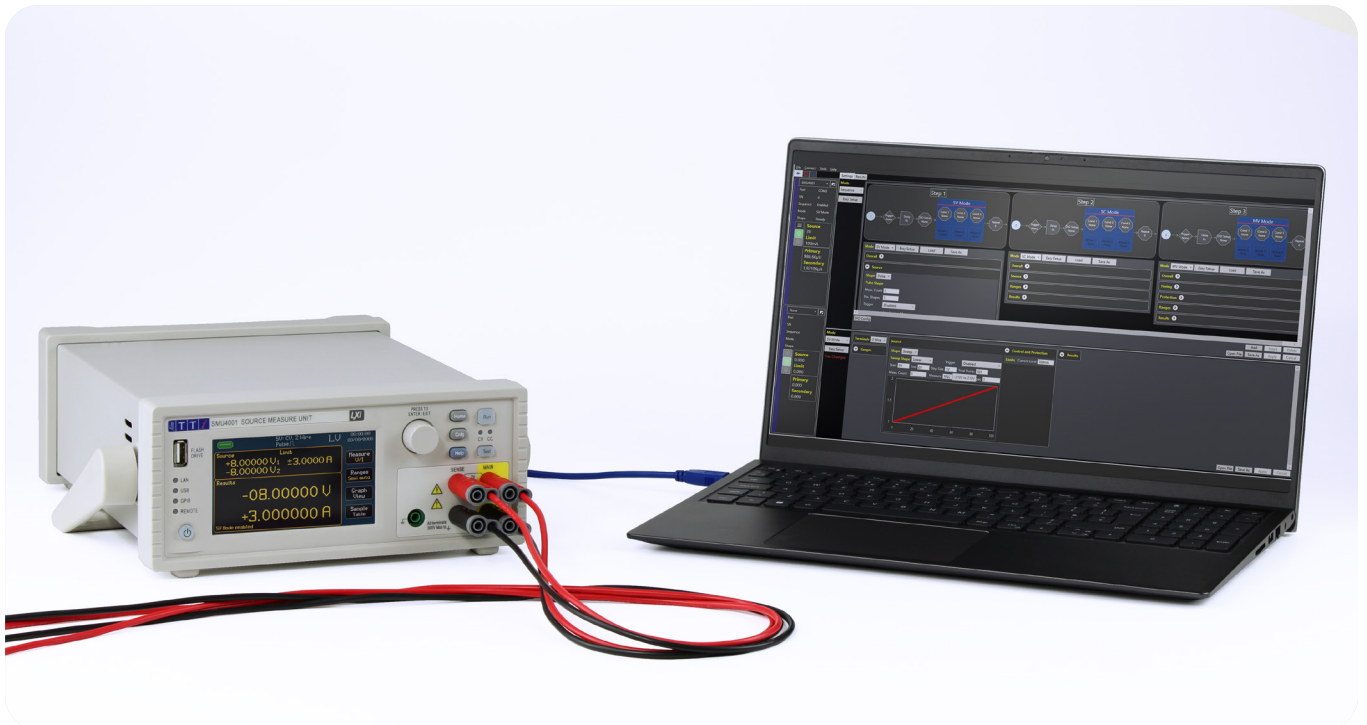


# INSTRUCTION MANUAL

EN



## TEST BRIDGE SMU

PC Software for SMU4000 Series

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# 1. INTRODUCTION

## Features

- Control 1 or 2 SMUs
- Full control of SMU
- Sequence builder
- Advanced graphing of data
- USB and LAN compatible

## Intended use

List of compatible instruments:

(Firmware updates may be required for compatibility)

SMU	
Series	Models
SMU4000	SMU4001, SMU4201 Compatible with firmware version 1.45-1.10-1.70-1.20-1.00-a and above

## Using this manual

Colour coding:

Green = Larger view / selected area

- ① Orange = Instruction to select
- ① Blue = Optional instruction to select
- ① Yellow = Description of item

## Symbols

The following symbols are displayed throughout the manual:

### CAUTION



Indicates a hazard that could damage the product that may result in loss of important data or invalidation of the warranty.

### NOTE

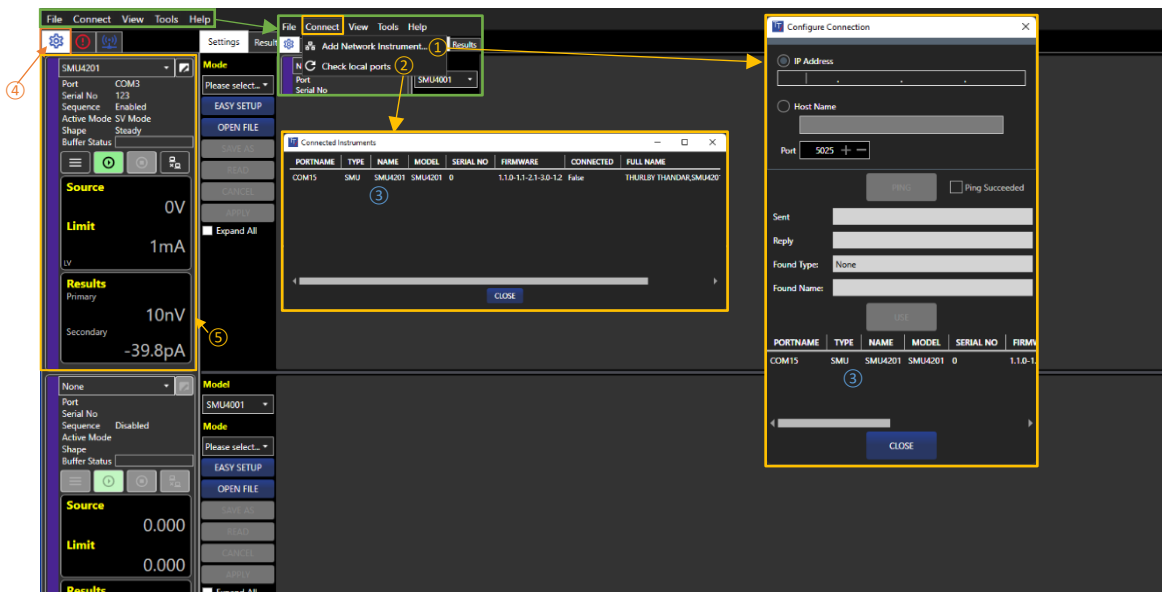


Indicates a helpful tip

## 2. GETTING STARTED

### File

**Open/Save Configuration:** Open or save the Instrument Control Panel and Recording Channel configurations.



**Exit:** Close the application.

### Connect

**Add Network Instrument:** ① Specify the IP address or hostname and enter the port number (5025) – see the instrument’s Instruction Manual for more details. Click the **Ping** button to test the connection- if successful, the **Use** button will activate. Click the **Close** button to continue.

**Check Local Ports (USB):** ② Display and refresh the list of available instruments.

The Instrument can be renamed from the connect window; double click on the name ③ to edit.

### NOTE



Following a power cycle, checking ports can take up to 10 seconds if not connected via LAN.

### View

Show/Hide the SMU control panel or graph.

### Tools

**Arb Generator:** Offline arbitrary waveform generator.

**File Upgrade:** Upgrade files from older versions of setup and sequence files to the latest version.

**Options:** Select from various ‘View’ and ‘Data’ options.

### Help

**Help:** This PDF guide to using the software.

**About:** Application details and a ‘report generator’ function to provide feedback.

### Instrument Control Panel

The Instrument Control Panel is selected using the icon ④. 1 or 2 SMUs can be connected to the Control Panel. Each Instrument will populate one control box ⑤. For details on how to use the Instrument control box, see *Instrument control*.

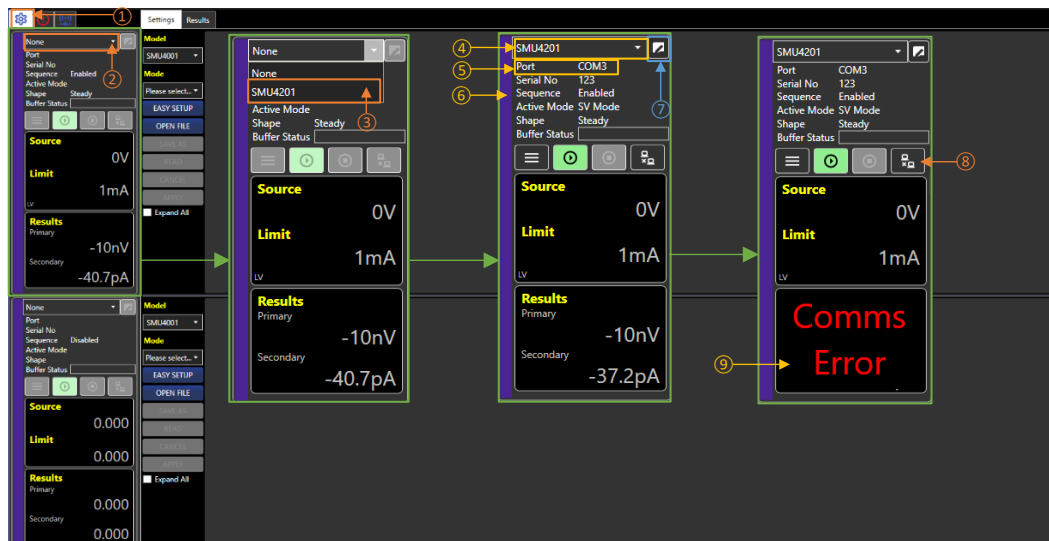
### Entering Values

Values entered validate after 1s. This is to allow users to enter a decimal point.

