etracer PC software user’s manual

For software version 2.xx

Document revision：0.12

LETHAL HIGH VOLTAGE!!!

etracer is designed for testing vacuum tubes. Its output voltage can be as high as 800 Volts. Do not touch any parts on the PCB (Printed Circuit Board) when the PCB is powered. Under powered condition if any of the NEGV_ON, HV1_ON or HV2_ON indicating LEDs is lighted it means high voltage exist on the board. Please wait until the LEDs go off before powering off the PCB. If for any reason the LEDs did not go off please recycle the power and wait for about 20 seconds.

End user agreement:

etracer is a testing equipment designed for professional use. We extensively describe the circuit architecture and the operation principle of etracer in this manual and in other related material. Users shall read this manually carefully and thoroughly and understand how to operate etracer safely. We are not responsible for any electric-shock, damage to vacuum tubes, injury or loss of property caused by using etracer.

Use of the etracer implies you agree with the terms above.

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1 Operation principle of the etracer

The design of etracer utilizes the most advanced technologies available today including SMPS (Switching Mode Power Supply) and DSP (Digital Signal Processing). These technologies enable an amazing test voltage and current capacity while keeping the footprint small.

The operation principle of etracer is similar to a flash light used in the photography industry: a capacitor is charged slowly and only discharges (flash) for a short duration. After the capacitor is charged to the target voltage the micro-controller in etracer turns on the high-voltage switch for less than 2ms and perform measurements during this short period. This design not only save power but also ensure a safe operating environment.

1.1 Positive High Voltage Supplies

etracer provides two identical positive high voltage supply modules. Each module is capable of delivering a maximum voltage of 750 Vdc and a maximum current of 300mA. The two modules are named HV1 and HV2 respectively. Each module uses a circuit topology similar to a buck-boost converter to charge a capacitor to the target value.

Although HV1 and HV2 are two identical modules, in the software HV1 is used as the primary high-voltage source to power the plate electrode of a DUT (Device Under Test). HV2 can be used to power the screen electrode of a pentode type DUT, or supply the plate voltage for the second unit of a twin-triode type DUT. HV2 can also be used to supply positive grid sweeping voltages for testing a triode under positive grid bias.

1.2 Negative Voltage Supply

The NEGV, the negative voltage supply of etracer shares a similar architecture with HV1 and HV2 but with an inversed polarity. Due to the fact that the grid current of the DUT is very low (<0.1mA) under a negative bias the negative voltage supply does not support current measurement.

Because of the choice of circuit design etracer could not set the negative grid voltage of a DUT to the desired value if the there exists a negative voltage that is lower than the desired value on the grid of the DUT. When a vacuum tube is heated up by the heater there will be an induced negative voltage on the grid due to grid current. The amount of negative voltage induced depends on the plate voltage and is not a constant value. A 47k ohms resistor parallelly connected between the NEGV output and GND in etracer provides a leakage path for the grid current but it could not eliminate the induced negative voltage completely. It is observed that a value of about -0.3V on the grid is common and hence in reality it is only a problem to measure the curve at zero volt for the grid. To overcome this issue a transistor switch is introduced to the output circuit of NEGV. When the desired (configured) NEGV test voltage is 0V the switch shorts the grid of the DUT to ground. The plotted curve is drawn with a thicker line when the DUT is measured under this short-circuit grid bias condition.

1.3 Filament (Heater) supply

The filament supply of etracer is designed around a LM2596 IC. LM2596 is a high efficiency switching mode DC to DC converter. It converts the 29V system voltage to an output DC voltage from 1.5V to 27V. The maximum conversion efficiency can be as high as 90%. The output power rating for the heater supply on etracer is 30 Watts. If the output power exceeds 30 Watts a forced air cooling is required.

1.4 Connection example

Figure 1.1 demonstrates a typical connection for testing a pentode under triode-connected, ultra-linear or pentode configuration. For connections for testing other types of tubes please refer to the etracer PCB manual.

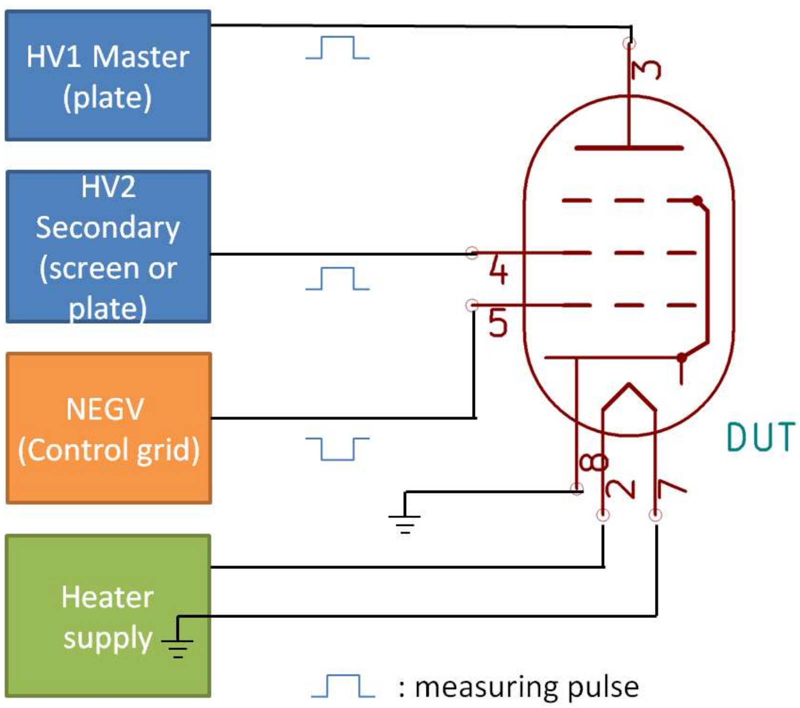


Figure 1.1 A connection example for testing a pentode

2 Introduction to the etracer PC software

2.1 Software installation and folder structure

Currently only software for Microsoft Windows is available. The software is in 32-bit mode and it can run under a 32-bit version or a 64-bit version of Windows. The supported OS is Windows 7, Windows 8 and Windows 10. Linux users can execute etracer software under WINE, the MS Windows environment emulator, by specifying the COM port manually. Currently only WINE with Ubuntu Linux distribution is verified.

It is assumed the readers of this document have basic knowledge of the MS Windows operating system such as the files directories structure, accessing the file dialog and other software widgets.

The software is packed as a single zip file and can be downloaded from the official etracer website: http://www.essues.com/etracer. To ensure portability there is no installation procedure needed.

Please create a folder (Referred to as the parent folder in the remaining of this section) and unzip the downloaded file to this newly created folder. After unzipping the parent folder should contain an executable file named etracer_v2.xx.exe (xx is the software revision number) with two sub-folders named “tubecfg” and “languages”. A readme.txt text file in the parent folder contains the change log of the software. The executable file is the only file needed to control etracer.

The tubecfg subfolder contains many tube configuration files for common (mostly) audio tubes. A tube configuration file contains parameters such as test voltages and wiring information for a specific DUT. The user connects the DUT to etracer by plugging in the DUT to the socket and connects the pins of the DUT to the output of etracer according to the wiring information in the file. The software uses the test voltages described in the file to test the DUT when a test is launched.

The languages subfolder contains languages files to support non-English languages in the GUI (Graphics Users Interface).

Please keep the folder structure the same otherwise the software might not function properly. If the user generates new tube configuration files the created files can be stored under the tubecfg subfolder (default) or under other folders of the user’s choice.

The application software is written in Python. Due to Python is an interpreted language a full Python environment with the Python interpreter and libraries are required to execute the application hence the executable file takes more than 100MB. Please allow some time for the software to load especially for the user that use traditional hard drive to store the software.

If a software upgrade is available the user can download the updated software from the website and simply copy the latest executable file to the parent directory and delete the old one.

2.2 System configuration file

The etracer software requires a system configuration file to operate. The default name of the configuration file is etracer.cfg and the default path to it is the parent directory where the software executable file is located. At launch time the software will check whether etracer.cfg exists or not. If the file exists the parameters in the file will be loaded into memory. If the file does not exist a new configuration file will be created and the parameters are set to their default values. The parameters in the configuration file include the current calibration values, the font size, etc.

2.3 Device driver for etracer

etracer relies on the VCP (Virtual COM Port) driver from FTDI. Normally the driver comes installed in all Windows distribution starting from Windows 7 but it can be accidentally removed by the user by uninstalling software that supplies this driver in the software package. If the etracer software can't detect etracer it usually means the driver is absent. To check whether or not the VCP driver is installed open the Windows Device Manager and check the “COM and LPT ports” tree. When etracer is plugged in there should be a COM port named something like USB comport with a COM port number assigned to it if the VCP driver is properly installed. If instead a question mark appears under the Universal Serial Bus tree it means the VCP driver is missing.

The VCP driver can be found at FTDI's website:
http://www.ftdichip.com/Drivers/VCP.htm

It is recommended to download the setup executable version.

2.4 Introduction to the GUI (Graphic User Interface)

The main application window is split into different zones as shown in figure 2-1:

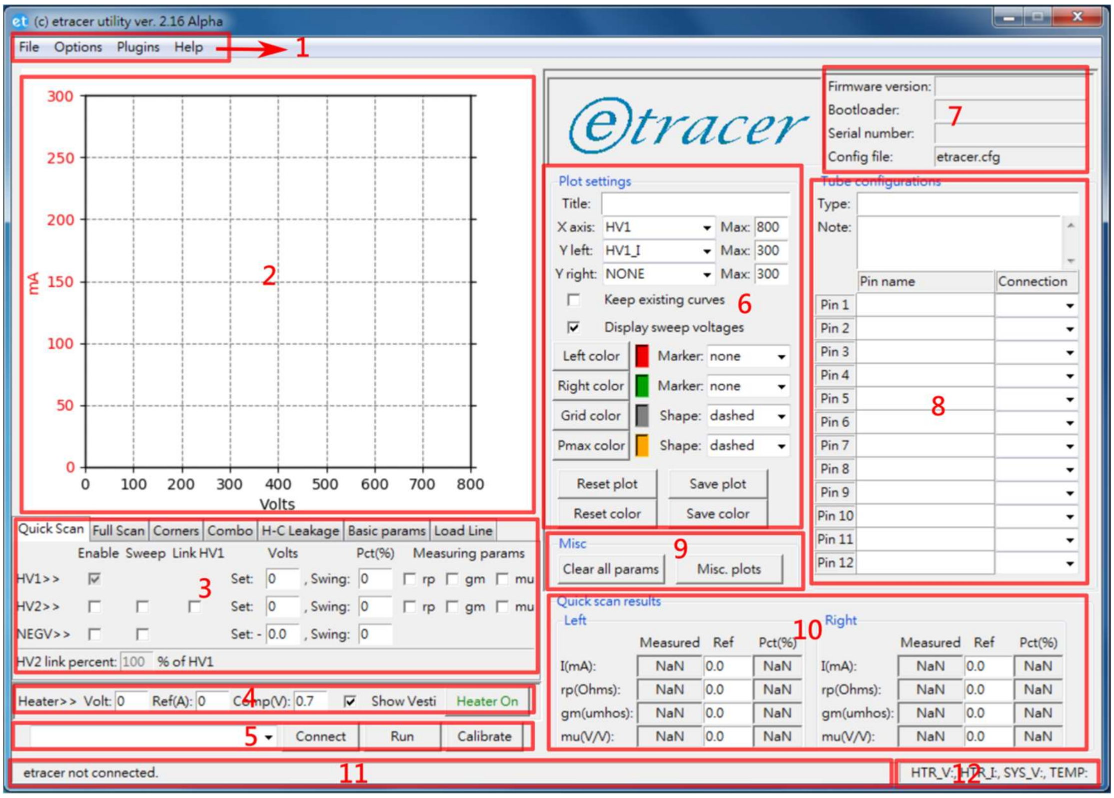


Figure 2-1 Numbering of different zones

- Zone 1 is the menu section.

  In the File menu vacuum tube configuration files and measurement data files can be accessed. If a full-scan is performed the data can be exported to other format (eg. the utracer .utd format) by selecting the "Export full-scan data" option. The user can load a system configuration file other than the default etracer.cfg by selecting the "Load configuration file" option. This option is useful if the user has more than one etracer connected to a PC.

  In the Option menu the system configuration parameters can be changed and the etracer firmware can be updated.

- Zone 2 is the measurement curves display area. It displays the voltage-versus-current curves when testing a tube. The vertical axis (y-axis) represents current measurements. Two groups of curves can be displayed with different colors corresponding to the scale marked on the left-hand side and on the right-hand side respectively. The group of curves with respect to the left-hand side of y-axis can be configured to display the output current of HV1 only or the summed output current of HV1 and HV2. The group of curves with respect to the right-hand side y-axis can only be configured to display the output current of HV2. If display of the second group of curves is not needed the combo-box for “Y right" in zone 6 can be set to “None”.

- Zone 3 is the test type configuration block. There are a total of 7 tabs in this block. The first three tabs “Quick Scan”, “Full Scan” and “Corners” are three basic tests that can be performed on the DUT.

  Under the Quick-Scan tab the user sets up the quiescent point and test condition for the DUT.

  Under the Full-Scan tab the user selects the sweeping range of HV1 and the source and range for the second sweeping source (HV2 or NEGV). If NEGV is selected as the second sweeping source HV2 can be configure as one of the following: disabled, sync with HV1 or fixed-value.

  Under the Corners tab the user can configure up to four corner test cases. The corners test is designed to capture potential tube failure under extreme conditions .

  The “Combo” tab allows the user to compose a combination of the three basic tests and the combined tests can be performed sequentially with a single trigger. This function is useful to test a batch of vacuum tubes of the same type.

  The “H-C Leakage” tab allows user to test the leakage current between the heater and the cathode by applying HV1 or HV2 to the cathode. This test mode requires the user to wire the cables manually during the test hence could not be integrated into the combo test.

  The “Basic params” and “Load Line” tabs allow the user to perform realtime analysis on the full-scan data. These two tabs do not access to etracer hardware and can be used without etracer connected to the PC.

- Zone 4 is the heater configuration block. The user configures the heater voltage and reference current as specified by the DUT’s datasheet here. The software uses the reference current to compensate the heater supply voltage. Heater supply on/off control is also in this zone. The “Show Vesti” option when checked (default) displays the estimated heater voltage seen by the DUT in the system status bar. If "Show Vesti" is not checked the real heater supply output voltage from etracer will be reported without taking the loss in the output circuit (protection diode, fuses, 0.1 Ohms sensing resistor) into account. The Comp(V) field hold the voltage compensation value for the protection diode in the output circuit and the default value is 0.7V.

- Zone 5 is the action zone. Options here include connect/disconnect to etracer, start/stop measurement and calibration.

- Zone 6 is the plot setting section. The display ranges of voltages and currents and type of curves to display can be configured here. The "Y left" and "Y right" combo-boxes selects the data source to display with respect to the dedicated Y scales. The 'Keep existing curves' option selects whether or not to clear previously measured curves when a new test is triggered. The "Display sweep voltages" determines whether or not to mark the curves in zone 2 with sweep voltages (on the control grid) values for full-scan. The color and marker type for the curves can be selected independently for the left and right curves.

- Zone 7 is the firmware information block. The firmware version and bootloader information will be displayed here when the PC is connected to etracer. The current configuration file name is also displayed here.

- Zone 8 is the wiring information area. The user can set the mapping between the pins of the DUT to the 6 outputs (HV1, HV2, NEGV, GND, HEATER1 and HEATER2) of etracer. Up to 12 pins can be configured. The user determines the name of each pin and selects which output of etracer that pin connects to. It is also possible to set a pin to NC (No Connection). Please note this area is just used as a reference for the user. The physical wiring shall be performed by the user manually.

- Zone 9 holds two miscellaneous buttons. The "Clear all params" clear all measurement data and tube configuration parameters. The "Misc. plots" button opens a new window when a full-scan data set is available. Various plots other than the plate-voltage vs. plate-current plot as displayed in zone 2 can be displayed in this new window.

- Zone 10 holds the results of a quick-Scan. If a quick-scan is performed the measured parameters will be displayed here.

- Zone 11 is the message bar where the application software displays messages.

- Zone 12 is the system status bar. When the connection to an etracer is active this bar will display etracer system status variables such as system voltage, heater voltage, etc. The data is updated at a rate of once per second.

3 Current Calibrations

To ensure measurement accuracy the user shall perform current calibrations or use the configuration file supplied by the manufacturer before testing a vacuum tube. The four output voltage sources (HV1, HV2, NEGV and heater supply) are calibrated at factory. The current calibrations can be done by the user. There are a total of five current calibrations options for etracer:

- No-load offset current calibration for HV1 and HV2
- Low current region scaling calibration for HV1
- Low current region scaling calibration for HV2
- High current region scaling calibration for HV1
- High current region scaling calibration for HV2

In order to calibrate the current scaling for the low-current region and high-current region respectively a 100k Ohms resistor (for the low current region) and a 1k Ohms resistor (for the high current region) are required. The Wattage rating for the resistors are >1/4 Watt for the 100k Ohms resistor and >1 Watt for the 1k Ohms resistor. The accuracy of the resistors should be +/- 1% or better. If the user could not find resistors with the specified accuracy the user can use an accurate DMM (Digital Multiple Meter) to measure the resistances of the resistors and fill in the measured values in the calibration menu. etracer applies a 300V test voltage on these resistors and use the ratio of the ADC (Analog to Digital Converter) reading and the value of the reference resistor to compensate the measurement. Please note the accuracy of the resistors directly affect the quality of the current calibrations.

3.1 No-load offset current calibration for HV1 and HV2

[1] Turn on the power of etracer, connect to a PC

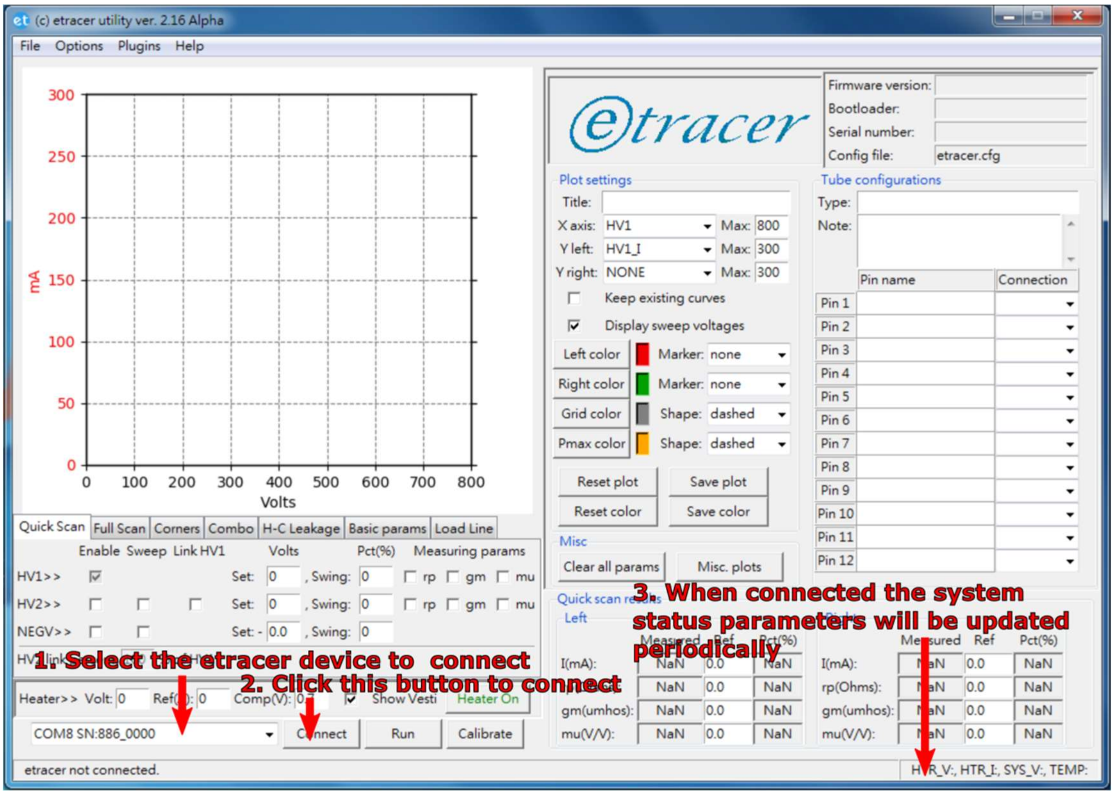


Figure 3-1. Steps to initiate the no-load offset current calibration

[2] Remove any wiring at the output of HV1 and HV2

[3] Click the ‘Calibrate’ button. The calibration menu will pop up.

