

DC Power Efficiency Measurement Software User Manual

Supports most Programmable Power Supplies and DC Electronic Loads

Also supports 2/4 Quadrant Power Supplies (must have programmable sink capability)
Must connect instruments through serial interface.

DC Power Efficiency Measurement Software (Source: Unknown) (Sink: Unknown)

Config Display Panel Graphs Table Tests Power Supply DC Load Data logger About

Source (Input)

0V 0A

Set Voltage: 0 V

Set Current: 0 A

0W

Sink (Output)

0V 0A

Set Voltage: 0 V

Set Current: 0 A

0W

Source [Input Voltage] [Voltage Sweep]: Unknown

Start Voltage: V Stop Voltage: V

Increment By: V Current Limit: A

Test Config

Measurement Samples per Test: Samples

Add Offset to Efficiency Values: %

Sink [Output Load] [Current Sweep]: Unknown

Start Current: A Stop Current: A

Increment By: A Set Voltage: V

Test Start

Test Name: Test Files Directory:

Single Input (No Sweep): ☐

Output Log

[2021-01-27 4:14:22 PM] Welcome Nirav, to my DC Power Efficiency Measurement Software.

[2021-01-27 4:14:22 PM] To use this software you will need a power supply and a DC Electronic Load.

[2021-01-27 4:14:22 PM] If you don't have a DC Electronic Load then you may use a 2/4 Quadrant Power Supply that has programm

[2021-01-27 4:14:22 PM] Click on Config Menu and then click Connect to get started.

Test Runtime 00:00:00 Test Status: Not Running Tests Completed: 0 of 0 Progress

Created by Nirav Patel
Supports Windows 10, 7, 8, & 8.1

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Theory of Operation

This software utilizes two instruments, one is a power supply to set the input voltage and the other is an electronic load to set the output load current. The power supply connects to the input terminals of your circuit. The power supply must operate in constant voltage mode and thus its current limit must be set appropriately. The dc electronic load connects to the output terminals of your dc circuit. The dc electronic load must operate in constant current mode.

The instruments must be connected through a serial interface. This software does not support any other type of interface. The accuracy of the software results depends on the accuracy of your instruments.

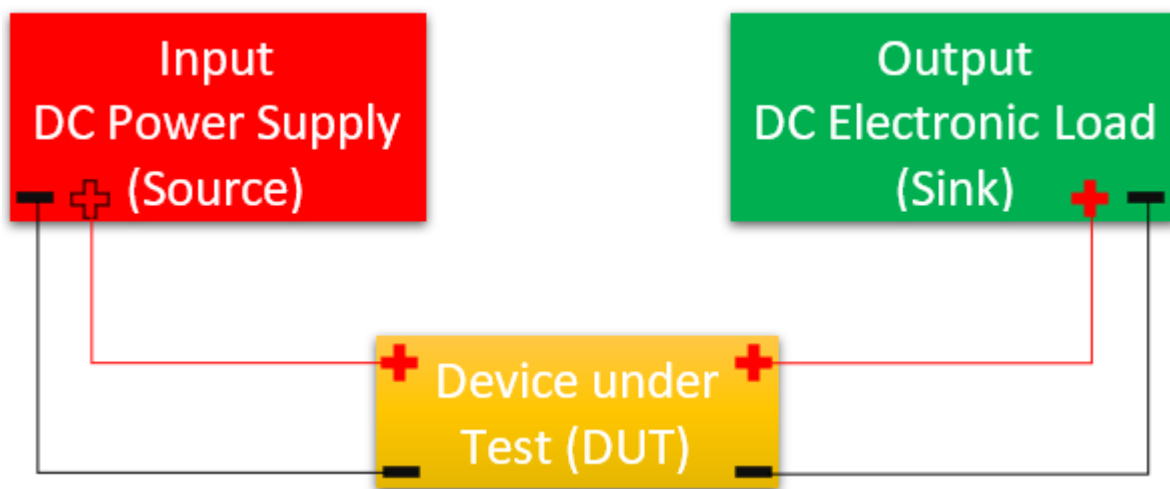


Figure 1: Test fixture. Connect your power supply to the input terminals of your device. And connect your dc electronic load and or 2/4 quadrant power supply to the output terminals of your circuit. The power supply will provide power to your circuit and measure voltage and current on the input terminals of the device. The dc electronic load will consume power from your device, as well as measure voltage and current on the output terminal of your device.

