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## GETTING STARTED: CREATING AND EXECUTING A TEST SETUP

The Hewlett-Packard 4145A/B Semiconductor Parameter Analyzer is a high performance DC parametric measurement instrument used to measure the DC characteristics of microelectronic devices.

This section will walk you through the steps required to create and execute a test setup that measures diode turn-on voltage using the HP4145A/B Semiconductor Parameter Analyzer. This is a simple measurement, but it will provide you with a general understanding of how Win4145 and the HP4145A/B are used to measure device characteristics.

### STEP 1: CABLE THE HARDWARE CONNECTIONS

Cable all the necessary connections between the instrument sources 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 Win4145's graphic workspace.

The test setup example presented in this section was executed using the HP4145A/B Semiconductor Parameter Analyzer along with the HP16058A Test Fixture and the HP16058-60005 Socket Module. A schematic of the hardware arrangement is shown below.

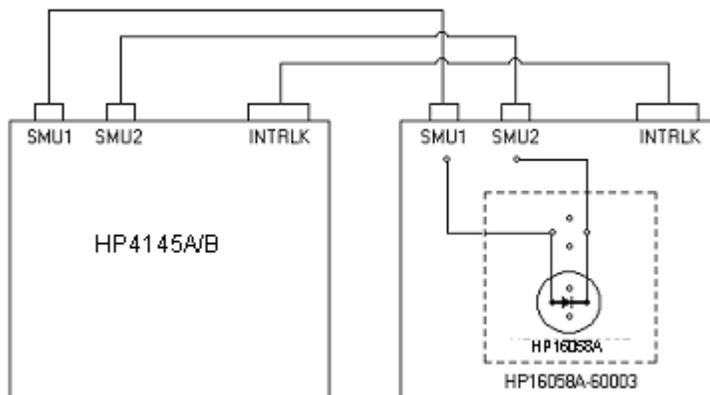
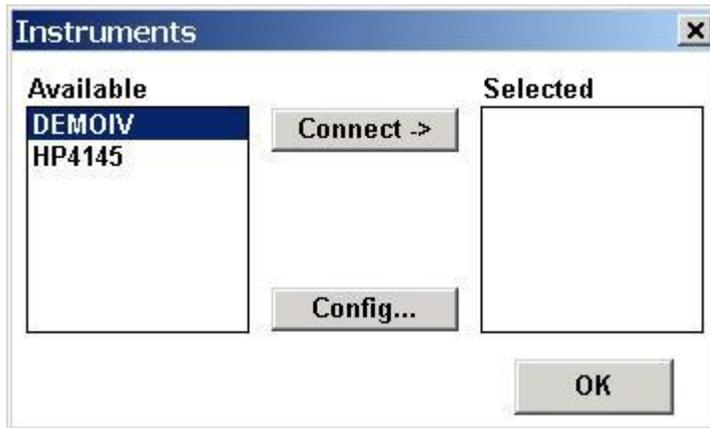


Figure 1: A Schematic of the Hardware Arrangement Used to Measure VON for an NP Diode.

## STEP 2: CONNECT THE HP4145 INSTRUMENT DRIVER



The HP4145 Driver is connected using the Instruments dialogue box accessed by choosing INSTRUMENTS/SELECT INSTRUMENT from the main menu bar.

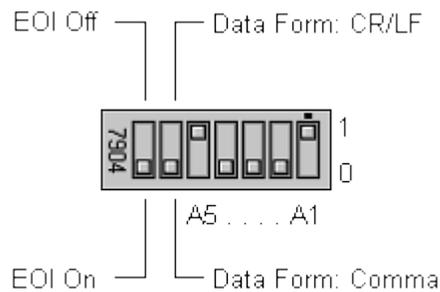
### HOW TO CONNECT THE HP4145 DRIVER:

1. Click the SELECT INSTRUMENTS toolbar button or select INSTRUMENTS/SELECT INSTRUMENT from the Win4145 measurement mode menu bar. This will open the Instruments dialogue box.
2. Highlight the HP4145 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 Win4145 desktop. Keep the Connect Instruments dialogue box displayed for now, because the next step requires you to click the CONFIG button in the Instruments window.

### STEP 3: SPECIFY THE GPIB ADDRESS

The HP4145 must be connected to your computer with the use of a standard IEEE-488 GPIB. The HP4145 Operation Manuals specify the use of an HP-IB interface in order to control the instrument remotely. The HP-IB designation is Hewlett-Packard's implementation of the IEEE-488 Standard Digital Interface for programmable instrumentation.