[4] Click the button marked “HV1 and HV2 offset current calibration” on the top of the calibration menu.

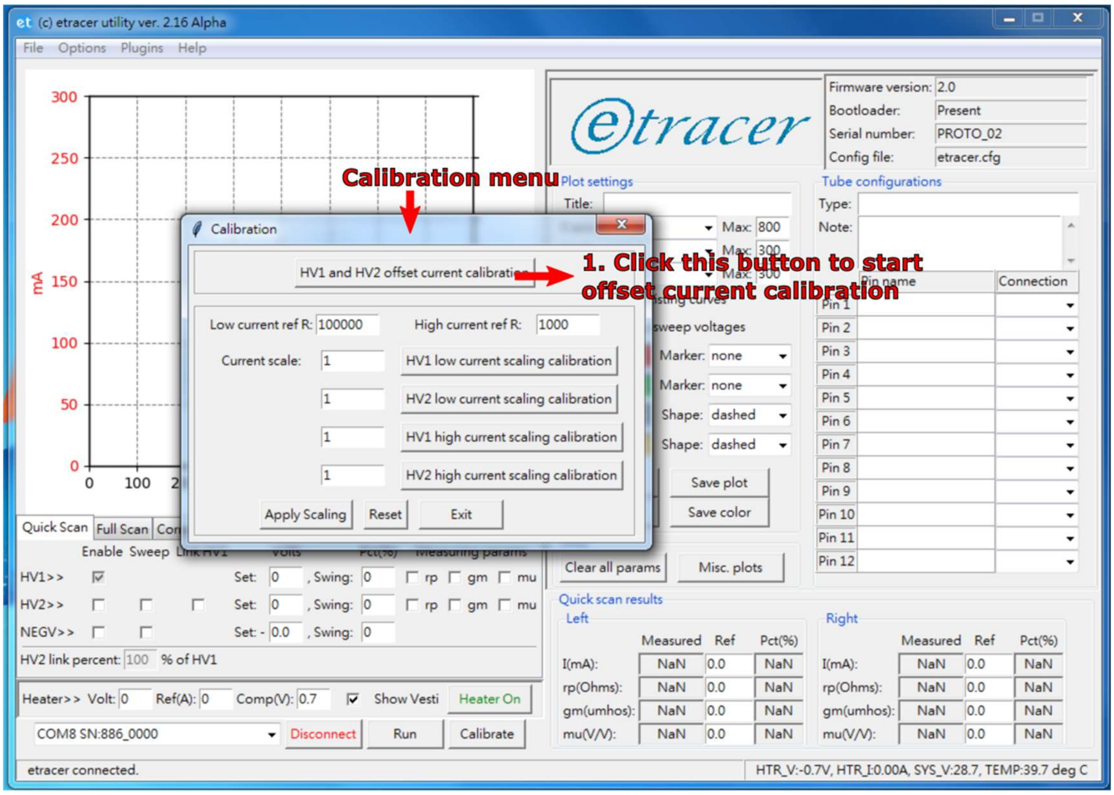


Figure 3-2. Calibration menu

[5] A message box will pop up reminding the user to remove all wirings from HV1 and HV2. Press the Ok button to proceed.

[6] The software starts the offset current calibration task. Two quasi-horizontal lines will be drawn from left to right. These two lines represent the zero-current drift of HV1 and HV2. The following figure shows the two lines when the calibration is done. Note the position of these two lines varies from board to board.

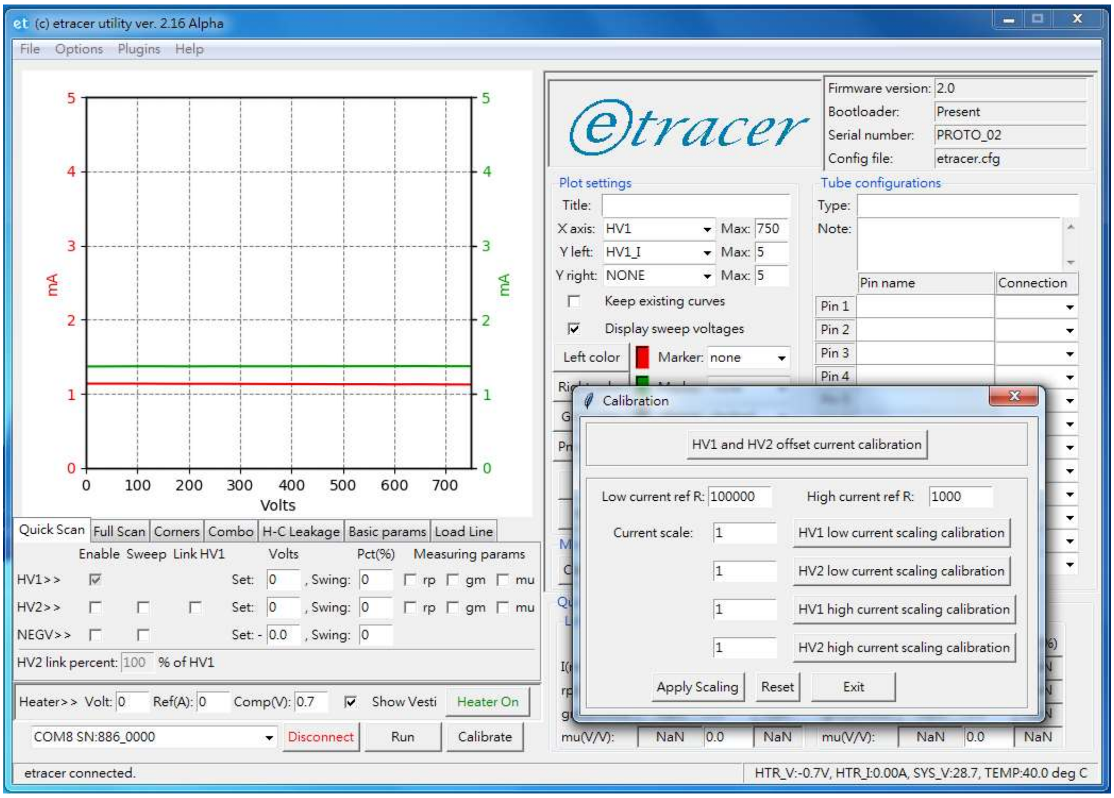


Figure 3-3. Example result for the no-load offset current calibration

[7] Upon the completion of calibration the calibration data will be written to the system configuration file indicated in zone 7 of the GUI (default etracer.cfg)

[8] Offset calibration only needs to be performed once unless the system configuration file is deleted or the etracer is connected to a different PC where a system configuration file is not available.

⚠ For the offset current calibration the outputs on both HV1 and HV2 can be as high as 750V.

3.2 Low current region scaling calibration for HV1

[1] A 100k Ohms resistor is required for low current region scaling calibration. With the calibration menu opened, if the accuracy is dubious for the resistor the actual measured resistance can be filled in the entry box marked “Low current ref R”. Click the button marked “HV1 low current scaling calibration” to proceed.

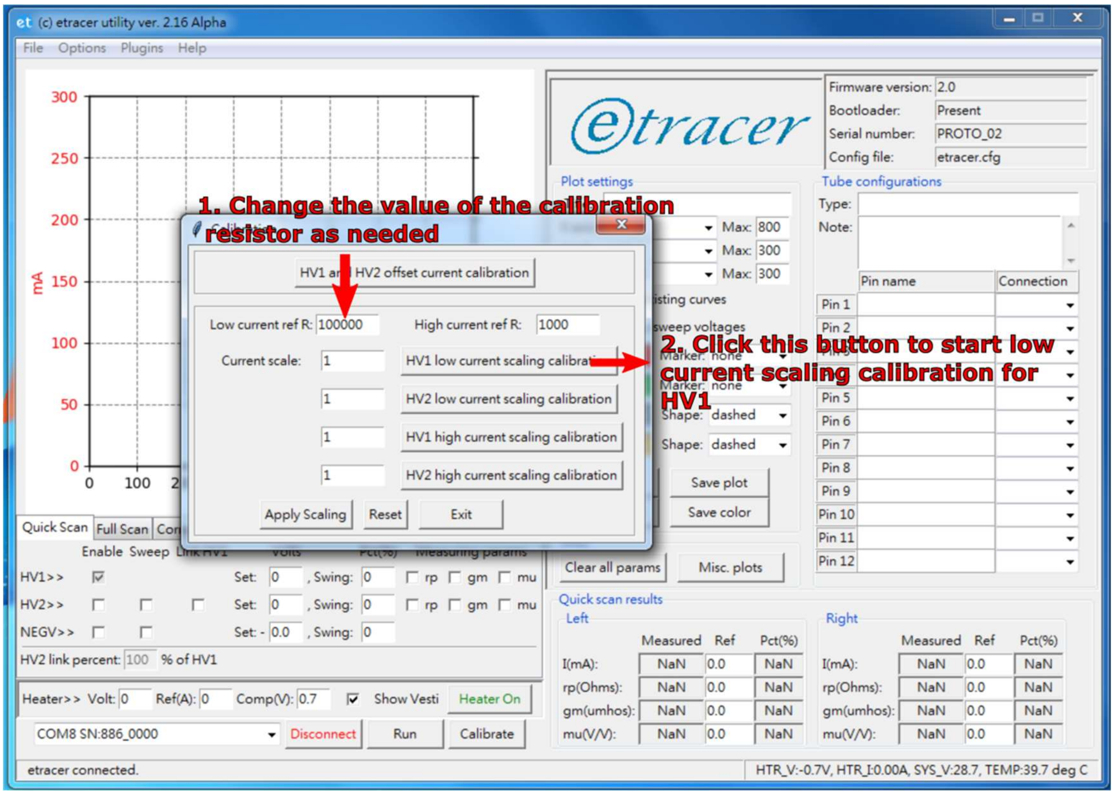


Figure 3-4. HV1 low current scaling calibration procedure

[2] A message box will pop asking the user to plug in a resistor between HV1 and GND. The resistance value is displayed according to the value in the entry box.

[3] etracer will output 300V on HV1 and take measurement. The measurement takes about 2 second. The measured ratio will be displayed after the measurement is done. The measured value should be between 0.9 and 1.1. The default ratio before calibration is 1.

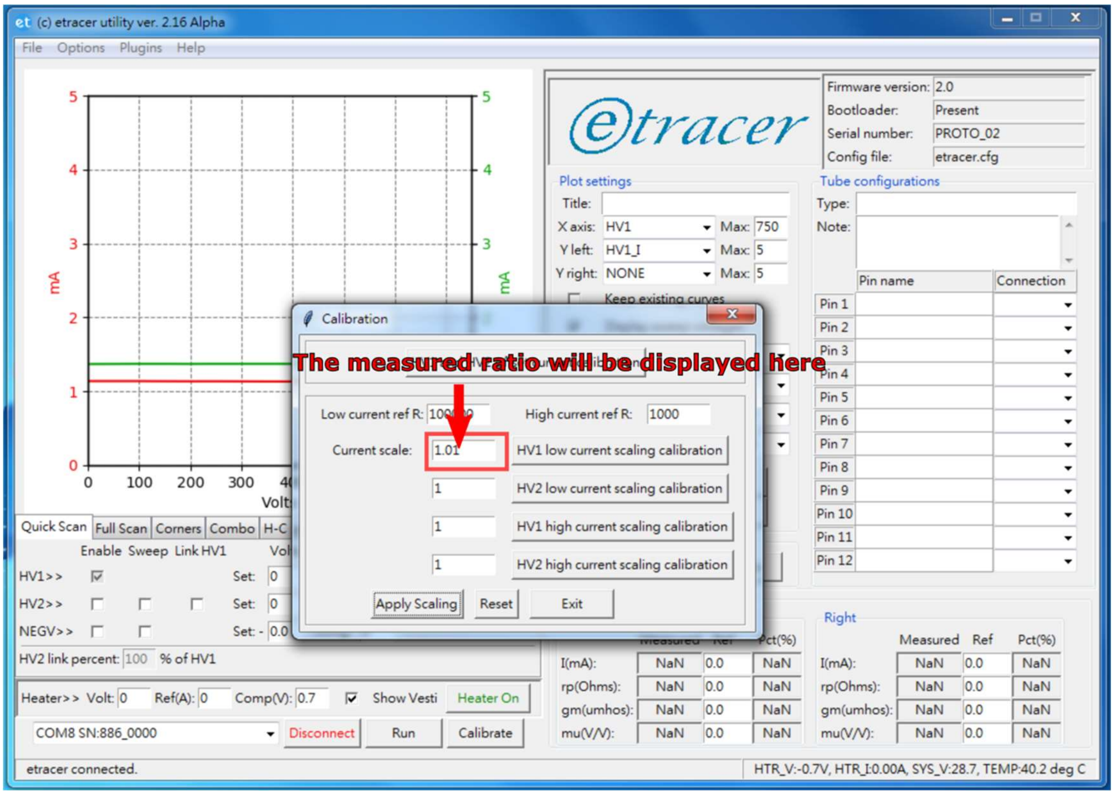


Figure 3-4. Example result for HV1 low current scaling calibration

[4] The user can also fine-tune or modify the ratio in the entry box.

[5] Click the "Apply Scaling" button to apply the scaling values to the system and update the system configuration file. Click the "Reset" button to set all values to defaults. Click the "Exit" button to exit.

3.3 Low current region scaling calibration for HV2

The procedure for low current region scaling calibration for HV2 is the same as the procedure described in section 3.2 above except the 100k Ohms resistor is connected between HV2 and GND instead of between HV1 and GND. To run this calibration click the button marked "HV2 low current scaling calibration" and the measurement result will be displayed in the entry box left to this button.

3.4 High current region scaling calibration for HV1

The procedure for high current region scaling calibration is the same as the procedure described in section 3.2 except the calibration resistor used is 1k Ohms. The resistance value can be modified by changing the content in the entry box marked "High current ref R". To run this calibration click the button marked "HV1 high current scaling calibration" and the measurement result will be displayed in the entry box left to this button.

3.5 High current region scaling calibration for HV2

The procedure for high current region scaling calibration for HV2 is the same as the procedure described in section 3.4 above except the 1k Ohms resistor is connected between HV2 and GND instead of between HV1 and GND. To run this calibration click the button marked “HV2 high current scaling calibration” and the measurement result will be displayed in the entry box left to this button.

4 Basic measurement modes

The etracer PC software provides three basic test modes: quick scan mode, full scan mode and corners test mode. A forth test mode, the combo test mode allows the user to compose a test that’s a combination of the three aforementioned basic tests.

4.1 Quick Scan mode

Quick scan mode is used to measure parameters of a vacuum tube at a specific DC bias point. The test time is very short (less than 10 seconds) because only a few data points are required. This test is similar to the traditional vacuum tube testers such as a Hickok TV-7. The output parameters are: quiescent current, plate AC resistance (r_p), transconductance (gm) and voltage amplification factor (μ or mu). The later three parameters can be described by the following formula:

$$\mu = gm \times r_p$$

Hence only two parameters are needed to be measured. The parameters etracer measure are gm and r_p.

When testing a rectifier tube only r_p can be measured (and makes sense) because there is no control grid in the DUT. When testing a pentode usually we check gm only because r_p and μ are usually very large (>100kohms, >1000 V/V) and the measurement errors tend to be large.

In the quick-scan tab the parameters to be measured can be selected. If a parameter is not selected the test result will display NaN (Not a Number). The bias point is specified by a target value with a swing percentage (Pct). For example, setting HV1 at 250V with 5% in the Pct filed means the measurements will be taken at the following three HV1 values: 237.5V (250×0.95), 250V, 262.5V (250×1.05)

⚠ Because the heater supply in etracer is a DC supply with one end connected to ground as opposed to the assumption of a center-grounded AC supply in most tubes datasheets, the negative bias setting for quick-scan should be adjusted by 1/2 of the rated heater voltage to compensate the cathode (heater) voltage difference if the DUT is a directly heated triode or pentode. For example, a 300B directly heated triode has a quiescent operation point with a plate voltage of 350V and a negative grid voltage of -74V in the datasheet. The reference plate current under this bias condition is 60mA. To compensate the aforementioned DC heater supply offset the negative grid voltage should be adjusted by 5V/2=2.5V. Hence in the configuration file of 300B the grid voltage setting is set to -71.5V instead of -74V. If the heater voltage is not compensated the measured plate current assuming a reference DUT will be lower than 60mA at this operating point.

The test results are displayed with percentages against the reference values from that datasheet.

NOTE It is important to understand how to interpret the quick-test result. Traditional gm tube testers rate the DUT based on the measured transconductance. For example, a DUT with a gm 80% or higher than the reference value is rated as a "new tube" and a gm 50% of the reference value is rated as a "good tube". The rating is especially critical when trading tubes because a tube rated as new might have a monetary value twice or more than a tube rated as good. Unfortunately there is no standard in the industry for the tube rating. And a tube rated "bad" might work flawlessly in certain circuits.

4.2 Full Scan mode

The full scan mode allows the user to capture a series of plate current curves with different grid biases against incrementing plate voltages. The start point, the end and the step size of the plate voltage and the sweeping voltage can be configured in the full-scan tab. The smaller the step size the longer the test time required. The bigger the step size the coarser the measured curves. The recommended step size for HV1 is between 10V to 50V. The step size for HV2 and NEGV depends on the DUT.

Due to the low power consumption nature of pulse-type testing the high voltage switching transistors in HV1 and HV2 are not equipped with heatsinks. If the user run full-scan at high voltage and high current such as testing a 211 please allow extra cooling time between each scan (eg. 5 minutes) otherwise the transistors might be overheated and eventually breakdown.

⚠ Because the heater supply in etracer is a DC supply with one end connected to ground, the measured curve for a given grid voltage is shifted by 1/2 of the heater voltage compared to the measurement condition in the datasheet if the DUT is a directly heated triode or pentode. For example, the measured curve for a grid bias of 0V for a 300B in etracer actually represents the curve of a negative grid bias of -2.5V (5V/2) under the test condition of the datasheet. This is not a problem as most modern DHT amplifiers adopt DC heater supplies to reduce hum.

4.3 Corners test mode

The corners test mode is designed to check the DUT at extreme voltage corners. It is observed some vacuum tubes appear to be good under normal test point but failed to operate properly in the real circuit. For example a faulty tube might test as good at a plate voltage of 400V but an abrupt jump in the plate current is observed at a plate voltage slightly above 400V. To capture this type of failures the user can configure the test condition so that the highest voltage corners expected in the real circuit is used to test the tube and a pass/fail criteria can be set based on the current measured.

A total of 4 corner cases can be configured in the software. In most of the supplied tube configuration files for triodes and pentodes the first two corner cases are configured. The first corner case is designed to capture cut-off region failure. The second corner case is designed to capture plate-to-cathode short failure at high plate voltage.

5 Quick guides for performing three types of basic tests using the supplied tube configuration files

5.1 Quick scan (a 12AX7 is used as an example)

[1] Connect PC to the etracer. Confirm the connection status (the status bar will refresh the readings of system parameters such as system voltage periodically). The firmware information in zone 7 will be updated as well.

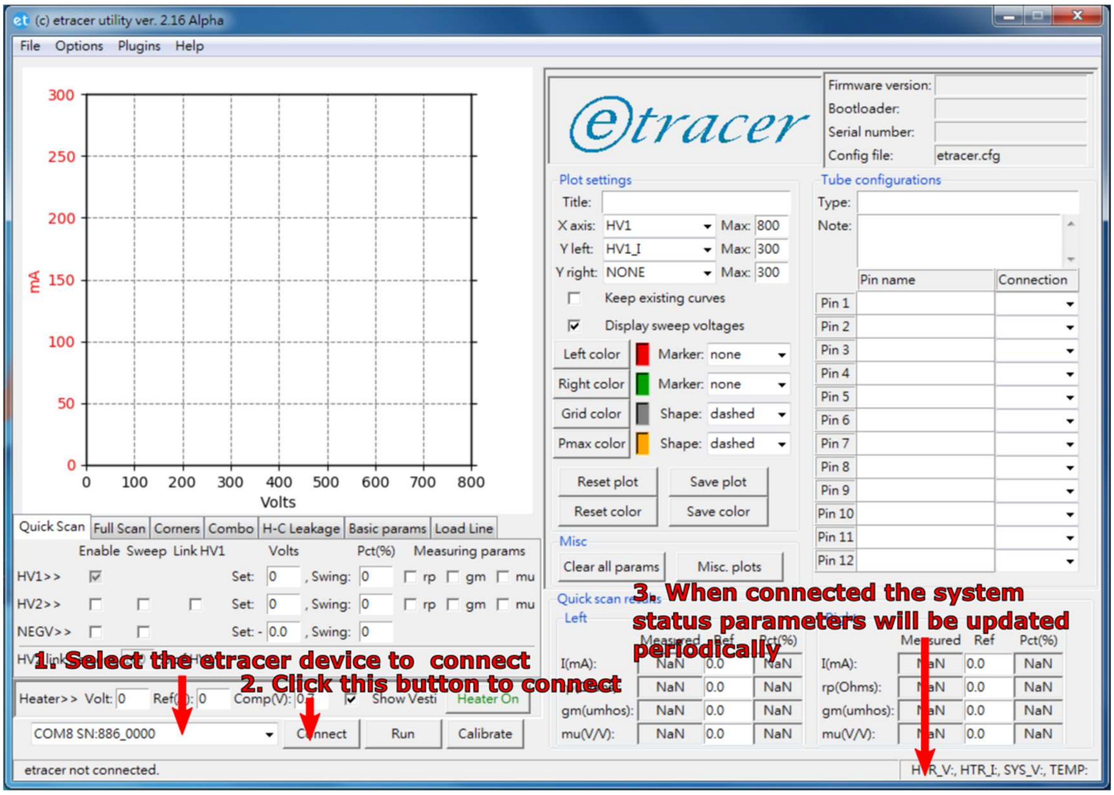


Figure 5-1. Connect PC to the etracer hardware

[2] Load the tube configuration file into memory. Select the configuration for a 12AX7 as depicted by figure 5-2 and figure 5-3.

