User's manual for the Sbox12 switching box

Document version 0.3

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1. Introduction

SBOX12 is designed as an add-on device to an etracer vacuum tube curve tracer/tester installed in the Model-01 chassis. The chassis of Sbox12 is designed to be placed underneath the model-01 chassis as depicted in figure 1 below. The Sbox12 comes in a kit format with everything needed to operate except an USB cable (type A male to type B male) connecting it to the host PC.

Figure 1. The etracer/sbox12 combo

It is assumed that readers of this manual are familiar with the etracer hardware and the etracer Model-01 chassis. In the rest of this document the 6 output pins (HV1, HV2, GND, NEGV, HTR1 and HTR2) from the etracer PCB brought to the small top panel of the Model-01 chassis are called “the source pins and the pins (10 on the Model-01 chassis) connecting to the tubes sockets are called “the destination pins”. The same naming (source pins and destination pins) applies the Sbox12 PCB except the Sbox12 has a total of 12 destination pins to support tubes with up to 12 pins.

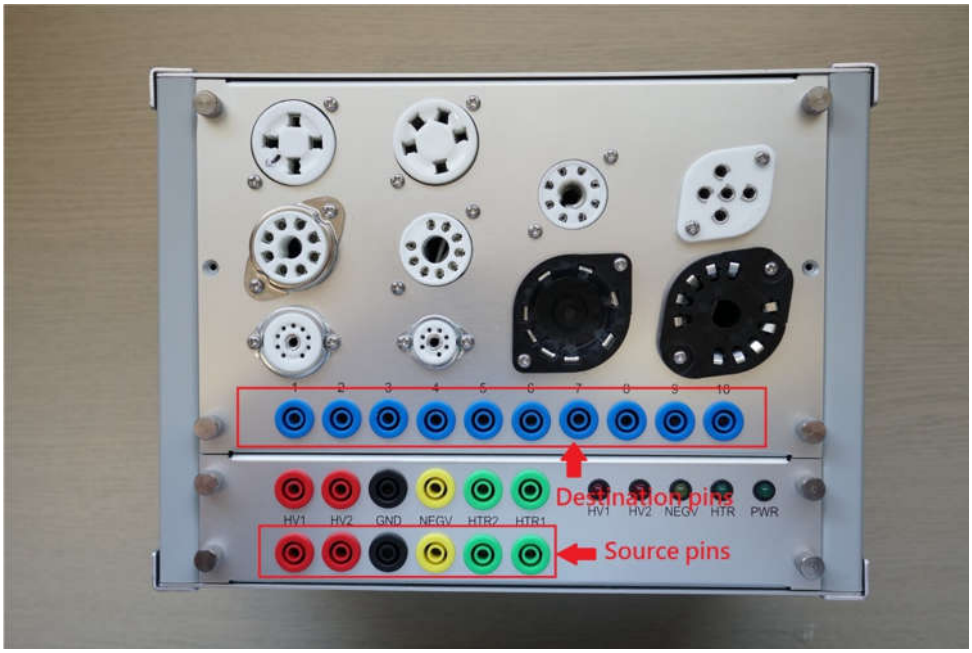

Figure 2. Source pins and destinations pins for the etracer

The heart of the Sbox12 is a 7-by-12 (A total of 84 relays) switching matrix that routes the 6 source pins (HV1, HV2, GND, NEGV, HTR2 and HTR1) from the etracer PCB to up to 12 destination pins that connect to vacuum tubes sockets. Each of the 12 destination pins can connect to any of the 6 source pins plus a no-connection option independently. With the control of the etracer PC software the switching matrix inside the Sbox12 is routed whenever a vacuum tube configuration file is loaded into the PC memory by the application software. Hence the effort of manual wiring to adapt to different pin configurations is no longer needed.

Note: The reason for a 7-by-12 matrix instead of a 6-by-12 matrix is the added possibility to connect the NEGV pin from etracer to different out pins with or without a resistor in series. This option is for future implementation of the software.

The Sbox12 PCB integrates an USB hub IC in it hence only one USB cable is needed to connect to a PC from the etracer/Sbox12 combo.

