Microvue

Wavevue Measurement Studio

User's Guide
IV Measurement Module

Microvue, Inc.
73 Princeton Street, North Chelmsford, Massachusetts 01863
Telephone: (978) 251-0456 • Fax: (978) 926-0514
Email: support@microvueinc.com • www.microvueinc.com

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Microvue, Inc.
73 Princeton Street, Suite 308
North Chelmsford, MA 01863 USA
Tel: (978) 251-0456
Fax: (978)-926-0514

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CHAPTER

1 Introduction

What is the User's Guide?

The User's Guide is part of the overall Wavevue manual set illustrated below. Its purpose is to introduce some basic IV measurement theory and to introduce the user to the interface components associated with the IV measurement module. Some of these will be shared with other measurement modules and some will be unique to the IV module. Refer to the Application Level User's Guide and Reference Guide for more detailed information on application level Wavevue functionality.

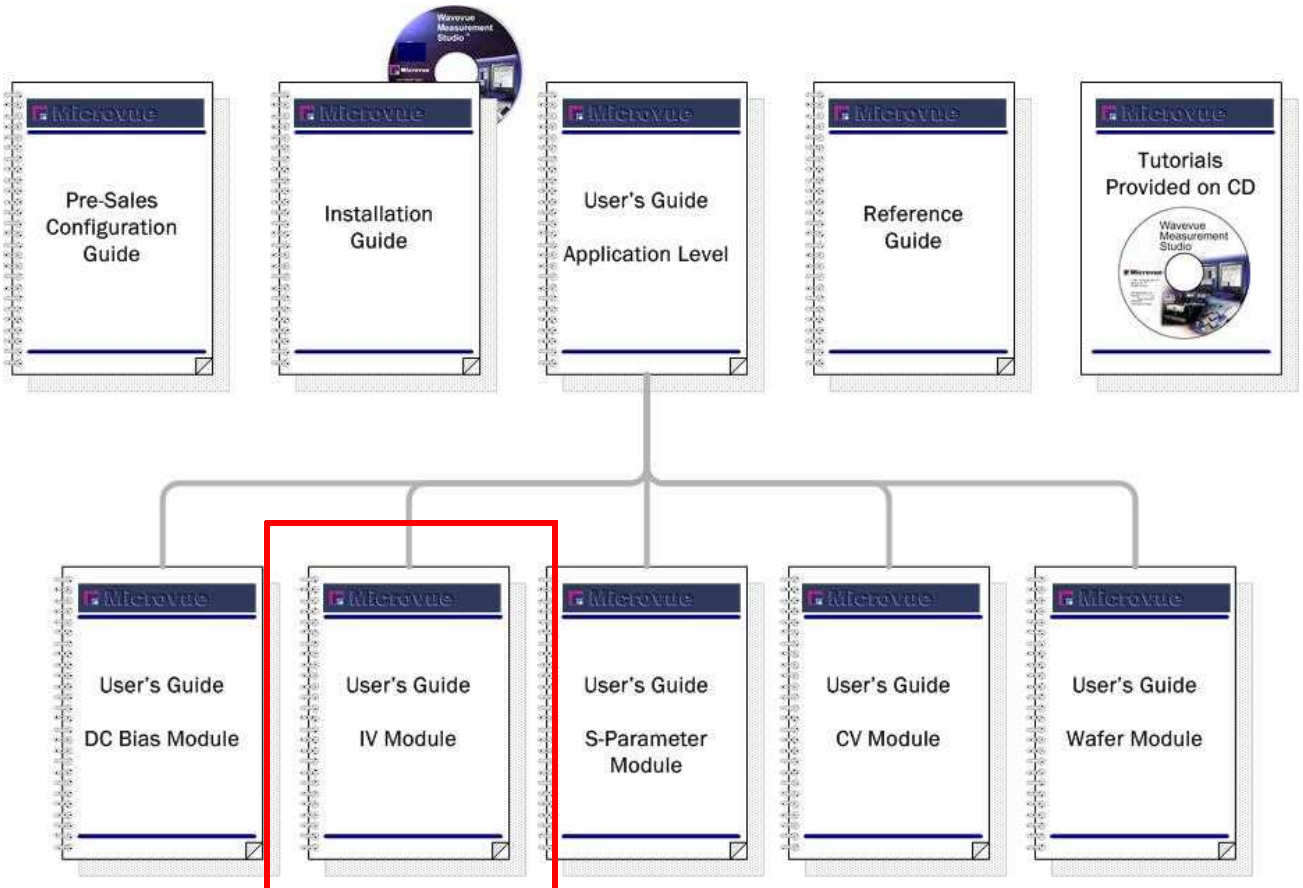


Figure 1. Manual Set Overview

Who should read the User's Guide?

The User's Guide is intended to be used by engineers setting up IV measurement projects and also by test personnel who will be running IV tests. You should be familiar with the material in the Application Level User's Guide before reading this guide. Prior experience with device handling and IV measurements will also be helpful.

What will I learn from the User's Guide?

The User's Guide will cover the following topics related to the IV Measurement module.

Table 1. User's Guide Overview

Chapter	Title	Description
2	Measurement Theory	• IV Measurement overview • IV Measurement feature set • IV Measurement block diagrams • IV Measurement data • IV Measurement definitions and equations
3	Understanding the IV Module Interfaces	• Instrument Setup • Device Setup • Connection Setup • Measurement Setup • Script Setup • Report Setup
4	Making IV Measurements	• Starting from a Standard Project • Starting a New Project • Additional Tutorials
5	Exporting Data to CAD Applications	• ICCAP • ADS

Where do I go from here?

Once you are comfortable with the material presented in this guide, you should be ready to begin making IV measurements. Refer to the Application Level User's Guide or Reference Guide if you need additional information about setting up reports or exporting data.

Notational Conventions

Throughout this manual, various symbols will be used to identify important information that may affect software operation, user safety, or device safety. This manual uses the following convention:

Table 2. Notational Conventions

Symbol	Description of Symbol
 WARNING	WARNING is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.
 DANGER	DANGER is used to indicate the presence of a hazard that will cause severe personal injury, death, or substantial property damage if the warning is ignored. This includes situations that ***may*** cause damage to hardware via electrostatic discharge (ESD).
 CAUTION	CAUTION is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.
 NOTE	NOTE is used to indicate important information about the product that is not hazard related. This might include useful tips regarding ease of use or possible errors.
 WWW	The symbol indicates a World Wide Web address.

Manual Conventions

- Throughout the manual set, the words Window, Screen and Form may be used interchangeably to refer to the depiction of a user interface. Unless otherwise noted, there is no difference between these terms.
- The following format is used throughout the manual set to indicate the sequence of menu navigation, where each ">" indicates another menu level:
  Configure > Instruments

CHAPTER

2 Measurement Theory

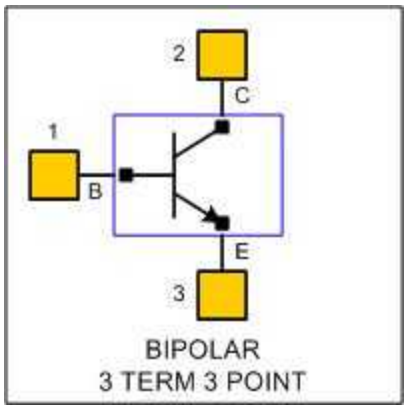
This chapter introduces some basic IV measurement concepts as they apply to Wavevue. It is not intended to be a comprehensive tutorial on IV measurements, but simply to make you familiar with terminology as it is used in Wavevue. You will first be introduced to the measurements on a purely theoretical level. Then you will see how the Wavevue IV module is configured to allow you to realize all of these different measurements, and any other IV measurement you may need.

IV measurement overview

Following is an introduction to some typical measurements that can be made with the IV module, although the list is far from all-inclusive. The device block diagrams shown are the bitmap files supplied with the standard Wavevue device definitions. The sample plots are all generated in Wavevue from actual measured data.

Common Emitter IV curves

This measurement is commonly made to get a general overview of the performance of bipolar transistors.



Terminal	Setup
Base	Force: current -- sweep from 0 to Ib-max Measure: voltage Loop order: outer
Collector	Force: voltage -- sweep from 0 to Vc-max Measure: current Loop order: inner
Emitter	Force: voltage -- fixed 0V (ground) Measure: none

The measurement is made by setting a series of Base current values while sweeping Collector voltage. The Emitter is maintained at ground potential. The result is a family of curves similar to the ones shown below.

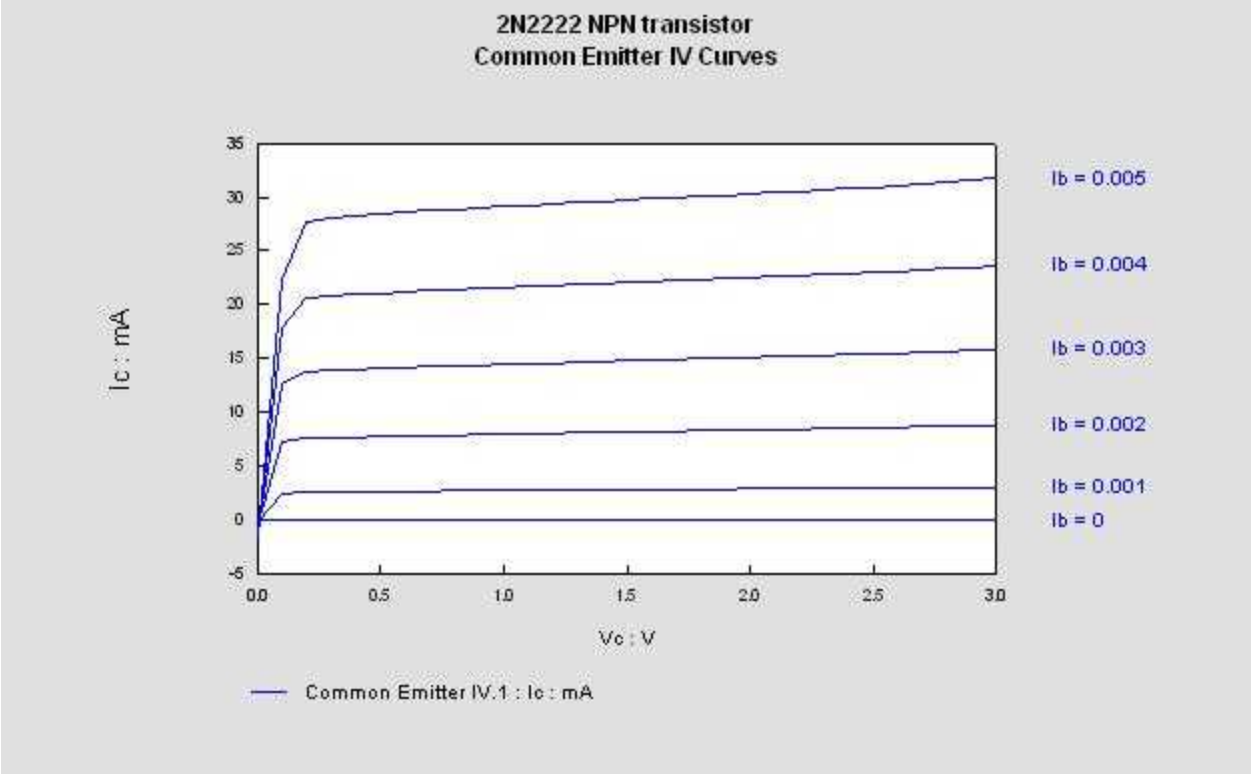
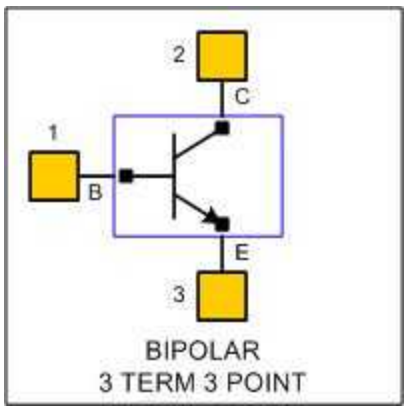


Figure 2. Common Emitter IV curves results

Base-Emitter forward diode curve

This measurement determines the forward diode characteristics of the Base-Emitter junction of a bipolar transistor.



Terminal	Setup
Base	Force: voltage -- sweep from 0 to 1 V Measure: current Loop order: inner
Collector	Force: none Measure: voltage (high impedance state)
Emitter	Force: voltage -- fixed 0V (ground) Measure: none

The measurement is made by sweeping Base voltage. The Collector is disconnected and the Emitter is maintained at ground potential. The result is a curve similar to the one shown below.

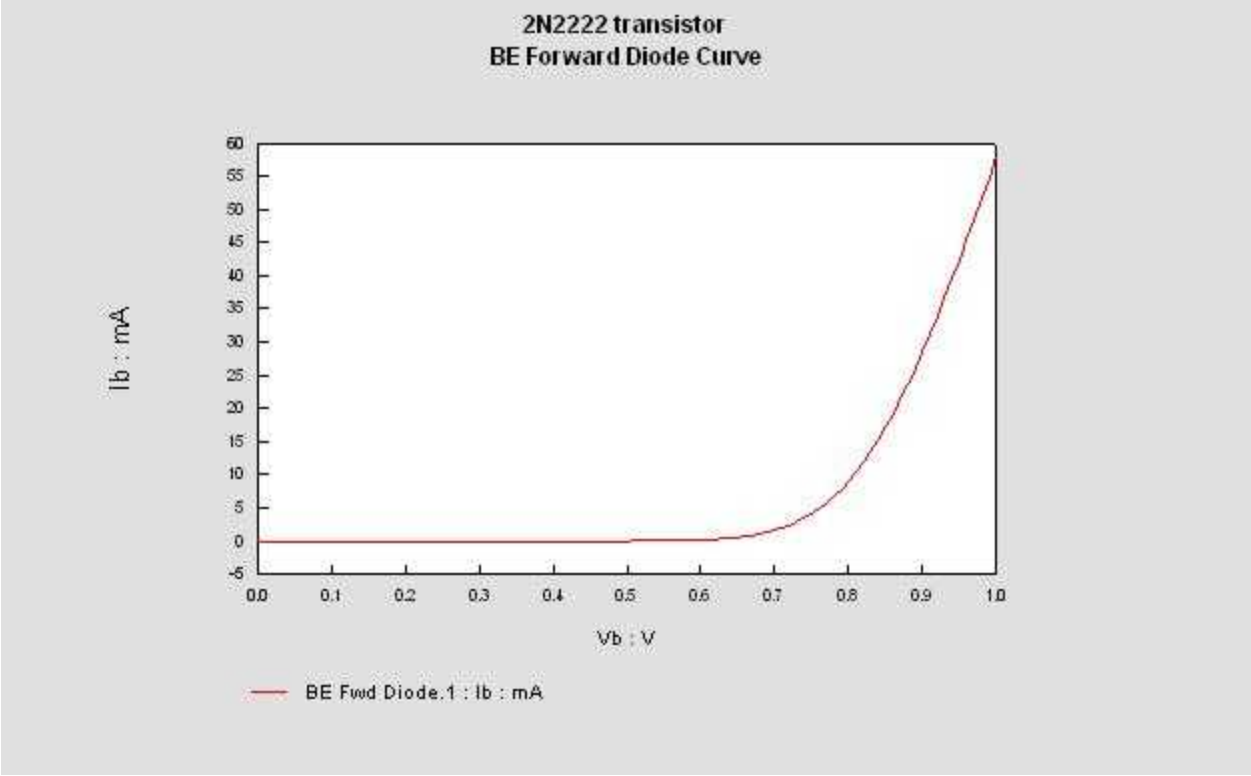
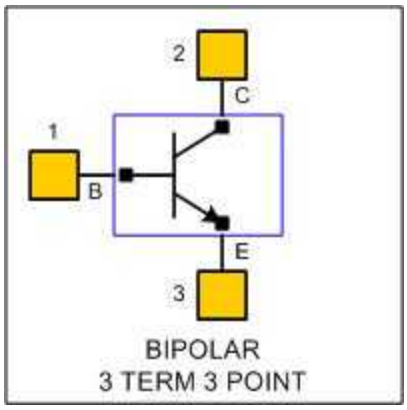


Figure 3. Base-Emitter forward diode curve results

Base-Collector reverse diode curve

This measurement determines the reverse diode characteristics of the Base-Collector junction of a bipolar transistor.



Terminal	Setup
Base	Force: voltage -- sweep from 0 to -10 V Measure: current Loop order: inner
Collector	Force: voltage -- fixed 0V (ground) Measure: none
Emitter	Force: none Measure: voltage (high impedance state)

The measurement is made by sweeping Base voltage. The Emitter disconnected and the Collector is maintained at ground potential. The result is a curve similar to the one shown below. Note that the compliance of the Base channel was set to 10uA to protect the device from damage.

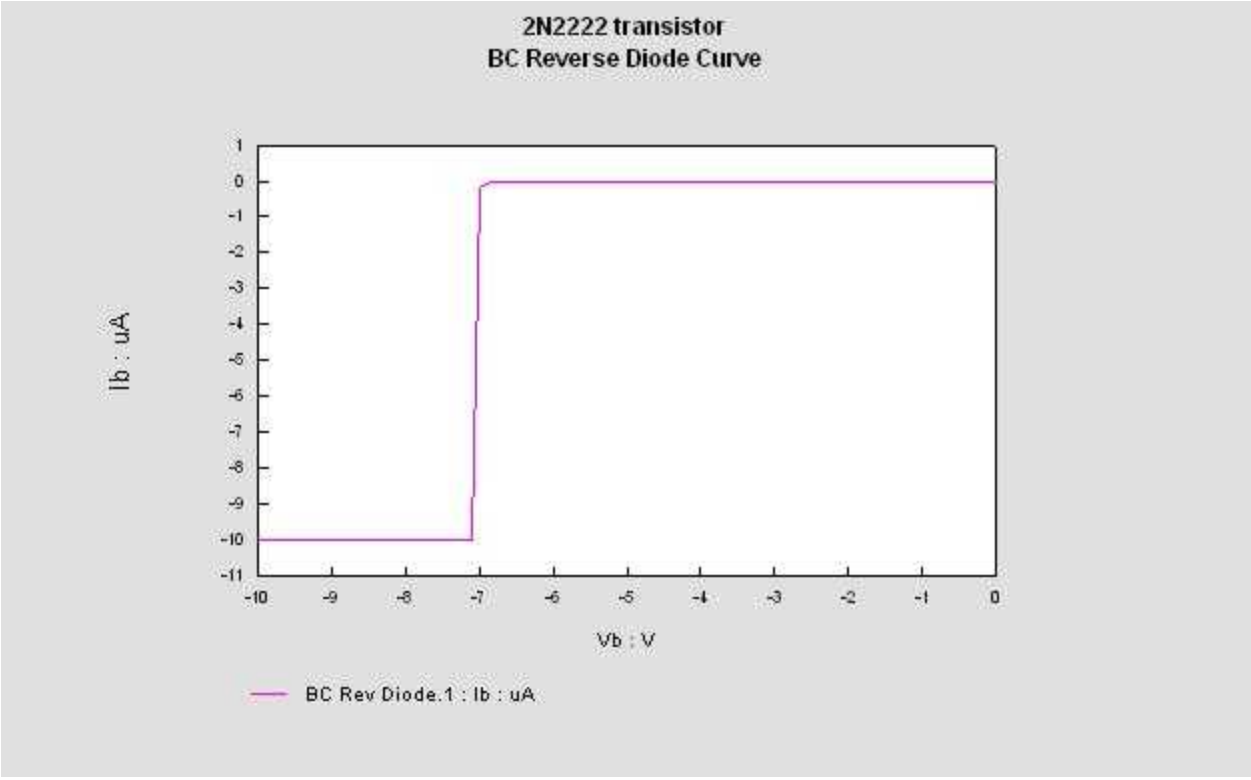
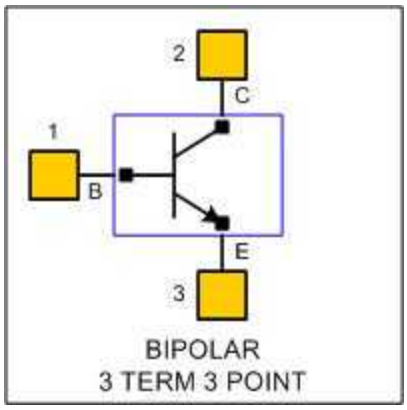


Figure 4. Base-Collector reverse diode curve results

Constant Base-Collector forward voltage Gummel

This measurement characterizes the current gain of a bipolar transistor over a broad dynamic range.



Terminal	Setup
Base	Force: voltage -- sweep from 0 to 1 V Measure: current Loop order: inner
Collector	Force: voltage -- sweep from 0 to 1 V Measure: current Loop order: synchronize with Base sweep
Emitter	Force: voltage -- fixed 0V (ground) Measure: none

The measurement is made by sweeping both the Base and Collector voltages together to maintain a constant voltage across the Base-Collector junction. The Emitter is maintained at ground potential. The result is normally plotted on a log scale as shown below. Note that the sample shown does not exhibit ideal behavior and that the curves typically do not cross.

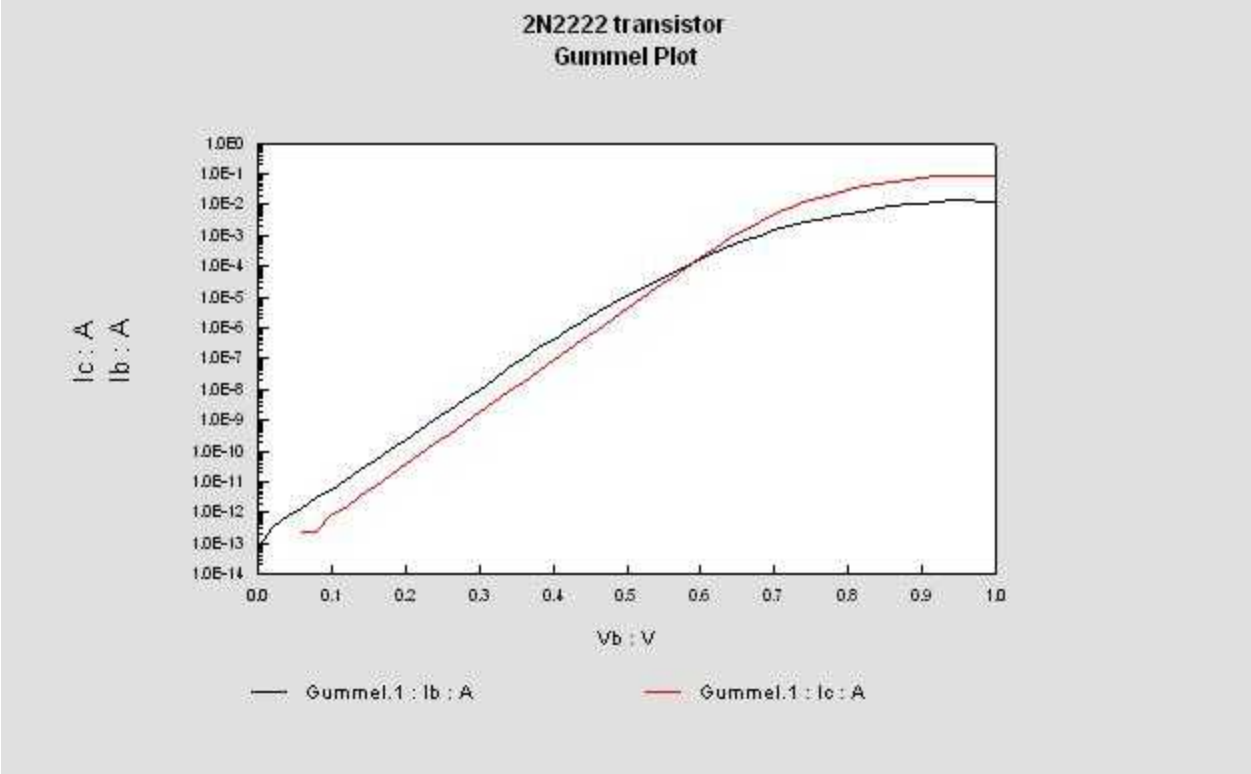
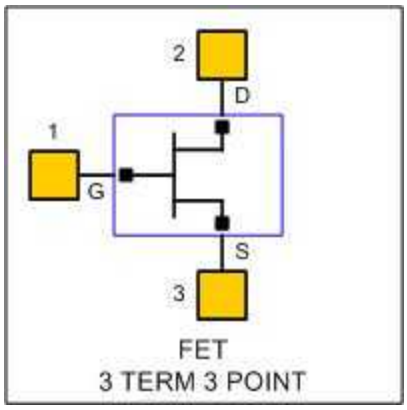


Figure 5. Constant Base-Collector forward voltage Gummel results

Common Source IV curves

This measurement is commonly made to get a general overview of the performance of field effect transistors (FETs).