This section provides the basic information necessary to remotely control the HP4145. Please refer Chapter 3 of the HP4145A/B Operation Manual, to review the details of HP-IB interface control.



Before installing the GPIB cable, make certain that the HP-IB Control Switch located on the back panel of the instrument is configured correctly. The EOI Bit and Data Form Bit must be set to the OFF position. The remaining five bits are the Address Bits and can be configured to any binary value between 0 and 30. The HP-IB Control Switch is set to an address of 17 at the factory.

The HP4145 Configuration dialogue box is used to specify the GPIB address configured on the instrument's HP-IB Control Switch. The ID display is a static display field only and does not require any definition by the user.

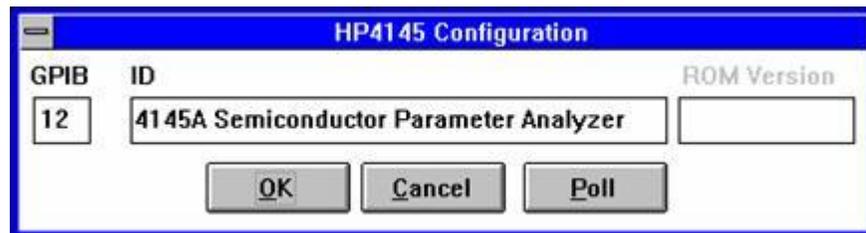


Figure 2: The Instrument GPIB Address is Designated in the HP4145 Configuration Dialogue Box.

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## HOW TO DEFINE THE HP4145 GPIB ADDRESS:

1. Open the Instruments dialogue box by selecting the SELECT INSTRUMENTS toolbar button or by selecting INSTRUMENTS/SELECT INSTRUMENT from the measurement mode menu bar.
2. Make certain that the HP4145 Driver is connected. If not, highlight the HP4145 Driver in the AVAILABLE field and click the CONNECT button. Refer *Step 2: Connect the HP4145 Instrument Driver* for more information regarding the connection procedure.
3. Open the HP4145 Configuration dialogue box by clicking the CONFIG button at the bottom of the Connect Instruments dialogue box.
4. Enter the HP4145 GPIB address in the GPIB field. The GPIB address is determined by evaluating the position of the five binary address bits on the HP-IB Control Switch located on the back panel of the instrument. The HP-IB Control Switch specifies a binary address between 0 and 30. The HP4145 leaves the factory with HP-IB Control Switch set to an address of 17. If you wish to change the GPIB setting, please refer to Chapter 3 of the HP4145A/B Operation Manual.
5. Click the OK button located at the bottom of the dialogue box. This will close the Configuration dialogue box. Click the OK button in the upper right-hand corner of the Instruments dialogue box to restore control to the Win4145 desktop.

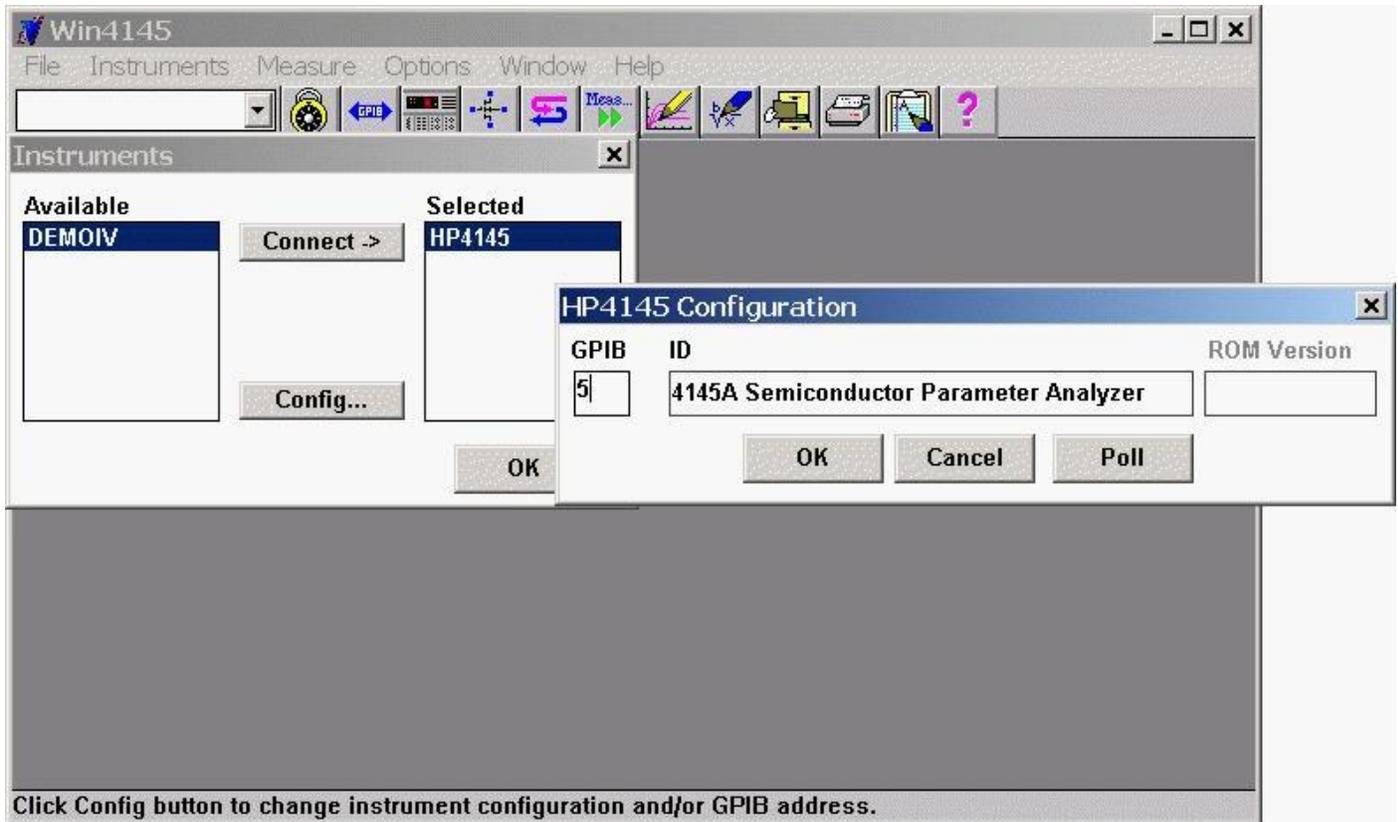
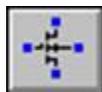


