

Process Flow: Radiant Premier II

This document outlines the processes to be employed in performing hysteresis measurements via the Radiant Premier II system located on Probe 1 station in J-Bay. This is a quick start guide and more detailed documentation can be found via Radiant's [support documentation](#).

1 Device Limitations and Setup

The Radiant Premier II has limitations as listed below:

- Max Voltage: 200 V
- Min Hysteresis Frequency: 0.03 Hz
- Max Hysteresis Frequency: 250 kHz (Power dependent)
- Max Area: 100 cm²
- Input Capacitance: 60 fF



1.1 High-Level Process Flow

This section outlines the high-level process flow that will be undertaken while also denoting where each process will be employed. Details for each of the processes undertaken in the Scifres Nanotechnology Laboratory (Purdue Cleanroom) will be described in subsequent sections. BNC is shorthand for Birck Nanotechnology Center.

1. Device Limitations and Setup
2. Sample Preparation and Cleaning
3. Equipment Setup
4. Program Setup
5. Data Collection

6. Data Export
7. View and Edit Data Post Collection
8. Common Errors and What Do They Mean

2 Sample Preparation and Cleaning

Sample should be cleaned via regular cleanroom procedures including toluene, acetone, and IPA as outlined in the [BNC Wiki](#).

3 Equipment Setup

3.1 Device Location

The Premier II is located in J-Bay on Probe Station 1. Required PPE are standard J-Bay PPE: shoe covers, hair net, glasses, lab coat, and gloves.

3.2 Plug Twinaxial BNC Cables In

The Premier II uses twinaxial BNC cables. These are plugged into the back and labeled drive and return. The return is a ground voltage, while the drive is the alternating current. These should already be plugged in, but if they are not, plug them into the probe station, and then plug them into the Premier II. Find the two probes you will use which have twin BNC cables. Connect these to the Premier II.

3.3 Probe Setup

To perform hysteresis, you need two contacts: the top contact and the bottom contact. The drive can be connected to the bottom contact and the return can be connected to the top. An example is given in Fig. 1.

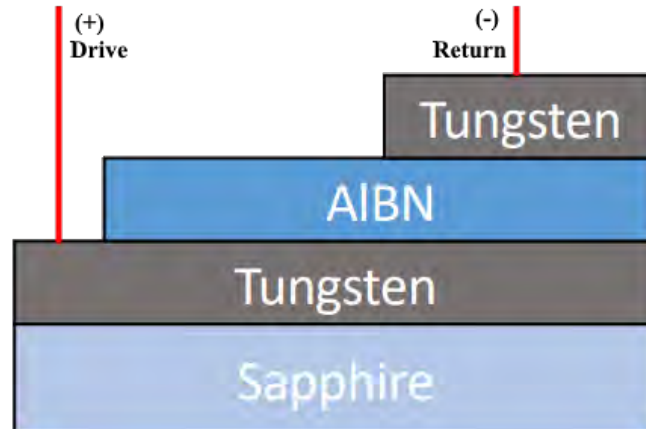


Fig. 1: A 2D side view of what the probe positions looks like.

4 Program Setup

4.1 Vision Software

The lower computer system on the rack for Probe Station 1 contains the software for Vision.

Double click the Vision software icon on the desktop. When it loads, it will list the attached testers. There should only be one tester attached (Fig. 2). Select the tester then click OK. *(You can confirm the correct tester by choosing a tester and clicking ID Tester. The associated tester will blink rapidly for a few seconds.)*

Once the tester is chosen, it will perform a self-calibration test. Make sure nothing is connected to the probes while the system performs the calibration. Once the calibration window in the top-left has disappeared you may lower the probes onto the contacts and continue.