Terminal	Setup
Gate	Force: voltage -- sweep from Vg-min to 0 Measure: current Loop order: outer
Drain	Force: voltage -- sweep from 0 to Vd-max Measure: current Loop order: inner
Source	Force: voltage -- fixed 0V (ground) Measure: none

The measurement is made by setting a series of Gate voltage values while sweeping Drain voltage. The Source is maintained at ground potential. The result is a family of curves similar to the ones shown below.

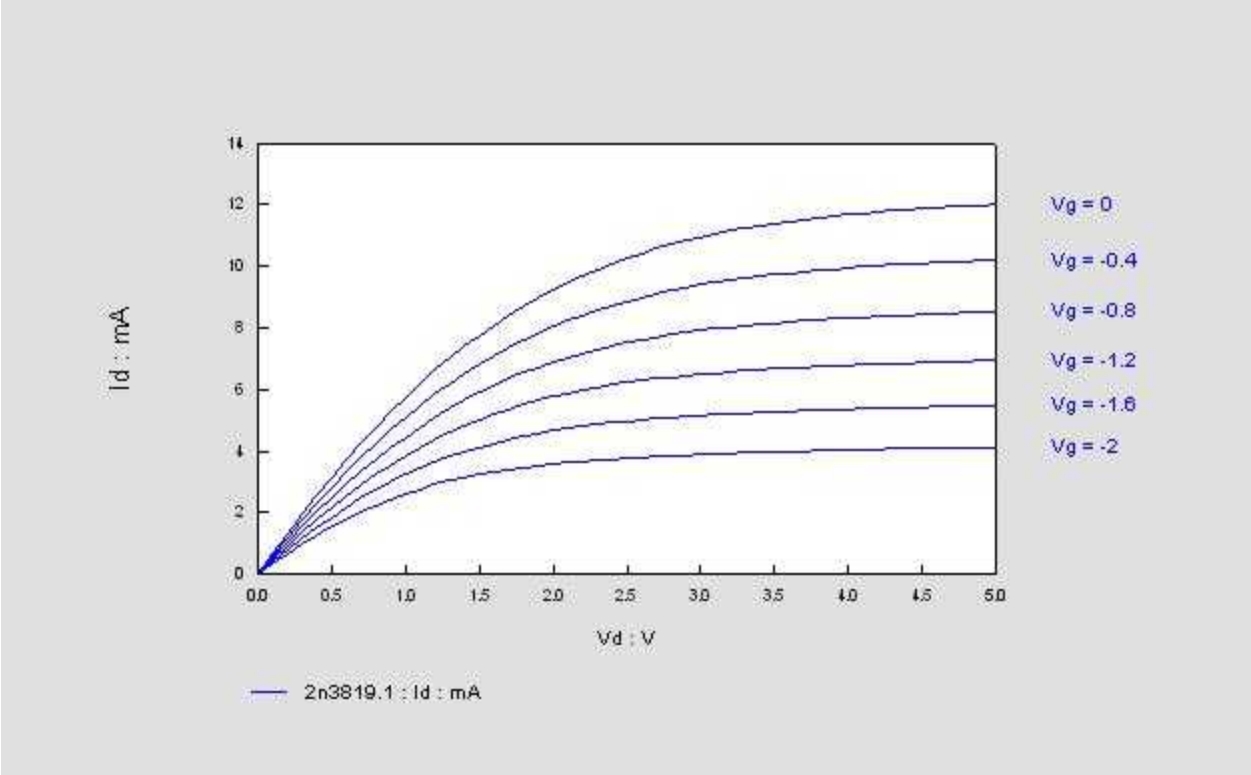
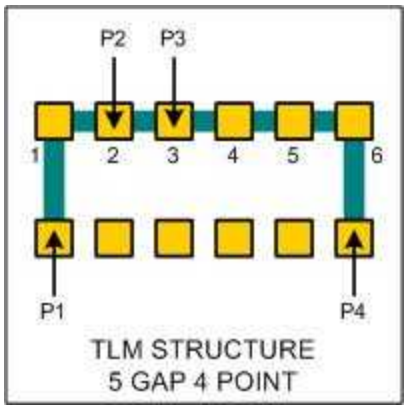


Figure 6. Common Source IV Curves results

Resistor Ladder measurement

This measurement is commonly made to determine the properties of printed resistors and bulk resistive materials



Terminal	Setup
P1	Force: current -- sweep from -1 to 1mA Measure: none Loop order: inner
P2	Force: none Measure: voltage
P3	Force: none Measure: voltage
P4	Force: voltage -- fixed 0V (ground) Measure: none

For each resistor "gap", several current values are set and the corresponding voltages are measured at P2 and P3 from the figure below. The voltage drop across the resistor is then calculated as: Vgap = |V3 – V2|. The Vgap values are then plotted vs. current and Rgap is calculated as the slope of a best-fit line.

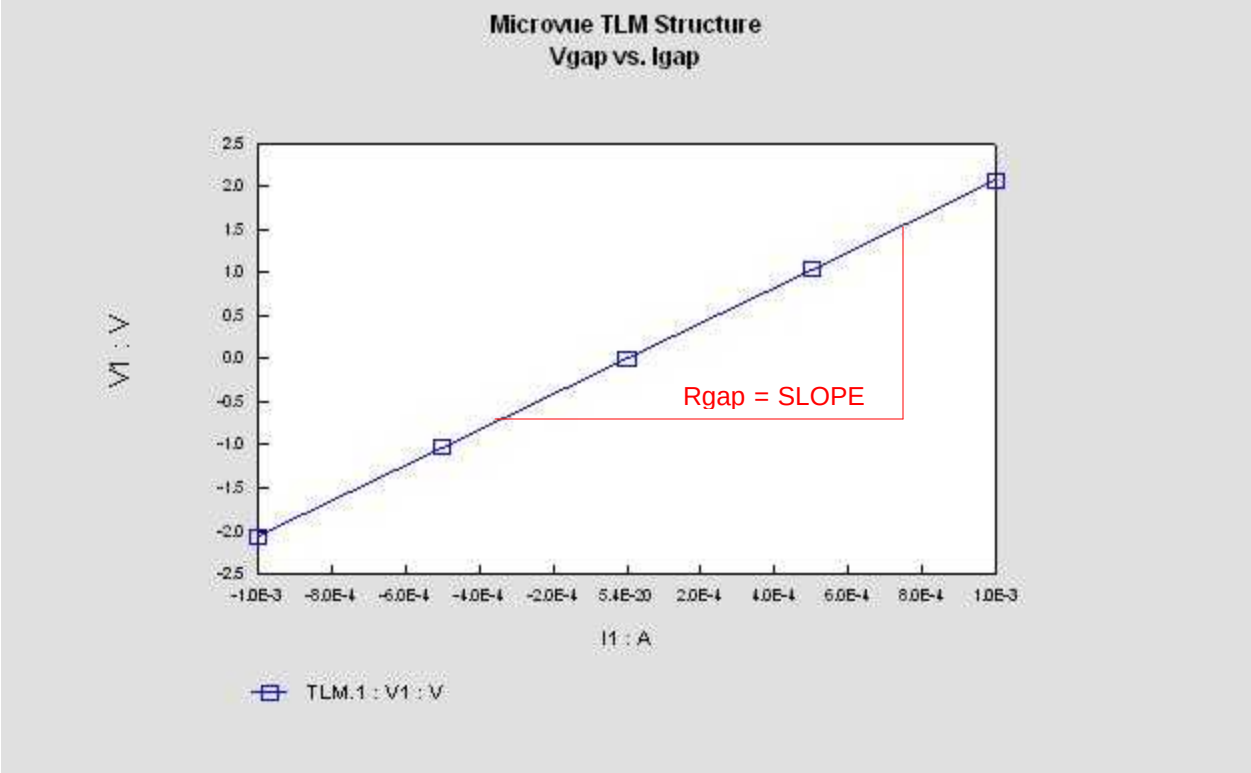


Figure 7. Transmission Line Measurement V vs. I results

The "squares" is then calculated for each gap as: Squares = Gap Length / Gap Width. The Rgap value for each gap is then plotted against the gap squares and several calculations are made from the resulting plot, shown below.

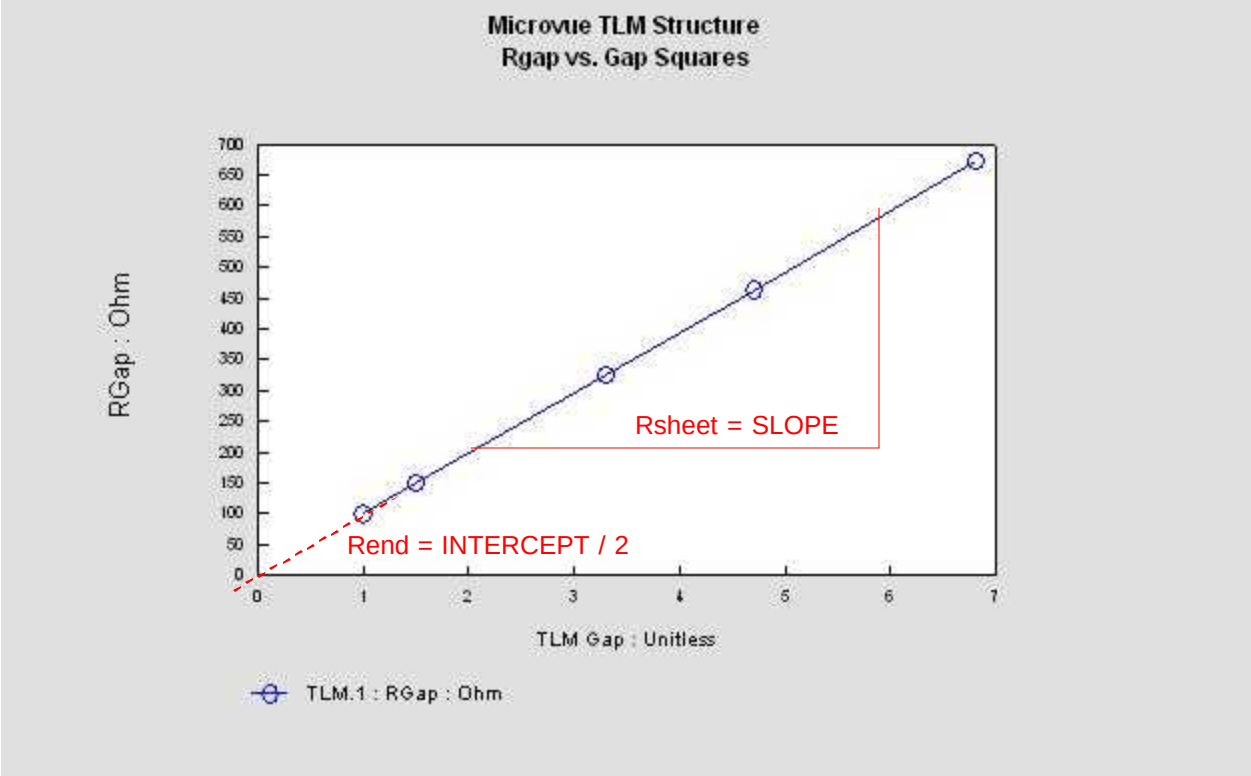


Figure 8. Transmission Line Measurement Rgap vs. gap squares results

A line fit to the Rgap values vs. gap squares gives you two of the calculated parameters. Rsheet is the slope of the line. Rend is half the y-intercept of the line (since the end resistance is assumed to be evenly distributed between the two ends of the resistor material). There are two additional parameters calculated from these results:

$$Rspec = \frac{(Rend * Gap\ Width^{*}) \wedge 2}{Rsheet}$$

$$Rc = Rend * Gap\ Width^{**}$$

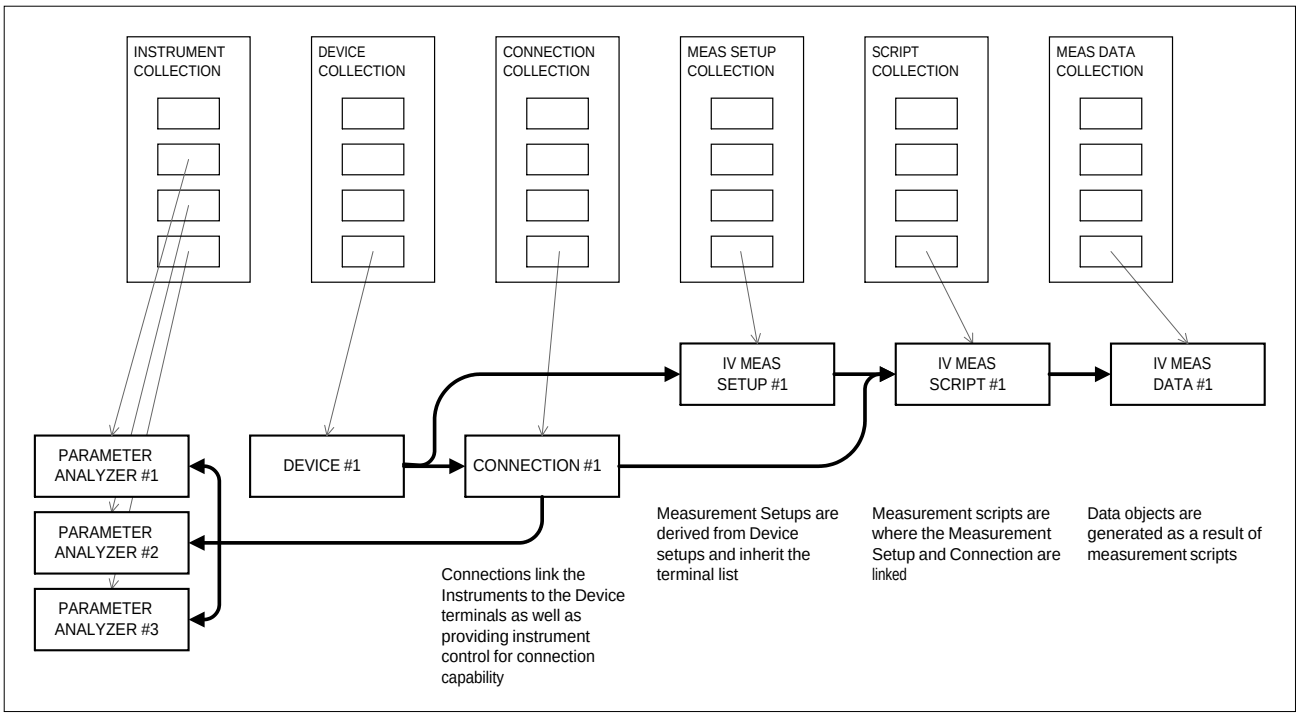
* Rspec is calculated for Gap Width measured in cm, and all gaps are assumed to be the same width
** Rc is calculated for Gap Width measured in mm

IV measurement feature set

Wavevue is an object-oriented program. It makes use of objects such as instruments, measurement setups, data objects, etc. These objects are managed by Collections, which are simply a container to organize related objects. Wavevue contains a number of these collections including the instrument collection, calibration setup collection, measurement collection, etc. You don't have to concern yourself overly with object management, as Wavevue handles the majority of it transparently to you.

Minimum project example

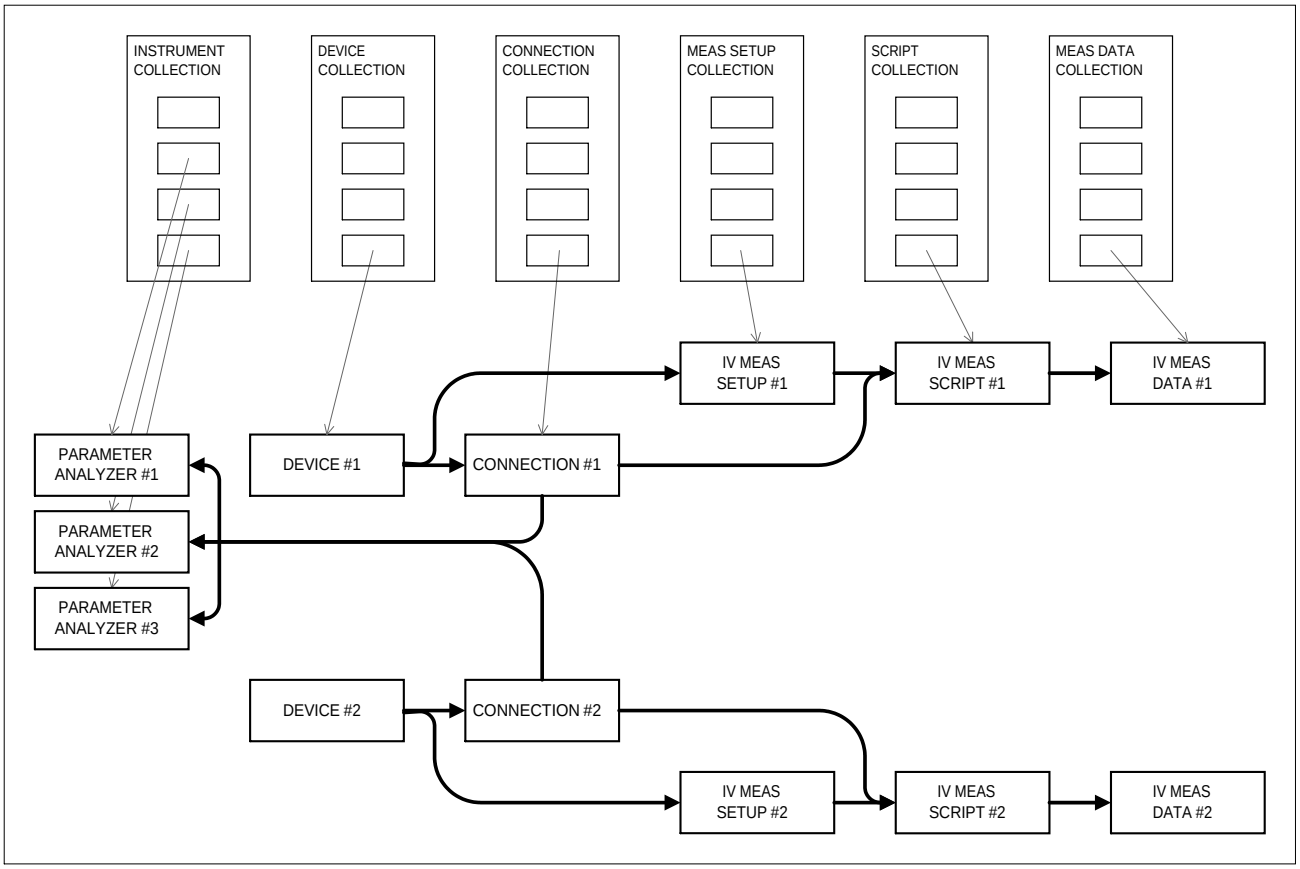
Making IV measurements requires a project consisting of the following at an absolute minimum: several Parameter Analyzer instruments, a Device setup, a Connection setup, an IV measurement setup, and an IV measurement script. The figure below illustrates all of these objects and how they are linked to each other and interact.



IV measurement projects differ from most other Wavevue measurements because Device and Connection setups are required. They are optional for most other measurements. <fill in more information here>. They do add what seems to be an unnecessary level of abstraction until you consider a more complicated scenario like the one depicted in the next section.

Complex project example

You are by no means limited to a single set of Parameter Analyzer instrument, or a single device setup, connection setup, or measurement setup in a Wavevue project. You can create multiple devices and have multiple measurements for each one. Some IV measurements, such as resistor ladders require multiple connection setups per measurement script. Although not illustrated in the figure below, you can have multiple test scripts for each measurement setup. Examples of this would be single device scripts and wafer-walking scripts for the same measurement. This kind of versatility is only possible because of the generic way that Wavevue handles all of its objects.



Instruments

The IV Measurement module includes a class of instruments previously unused by Wavevue – Parameter Analyzers. These multi-channel source-monitor units are designed for high speed measurement capability. The IV module supports the advanced features of these instruments which greatly enhance measurement speed and flexibility compared to the basic DC Curves capabilities of the DC Bias measurement module. In order to provide the ultimate configuration flexibility, Wavevue treats each channel of a Parameter Analyzer as a separate instrument object. This allows them to be mixed and matched as required to meet the power requirements of the device under test.

In most cases, a single multi-channel Parameter Analyzer will be used to make the IV measurements. This configuration is the most efficient because Wavevue can delegate all of the sequencing and timing functions to the Parameter Analyzer internal firmware. However, there will be rare cases where a single Parameter Analyzer cannot provide enough outputs, or does not meet the current or voltage requirements of the device. In this case, multiple Parameter Analyzers or a combination of Parameter Analyzers and DC Power Supplies may be used to measure the device. Since Wavevue cannot rely on the different instruments to synchronize correctly, all of the sequencing and timing functions are then handled within Wavevue. This results in significantly slower measurements, as even the sophisticated Parameter Analyzers are reduced to acting as simple DC Power Supplies.

Devices

The starting point for any Wavevue IV measurement is a device. Wavevue provides a good selection of pre-defined devices for you to work with. The list includes:

- Amplifiers, 1 and 2 stage
- Arbitrary devices, 1 and 2 port
- Bipolar transistors, full terminal access and common emitter
- Capacitors
- Diodes
- Field Effect Transistors, full terminal access and common source
- Inductors
- Resistors
- Resistor Ladders

Most devices are available in both single-pad and dual-pad Kelvin versions. You are also free to add your own custom devices if none of the pre-defined ones suit your needs. The parameters for Wavevue device objects include the terminal count and the names of the device terminals. In addition, some device objects include custom parameters which vary with the device type. Examples of custom device properties would be the resistor count and the dimensions of each resistor element in a resistor ladder.