2. Parts list for the Sbox12 kit

- One etraer PCB. Built and tested.
- One chassis set for the Sbox12 including one bottom plate, two side panels, one front panel and one top panel.
- Four angled bars for keeping the etracer model-01 chassis and the Sbox12 chassis together as one unit.
- Four rubber stands with four M4 screws.
- Six M3 screws with washers to mount the Sbox12 PCB to the bottom plate of the Sbox12 chassis.
- One Molex 5197-06 6 circuits housing with crimping terminals for connector J114 on the Sbox12 PCB

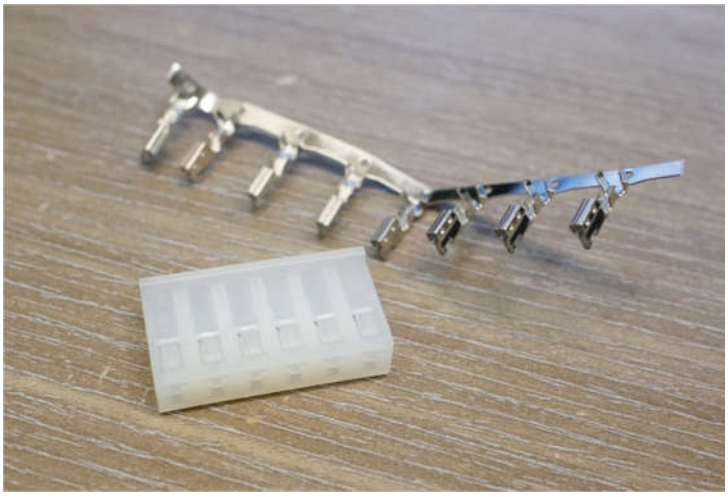

Figure 3. Molex 5197-6 housing and crimping terminals

- 2 meters of Nizing UL10362 600VAC 18AWG Teflon insulated wire (For bringing the pins of J114 to the banana jacks on the front panel)
- Twelve blue jump wires terminated with banana plugs on both ends for interconnecting the destination pins.
- (Optional) 8 color coded wires for the source pins (Red×2, Green×2, Black×2 Yellow×2) if the etracer was ordered when these cables were not included in the Model-01 chassis package.
- Fifteen clamp-on ferrite cores for the jump wires (12 for the wires connecting the destination pins and 3 for the wires connecting HV1, HV2 and NEGV.
- A short USB type A male to USB type B male cable to connect the Sbox12

and the etracer mounted in a Model-01 chassis.

3. Introduction to the Sbox12 printed circuit board (PCB)

The Sbox12 PCB is illustrated in figure 4 below.

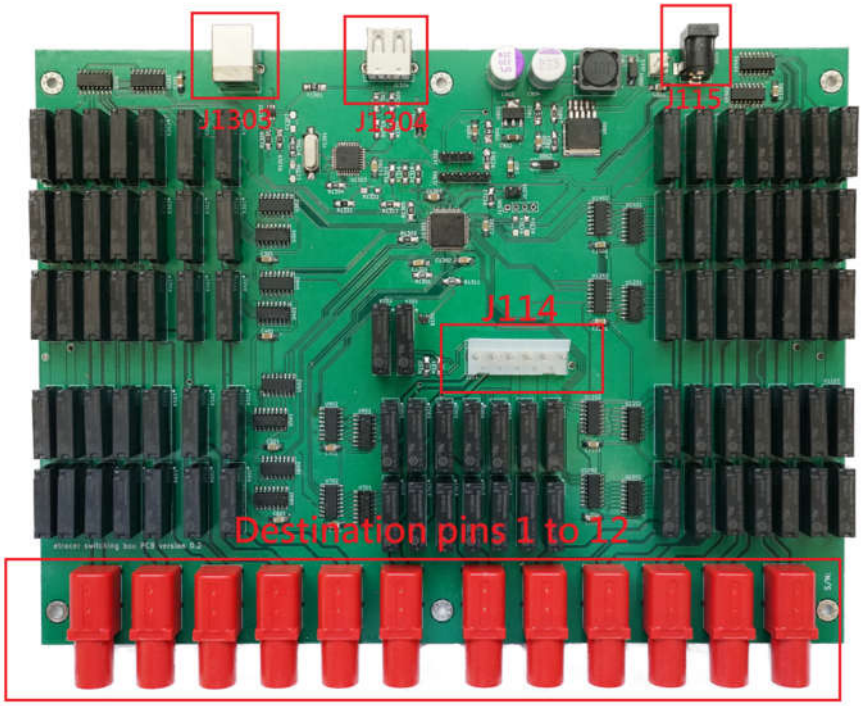

Figure 4. The Sbox12 PCB

On the back side (Top side in figure 4) of the Sbox12 PCB there are three connectors. Their functions are described below:

- J1303: This is the USB connector to the upstream of the integrated USB hub. Connect J1303 to the host PC.
- J1304: This is an exposed downstream port of the integrated USB hub. Connect J1304 to etracer with the short USB cable supplied with the SBOX12 kit.
- J115: This DC input jack can be used to power the Sbox12. In most applications this DC jack is not used as the Sbox12 can be powered by the host PC with the USB cable connecting J1303. In the USB specification

500mA/5V is guaranteed and it is more than enough to keep Sbox12 running. If for any reason the USB power is not sufficient to power a Sbox12 a DC input from 9V to 30V can be plugged in to supply power to the Sbox12. The Sbox12 hardware will automatically switch to the DC power source once it's present. J115 is center-positive as marked on the back panel of the Sbox12 chassis.

A PC host should be able to power a Sbox12 if the Sbox12 is connected to it directly. However, if the Sbox12 is connected to an USB hub the USB hub must be self-powered (powered by an external supply) otherwise the hub will only supply up to 100mA of current to the Sbox12 according to the USB specification. Alternatively the Sbox12 can be powered by an 9V to 30V DC supply through J115 as described above with a bus-powered USB hub.

The pins of J114 should be brought to the front panel and connect to 6 banana jacks mounted on the front panel as depicted below. The order of the pins on J114 is the same as the order of the banana jacks on the front panel (Left to right: HV1, HV2, GND, NEGV, HTR2 and HTR1).

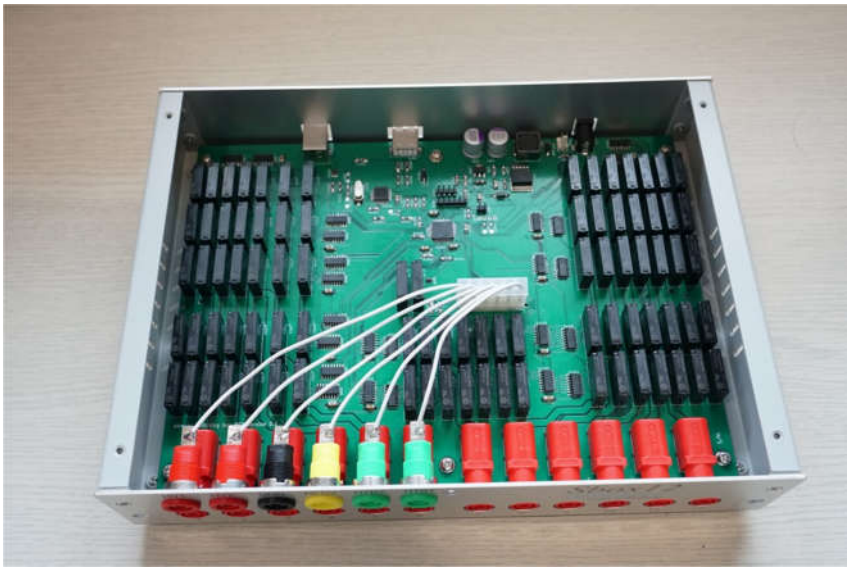

Figure 5. Connecting J114 to the banana jacks on the front panel.

4. Assembly

- Assemble the chassis with the supplied countersunk screws as depicted in the figure below. Leave the front panel and the top plate uninstalled. The two side panels are identical and hence can be mounted on either side. Mount the 4 rubber feet underneath the chassis with the included M4 screws.

Figure 6. Assembled chassis with rubber feet

- Mount the Sbox12 PCB onto the bottom plate of the chassis with the 6 M3 screws with washers attached.

