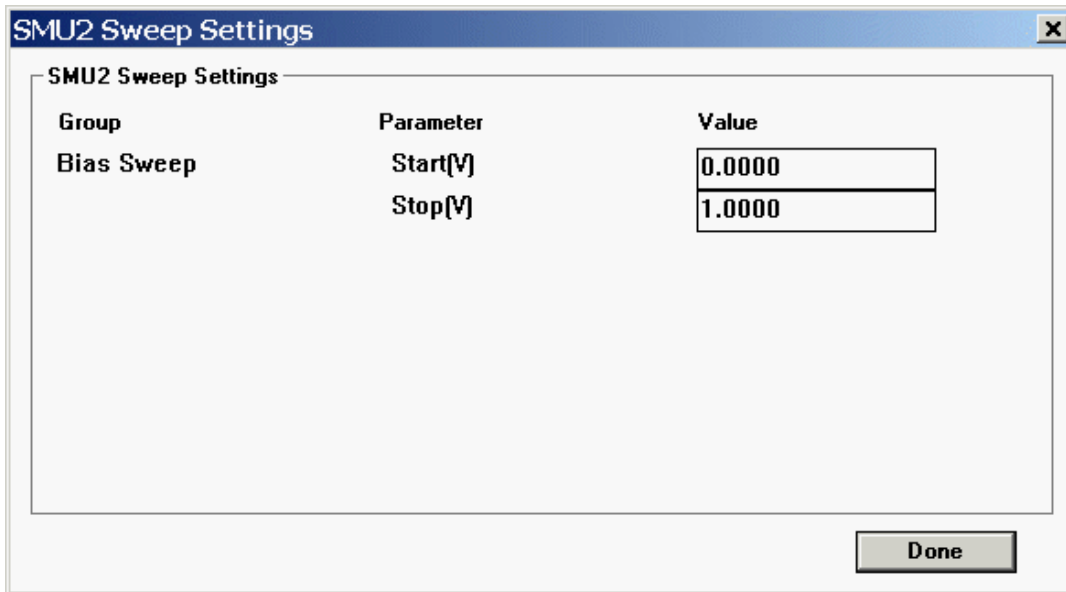
Current	▼
Multi-Sweep	▼
Sweep	
10.0000	

The Multi-sweep mode allows more than one and up to ten SMU's to sweep at the same time. The Multi-sweep works by defining one SMU as the primary (SWEEP) source. This source has all of the normal sweep setup inputs available including START, STOP, POINTS, and STEP. All other SMU's that will perform a sweep are configured as MULTI-SWEEP in the BIAS MODE. The settings for each multi-sweep source are only the START and STOP and are configured by clicking the **Setup** button.

The Multi-sweep mode is only available when the Mainframe Mode is MULTI-SWEEP.

A source unit can force a multi-sweep output only when the output of another source unit in the test setup is configured in a sweep mode. If a multi-sweep mode is designated in a test setup that does not include a primary sweep signal, ICS will display an error message when the user attempts to exit the Measurement Setup.

The stimulus of the multi-sweep signal *is not required* to match the stimulus of the primary sweep. In other words, if the primary sweep is a voltage output, the synchronized sweep can be either a voltage or current output.



While the *timing* of the sweep and multi-sweep signals are synchronized, the magnitudes can differ. The START and STOP values of the multi-sweep signal is specified for each individual multi-sweep source.

How to Source a Multi-Sweep Signal:

A multi-sweep signal is functional only when a sweep signal is forced by another source unit.

11. Select the "MULTI-SWEEP" designation from the available options listed in the BIAS MODE field.
12. Click the SWEEP button.
13. Enter the START and STOP values.
14. Click the DONE button.
15. Repeat for each multi-sweep source.

Compliance

The COMPLIANCE field is used to specify the limiting magnitude of a measured signal. When a source unit is sourcing voltage and measuring current, a current compliance must be specified. Similarly, if a source unit is sourcing current and measuring voltage, a voltage compliance must be specified.

The compliance limit allows the user to execute a test setup that is within an acceptable power range of the device by limiting the operating range of the source unit. For example, if a 1mA compliance limit is specified for a source unit that is sourcing a sweep voltage and returning a current, the source unit will supply an increasing voltage signal until a 1mA current is returned.