Connections

Connection setups provide the linkage between instrument channels and device terminals. There are two aspects to IV measurement connection setups. The "bindings" aspect of a connection setup specifies which Parameter Analyzer channel is used to test each terminal of a device. This is only a virtual connection, however. The "connection commands" aspect specifies switch matrix and other instrument control commands to actually create the physical equivalent of the virtual binding. In addition, operator prompts and instrument or device settling times may be specified in the connection commands section.

Measurement Setups

Each IV measurement setup is linked to a device setup. This linkage is required to specify the number of terminals which need to be configured. Wavevue makes no other inferences about how the measurement should be set up based on the device type, however. Each active terminal of a device is set up independently, allowing for maximum flexibility. IV Measurement setups are independent of the model of Parameter Analyzer used to perform the measurements. This allows the same setup to be used on multiple test setups and configurations, which insures consistent measurement technique throughout a test lab. There is a large variety of setup options for each device terminal including force mode, sweep type, measurement type, measurement range, compliance limit, power compliance limit, turn-on order, etc. In theory, there is no fixed limit on the number of terminals an IV device can have in Wavevue. In practice, however, anything more than four can become impractical. Most Parameter Analyzers provide four source-monitor channels, and as mentioned previously, Wavevue is most efficient when a single Parameter Analyzer is being used for all of the device terminals.

Scripts

The IV measurement script is where many of these setup objects are finally tied together. IV measurement scripts follow the same pattern as other Wavevue measurement scripts where they specify a Setup object and Data object. There are some unique aspects to IV measurement scripts, however. One is that they require a Connection object to be specified. Connection setups are optional with most other Wavevue measurements, but since they perform the binding function for IV measurements, they are mandatory. Some types of IV measurement scripts can also contain multiple Connection setups, and actually change the connection configuration during the measurement. Examples of this type of measurement would be resistor ladder measurements. And the final unique feature of IV measurement scripts is that they are never automatically generated by Wavevue, regardless of the User Preference setting. This is because Wavevue has no good way to guess the correct Connection object for a particular IV Measurement setup object.

IV measurement block diagrams

Wavevue supports a wide variety of IV measurement configurations. Examples of some typical configurations are shown in the sections below. The examples are not all-inclusive, and multiple Parameter Analyzers can also be used and RF/DC hybrid measurement setups can also be realized.

Direct connection to device

The simplest IV measurement setup involves using a single Parameter Analyzer and directly connecting to the device. This could either be a device in a test fixture with triax or coax connectors, or Kelvin probes on a prober directly connected to the Parameter Analyzer cables. The connection setups for this configuration would only contain binding information and would not require any instrument commands to implement the connections.

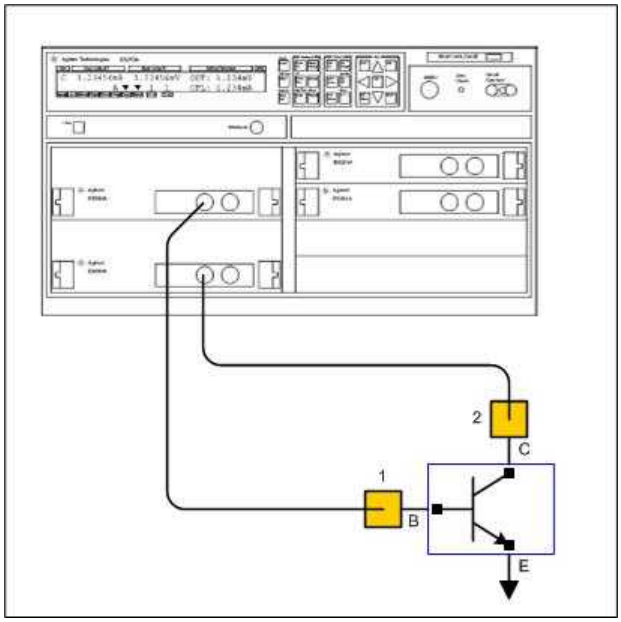


Figure 9. Direct connection block diagram

Connection via switch matrix

A more typical IV measurement setup involves using a switch matrix to route the signals to the device under test. Many companies elect to implement a standard pad pattern on all of their devices, which allows a single probe card to be used to test a wide variety of devices. This configuration greatly increases test throughput, since the probe card and measurement setup don't need to be re-configured for every new wafer to be tested. Connection setups for this configuration would include switch matrix control commands.

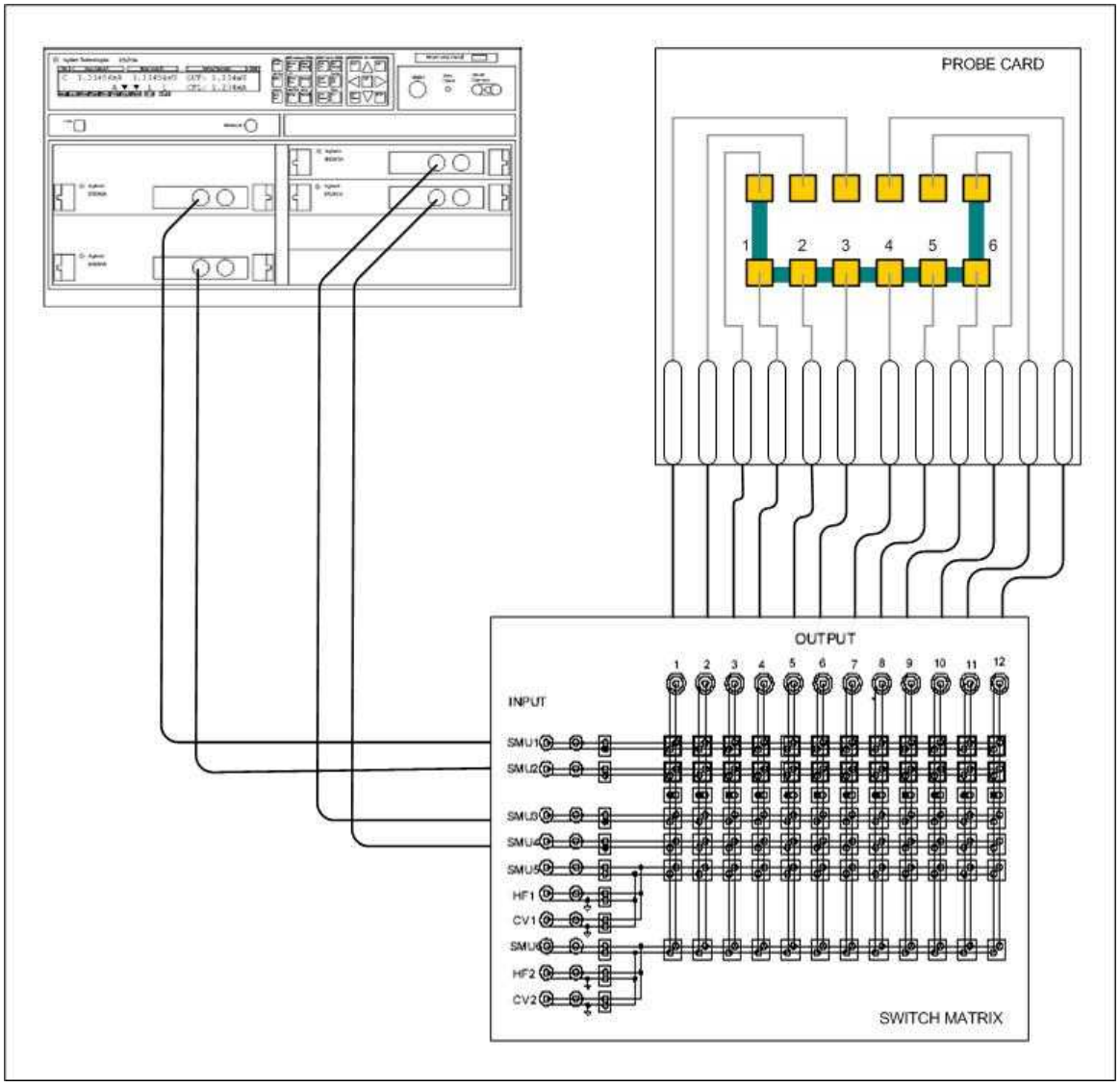


Figure 10. Connection via switch matrix block diagram

IV measurement data

As with all Wavevue measurement data, IV data is stored in generic data objects. Wavevue data objects are subdivided into a few major sections, including Stimuli, Responses, and Tag Data. They are described further in the table below

Table 3. Wavevue Data Object Overview

Category	Description
Stimulus	• Independent test data • Instrument settings which produce the response in the device under test • Inherited from measurement setup objects, not measured • Generally available as X-axis data for plots • Normally stored in fundamental units, but can be converted as needed for reports

Response	• Dependent test data
	• Read from the test instruments
	• Normally changes as a function of the stimulus values
	• Exists as an n-dimensional array, where n = the number of stimuli
	• Generally available as Y-axis data for plots
	• Normally stored in fundamental units, but can be converted as needed for reports
	• Two types of responses exist:
	  ○ Direct Responses are read from the test instruments and physically stored in the data object
	  ○ Indirect Responses are calculated from Stimuli and Direct Responses and aren't actually stored in the data object. Only the definition is stored and the value is calculated in real-time when needed.

Tag Data	• Independent test data
	• Doesn't change as a function of the stimulus values
	• Exists as single values, not as n-dimensional arrays
	• Generally available as notes for single data object plots, or as X-axis data for cross-data object plots
	• Stored as text, so cannot be converted to other units for reporting
	• 4 major categories:
	  ○ Measurement Info (part number, lot, process step, etc.)
	  ○ System Variables (operator, start time/date, end time/date, etc.)
	  ○ Environment Info (DC bias settings, wafer reticle, test temperature, etc.)
	  ○ Measurement specific values (Rsheet, Rend, Ftau, etc.)

IV measurement stimuli

The table below summarizes the Stimulus data available in IV measurement objects. All stimuli are stored in fundamental units, but can be converted to any other necessary units for reporting by the data object.

Table 4. IV Measurement data stimuli

Stimulus	Notes
TLM gap	• TLM devices only • Stored as unitless "squares"
VIA try	• VIA devices only • Stored as unitless "tries"
<Vterminal>	• Voltage settings for any terminals with "Voltage" as their force mode • Name varies and is inherited from the IV measurement setup • Several voltage stimuli may exist in the data object • Stored as volts
<Iterminal>	• Current settings for any terminals with "Current" as their force mode • Name varies and is inherited from the IV measurement setup • Several current stimuli may exist in the data object • Stored as amperes

IV measurement responses

The tables below summarize the Direct and Indirect Response data available in IV measurement objects. All responses are stored in fundamental units, but can be converted to any other necessary units for reporting by the data object.

Table 5. IV Measurement data direct responses

Direct Response	Notes
<Vterminal>	• Voltage readings for any terminals with "Voltage" as their read mode • Name varies and is inherited from the IV measurement setup • Several voltage responses may exist in the data object • Stored as volts
<Iterminal>	• Current readings for any terminals with "Current" as their read mode • Name varies and is inherited from the IV measurement setup • Several current responses may exist in the data object • Stored as amperes
Vgap	• TLM and VIA devices only • Stored as volts

Table 6. IV Measurement data indirect responses

Indirect Response	Notes
<Rterminal>	• Resistance for any terminals with both voltage and current available • Name varies and is inherited from the IV measurement setup • Several resistance responses may exist in the data object • Stored as ohms
Rgap	• TLM and VIA devices only • Stored as ohms
Beta	• Bipolar transistors only • Only if both Ib and Ic are available in the data object • Stored as unitless
Gm	• FET devices only • Only if both Vg and Id are available in the data object • Only if there are at least 5 Vg values measured • Stored as unitless

IV measurement tag data

The tables below summarize the Tag data available in IV measurement objects. Tag data is generally single-value and cannot be converted to non-fundamental units. There are tag data items that are IV Measurement specific and those that are potentially available in any Wavevue measurement data object.

Table 7. IV Measurement specific data tag data

Tag Data Item	Notes
Rsheet	• TLM devices only • Sheet resistance of printed resistor material • Stored as text in ohm/sq, cannot be converted
Rend	• TLM devices only • End resistance of printed resistor material • Stored as text in ohm, cannot be converted
Rspec	• TLM devices only • ??? resistance of printed resistor material • Stored as text in ohm-cm^2, cannot be converted
Rc	• TLM devices only • ??? resistance of printed resistor material • Stored as text in ohm-mm, cannot be converted
Rvia	• VIA devices only • Resistance of vias between layers • Stored as text in ohm, cannot be converted

Table 8. Generic Wavevue data tag data

Tag Data Item	Notes
<meas info>	• User-defined information entered prior to running scripts • Names and values vary • Number of items varies
TestStartDate	• Stored in MM/DD/YYYY format
TestStartTime	• Stored in HH/MM/SS format
TestEndDate	• Stored in MM/DD/YYYY format
TestEndTime	• Stored in HH/MM/SS format
WaferReticle	• Only if in a For Each Reticle script loop • Stored as text, "(Row,Col)"
WaferSubsite	• Only if in a For Each Reticle script loop • Stored as text
TempTarget	• Only if in a For Each Temperature script loop • Desired temperature setpoint • Stored as text, cannot be converted
TempActual	• Only if in a For Each Temperature script loop • Actual measured temperature at start of test • Stored as text, cannot be converted
StressTimestamp	• Only if in Loop Every script loop • Timestamp at start of current test iteration • Stored in MM/DD/YYYY HH/MM/SS format
StressIteration	• Only if in Loop Every script loop • Loop iteration counter • Stored as text, cannot be converted

IV measurement definitions and equations

There are a number of calculated indirect responses and notes associated with the IV measurement module. They are described in detail in the sections below.

Terminal Resistances

Any device terminal which has both a stimulus and response also has an associated resistance value. It is calculated as follows:

$$R\text{-terminal} = \frac{V\text{-terminal}}{I\text{-terminal}}$$

Resistor Ladder Calculations

Resistor ladder measurements result in several different calculated values. They are described in detail below. Also refer to the Resistor Ladder measurement introduction earlier in this chapter for more detail.

R-gap = slope of line fit to V-gap vs. I1 plot

R-sheet = slope of line fit to R-gap vs. gap squares plot

$$R\text{-end} = \frac{y\text{-intercept of line fit to R-gap vs. gap squares plot}}{2}$$

$$Rspec = \frac{(Rend * Gap\ Width^{*})\ ^{\wedge}\ 2}{Rsheet}$$

$$Rc = Rend * Gap\ Width^{**}$$

* Rspec is calculated for Gap Width measured in cm, and all gaps are assumed to be the same width

** Rc is calculated for Gap Width measured in mm

Beta

Beta is the current gain of a bipolar transistor. Wavevue calculates it on a point by point basis from the base and collector currents using the following formula.

$$\text{Beta} = \frac{Ic}{Ib}$$

Gm

Gm is defined for FETs as the derivative of drain current with respect to gate voltage. Wavevue uses a point by point delta approximation for the derivative as follows.

$$Gm = \frac{Id_n - Id_{n-1}}{Vg_n - Vg_{n-1}}$$

Obviously, using fairly small steps for the gate voltage will result in a better approximation than if they are too widely spaced.

CHAPTER

3 Understanding the IV Module Interfaces

This section will introduce you to each of the user interface components you will be using to set up IV measurements and to analyze the data after the measurements are performed. Each setup window will be subdivided into two sections: 1) adding a setup, and 2) setup settings. The adding a setup section will show the steps necessary to add a new instance of the particular setup being discussed. The setup settings section will show screen shots of every tab on the setup form and briefly describe the function of each control. Some of these setup windows are generic and shared between all of the measurement modules. The features of particular interest to the IV measurement module will be highlighted. This is not intended to be a step-by-step tutorial on setting up a measurement project, but simply to explain the function of all controls on each of the setup windows. Note however, that the order that the interfaces are introduced in this chapter is the same order you will usually encounter them in when setting up a new project.

NOTE

The figures in this section were generated in Windows XP and may appear slightly different in other versions of Windows. But the functionality will be the same even if they look slightly different.

Instrument Setup

The IV measurement module is designed to take advantage of the high speed measurement capabilities of Parameter Analyzers. It supports most of the common industry standard instruments. The list of supported instruments is updated frequently, so refer to the Microvue website for the most up to date information.

As with the DC Bias module, the IV module treats each output of a Parameter Analyzer as a separate instrument object. This provides the greatest flexibility for the measurement engine and allows the Parameter Analyzer channels to be assigned in the optimum arrangement for the device terminal requirements.

Adding a Parameter Analyzer

Click the Instruments icon, or select *Configure* > *Instruments...* from the main menu. When the Instrument Setup window appears, click *Add* to add the first Parameter Analyzer channel. The Add Instrument window shown below will appear.

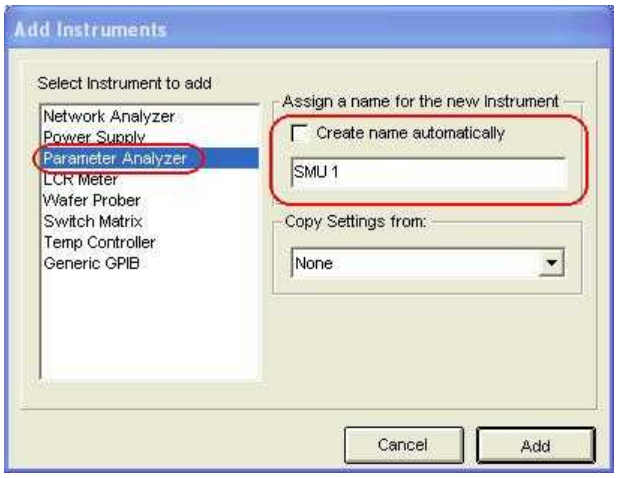


Figure 11. Add Instrument window

Table 9. Add Instrument window controls

Setting	Description
Select Instrument to add	List of supported instrument types. Selecting one will update the automatic name if that option is selected
Create name automatically	Check box that causes Wavevue to automatically generate names for your instruments. These names consist of a fixed abbreviation for each instrument type plus a numeric suffix (i.e. "LCRMtr 1"). If this control is checked, the name field is disabled.
(instrument name)	Field where you can type the name of the new instrument. If auto-naming is selected, this field is disabled.

Copy Settings from	Pull-down list of existing instruments of the same type. This field can simplify setting up multi-channel power supplies or parameter analyzers, since the new instrument can inherit all of the settings from an existing one.

Select "Parameter Analyzer" from the list on the left and change the name on the right to something meaningful like "SMU 1". Click *Add* to add the new instrument object to the project. This window will disappear and the new instrument will be selected in the Instrument Setup window.

Parameter Analyzer settings

The Info tab shown below contains some summary information for the instrument object and allows you to change the instrument model. You must select the correct instrument model from the pull-down list in order for Wavevue to use the correct driver.

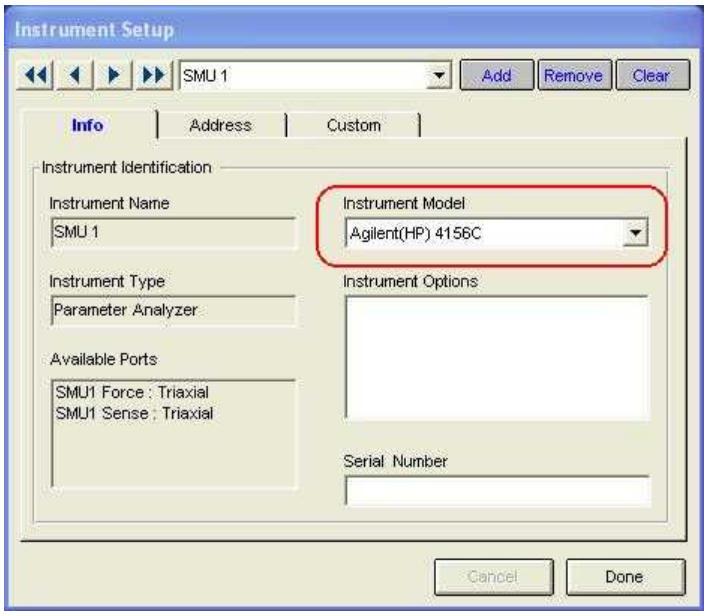


Figure 12. Instrument Setup window, Info tab

Table 10. Instrument Setup window, Info tab controls

Setting	Description
Instrument Name	Informational only.
Instrument Type	Informational only.
Available Ports	Informational only.
Instrument Model	Pull-down list of supported models of the selected instrument type. The list is generated by the virtual instrument driver of the selected type.
Instrument Options	List of relevant options for the selected instrument model. The list will be empty for many instrument models. Checking various options will allow Wavevue to attempt to take advantage of optional capabilities of some instruments. For this reason, make sure that the instrument actually

	includes an option before checking it or some optional functionality may fail.
Serial Number	Field where the instrument serial number can be typed. Leaving it blank has no adverse effects. It is provided simply as a convenience for lab equipment tracking purposes.

The Address tab shown below is where all of the interface settings for the instrument reside. By default, Wavevue will select the factory preset address for the selected instrument model. It will also set reasonable command and sweep timeout values for the instrument model. So if your instrument is still set to the factory preset address, you can generally ignore this tab entirely.

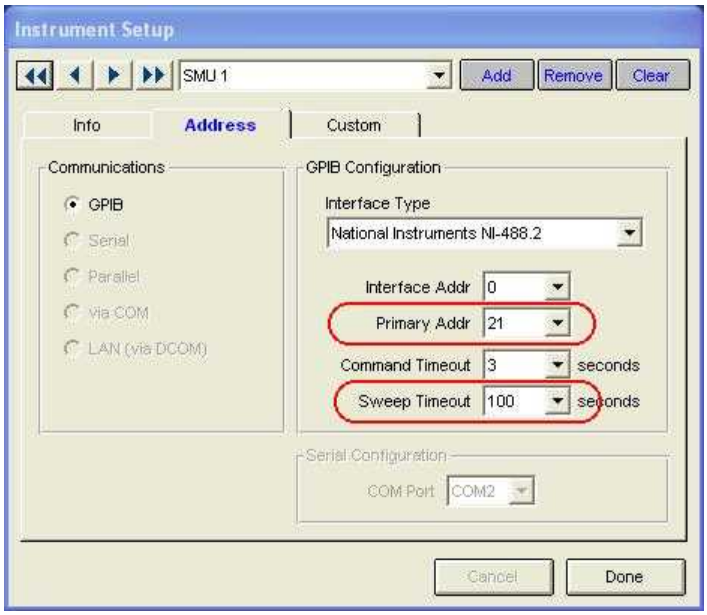


Figure 13. Instrument Setup window, Address tab

Table 11. Instrument Setup window, Address tab, Communications controls

Communications	
Setting	Description
(interface type)	Radio button to select the type of communications interface for the instrument. Only supported interfaces for the selected instrument model are enabled, so for 95% of instruments, GPIB will be the only option.