How the software calculates power efficiency among other stuff

The software only gets the measured voltage and current data from your power supply and dc electronic load. It uses this data to calculate input power (W), output power (W), power efficiency (%), power loss (%), input resistance (Ω), output resistance (Ω), and circuit resistance (Ω).

$$\text{Efficiency (\%)} = \eta = \frac{\text{Power out (W)}}{\text{Power in (W)}} * 100$$

$$\text{Power out (W)} = (\text{Output voltage (V)}) * (\text{Output current (A)})$$

$$\text{Power in (W)} = (\text{Input voltage (V)}) * (\text{Input current (A)})$$

$$\text{Input Resistance (\Omega)} = \frac{\text{Input voltage (V)}}{\text{Input current (A)}}$$

$$\text{Output Resistance (\Omega)} = \frac{\text{Output voltage (V)}}{\text{Output current (A)}}$$

$$\text{Circuit Resistance (\Omega)} = \text{Input Resistance (\Omega)} - \text{Output Resistance (\Omega)}$$

$$\text{Power loss (\%)} = 100\% - \text{Power Efficiency (\%)}, \text{ assume max efficiency is } 100\%$$

Figure 2: The above equations are used by the software.

Software Loops

The core of the software is nothing but a three for loop, each one is within another one. The first loop is for setting input voltage on the power supply. The second loop is for setting the output load current on your dc electronic load. The third loop is about measuring voltage and current on the input and output side of your device.

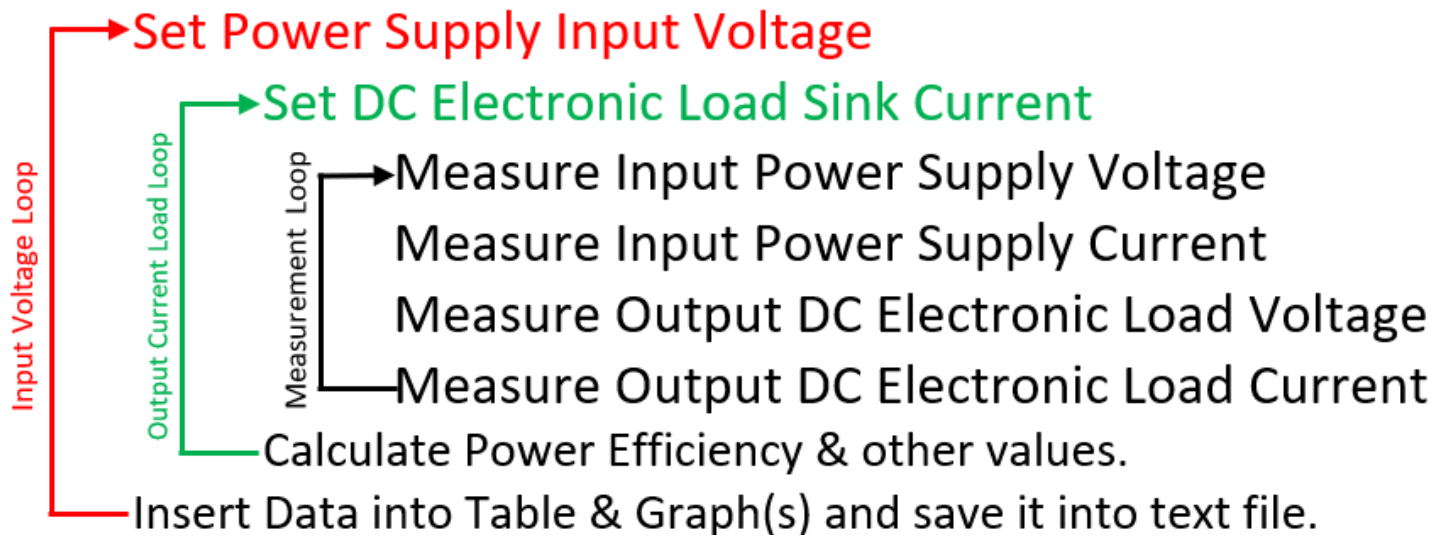


Figure 3: The Software loop for calculating power efficiency (%) for multiple input voltages and output current load values.