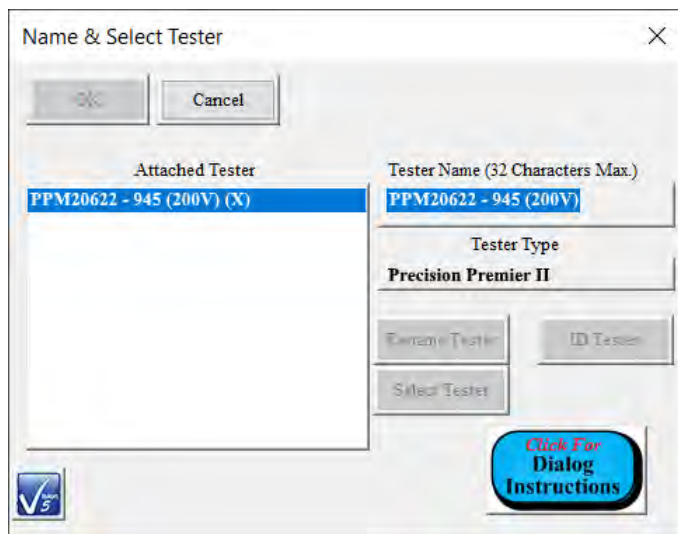


Fig. 2: The intro to Vision software tester selection. The J-Bay setup should only have one tester as shown.

4.2 Find Library

The Task Library is located on the right-hand side (Fig. 3). To begin setting up the hysteresis measurements, drag the "Nested Loops - Accumulate" above to the Editor (Fig. 4). This module can be found in the Task Library → Customized Tests → Nested Loops - Accumulate.