## 3. INSTRUMENT SETUP

### Select an Instrument

Firstly, ensure Instrument Control is selected ①.



Select the drop-down box in the Instrument Control Panel ② to show all instruments available.

If a connected instrument is not shown, see *Connect*.

The available instruments will be listed under the instrument name, e.g. 'SMU4001' for the SMU4001 source measure unit. If there is a mode or a sequence in the editor, you will be asked if you want to keep it or load the current mode/sequence from the instrument.

Select the instrument ③ to activate the Instrument Control Panel.

The instrument name will now be shown ④, in addition following additional information will be shown:

- COM port details or IP address
- Serial number
- Sequence mode status
- Active mode
- Active shape
- Buffer status (the status will show green unless it is > 90% full, when it will turn red)

A coloured strip will be allocated ⑥ on the left, indicating the product category.

The instrument can be given a unique name, using the edit box ⑦.

The meter digits show live readings when available (if off measurements are turned off, they will not be displayed).

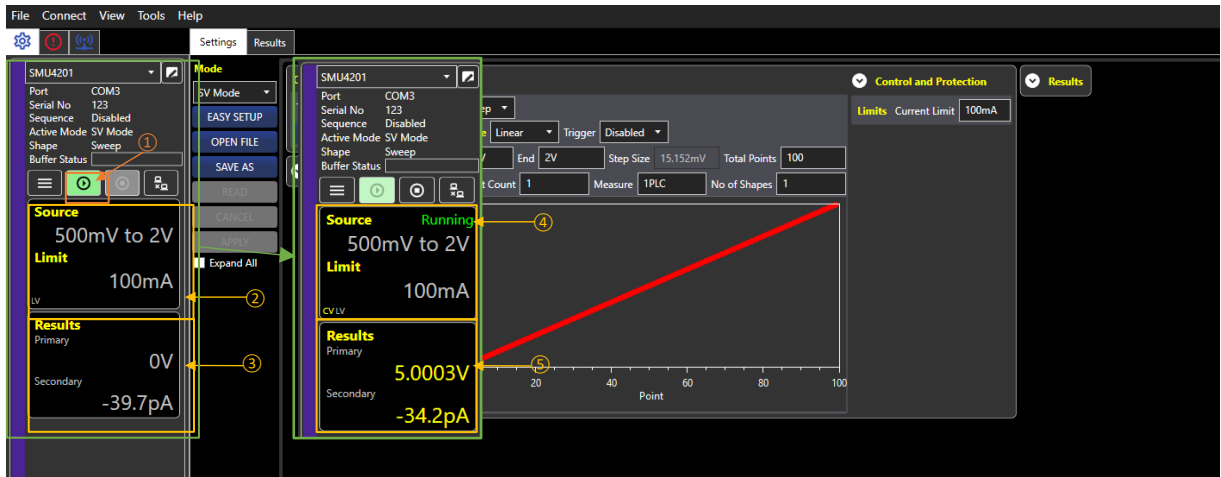
#### NOTE



The channel output state will match the instrument when connected; this may be on or off, depending on the setup.

To disconnect an instrument, select the disconnect button ⑧, or choose **None** from the drop-down box. This will reset the Instrument Control Panel back to the default state. If an instrument is connected and communication is lost a 'Comms Error' will show ⑨. Check connections and reconnect, as shown above. The mode or sequence in the editor will stay. This allows you to edit a Mode or Sequence offline before reconnection (or connecting to another instrument) and applying it.

# Instrument control



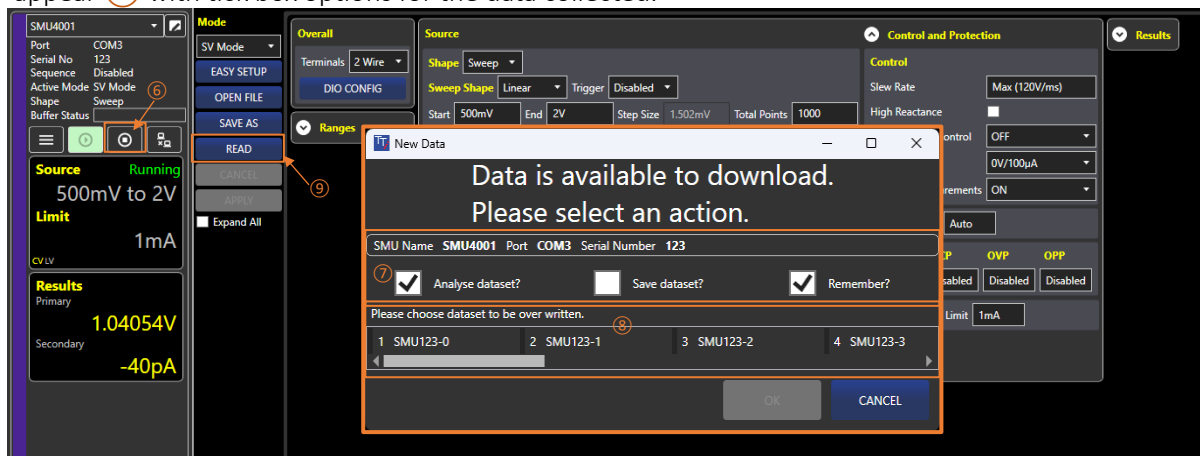
To run the setup, use the Run button ①.

If the instrument is in a mode that uses the source, the source level and limit are shown in ②. For example, when a sweep is selected as the shape, the source level will be shown as the first and last level of the sweep.

The live primary and secondary results are shown in ③ unless the output is off and 'Off Measurements' are disabled. If 'Off Measurements' are enabled, the results will be in grey. If a Math function has been added, it will also be shown here.

When the Run button ① is pressed, 'Running' ④ will appear in the source window, and the results will be shown in yellow ⑤.

Once the setup or sequence is complete, or the stop button ⑥ is pressed, a New Data pop-up will appear ⑦ with tick box options for the data collected.



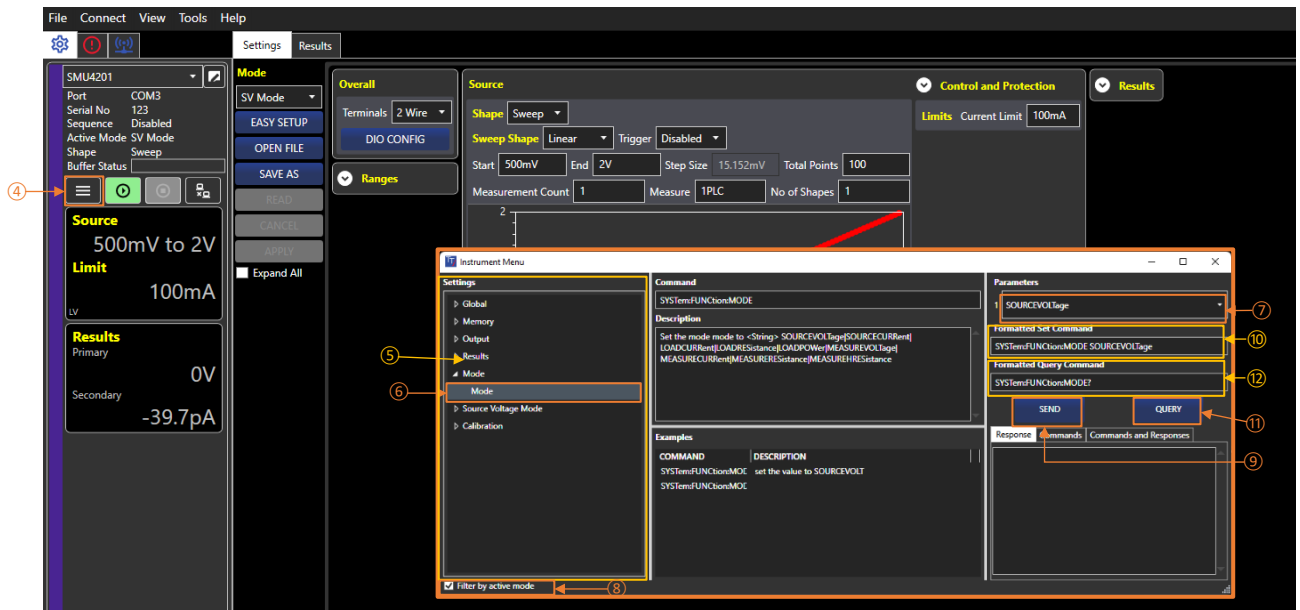
**Analyse dataset?:** Transfer data to the results tab for further analysis; see 'Results' for more details.