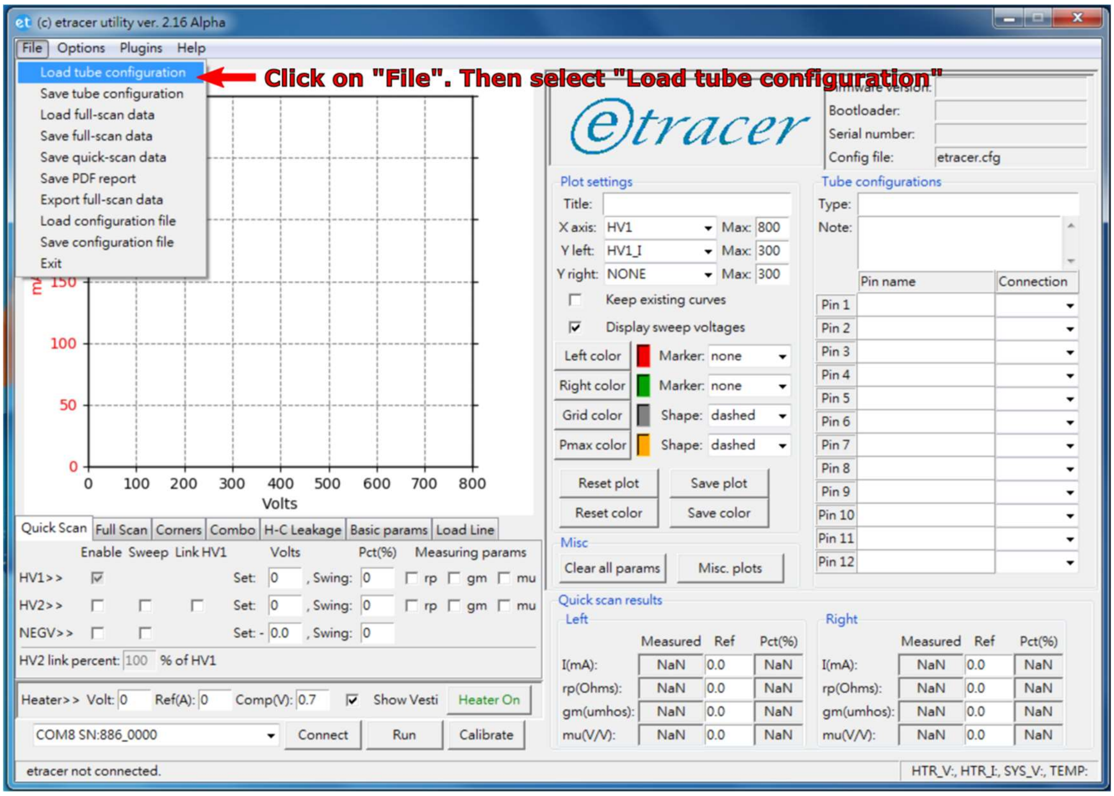


Figure 5-2.

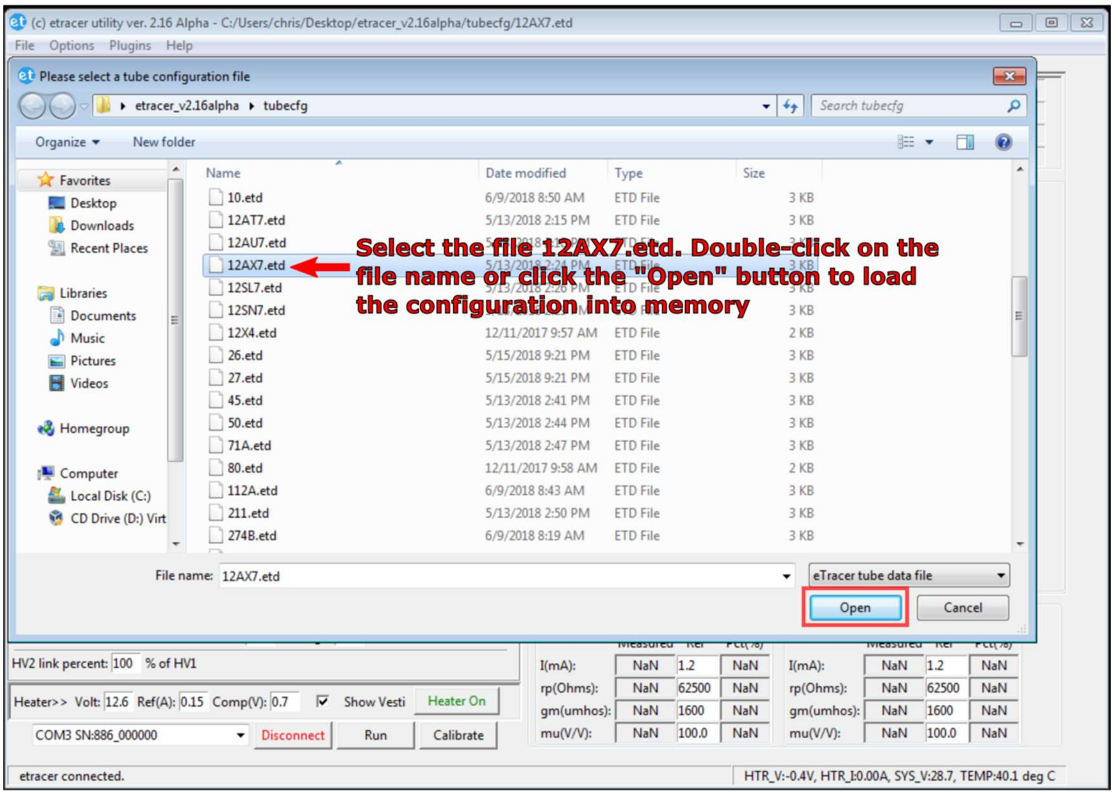


Figure 5-3.

[3] Wire the output pins of the etracer to the pins of the DUT following the wiring instruction as depicted below. Pin 1 connects to HV1, pin 2connects to NEGV, etc.

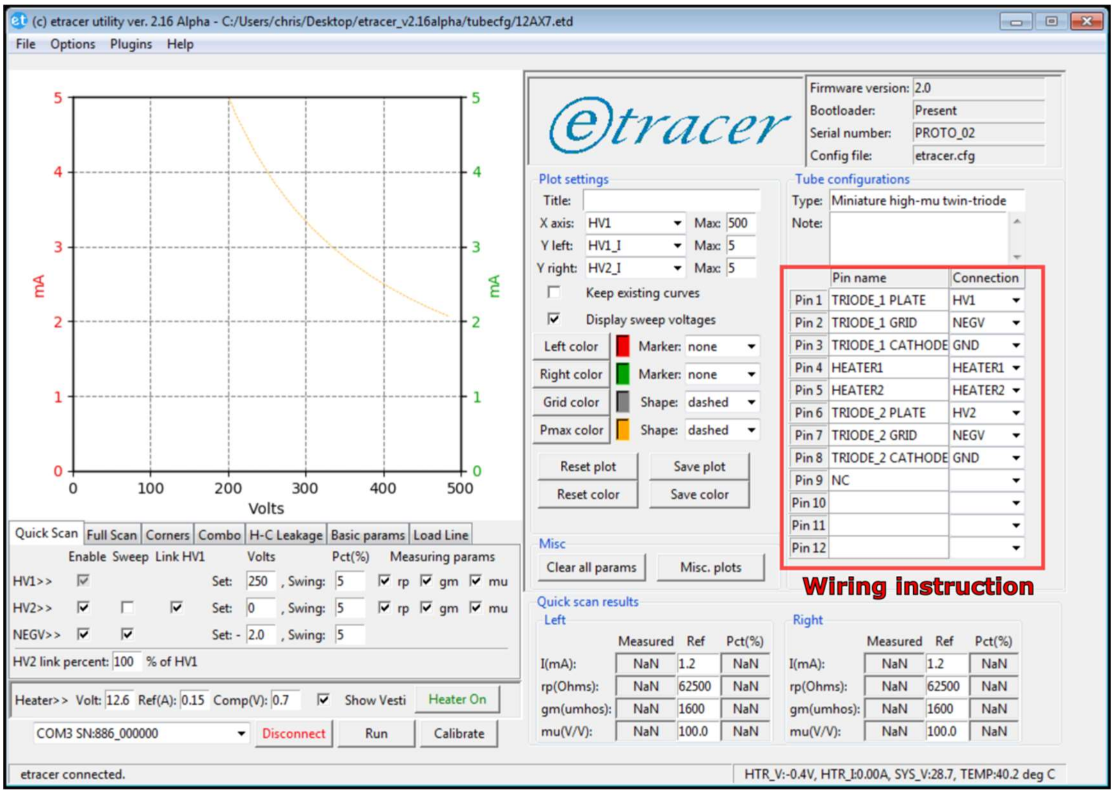


Figure 5-4

[4] Turn on the heater supply. Check the readings of the heater voltage and the heater current at the status bar on the bottom-right corner. The reading of the heater voltage should be close to the configured value (12.6V in this example). Wait for more than 1 minute and make sure the filament of the DUT is lighted up and the current reading agrees with the datasheet.

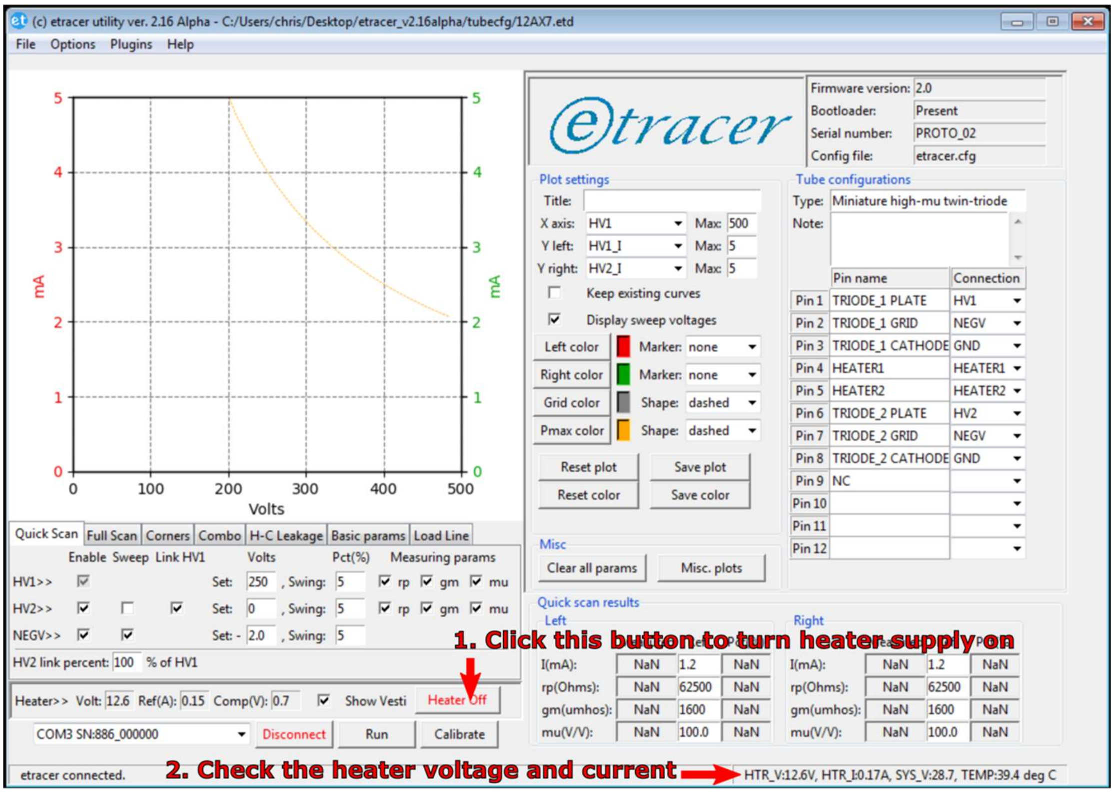


Figure 5-5.

[5] Select the Quick-scan tab. Check the test range and percentage settings and change the values if needed.

[6] Click the Run button to start a test.

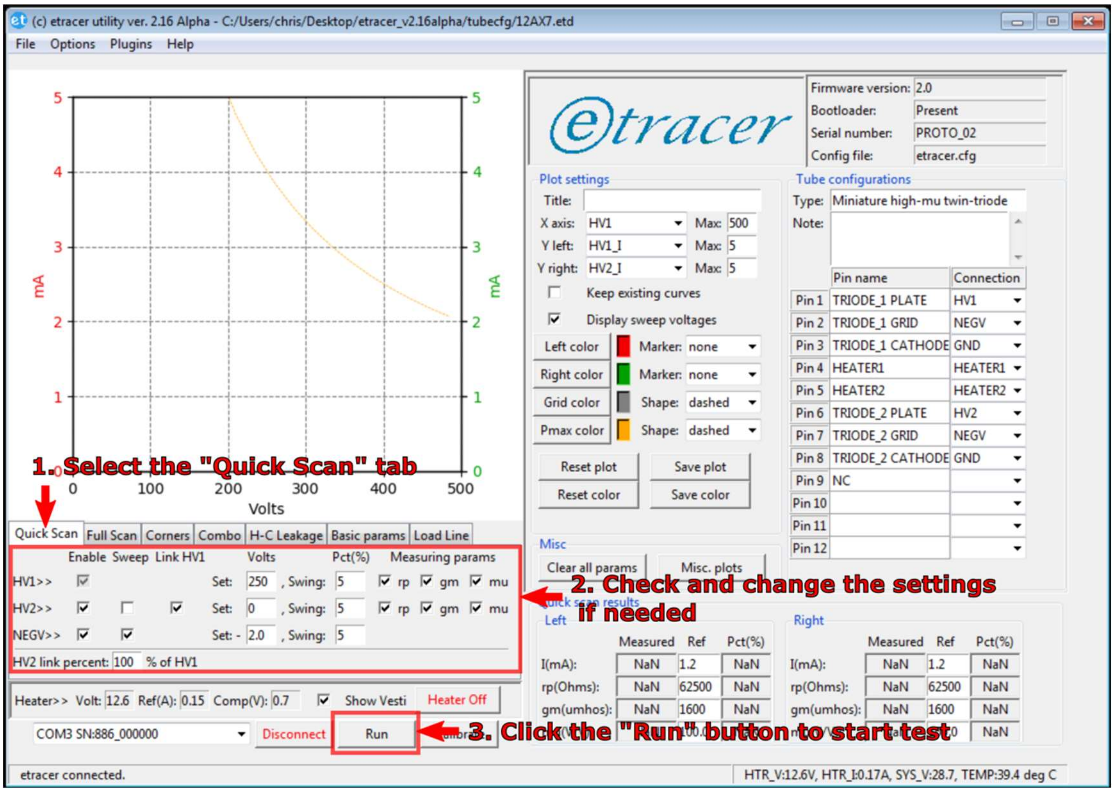


Figure 5-6.

[7] Wait for the test to finish. Take the test results.

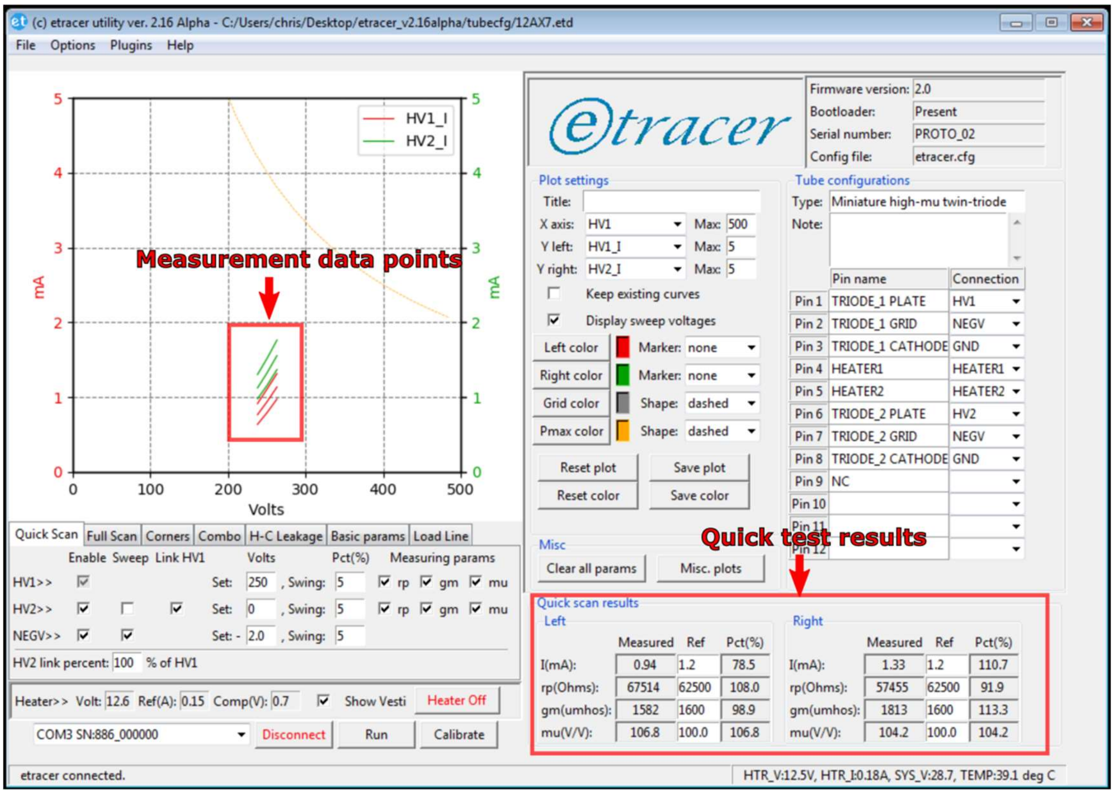


Figure 5-7.

[8] The measurement data can be saved to a file by selecting File->Save quick-scan data. Enter the filename and the data will be stored in a TXT (text) file format. The saved text file can be opened by other text editor applications such as Microsoft Notepad.

5.2 Full scan (a 12AX7 is used as an example)

[1] Step 1 to step 4 are the same as the steps in section 5.1 for quick-scan. Connect PC to the etracer. Confirm the connection status (the status bar will refresh the readings of system parameters such as system voltage periodically).