The maximum compliance limit that ICS will allow is determined by the operating boundaries of the instrument. Please refer to the KI4200 Operation Manual for an overview of the KI4200 compliance configurations and power limitations.

Detecting Compliance Events

If the Display Errors switch is selected in the Mainframe Settings dialogue box, ICS will display a message if a compliance limit is detected. (The Mainframe Setup dialogue box is opened by clicking the Setup Editor OPTIONS button or by clicking the MAINFRAME component in the Measurement Setup dialogue box). The message box will identify the source unit in compliance. The Continue on Any option will result in the instrument NOT stopping when a channel reaches compliance; otherwise the data for all points after compliance is reached is returned as zero.

As a default, the Display Errors switch is OFF. If you want ICS to identify compliance events, make certain that the Display Errors switch is selected in the Mainframe Setup dialogue box.

Stimulus Controls

Bias	Stimulus	<div>Voltage</div>
-------------	-----------------	--------------------

The stimulus menu consists of two selections: VOLTAGE and CURRENT. This specifies the characteristic of the forcing signal. Timing and averaging configurations are defined in the 4200 Mainframe Setup dialogue box.

When configuring modules that can source and monitor either voltage or current, selecting the characteristic of the forcing signal defines the characteristic of the measured signal. For example, the SMU can be configured to source a voltage and monitor a current, or source a current and monitor a voltage. However, selecting the forcing signal characteristic DOES NOT automatically specify the data that will be written to the corresponding data window. All data doesn't have to be returned, but the data can be the sourcing signal itself (calculated), the complement of the sourcing signal (measured), or both. Data return specifications are defined in the Measure Group menu.

Measure Controls

Measure	Meas. Voltage	<input checked="" type="checkbox"/>	<div>VG</div>
	Meas. Current	<input checked="" type="checkbox"/>	<div>IG</div>

The Measure Group control box consists of three switches: VOLTAGE, CURRENT, and TIME. In addition to the three measure switches, a text field is located to the right of each switch.

These switches and text fields are used to specify and label the data that will be returned when the test setup is executed. Timing and averaging configurations are defined in the 4200 Mainframe Setup dialogue box.

Specifying Returned Data

ICS may be configured to return the sourcing signal, the sourcing signal complement, the measurement time, a combination of these, or none.

A source unit's measurement configuration is specified by turning on or off the VOLTAGE and CURRENT switches located in the Measure Group control box.

Four possible measurement configurations are described below.

THE SOURCING SIGNAL IS RETURNED: To specify this configuration, select the switch that matches the characteristic of the sourcing signal.

In this mode of operation, the returned values are not true measurements. The returned values are calculations based upon the source setup.

For example, consider the gate threshold characteristic of a MOSFET. In a gate threshold test setup, a constant voltage is applied to the drain, while a swept voltage is applied to the gate. The gate threshold characteristic is a plot of I_{ds} vs. V_{gs} . Therefore, V_{gs} , the voltage sweep applied to the gate, must be returned since V_{gs} data is required for the plot. The gate current is not important in this test setup. The source unit connected to the gate is configured to apply a voltage sweep and return only the values of the applied sweep.

THE SOURCING SIGNAL COMPLEMENT IS RETURNED: To specify this configuration, select the switch corresponding to the opposite characteristic of the sourcing signal.

For example, consider the gate threshold example described above. The sourcing signal on the drain is a constant voltage supply. However, the same source unit is also measuring I_{ds} , the drain current. Returning V_{ds} would not provide any useful information, because V_{ds} is a constant value throughout the test setup.

BOTH THE SOURCING SIGNAL AND ITS COMPLEMENT ARE RETURNED: To specify this configuration, both switches should be ON.

For example, consider the DC forward current gain of a bipolar transistor in common emitter mode. In this test setup a swept voltage supply is applied to the collector. The plot of the forward current gain is a plot of I_{ce} vs. V_{ce} . Therefore, both I_{ce} and V_{ce} must be returned since I_{ce} and V_{ce} data is required to construct the plot.