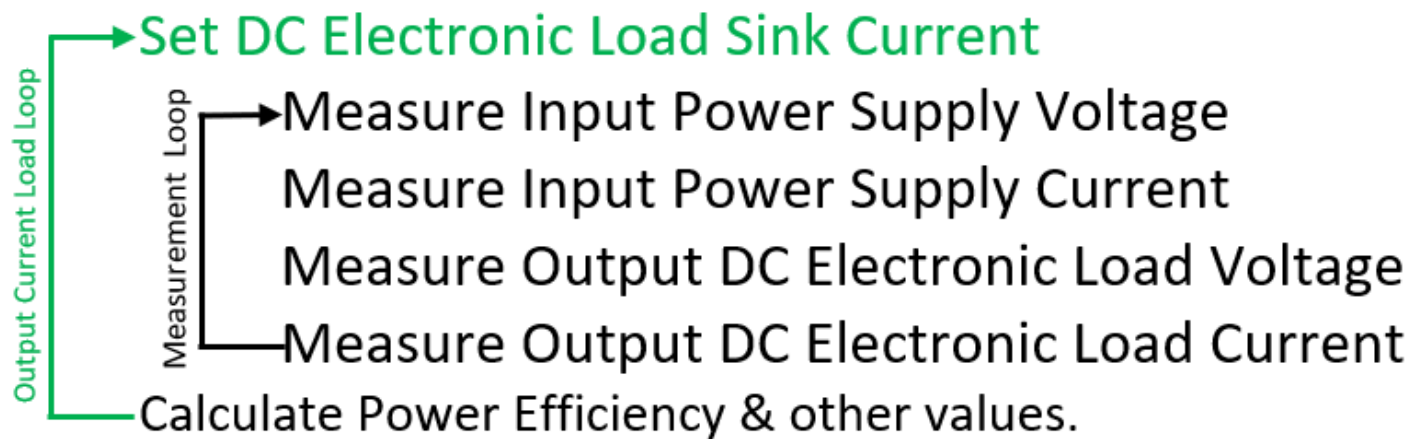
The input voltage loop depends on start voltage, stop voltage and voltage increment values. The output current loop depends on start current, stop current and increment current values. The final loop is your measurement loop, this loop depends on measurement samples. The total tests depend on how many input voltages you want to test your device's power efficiency for. Please keep in mind the maximum input voltages the software can handle is 50. The set input voltage loop can only loop 50 times. The set sink current loop determines how many load current values you want your device to be tested for, per input voltage value. The measurement loop runs for each set sink current value.

1 measurement sample = 4 measurements (2 for power supply + 2 for dc electronic load)

The maximum measurement samples the software can handle for total input voltage loops is 50000. That is $50000 * 4 = 200000$ measurements read from power supply and dc electronic load.

Of course, you should never reach these limits, the software would have to do a lot of computational processing and your computer might not handle it, and the software might crash. A total of 20 input voltage values per complete software loop.

Set Power Supply Input Voltage



Insert Data into Table & Graph(s) and save it into text file.

Figure 4: The Software loop for calculating power efficiency (%) for single input voltage and multiple output current load values. This loop is enabled by checking the single input (no sweep) check box in the test start box.