Table 12. Instrument Setup window, Address tab, GPIB Configuration controls

GPIB Configuration	
Setting	Description
Interface Type	Pull-down list of supported GPIB interface cards. The default is "National Instruments NI-488.2".
Interface Addr	Pull-down list of possible interface card address values. The default value is automatically set when the Interface Type is selected and is correct in 90% of cases.
Primary Addr	Pull-down list of possible instrument address values. The default value is read from the instrument driver and corresponds to the factory preset value for the instrument model. Change as required to match your hardware configuration.
Command Timeout	Pull-down list of timeout values. The default value is read from the instrument driver and should be reasonable for most measurements. This value specifies the interval to wait after normal commands before generating a timeout error.
Sweep Timeout	Pull-down list of timeout values. The default value is read from the instrument driver and should be reasonable for most measurements. The value specifies the interval to wait for sweeps and long operations to complete before generating a timeout error.

Table 13. Instrument Setup window, Address tab, Serial Configuration controls

Serial Configuration	
Setting	Description
COM Port	Pull-down list of COM port selections. Select the port used to control serial instruments.

And finally, the Custom tab is where any Instrument Type specific settings are made. Note that the appearance of this tab varies based on the type of instrument selected. For Parameter Analyzers, the channel number is the only custom setting. Refer to Appendix A for additional detail on setting the correct channel numbers for mainframe-type Parameter Analyzers such as the Agilent 4142B or Agilent 5270A.

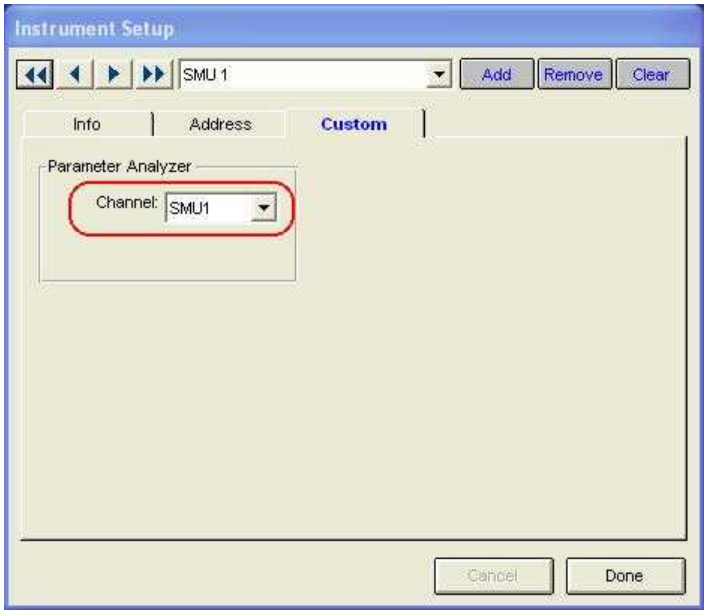


Figure 14. Instrument Setup window, Custom tab

Table 14. Instrument Setup window, Custom tab controls

Parameter Analyzer	
Setting	Description
Channel	Pull-down list of available output channels on the Parameter Analyzer. The list is filled from the instrument driver and varies from model to model.

The easiest way to configure the instruments for IV measurements is to completely set up the first parameter analyzer channel, then use the "Copy Settings From" feature when adding the remaining Parameter Analyzers. Using this technique, you only need to change the Channel on the Custom tab for each additional channel of a Parameter Analyzer

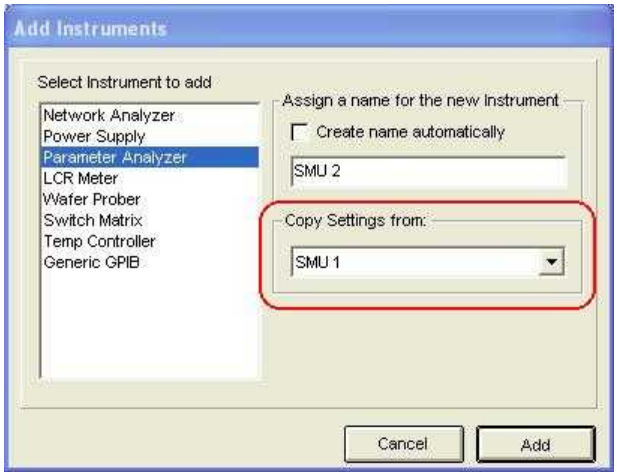


Figure 15. Add Instruments window, copying settings

Having extra Parameter Analyzer objects in a project doesn't have any negative effects, so you may want to set up all of the SMU channels for your Parameter Analyzer, even if you don't expect to use them all. This makes your Instrument Setup as versatile as possible. You can double-check your setup using the summary on the Application Status window shown below. You should see four Parameter Analyzer instruments with the same model number and GPIB address, but different Custom parameter (channel).

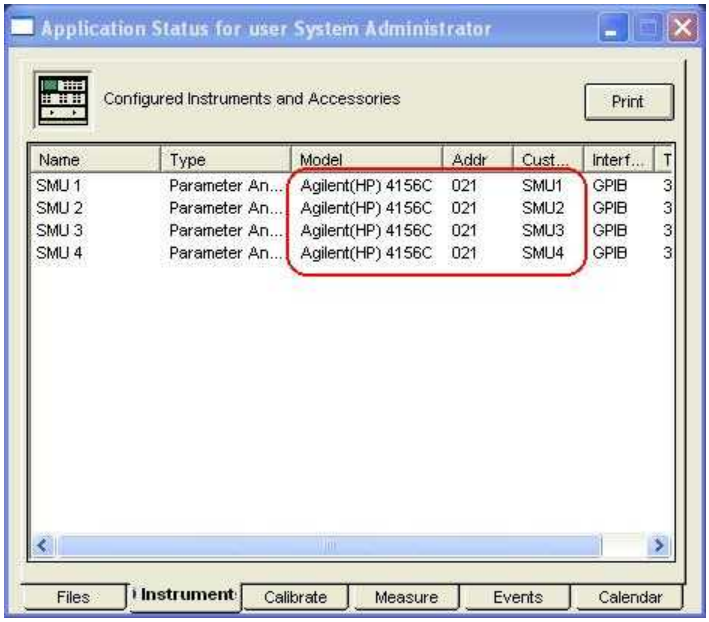


Figure 16. Application Status window, Instruments tab

Device Setup

Every IV measurement setup is specific to a Wavevue Device object. The Device object defines the number of terminals on the device, the name of each terminal, and whether terminals are active (requiring a measurement setup), or passive (sense terminals only). The following paragraphs describe Wavevue's built-in devices. Refer to Appendix B for information on creating your own custom devices.

Adding a device

Click the Devices icon, or select *Setup* > *Device Type...* from the main menu. When the Device Setup window appears, click *Add* to add the first device object. The Add Device Type window shown below will appear.

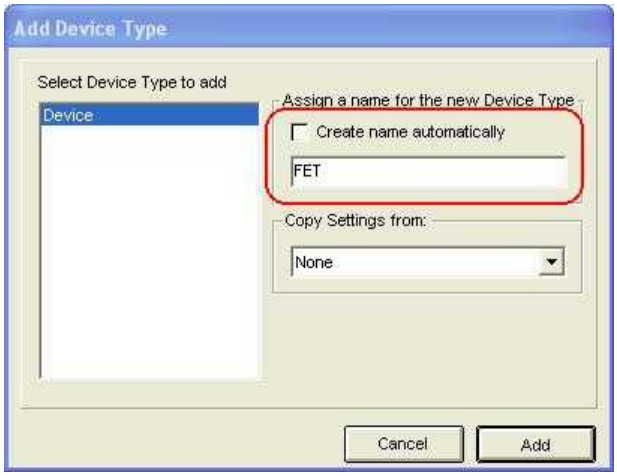


Figure 17. Add Device Type window

Table 15. Add Device Type window controls

Setting	Description
Select Device Type to add	Informational only for devices.
Create name automatically	Check box that causes Wavevue to automatically generate names for your devices. These names will simply be numbered devices (i.e. "Device 1"). If this control is checked, the name field is disabled.
(device name)	Field where you can type the name of the new device. If auto-naming is selected, this field is disabled.
Copy Settings from	Pull-down list of existing devices. This field generally isn't used with Devices because there is seldom a need to create two nearly identical devices.

Change the name on the right to something meaningful like "FET". Click Add to add the new device object to the project. This window will disappear and your new device will be selected in the Device Setup window.

Device settings

The Device tab shown below displays summary information about your device and allows you to change the device type. Note that the Device Type pull-down is the only active control on this tab. Information on all three tabs updates automatically whenever you change the device type.

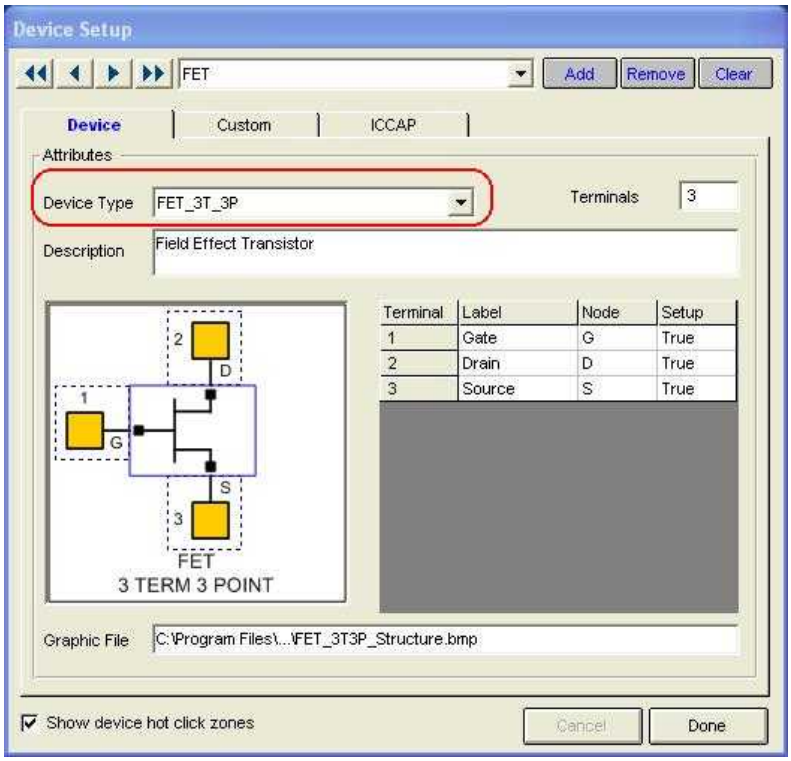


Figure 18. Device Setup window, Device tab

Table 16. Device Setup window, Device tab controls

Column Name	Description
Device Type	Pull-down list of all of the pre-defined Wavevue device types plus any user-defined device types. This list is generated by the list of *.dsp files in the "Device Types" folder in the Wavevue installation directory structure.
Terminals, Description	Informational only. Filled from the device setup file.
Terminal Grid	Informational only. Filled from the device setup file. Terminal: index of the terminal Label: name of the terminal Node: abbreviation of the terminal name Setup: True or False indicating whether the terminal gets its own IV setup, or is simply a secondary pad tied to an existing terminal.
Graphic File	Informational only. Name of the bitmap file displayed in the picture box in the upper left corner of the tab. Filled from the device setup file.
Show device hot click	Check box indicating whether or not dotted lines should be shown on the

zones	graphic around the "hot" zones where clicking will select the active terminal. These zones are not active in this window, but only when the same graphic is used on the IV Measurement setup window.

NOTE

Wavevue uses a standard naming convention for its standard devices. For instance, "FET_3T_3P" indicates a field effect transistor with 3 active terminals (3T) and 3 pads (3P), one per terminal. The Kelvin equivalent of that device would be the "FET_3T_6P", where the 6P indicates 6 pads, two per terminal.

The Custom tab is empty in this case, as FET devices have no custom properties. It will be shown in later examples of custom devices, though.

The ICCAP tab shown below displays the ICCAP mdm file header line for the device we are defining. It is for informational purposes only, and is not directly editable. It will update automatically to reflect any changes to the device type, however.

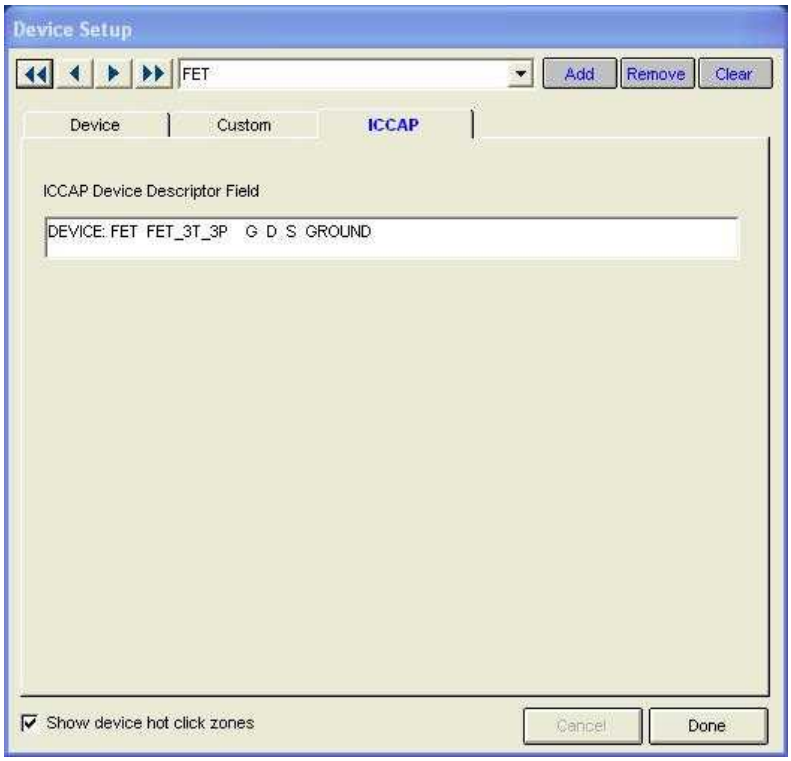


Figure 19. Device Setup window, ICCAP tab

Connection Setup

Connection setups perform two functions related to IV measurements. The first is that they act as the binding object, specifying which Parameter Analyzer channels correspond to which device terminals. This is purely a virtual connection, however. No physical connection is created by the binding. The second is that they also allow you to specify the instrument control necessary to physically realize the virtual connections. This would include controlling switch matrices, and any other auxiliary GPIB control you need to perform to realize a measurement connection.

NOTE

Since Connection Setups provide the binding between test instruments and the device terminals, they must be based on an existing device setup. Make sure you define your devices before trying to create connection setups.

Adding a connection

Click the Connections icon, or select *Setup* > *Connection Manager...* from the main menu. When the Connection Setup window appears, click *Add* to add the first connection object. The Add Connection window shown below will appear.

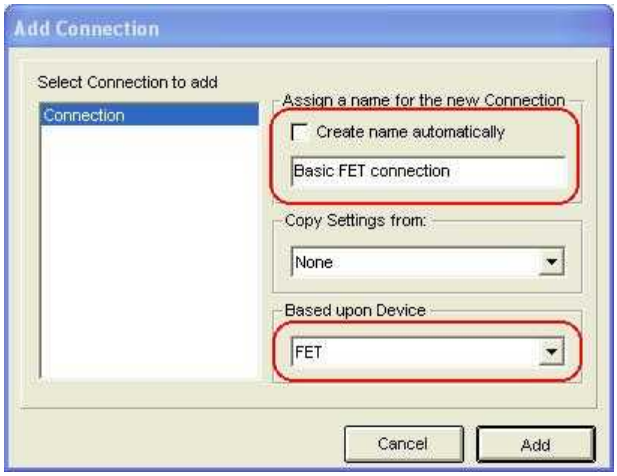


Figure 20. Add Connection window

Table 17. Add Connection window controls

Setting	Description
Select Connection to add	Informational only for connection setups.
Create name automatically	Check box that causes Wavevue to automatically generate names for your connection setups. These names will simply be numbered connections (i.e. "Connection 1"). If this control is checked, the name field is disabled.
(connection name)	Field where you can type the name of the new connection. If auto-naming is selected, this field is disabled.

Copy Settings from	Pull-down list of existing connections. This field generally isn't used with connections because there is seldom a need to create two nearly identical setups. The exception to this would be the multiple connection setups that need to be created for resistor ladder measurements. Copying them saves you the trouble of having to repeat the bindings section and only adjust the switch matrix commands.

Change the name on the right to something meaningful like "Basic FET connection". If you have more than one device defined, select the appropriate device for this connection setup. Click *Add* to add the new connection setup object to the project. This window will disappear and the new connection setup will be selected in the Connection Setup window.

Connection settings

The Setup tab shown below contains the Device to Instrument bindings and also any instrument commands required to realize the connection.

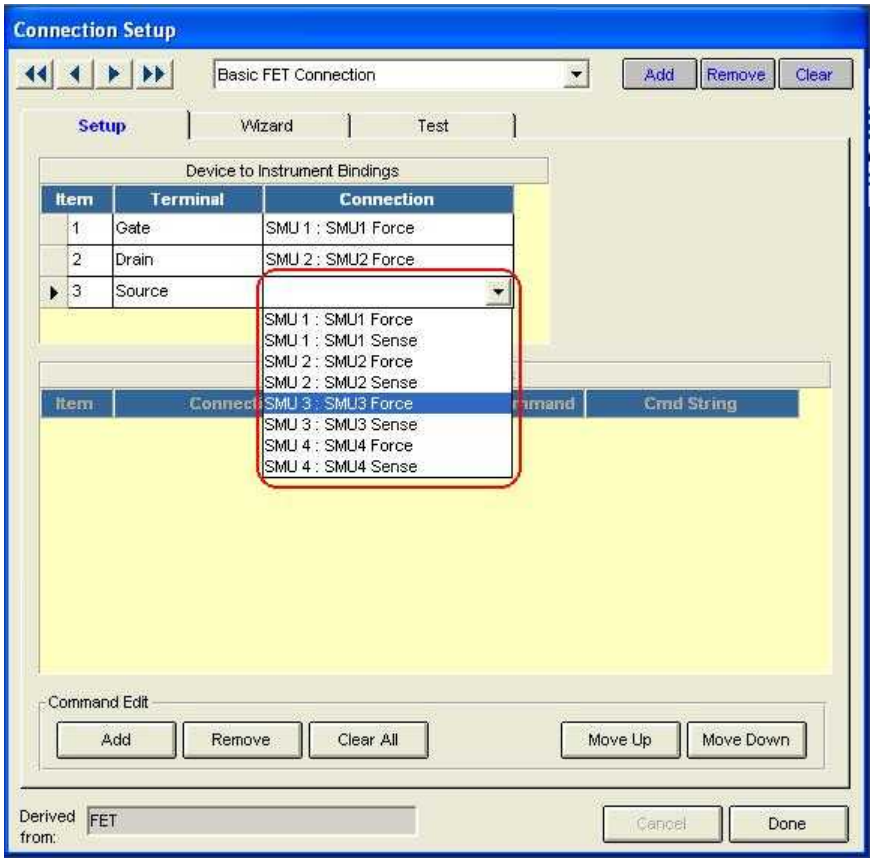


Figure 21. Connection Setup window, Setup tab, Bindings section

Table 18. Connection Setup window, Setup tab, bindings section controls

Device to Instrument Bindings	
Column Name	Description
Terminal	For informational purposes only. The terminal name from the device setup file. This column is not editable.
Connection	Pull-down list of the available channels or terminals on each instrument in the project. Selecting a Parameter Analyzer channel "binds" it to the device terminal for measurement purposes.

If your connections are hard-wired and don't require any instrument control, you can stop at this point. Click Done and you will receive a warning that your connection setup doesn't contain any instrument control commands. This is a one-time warning in case you forgot a step, but will not continue to nag you the next time you look at this connection setup.

Wavevue provides a couple of different ways to set up instrument control to implement a connection. One method is to manually enter commands using the lower half of the window displayed below.

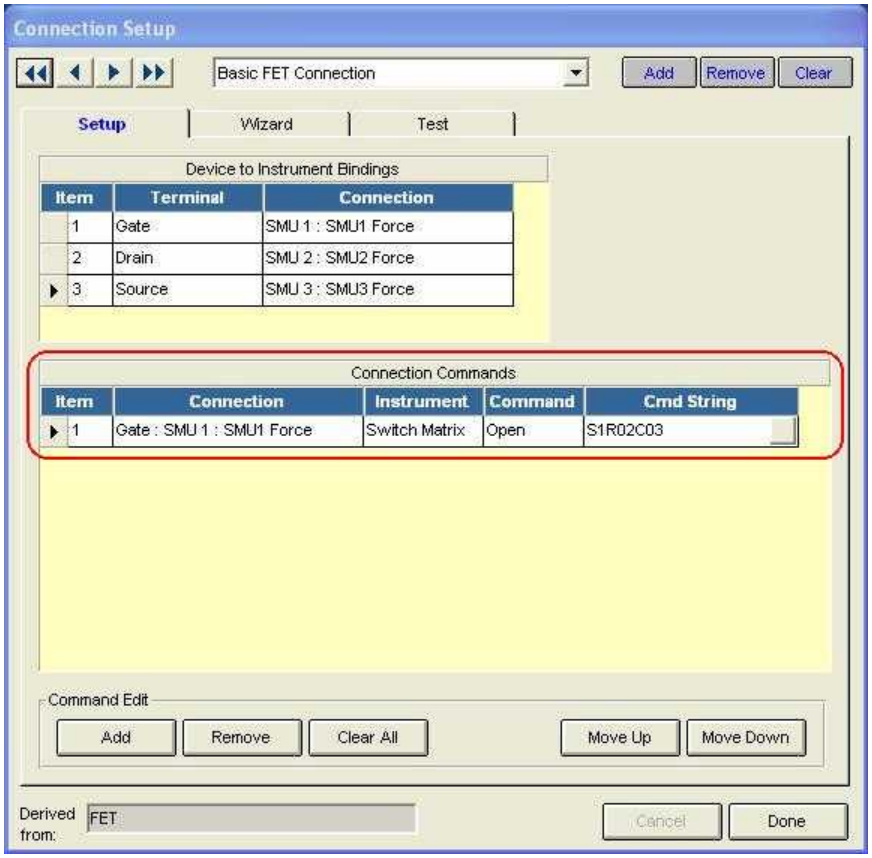


Figure 22. Connection Setup window, Connection tab, Connection commands section

Click the *Add* button to add a new connection command to the list. Each connection command is made up of the following fields:

Table 19. Connection Setup window, Connection tab, connection commands controls

Column Name	Description
Connection	Pull-down list of the available device to instrument bindings. Can also be "(non-specific)". Note that this field is for documentation purposes only.
Instrument	Pull-down list of the available instruments in the project. Can also be "None" for non instrument-related utility commands.
Command	Multi-function field depending on value of Instrument field Instrument = None: Pull-down list of Prompt and Sleep utility commands Instrument <> None: Pull-down list of the available commands for the selected instrument. The list is populated by the instrument driver and varies by instrument.
Cmd String	Multi-function field, depending on values of Instrument and Command fields. Instrument = None, Command = Prompt: The prompt message to be displayed during the connection. Type the text into the field. Instrument = None, Command = Sleep: The sleep duration. Click the button in the box and enter the sleep duration in the Sleep Command Helper window that appears. Click *OK* to set the value. Instrument = Switch Matrix, Command = Open All: Field is not used Instrument = Switch Matrix, Command = Open or Close: The Wavevue switch command universal syntax for a crosspoint. Click the button in the box and select the card slot, row, and column in the Switch Command Helper window that appears. Click *OK* to set the value. Instrument = (anything), Command = Preset: Field is not used. Instrument = (anything), Command = Output: The GPIB command to send to the instrument. Type the command into the field.