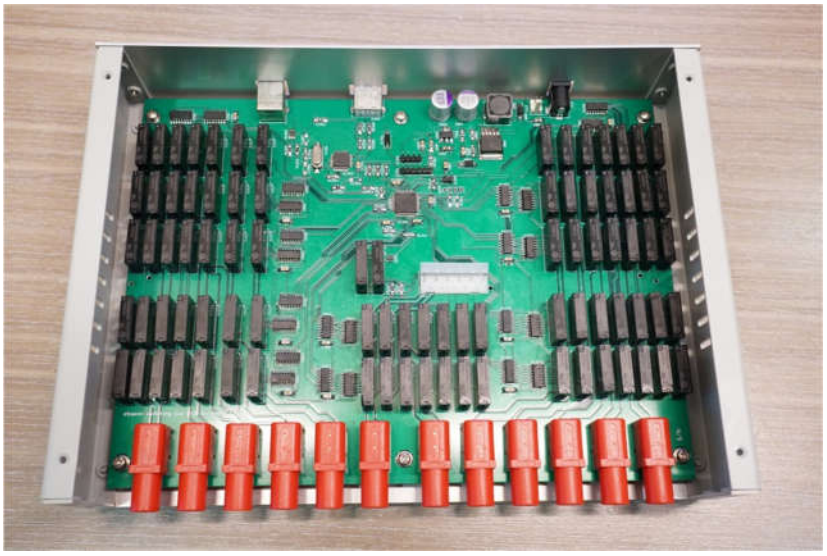

Figure 7. PCB installed

- Mount 6 color coded banana jacks to the front panel (HV1 and HV2: red, GND: black, NEGV: yellow, HTR1 and HTR2: green).
- Solder wires to the 6 banana jacks and make a connector connecting these wires to the etracer PCB through the supplied Molex 5197-06 6-pin female connector.

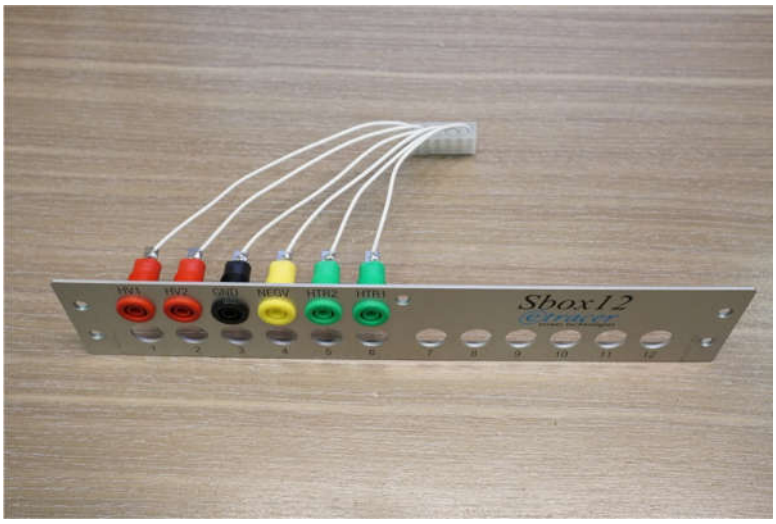

Figure 8. Banana jacks for the source pins and the connecting wires

Hint: After the banana jacks are mounted to the front panel, it might be helpful to mount the front panel to the chassis before working on the wirings. With the front panel mounted the wire length for each pin can be easily determined.

- Use the Sbox12 utility to verify the connections between the source pins and the destination pins if needed.
- Mount the top plate and place the Model-01 chassis on top of it
- Mount the 4 angled bar on the 4 sides of the chassis combo. The recommended mounting method is depicted in figure 9 and figure 10 below:

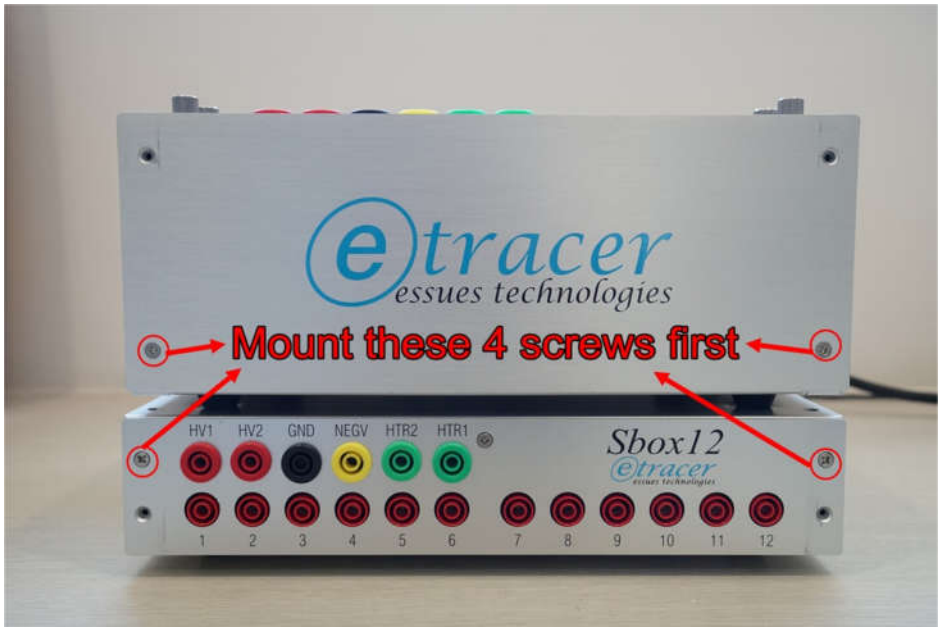

Figure 9. Recommended method to mount the angled bars (1)