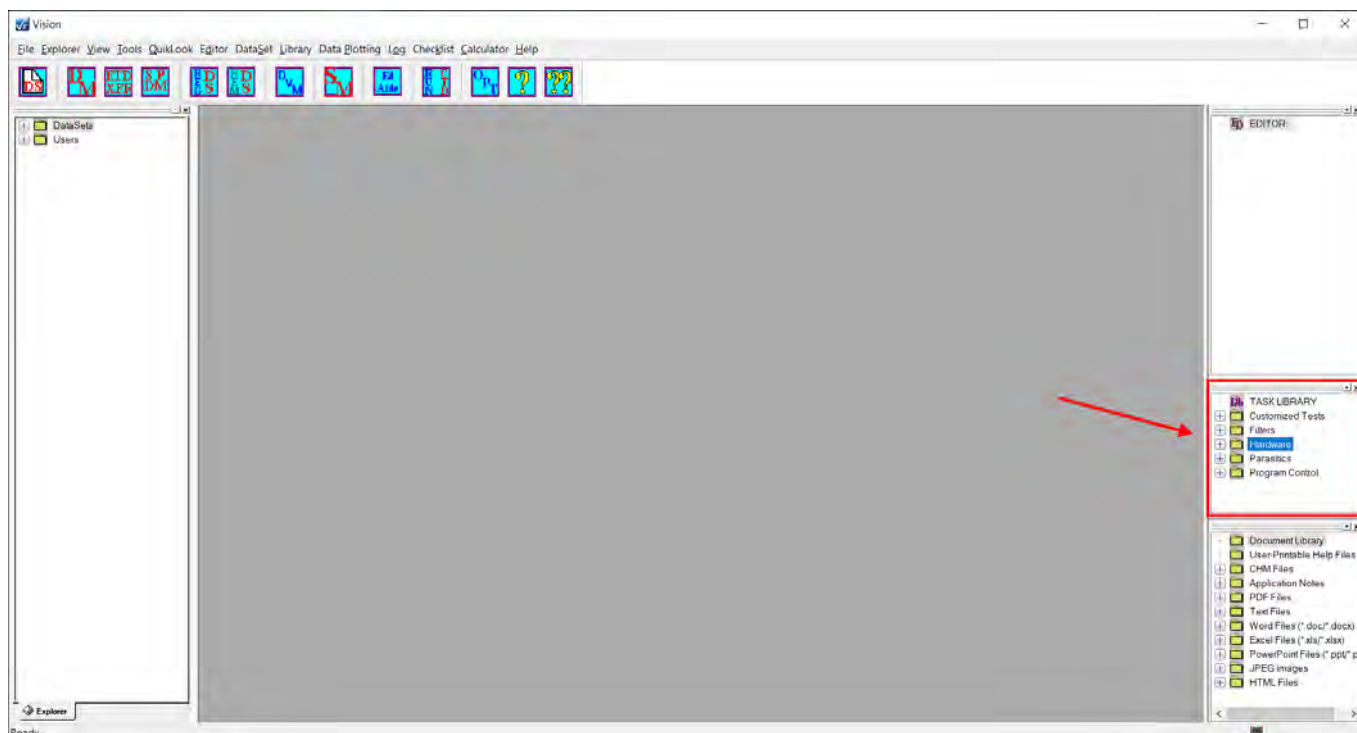


Fig. 3: The editor is located on the right-hand side of the Vision software.

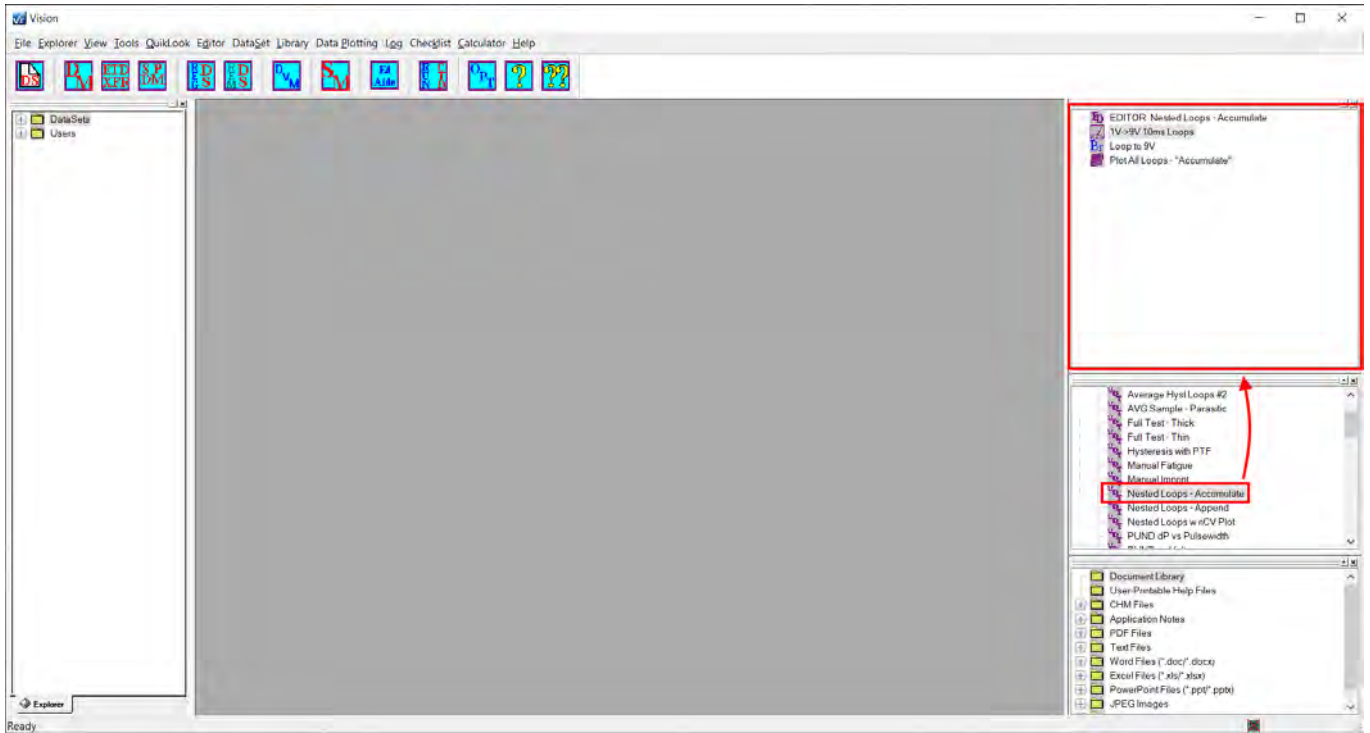


Fig. 4: Drag "Nested Loops - Accumulate" to the editor in order to prepare the hysteresis process.