Figure 3: How to Define the HP4145 GPIB Address

#### STEP 4: CREATE THE TEST SETUP

Test setups are created in the Setup Editor. Open the Setup Editor by selecting the EDIT TEST SETUP 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.

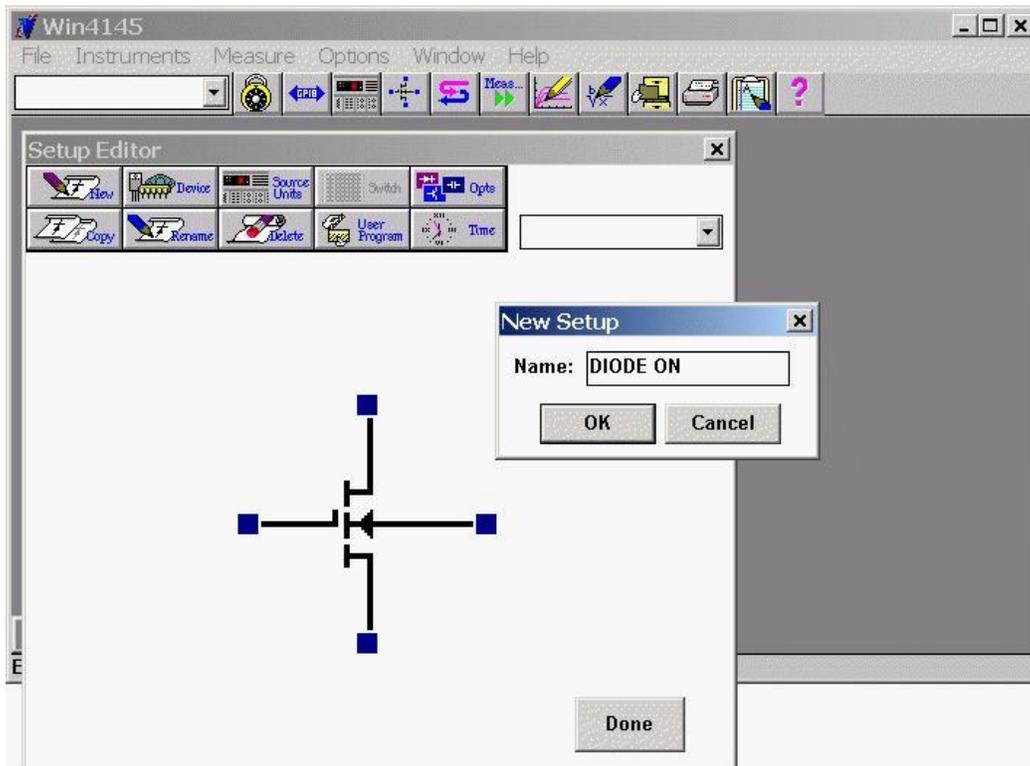


Figure 4: How to Define the Setup Name

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## 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.