**Save dataset?:** Save data as a .CSV, .TSV or .TXT file (CSV ignores the PC's 'Regional format' settings. TSV and TXT formats will change depending on the 'Regional format' settings).

**Remember?:** Remember the selected options for next time.

Up to 10 datasets can be held in the results tab. Once the limit is reached, the New Data pop-up will contain the option to overwrite one of the existing datasets ⑧. Pressing the Read button ⑨ will retrieve the latest recorded results from the buffer in the SMU; if no data is available, the button will be disabled.

# Instrument menu



To access the Instrument Menu, select the Menu button **④**. This menu contains settings and functions such as OVP, limits, ranges etc. These are instrument specific and will vary depending on the instrument connected.

Each block of settings is contained within a tree view **⑤**; the selected setting on the left **⑥** defines the available parameters **⑦** on the right. If no parameter is available, the action has no numeric value option.

## NOTE



By default, only the commands for the active mode are visible; to access the commands for all the other modes, un-tick **⑧**. For example, if the command to change the mode is sent and the “Filter by active mode” is ticked, the tree will refresh to show the commands for the new mode.

Selecting a command will display the description and an example (referenced from the Programming Manual). Commands that have string parameters with fixed options will be shown in a dropdown list. Commands with numeric parameters will allow the user to enter a value in a text box. Commands where the numeric parameter has units will also have a dropdown list of the allowed units. Units are optional; where they are omitted, the base units will be used, e.g. V, A, W,  $\Omega$  or s.

Press **Send** **⑨** to send the formatted set command **⑩**. Alternatively, right-click to execute the example.

Press **Query** **⑪** to send the formatted query command **⑫**. The response will be shown in the “Response” box.

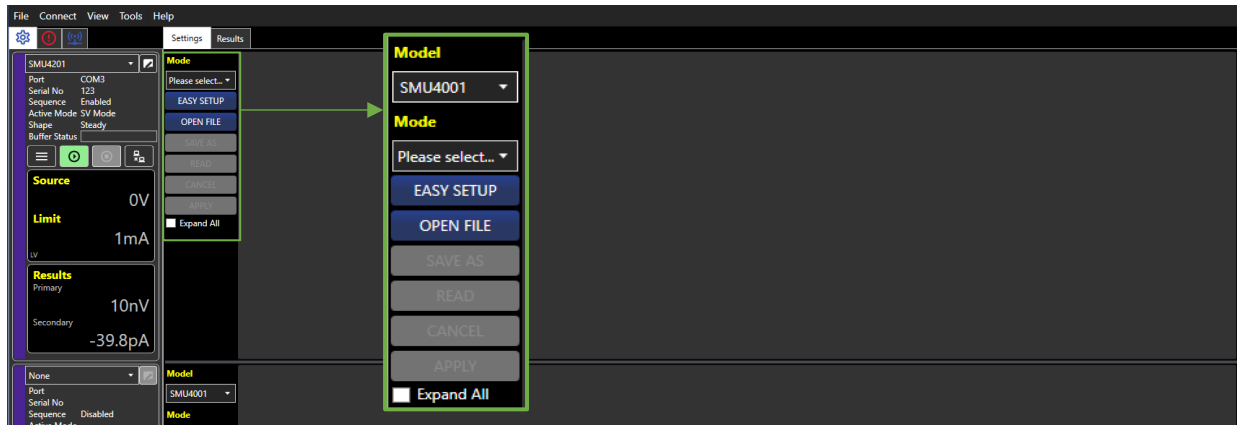
## NOTE



All commands are in the tree for reference. However, some cannot be executed; these commands send/receive files to/from the SMU or return large amounts of binary or ASCII data.

## 4. SETTINGS

The settings tab provides an interactive display of the settings for an SMU and allows setups to be created without an SMU connection.



The following options are available:

**Model:** Select the model for which the setup will be created, e.g., SMU4001. This is only available when an instrument is not connected.

### NOTE



Setups are model specific; e.g. A setup created for an SMU4001 will not run on an SMU4201. However, Setups and Sequences can be converted from one model to another using Test Bridge whilst the instrument is not connected.

**Mode:** Select the mode of the setup. This can be any of the following: SV Mode, SC Mode, LC Mode, LR Mode, LP Mode, MV Mode, MC Mode, MR Mode, MHR Mode or Sequence. Selecting a mode will show the editor for the mode.

**Easy Setup:** Open the Easy Setup window; see *Easy Setup Window* for more details.

**Open File:** Load a setup (.stp) or sequence (.seq) from a file into the editor.

**Save As:** Save the setup or a sequence to a file.

### NOTE



Save As and Apply will not be available if the setup or sequence has errors.

When a setup or sequence that contains a list is saved, a folder containing the file with the same name as the setup or sequence (for the list . CSV files) will also be saved to the chosen location.

**Expand All:** Show (expand) or hide all hidden sections of a setup or sequence in the editor.

The following options are available once an instrument is connected, data has been collected, or parameters have been changed:

**Read:** Manually read the buffer for the connected SMU only if it contains data.

**Cancel:** Cancel all changes and reload the active setup or sequence from the instrument.

### NOTE

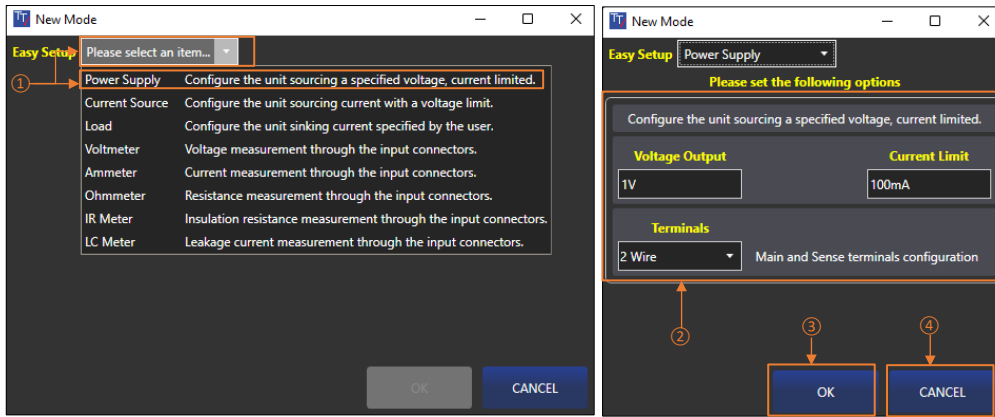


If the setup or sequence contains a list and is then cancelled, lists will not be loaded.

**Apply:** Send the setup or sequence to the instrument.



## Easy Setup Window



The Easy Setup menu contains a number of pre-configured setups, providing instant configuration for basic operational use of the SMU. First, select the setup from the dropdown list (1).

A brief description of the selected mode and mode-specific options will become available (2); only the description will appear if no options are available.

Enter the required values and select OK (3) to activate the mode with the set options; selecting Cancel (4) will close the window, and no changes will be applied.

## Mode Editor (Manual Setup)

The Mode Editor contains options for the source and measurement operating functionality. Once a mode has been selected, mode-specific options will become available. For sequence mode, See *Sequence Mode Editor*.



The Mode Editor is grouped into sections (as appears on the SMU GUI- Manual Setup):

**Overall:** General settings for the selected mode.

**Source/Sink/Measure:** The shape, control, limits and protection.

**Results:** Post-processing (Math and sorting functions).

**Ranges:** Set the current and voltage range.

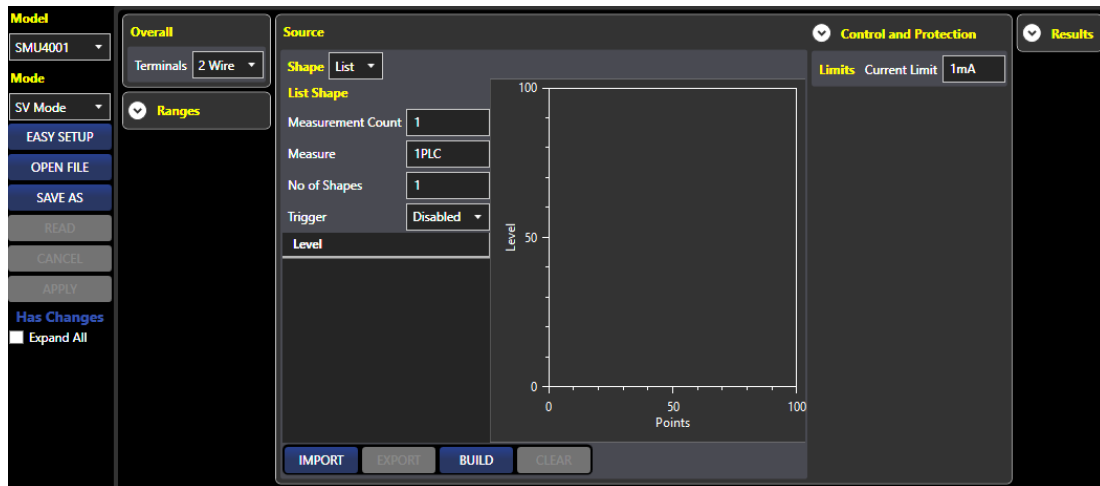
Invalid values will have a red outline (1). In addition, a summary of all the current errors will be shown at the bottom of the editor (2). While there are invalid values, saving the setup to file or applying it to the SMU (3) will not be possible.