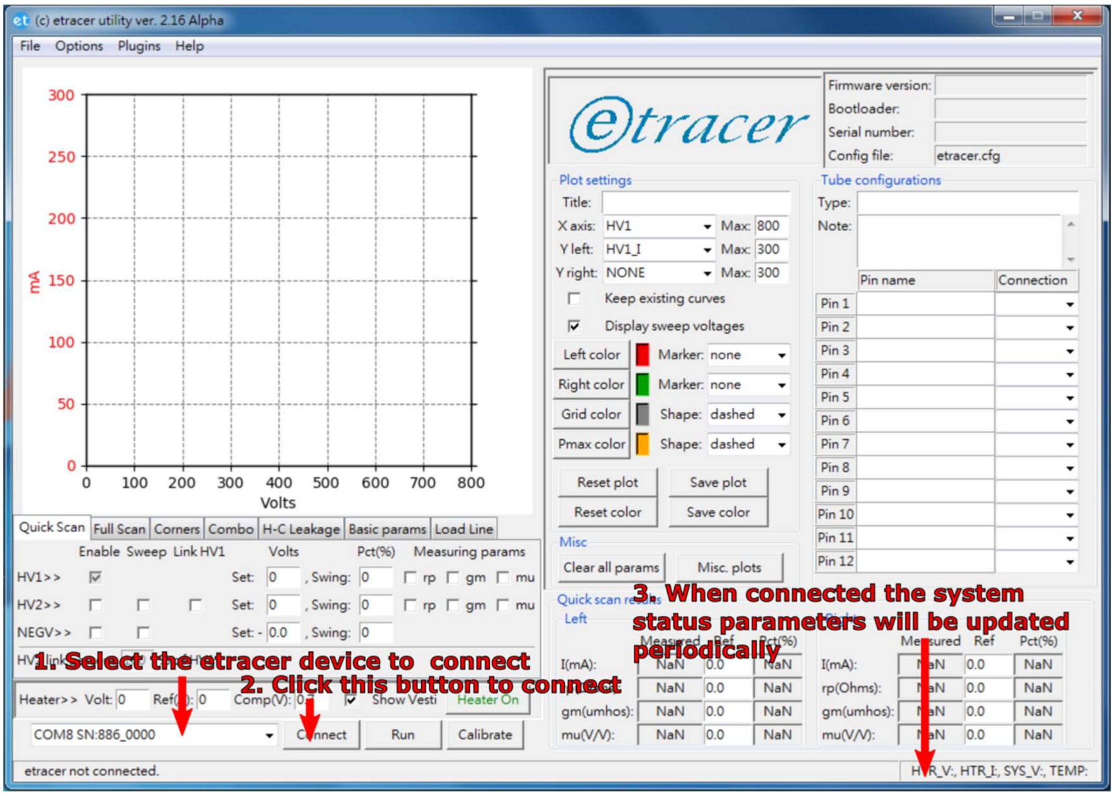


Figure 5-8. Connect PC to etracer hardware

[2] Load the vacuum tube configuration file into memory.

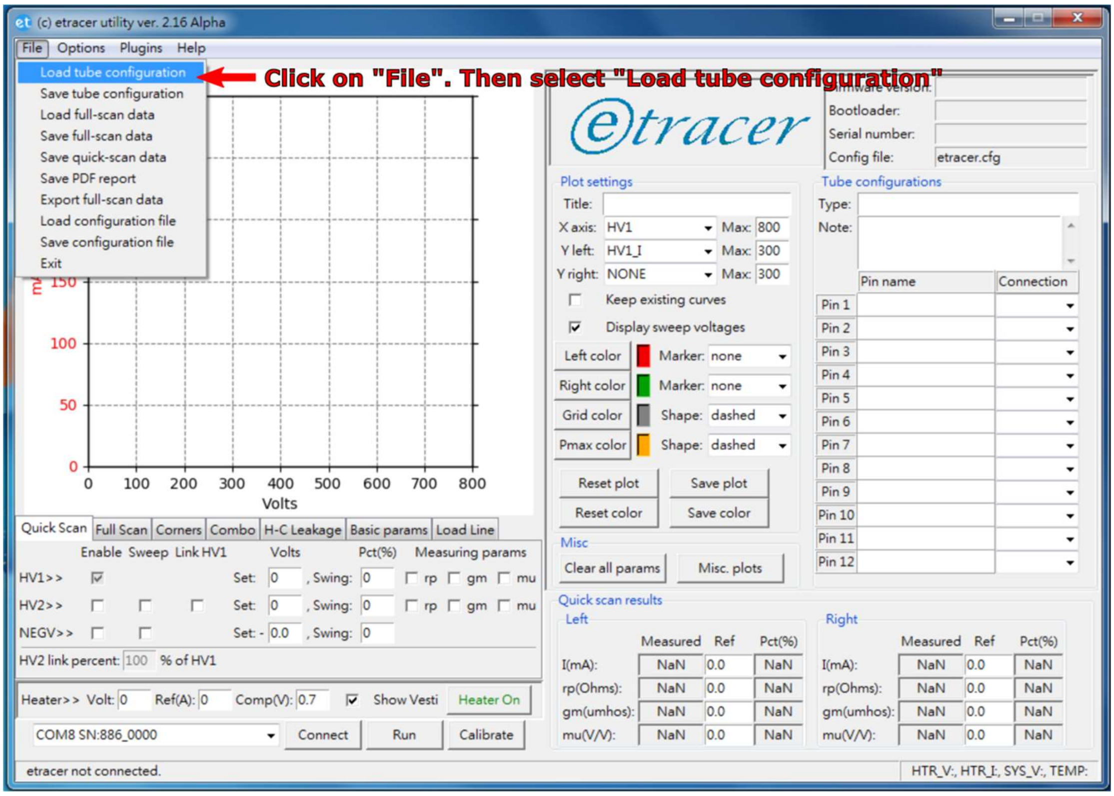


Figure 5-9.

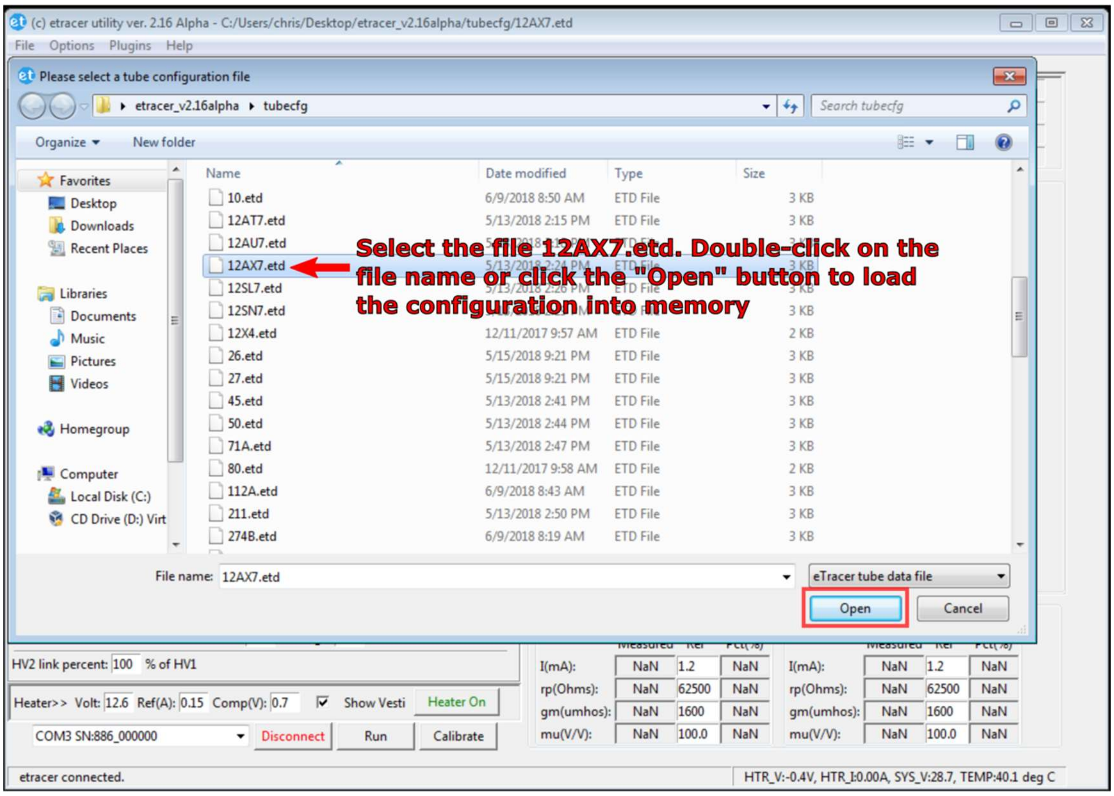


Figure 5-10.

[3] Wire the output pins of the etracer to the pins of the DUT following the wiring instruction as depicted below. Pin 1 connects to HV1, pin 2connects to NEGV, etc.

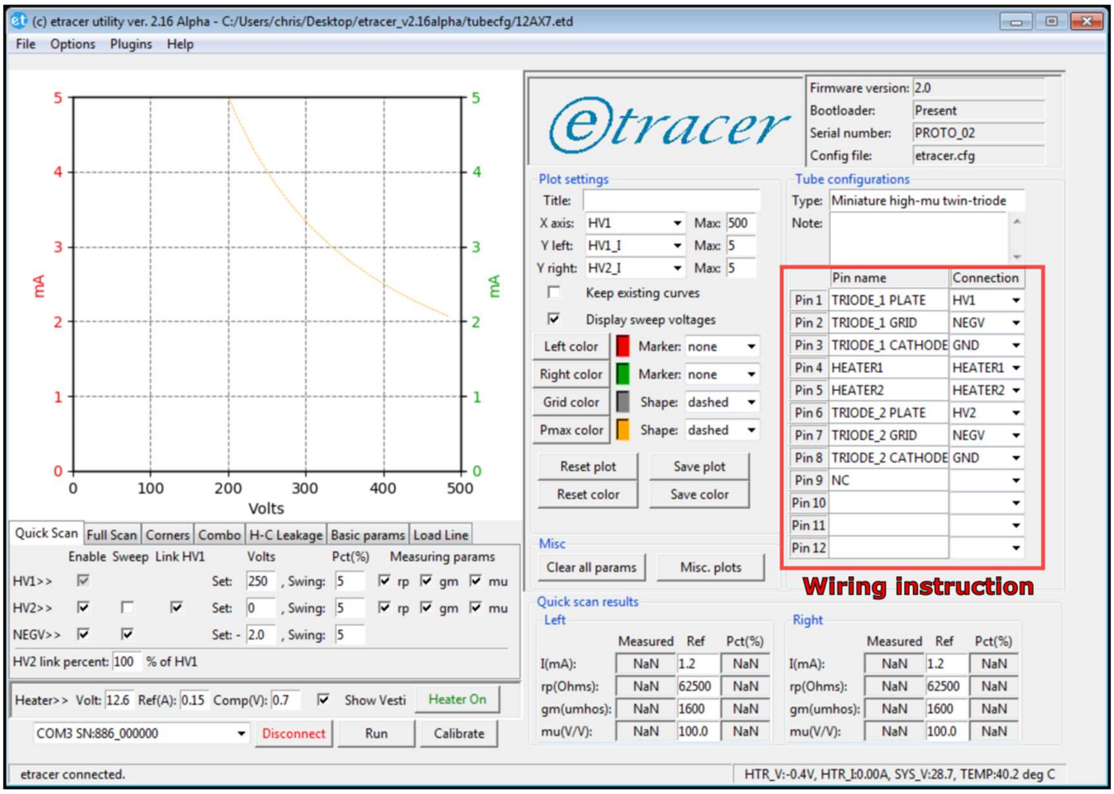


Figure 5-11

[4] Turn on the heater supply. Check the readings of the heater voltage and the heater current at the status bar on the bottom-right corner. The reading of the heater voltage should be close to the configured value (12.6V in this example). Wait for more than 1 minute and make sure the filament of the DUT is lighted up and the current reading agrees with the datasheet.

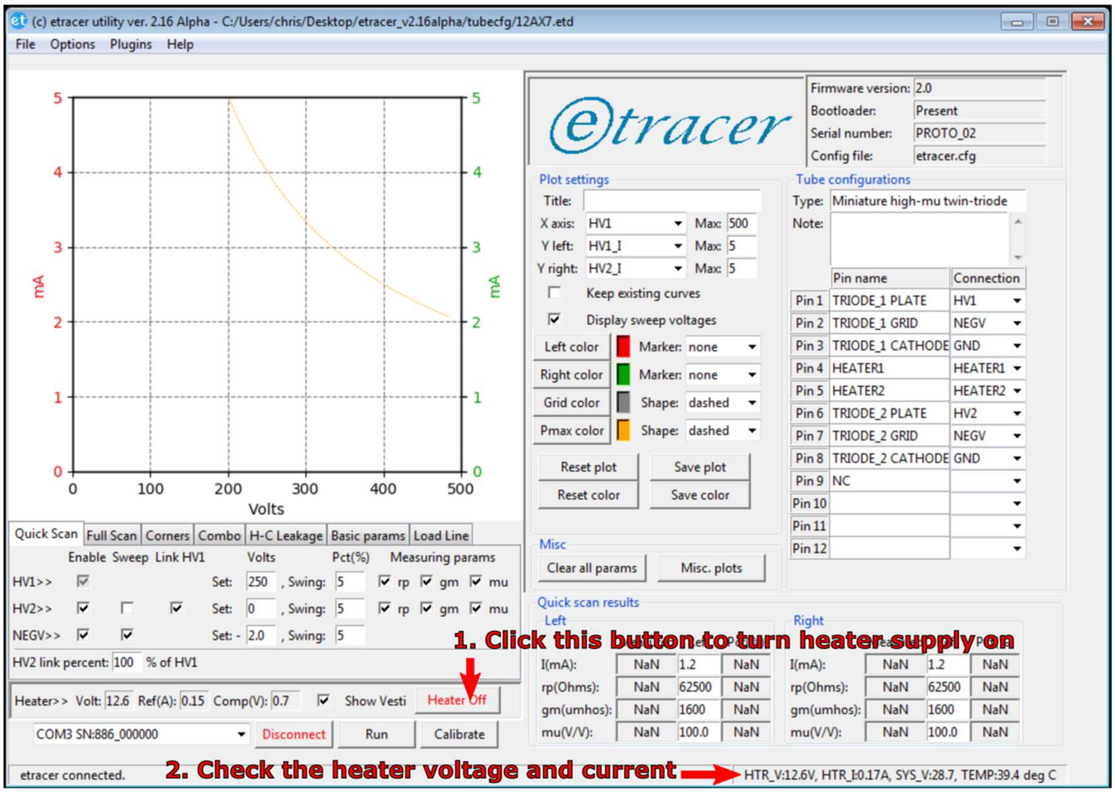


Figure 5-12.

[5] Select the Full-scan tab. Check the configuration parameters (sweeping range, sweeping source, etc.) and change the values if needed.

[6] Click the Run button to start a full-scan

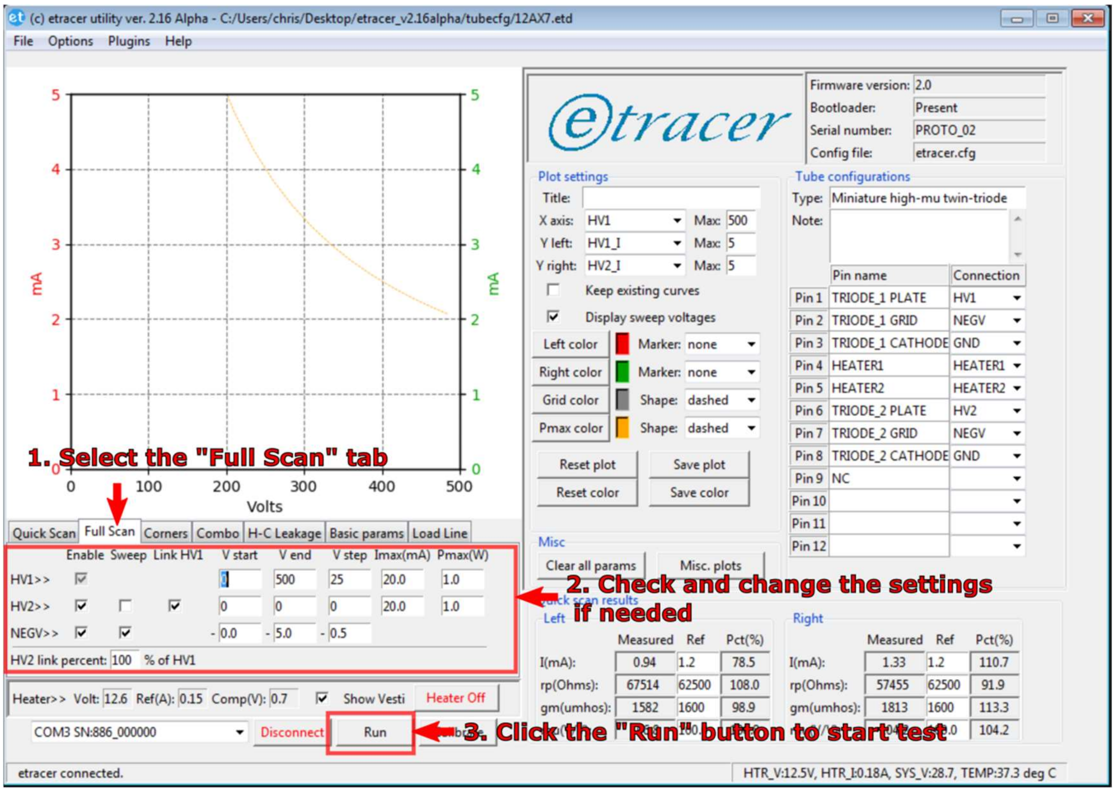


Figure 5-13.

[7] The software will control the etracer to output various voltage combinations of HV1, HV2 and NEGV following the configured parameters. The curves will be drawn and appear on the screen gradually.

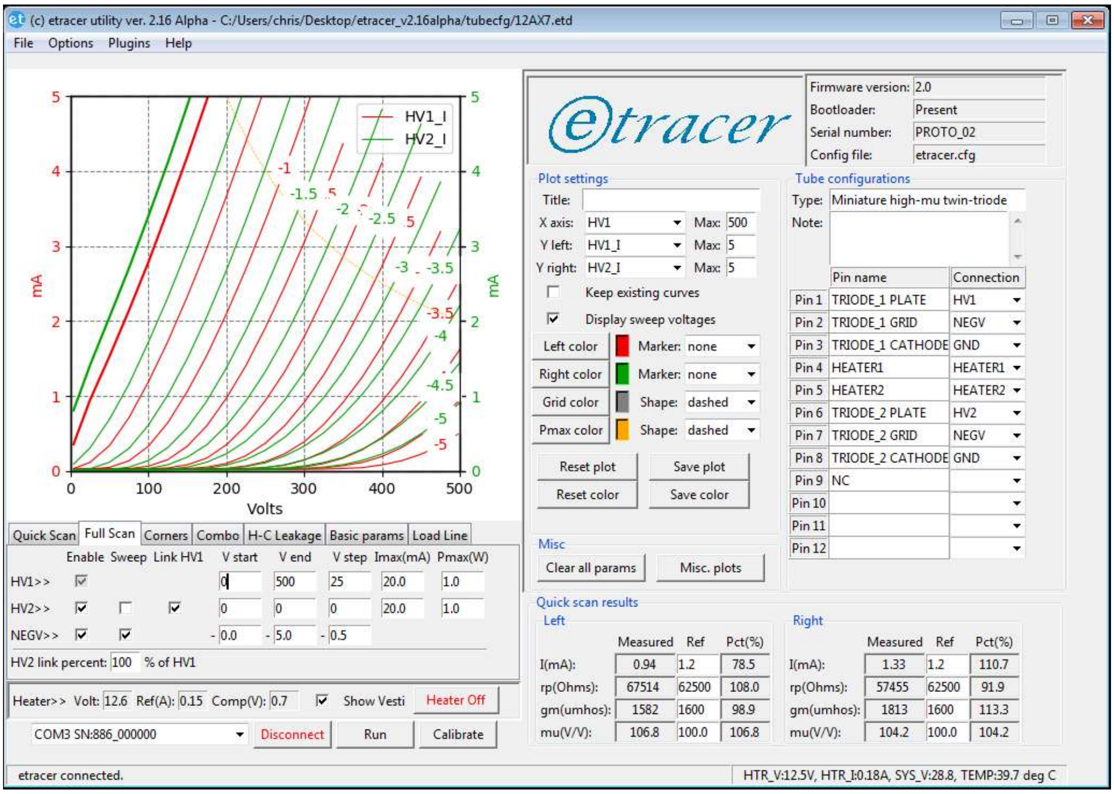


Figure 5-14. An example full-scan test result

[8] The measurement data can be saved to a file by selecting File->Save full-scan data. Enter the filename and the data will be stored in a CSV(Comma Separated Values) file format. The saved full-scan data file can be downloaded into PC memory by selecting File->Load full-scan data and the curves will be drawn on the screen accordingly.

5.3 Corners test (a 12AX7 is used as an example)

[1] Step 1 to step 4 is the same as the steps in section 5.1 for quick-scan. Connect PC to the etracer. Confirm the connection status (the status bar will refresh the readings of system parameters such as system voltage periodically).