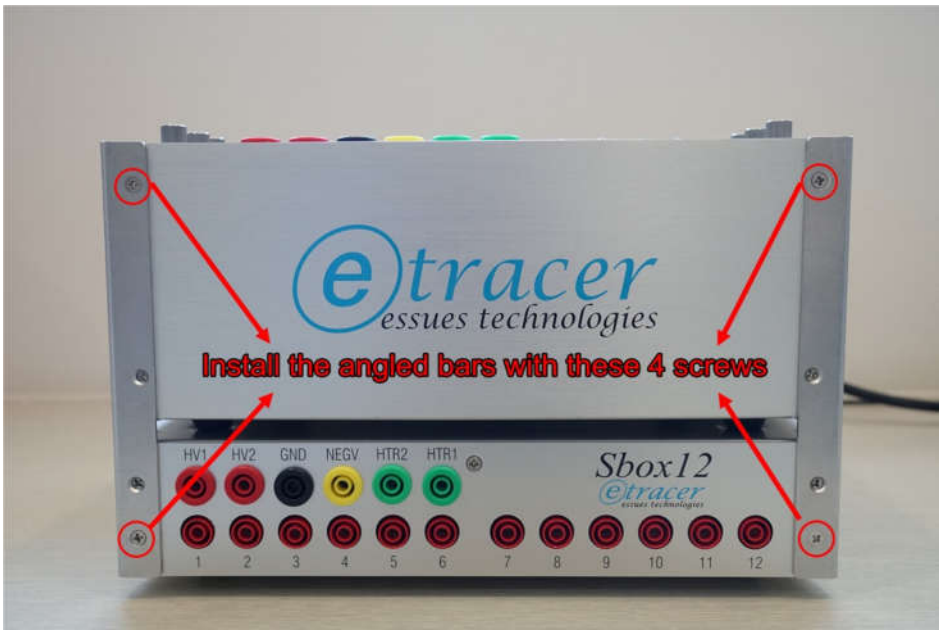

Figure 10. Recommended method to mount the angled bars (2)

- Connect the included short USB type A to type B cable as shown in figure 1.

Figure 11. Connection of between etracer and Sbox12.

- Connect a USB cable from the control PC to the Sbox12 (Marked “To PC”).
- Connect the 6 source pins on both chassis with the supplied color coded wires and the clamp-on ferrite cores as depicted in figure 12.

Figure 12. Connection of the source pins

- Connect the destination pins (only 1-10 needed for Model 01 chassis) on both chassis with the supplied wires and the clamp-on ferrite cores as depicted in figure 13 and figure 14.