## NOTE



Changes will be shown in the Mode Editor. To apply the latest changes to the SMU, press the **Apply** button in the *Settings* section.

## List Source Shape



The list source shape editor has the following additional options:

**Import:** Import a list of levels from a CSV file. If the CSV file contains multiple columns, a pop-up will appear with the option to select the column to import.

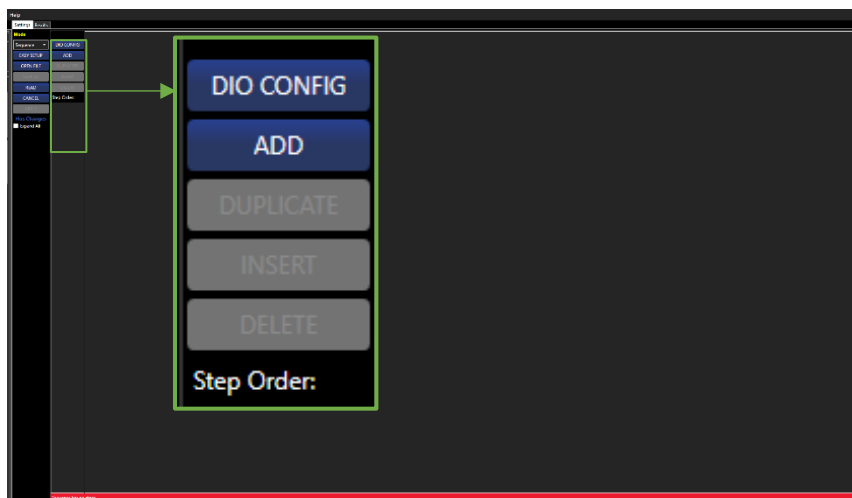
**Export:** Export the present list of levels to a CSV file.

**Build:** Open the Arb generator; this allows a custom list to be created; see *Arb Generator*.

**Clear:** Remove all points from the list.

## Sequence Mode Editor

The Sequence Mode Editor allows for the setup and configuration of multiple steps to form a sequence. This is created using user-stored configuration setups loaded into the sequence model to create a base for the additional actions. The Sequence Mode Editor has the following options:



**DIO Config:** Open the DIO Config window, used to configure the DIO pins.

**Add:** Add a new step to the end of the sequence, up to a maximum of 25.

**Duplicate:** Duplicates the selected step and adds the step to the end of the sequence.

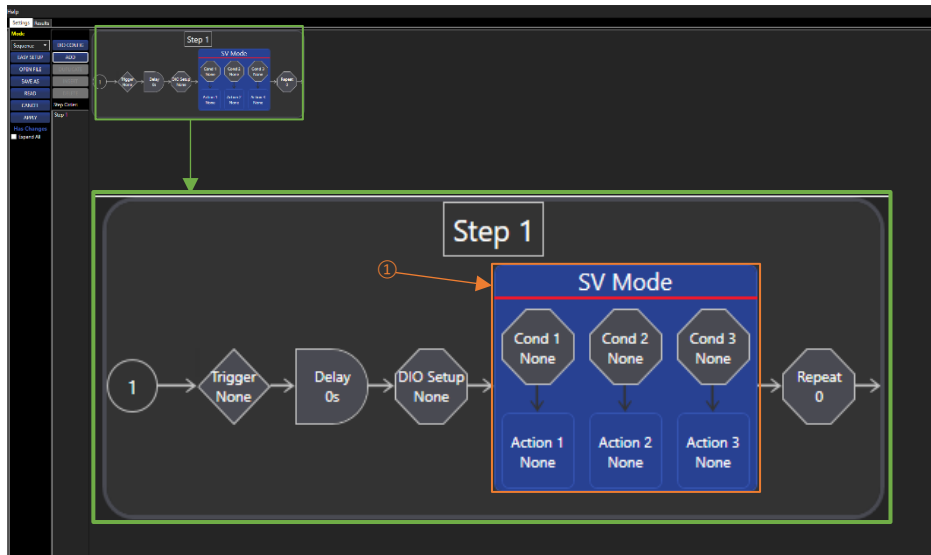
**Insert:** Insert a new step before the selected step.

**Delete:** Delete the selected step.

**Step Order:** Drag and drop the steps in the list box to re-order them.

To start building a sequence, **Add** a step. The steps are shown in order going across the window from left to right. See *Sequence Step Editor* for details on how to edit a step.

# Sequence Step Editor



The sequence step editor allows the following:

- Build/load a setup
- Set delays
- Repeat and jump to and from steps
- Create multiple triggered events
- Set output statuses

The Sequence Step Editor provides the option to edit the step of a sequence.

Each step must have a setup added; a default setup has been added to get started. Only one configuration setup can be added to each step.

The top of the sequence shows an overview of the step and in what order things will happen. Selecting an item in the overview will show more settings for that item below.

See the SMU4000 Series Instruction Manual for details on what can be set; this can be found at:

[www.aimtti.co.uk/support](http://www.aimtti.co.uk/support)

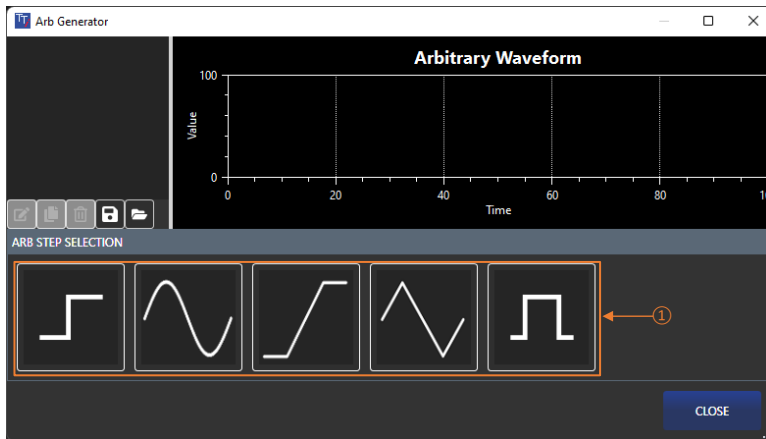
Selecting the mode box ① will show the mode editor ②. It is possible to set the name of the mode and the step using Overall > Name ③.

**Easy Setup:** Open the Easy Setup window; see *Easy Setup Window* for more details.

**Load:** Load a setup (.stp) from a file into the editor. The first eight characters of the selected file name will replace the mode name.

**Save As:** Save the setup to a file.

# Arb Generator



The Arb generator provides the tools to create a custom list of points that can be loaded as a list into a setup. A range of built-in step options is available, including sine wave, square wave, triangle wave, ramp, and step.

To add a step to the arb, select a shape from the options in the step selection ①.



Each shape has a unique pop-up window that gives the editable parameters for that shape:

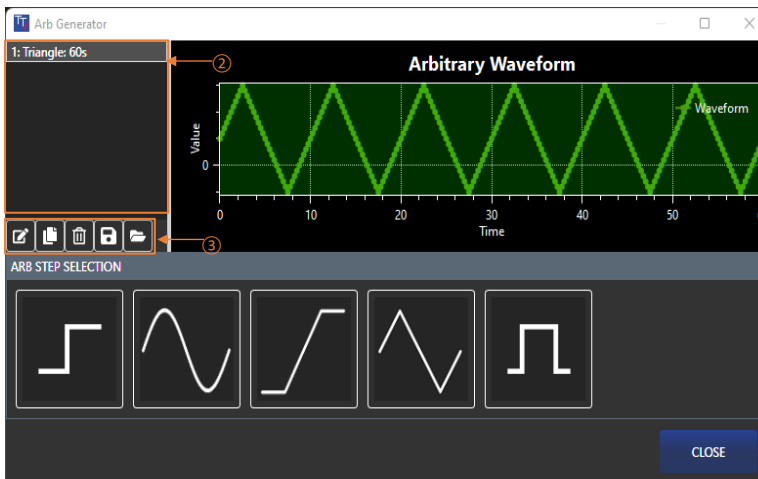
Each step has the option to Insert, Add or Cancel:

**Insert-** Place the step BEFORE the selected step.

**Add-** Place the step AFTER the last step.

**Cancel-** Return to the sequence without making any changes.

There is also an option to name the step.



