

Semiconductor Parameter Analyzer (Operating instructions)

A PDF copy of this document should be available on the Windows Desktop of the SPA computer

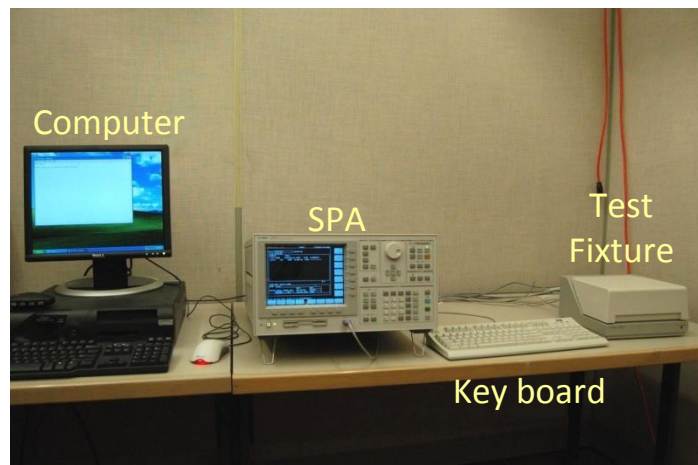
Read this document fully before attempting to operate the SPA



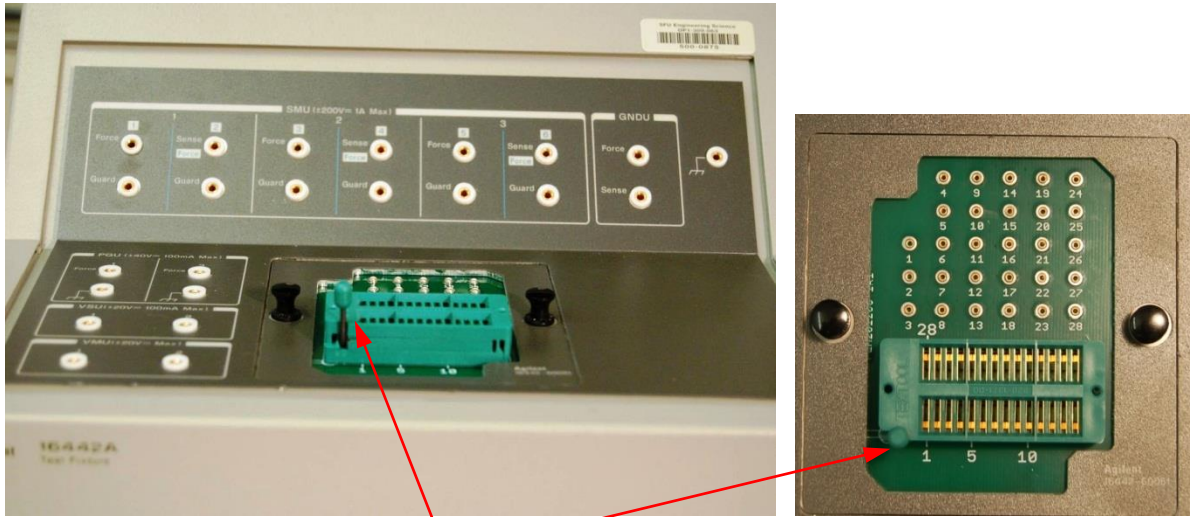
INTRO: ENSC225 laboratory experiments will require obtaining the I-V characteristics of active components such as Diodes, BJTs and MOSFETS. You will be using the model 4155C SPA (Semiconductor Parameter Analyzer), a very specialized professional grade, industry standard instrument made by Agilent Technologies. This is a very precise instrument and of course quite expensive too. Therefore, you have to operate this instrument carefully.

The following pages will give you step-by-step instructions on how to scan a diode. Hopefully, while operating this instrument you will understand the operation logic/protocol and should be able to get a good handle on it by the time we have to use this machine for BJTs and FETs. Having the knowledge of SPA instrument operation will be a very good line item for you to list in your resume, particularly if you are looking for hardware jobs (co-op or permanent).

LOCATION: The SPA (See photo below) is located in the normally secured room ASB 9846.4, at the north end of Lab-1. Unless otherwise specified or specially arranged, this lab will be open from 0900-1600 during working days over the date range defined in your ENSC225 lab assignment(s).