A MOSFET schematic will appear at the center of the Setup Editor when the Setup Editor is first opened. In this step the MOSFET schematic will be replaced with a diode schematic. The MOSFET device is the default Setup Editor schematic. To change the default device schematic, refer to *Chapter 2: The Setup Editor* of the Win4145 Reference Manual.

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### 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.

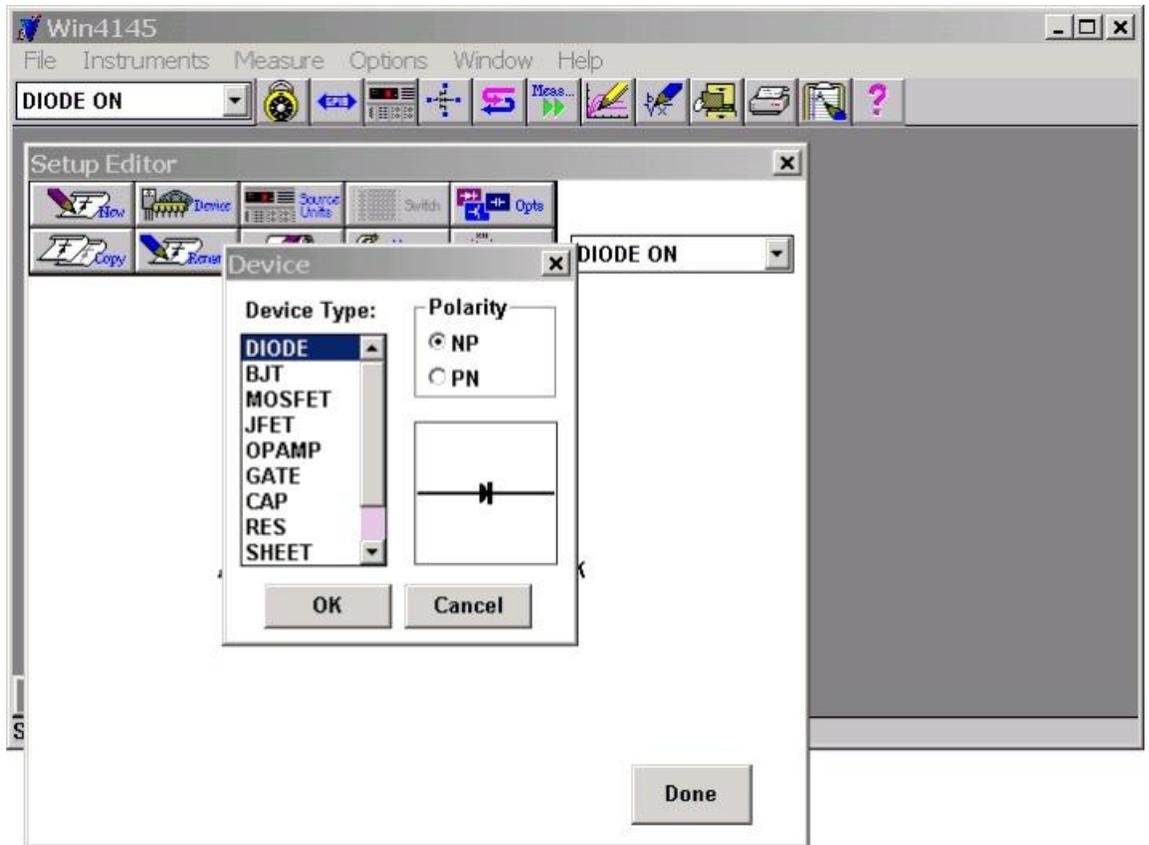


Figure 5: How to Select the Device Schematic

#### STEP 4C: DESIGNATE THE SOURCE/DUT CONNECTIONS

The source/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/DUT connections designated in the Setup Editor are a graphic representation of the physical connections between the instrument and the test fixture. 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 above the device schematic pin as a means of indicating the connection. This example will connect an HP4145 SMU to each end of an NP diode.