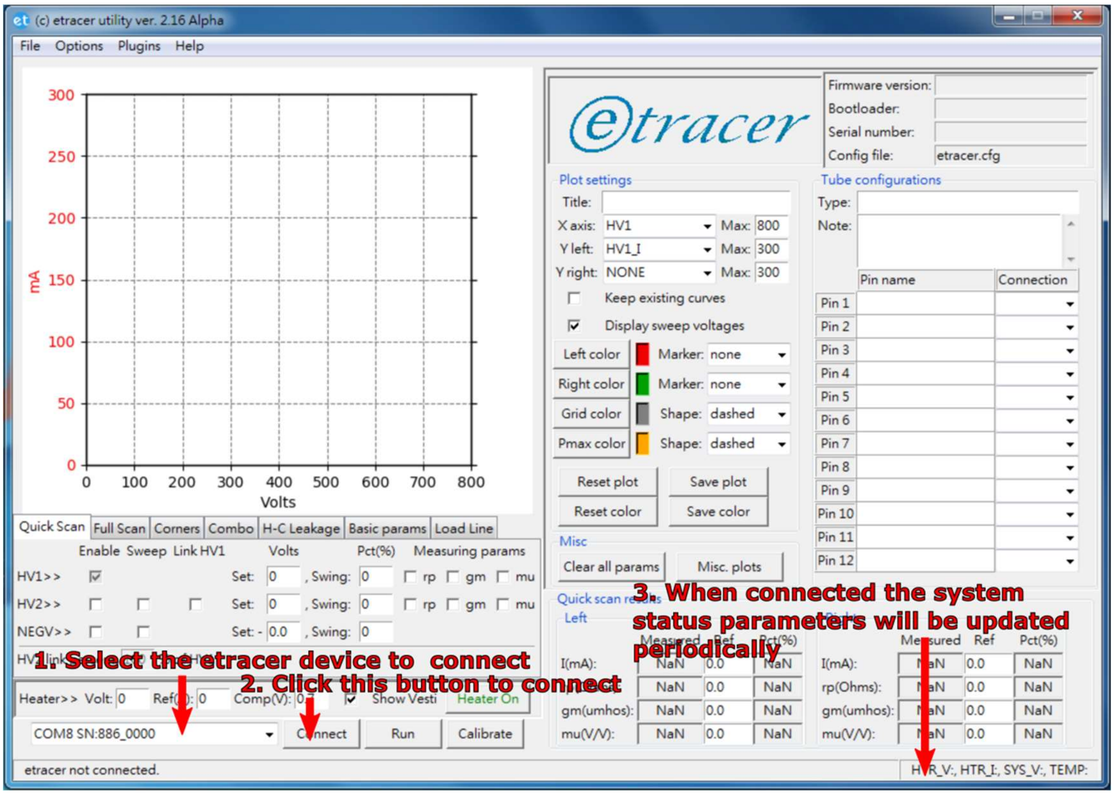


Figure 5-15.

[2] Load the vacuum tube configuration file into memory.

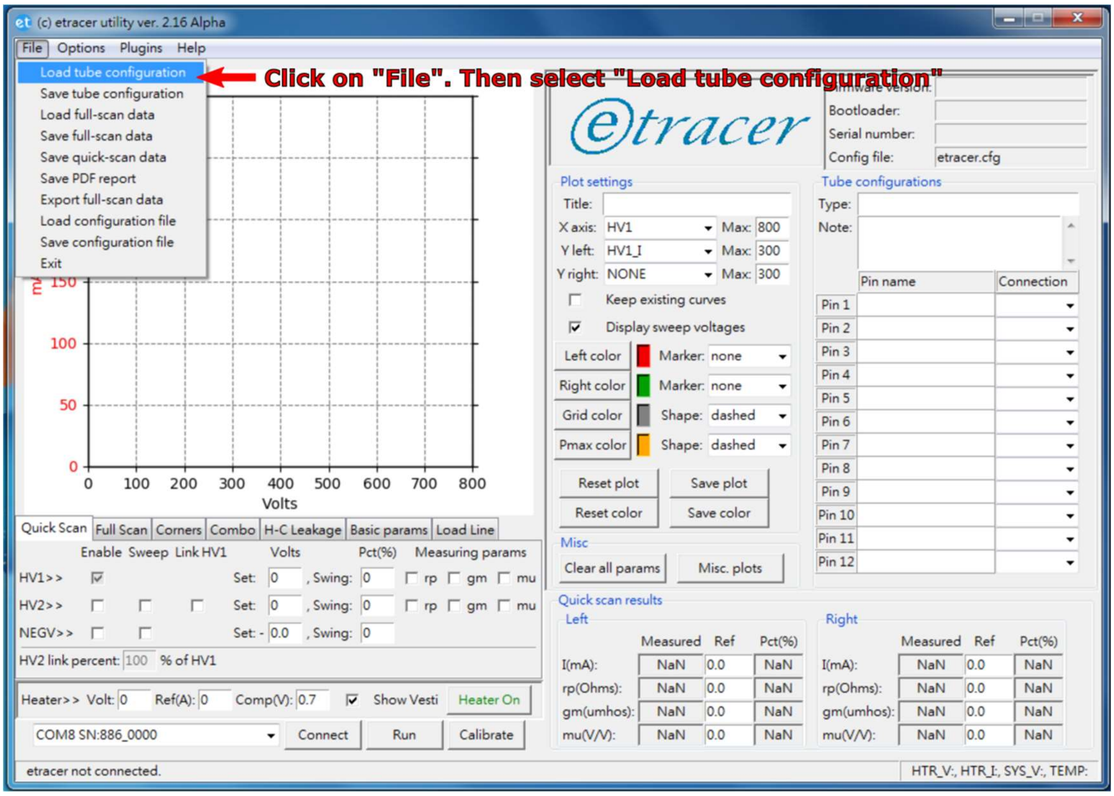


Figure 5-16.

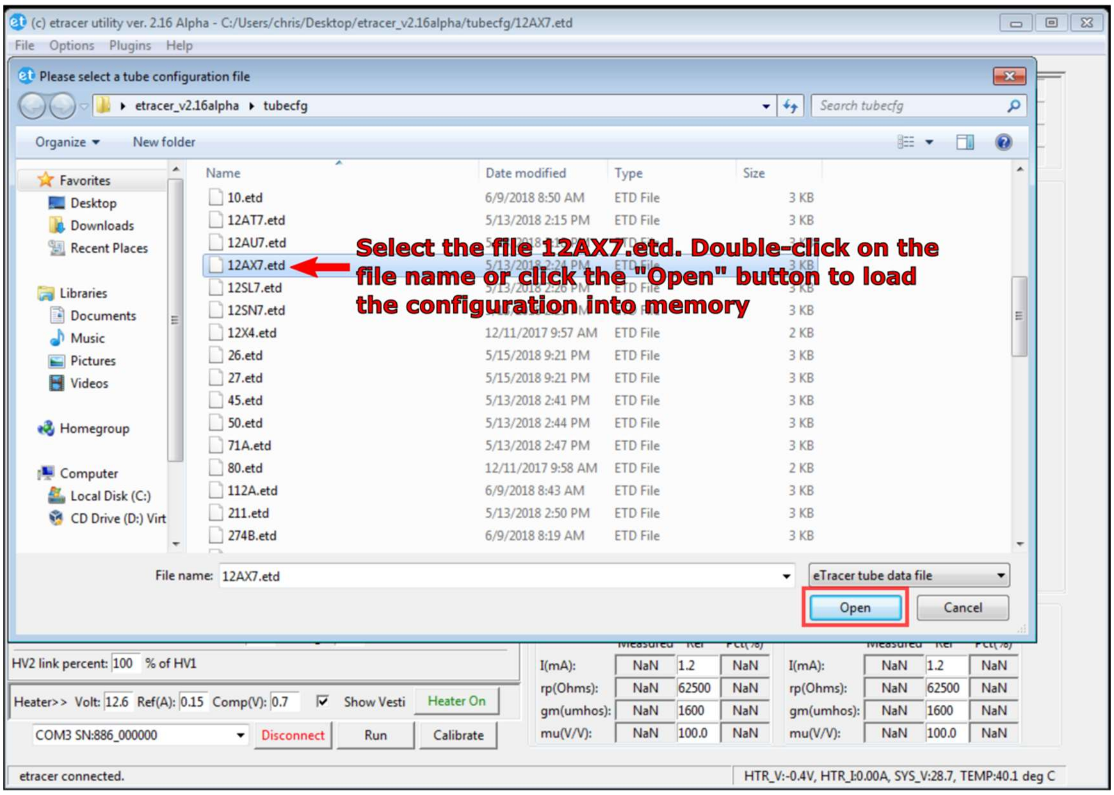


Figure 5-17.

[3] Wire the output pins of the etracer to the pins of the DUT following the wiring instruction as depicted below. Pin 1 connects to HV1, pin 2connects to NEGV, etc.

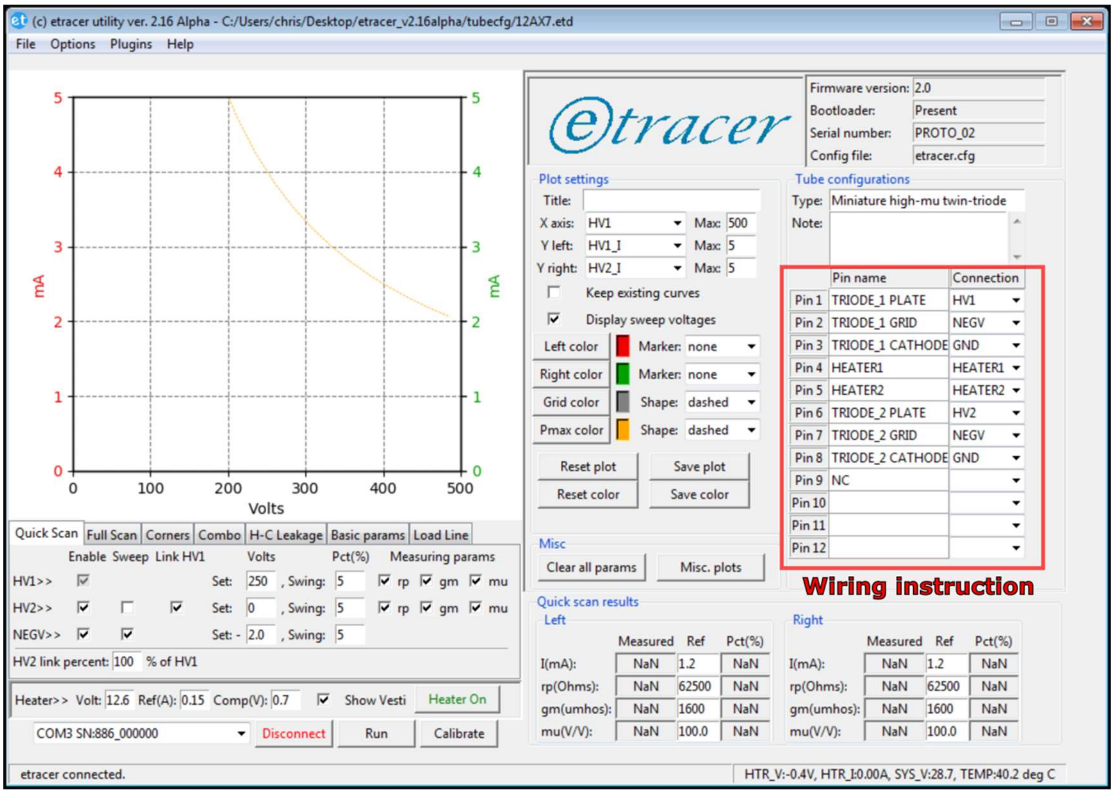


Figure 5-18

[4] Turn on the heater supply. Check the readings of the heater voltage and the heater current at the status bar on the bottom-right corner. The reading of the heater voltage should be close to the configured value (12.6V in this example). Wait for more than 1 minute and make sure the filament of the DUT is lighted up and the current reading agrees with the datasheet.

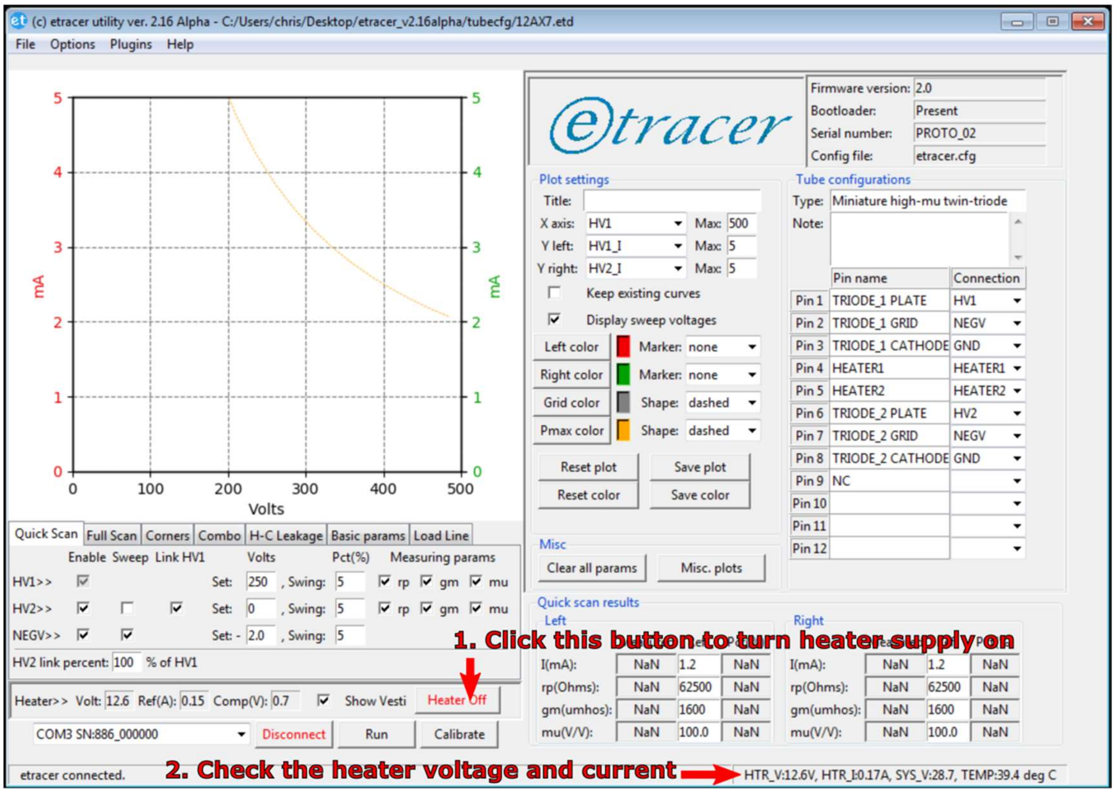


Figure 5-19.

[5] Select the “Corners” tab. Check the configuration parameters and change the values if needed.

[6] Click the Run button to start a corners test.

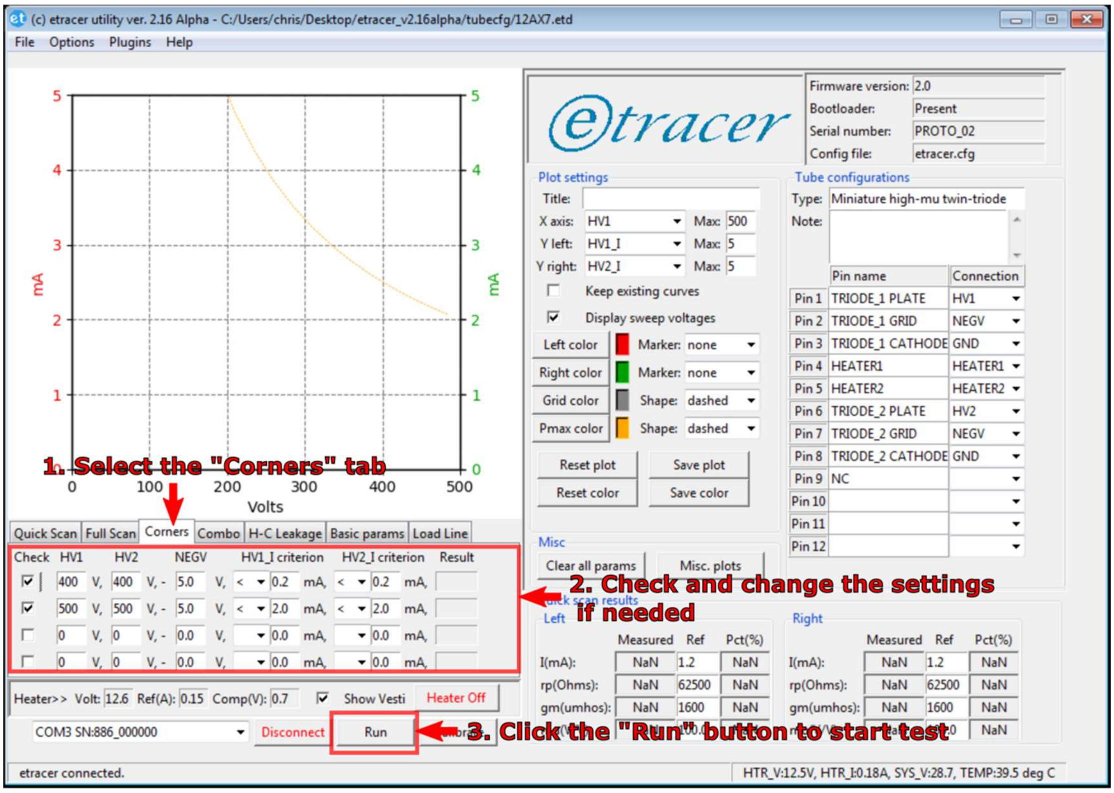


Figure 5-20.

[7] Take the test results.

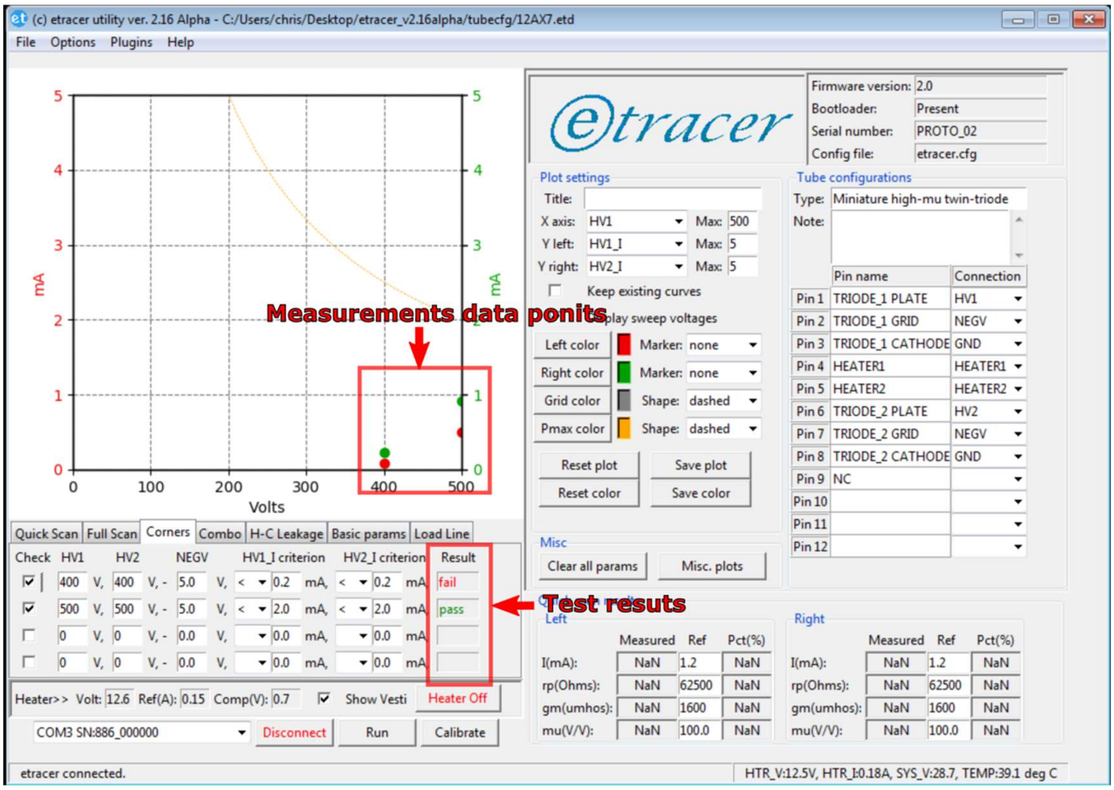


Figure 5-21.

6 Detailed settings under the Quick Scan tab

There are four configuration rows under the Quick scan tab for HV1, HV2, NEGV and HV2-linkage respectively.

