DIY EL84 Project, Part 5: Optional Volume Control and Input Switch Assembly, Power-Up and Testing

First Power-Up of the Tubelab Simple Push-Pull amplifier

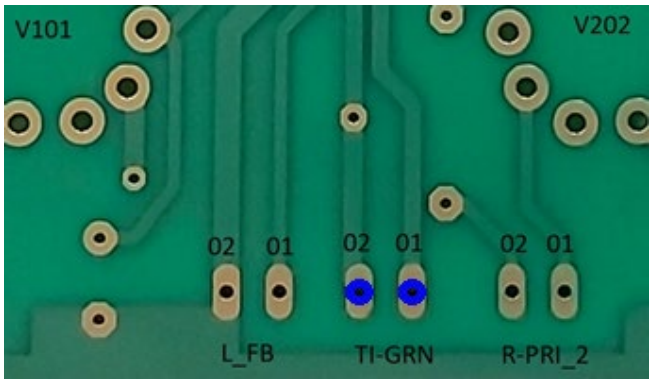
A Variac, a variable A.C. voltage transformer is a very useful device for the first switch on as the A.C. supply voltage can be increased gradually when carrying out initial tests.
However, inexpensive alternatives can be used such as a 100-Watt incandescent bulb inserted into its bulb socket mounted for safety on a piece of wood. The bulb is wired so that the live (brown) wire is connected in series. This is the method that will be used.

Insert the four EL84 tubes into their sockets, V102, V101, V202 and V201.
Insert the two 12AT7 (ECC81) tubes into their sockets, V100 and V200.
Do not insert the rectifier valve 5AR4 (V-1) into its socket for now.

In the A.C. mains I/P, insert a 3-amp, slow blow fuse in the drawer/holder.

Place the amp so it'll be easy to access the PCB connectors. Exercise extreme caution, as there'll be very high voltages.

Set your multi-meter to A.C. volts, if it's not an auto ranging type, set it to a 12, 20 or 30 volt range.
Insert the A.C. cable into the A.C. socket and switch the amp on.



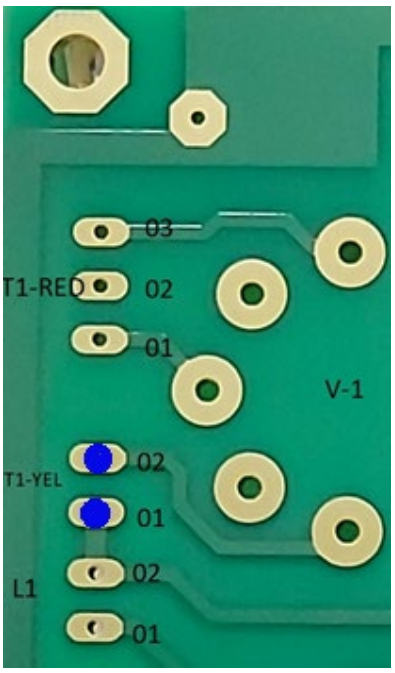
Measure the voltage at the connector T1-GRN, pins 1 & 2 (blue circles).

The expected voltage is 6.3 volts A.C. With the Inrush Current Limiter in circuit, the voltage will rise slowly and could take a minute or two for the voltage to reach its maximum. After a minute or so check all the valves fitted, that their heaters are lit. Switch the power off and unplug the A.C. cable from the amp.
Insert the 5AR4 rectifier valve into its socket (V-1), ensuring that it's inserted into the socket correctly, aligning the keys together.

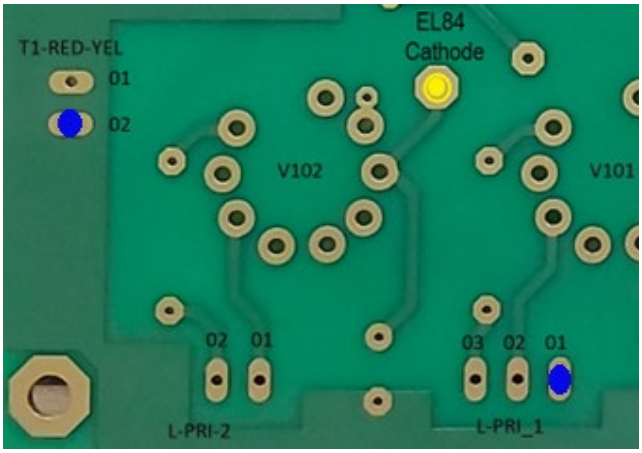
With the mains cable disconnected, you now need to connect in series with the 100-Watt bulb & socket that has been made (must be incandescent). This will allow a gentle first power-up of the amp.

Insert the mains plug into the mains socket.
Switch on the amplifier.
The bulb should glow weaker than you would expect from a 100-watt bulb. If the amp is running correctly about half of the line voltage will be dissipated by the bulb (~120 volts) and the other half by the amp.

After the amp has been on for a couple of minutes, allowing the power supply capacitors and valves to stabilise – measure voltages again at connector T1-GRN, pins 1 & 2 (blue circles), you should have approximately 3 volts A.C.