NO RETURN MEASUREMENTS ARE RETURNED: To specify this configuration, all switches should be OFF.

For example, consider the forward transfer characteristics of a MOSFET. In this test setup a constant supply of 0.0V is applied to the source in order to establish a grounding condition. The forward transfer characteristic is a plot of I_{ds} vs. V_{ds} . Both of these measurements are obtained from the source unit connected to the drain. Since the gate current present in this mode is very small relative to the drain current, measuring the source current will not provide any useful information. As a result, the source unit connected to the source supplies a constant 0.0V, but returns nothing.

Labeling Measured Data

All of the data that corresponds to a single curve is collectively referred to as a "data vector". Each data vector is identified by a "data vector label" that must be defined in the text field to the right of the VOLTAGE, CURRENT, or TIME switch. A data vector label can be any alphanumeric string up to six characters in length.

THE DATA VECTOR LABEL CANNOT END WITH A NUMBER.

The presence of only three data vector fields does not mean that only two data vectors can be specified in a test setup. In fact, by using a combination of step and sweep source units, many data vectors can be defined per test setup.

Test setups that use a combination of stepped sources and swept sources can return both sequential and non-sequential data vectors. Test setups that use a combination of constant sources and swept sources only return non-sequential data vectors.

Sequential Data Vectors

A sequential data vector is a device characteristic that is described by a family of unique curves. Each curve is measured in response to a stepped bias condition. Sequential data vectors are the result of test setups that include stepped sources and repeated sweeps.

For example, consider the DC collector characteristics of a bipolar transistor. The DC collector characteristics are obtained by generating a family of I_{ce} vs. V_{ce} curves. This setup was created by applying a stepped current supply to the base and a swept voltage supply to the collector. The source unit connected to the collector returned both collector voltage (V_{ce}) and collector current (I_{ce}). Each time the base current was stepped to a new value, a unique I_{ce} curve was obtained in response to the collector voltage sweep. The result of this test setup was a family of unique I_{ce} curves. I_{ce} is a sequential data vector because collector current is described by a family of unique curves measured in response to stepped base current.

Non-Sequential Data Vectors

A non-sequential data vector is a device characteristic that is described by a single curve.

For example, consider the example presented in the previous section, *Sequential Data Vectors*. The DC collector characteristics of a bipolar transistor were obtained by generating a family of I_{ce} vs. V_{ce} curves. This test setup was created by applying a stepped current supply to the base and a swept voltage supply to the collector. The source unit connected to the collector returned both collector voltage (V_{ce}) and collector current (I_{ce}). Because the base current was stepped, this test setup returned a family of I_{ce} curves. The voltage sweep applied to the collector during each base current step was the same. Therefore, V_{ce} is a non-sequential data vector, because V_{ce} can be described by a single curve.

Controlling Integration Time

Integration time is the time required to get measurement data. The longer the integration time, the better the data is a generally true statement, however sometimes the trade-off between increasing the integration time and the quality of the data becomes unfavorable. In some cases, the increased measurement time does not yield significantly better data. It is therefore important to properly control the integration Time to achieve the best data in an acceptable test time.

The 4200 driver has two sets of controls for setting the Integration Time.



The first is by using the ICS Measurement Remote Control. The Measurement Remote Control has a button that allows the selection of four (4) different Integration Modes.