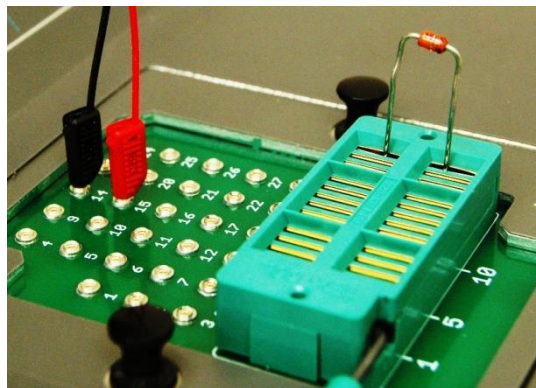
TEST FIXTURE: The test fixture holds the components being tested (or DUT “Device Under Test”). When you open the lid of the test fixture you will see the inside as shown below.



Gently rotate the ZIF socket lever up (open) or down (closed). DO NOT PULL LEVER!

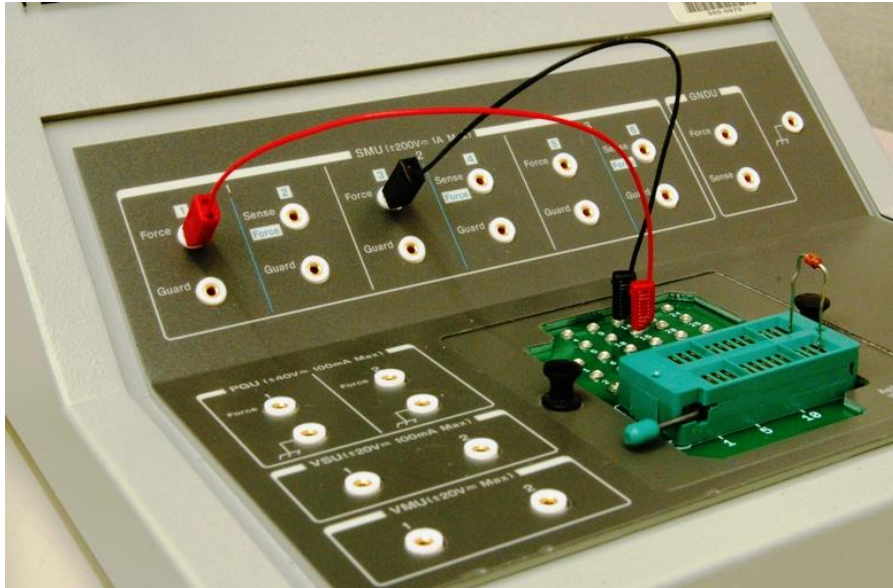
The component will be held by a ZIF (Zero Insertion Force) socket. The close-up view of the socket and the terminals are shown to the right. For the diode experiment, fold the diode pins such that the two terminals can fit on the socket. There is a small lever on the left side of the ZIF socket. If the lever is pointing up, the socket’s clam-shell lead receptacles are open and ready to receive a device to be tested. In the open mode, no pressure is applied to the component pins thus allowing you to place and remove parts easily. When the lever is down the socket applies sufficient pressure on the component pins to establish good electrical contact. Do not force the component into the socket or forcibly remove the component. Please be gentle in your operation.

When placing the diode, make sure the anode of the diode is pointing away from you and the cathode (banded end) is pointing toward you. Place the anode in ZIF pin15 and the cathode into pin14 of the socket. See image below.



You will be sitting on this side of the test fixture

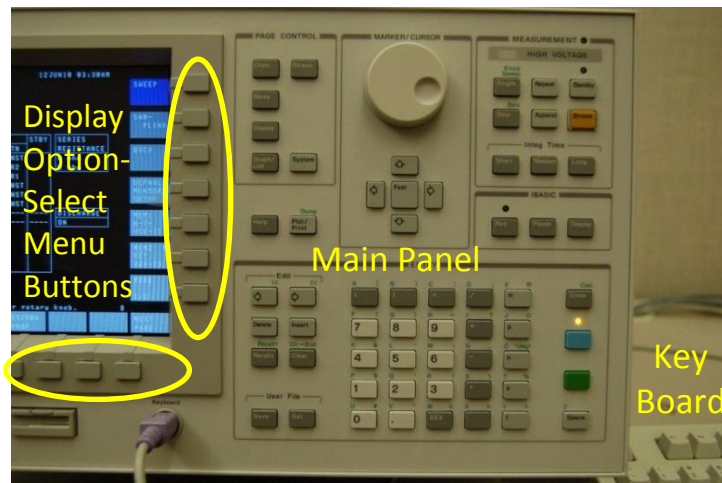
Use the red lead to connect the ZIF socket module pin 15 to the Source/Monitor Unit labelled SMU1 (Force). Connect the black lead from ZIF 14 socket module to SMU3 (Force). See the following picture.



Close the lid of the test fixture. The lid should always be closed during the measurement.