Main Software Window

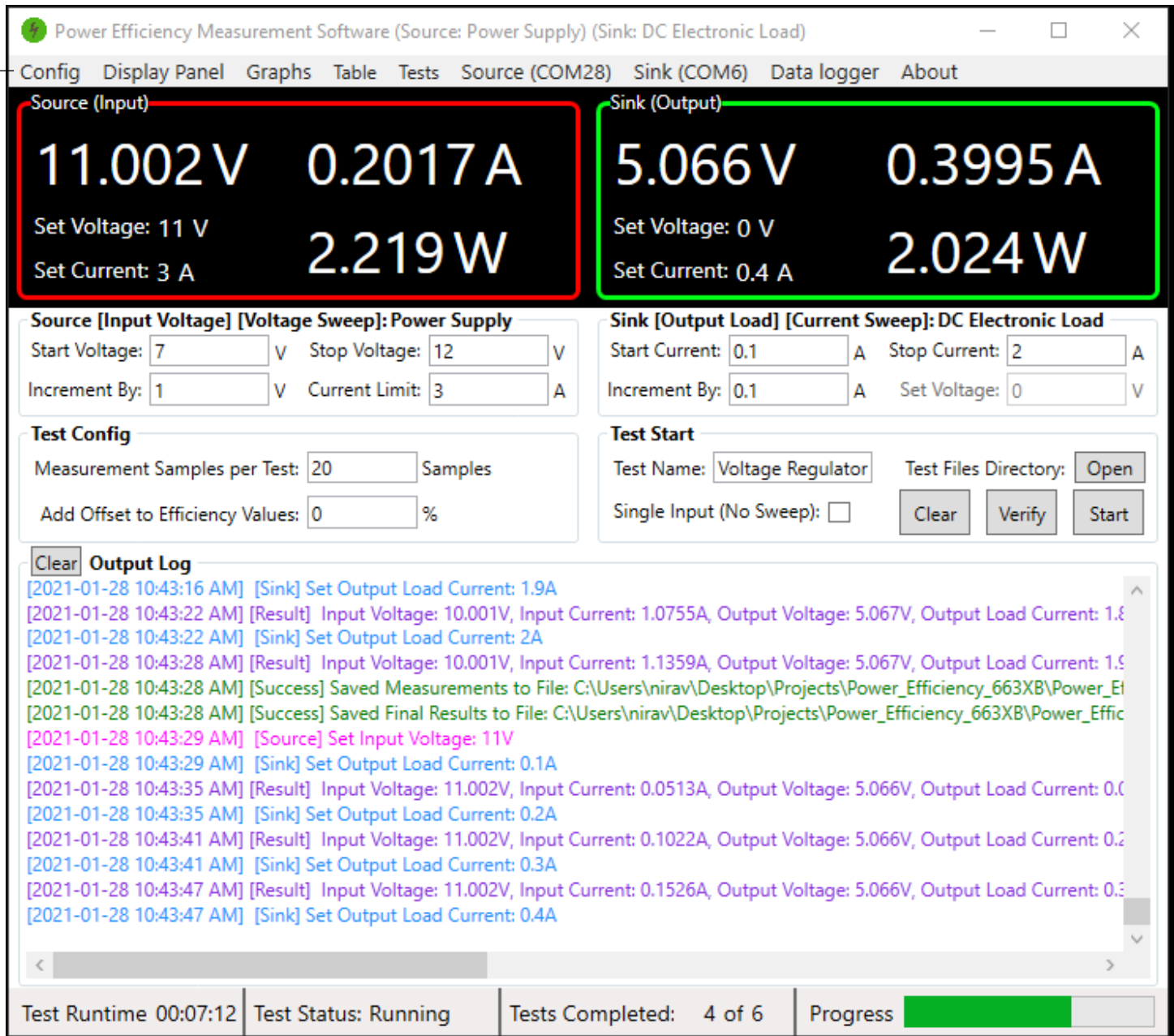


Figure 5: The main software window while tests are being completed. It is recommended to not interact with any software windows like graph windows as doing so may slow the testing down as the UI thread has a higher priority than the test loop function.

➔ Click the config menu and then click connect to open the COM select window.

COM Select Window

Select COM Ports for Source and Sink

COM Ports for Source

Refresh

COM3 - Intel(R) Active Management
COM6 - USB-SERIAL CH340 (COM6)
COM28 - USB-SERIAL CH340 (COM28)

Power Supply Source [Input]

COM Port Number: COM22

Bits per second: 9600

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

Write Timeout: 1000

Read Timeout: 1000

Request to Send: False

Source Information

Connects to the input terminals of your device. Provides power to the device connected to it.

Name:

Max Voltage: V

Max Current: A

Commands: Load

DC Electronic Load Sink [Output]

COM Port Number: COM23

Bits per second: 9600

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

Write Timeout: 1000

Read Timeout: 1000

Request to Send: False

Sink Information

Connects to the output terminals of your device. Takes power from the device connected to it.

Name:

Max Voltage: V

Max Current: A

Commands: Load

COM Ports for Sink

Refresh

COM3 - Intel(R) Active Management
COM6 - USB-SERIAL CH340 (COM6)
COM28 - USB-SERIAL CH340 (COM28)

Info Log Clear

[2021-01-27 5:57:34 PM] Test Data will be saved inside the software directory.
[2021-01-27 5:57:34 PM] C:\Users\nirav\Desktop\Projects\Power_Efficiency_663XB\Power_Efficiency_663XB\bin\Debug\
[2021-01-27 5:57:34 PM] Click the Data Files Directory button to select another directory.
[2021-01-27 5:57:34 PM] Set your power supply parameters and load the commands file.
[2021-01-27 5:57:34 PM] Set your DC Electronic Load parameters and load the commands file.
[2021-01-27 5:57:34 PM] Click the Connect button when you are ready.