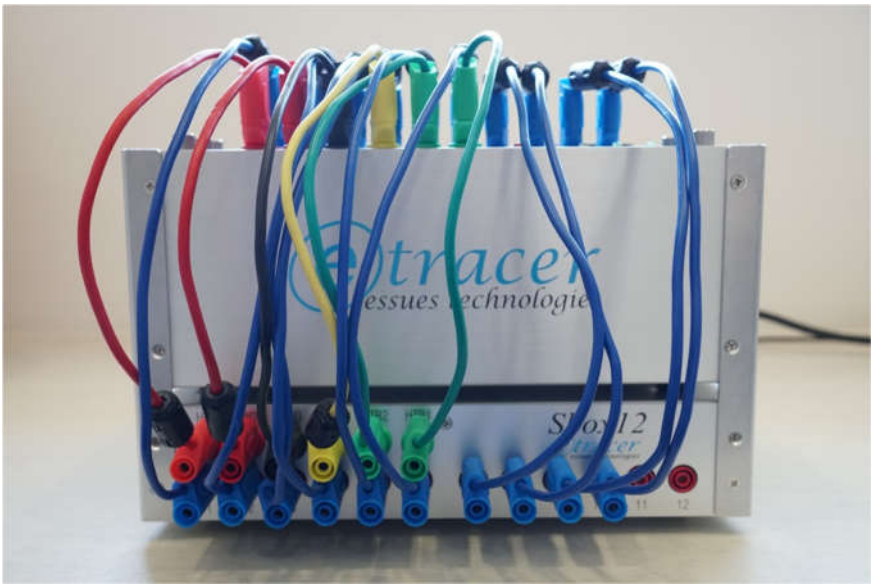

Figure 13. Connection of the 10 destination pins

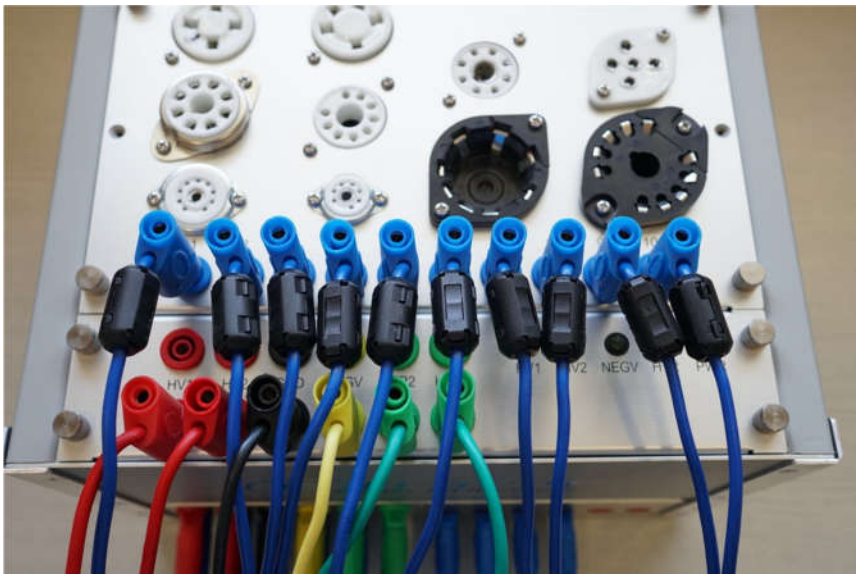

Figure 14. Top view of the wiring for the destination pins.

- Launch the etracer PC software. Enable and configure Sbox12, load a tube configuration file and run a quick-scan or a full-scan as described in section 5.

5. USB driver, software configuration and test flow

The Sbox12 can be configured by the etracer PC control software directly. Support for Sbox12 is implemented in the etracer control software since version 2.1.11alpha.

For Microsoft Windows 7 and Windows 8 a USB device driver (actually a single inf file) is needed. When the Sbox12 is plugged into a PC for the first time the PC will ask for the device driver. Just point the directory to the associated folder (Win7 or Win8) of the unzipped driver package downloaded from our website and the driver will be installed automatically. It is normal if the PC complains the driver is not digitally signed by Microsoft. The underlying device driver usbser.sys is native for both Windows 7 and Windows 8. For Windows 10 Sbox12 should be recognized as a USB COM port automatically.

To enable Sbox12 support in the etracer PC software open the configuration manual by selecting Options->Configurations. The configuration window will appear and the Sbox12 configuration is on the last row. Check the Enable Sbox12 checkbox to enable the Sbox12 functionality. The detected Sbox12 should be displayed in the combobox. If the software is running under an OS simulation software such as Wine the COM port for the Sbox12 can be specified by type in the COM port number (eg. COM2) manually.