4155C SPA INTRO & COMPUTER SETUP: The SPA has three sets of buttons for control and input of test parameters. A set of on-screen menu option-select buttons are located on the display frame. All remaining instrument controls are located within the main panel. A standard external PC style keyboard is provided.



(The SPA screen is not a touch-screen. Option-Select buttons are located on the display frame.)

Please do not touch / scratch the screen)
I-V Characteristics SWEEP of a diode

Log into the computer. Choose **ENSC225** user and the password is “**ensc225**”

After log-on, open the **SPADATA2** folder on the desktop, delete all the files in that folder and empty trash.

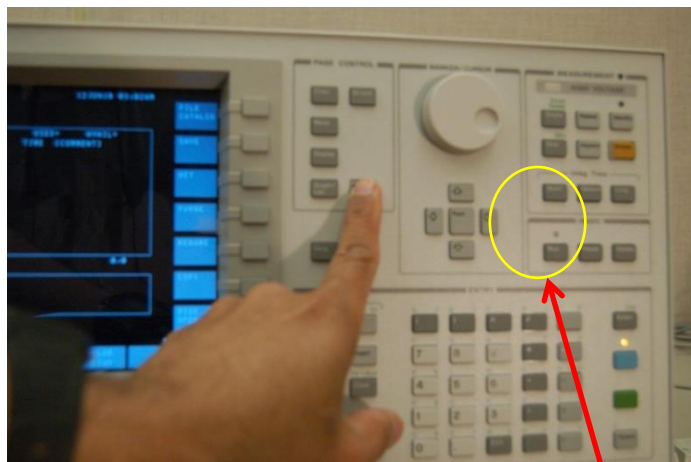
Power ON the SPA by operating the switch at the bottom left of the SPA face panel.



It takes a moment to initialize and you will get the SPA intro screen.

Procedure for setting the SPA for components scan (Diode/BJT/MOSFET)

Now press the **[SYSTEM]** button on the main panel *PAGE CONTROL* group.



The SPA screen will show that the “Floppy Disc” has been selected as data storage media. You have to change that to 4155CSPA using the cursor (arrow) buttons just below the knob on the main panel to move the highlighted section on the screen to the FLOPPY DISC. You can move this using the arrow keys of the keyboard as well.



Now you will see 4155CSPA option appear on the right top of the screen. Choose the **4155CSPA** by pushing the corresponding menu selection button. (Pointed by the index finger 😊)

(If the SPA displays **Warning 339** – the computer is off, you've not logged-in or is improperly connected).



The display should indicate that the SPA is now set to communicate to the computer through the folder called **SPADATA2**.

Now press the [**CHAN**] button on the main panel **PAGE CONTROL** group.



SPA DEVICE MEASUREMENT SETTINGS: You should now see the set-up screen for device measurement scan settings. The SPA contains several preset modes for standard components and we have to choose the **Diode VF-IF** scan mode.

Channels: Channel Definition

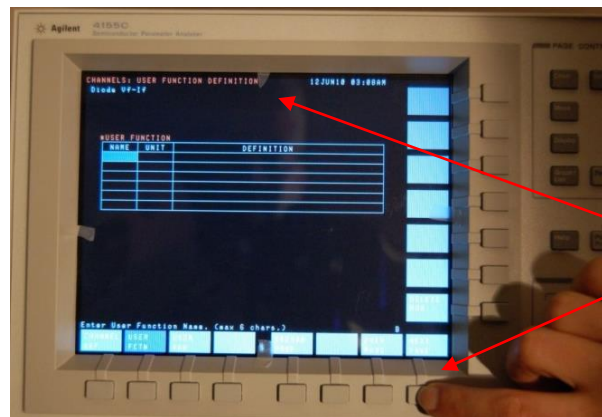
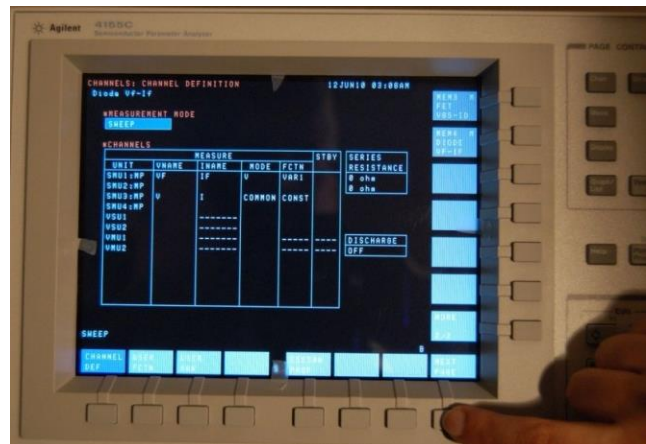


After pushing the **CHAN** button, choose the **More 1/2** option-select button as shown.