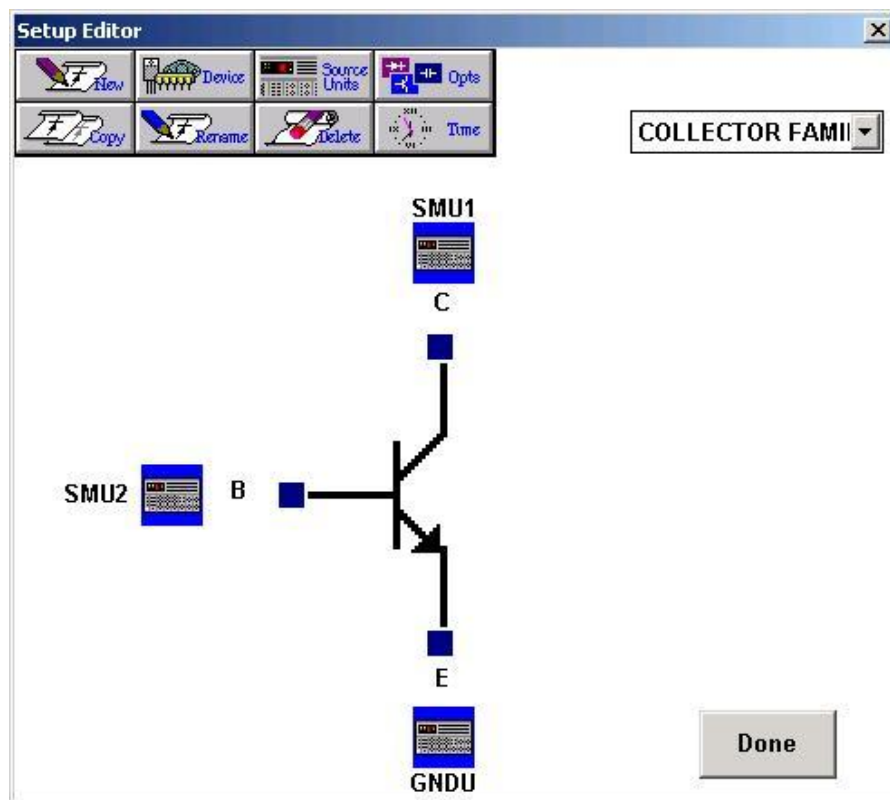
By default ICS will have the Measurement Remote Control Integration Mode set to User. This will allow the Integration Time to be controlled by the settings in the Instrument Mainframe Options.

Mainframe Settings		
Group	Parameter	Value
General	Mode	Sweep
Integration	Type	Short
Timing	Hold Time[s]	0.0000
	Delay Time[s]	0.0000
Options	Display Errors	<input type="checkbox"/>
	Check Commands	<input type="checkbox"/>
<div>Hide Advanced</div>		

Collector Family Setup Conditions

Collector Family

This setup measured the DC collector characteristics of a 2N3700 bipolar transistor. A voltage sweep was applied to the collector for a series of stepped base currents. A family of curves was generated by measuring and plotting the collector current with respect to the collector voltage sweep for each base current step. The following source units and setup conditions were used:



Mainframe Setup

Measurement Setup Dialog

Component	Summary
Mainframe	Mode Sweep
SMU1	Sweep Voltage 0.0000,1.0
SMU2	Const Voltage 0.0000
SMU3	Const Voltage 0.0000

Mainframe Settings

Group	Parameter	Value
General	Mode	Sweep
Integration	Type	Short
Timing	Hold Time(s)	0.0000
	Delay Time(s)	0.0000
Options	Display Errors	<input type="checkbox"/>
	Check Commands	<input type="checkbox"/>