If you are entering Switch Matrix commands, you can also use the Wizard to assist you. Switch to the Wizard tab shown below. Clicking on the crosspoints in the Connection Helper toggles connections on and off. Each highlighted crosspoint creates a corresponding connection command back on the Setup tab.

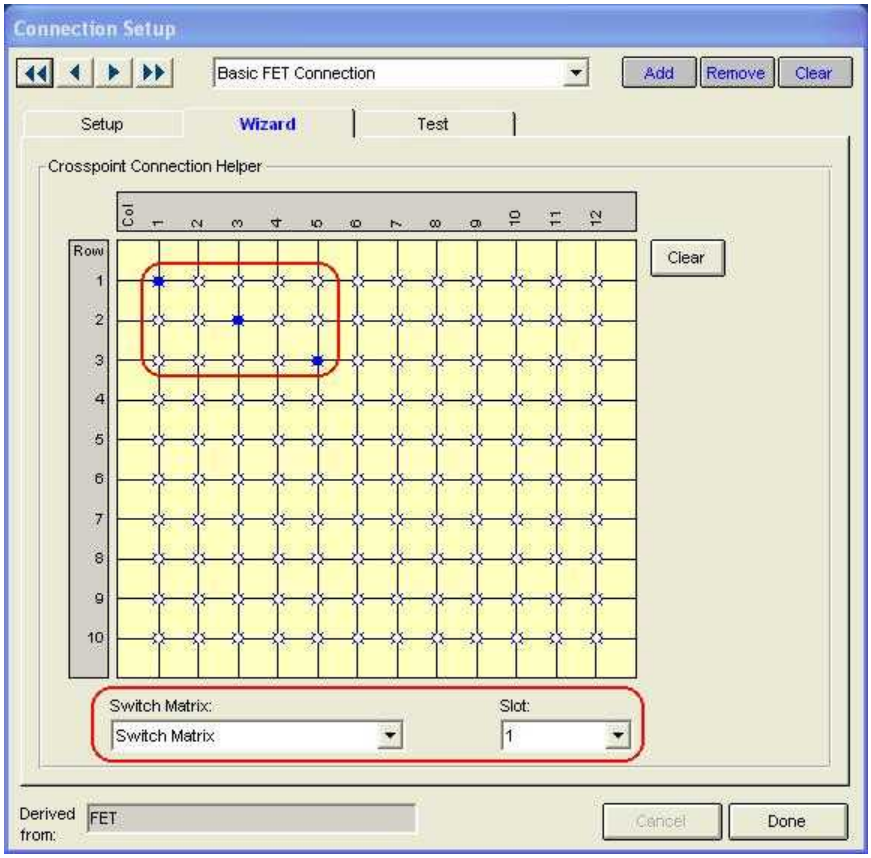


Figure 23. Connection Setup window, Wizard tab

Table 20. Connection Setup window, Wizard tab controls

Setting	Description
(crosspoints)	Clicking on a crosspoint toggles it on and off. Crosspoints which are toggled on generate switch matrix control commands back on the Setup tab.
Clear	Button which clears all crosspoints in the current matrix and slot
Switch Matrix	Pull-down list of all Switch Matrix instruments in the current project. Selecting a switch matrix updates the crosspoint graphic to reflect switch commands in effect for that instrument.
Slot	Pull-down list of slots available in the currently-selected Switch Matrix. Selecting a slot updates the crosspoint graphic to reflect switch commands in effect for that slot.

NOTE

The crosspoint graphic is a 10x12 matrix switch card. This was selected because it represents the biggest available switch card in any of the supported Switch Matrix instruments. However, your switch cards may be smaller. Take care when creating switching commands because Wavevue does not prevent you from creating impossible switch control commands.

Changes you make on the Wizard tab and the commands on the Setup tab will stay in sync with each other as shown in the screen shot below. The three "(Wizard-generated)" commands in the Connection Commands grid were added in response to the three crosspoints selected on the Wizard tab.

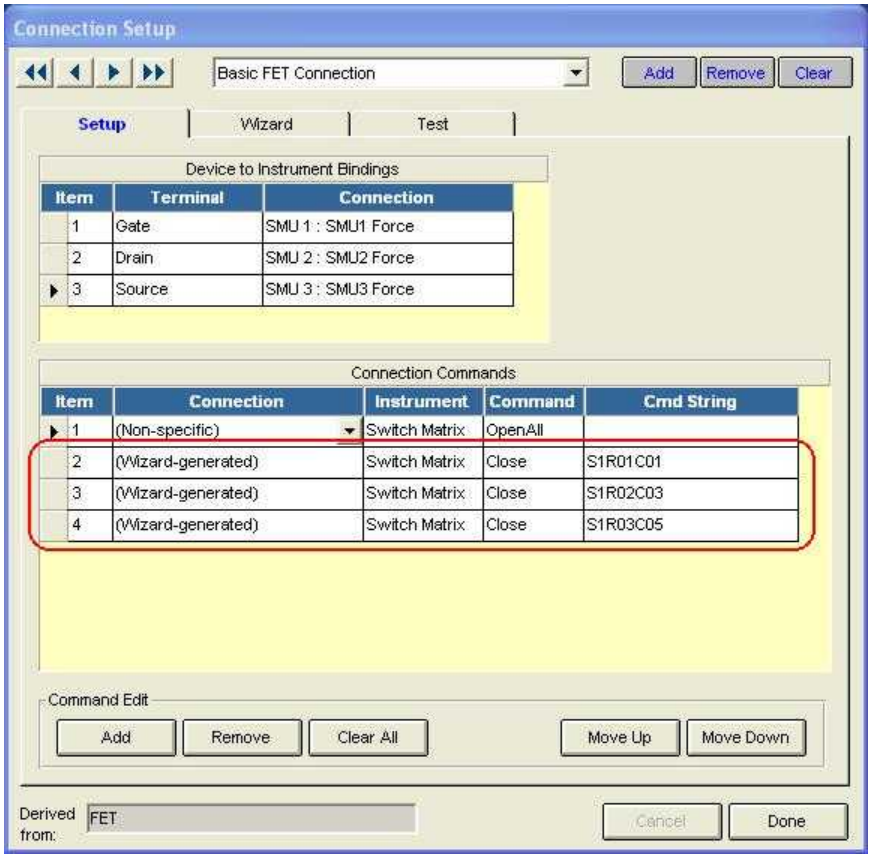


Figure 24. Connection Setup window, Setup tab

NOTE

Connection setups do not automatically open any existing switch crosspoints prior to closing the new ones specified in the commands. In order to insure that you do not have any undesired extra switch paths closed, it is recommended that you start your Connection setups with an "OpenAll" command. You may also choose to implement an extra Connection Setup which simply contains an "OpenAll" command and insert it at the end of measurement scripts to make sure no unwanted connections remain after testing is complete.

The Connection Setup window also provides a tool to allow you to test your connection setups prior to using them in a measurement script. Switch to the Test tab shown below. The Make Connection button processes the connection commands the same was as the script engine.

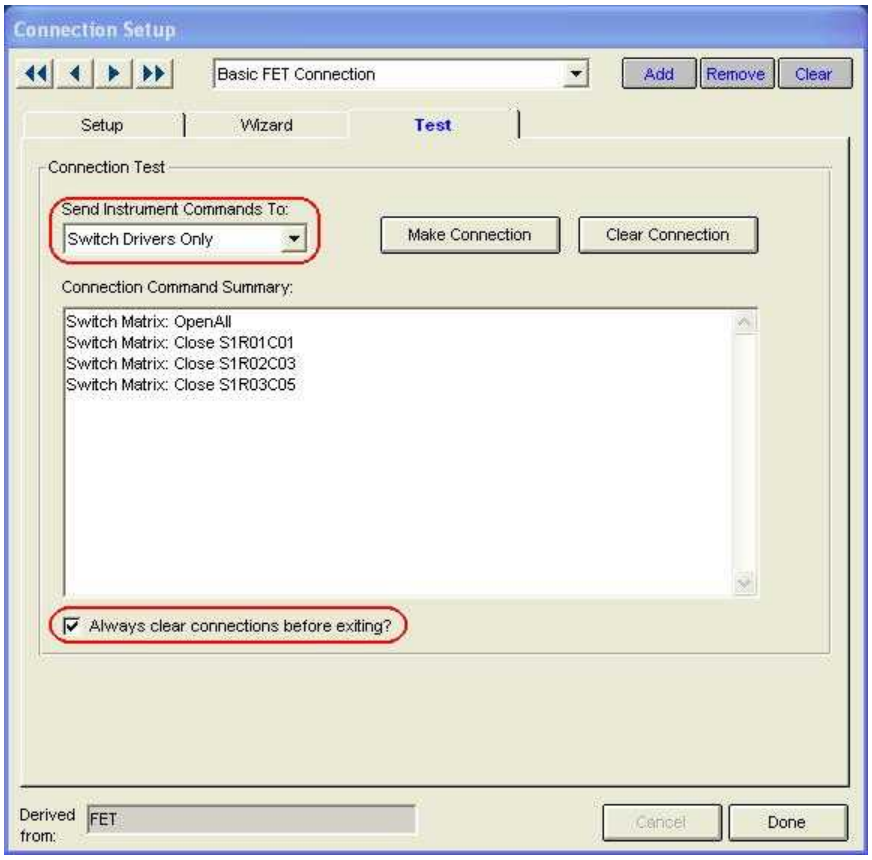


Figure 25. Connection Setup window, Test tab

Table 21. Connection Setup window, Test tab controls

Setting	Description
Send Instrument Commands To:	Pull-down list of: All Instruments – causes all instrument control commands to be issued when the *Make Connection* button is clicked. Switch Drivers Only – causes only Switch Driver commands to be issued when the *Make Connection* button is clicked.
Make Connection	Clicking this button issues the selected instrument control commands.
Clear Connection	Clicking this button opens any switch control crosspoints that were closed by the *Make Connection* button.
Connection Command Summary	Informational only. List of commands that have been sent by the *Make Connection* button.
Always clear connections before exiting?	Check box which causes Wavevue to automatically perform a Clear Connection operation prior to exiting the form, in case the operator forgets.

Measurement Setup

IV Measurement setups define the stimulus and response conditions for each terminal of a device. They also define turn-on and turn-off sequence and looping order for nested sweeps. As with all Wavevue calibration and measurement setups, IV measurement setups are non instrument-specific. The actual binding between instrument objects and the measurement setup doesn't occur until the measurement script is executed.

Adding a measurement

Click the IV measurement icon, or select *Setup* > *Parametric DC Measurement...* from the main menu. When the DC IV Measurement Setup window appears, click *Add* to add the first measurement setup object. The Add DC IV Meas window shown below will appear.

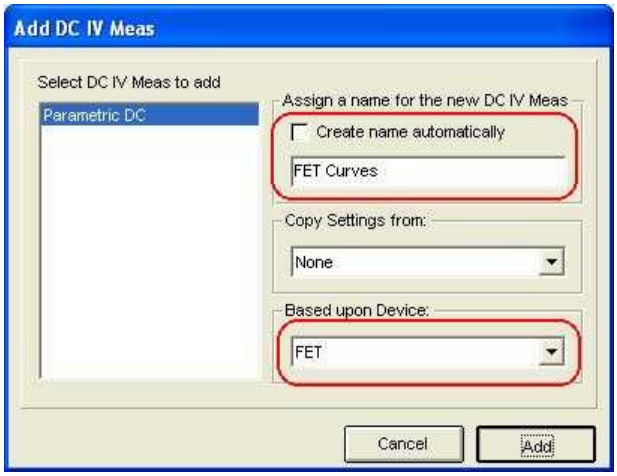


Figure 26. Add DC IV Meas window

Change the name on the right to something meaningful like "FET Curves". If you have more than one device defined, select the appropriate device for this measurement setup. Click *Add* to add the new measurement setup object to the project. This window will disappear and the new measurement setup will be selected in the DC IV Measurement Setup window.

Measurement setup settings

The setup tab is where most of the IV measurement settings reside. Note that only the settings for the active terminal are shown at any given time and that changing the active terminal updates all of the other settings on the tab.

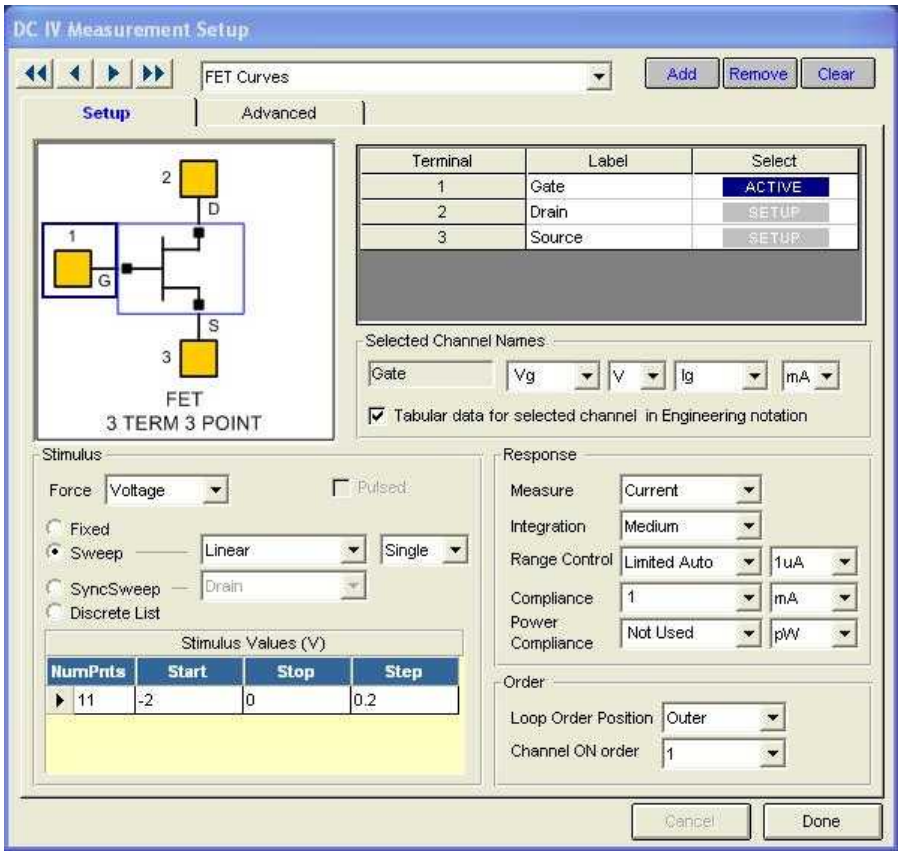


Figure 27. DC IV Measurement Setup window, Setup tab

Note that many of the controls are linked to each other to make setup easier and to prevent setting invalid states.

Table 22. DC IV Measurement Setup window, Setup tab, device settings

Setting	Description
(device picture)	Picture of the selected device which contains "hot" areas around each terminal. Clicking on the terminal pad will change the active terminal.
Terminal	Informational only. Index of the each terminal on the device.
Label	Informational only. Name of each terminal on the device.
Select	Indicates the currently active terminal. Each terminal is set up independently, and the active terminal is indicated by "ACTIVE" highlighted in blue in this column. The inactive terminals will be indicated by "SETUP" highlighted in gray.

Table 23. DC IV Measurement Setup, Setup tab, Selected Channel Names settings

Selected Channel Names	
Setting	Description
Voltage Name	Pull-down list of voltage designations for the active terminal. Wavevue will select an appropriate default value for standard device. However, you can select an alternate from the list, or type in your own custom designation. This will become the parameter name for the measured data.
Voltage Units	Pull-down list of the voltage units of measure for the active terminal.
Current Name	Pull-down list of voltage designations for the active terminal. Wavevue will select an appropriate default value for standard device. However, you can select an alternate from the list, or type in your own custom designation. This will become the parameter name for the measured data..
Current Units	Pull-down list of the voltage units of measure for the active terminal.

Table 24. DC IV Measurement Setup, Setup tab, Stimulus settings

Stimulus	
Setting	Description
Force	Pull-down list of "Voltage", "Current", or "None". Specifies the source mode of the Parameter Analyzer channel applied to the active terminal.
Sweep Type	Radio buttons used to select "Fixed", "Sweep", "Sync Sweep", or "Discrete List". Each setting then enables or disables other interface elements.
Sweep Mode	Sweep Type = Sweep: Specifies "Linear" or several variations of log-spaced sweep points. Sweep Type = (other): Disabled
Sweep Method	Sweep Type = Sweep: Specifies "Single" or "Dual" sweep. Sweep Type = (other): Disabled
Sync Sweep Channel	Sweep Type = Sync Sweep: Specifies the reference channel for the synchronized sweep Sweep Type = (other): Disabled
Stimulus Values	Grid that re-sizes based on Sweep Type. Note that all values should be entered in the units specified in the Selected Channel Names block. Sweep Type = Fixed: Enter the fixed stimulus value (voltage or current) Sweep Type = Sweep: Enter the sweep Start, Stop, and Step or number of points values. If the Sweep Mode is Linear, you can enter either step size or points and Wavevue will calculate the other. If the Sweep Mode is logarithmic, you can only enter the sweep start and stop values. Sweep Type = Sync Sweep: Enter the Ratio and Offset values used to calculate the Sync Sweep values based on the reference channel settings. For instance, for a true 1:1 tracking sweep, the Ratio would be 1 and the Offset would be 0. Note that these values are unitless. Sweep points are calculated from the formula: *Sync Value = Ratio * Ref Value + Offset* Sweep Type = Discrete List: Enter a series of values to define the list.

Table 25. DC IV Measurement Setup, Setup tab, Response settings

Response	
Setting	Description
Measure	Pull-down list which specifies the read mode of the Parameter Analyzer channel for the active terminal. Note that the list of choices available depends on the Force stimulus setting Force = Voltage: Choices are "Current" or "None" Force = Current: Choices are "Voltage" or "None" Force = None: Choices are "Voltage", "Current", or "None"
Integration	Pull-down list of integration time settings for the active channel – "Short", "Medium", "Long", and "Very Long". In general, longer shorter integration means faster measurements, but less accuracy. The default of "Medium" is fine for most measurements, but extremely low current measurements may require "Long" or even "Very Long".
Range Mode	Pull-down list of measurement range modes for the active terminal – "Auto", "Fixed", or "Limited Auto".
Range Setting	Enter the range to be used for the active terminal based on the Range Mode setting Range Mode = Auto: Disabled. Parameter Analyzers will auto-range every data point. This is the slowest, but most accurate mode. Range Mode = Fixed: Specifies fixed range to be used. Parameter Analyzers won't range up or down from this range. This is the fastest, but potentially least accurate mode. Range Mode = Limited Auto: Specifies the lowest range to be used. Parameter Analyzers will range up as required, but will never go lower than the specified range. Faster than Auto range if incredible accuracy isn't needed for low current measurements.
Compliance Value	Pull-down list of compliance settings for the active terminal. The first choice is "Instrument" which indicates that the maximum available compliance for the instrument is to be used. If none of the options are appropriate, you can also type in a custom value.
Compliance Units	Pull-down list of the units of measure for the compliance value.
Power Compliance Value	Pull-down list of power compliance settings for the active terminal. The first choice is "Not Used", indicating that there is no separate power compliance for the measurement. Power compliance is used to protect devices from thermal damage by limiting the power dissipation independently of the parameter compliance value.
Power Compliance Units	Pull-down list of the units of measure for the power compliance value.

Table 26. DC IV Measurement Setup, Setup tab, Loop Order settings

Order	
Setting	Description
Loop Order Position	Pull-down list of loop order options for the active channel. Sweep Type = Sweep: Choice of "Inner" or "Outer" loop. Waveveue currently only supports two levels of nested sweeps. Sweep Type = (other): Disabled
Channel On Order	Pull-down list of the turn-on order for the active channel. Channels are turned off in either the opposite order, or simultaneously, depending on the Parameter Analyzer capabilities.

Switching to the Advanced tab gives you access to a few more advanced channel setup parameters as shown below. Note that the ICCAP Inputs and Outputs display is for informational purposes only and cannot be directly edited. It will update to reflect any changes made on the Setup tab.

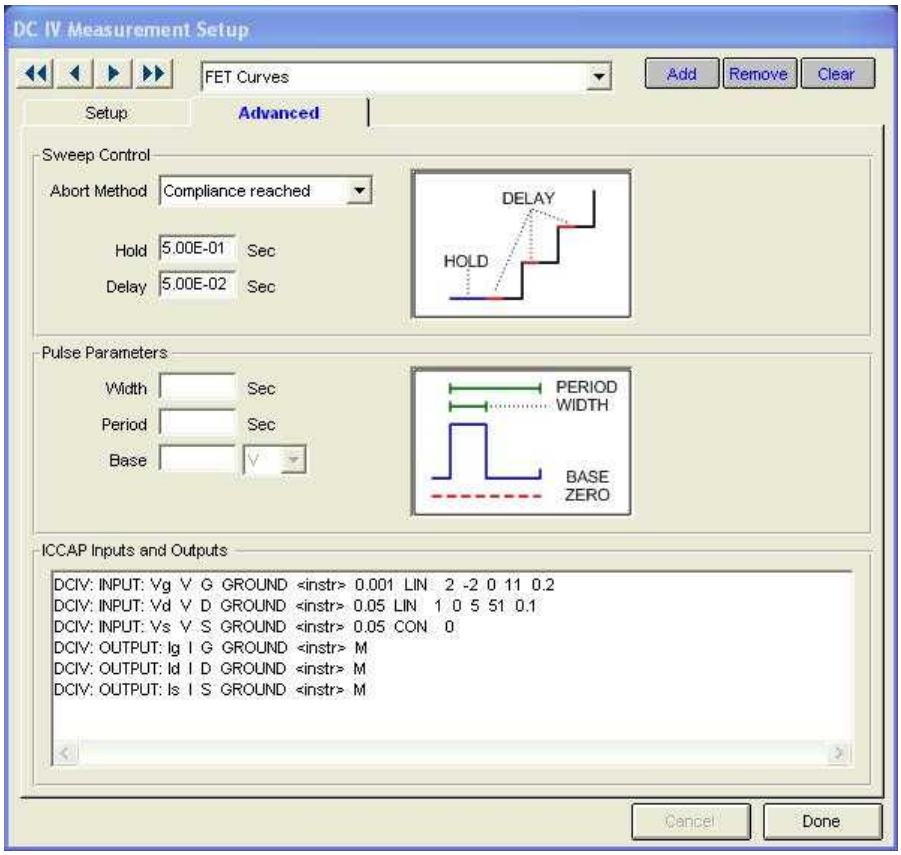


Figure 28. DC IV Measurement Setup window, Advanced tab

Table 27. DC IV Measurement Setup, Advanced tab, Sweep Control settings

Sweep Control	
Setting	Description
Abort Method	Pull-down list of Parameter Analyzer sweep abort conditions: "Never", "Compliance Reached", or "Abnormal Condition". Note that not all sweep abort conditions are supported by all Parameter Analyzers. If "Never" is selected, the compliance will not be exceeded, but the Parameter Analyzer will continue to take data points.
Hold	The Parameter Analyzer will set all of the channels to their initial values, then wait the specified Hold time before starting any sweeps. This parameter is provided to allow accurate measurements of devices with slow response due to heating or other effects.
Delay	The Parameter Analyzer will set each sweep value, then wait the Delay time prior to taking any readings. Note that the initial reading includes both the Hold and Delay times. This parameter is provided to allow accurate measurements of devices with slow response due to heating or other effects.