Steps are listed on the left-hand side ②, these can be selected, and the following actions can be applied using the tools ③:

**Edit:** Edit the selected step. Opens the edit window.

**Duplicate:** Duplicates the selected step and opens the edit window.

**Delete:** Delete the selected step.

**Save:** Save an arb as a .CSV or .ARB file.

## NOTE



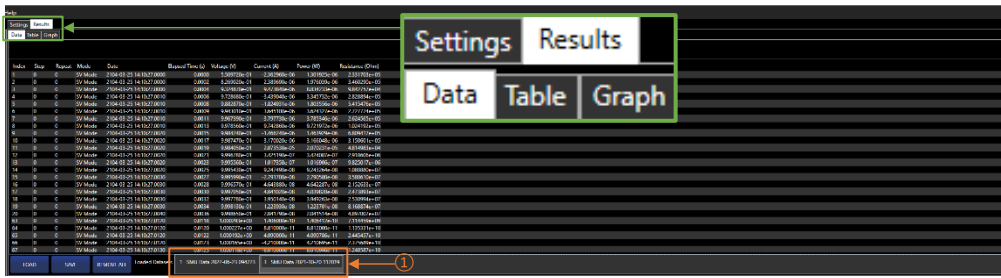
Arb files allow you to edit the arb steps later. Saving as a CSV file will not allow you to edit the arb; you can only load the points into a list.

**Load:** Load an .ARB file.

If the Arb Generator was opened from the list editor, clicking **OK** will return the Arb as a list of points to the list editor. You will be asked if you want to replace the current list or append the new points to the current list.

# 5. RESULTS

The results section is split into three tabs: Data, Table and Graph.

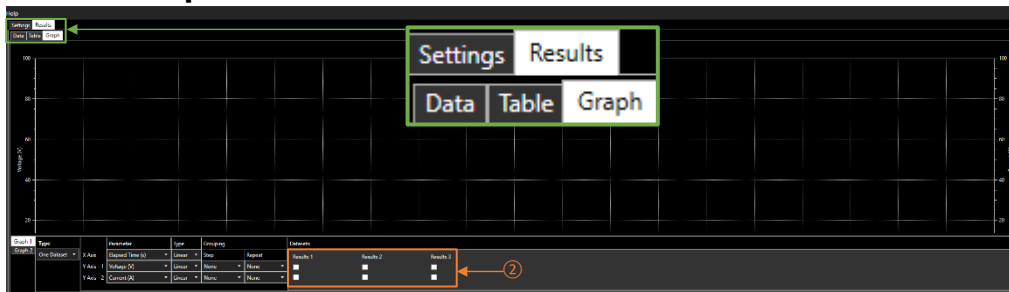


## Data

The Data tab shows the values in a dataset that have been loaded from the instrument or a file, these are loaded from the **Loaded Datasets** ① panel; click to select the required dataset or right-click to rename or remove it. See 'Instrument control' for more details on loading data from the SMU.

If Math is applied to the results, a Math column will be displayed.

## Table / Graph

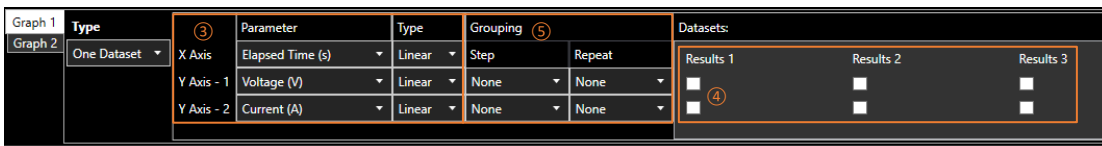


The data shown in the table tab shows the data selected in the **Datasets** section ② of the graph configuration panel; this is the data used to configure the graph.

## Graph Configuration

There are two types of graphs: **One Dataset** and **Two Datasets**, each with their own settings.

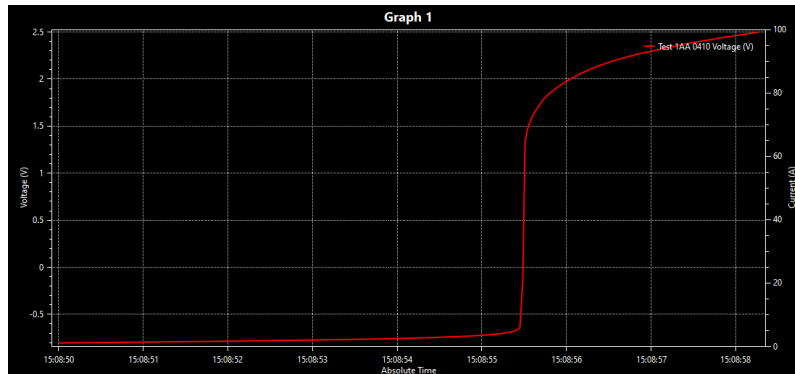
### One Dataset



Allows the plotting of data from multiple datasets. Choose X and Y parameters, axis type (linear or log), and grouping ③. For each dataset, tick to show on the primary and/or secondary y-axis ④.

Grouping is for use with results from a sequence ⑤. Grouping can be done on a change of step or change of repeat. Split will insert a break in the data but leave the data in the same series. New Series will create a new series for each group.

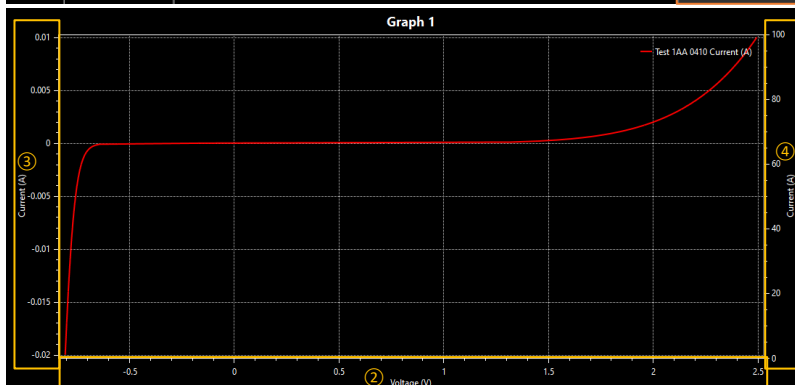
# Graph Features- One Dataset



Graph 1	Type	Parameter	Type	Grouping	Repeat	Datasets
Graph 2	One Dataset	Absolute Time	Linear	Step	None	<input checked="" type="checkbox"/> Test 1AA 0410
	X Axis	Voltage (V)	Linear	None	None	<input type="checkbox"/>
	Y Axis - 1	Voltage (V)	Linear	None	None	<input checked="" type="checkbox"/>
	Y Axis - 2	Current (A)	Linear	None	None	<input type="checkbox"/>

## Datasets, Parameters and Graph Types

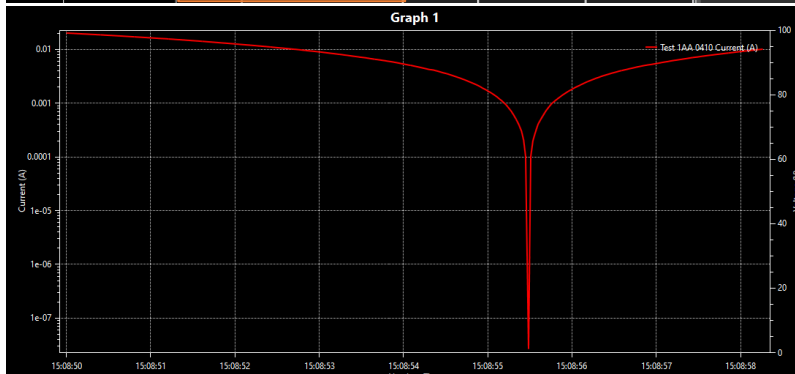
Select the tick box of the required dataset ① to show data on the graph. A graphical representation of the selected data will be displayed based on the graph's default settings.



Graph 1	Type	Parameter	Type	Grouping	Repeat	Datasets
Graph 2	One Dataset	Voltage (V)	Linear	Step	None	<input checked="" type="checkbox"/> Test 1AA 0410
	X Axis	Voltage (V)	Linear	None	None	<input checked="" type="checkbox"/>
	Y Axis - 1	Current (A)	Linear	None	None	<input checked="" type="checkbox"/>
	Y Axis - 2	Current (A)	Linear	None	None	<input checked="" type="checkbox"/>

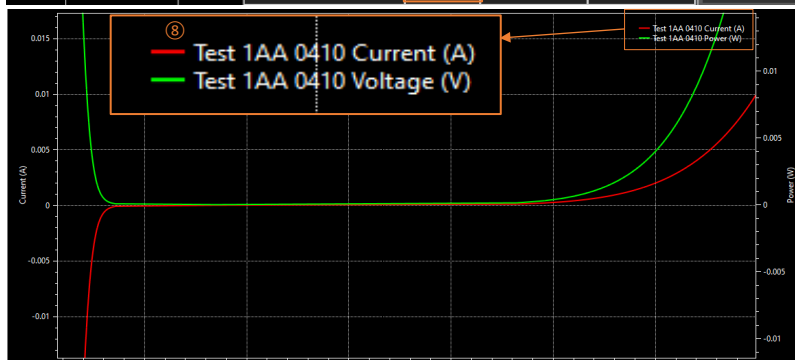
The X ②, Y1 ③ & Y2 ④ graph axes types can be changed using the Parameter settings ⑤.