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## HOW TO DESIGNATE THE SOURCE/DUT CONNECTIONS:

1. Select the Setup Editor SOURCES button. This will open the Source Units dialogue box.
2. The Source Units dialogue box will display a list of available sources. The Source Units dialogue box will display four stimulus/measurement units, two voltage source units, and two voltage monitor units.
3. Click on the desired source. For this example, click on the "HP4145.SMU1" designation.
4. Designate the source/DUT connection by clicking on the blue pad corresponding to the appropriate device schematic location. For this example, connect SMU1 to the diode anode by clicking on the corresponding blue pad.
5. Repeat this process for each source connected to the DUT. For this example, select the "HP4145.SMU2" designation and connect it to the cathode.
6. After all of the source/DUT connections are designated, close the Source Units dialogue box by clicking the DONE button of the dialogue box.
7. If an incorrect source/DUT connection is mistakenly designated, undesignate the connection as described in *Chapter 2, Removing Instrument/DUT Connections*.

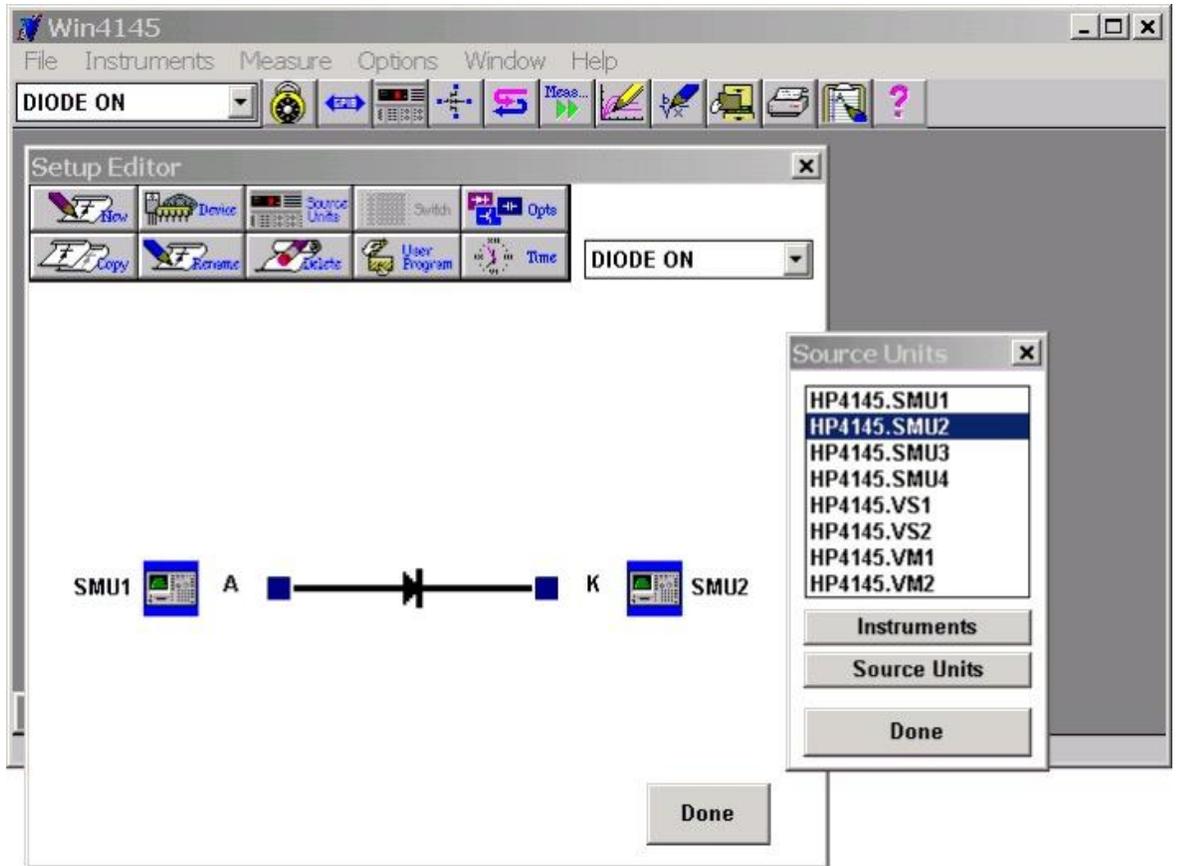


Figure 6: How to Specify the Source/DUT Connections

#### STEP 4D: SPECIFY THE SOURCE/MEASURE CONFIGURATION OF EACH SOURCE

Every available source has its own Source Unit Setup dialogue box used to specify the source/measure configuration of the respective SMU, Vs, or Vm. Once an source/DUT connection is designated, the corresponding Source Unit Setup dialogue box is opened by clicking on the instrument icon displayed above 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 21 data points. SMU1 will measure voltage (V) and current (I). SMU2 (connected to the cathode) will source a constant voltage of 0.0V and will not measure anything.