5 Data Collection

5.1 Hysteresis Setup

Double click 1V→9V 10ms Loops. The window shown in Fig. 5 will open. This controls the settings for each individual hysteresis measurement.

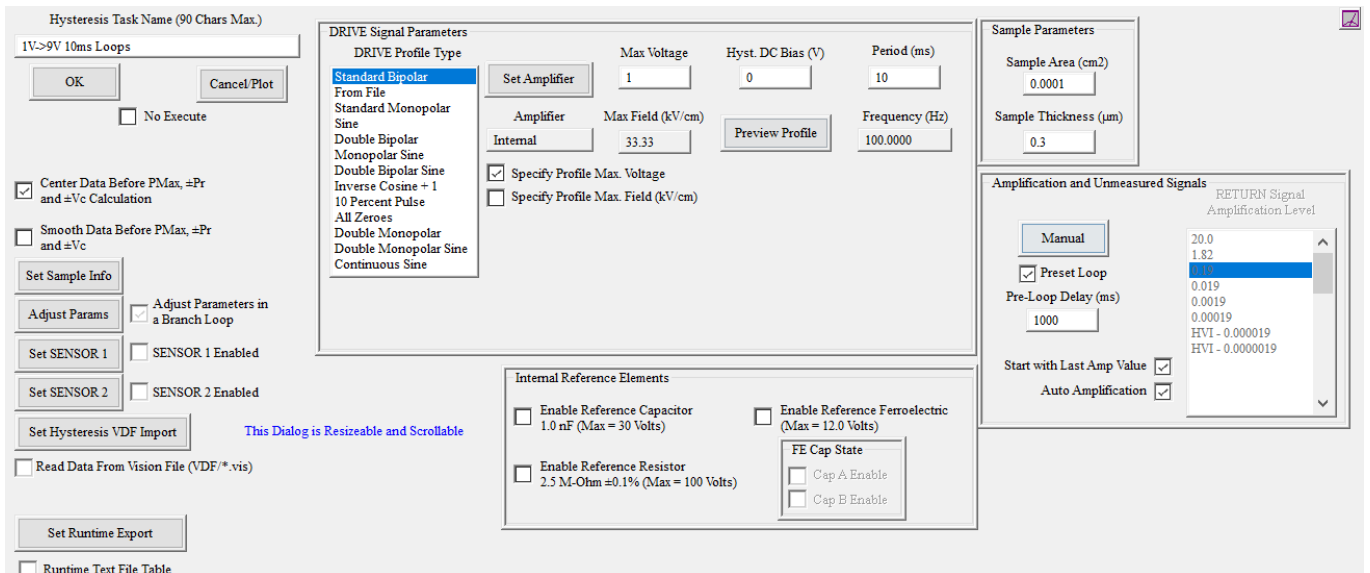


Fig. 5: When editing the hysteresis window, this window will open. It contains all the settings for each individual hysteresis measurement.

Ensure the below parameters have been set properly.

1. DRIVE Profile Type: Shape of the driving voltage. Standard Bipolar is the typical triangle wave.

2. Specify Profile Max Voltage or Max Field (kV/cm): If you specify max field, ensure sample thickness is entered correctly.
3. Max Voltage or Max Field. Enter maximum value. Can be negative to start wave in other direction.
4. Period (ms): Frequency is entered here as the period. Remember $f = 1/T$.
5. Sample Area (cm²): This will influence the polarization scale.
6. Sample Thickness (μm): This will allow measurements and graphing of data by electric field instead of voltage.
7. Preset Loop: Allows a pre-measurement hysteresis loop.
8. Auto Amplification: Amplifies return signal. Disable for more control over measurements, faster measurements, and to stop unrecorded signals before measurement. Disabling this may require testing to find proper amp level for each situation. RETURN Signal Amplification Level: Manually select amp level. Start at 0.19.