Select an option from the drop-down box to show alternative parameter types from the loaded data. The options are Voltage, Current, Power Resistance or Expression; the X axis also includes the options of Elapsed Time and Absolute Time.



Graph 1	Type	Parameter	Type	Grouping	Repeat	Datasets
Graph 2	One Dataset	Absolute Time	Linear	Step	None	<input checked="" type="checkbox"/> Test 1AA 0410
	X Axis	Voltage (V)	Linear	None	None	<input checked="" type="checkbox"/>
	Y Axis - 1	Current (A)	Log	None	None	<input checked="" type="checkbox"/>
	Y Axis - 2	Voltage (V)	Log	None	None	<input checked="" type="checkbox"/>

Each graph axis type can be displayed in either a Linear or Log (logarithmic) format using the Type settings ⑥.



Graph 1	Type	Parameter	Type	Grouping	Repeat	Datasets
Graph 2	One Dataset	Voltage (V)	Linear	Step	None	<input checked="" type="checkbox"/> Test 1AA 0410
	X Axis	Voltage (V)	Linear	None	None	<input checked="" type="checkbox"/>
	Y Axis - 1	Current (A)	Linear	None	None	<input checked="" type="checkbox"/>
	Y Axis - 2	Power (W)	Linear	None	None	<input checked="" type="checkbox"/>

There are two Y-Axis options:

Y Axis-1 (Right)

Y Axis-2 (Left)

When both are selected for a single dataset ⑦, the data will be shown on one graph. Each variation of data displayed is assigned a colour ⑧.

## Grouping

Grouping is designed to be used with measurement data collected from the SMU when in Sequence Mode; the recorded measurement data must contain steps and/or repeats for grouping to work.

Grouping allows you to split a dataset when a step repeats or changes. Steps and/or repeat grouping can be viewed as **None**, **Split** or **New Series**.

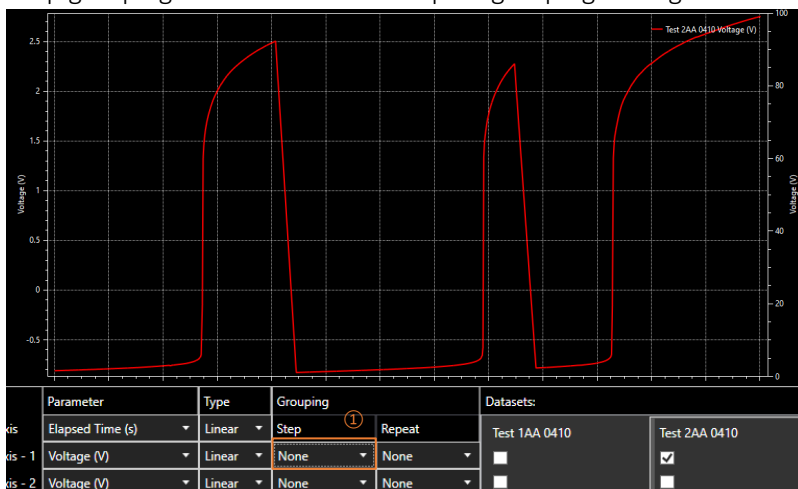
### NOTE



If the X axis is set to Elapsed time, the time will reset at the start of each series. See example ③ (below).

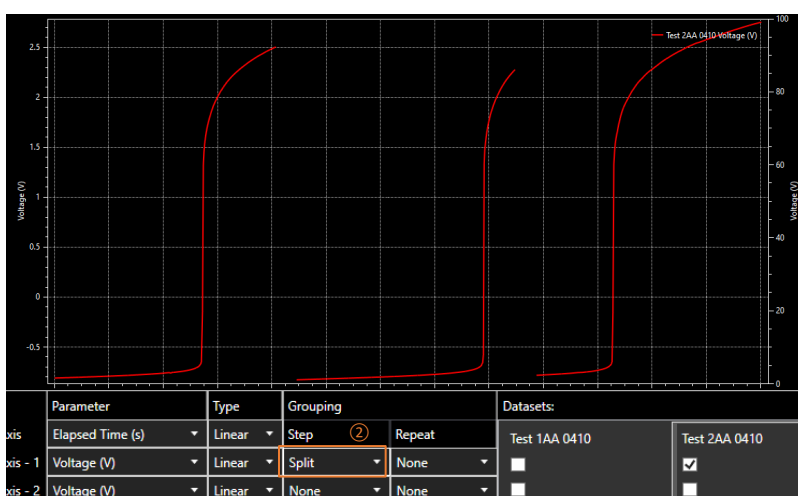
If the graph type is set to **Log**, the absolute value of the parameter will be displayed.

Step grouping must be set before repeat grouping settings are available.

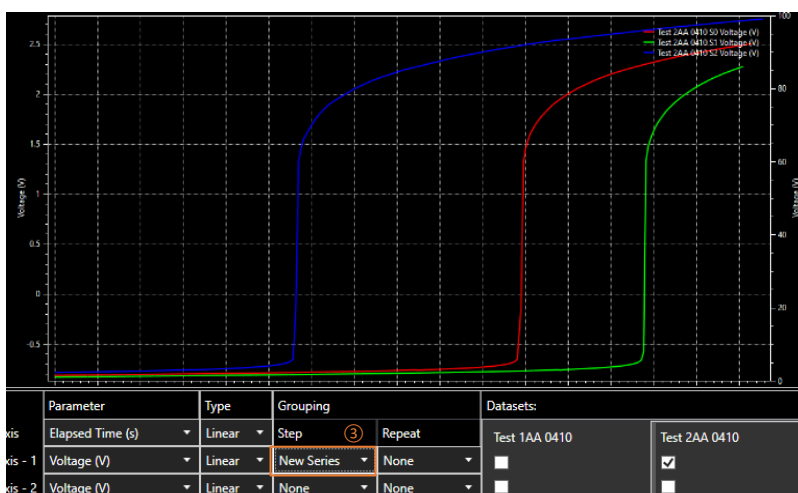


**Grouping by Step-** These examples show a sequence with three steps and no repeats:

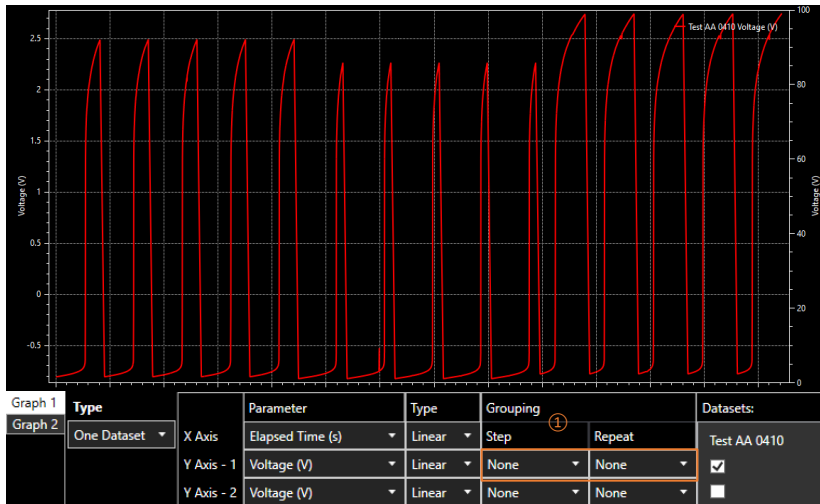
① **None-** Entire dataset is shown as a continuous line of data.



② **Split-** Each step within the dataset is split into individual steps on the X-Axis.

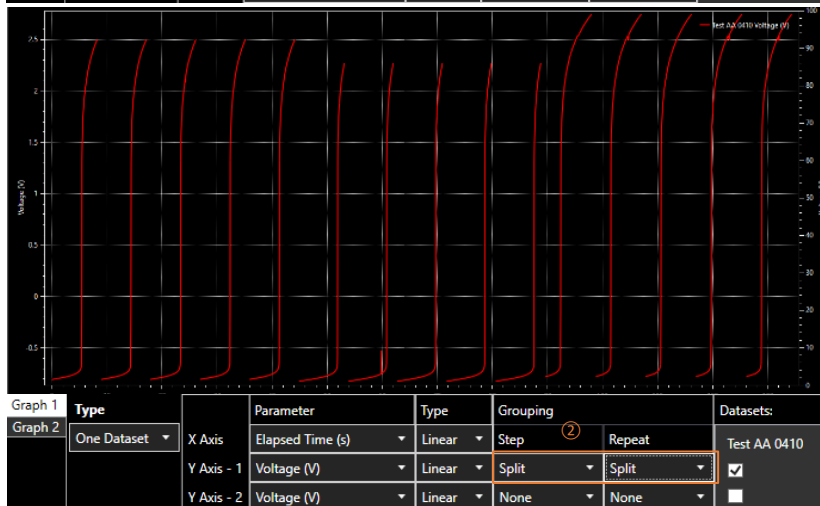


③ **New Series-** Each step within the dataset is shown as a new series on the X-Axis.