HOW TO SPECIFY THE SOURCE/MEASURE CONFIGURATION OF EACH SOURCE:

1. Click once on one of the displayed instrument icons to open the Source Unit Setup dialogue box corresponding to the connected SMU.
2. Configure the SMU1 controls as shown in Figure 7. Configure the SMU2 controls as shown in Figure 8. Use the mouse or TAB key to move between the different switches and fields in each Source Unit Setup dialogue box.
3. Click OK to close a Source Unit Setup dialogue box. Only one Source Unit Setup dialogue box can be opened at a time.

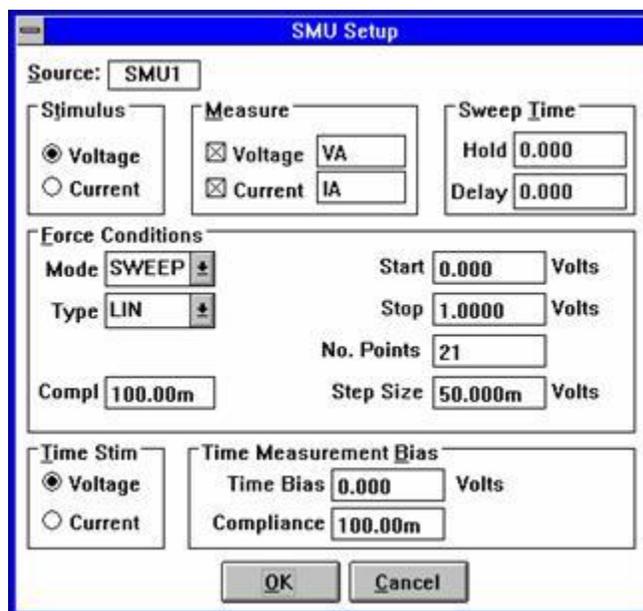


Figure 7: SMU1 Source/Measure Configuration for the DiodeOn Test Setup

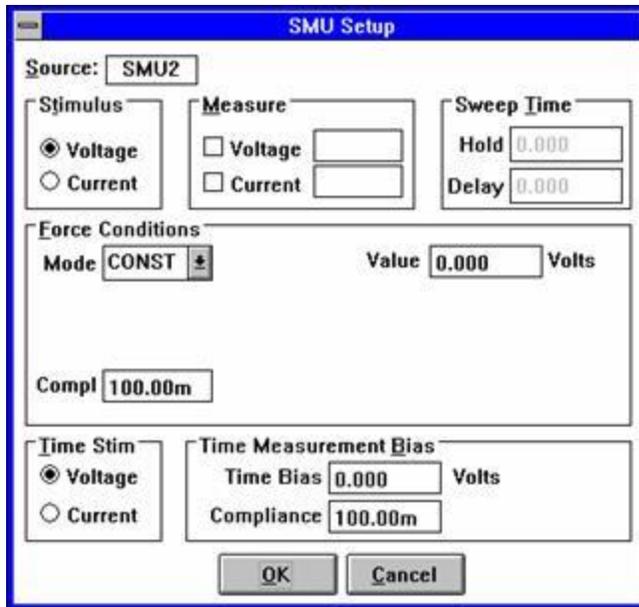


Figure 8: SMU2 Source/Measure Configuration for the DiodeOn Test Setup

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#### STEP 5: INSERT THE DUT INTO THE TEST FIXTURE

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

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#### STEP 6: EXECUTE THE MEASUREMENT

Execute the DiodeOn test setup by clicking the toolbar MEASURE button. This will open the Measurement Remote Control window. This window is where test execution is started. Click the "Single" button to begin the measurement. Shortly after the measurement is in process, a message will appear on the bottom of the Win4145 window telling you that the test setup is being executed.

After a few moments another message will be displayed telling you that SMU1 reached compliance. Click IGNORE to complete the measurement.

## 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 spreadsheet icon labeled "DiodeOn" at the bottom of the Win4145 desktop. The spreadsheet existed before you executed the measurement, but it contained no data.

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.