Config

Data Files Directory: Select

Verify Power Supply: Verify

Verify Load Device: Verify

Connect

Figure 6: The most important window, the software will not function without properly configuring your power supply and dc electronic COM connections.

How to connect your Power Supply to the software

Power Supply Source [Input]

COM Port Number: Enter the com port or double click on it from the source list.

Bits per second: Select the COM bit rate, for most HP, Agilent, Keysight is 9600.

Data bits: Data bits is usually 8 for most devices.

Parity: Parity is usually None for most devices.

Stop bits: Stop bits is usually 1.

Flow control: Flow is also usually none.

Write Timeout: Write timeout depends on your device, is in milliseconds.

Read Timeout: Read timeout depends on your device, is in milliseconds.

Request to Send: Usually set to false, at least for HP, Agilent, Keysight devices.

Source Information
Connects to the input terminals of your device. Provides power to the device connected to it.

Name: The name of your power supply or any name really.

Max Voltage: V The maximum voltage your power supply can output.

Max Current: A The maximum current your power supply can output.

Commands: Must load a command text file to let software know what commands to send to your power supply. **Very Important Step. If skipped, then default SCPI commands will be used.**

Figure 7: Power Supply config box.

```
PowerSupply_Command_Template.txt - Notepad
File Edit Format View Help
replace_me_Set_Voltage_Command
replace_me_Set_Current_Command
replace_me_Measure_Voltage_Command
replace_me_Measure_Current_Command
replace_me_Output_On_Command
replace_me_Output_Off_Command
0
20
0
-----End of Command-----
```

Figure 8: This power supply command template text file can be found inside the software's directory, located inside the Command files folder.

```
SCPI_Standard.txt - Notepad
File Edit Format View Help
VOLT
CURR
MEAS:VOLT?
MEAS:CURR?
OUTPut ON
OUTPut OFF
10
12
1
```

Figure 9: This is what a proper command file should look like.

How to connect DC Electronic Load to the software

DC Electronic Load Sink [Output]

COM Port Number:

Bits per second:

Data bits:

Parity:

Stop bits:

Flow control:

Write Timeout:

Read Timeout:

Request to Send:

Sink Information

Connects to the output terminals of your device. Takes power from the device connected to it.

Name:

Max Voltage:

Max Current:

Commands:

Enter the com port or double click on it from the source list.

Select the COM bit rate, for most HP, Agilent, Keysight is 9600.

Data bits is usually 8 for most devices.

Parity is usually None for most devices.

Stop bits is usually 1.

Flow is also usually none.

Write timeout depends on your device, is in milliseconds.

Read timeout depends on your device, is in milliseconds.

Usually set to false, at least for HP, Agilent, Keysight devices.

The name of your dc electronic load or any name really.

The maximum voltage your dc electronic load can handle.

The maximum current your dc electronic load can handle.

Must load a command text file to let software know what commands to send to your dc electronic load. **Very Important Step. If skipped, then default SCPI commands will be used.**

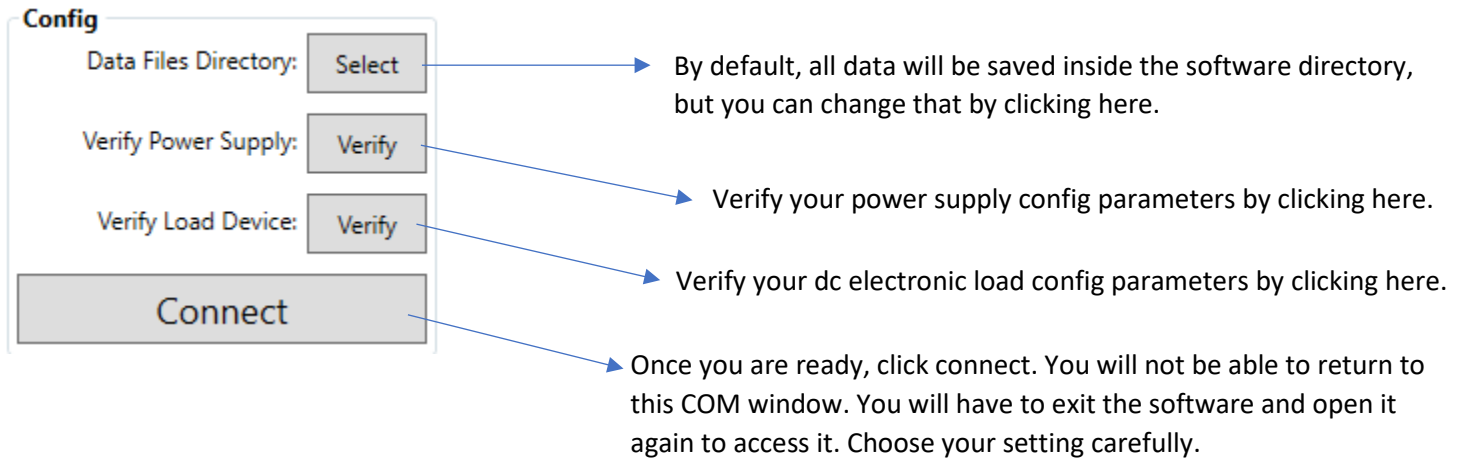
Figure 10: DC Electronic Load config box.

```
DCLoad_Command_Template.txt - Notepad
File Edit Format View Help
replace_me_Set_Voltage_Command_if_not_supported_then_leave_it_blank
replace_me_Set_Constant_Current_Load_Value_Command
replace_me_Measure_Voltage_Command
replace_me_Measure_Current_Command
replace_me_Output_On_Command
replace_me_Output_Off_Command
0
20
0
-----End of Command-----
```