Rename Hysteresis Task Name to "Hysteresis Loop Settings" to clear up confusion later on. Press OK.

5.2 Branch Setup

Double click on Loop to 9V. This controls the looping function for hysteresis. Under Parameter to Compare, find Loop Counter and select it. Set Comparison to $<$ and Integer to , where is the intended cycle count. Make sure to set Branch Loop Limit to a value above . Rename Branch Task Name to Loop Counter or Loop to Cycles. Press OK.

5.3 Hysteresis Filter Setup

Double click on "Plot All Loops-"Accumulate". This controls the plotting function of the hysteresis measurements taken. Settings can be left default. By default, Vision will plot a centered polarization loop, P vs E loops. Can be changed to C vs V and more. Clicking on Plot Setup will allow editing of the title and axis before data collection and automatic plotting. When finished click OK.

5.4 Create New Dataset

Data can be collected in one dataset for one session, one sample, one measurement, or however sorting is preferred. Data is typically taken on a per-session per-specimen basis. These datasets can be appended or modified later. Click the New Dataset icon as shown in Fig. 6. The window shown in Fig. 7 will open and ask for inputs. Fill in required fields: Dataset Name, Dataset Path, and Experimenter Initials. By default, the path is under C:\Datasets\ Save your data under your PUID (email prefix).



Fig. 6: *The icon to start the process of creating a new data set.*

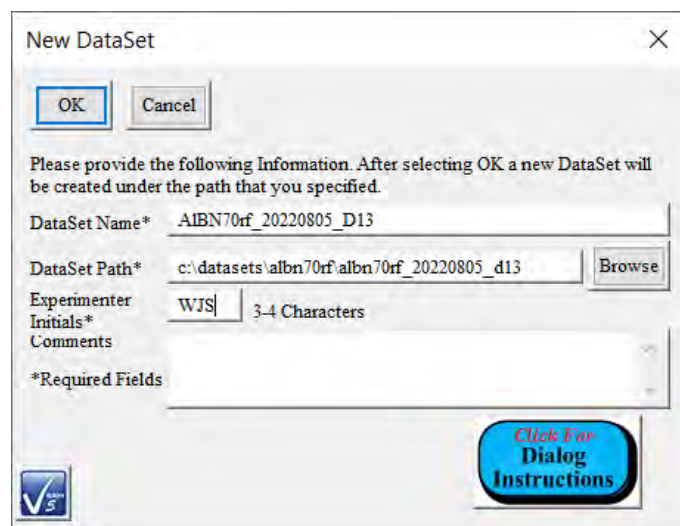


Fig. 7: The new DataSet prompt should be setup similar to this. The chip we are working with is AlBN 70rf on August 5th 2022, and the device is D13.

5.5 Drag Editor to Current Test Definition

The editor program is still in the editor, and will not run if you attempt to run the Test Definition. In order to get the program to run on the settings in the editor, right click EDITOR: Nested Loops Accumulate and select Test Definition to Current Dataset or click and drag the EDITOR: Nested Loops Accumulate to the Dataset in the explorer. A new prompt will open up asking to name the Current Test Definition (CTD). Name it. The program loop is now listed under the Dataset in the explorer. Notice that we see the Hysteresis Loop and the Loop to . This top program is the Current Test Definition and the program which will run in the next step.