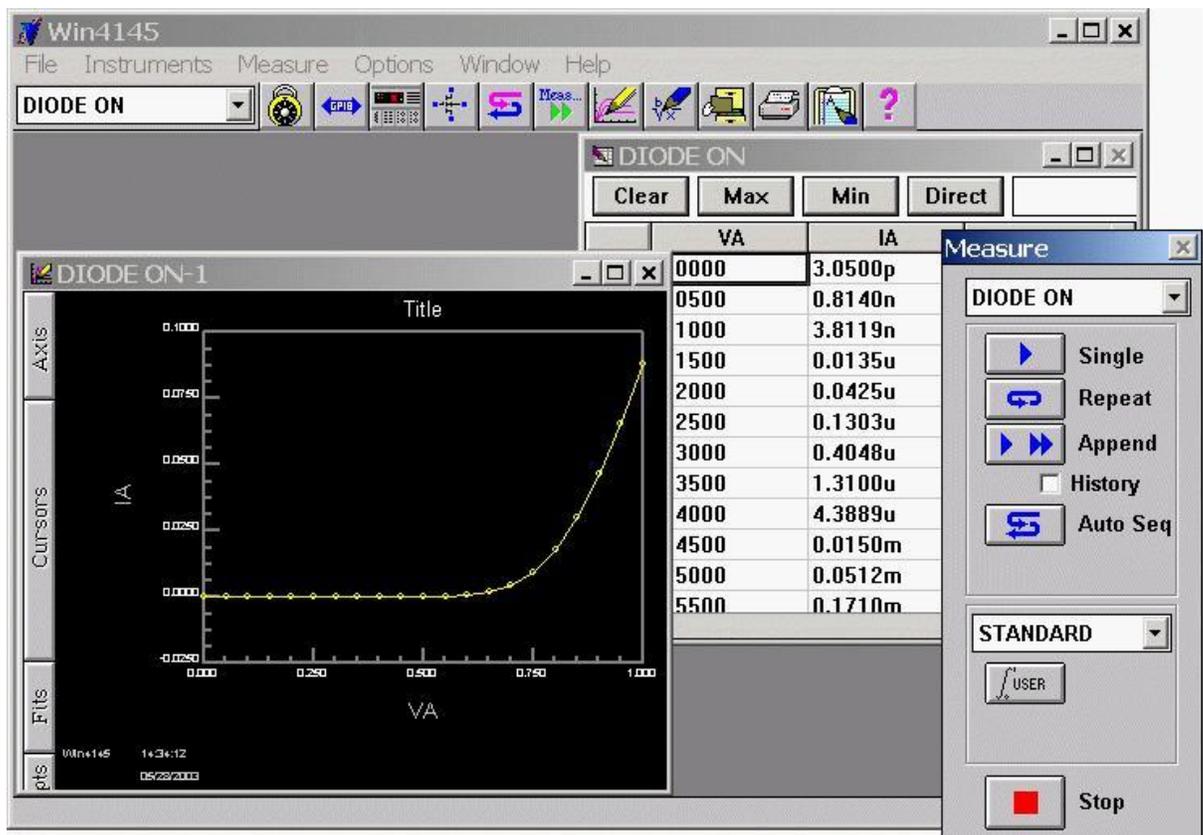


Figure 9: View Test results

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## 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.

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### 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:

a. Click once on the appropriate data window spreadsheet icon (the data window can be either displayed or minimized).

b. Click the toolbar setup window arrow and select the desired setup from the displayed drop-down list.

2. Click the CREATE PLOT toolbar button. This will open an empty plot window and the Plot Data dialogue box.

3. Designate the independent variable (x-axis) of the plot by selecting the appropriate data vector listed in the pull-down list. Only two quantities were measured in the DiodeOn test setup, voltage and current. There should be two data vectors in the dialogue box Data window: "V" and "I". This example will create a plot of current with respect to voltage. Since voltage will be the x-axis, select "V".

4. Designate the first dependent variable (y-axis) of the plot (in our case the only dependent variable) by selecting the appropriate data vector in the dialogue box Data window. For this example, select "I".

5. You could plot up to nine more data vectors with respect to the independent variable if more data vectors were measured by using the Build Group function (please refer to the Win4145 Reference Manual for more information on this function). You can measure more than ten data vectors, but only ten data vectors can be plotted in a single plot window.
6. 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.
7. Click the DONE button to close the Plot Data dialogue box.