Figure 11: This dc electronic load command template text file can be found inside the software’s directory, located inside the Command files folder.

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Config Box, Ready to Connect



Input and Output Parameters Explained

Source [Input Voltage] [Voltage Sweep]: Power Supply

Start Voltage: V Stop Voltage: V
Increment By: V Current Limit: A

The final input voltage you want your circuit to be tested for. The software may not reach this value depending on increment value.

Your power supply must operate in constant voltage mode (CV), set the current limit so that you power supply stays in CV mode.

The value the software will sweep input voltage values from start to finish. Larger number means less tests.

The initial input voltage you want your circuit to be tested for.

Sink [Output Load] [Current Sweep]: DC Load

Start Current: A Stop Current: A
Increment By: A Set Voltage: V

The final output load current value you want your circuit to be tested for. The software may not reach this value depending on increment value.

Should not be used, useful for 2/4 quadrant power supplies. Not so much for dc electronic loads. **Disabled by default.**

The value the software will sweep output load current values from start to finish. Larger number means less tests.

The initial output load current value you want your circuit to be tested for.

Test Config

Measurement Samples per Test: Samples
Add Offset to Efficiency Values: %

Adds an offset value to final efficiency result, not very helpful.

Measurement Samples per current load value. 1 measurement sample = 4 measurements.

Test Start

Test Name: Test Files Directory:
Single Input (No Sweep): ☐

Opens data folder, where your data is.

Starts the testing procedure.

Verifies your Source and Sink parameters. Safety Checks.

Clears input text fields.

Check this box to test circuit for only 1 input voltage.

Name your test or not.

How to Access Graphs and Table (must be opened before test start)

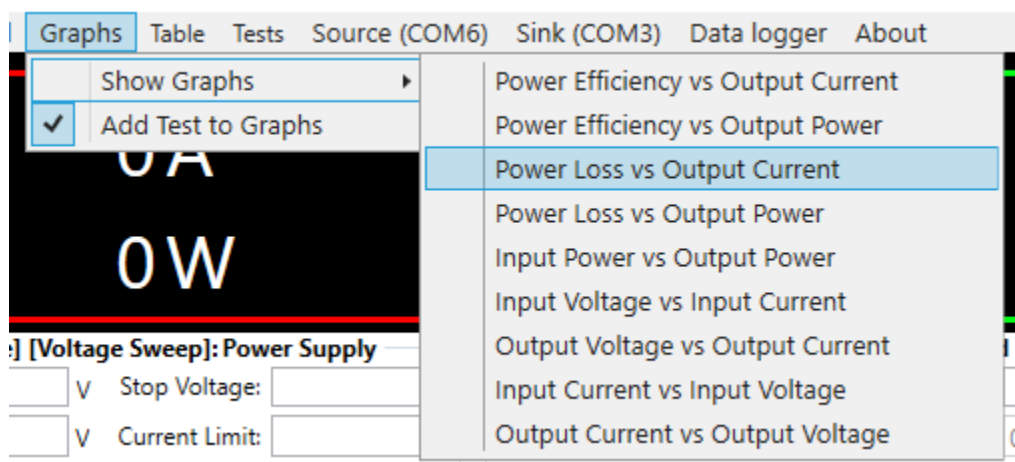


Figure 12: You may open any graph window you like or just open all of them. The more graphs you open the more CPU processing power will be used. The RAM usage will also increase.