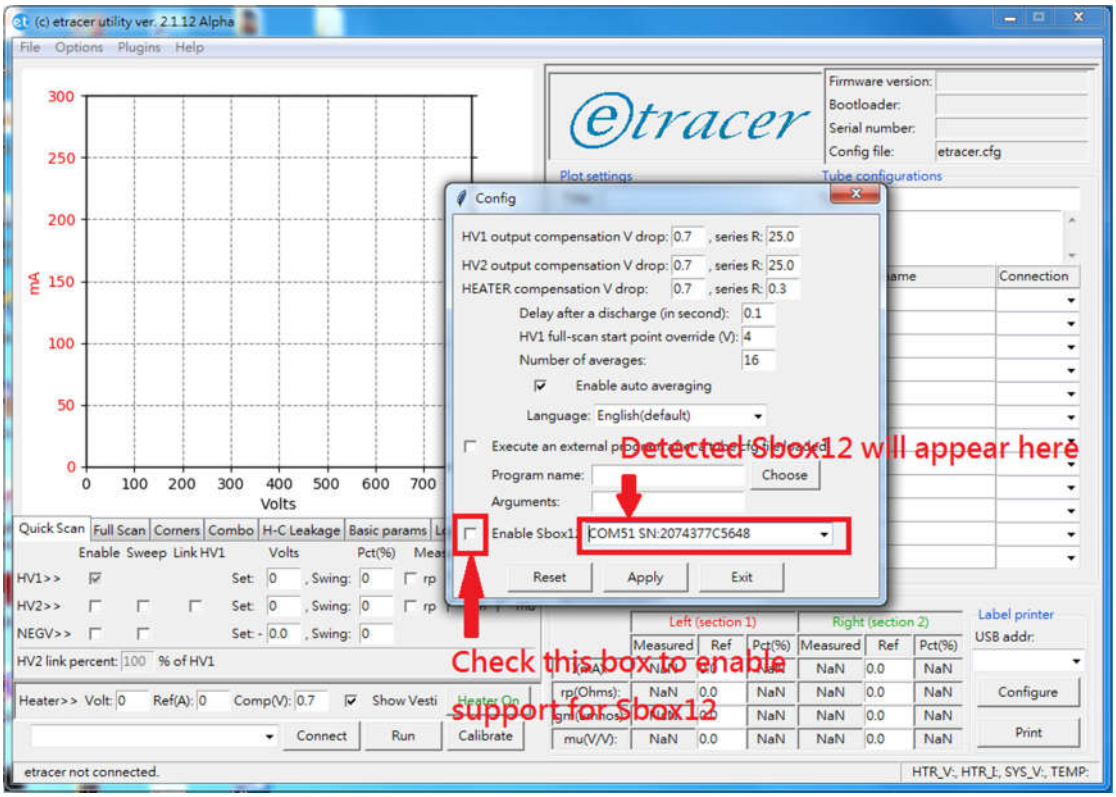

Figure 15. Configure Sbox12 in the configuration window

When Sbox12 functionality is enabled every time a tube configuration is loaded by the etracer control software the relays inside the Sbox12 will be configured according to the pin configuration panel as shown in figure 16 with the 12AX7 configuration file as an example.

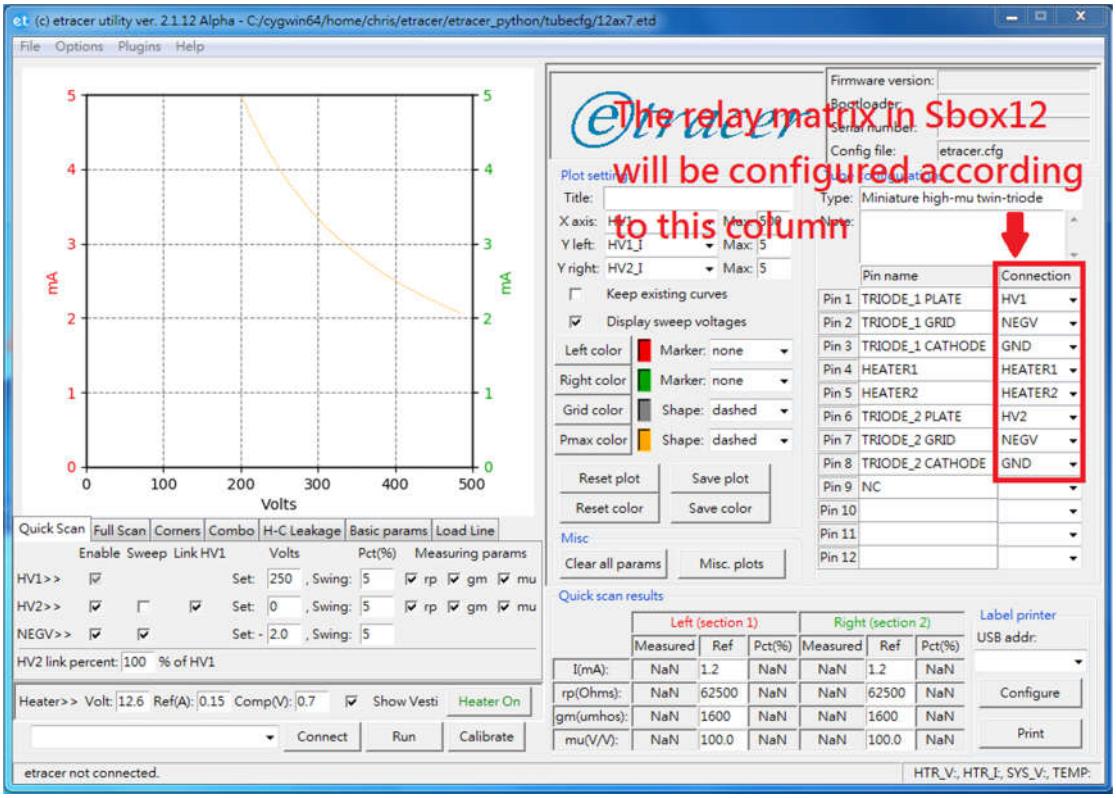

Figure 16. The Sbox12 relay matrix configuration (12AX7 as an example)

6. Sbox12 GUI control utility

This utility can be used independently. It allows the user full control of the switching matrix inside a Sbox12.