The first row is the HV1 configuration row. In this row HV1 is always configured as enabled. HV1 is the voltage applied on the plate electrode of the DUT. The applied voltage is configured in the Set field. The Swing field is the amount of voltage swing applied to the plate during a quick-scan expressed in percentage. The recommended value is between 5% and 10%. Please consult the vacuum tube manuals for the setting values. In the right-end of this row there are three checkboxes for calculations of the parameters based on the voltage and current readings of HV1: r_p (AC resistance), gm (transconductance) and mu (Voltage Amplification Factor). If the DUT is a rectifier check r_p and uncheck the other two. If the DUT is a triode or a pentode check all three boxes.

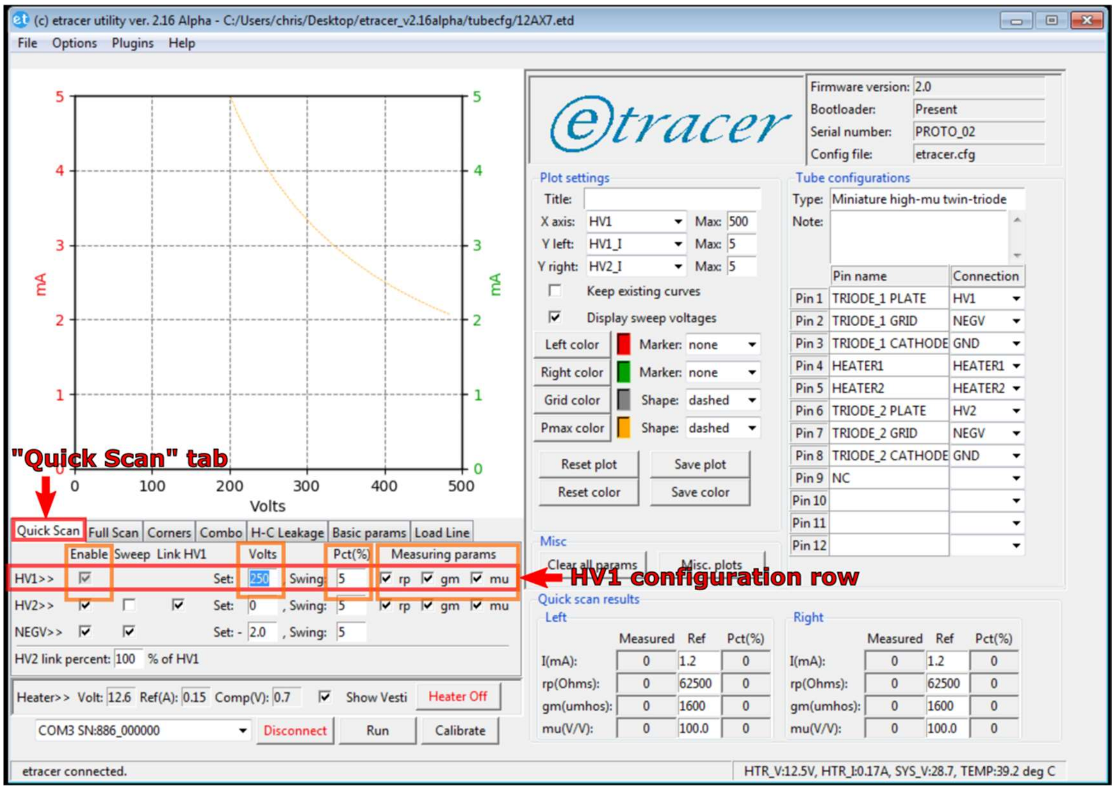


Figure 6-1.

The second row is the HV2 configuration row. The configuration method is similar to configuring the HV1 row. The enable checkbox enables the output of HV2. If the DUT is a single triode or a half-wave rectifier leave this box unchecked. The Sweep checkbox assigns HV2 as the source of control signal applied on the grid of the DUT. Only one source can be selected as the control signal source, either HV2 or NEGV. If this checkbox is checked, HV2 should be connected to the grid electrode of the DUT for testing a DUT under positive-grid bias. The amount of voltage swing is set by the Swing entry-box expressed in percentage. Note under positive grid-bias test mode the DUT can only be a triode or a triode-connected pentode because HV2 is no longer available for driving the screen electrode of a pentode. The Link HV1 checkbox forces HV2 output voltage follows HV1 with a percentage (default 100%). This mode can be used to test both section of a full-wave rectifier or a twin-triode simultaneously. Under this configuration HV2 should be connected to the plate electrode of the second section of the DUT. Another application for the Link-HV1 option is forcing a pentode connected as a triode because the voltage (HV2) applied on the screen electrode of the DUT is the same as the voltage applied on the plate of the DUT (HV1). The linkage percentage can be set to 50% to 100% to test a pentode under ultra-linear configuration. If both Link-HV1 and Sweep options are unchecked a fixed voltage value can be configured in the Set filed. This voltage will appear on HV2 during a quick-scan and can be used to test a pentode under pentode configuration. The last three items (r_p, gm and mu) share the same meanings as the three parameters in the HV1 configuration row but using the voltage and current readings on HV2 to derive the three parameters. If the DUT is a full-wave rectifier or a twin-triode these boxes should be checked accordingly to enable parameters calculations for the second section of the DUT.

The third row is the NEGV configuration row. The Enable checkbox in this row enables the output of NEGV. If the DUT is a rectifier uncheck this box. If the DUT is a triode or a pentode the Sweep checkbox should be checked if a test under negative grid-bias is desired. The quiescent voltage on the control grid is set by the Set entry-box. Please aware the entered value is positive and the system will negate the value as indicated by the negative sign before the entry-box. The amount of control signal swing is set in the Swing entry-box expressed in percentage.

The forth row is the HV2-linkage row. The HV2 linkage percentage against HV1 when the “Link HV1” checkbox in row 2 is checked can be entered here. The default linkage value is 100%.

The following is a summary of configurations for different DUT types for quick-scan assuming the DUT is tested under negative grid bias if applicable:

[1] Half-wave rectifier (eg. 81):

- HV1 row: Enable (always set by the software). Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box. Check r_p, uncheck gm and mu.

- HV2 row: Uncheck Enable, Sweep and Link-HV1. Uncheck r_p, gm and mu.
- NEGV row: Uncheck Enable and Sweep.
- HV2 linkage row: Disabled (grayed out).

[2] Full-wave rectifier (eg. 5U4):

- HV1 row: Enable (always set by the software). Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box. Check r_p. Uncheck gm and mu.
- HV2 row: Check Enable and Link-HV1. Uncheck Sweep. Check r_p. Uncheck gm and mu.
- NEGV row: Uncheck Enable and Sweep.
- HV2 linkage row: Disabled (grayed out).

[3] Single triode (eg. 300B):

- HV1 row: Enable (always set by the software). Configure the quiescent voltage in the Set box. Configure the amount of swing in percentage in the Swing box. Check r_p, gm and mu.
- HV2 row: Uncheck Enable, Sweep and Link-HV1. Uncheck r_p, gm and mu.
- NEGV row: Check Enable and Sweep. Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box.
- HV2 linkage row: Disabled (grayed out).

[4] Twin-triode (eg. 12AX7):

- HV1 row: Enable (always set by the software). Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box. Check r_p, gm and mu.
- HV2 row: Check Enable and Link-HV1. Uncheck Sweep. Check r_p, gm and mu.
- NEGV row: Check Enable and Sweep. Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box.
- HV2 linkage row: Set to 100%.

[5] Triode-connected pentode (eg. 6L6):

- HV1 row: Enable (always set by the software). Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box. Check r_p, gm and mu.

- HV2 row: Check Enable and Link-HV1. Uncheck Sweep. Uncheck r_p, gm and mu.
- NEGV row: Check Enable and Sweep. Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box.
- HV2 linkage row: Set to 100% (default value).

[6] Pentode in pentode mode (fixed voltage on the screen electrode):

- HV1 row: Enable (always set by the software). Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box. check r_p, gm and mu.
- HV2 row: Check Enable. Uncheck Sweep and Link-HV1. Uncheck r_p, gm and mu. Configure the desired voltage for HV2 in the Set box.
- NEGV row: Check Enable and Sweep. Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box.
- HV2 linkage row: Disabled (grayed out).

[7] Pentode in ultra-linear mode (Voltage on the screen electrode is proportional to the voltage on the plate electrode):

- HV1 row: Enable (always set by the software). Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box. check r_p, gm and mu.
- HV2 row: Check Enable and Link-HV1. Uncheck Sweep. Uncheck r_p, gm and mu.
- NEGV row: Check Enable and Sweep. Configure the quiescent voltage in the Set box. Configure the amount of voltage swing in percentage in the Swing box.
- HV2 linkage row: Set to the desired percentage (50%~100%).

7 Detailed parameters settings in the Full Scan tab

There are four configuration rows under the Full-scan tab for HV1, HV2, NEGV and HV2-linkage respectively.

The first row is the HV1 configuration row. In this row HV1 is always configured as enabled. HV1 is the voltage applied on the plate electrode of the DUT. The output voltage HV1 is configured by the start voltage (Vstart), end voltage (Vend) and a step size for voltage increment (Vstep). Only integers are allowed for these three fields. The Imax field hold the maximum current allowed during a full-scan. If the measured current exceeds this value etracer will stop curve tracing for the specific curve. The Pmax box holds the maximum power of the DUT. The curve tracing stop when the measured power (plate voltage times plate current) exceeds Pmax by 1.5 times for a specific curve. Pmax is displayed in the plot as an orange curve by default. Please refer to the datasheet of the DUT to determine the settings for these values.

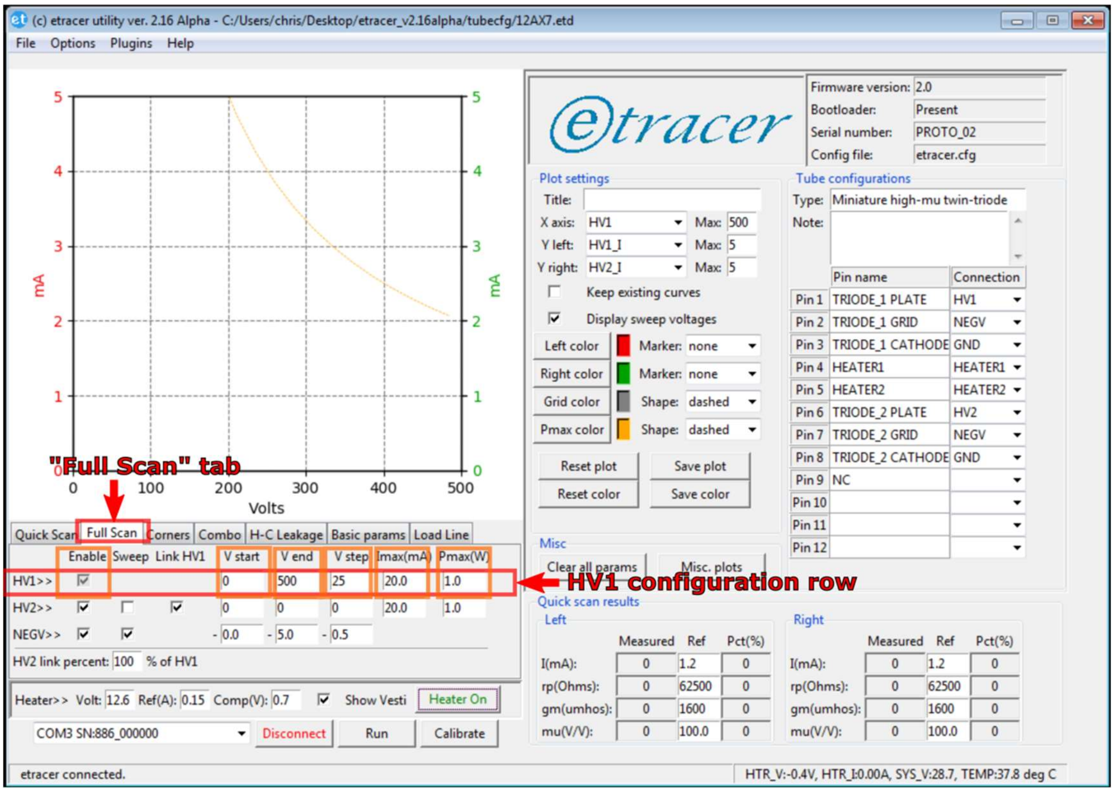


Figure 7-1.

The second row is the HV2 configuration row. The configuration method is similar to configuring the HV1 row. The enable checkbox enables the output of HV2. If the DUT is a single triode or a half-wave rectifier leave this box unchecked. The Sweep checkbox assigns HV2 as the source of the control signal applied on the grid. In this mode HV2 should be connected to the grid electrode of the DUT for testing the DUT under positive grid bias. The voltage values for HV2 are configured by setting the Vstart, Vend and Vstep entry-boxes. The minimum step size is 1V. Note under the positive grid bias testing mode the DUT can only be a triode or a triode-connected pentode because HV2 is no longer available for driving the screen electrode of a pentode. The Link HV1 checkbox forces HV2 output voltage follows HV1 with a scaling percentage (default 100%). When the linkage is set to 100% in row 4 this mode can be used to test both section of a full-wave rectifier or a twin-triode simultaneously. Under this configuration HV2 should be connected to the plate of the second section of the DUT. Another application for the Link-HV1 option is forcing a pentode connected as a triode because the voltage (HV2) applied on the screen electrode of the DUT is the same as the voltage applied on the plate of the DUT (HV1). The linkage percentage can be set from 50% to 100% to test a pentode under ultra-linear configuration. If both Link- HV1 and Sweep options are unchecked a fixed voltage value can be configured in the Vstart filed. This voltage will appear on HV2 throughout the test and can be used to test a pentode under pentode configuration.

The third row is the NEGV configuration row. The enable checkbox in this row enables the output of NEGV. If the DUT is a rectifier uncheck this box. If the DUT is a triode or a pentode the Sweep checkbox should be checked if testing the DUT under negative grid bias is desired. The voltage values for NEGV2 are configured by setting the Vstart, Vend and Vstep entry-boxes. Please be aware the entered values are positive and the system will negate these values as indicated by the negative sign before each entry-box.

If both HV2 and NEGV are set as the sweep sources two scans will be performed by the software one-by-one to capture the curves under both positive grid-bias and negative-bias. The software will start with a positive scan (HV2 connected to the grid electrode) followed by negative scan (NEGV connected to the grid electrode). Please follow the message of the software to connect the wire on the grid electrode accordingly.

The forth row is the HV2-linkage row. The HV2 linkage percentage against HV1 when the “Link HV1” checkbox in row 2 is checked can be entered here. The default linkage value is 100%.

The following is a summary of configurations for different DUTs for full-scan assuming the DUT is tested under a negative grid bias if applicable:

[1] Half-wave rectifier (eg. 81):

- HV1 row: Enable (always set by the software). Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for HV1. Configure the maximum current (Imax) and maximum power (Pmax).
- HV2 row: Uncheck Enable, Sweep and Link-HV1.
- NEGV row: Uncheck Enable and Sweep

- HV2 linkage row: Disabled (grayed out).

[2] Full-wave rectifier (eg. 5U4):

- HV1 row: Enable (always set by the software). Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for HV1. Configure the maximum current (Imax) and maximum power (Pmax).
- HV2 row: Check Enable and Link-HV1. Uncheck Sweep.
- NEGV row: Uncheck Enable and Sweep.
- HV2 linkage row: Disabled (grayed out).

[3] Single triode (eg. 300B):

- HV1 row: Enable (always set by the software). Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for HV1. Configure the maximum current (Imax) and maximum power (Pmax).
- HV2 row: Uncheck enable, Sweep and Link-HV1.
- NEGV row: Check Enable and Sweep. Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for NEGV.
- HV2 linkage row: Disabled (grayed out).

[4] Twin-triode (eg. 12AX7):

- HV1 row: Enable (always set by the software). Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for HV1. Configure the maximum current (Imax) and maximum power (Pmax).
- HV2 row: Check Enable and Link-HV1. Uncheck Sweep.
- NEGV row: Check Enable and Sweep. Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for NEGV.
- HV2 linkage row: Set to 100%.

[5] Triode-connected pentode (eg. 6L6):

- HV1 row: Enable (always set by the software). Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for HV1. Configure the maximum current (Imax) and maximum power (Pmax).
- HV2 row: Check Enable and Link-HV1.Uncheck Sweep.
- NEGV row: Check Enable and Sweep. Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for NEGV.
- HV2 linkage row: Set to 100%.

[6] Pentode in pentode mode (fixed voltage at the screen electrode):

- HV1 row: Enable (always set by the software). Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for HV1. Configure the maximum current (Imax) and maximum power (Pmax).
- HV2 row: Check Enable. Uncheck Link-HV1 and Sweep. Set the desired voltage in the Vstart entry-box.
- NEGV row: Check Enable and Sweep. Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for NEGV.
- HV2 linkage row: Disabled (grayed out).

[7] Pentode in ultra-linear mode (Voltage on the screen electrode is proportional to the voltage on the plate electrode):

- HV1 row: Enable (always set by the software). Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for HV1. Configure the maximum current (Imax) and maximum power (Pmax).
- HV2 row: Check Enable and Link-HV1. Uncheck Sweep.
- NEGV row: Check Enable and Sweep. Configure the start voltage (Vstart), end voltage (Vend) and step size (Vstep) for NEGV.
- HV2 linkage row: Set to the desired percentage (50%~100%).

8 Detailed parameters settings for the corners test

A total of four corner test cases can be configured under the "Corners" tab. Each configuration row under the "Corners" tab represents a corner test case.

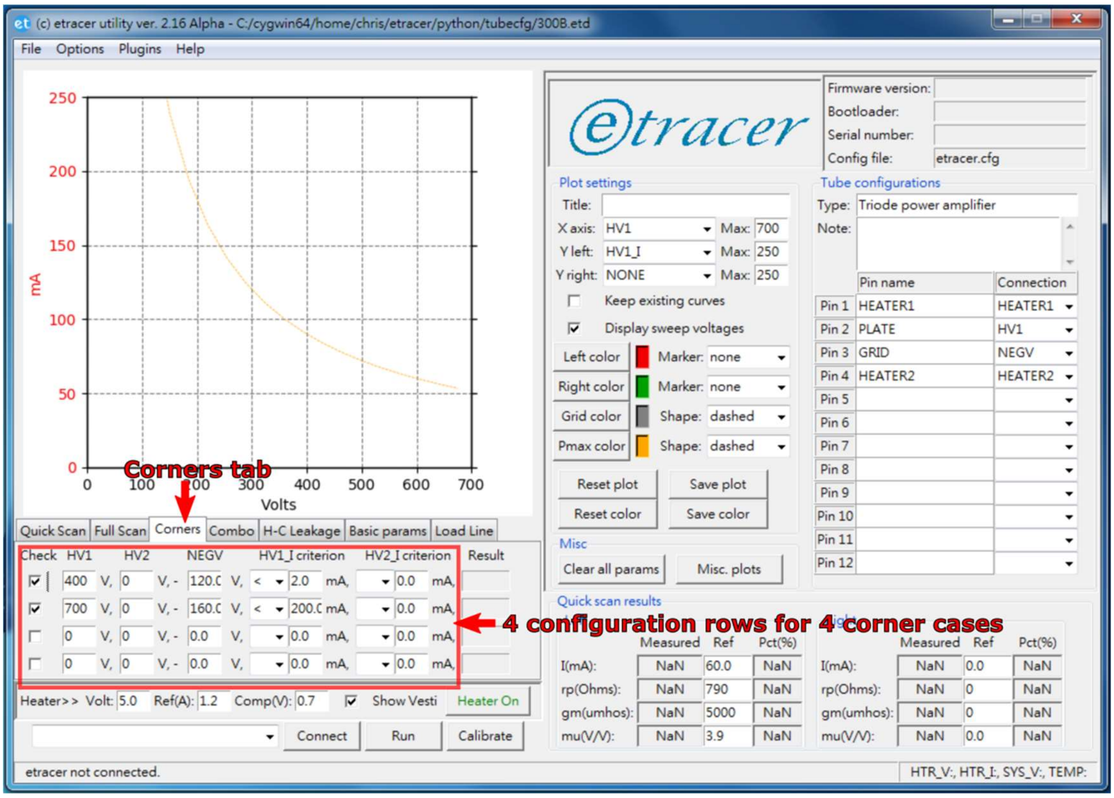


Figure 8-1. Corner test configuration

The “Check” check box on the left-most-side in each row indicates whether or not the specific test case represented by that row is enabled. In each test case the user configures the test voltages on HV1, HV2 and NEGV. A pass/fail criterion can be configured by comparing the measured currents against threshold values. The comparing criteria are none, less than and higher than.