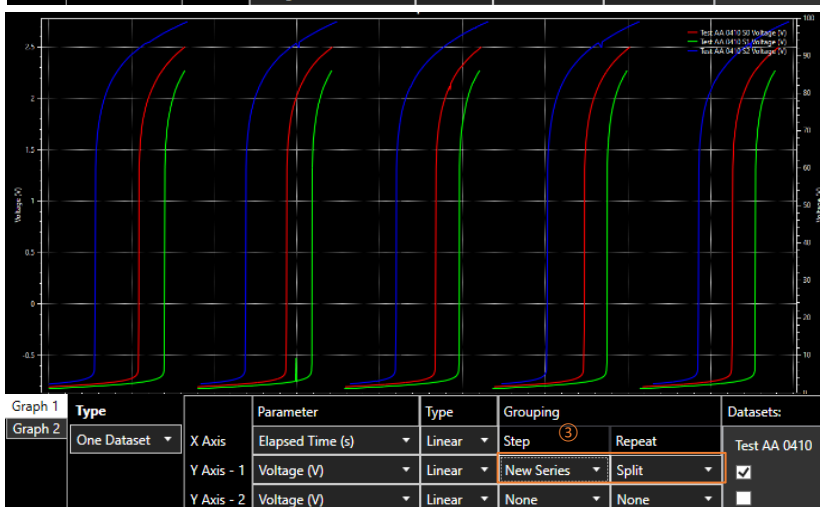


**Grouping by Repeat-** These examples show a sequence with three steps and four repeats:

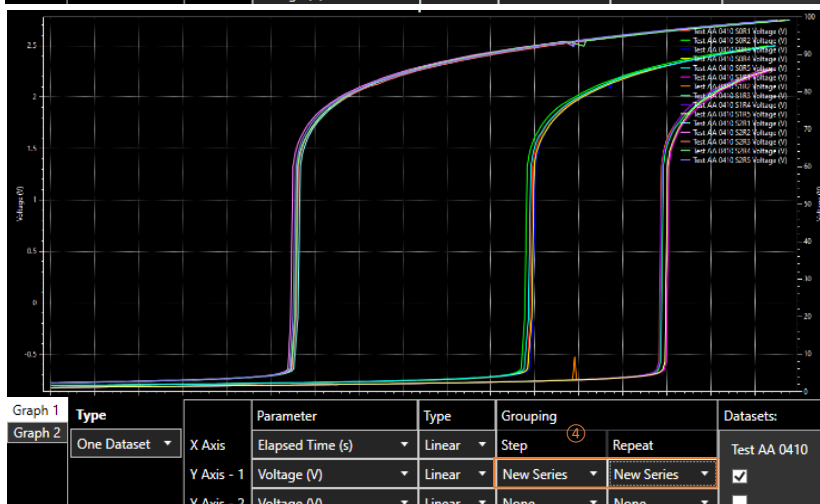
① None- Entire dataset is shown as a continuous line of data.



② Split / Split- Each step and repeat within the dataset is split into individual steps and repeats on the X-Axis.



③ New Series / Split- Each step within the dataset is shown as a new series on the X-Axis. In addition, each repeat within the dataset is split within the series.



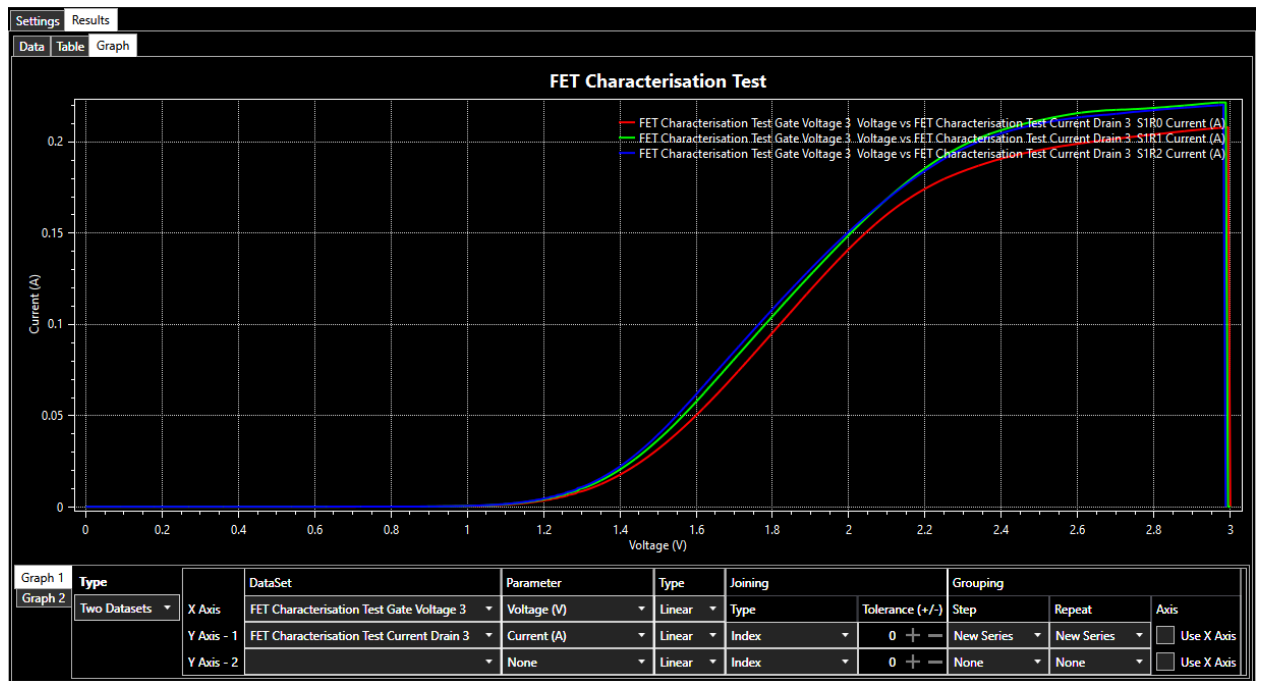
④ New Series / New Series- Each step and repeat within the dataset is shown as a new series on the X-Axis.



## Two Datasets

Graph 1	Type	DataSet	Parameter	Type	Joining	Grouping			
Graph 2	Two Datasets	X Axis	Elapsed Time (s)	Linear	Type	Tolerance (+/-)	Step	Repeat	Axis
		Y Axis - 1	None	Linear	Index	0 +/-	None	None	<input type="checkbox"/> Use X Axis
		Y Axis - 2	None	Linear	Index	0 +/-	None	None	<input type="checkbox"/> Use X Axis

This graph allows you to plot data from one dataset against data from a second. To enable the application to match the data, select the parameter on which the datasets should be joined and any tolerance in the joining ①.



## NOTE



Take care when joining datasets that contain multiple steps or repeats such that parameters with the same value are matched correctly. E.g. data from a sequence with multiple steps and/or repeats with similar data may not join as expected.

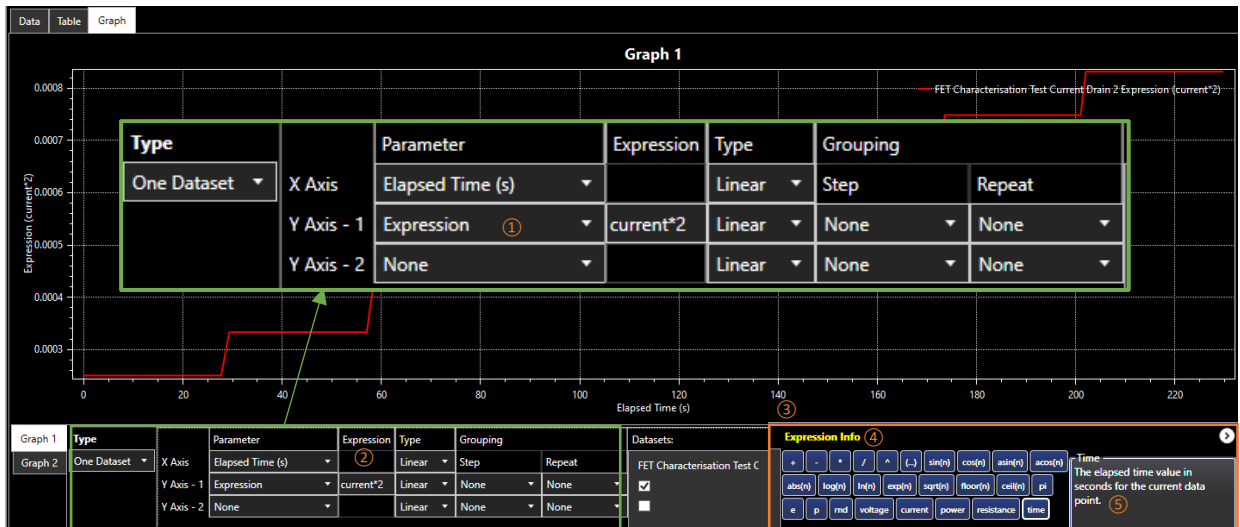
When joining two datasets, you need to select which parameters should be used; they can be any of the following: Index, Absolute Time, Relative Time, Voltage (V), Current (A), Power (W) or Resistance (Ohms). A tolerance can also be set; this is the range of values that can be matched between the two datasets.