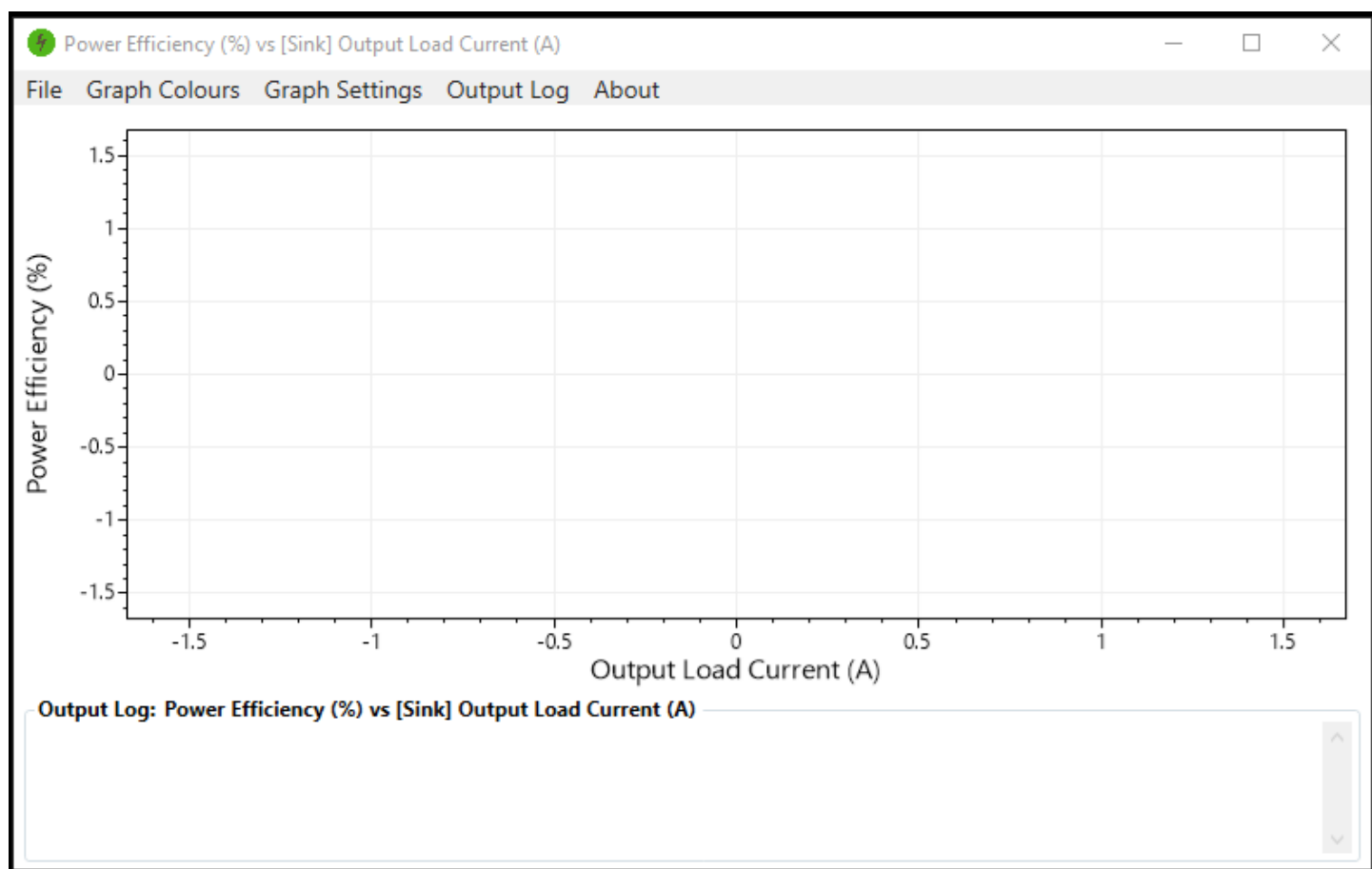


Figure 13: Graphs must be opened before you start the test.

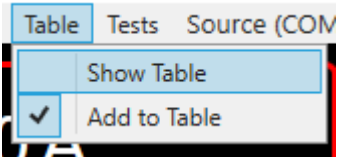


Figure 14: Click show table to open the table, must be opened before starting the tests.