Table 28. DC IV Measurement Setup, Advanced tab, Pulse Parameters settings

Pulse Parameters	
Setting	Description
Width	Enter the pulse width value here. This is the pulse "on" time.
Period	Enter the pulse period value here. This is the total of the pulse "on" and "off" times.
Base	Enter the pulse base value here. This is the stimulus to be provided during the "off" portion of the pulse period.
Base Units	Pull-down list of the units of measure of the pulse base value.

Script Setup

As with all Wavevue measurement modules, Scripts are where the actual measurement occurs. IV Measurement scripts differ from some of the other modules because they are not automatically generated by Wavevue, regardless of the user preference setting. This is because Wavevue cannot predict which Connection setup will be required for an IV Measurement setup, so any script that it automatically generates would probably be useless. The IV Measurement script is where all of the objects we have discussed so far in this chapter finally come together.

Adding a script

Click the Script icon, or select *Measure* > *Edit Scripts...* from the main menu. When the Script Editor window appears, click *Add* to add the first script object. The Add Script window shown below will appear.

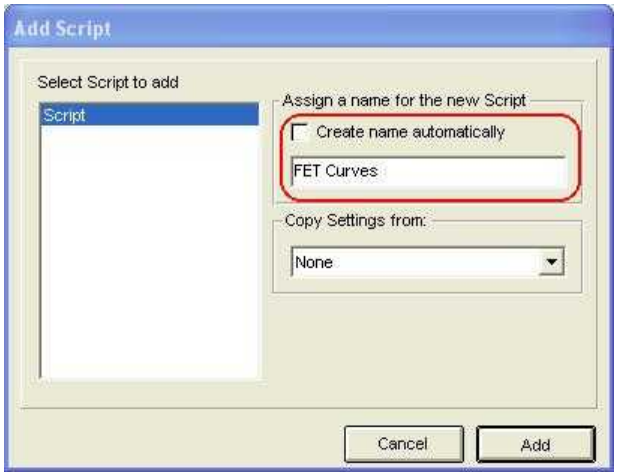


Figure 29. Add Script window

Change the name on the right to something meaningful like "FET Curves". It may be easier to keep track of your measurement scripts if you make the names match the corresponding IV Measurement setups. Click *Add* to add the new script object to the project. This window will disappear and the new (blank) script will be selected in the Script Setup window.

Script settings

Click on the *Measurements* button in the left side menu, then click the DC-IV icon. The Parametric DC Measurement definition window will appear as shown below:

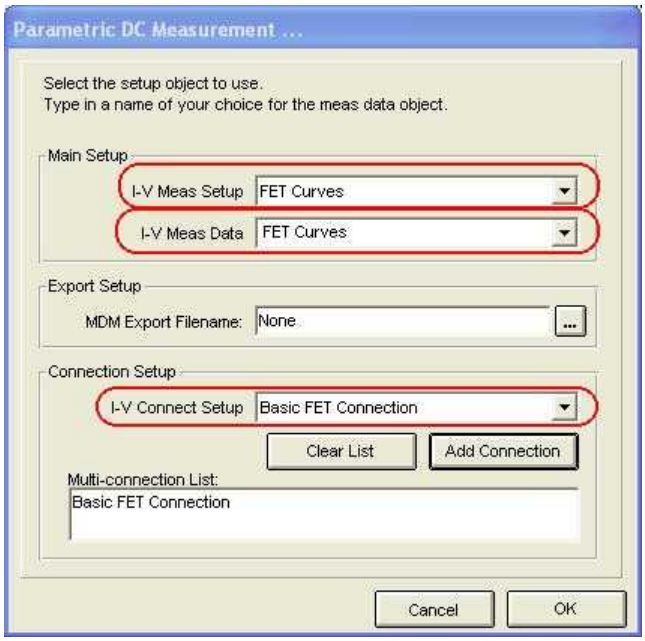


Figure 30. Script Editor Parametric DC Measurement window

Table 29. Script Editor Parametric DC Measurement window settings

Parametric DC Measurement	
Setting	Description
I-V Meas Setup	Pull-down of the available IV measurement setups. Select the appropriate one for this measurement.
I-V Meas Data	Enter the name of the data object. In order to facilitate re-usable reports, you will probably want to standardize the data name you use for various IV measurement types
MDM Export Filename	Select the name of the ICCAP export file to generate. Click the button to the right of the field to bring up a Windows Explorer window to aid in file naming. Leave the setting as "None" if you don't wish to generate an export file.
IV Connect Setup	Pull-down list of the available connection setups. Select the appropriate connection for the measurement and click the *Add Connection* button. Note that all IV measurement scripts must include at least one connection setup, and that some types use multiple connection setups.
Multi-connection List	Information only. List of connection setups that have been selected for this measurement.

Once all of the settings are correct, click OK and the new measurement script will be added to the display window.

Report Setup

The Report Editor is one of the most powerful features in Wavevue. However, it is also probably one of the most under-utilized features because it takes some practice to get used to all of its capabilities and nuances. The Report Editor is completely generic. None of the features are specifically tailored to IV measurement data. Rather than supporting long lists of hard-coded parameter values for each measurement type, the Report Editor knows how to query the Wavevue data objects to determine what data they contain and what in what formats it can be supplied. The following sections will briefly explain all of the capabilities of the Report Editor and will try to highlight those of particular interest in creating certain types of IV data reports.

Adding a report

Click the Report icon, or select *View* > *Report Editor...* from the main menu. When the Report Editor window appears, click *Add* to add the first report setup object. The Add Report Setup window shown below will appear.

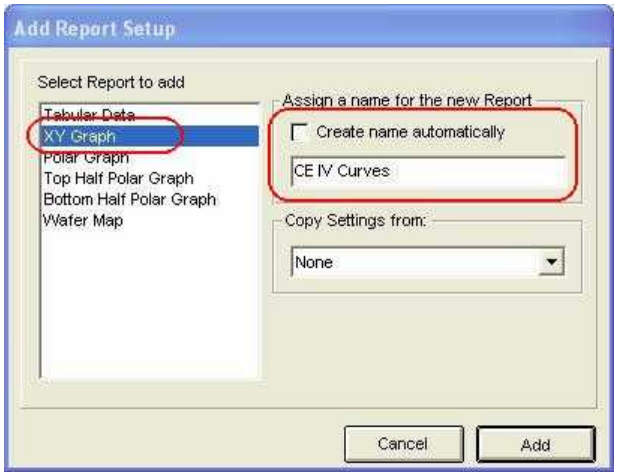


Figure 31. Add Report Setup window

Select XY Graph from the list on the left and change the name on the right to something meaningful like "CE IV Curves". Click *Add* to add the new report setup object to the project. This window will disappear and the new report will be selected in the Report Editor window.

Report settings

The Report Level tab is for general report settings, like titles and the report type.

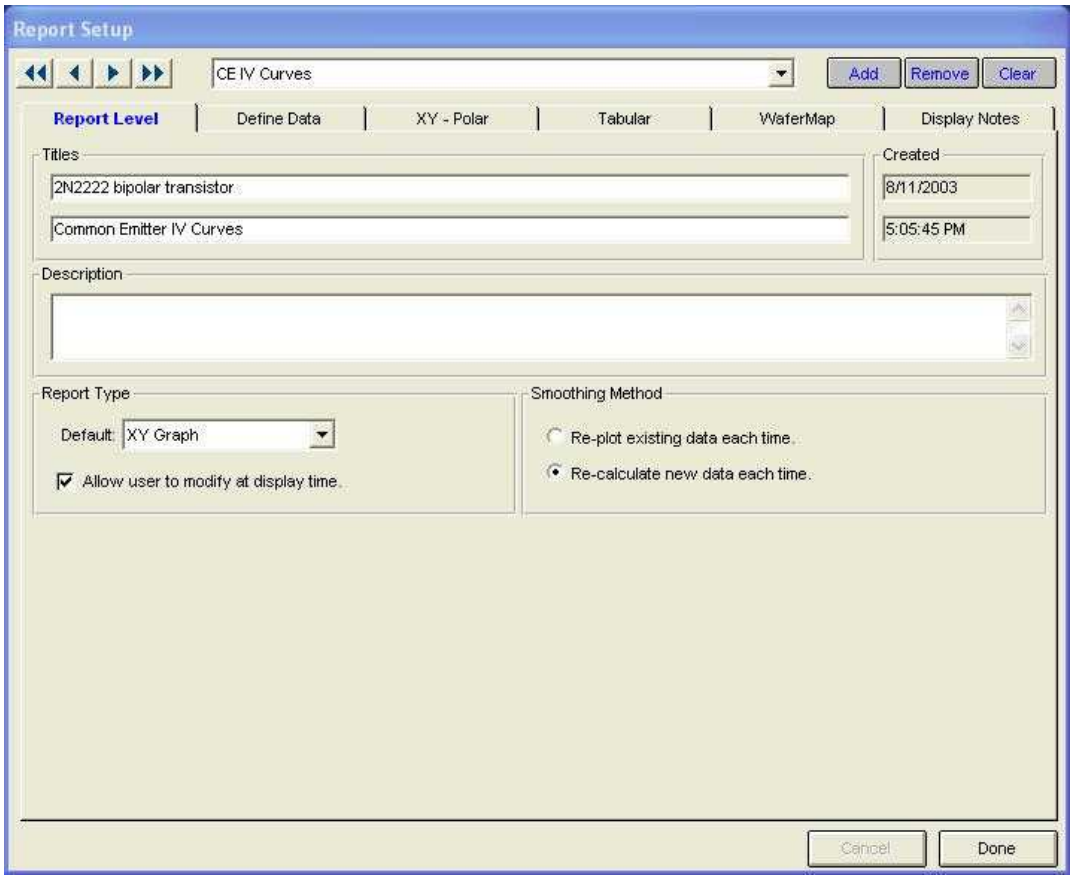


Figure 32. Report Editor window, Report Level tab

Table 30. Report Editor window, Report Level tab settings

Setting	Description
Titles	Two lines of title information that can be added to the top of plots
Created	Time and date stamp when the report was created. Informational only and can not be edited.
Description	Informational notes about this report. These are for user convenience only and don't actually appear on the report.
Report Type	Pull-down list of available report types including "TabularData", "XY Graph", "Polar Graph", "Top Half Polar Graph", "Bottom Half Polar Graph", and "Wafer Map". Defaults to the type selected when the report was created, but can be changed to "morph" the report to a different type.
Smoothing Method	Radio-button control to select the fitted data lifetime: Re-plot existing data every time ignores any changes to the Curve fitting parameters and continues to use the fit parameters stored in the data object. Re-calculate new data each time checks the Curve fitting setup, uses the latest parameters, and re-fits the data each time it is plotted. This mode can be used to test the effects of different order curve fits on data to determine the optimum fit.

The Define Data tab is used to define the actual data traces for the report.

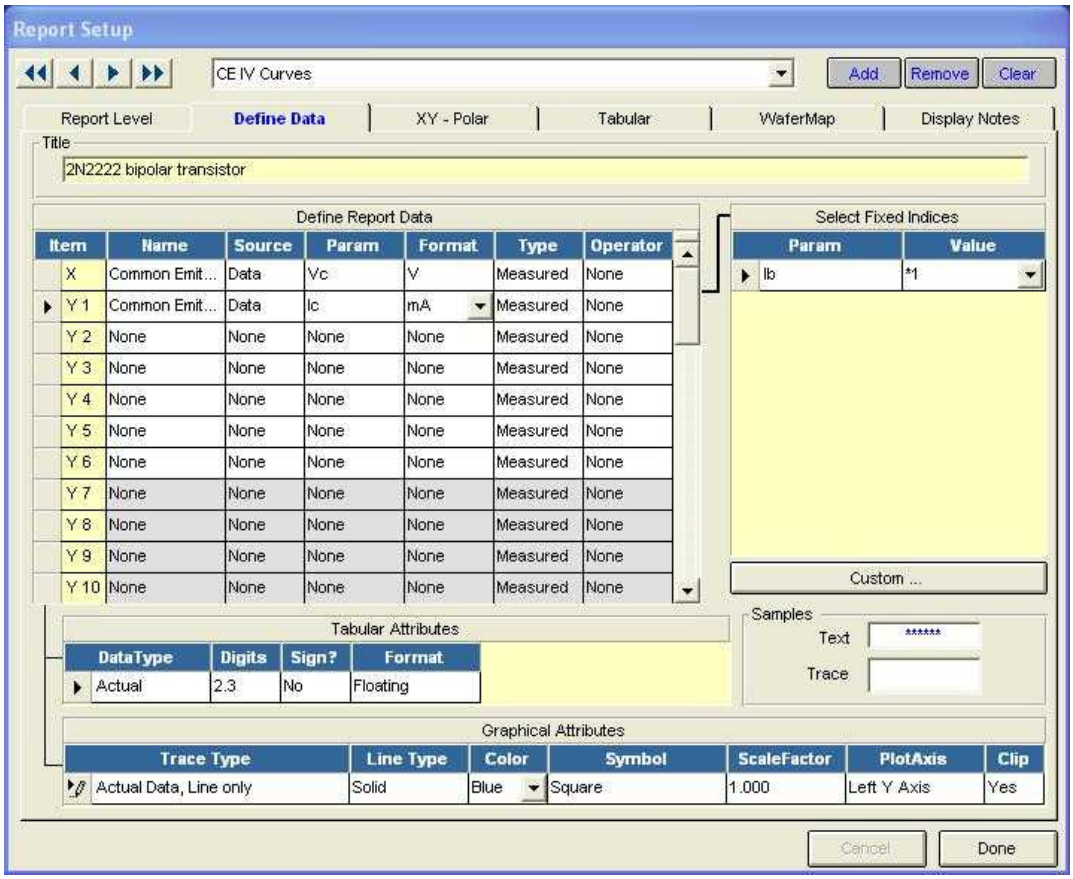


Figure 33. Report Setup window, Define Data tab

Table 31. Report Setup window, Define Data tab, Title settings

Title	
Setting	Description
(title)	The first Title line from the previous tab, copied here for reference. Not editable.

Table 32. Report Setup window, Define Data tab, Define Report Data settings

Define Report Data	
Setting	Description
Item	The "trace" being defined: X is the independent data for the report – the X axis for XY plots, the index for polar plots, and column 0 for tabular reports Y1-Y6 can either be traces on an XY plot or columns in a tabular report. Y7-Y12 can only be columns in a tabular report. Plots are limited to six data traces. For identification purposes only, not editable.
Name	Drop-down list of data objects available to build reports from. These fall into the 3 source categories explained below. The list is populated by Wavevue in real-time from the objects available in the measured data and script collections.
Source	The class of data item selected in the name field: Data indicates that the object exists in the current data collection in memory. This is the optimum way to set up a report, since you can fine-tune the scaling and determine the appearance of the finished report. Script indicates that the data name is referenced in a script in memory, but that the data doesn't actually exist yet. These data objects can be used to set up reports prior to the actual measured data existing. Script data objects will be replaced by actual measured ones at the time of viewing. Virtual data doesn't exist either in a script or the data collection and is simply used to set up generic plots in the absence of actual data. Virtual data objects will be replaced by actual ones at the time of report viewing.
Param	Drop-down list of data items available in the object selected in the Name field. This list is populated in real time based on the selected data object. The list presented for Y items is different than for the X item, and may actually depend on the X item selected.
Format	Drop-down list of data formats available for the selected parameter. This list is populated in real time based on the Param selected.
Type	Drop-down list of the available data arrays stored in the data object: Measured data is the data read from the instrument, including any calibration correction applied. Processed data includes post-processing corrections such as fixture or pad parasitic deembedding. Edited data is only available for Noise Parameter data and includes manual correction of the data to remove problematic data points.
Operator	Drop-down list of math operations that can be applied to the data prior to viewing: None displays the actual data Abs Value takes the absolute value of the data (changes any negative values to positive) Invert Pol reverses the sign of the data so that negative values appear as positive and vice verse. It can be useful if power supplies or parameter analyzers must be connected to a device in reverse polarity due to switching constraints Clip Pos "clips" any positive values and changes them to zero Clip Neg "clips" any negative values and changes them to zero

Table 33. Report Setup window, Define Data tab, Select Fixed Indices settings

Select Fixed Indices	
Setting	Description
Param	Names of any additional stimulus or tag data items which need to be specified in order to uniquely identify the data trace to be reported. This entire section of the window is populated in real time by Wavevue, depending on the contents of the selected data object.
Value	Drop-down list of the possible data values for the selected Param. There are some special values added to the end of the list of data values for each Param: *1-*4 indicate a loop. They will loop through all of the possible values and generate an entire "family of curves" for the selected item. If multiple loops are specified (only legal for tabular reports), *1 indicates the innermost loop, *2 is the next outermost, etc. This feature is used to generate plots like the bipolar transistor Common Emitter IV curves in the Measurement Theory section. TBD is the last value in every list. If this value is selected, Wavevue will prompt the operator to select the desired value at display time. This is useful for generating reports prior to having actual data and then pinpointing the exact data to be reported at display time.

Table 34. Report Setup window, Define Data tab, Tabular Attributes settings

Tabular Attributes	
Setting	Description
Data Type	Drop-down list of data types that can appear in a tabular report: Actual is the measured data Fitted is interpolated data based on the curve fit type and order specified in the Curve fitting setup object.
Digits	Drop-down list of available tabular precision options. The digit before the decimal point is used to control the field width and the digit after the decimal point is used to control the precision.
Sign	Drop-down list that specifies data formatting: Yes indicates that all values are preceded by a sign, both positive and negative No indicates that positive numbers have no sign but negative numbers do
Format	Drop-down list of available numeric formats: Floating indicates conventional floating point format Scientific indicates that all values will be displayed in scientific notation with a magnitude and an exponent Engineering is similar to scientific, except that the exponents are always multiples of 3.

Table 35. Report Setup window, Define Data tab, Graphical Attributes settings

Graphical Attributes	
Setting	Description
Trace Type	Drop-down list of trace types that can appear in a graphical report: Actual Data, Line Only is simply a continuous line that connects all the data points. Actual Data, Symbols Only plots a symbol at each data point, but no connecting lines Actual Data, Line and Symbols plots a symbol at each data point, and a continuous line that connects all of the symbols. Fitted Data, Line Only is a continuous line that connects all the data points on the fitted curve. Fitted Data, Symbols Only plots a symbol at each point on the fitted curve, but no connecting lines. Fitted Data, Line and Symbols plots a symbol at each data point on the fitted curve, and a continuous line connects all of the symbols. Fitted Line with Actual Symbols plots a symbol at each data point, but then draws a continuous line through all of the fitted points. It is an excellent way to judge the quality of the curve fit.
Line Type	Drop-down list of available line types for traces. These can be used to differentiate the traces if color printing isn't available.
Color	Drop-down list of available trace colors. The value selected applies to the trace line and symbols.
Symbol	Drop-down list of available shapes for the data point symbol.
ScaleFactor	Drop-down list of available scale factors. Data traces can be scaled to allow traces of different magnitudes to be plotted in the same region to compare shape.
PlotAxis	Drop-down list of the axis each trace will be scaled for. The left and right axes on an XY plot may have different scales.
Clip	Drop down list of clipping control: Yes indicates that traces will be clipped to stay within the plotting rectangle for XY plots, or the circle for polar plots. No indicates that traces are allowed to exceed the plotting rectangle for XY plots, or the circle for polar plots.

Table 36. Report Setup window, Define Data tab, Samples settings

Samples	
Setting	Description
Text	A sample of data as it will appear in a tabular report based on the Tabular Attributes settings. Changes in real time to reflect those settings. For informational purposes only, not directly editable.
Trace	A sample section of plot trace as it will appear in a graphical report based on the Graphical Attributes settings. Changes in real time to reflect those settings. For informational purposes only, not directly editable.

The XY – Polar tab contains additional settings for graphical reports, including axis scaling controls.

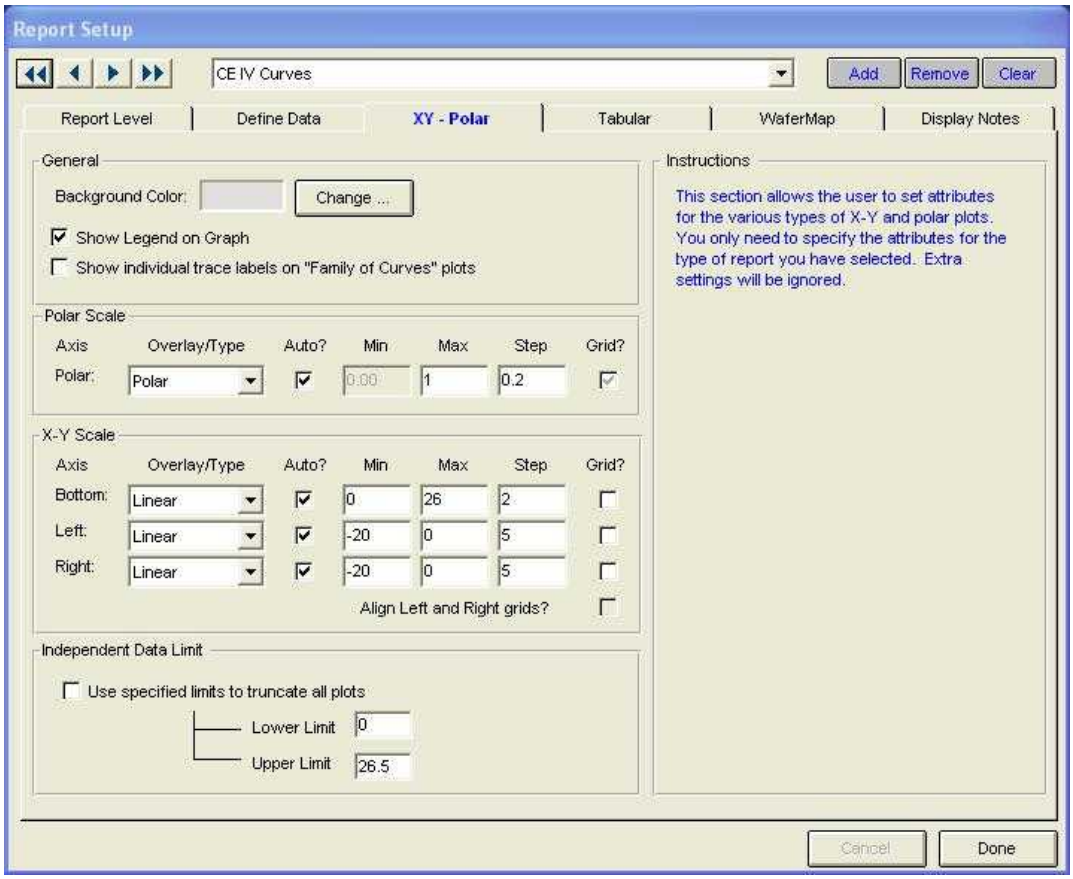


Figure 34. Report Setup window, XY-Polar tab

Table 37. Report Setup window, XY-Polar tab, General settings

General	
Setting	Description
Background Color	Sample block which shows the currently selected color plus a Change button that launches a standard Windows color select dialog.
Show Legend on Graph	Check box which controls whether the legend identifying the individual report traces is added to the bottom of graphical reports.
Show individual trace labels on "Family of Curves" plots	Check box which controls whether or not each trace in a "family of curves" report is given an individual label. This feature is optional because in the case of closely-spaced curves, the labels all fall on top of each other and are unreadable. So whether or not they are useful is a judgment call for the user.