For example, if you were measuring currents on two SMUs where the set voltage is being swept in the same sweep, and you want to compare the values, the voltages being measured would be very similar but not exactly the same, setting the tolerance to half the step size would allow the two datasets to be connected and will enable you to plot current 1 against current 2. Once the datasets are joined, you can plot and group parameters in the same way as you can in the “One Dataset” graph with one addition when grouping the y-axis dataset is used unless you tick the “Use X Axis” tick box ②.

## Expressions

Expressions can be added to the data shown in the graph. To add an expression, select 'Expression' from the Parameter options ① the Expression column will appear ②, in which an expression can be written, e.g. current\*2

The 'Expression Info' tab ③ will automatically appear when 'Expression' is chosen; each permitted expression is displayed as selectable buttons, and when clicked ④, a description is shown ⑤.

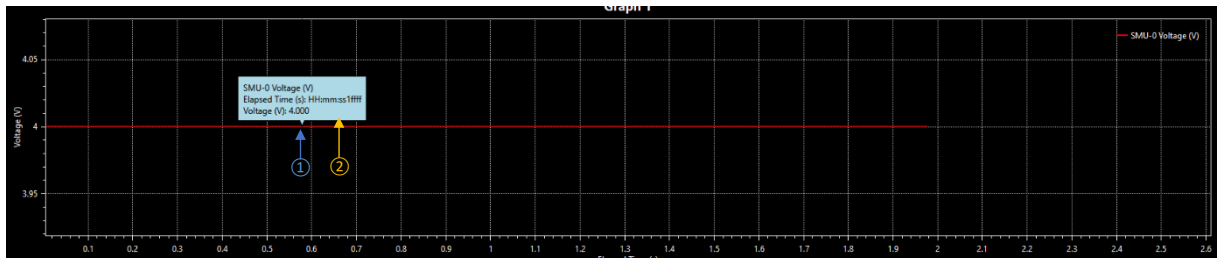


### Expression explanations:

+	Addition
-	Subtraction may also be used as a unary minus.
*	Multiplication
/	Division
^	Power, e.g. $\sin(n)^2$ will evaluate to the square of $\sin(n)$
( ... )	Group parts of the expression. E.g., $(1+2)/3$
$\sin(n)$	Returns the sine of n where n is in radians and is a valid expression. The returned value is in the range -1 to +1.
$\cos(n)$	Returns the cosine of n where n is in radians and is a valid expression. The returned value is in the range -1 to +1.
$\asin(n)$	Returns the arcsine of n where n is a valid expression. The returned value is in the range $-\pi/2$ to $+\pi/2$ .
$\acos(n)$	Returns the arccosine of n where n is a valid expression. The returned value is in the range $-\pi/2$ to $+\pi/2$ .
$\abs(n)$	Returns the absolute value of n where n is a valid expression.
$\log(n)$	Returns log base 10 of n where n is a valid expression.
$\ln(n)$	Returns log base e of n where n is a valid expression.
$\exp(n)$	Returns $e^n$ where n is a valid expression.
$\sqrt{n}$	Returns the square root of n where n is a valid positive expression.
$\text{floor}(n)$	Returns the nearest integer which is less than or equal to n where n is a valid expression. E.g. 2.34 returns 2.
$\text{ceil}(n)$	Returns the nearest integer which is greater than or equal to n where n is a valid expression. E.g. 2.34 returns 3.
pi	3.14159...
e	Euler's number 2.71828...
p	The current point number
rnd	Produces a random number between -1 and +1
Voltage	The Voltage value in Volts for the current data point
Current	The current value in Amps for the current data point
Power	The power value in Watts for the current data point
Resistance	The resistance Value in Ohms for the current data point
Time	The elapsed time Value in seconds for the current data point







## Graph View

The View menu can show or hide graphs 1 or 2. If one graph is hidden, the remaining one will fill the graph display area. If both graphs are visible, the size can be adjusted using the central splitter bar.



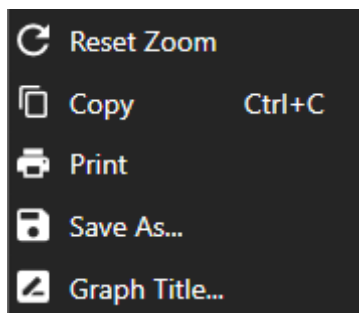
**Show Values** - Click and drag the mouse across the graph ① to show the details ② of that specific point in the logged data. This can be dragged along the entire data line to show any point within the log.

The following actions are available for graph navigation. To begin, click on the graph area:

 <b>Pan</b>	Right-click and drag	Alt + left click and drag	Arrow keys	 <b>fine pan</b>	Ctrl + Right-click and drag	Ctrl + Alt + left click and drag	Ctrl + Arrow keys
 <b>Zoom</b>	Mouse wheel (Will zoom X/Y1 Axes)	Numeric keypad +/-	Page Up / Page Down	 <b>Fine zoom</b>	Ctrl + mouse wheel	Ctrl + numeric keypad +/-	Ctrl + Page Up / Page down
 <b>Zoom a rectangle</b>	Ctrl + right-click and drag	Middle mouse button	Ctrl + Alt + left click and drag	 <b>Reset zoom</b>	'A' on the keyboard,	Right click select Reset Zoom	Alt + Ctrl + left double click
<b>Note:</b> To zoom in one axis only, place the cursor over the axis, then use the mouse wheel to zoom							

## Graph Options

Right-click on the graph for the graph options.



**Reset Zoom:** Reset the zoom level to show all data.

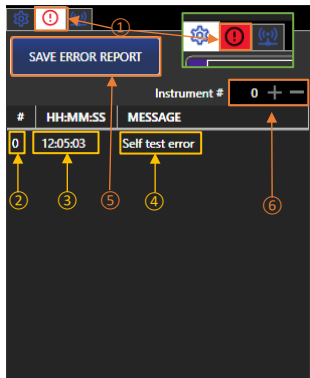
**Copy:** Copy an image of the graph as seen in the graph display.

**Print:** Print the graph on a white background.

**Save As:** Save an image of the graph on a white background, or save the graph data as a .CSV, .TSV or .TXT file (CSV ignores the PC's 'Regional format' settings. TSV and TXT formats will change depending on the 'Regional format' settings). This is useful when comparing two datasets on one graph; only the displayed data will be exported.

**Graph Title:** Rename the graph.

## 6. ERROR LOG AND COMMUNICATIONS



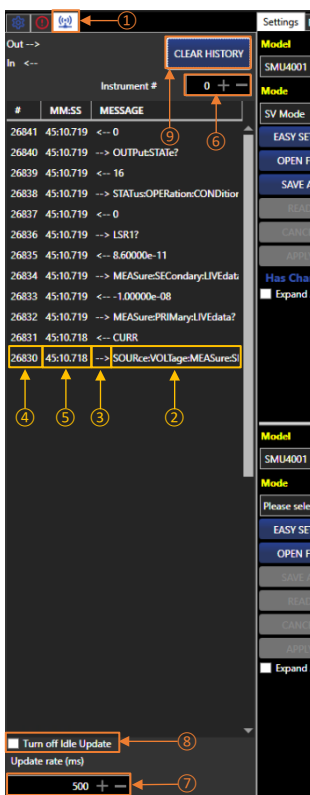
### Error Log

The Error Log panel is selected using the tab (1) and will present any errors that have been logged. The icon background will turn red if there are new errors and the tab isn't selected.

Each error message (4) has an index number (2) and time allocated (3) as a reference point.

The Error Log can be saved using the **Save Error Report** button (5).

To change the instrument, select the number reference (6) using the +/- keys. Numbers run from 0-1, starting with the first instrument at 0.



### Communications

The communications panel is selected using the tab (1).

The communications panel shows the commands between Test Bridge and the connected instruments.

Messages (2) are either sent or received commands; this is indicated with the Out/In arrows (3). In addition, each message has an index number (4) and time allocated (5) as a reference point.

To change the instrument, select the number reference (6) using the +/- keys. Numbers run from 0-1, starting with the first instrument at 0.

Messages are recorded at the selected interval update rate (7) - the minimum is 100ms. Messages are recorded even when the instrument is idle. To stop communications recording idle data, select the **Turn Off Idle update** (8).

The history can be cleared using the **Clear History** button (9).

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