8.1 Configuring a test case to capture the cut-off region failure

Figure 8-2 and figure 8-3 are two full-scan results for two 300B tubes. It can be observed that the tube in figure 8-3 has a much lower cut-off plate voltage (the plate currents start to rise at a much lower plate voltage). This tube might test as good under quick-scan but the maximum output power and distortion for this tube does not meet the design specification. To capture this type of failure we can configure a corner test case to make sure the measured plate current remains low at a negative enough grid bias and a high enough plate voltage. As an example the supplied 300B configuration file has a test condition of 400V on the plate (HV1) and -120V on the grid (NEGV). The pass criterion is a plate current less than 2mA. This test case will capture the failure shown in figure 8-3 easily.

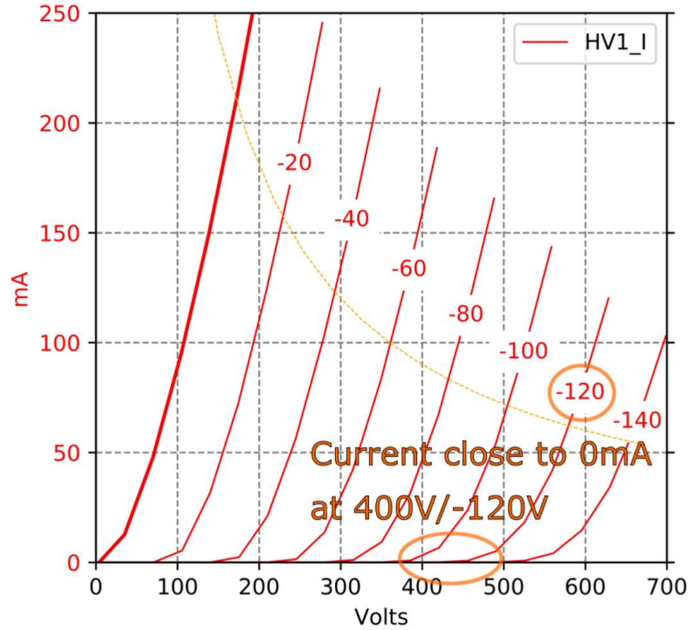


Figure 8-2. A full-scan result of a good 300B tube

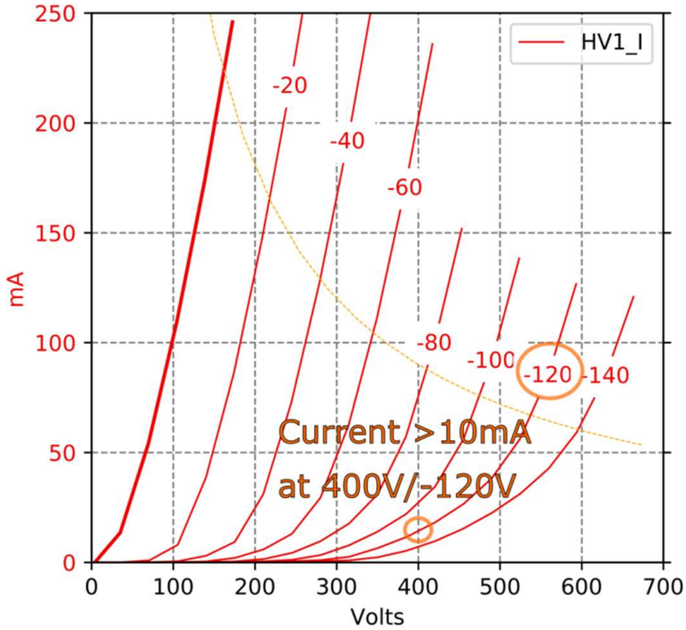


Figure 8-3. A full-scan result for a 300B tube with an abnormal cut-off region

8.2 Configuring a test case to capture the short failure at a high plate voltage

In the datasheets the maximum allowed plate voltage for a tube is usually given. This value can be used for generating the test case to capture the high-voltage short failure.

NOTE Some datasheet specifies the maximum plate voltage as the "maximum allowable plate voltage for the quiescent operating point" instead of the "absolute maximum voltage allowed on the plate". For example, in the datasheet for a Western Electric 300B the "Maximum Operating Conditions" are given at a plate voltage of 450V. However, in the real circuit the plate voltage can swing up to as high as 700V when the full output power is reached.

To capture this type of failure we can configure HV1 (and HV2 if needed) to the highest voltage expected in a real circuit and check the plate current against the reference value in the datasheet. The grid voltage should be properly selected so that the expected plate current does not exceed etracer's measuring capacity of 300mA at such high plate voltage. As an example the supplied test case for a 300B has a test voltage of 700V on the plate (HV1) and -160V on the grid. The pass criteria for the measured current is set to "less than 200mA" which is approximately twice of the plate current in the datasheet for a reference 300B tube.

9 Combo test

Combo test is designed to perform a combination of the three basic tests (quick-scan, full-scan and corners) sequentially (full-scan → quick-scan → corners) with a single trigger. It is especially useful when the user want to test a batch of tubes of the same type. The combo test is further automated by an auto-DUT-insertion-detection feature and a countdown counter that triggers the test when expired.

9.1 Composing a combo test

Before configuring a combo test the individual tests (quick-scan, full-scan and corners) shall be properly configured under each tab respectively. In this section we use a 12AX7 configuration file as an example. Assuming the 12AX7.etd configuration file is loaded into the PC memory so that the three basic tests are properly configured. Select the "Combo" tab to configure the combo test.

There are a total of 5 configuration rows under the "Combo" tab:

The first row allows the users to select what basic test to be included in the combo test. Three checkboxes represent three basic tests respectively.

In the second row the "Auto DUT insertion detection" checkbox enables the auto DUT insertion detection when checked. The detection is based on the heater supply current: If a DUT is removed the current is zero and when a DUT is inserted the heater supply current becomes non-zero. The "Warmup time" entry-box set the countdown timer in seconds before the comb-test automatically starts after an insertion of a DTU is detected. If the "Auto DUT insertion detection" checkbox is not checked the combo test will be in manual mode and the user can trigger the combo test by clicking the "Test now" button in the combo test window to be introduced later. The "Play sound" checkbox when checked makes the software to play a sound effect when a combo test is started and when a combo test is done.

The third row allows the users to select different types of report when a combo test is done. The options are: Full-scan CSV file, Quick-scan TXT file, and combined report in PDF format.

The forth row allows the user to configure the filenames with a prefix and a sequential number for the report. For example: If the prefix is set to 12AX7 and the sequential number is set to 1 the output files will be 12AX7_1.csv, 12AX7_1.txt and 12AX7_1.pdf . The actually output files depends on the selection in the third row. The sequential number will automatically incremented by one after the completion of each combo test.

The fifth row allows the user to select the output directory for the reports.

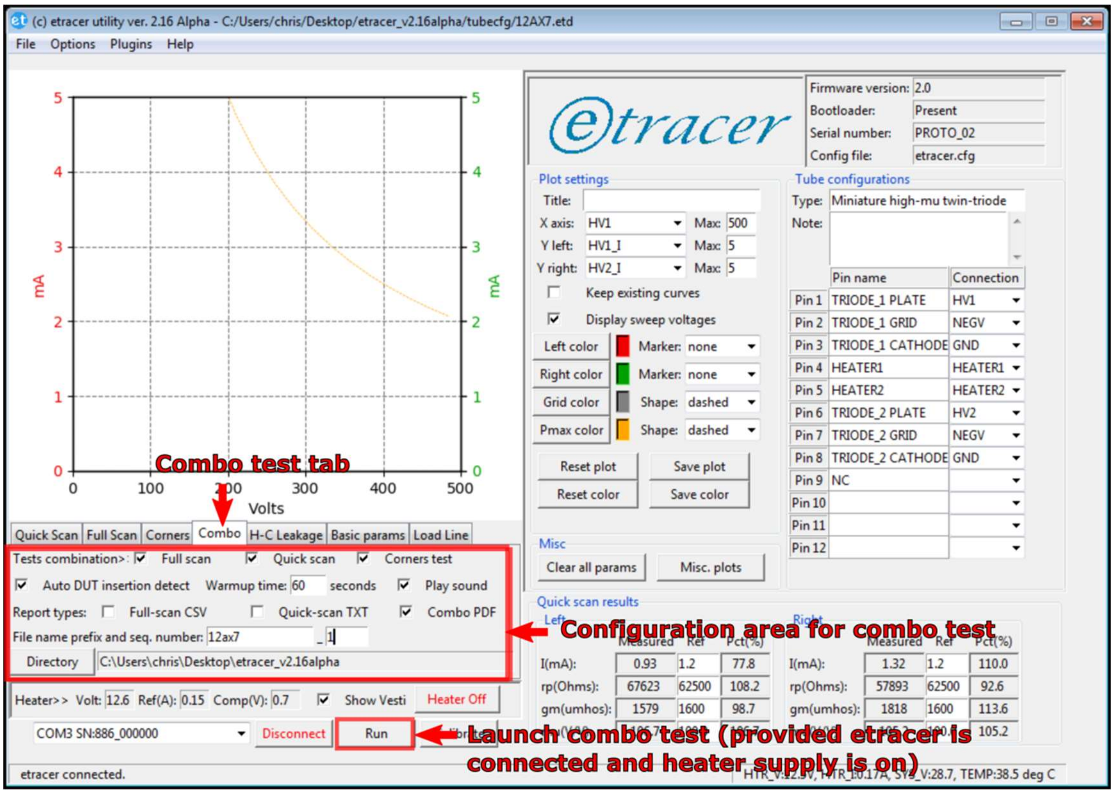


Figure 9-1. An example configuration for a combo test

In the example configuration in figure 9-1 all three basic tests are selected. The software will automatically detect an insertion of a DUT and start a 60 seconds countdown when a DUT insertion is detected. After the counter expires the test will be automatically launched and the report will be in a PDF format with a filename of 12ax7_1.pdf. A sound will be played when the test starts and ends.

9.2 Start the combo-test

After completing the configuration under the "Combo" tab click the "Run" button will bring up the combo test window. Please note that etracer should be in the connected state and the heater supply should be turned on before launching the combo-test.

The functionally of each control entity in the combo-test window is illustrated in figure 9-2.

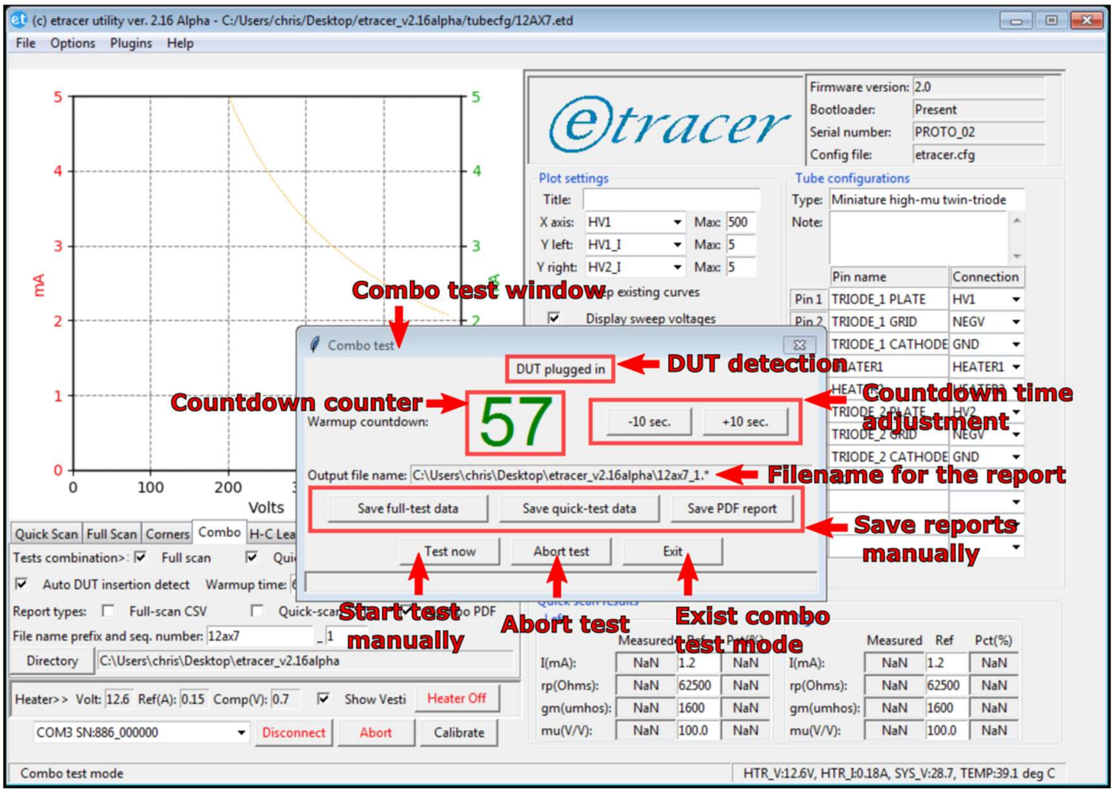


Figure 9-2.

When the countdown counter reaches 0 the combo-test will automatically start. The countdown time can be adjusted by the "-10 sec." and "+10 sec." buttons. The tab will be switched to the corresponding basic test ongoing when a combo test is triggered by either the countdown counter or manually by clicking the "Test now" button.

10 Heater-Cathode leakage test

The purpose of the heater-cathode leakage test is to measure the leakage current between the heater and the cathode of a DUT. A good tube should exhibit a very low leakage current (in the uA range) between heater and cathode. Note this test is only valid for indirectly-heated tubes. The heater-cathode leakage test is a feature that was not planned when the etracer was designed. Due to the restriction of the ADC (Analog to Digital Converter) in etracer the current reading is not accurate in the uA range. Hence the heater-cathode leakage test is designed as a pass-fail test and the resolution of the current reading is 10uA at best.

10.1 Configuring the heater-cathode leakage test

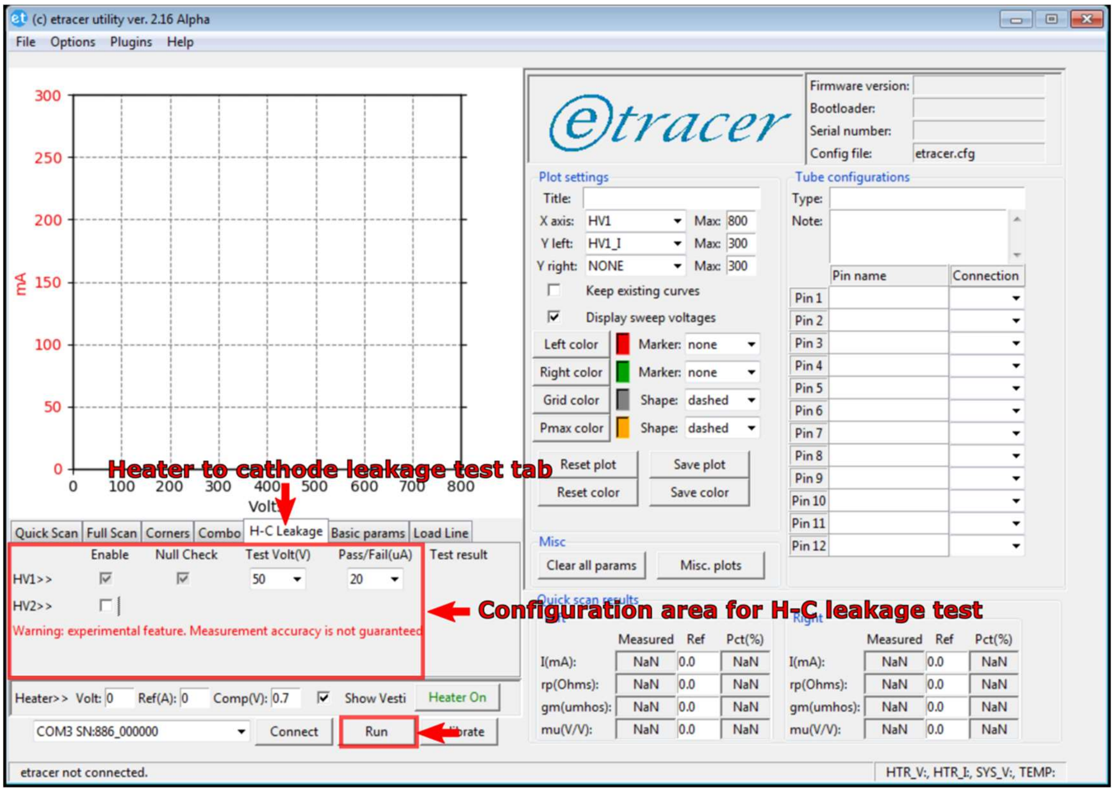


Figure 10-1.

There are two parameters that can be configured for the H-C leakage test: The test voltage and the pass/fail current in uA. HV1 is used as the test voltage source by default. If the DUT has a second cathode HV2 can be used to apply test voltage on it. Check the enable box for HV2 to enable the output of HV2. The output voltage on HV2 will be the same as HV1. The test can be run with heater supply either turned on or turned off. Press the “Run” button launches the H-C leakage test.

10.2 Perform the heater-cathode leakage test

The H-C leakage test is performed in two steps. The first step is the “Null Check” step where the current reading is calibrated with HV1 and HV2 connected to nothing. The second step is the leakage current measurement step where the leakage current is measured.

A pop-up message box before each step guides the users to connect the wires accordingly.

The test result will be compared against the pass/fail criteria and displayed in the result field when the test is done as depicted in figure 10-2.

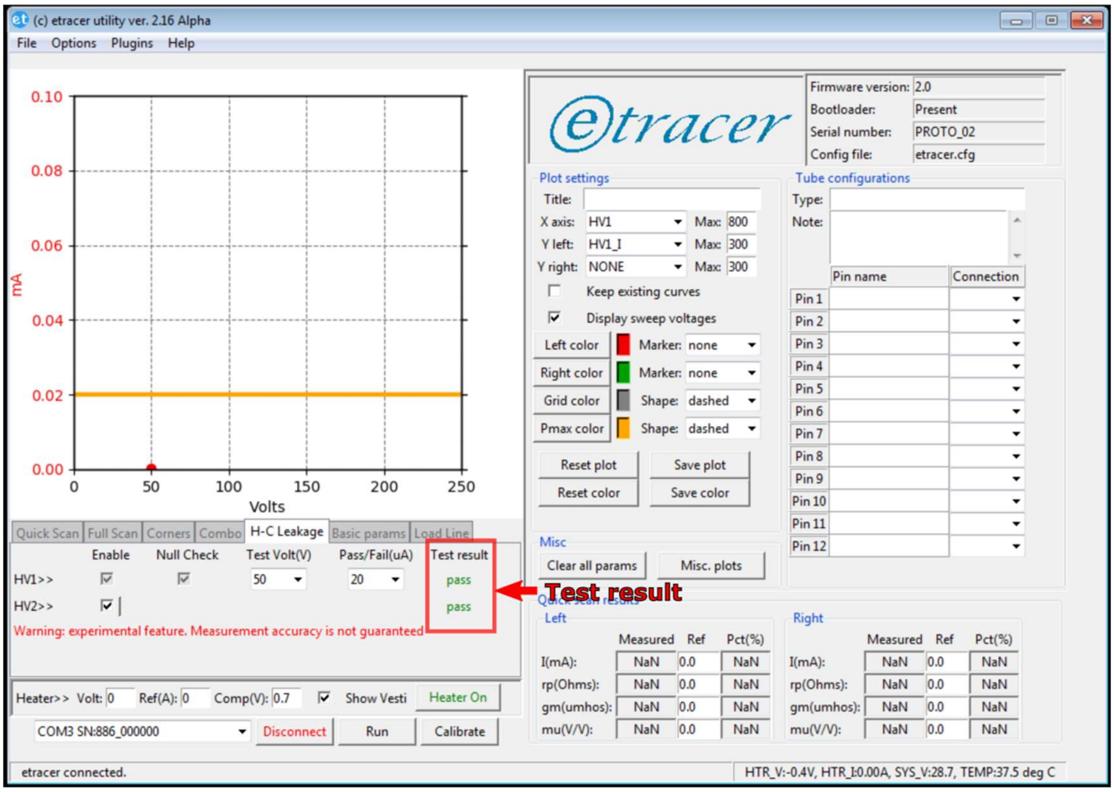


Figure 10-2. Example test result of a H-C leakage test

11 Basic parameters display

The [Basic params] tab allows the user to check the three basic parameters (rp, mu and gm) following the mouse pointer when a full-scan data is available. The source of the data can be set to the left or the right axis. The parameters are calculated based on interpolations hence the more full-scan data points the more accurate the result. The "Voltage %" and "Current %" entry boxes are used to hold the percentage of voltage and current deviations to the point indicated by the mouse pointer for parameters calculations. A value of 4% to 6% should work for most cases. There are two algorithms used to derive the parameters: mu-based and gm-based. The software will automatically pick one based on the curves' slopes. The user can override the algorithm by click on the corresponding buttons. Usually mu-based algorithm works better for triodes while gm-based algorithm works better for pentodes.