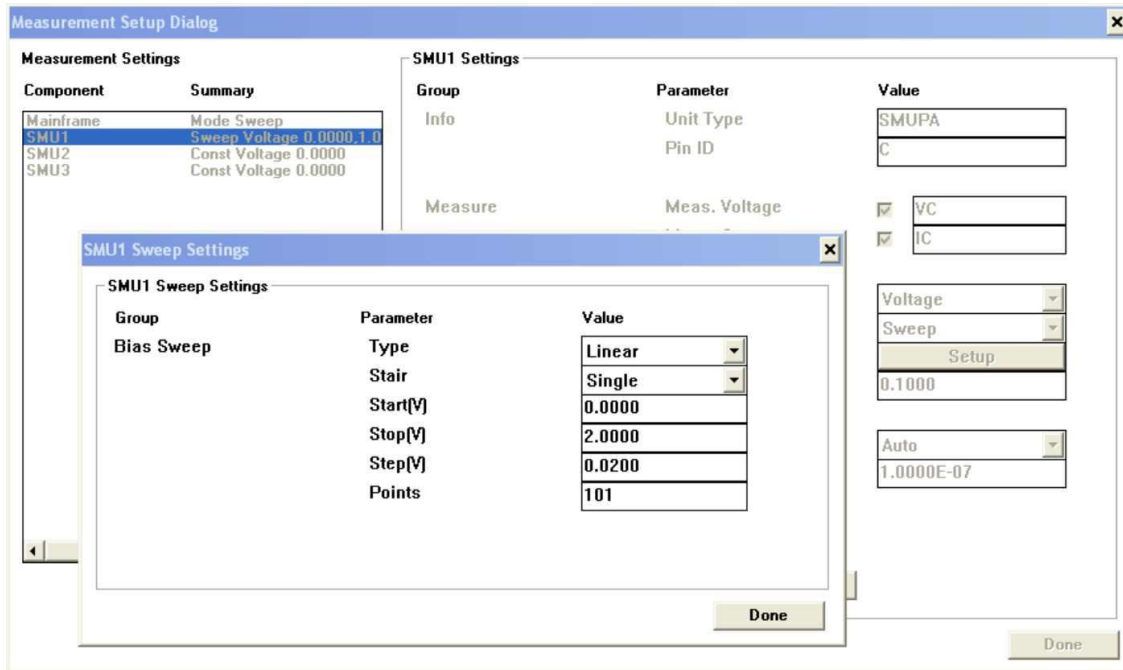
Show Advanced

Done

MODE: Sweep

SMU Setups

Collector: SMU1



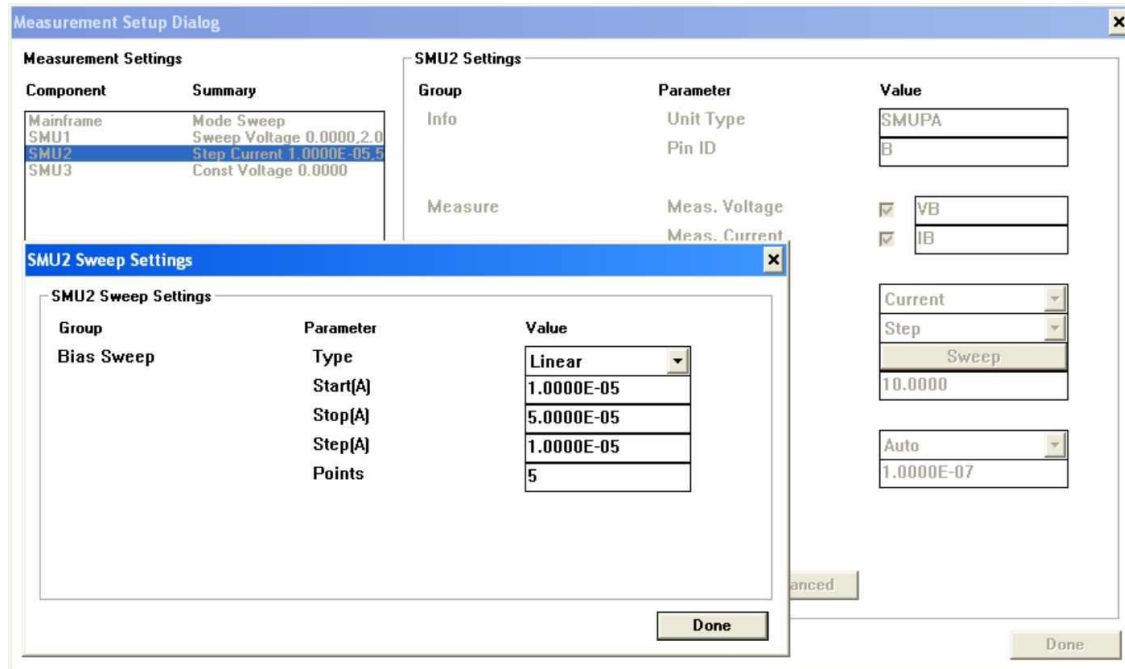
MEASURE: VC, IC

STIMULUS: Voltage

BIAS MODE: Sweep

SWEEP: 0-2V, 101 POINTS

Base: SMU2



MEASURE: None

STIMULUS: Current

BIAS MODE: Step

SWEEP: 10 uA to 50 uA, 5 POINTS

Results