A use case of this utility software is checking the function of each relays on the PCB. Relays are mechanical devices and hence might malfunction along the time. The relays used in the Sbox12 are type APAN3105 from Panasonic. The relays can be replaced by experienced users easily.

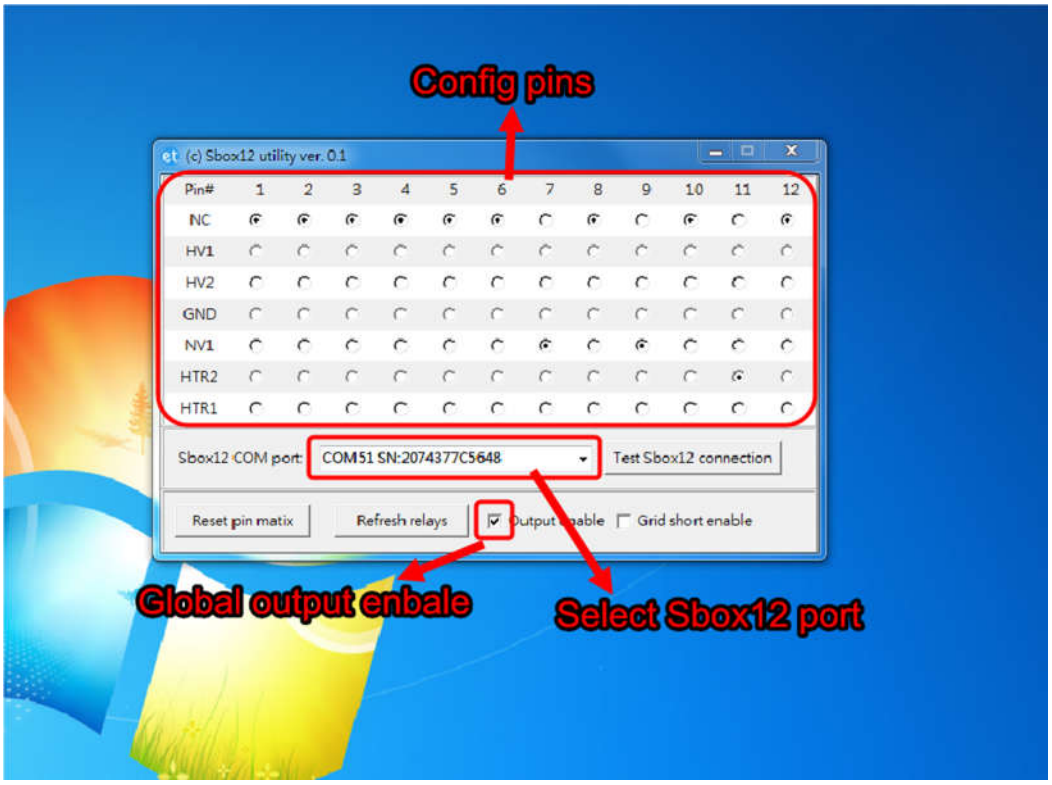

Figure 15. Sbox12 GUI control utility

When the global output enabled the user should be able to hear the click sound from the relay every time a pin configuration is changed. A DMM (digital multi-meter) can be used to verify the connections with respect to the settings in the software.

7. Known issues

- Although it's possible to perform a full curves scan with both positive (HV2) and negative (NEGV) grid voltages automatically by configuring the Sbox12 the current etracer software structure could not handle this combination. The user will need to manually route the correct voltage source (NEGV or HV2) to the grid electrode of the DUT following the software's instruction.
- Sbox12 does not handle USB sleep and wakeup events. If Sbox12 is powered by the USB port only The PC might lose connection to the Sbox12 in a wakeup event. An unplug-and-plug of the USB cable from the PC to Sbox12

will reinitialize the connection and reset the Sbox12. A tube configuration file reload is required for the etracer software to configure the switching matrix properly.