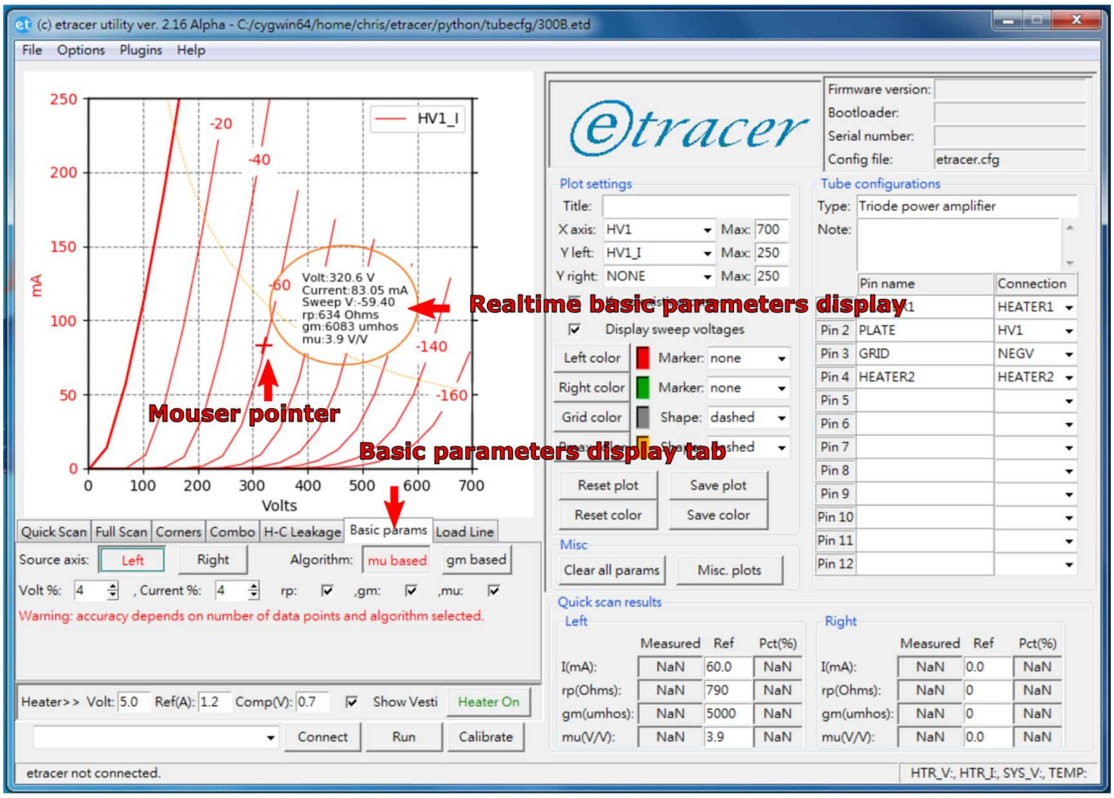


Figure 11-1. Basic parameters display

12 Load-line analysis

The [Load Line] tab allows the user to perform load-line analysis for a DUT as a single-ended output stage when a full-scan data set is available. The load-line is represented by two connected lines in the plot: one solid line and one dashed line. The solid line represents the half swing for a sinusoidal waveform while the dashed line represents the other half part of the sinusoidal waveform. The solid line has one circle mark on each end which can be moved by the user by click-and-drag on the mouse. The dashed line will change accordingly to reflect the full load-line. The configuration parameters for the load-line will also be updated on the fly. The user can also enter the parameters in the entry boxes and the load-line will be updated accordingly. If the load resistance is fixed (determined by the load resistance or the impedance of an output transformer) the user can check the "Lock load resistance" checkbox so that the slope of the load-line does not change during mouse-dragging.

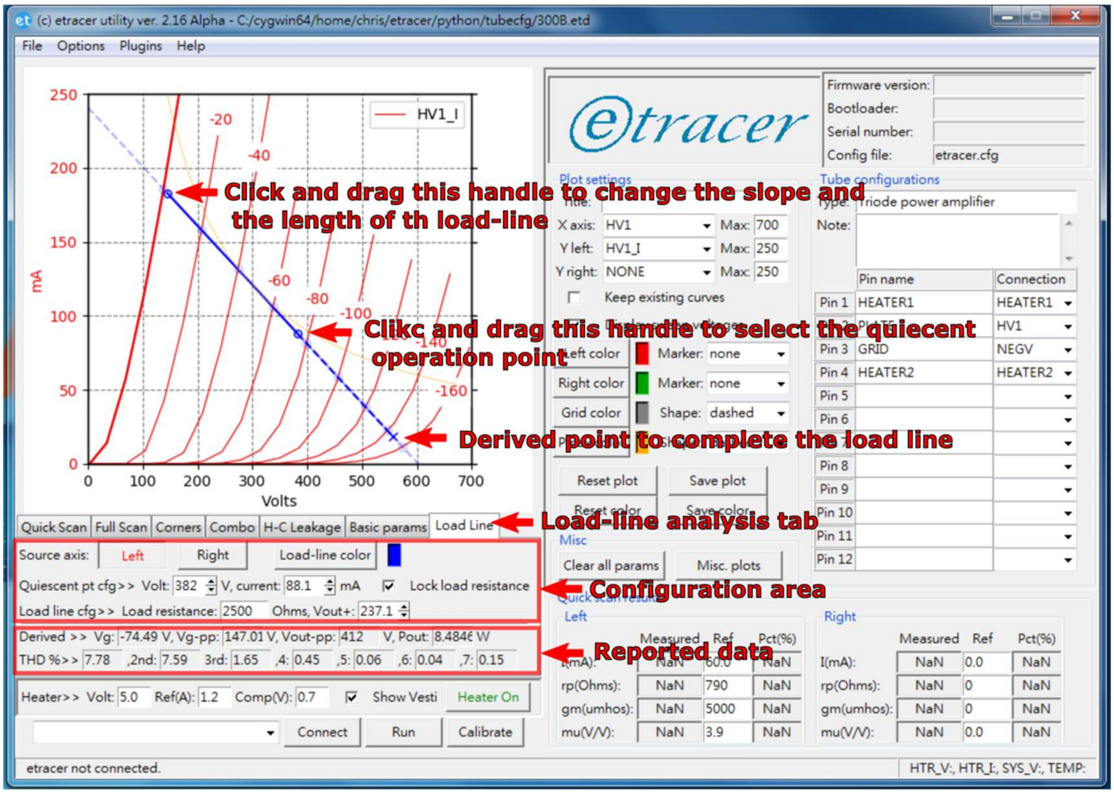


Figure 12-1. Load-line analysis (A 300B is used in this example)

The software calculates and updates the reported parameters on the fly. The reported parameters includes the grid bias, the AC output voltage swing, the output power and a THD (Total Harmonic Distortion) and harmonics report based on FFT (Fast Fourier Transform) up to the 7th order.

13 Creating and editing a vacuum tube configuration file (file extension name .etd)

The content of a vacuum tube configuration file follows the standard of a Microsoft Windows INI file. The contents are separated by sections. A section is defined by a name in a pair of square-brackets. The scope of a section is the first line under the section name in brackets to the last line before a section name in bracket if one exists. In the following example two sections, section 1 and section 2 are defined. In each section variables are defined using the format: parameter=value

```
[section 1]
option_1=a
option_2=b

[section 2]
option_3=c
```

It is not recommended to edit the vacuum tube configuration file directly. If there is a need to modify or change the settings of a vacuum tube configuration file please load the existing file and change the settings in the GUI. When the editing is done the data can be saved using the same file name or saved as a new file by selecting File->Save tube configuration in the menu zone.

A complete tube configuration file should contain configurations for the three basic tests, the heater voltage/current, the reference values for quick scan, the wiring for the DUT and the data-axis assignment.

14 Setting system configuration parameters

The system configuration menu can be brought up by selecting Option->Configuration in the menu zone.

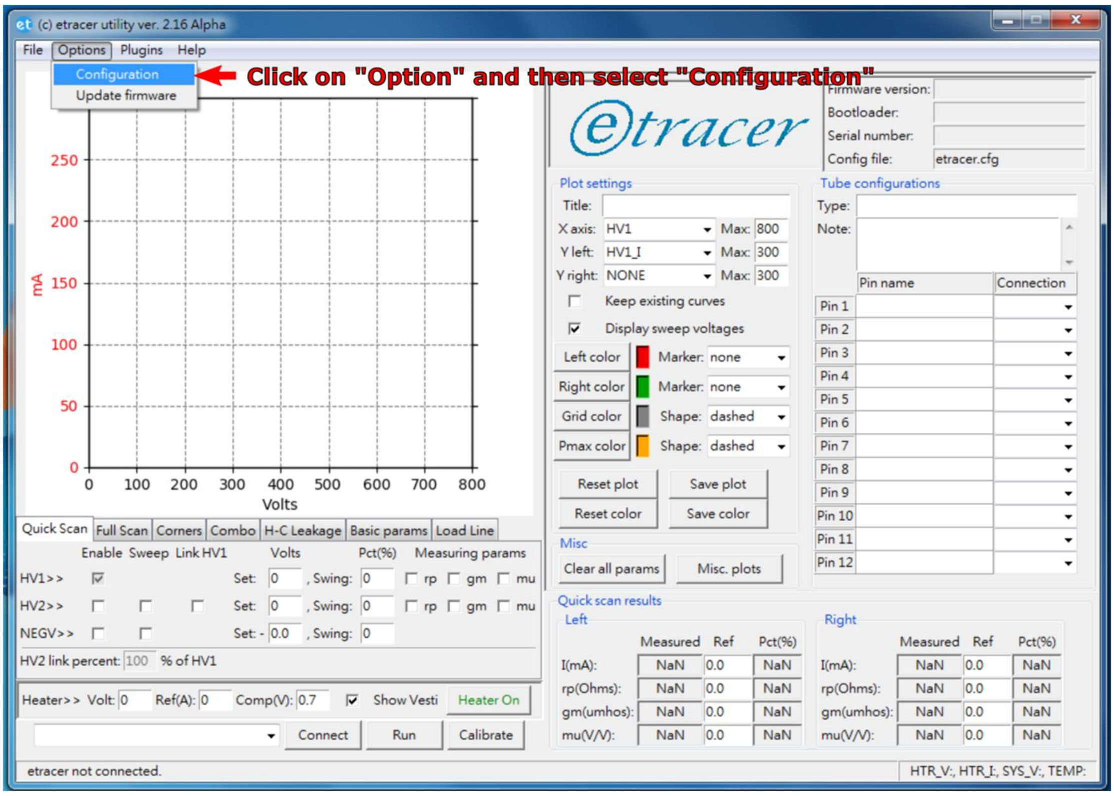


Figure 14-1.

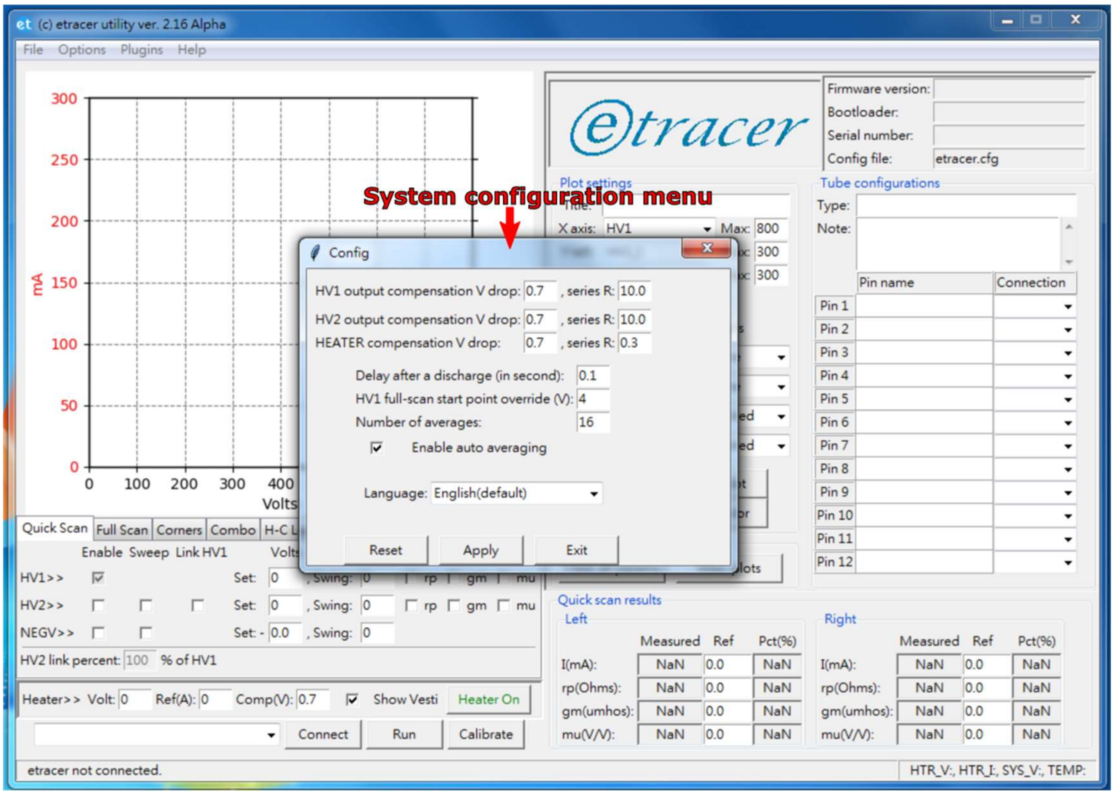


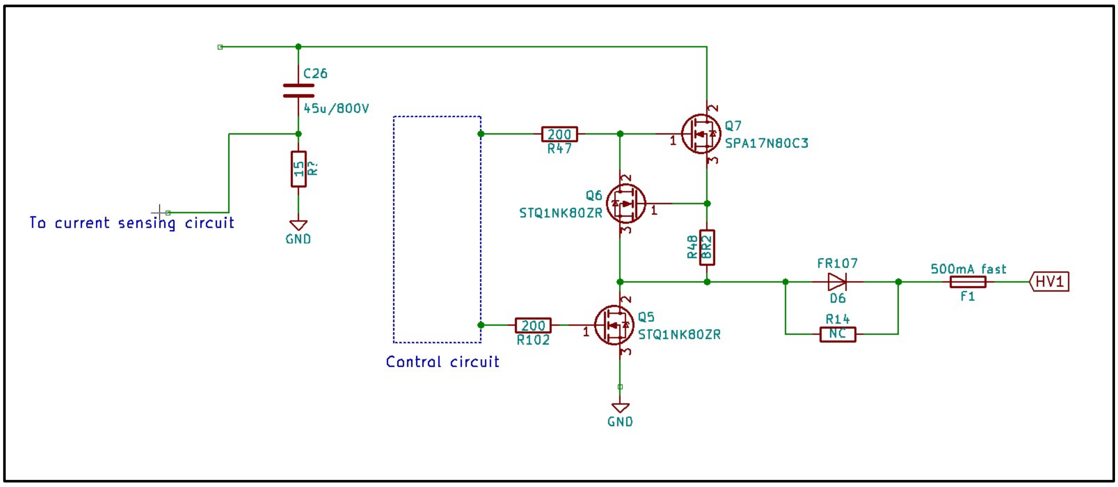
Figure 14-2.

In this menu the compensation values for HV1, HV2 and HEATER output can be set. Other configurable options include the measurement behavior of the etracer.

The reset button reset all values to system defaults. After the parameters are changed click on the Apply button to save the changes. The options in this menu are explained below.

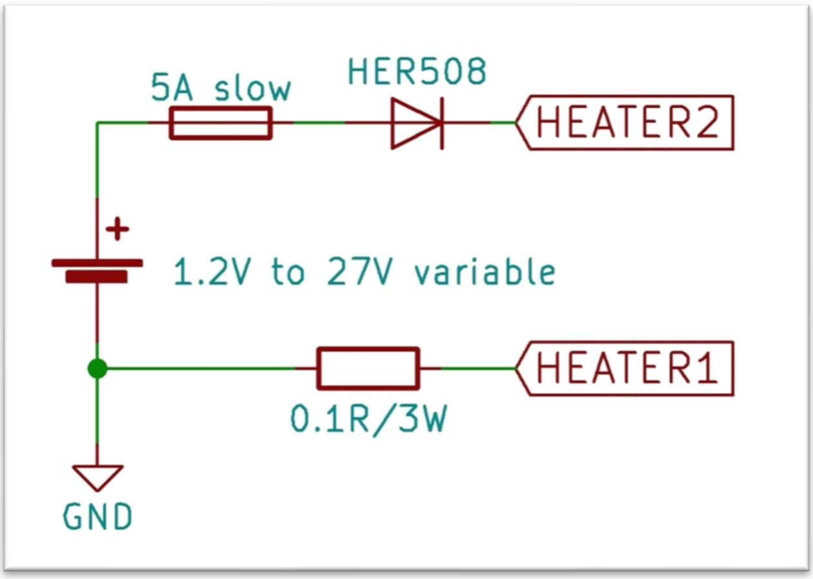
14.1 HV1 and HV2 output circuit compensation (Diode voltage drop and series resistance):

The first two rows of the system configuration menu allow setting of the compensation parameters for the HV1 and HV2 output respectively. Here we use the output circuit of HV1 as an example. The following figure is the output circuit of HV1. The voltage drop of the protection diode (D6) is compensated by the value in the first entry box of the first row. The default compensation value is 0.7V. The series output resistance is the combination of the 8.2 ohms current sensing resistor (R48) plus the on-resistance of the output transistor (Q7) plus the resistance of the protection diode (D6) plus the resistance of the fuse (F1). The default compensation value is 10 Ohms.



14.2 HEATER output circuit compensation (Diode voltage drop and series resistance)

The third row in the system configuration menu contains parameters for HEATER output circuit compensation. A simplified heater supply circuit is depicted in the following figure. At the factory the voltage is calibrated between the positive terminal and the negative terminal (Gnd) of the battery (1.2V to 27V). The calibration does not include the protection diode and all series resistances and hence we rely on a model to compensate the voltage output between HEATER1 and HEATER2. The value of Vdrop models the voltage drop across the protection diode (HER508). The default value is 0.7V. The series R value is the combination of the 0.1 Ohm current sensing resistor, the resistance of the protection diode, the resistance of the fuse and all resistances in the connectors and wirings. The default value is 0.3 Ohm.



14.3 Delay after a discharge

This parameter determines the delay after a discharge (eg. Bring NEGV back from the lowest grid voltage setting) before further instructions is sent to etracer. For normal operation this parameter should be kept at its default value of 0.1 second.

14.4 HV1 full-scan start point override

In the full-scan tab we specify the output voltages of HV1 by assigning the start voltage (Vstart), the end voltage (Vend) and the step size (Vstep). Usually we set the start value as zero and use numbers such as multiple of 25 for Vend and Vstep. For example: Vstart=0, Vend=500 and Vstep=25. It is observed when testing a pentode in pentode mode the screen current and plate current is very high when the voltage on the plate is low. This causes a peak at HV1=25V in the curves with grid biases close to zero volt with the above example settings. This poses a problem when high-order interpolation is used for post-processing. The problem can be solved by starting HV1 scan from a non-zero volt (eg. 4V). One way to do it is configuring Vstart, Vend to something like Vstart=4V and Vend=504V. The HV1 full-scan start point override option provides an alternative way to achieve the same goal. While keeping Vstart and Vend unchanged (eg. Vstart=0V, Vend=500V) the override value will force HV1 output starting from the configured override value. For example, if the configured override value is 4V the scan voltages of HV1 becomes 4V, 25V,50V… in the above example.

14.5 Number of average

This parameter determines the number of measurements the software would issue for a single data point. The default value of 16 gives a good balance of speed and accuracy.

14.6 Enable auto averaging

When enabled the firmware will determine the measurement time for a single measurement pulse by firstly measure the output current of HV1. If the measured current is low a longer time is allowed to perform more measurements within a measurement pulse. If the measured current is high the measurement time is shorten to prevent excessive discharge current from affecting the measurement accuracy. Please leave this option enabled unless there is a special need (eg. check the quality of current scaling calibration).

14.7 Language selection

This option allows user to select the language for the text used in the software. The change will take effect on the next launch of the software.