Look for the **Diode VF-IF** option-select button on the top right. Choose that option.



This will set SMU1 (Source/Monitor Unit) as the anode lead and SMU3 as the cathode lead for the diode characteristics measurement sweep.



Press the **NEXT PAGE** option-select button at the display bottom-right corner **twice** (this skips over the *Channels: User Function Definition* screen).

The diode scan (Sweep Setup) Parameters screen should appear. The SPA's predefined settings for a diode sweep are:

Start at **-500mV (-0.5V)**, Stop at **2V**, Sweep step of **10mV**, and a compliance value of **40mA**

We'll need to modify these parameters slightly.

The **compliance** value sets the maximum current that the SPA would allow to flow through the component under test.



By default, the CAPS LOCK on the SPA keyboard will be on, disable it using the keyboard's **CAPS LOCK** button.

Using the cursor buttons (either on the main panel or using the keyboard) move the cursor and set the following.

Start the sweep at **0V**, Stop at **0.8V** and a step of **2mV**.

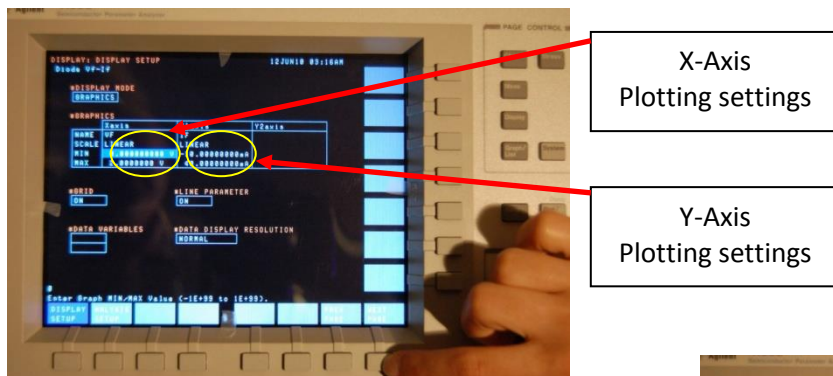
For each setting, type the value using the keyboard and hit Enter. The standard engineering multiplier convention applies here too. “m” for milli, “u” for micro, “n” for nano, etc.

After this set-up, press **NEXT PAGE** option-select button.



This will invoke the graphics setting – *Display: Display Setup* screen.

The graphics setting screen will allow you to set the plotting parameters of the X and Y axis. Set X-axis to minimum of 0V and a maximum of 1V. Set Y-axis, to minimum -2mA and maximum 3mA.



Then press **NEXT PAGE**

The plotting screen will appear as shown here to the right.



Now press the [**SINGLE**] Sweep button on the main panel *MEASUREMENT* button group.



Now the SPA will sweep through the settings and display a plot of the forward characteristics of the diode as shown below.



At this stage you may choose the button "Scaling" and then choose "Auto Scaling" to draw the plot more neatly on the SPA screen.

To transfer this data (CSV format) to a computer use the following steps:

Press [**GRAPH/LIST**] button from the main panel *PAGE CONTROL* button group.

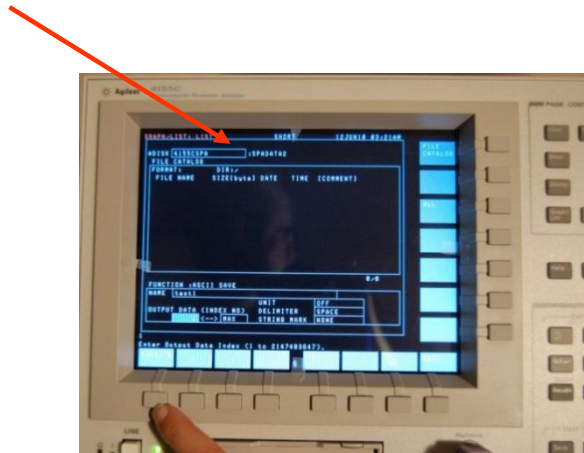


This will bring up a new screen that has the **IF** and **VF** data. Now press the **SPREAD SHEET** option-button.



Supply a meaningful file name using the keyboard and hit enter. You should be able to see the file name you have given has been accepted by the SPA.

You should also check if the **4155CSPA** and the **SPADATA2** folder name appear on the top of the screen¹.



Now push **EXECUTE** option-select button.

The SPA will transfer the sweep data to the computer and your file will appear inside the **SPADATA2** folder. This file will be in CSV format for easy import into a spreadsheet program such as Excel so that you can further analyze the data.