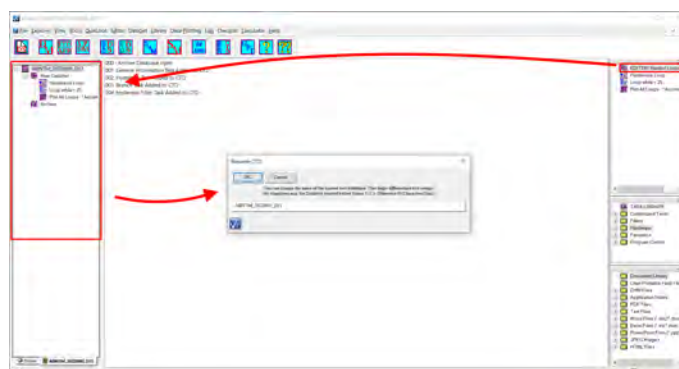


Fig. 8: The editor is in the top right. To move the program from edit to run mode, drag the EDITOR from the editor to the explorer on the left hand side. A window will pop up and ask you to name the Current Test Definition.

5.6 Run Current Test Definition

Click Run Current Test Definition (Fig. 9). A new window should appear which shows the experiment data running and collected. The task window will now fill with data and the loop counter will count up. Check to see if the data expected. If not, you can stop the current test by clicking the Stop Hysteresis button which appears in the top-left during each individual measurement.

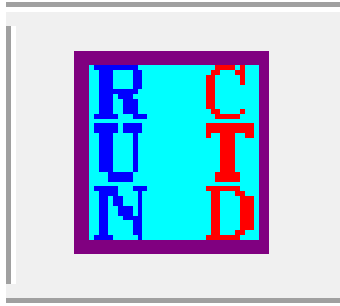


Fig. 9: *The icon to run the current editor loop.*

After running, the hysteresis curve will automatically plot with the settings set before by the Current Test Definition. To export the data, look ahead to the exporting section. Otherwise, close the plot window and continue to the next device and setup the next Current Test Definition. If you try to redo the measurement without loading the Current Test Definition from the editor window, the name of the current test in the archive will have the same name but a suffix of :1, :2, etc.

6 Archive and Exporting

6.1 Accessing Past Test Definitions

To access the archive, we must first make sure we open a Dataset. If one is not open, then find it through the library on the left. Once you've found the Dataset, double click it to open it. The top shows the last run Current Test Definition, while an Archive is shown below. Opening an archive shows all of the Test Definitions run on that Dataset. Opening the Test Definition and clicking Experiment Data tab and scrolling to the bottom will show the Plot function executed at the end of the test. Double click it to replot the data. Change settings as in the Plot All Loops-"Accumulate" and click OK. The data is plotted. Right clicking the plot will bring up plotting settings. Once complete with these settings, move on to exporting.

6.2 Exporting Data

When the plot is shown, right click it and select Export Dialog. A dialog window appears.

To export the graph as a picture, select PNG. Set Export Destination to File and select file location and name. Click Save. In the dialog window, chose Export Size and click Export. Graph is exported.

To export the graph as data points, select Text/Data. Set Export Destination to File and select file location and name. Click Export. Export Style to List (Table is more easily to manipulate in Excel, but List is used for Matlab data sorting). Click Export. Data is now exported.

7 Common Errors and What Do They Mean

1. Overvoltage of integrator output in either direction.

Typically, this error is caused by a failed device. Typically a region of oxidation can be seen after cycling. If this error persists, reduce the voltage/field through the material and test again to see if a capacitor-like response is still viable.

2. (-2) TIA output overvoltage in both directions This error's cause is unknown. It does, however, not occur immediately. This error is caused later in cycling, and may be caused by breakdown of the material. (unconfirmed)
3. Polarization = 0 for every cycle This error is most likely an open circuit on the return probe. Try moving the probe to see if this resolves issue

8 Edit History

Documentation history, with the most recent at the top.

May 9th, 2023: Changed outline to match other Specere documentation. Reduced specifics for general use. Added device limitations section. Updated for current knowledge.

August 8th, 2022: Added errors section and modified wordings.

August 2nd, 2022: Document Written for single Specere personal and experiment specific performance.

References