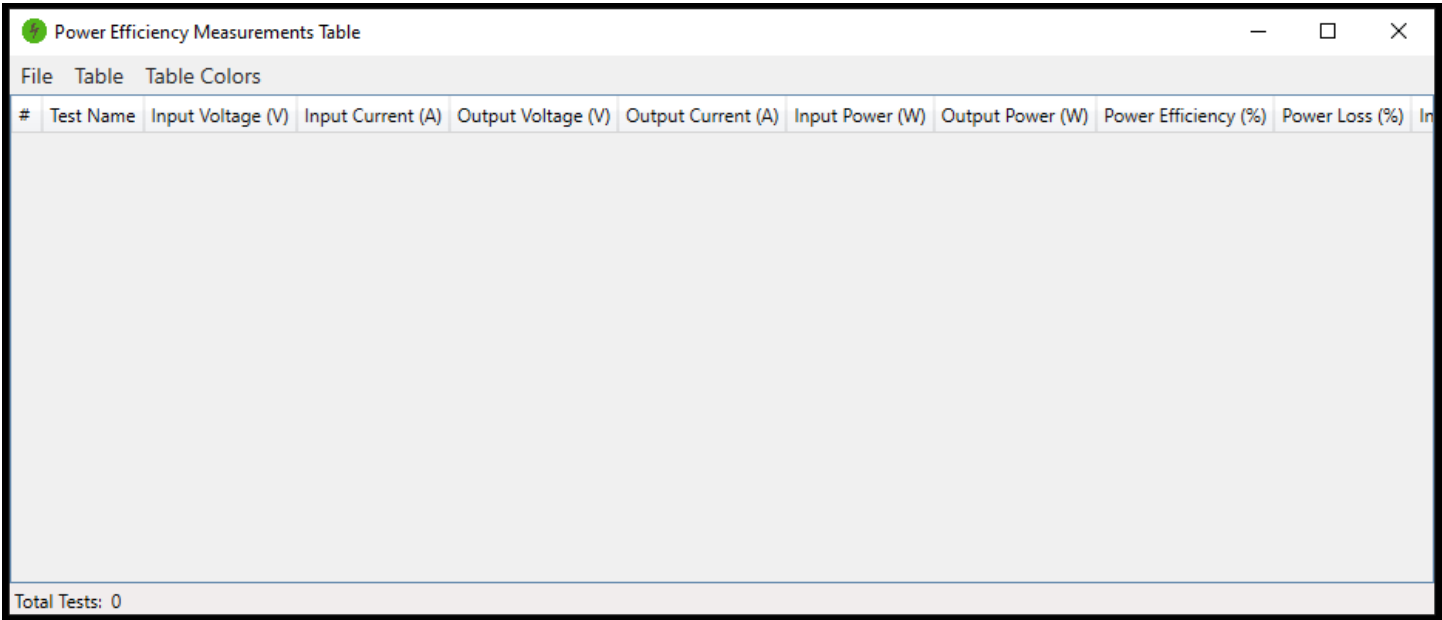


Figure 15: Data will automatically be added to the table as tests are completed.

Send Serial Commands

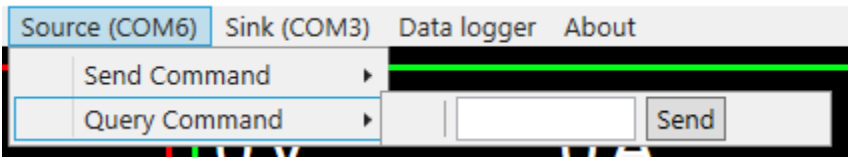


Figure 16: For some instruments you may have to send additional commands before starting the tests.

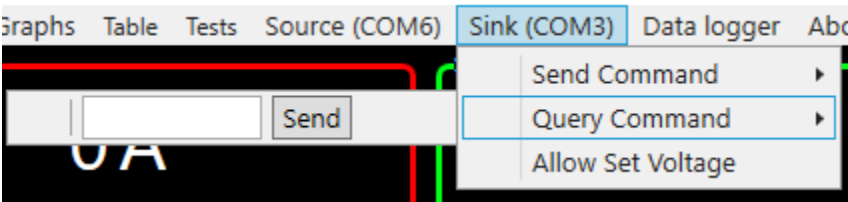


Figure 17: Do not enable set voltage for Sink.