Table 38. Report Setup window, XY-Polar tab, Polar Scale settings

Polar Scale	
Setting	Description
Overlay/Type	Drop-down list of overlays for the polar plot: "Smith Z", "Smith Y", "Polar", and "Polar/Smith Z" (the top and bottom halves of the plot have different overlays). Note that selecting a Smith overlay disables the Max scale field and sets it to 1.
Auto?	Check box which controls whether the polar plot autoscales or is manually scaled. In autoscale mode, the Max, and Step fields are ignored.
Min	Min axis value actually has no meaning on Polar plots, so this field is merely a placeholder for esthetics in the form.
Max	Field for the maximum radius of the polar plot.
Step	Field for the step value of grid circles on the polar plot.
Grid?	Check box which controls whether or not a polar plot has a grid overlay.

Table 39. Report Setup window, XY-Polar tab, X-Y Scale settings

X-Y Scale	
Setting	Description
Overlay/Type	Drop-down list of mapping modes for the selected axis: "Linear" or "Logarithmic".
Auto?	Check box which controls whether the selected XY plot axis autoscales or is manually scaled. In autoscale mode, the Min, Max, and Step fields are ignored.
Min	Field for the minimum value of the selected axis.
Max	Field for the maximum value of the selected axis.
Step	Field for the step value of tic marks or grid lines on the selected axis.
Grid?	Check box which controls whether or not an XY plot has a grid overlay. If checked, grid lines extend the full length of the axis. If not checked, only short tic marks are used to indicate the axis values.
Align left and right grids?	Check box which controls whether or not Wavevue attempts to keep the same number of tic marks or grid lines on the left and right axes in autoscale mode. This option is available for esthetic reasons to make XY plots with grids on both axes look better.

Table 40. Report Setup window, XY-Polar tab, Independent Data Limit settings

Independent Data Limit	
Setting	Description
Use specified limits to truncate all plots	Check box plus two entry fields which allow subsets of the data to be specified for the report. The Lower limit and Upper limit values refer to the X data and will cause the report to only show the specified subrange of the available data.

The Tabular tab contains additional settings for tabular reports.

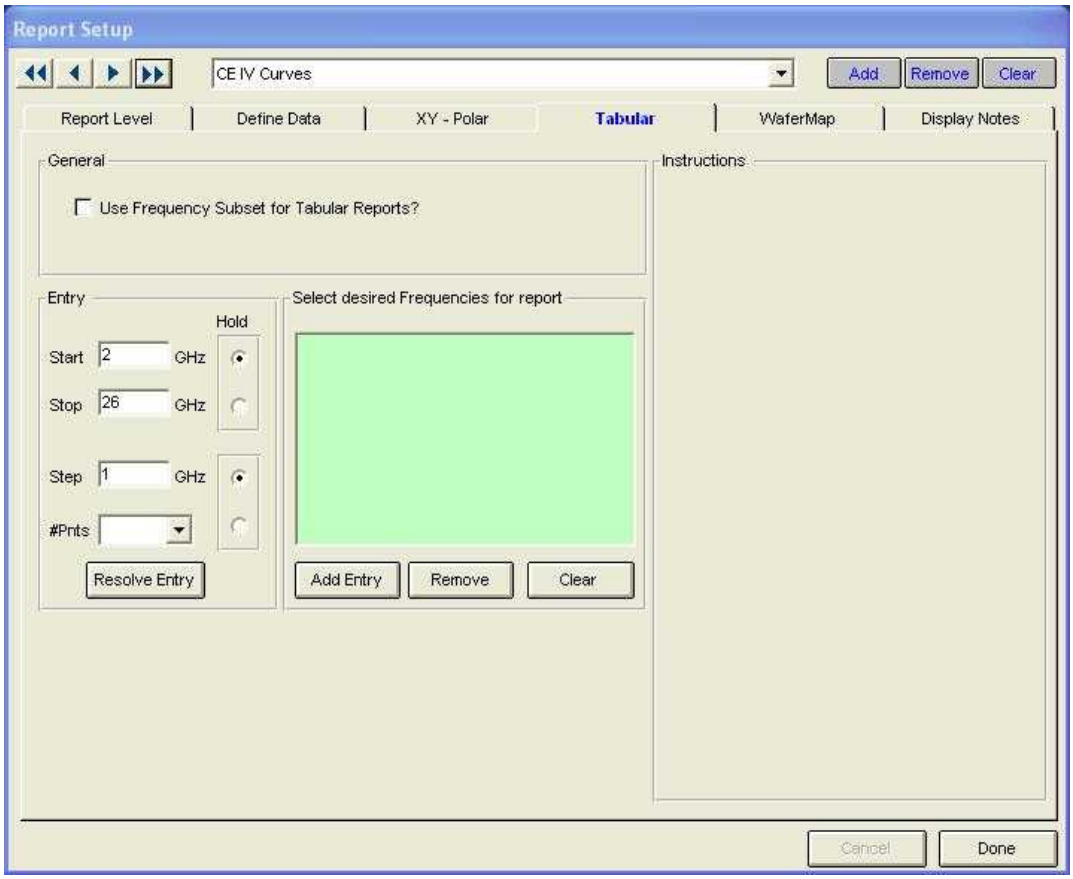


Figure 35. Report Setup window, Tabular tab

Table 41. Report Setup window, Tabular tab settings

Setting	Description
Use Frequency Subset for Tabular Reports?	Check box which controls whether or not Wavevue reports a subset of the actual data in tabular reports. This can include reducing the start/stop range as well as reducing the number of points by increasing the step size.
Entry	Control to allow data segments to be specified. Start, Stop, Step, and #Pnts are all used to define a single data segment. The Hold radio buttons indicate which values should be anchored when Wavevue must make adjustments because the start/stop/step/#pnts values are not internally consistent. Resolve Entry forces the consistency check and updates the values as necessary.
Select desired Frequencies for Report	Display of the currently selected segments which define the data to be reported in the tabular report. Add Entry adds a new segment to the list based on the current start/stop/step/#pnts. Remove deletes the currently highlighted segment from the list. Clear removes all of the segments from the list.

The Wafer Map tab contains settings for Wafer Map reports.

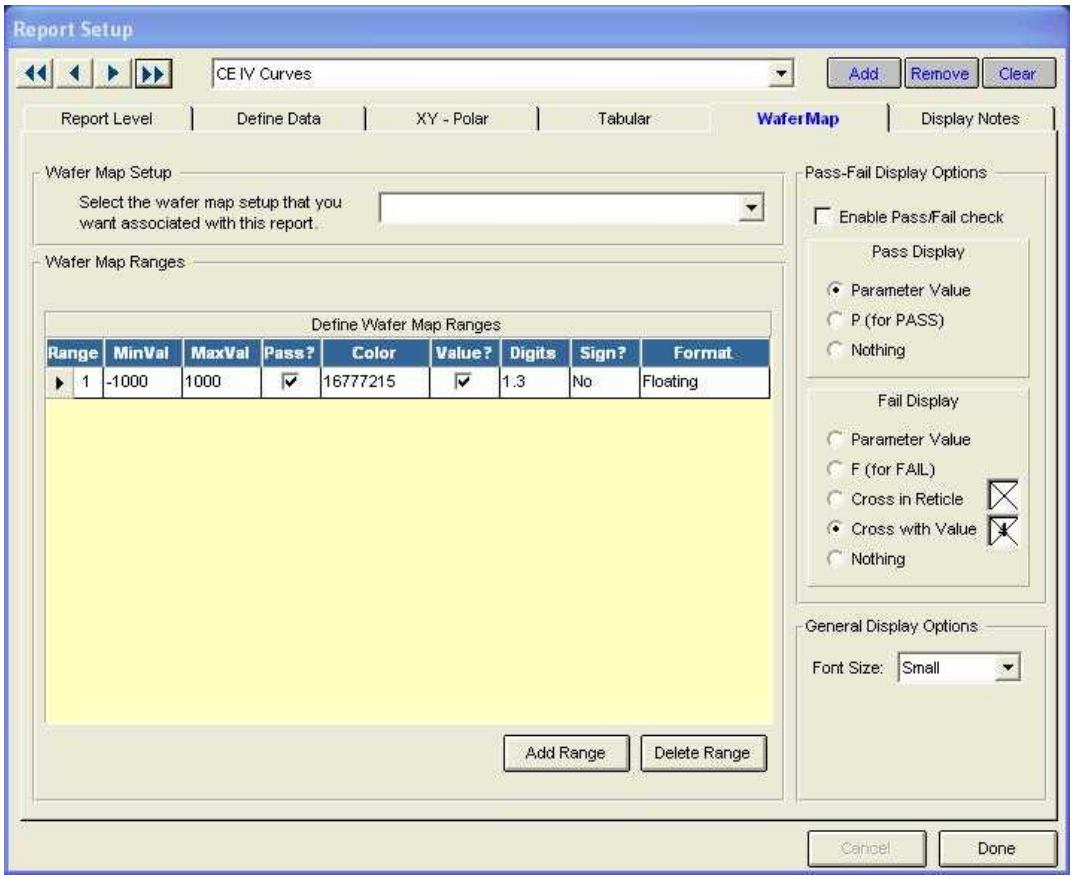


Figure 36. Report Setup window, Wafer Map tab

Table 42. Report Setup window, Wafer Map tab, Wafer Map Setup settings

Wafer Map Setup	
Setting	Description
Select the wafer map setup that you want associated with this report	Drop-down list of the wafer map setups available in the current project. The data set alone doesn't contain enough of the dimensional information about the wafer to generate a wafer map report, so you need to specify the wafer map setup that was used in the script that generated the data.

Table 43. Report Setup window, Wafer Map tab, Wafer Map Ranges settings

Wafer Map Ranges	
Setting	Description
Range	Index used to differentiate ranges. Not editable.
MinVal	The lower bound for the selected range
MaxVal	The upper bound for the selected range
Pass?	Check box which indicates whether the selected range is considered passing or failing data. This setting effects which of the Pass-Fail Display Options apply to the selected range.
Color	Sample display plus button for specifying the color for the selected range. Clicking the button in the grid cell displays a standard Windows color selection dialog.
Value	Check box which indicates whether each reticle in the wafer map should include the numeric data value as well as the color and other pass/fail indicators.
Digits	Drop-down list of available value precision options. The digit before the decimal point is used to control the field width and the digit after the decimal point is used to control the precision. This functions exactly the same as the Digits control in the Tabular Attributes section of the Define Data tab.
Sign?	Drop-down list that specifies data formatting: Yes indicates that all values are preceded by a sign, both positive and negative No indicates that positive numbers have no sign but negative numbers do This functions exactly the same as the Sign? control in the Tabular Attributes section of the Define Data tab.
Format	Drop-down list of available numeric formats: Floating indicates conventional floating point format Scientific indicates that all values will be displayed in scientific notation with a magnitude and an exponent Engineering is similar to scientific, except that the exponents are always multiples of 3. This functions exactly the same as the Format control in the Tabular Attributes section of the Define Data tab.
Add Range	Button which adds a new range to the list with default values. Add the desired number of ranges, then set all of the appropriate parameters for each range.
Delete Range	Button which removes the currently selected range.

Table 44. Report Setup window, Wafer Map tab, Pass-Fail Display Options settings

Pass-Fail Display Options	
Setting	Description
Enable Pass/Fail check	Check box which determines whether the Pass-Fail formatting options override the options specified in the Wafer Map Ranges grid.
Pass Display	Radio buttons to specify the appearance of data which meets the Pass criteria.
Fail Display	Radio buttons to specify the appearance of data which meets the Fail criteria.

Table 45. Report Setup window, Wafer Map tab, General Display Options settings

General Display Options	
Setting	Description
Font Size	Pull-down list of font sizes to be used for the wafer map values: "Small", "Normal", or "Large". Used to keep value labels from overwriting each other on dense wafer maps.

The Display Notes tab contains settings controlling how additional notes may be added to any of the available report types.

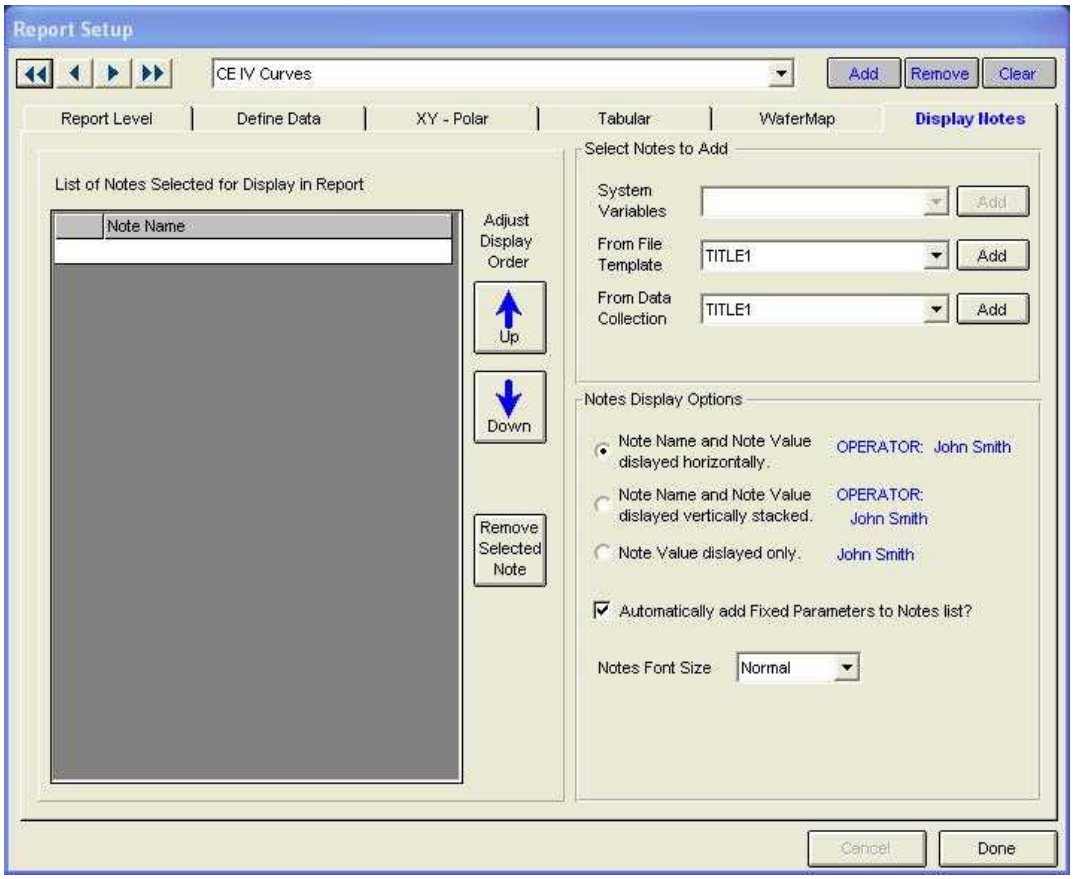


Figure 37. Report Setup window, Display Notes tab

Table 46. Report Setup window, Display Notes tab, List of Notes settings

List of Notes	
Setting	Description
(list)	List of notes which have been selected for the current report. These may not be directly edited in this display.
Up/Down	These buttons can be used to change the order of the notes on the report. Clicking one of them moves the selected note up or down in the display order.
Remove Selected Note	Clicking this button removes the selected note from the list.

Table 47. Report Setup window, Display Notes tab, Select Notes to Add settings

Select Notes to Add	
Setting	Description
System Variables/Add	Pull-down list of available notes in the System Variables collection. System variables are not maintained between runs, so use care in adding them to reports. A value that exists after measurement may not still be available when you want to view your report. Select a note, then click *Add* to add it to the list.
From File Template/Add	Pull-down list of available notes from the "Meas Info" screen which can optionally be displayed prior to running any measurement script. Select a note, then click *Add* to add it to the list.
From Data Collection/Add	Pull-down list of available notes in the current data collection. Select a note, then click *Add* to add it to the list.

Table 48. Report Setup window, Display Notes tab, Notes Display Options settings

Notes Display Options	
Setting	Description
(format option)	Radio buttons used to select the desired display format for notes. They can be single or double line, with or without the note name.
Automatically add Fixed Parameters to Notes list?	Check box which controls whether any Fixed Index values for the report traces are automatically added as notes. Selecting this feature is an easy way to make your reports self-documenting without having to remember to add or remove notes as the measurement conditions change.
Notes Font Size	Pull-down list of font sizes to be used for the notes: "Small", "Normal", or "Large". Used to keep long note values from running off the side of the reports.

CHAPTER

4 Making IV Measurements

Now that you are familiar with all of the user interface elements necessary to create an IV measurement project, this chapter will illustrate how they interact to define an IV measurement.

Starting from a Standard Project

IV measurement setups tend to vary so much from customer to customer and device to device that no meaningful Standard Projects have been defined for IV measurements.

Starting a New Project

Creating an IV measurement project from scratch will involve most of the setup screens introduced in the previous chapter. This section will concentrate on the order of steps and interactions between the various setup objects rather than all of the details of each step.

Create Instruments

The first step in creating an IV measurement project is setting up the Parameter Analyzer objects. You will need to add a separate Parameter Analyzer object for each channel of the instrument you need to use. Open the Instrument Setup window and add the first Parameter Analyzer channel. Make sure that the model, GPIB address, and channel are set correctly. Then add the rest of the channels, but copy the settings from the first one. The only thing you will need to change on the additional channels is the channel number. It is recommended that you set up all of the channels available on your Parameter Analyzer, since it doesn't take very long and will make your project as versatile as possible as you add more device tests.

Create Devices

The next step is creating your Device objects. Open the Device Setup window and create any devices you expect to test. Additional devices can easily be added later, so don't worry if you forget about any on the initial project creation. You may want to select names that correspond to specific devices you will be testing rather than generic ones like "FET" or "bipolar".

Create Connection Setups

The next step is creating Connection Setups for each device. Open the Connection Manager window and create any connection setups you expect to need. Note that connection setups are device-specific, so you will need at least one for every device you plan to test. Even if all of your connections are hardwired, every IV measurement script still requires a connection setup to create the Parameter Analyzer channel to device terminal linkage required to make the measurement. If your connection setups contain switch matrix control commands, it's a good idea to test them at this stage prior to connecting to an actual device that may be damaged by incorrect signal routing.

Create Measurement Setups

The next step is creating Measurement Setups for each test you plan to run. Note that measurement setups are device-specific, so even if you run very similar tests on two different devices, they will each need their own measurement setup. Open the DC IV Measurement Setup window and pay careful attention to compliance limits and measurement ranges when setting up each channel. The default measurement ranges are fairly low, and may lead to slower than necessary measurements if extreme accuracy isn't needed. The default compliance is the instrument maximum, which is usually sufficient to damage devices if something goes wrong during measurement, so you will probably want to change it to a lower value.

Create Measurement Scripts

The last step required to actually perform a measurement is creating scripts. Open the Script Editor window and create a measurement script for each measurement you plan to run. If you plan to eventually sequence several measurements in a single script, it's still a good idea to create each one as a stand-alone test so that you can debug it individually before creating a long complex script. When adding IV Measurement scripts, note that you must specify a connection setup for each script. The connection setup is optional for some other measurements, but is mandatory for IV measurements. Make sure that the connection setup you select and the measurement setup are both derived from the same device object. Also note that you will want to select different data object names for different measurements, but will probably want to follow some sort of naming standard to allow you to more easily re-use standard reports. Also take note of the data collection management options on the Script Editor if you plan to run a series of measurement scripts and then generate some reports. If each script is set to clear the data collection, you will lose previously measured data each time you run a new measurement script.

Run Measurement Scripts

At this point, it is a good idea to save the entire project, if you haven't already done so. On the off chance that something goes wrong, you wouldn't want to lose all your effort. You are now ready to run your measurement scripts to test them out and to generate some data. Select the script from the pull-down on the main toolbar and click *Run*. If you will eventually be running tests on-wafer, it's best to manually touch down on a known good device first and run the stand-alone test to verify it before doing a time consuming walk over the entire wafer, only to discover that there was an error in the measurement setup and none of the data is valid. It will also be much easier to set up and fine tune your reports if you have actual representative data to work with. Once you have tested your scripts, save the measured data to a .mea file so that you will have it available to work with later, either on the test stand, or off-line in your office.

Create Reports

Once you have representative data, the task of creating reports is much easier. Open the Report Editor window and create a Report Setup for each plot or tabular report you wish to view. Note that it is usually most effective to create a very basic report by simply selecting the data and letting Wavevue default and auto-scale everything else. Wavevue will also create a single-report layout with the same name as the report you create. View that report, and then go back and only adjust those settings that you need to change. This method saves a lot of time and effort over trying to guess what will look good at the start. You can repeat the fine-tuning process several times until you get the results you like.

Additional Tutorials

Tutorials for making IV measurements on different types of devices are being written regularly. Refer to the Microvue website for the most up to date list of tutorials. You can also download electronic versions of the tutorials there.

WWW http://www.microvueinc.com/Tutorials.htm

CHAPTER

5 Exporting Data to CAD Applications

Wavevue's mission is device measurement, not modeling. However, it is designed to interface with CAD applications to assist engineers in comparing actual vs. predicted behavior for devices. Currently only data export from Wavevue to CAD applications is supported, although measurement setup import is in the product roadmap.

ICCAP

Wavevue is designed to complement Agilent's ICCAP product by acting as the measurement engine to provide data for ICCAP's modeling engine. This is a more cost-effective use of resources than trying up expensive ICCAP modeling licenses to run test equipment.