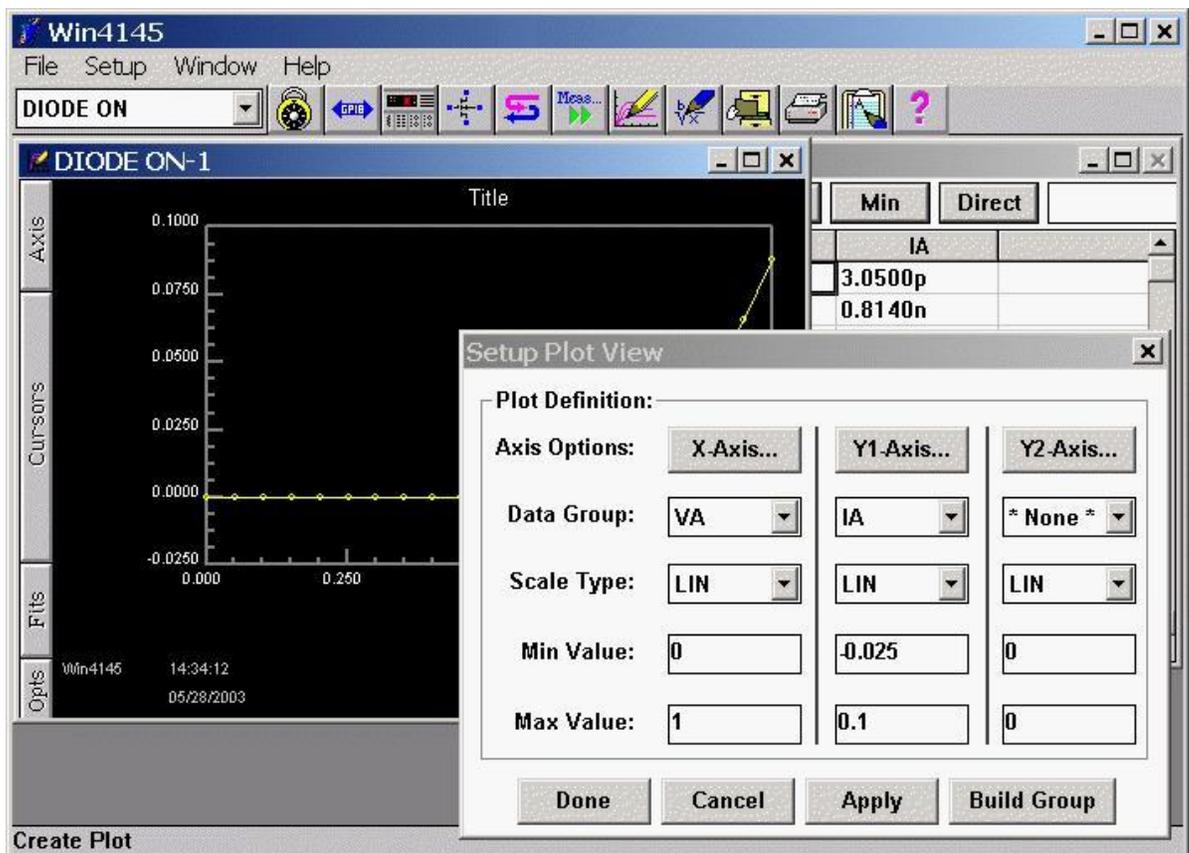


Figure 10: Data Plot Setup

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## 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 Win4145 Stores Information*.

Project files are defined with the File Manager. The File Manager is a powerful tool that allows you to create a structured database of project files. In Win4145, a project file is not defined by specifying a filename; instead, project files are defined by specifying the contents of up to six project file attribute fields displayed in the File Manager. A project file is opened by displaying the File Manager and selecting the attribute designations you specified when the project file was saved.

This example will show you how to save the previously defined test setup, instrument selection, and measurement results as a project file by specifying a project file definition. This definition will be simple and will use only three of the available six project file attribute fields.

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### HOW TO SAVE YOUR WORK AS A PROJECT FILE

1. Click the SAVE AS toolbar button or select FILE/SAVE AS... from the menu bar. This will open the File Manager.
2. In the Attribute #1 field, type "Samples". If the Attribute #1 field already includes a designation, delete the existing designation. Advance to the next attribute field by using the mouse or hitting the TAB key.
3. Move to the Attribute #2 field and type "HP4145".
4. Move to the Attribute #3 field and type "Diodes".
5. Click OK. You just created your first project file. Notice that we were able to specify any alpha-numeric designation in the attribute fields. We didn't specify the information that the field labels prompted us for. The labels of the attribute fields are completely user-definable. Please refer to *Setting the File Manager Options* in Chapter 3 of the Win4145 Reference Manual.

If you close Win4145 and want to open this project file later, follow the steps outlined below.

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#### HOW TO OPEN THE PROJECT FILE

1. Select FILE/OPEN from the Win4145 menu bar. If you are prompted with the question, "*Temp File Exists. Load Temp File?*", answer NO. This will open the File Manager.
2. Click once on the "Attribute #1" field. This will display a drop-down list of designated project titles. Click the SAMPLES designation.
3. Click once on the "Attribute #2" field. This will display a drop-down list of previously specified designations. Click the HP4145 designation.
4. Click once on the "Attribute #3" field. This will display a drop-down list of previously specified designations. Click the DIODES designation.
5. Click OK. This will close the File Manager and load the instrument driver(s), test setup(s), and data corresponding to the project file just specified.