CONTINUE WITH ANOTHER SWEEP: If you want to continue, press the **EXIT** option-select button to go back to the measurement mode.

¹ If you do not see the **4155CSPA** on the top display window, you should go back to [Procedure for setting the SPA for components scan \(Diode/BJT/MOSFET\)](#) (page 4 of this document)

You can continue setting another sweep parameter by pushing the [MEASURE] button on the main panel *PAGE CONTROL* group and go to the sweep setting menu.



If something goes wrong, please report it immediately to the TAs/Instructor/Lab Tech.

The detailed OEM instruction manuals for the SPA will be placed on the lab1 computers in

Desktop > Reference Material > Equipment > Manuals > Agilent > 4155C

Ending Your Session

1. Move your files from the computer SPADATA2 folder to your flashdrive.²
2. Delete any remaining contents of the SPADATA2 folder. The folder should be empty.
3. Empty the Recycle Bin.
4. Logout
5. Power **OFF** the SPA.

Remove your part(s) from the SPA test fixture. ZIF socket open - lever UP. Ensure that all test-leads are carefully contained inside the test fixture unit with the lid closed. These test-leads are highly specialized and will be extremely difficult and costly to replace if lost.

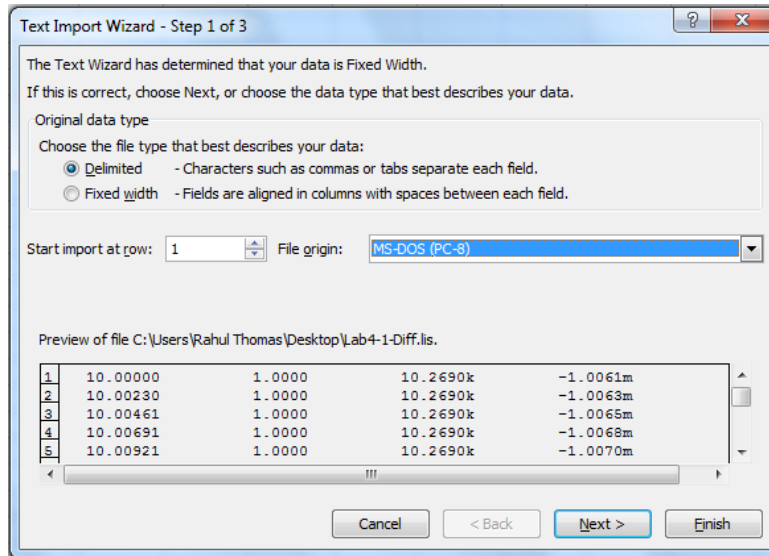
² You should verify the content validity of file(s) copied to your storage device on another computer and create a safe backup prior to performing step 2.

Procedure for importing .csv files into Excel

The exported .csv file will be saved in the *SPADATA2* folder. In order to import this file correctly into Excel you need to use the delimiter function to separate the data into different cells.

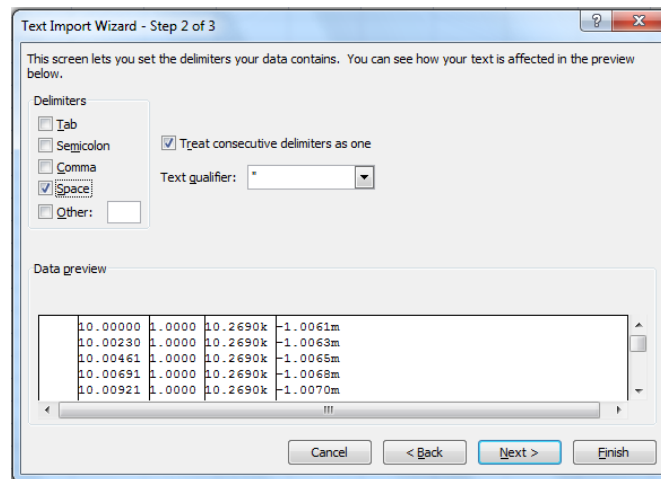
If you are using Excel 2007 or 2010 click on the **DATA** tab and select **From Text** in the Get External Data Section. For Excel 2003: Data -> Get External Data -> Import Data

Select the desired .csv file from the *SPADATA2* folder. This will bring the following *Text Import* window:



Ensure that **Delimited** is selected under the file type description. Click **Next**.

Under the list of available delimiters select **SPACE**, as shown in the figure below.



Click **Next** and then click **Finish**. An import data window will appear. Choose the desired sheet you wish to import the data into and click **OK**. The exported data should now be correctly imported into Excel.