Overview

ICCAP mdm files are currently created during the measurement process as each measurement is completed, rather than being a post-processing function. When you are creating the IV measurement script, specify the name of the mdm file to be created in the Parametric DC Measurement window shown below.

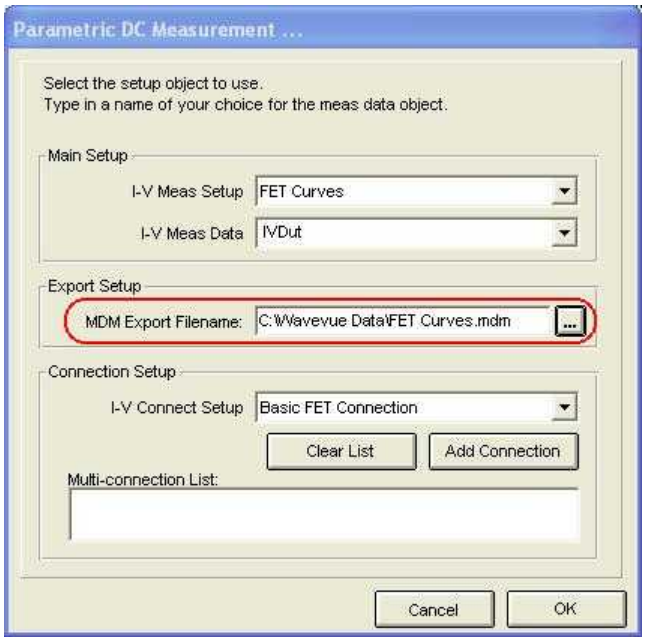


Figure 38. Parametric DC Measurement window

If the MDM Export Filename is left at the default value of None, then no export will happen. Otherwise, Wavevue will automatically create the specified file at the completion of the measurement.

Header format

Wavevue will automatically create an mdm INPUT header line for each IV stimulus and an OUTPUT header line for each response. These can be previewed in the Advanced tab of the DC IV Measurement Setup window shown below. All of the IV sweep types are supported by mdm syntax.

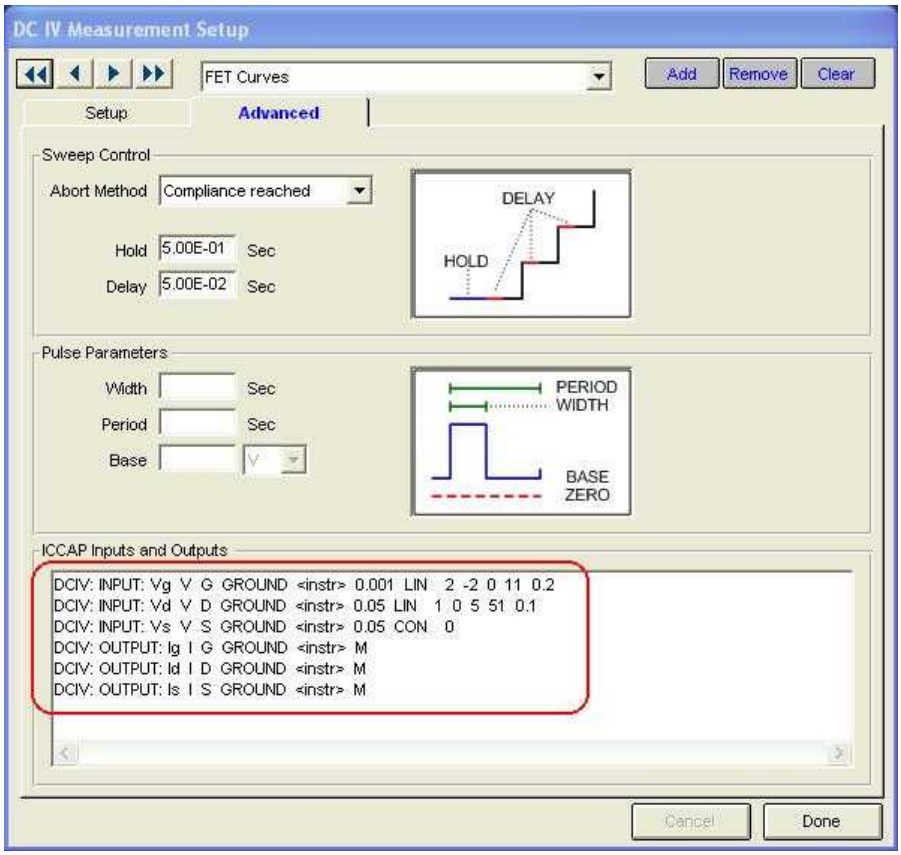


Figure 39. DC IV Measurement Setup window, Advanced tab

NOTE

Each INPUT and OUTPUT currently has the measurement instrument set to "<instr>". This is a flag which indicates to Wavevue that the value isn't known yet and must be resolved at the time of the actual export. The "DCIV:" at the beginning of each line will also be stripped off by Wavevue prior to the actual export.

Example MDM format file

Below is an example of an mdm export file created by Wavevue. This file is the result of a Gummel measurement as described in chapter 2.

```
! VERSION = 6.00
! AUTHOR = Wavevue Measurement Studio, Version 4.04.05
! CREATED = 7/1/2003 4:08:01 PM

BEGIN_HEADER
 ICCAP_INPUTS
  Vb  V  B  GROUND  DEFAULT  0.03  LIN  1  0  0.70  36  0.02
  Vc  V  C  GROUND  DEFAULT  0.1  SYNC  1  0  Vb
  Ve  V  E  GROUND  DEFAULT  0.1  CON  0
 ICCAP_OUTPUTS
  Ib  I  B  GROUND  DEFAULT  M
  Ic  I  C  GROUND  DEFAULT  M
END_HEADER

BEGIN_DB

 ICCAP_VAR Vc 1.0000E+00
 ICCAP_VAR Ve 0.0000E+00

#Vb           Ib            Ic
 0.0000E+00   1.1800E-12    -9.3000E-13
 2.0000E-02   1.2000E-12    -1.0000E-12
 4.0000E-02   1.3400E-12    -1.2300E-12
 6.0000E-02   1.4200E-12    -4.1000E-13
 8.0000E-02   1.4400E-12    -1.5000E-13
 1.0000E-01   1.4800E-12    1.0000E-13
 1.2000E-01   1.6100E-12    1.0500E-12
 1.4000E-01   1.8400E-12    3.0800E-12
 1.6000E-01   2.2500E-12    7.6800E-12
 1.8000E-01   2.9700E-12    1.7430E-11
 2.0000E-01   4.1000E-12    3.8640E-11
 2.2000E-01   6.0000E-12    8.4840E-11
 2.4000E-01   9.1900E-12    1.8498E-10
 2.6000E-01   1.4580E-11    4.0340E-10
 2.8000E-01   2.4030E-11    8.7904E-10
 3.0000E-01   4.0420E-11    1.9072E-09
 3.2000E-01   7.0040E-11    4.1498E-09
 3.4000E-01   1.2445E-10    9.0324E-09
 3.6000E-01   2.2654E-10    1.9609E-08
 3.8000E-01   4.2229E-10    4.2666E-08
 4.0000E-01   8.0724E-10    9.2805E-08
 4.2000E-01   1.5767E-09    2.0130E-07
 4.4000E-01   3.1377E-09    4.3787E-07
 4.6000E-01   6.3664E-09    9.5285E-07
 4.8000E-01   1.3095E-08    2.0687E-06
 5.0000E-01   2.7178E-08    4.4947E-06
 5.2000E-01   5.7080E-08    9.7788E-06
 5.4000E-01   1.2065E-07    2.1231E-05
 5.6000E-01   2.5552E-07    4.6042E-05
 5.8000E-01   5.4424E-07    9.9884E-05
 6.0000E-01   1.1589E-06    2.1591E-04
 6.2000E-01   2.4550E-06    4.6342E-04
 6.4000E-01   5.1707E-06    9.8611E-04
 6.6000E-01   1.0685E-05    2.0521E-03
 6.8000E-01   2.1248E-05    4.0935E-03
 7.0000E-01   3.9961E-05    7.6891E-03

END_DB
```

ADS

Wavevue does not currently export data to ADS in mdf file format. This capability is planned for a future release of the product, however.

CHAPTER

6 Getting help

Where to get more information

If you purchased your Microvue product from a third-party vendor, you can contact that vendor for service and support. Otherwise you may contact Microvue directly as shown below. Requests for sales, service, and technical support information will receive a prompt response.

- Telephone: (978)-251-0456
- FAX: (978)-926-0514
- e-mail: support@microvueinc.com

NOTE

When sending e-mail for technical support, please include information about both the hardware and software, plus a detailed description of the problem, including how to reproduce it. Be sure to include all project files associated with the issue in order to expedite support.

APPENDIX

A Defining Parameter Analyzer Channels

Overview

The Agilent 5270A and the Agilent 4142B are both 8 slot mainframes that can hold multiple SMU modules. Some of these modules are single height/width and some are double. An E5270 has SMU modules that are either 1 or 2 mainframe slots in *height*. The HP4142 has SMU modules that are either 1 or 2 mainframe slots in *width*.

For both instruments, a common question is:

Q: "How do I specify the slot number in Wavevue (or any application for that matter) for an SMU module if it occupies two mainframe slots instead of one?"

A: The answer for both instruments is to always specify the higher number. For the 5270A, this means the bottom-most slot occupied by the SMU module. For the 4142B, this means the right-most slot occupied by the SMU module.

Determine the slot for each SMU module using the process above and use that number in Wavevue as the slot number for a given channel of the overall supply

Agilent E5270A

The Agilent E5270A mainframe currently supports the E5280A 2-slot High Power SMU and the E5281A 1-slot Medium Power SMU. The user can configure any combination of 1-slot and 2-slot SMU modules.

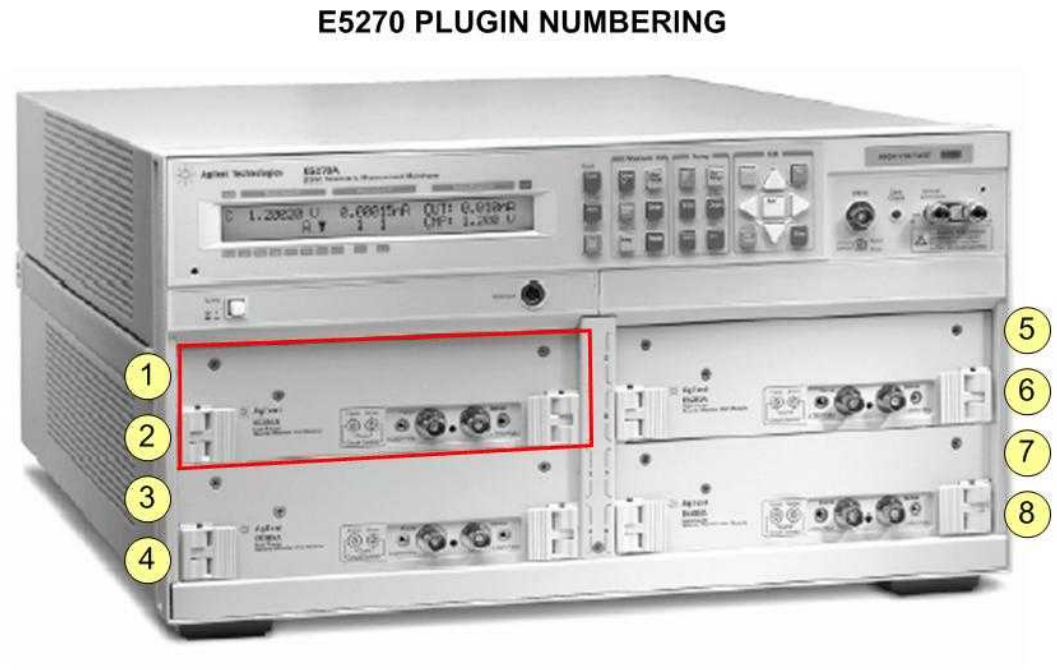


Figure 40. Agilent E5270A example

In this case, there are 4 SMU modules that occupy 2 slots each. The Appropriate slot numbers to define the four SMU's are 2,4,6, and 8 respectively. For an E5270, the connectors will always be in the same slot that applies to the channel number definition. This is not necessarily true for the HP4142.

Agilent 4142B

The Agilent 4142B mainframe currently supports the 41420A 2-slot High Power SMU and the 41421B 1-slot Medium Power SMU. The user can configure any combination of 1-slot and 2-slot SMU modules.

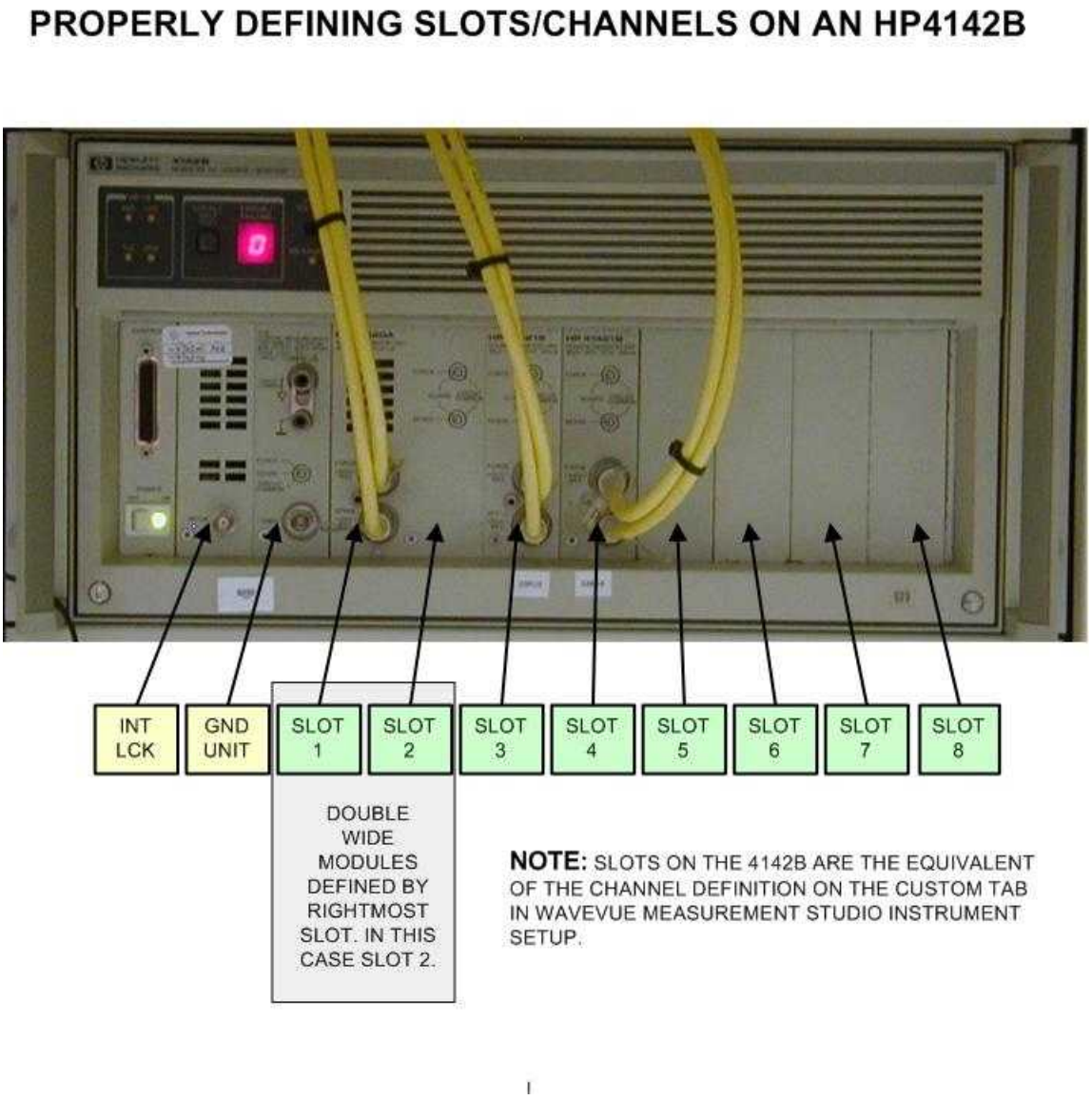


Figure 41. Agilent 4142B Example

In this case, there are 3 SMU modules that occupy 2 slots and 1 slot each. The Appropriate slot numbers to define the three SMU's are 2,3, and 4 respectively. For an HP4142, the connectors will NOT always be in the slot that applies to the channel number definition.

APPENDIX

B Creating a Custom Device

Overview

Wavevue allows you to create additional devices which will be added to the list available on the Device Type pull-down list. During installation, Wavevue creates two device-related folders in the installation path – "Device Types" and "Device Bitmaps".

"Device Types" contains the *.dsp (device setup) files. These are plain text files which define the device characteristics. On start-up, Wavevue scans this directory and uses it to create the list of devices available. Any *.dsp file that you add to this directory will then be available as a new device the next time Wavevue is run.

"Device Bitmaps" contains the *.bmp (bitmap) files for each device. One of the pieces of information in the *.dsp file for each device is the name of the corresponding bitmap file. Note that multiple devices may link to the same bitmap file. This file is used on the Device Setup window and also on the IV Measurement Setup window.

NOTE

The standard Wavevue devices are overwritten by each successive installation of Wavevue. For this reason, it is highly recommended that you do not directly edit these files, as you will likely lose your changes each time you upgrade Wavevue. Instead, you should make a copy of the standard device with a different name and make your changes there. Your custom devices will not be affected by subsequent Wavevue upgrades.

Dual Source FET

When creating a custom device, it is recommended that you find the closest standard Wavevue device to use as a starting point. Copy that *.dsp file and use it as a starting point in order to avoid syntax errors.

The example that follows will illustrate creating a dual source FET based on the Wavevue standard FET_3T_3P device. To create a new 4-terminal FET device, copy the existing "SPEC_FET_3T3P.dsp" file and re-name it as "SPEC_FET_4T4P.dsp". Then open the file using a word processor. Prior to making any edits, the new dsp file should look like this.

```
<REV2>
!
! DEVICE SPEC FILE
!
! DEVICE NAME: FET_3T_3P
! FILE   NAME: SPEC_FET_3T3P.DSP
! CREATED    : MARCH 13 2003
!
! NOTES:
! Graphics file must be 200x200 pixel bitmap format only.
! Graphics file pixel orgin is defined as (0,0) in upper left.
! Hot spot locations and dimensions are in pixels (positive values only).
! Hot spot location is upper left corner of hot spot rectangle.
!
DEVICENAME     = FET_3T_3P
DEVICEDESC     = Field Effect Transistor
GRAPHICFILE    = FET_3T3P_Structure.bmp
NUMTERMINALS   = 3
TERMNAMES      = Gate , Drain , Source
TERMABBREV     = G    , D     , S
ACTIVETERM     = True , True  , True
HOTSPOTX1LOC   =   5  ,  80   ,  80
HOTSPOTY1LOC   =  55  ,   5   , 115
HOTSPOTX2LOC   =  55  , 130   , 130
HOTSPOTY2LOC   = 105  ,  55   , 165
HOTSPOTCOLOR   =   1  ,   1   ,   1
HOTSPOTBUFFER  = 0
!
<END>
```

The meanings of the various tags in the file are explained in the table below.

Table 49. Device Setup file description

Tag Name	Description
DEVICENAME	The Device name which will be presented in the Wavevue device type pull-downs
DEVICEDESC	Description of the device which will be displayed on the Device Setup window.
GRAPHICFILE	The name of the graphic file which will be displayed on the Device Setup form to represent this device. These files should be 200x200 pixel bitmap files.
NUMTERMINALS	The number of terminals on the device
TERMNAME	The names for each terminal
TERMABBREV	The abbreviations for each terminal
ACTIVETERM	Flag indicating the type of terminal: True: active terminal which gets an IV measurement setup False: inactive sense terminal tied to another active terminal
HOTSPOTX1LOC	X1 point which defines the rectangular "hot spot" for each terminal
HOTSPOTY1LOC	Y1 point which defines the rectangular "hot spot" for each terminal
HOTSPOTX2LOC	X2 point which defines the rectangular "hot spot" for each terminal
HOTSPOTY2LOC	Y2 point which defines the rectangular "hot spot" for each terminal
HOTSPOTCOLOR	Color of the rectangle drawn around the "hot spot" on the Device Setup window.
HOTSPOTBUFFER	Pixel width of the "buffer" zone around the "hot spot" area (setting it to non-zero effectively makes the hot spot zone bigger.

Edit the file as follows. Add a column to the terminal data for the extra terminal and re-set all of the values. The easiest way to set the "hot spot" locations is to select dummy values to start with and then fine-tune the settings by jumping back and forth between the Device Setup window in Wavevue and the dsp file. Once you have completed the edits, the file should look like this.

```
<REV2>
!
! DEVICE SPEC FILE
!
! DEVICE NAME: FET_4T_4P
! FILE   NAME: SPEC_FET_4T4P.DSP
! CREATED    : MARCH 13 2003
!
! NOTES:
! Graphics file must be 200x200 pixel bitmap format only.
! Graphics file pixel orgin is defined as (0,0) in upper left.
! Hot spot locations and dimensions are in pixels (positive values only).
! Hot spot location is upper left corner of hot spot rectangle.
!
DEVICENAME     = FET_4T_4P
DEVICEDESC     = Field Effect Transistor, Source separated (no air bridge)
GRAPHICFILE    = FET_4T4P_Structure.bmp
NUMTERMINALS   = 4
TERMNAMES      = Gate , Drain , Source , Source2
TERMABBREV     = G    , D     , S      , S2
ACTIVETERM     = True , True  , True   , True
HOTSPOTX1LOC   = 5    , 80    , 64     , 109
HOTSPOTY1LOC   = 55   , 5     , 115    , 115
HOTSPOTX2LOC   = 55   , 135   , 109    , 154
HOTSPOTY2LOC   = 105  , 45    , 165    , 165
HOTSPOTCOLOR   = 1    , 1     , 1      , 1
HOTSPOTBUFFER  = 0
!
<END>
```

You will also need to create a graphic file for your new device. You can use any drawing tool that is capable of creating bitmap files. The standard Wavevue device drawings were created using Microsoft Visio. The graphic file for the dual source FET appears as follows. Note that the device bitmap files should be 200x200 pixels to avoid distortion on the various Wavevue windows.

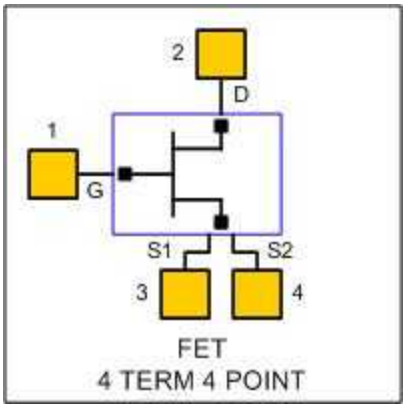


Figure 42. Dual source FET device bitmap

For additional tutorials on creating custom devices, refer to the tutorials section of the Microvue website. You can also contact Microvue for assistance in creating device graphics files.

WWW http://www.microvueinc.com/Tutorials.htm