On connector T1-YEL, pins 1 & 2 (blue circles), you should get approximately 2.5 volts A.C.
Warning: Even though is a small A.C. voltage across those points, there is a significantly higher DC voltage between these points and the circuit ground.

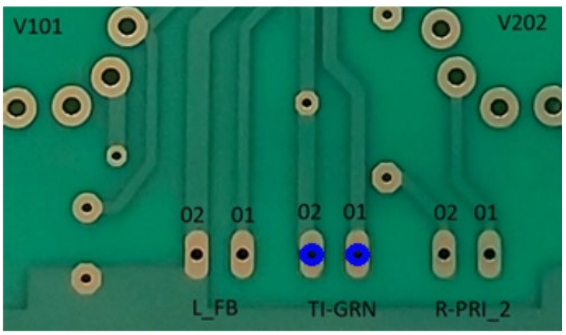


On connector points T1-RED-YEL, pin 2 & connector L-PRI_1, pin 1 (blue circles), you should get approximately 150 volts D.C.
All valves should be glowing dimly. After about 5 minutes, turn the amplifier off and then remove the light bulb cable connection.
Measure again the voltage at connector T1-RED-YEL, pin 2 & connector L-PRI_1, pin 1 (blue circles). There should be no more than 1 or 2 volts D.C.

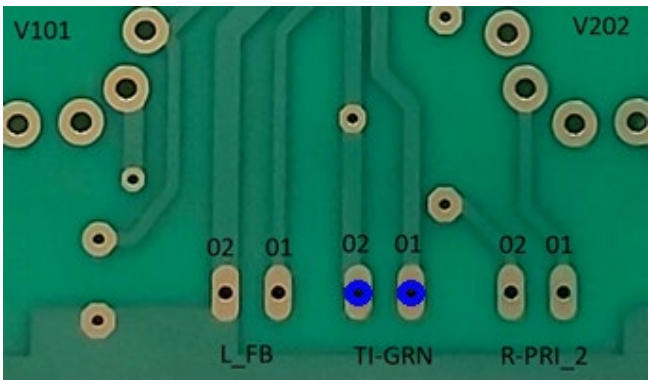
Connect your loudspeakers to the speaker binding posts. If your build includes a volume control, set to minimum. If your build doesn't include a volume control, then insert shorted RCA plugs into the input sockets. Connect the mains cable to the amp and switch it ON.

Give the amp a minute or two to warm up.
If everything is correct all the tubes should light, the fuse shouldn't blow and nothing should be heard from the speakers and of course, there should be no smoke and/or smell of burning.

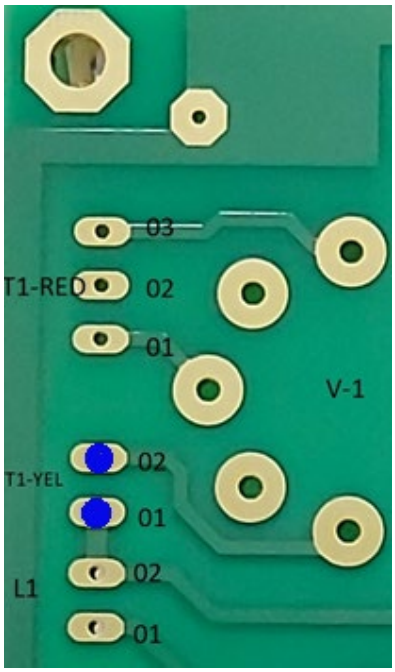
The full voltage will be applied to the valves now, so be careful making the following measurements.



Measure at connector T1-GRN, pins 1 & 2 (blue circles), you should have 5.9 to 6.3 volts A.C. This is the 6.3V A.C. 4 Amp Heater supply.

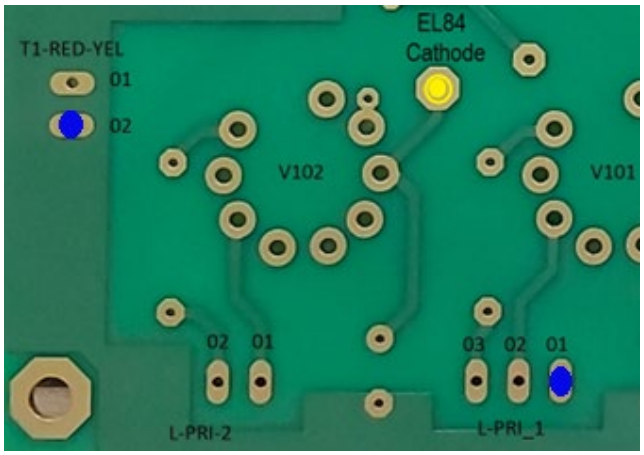


Now measure at connector T1-YEL, pins 1 & 2 (blue circles), you should have 4.7 to 5.0 volts A.C. This is the 5V A.C. 2 Amp supply to the rectifier valve V-1.



If your Mains Transformer has numerous primary windings, first ensure what is your mains supply voltage before making connections and use the corresponding colours for the 240VAC primary winding. In the case of a Primary Winding U.K. mains transformer, they also have a +10V tap, (i.e. 250VAC).

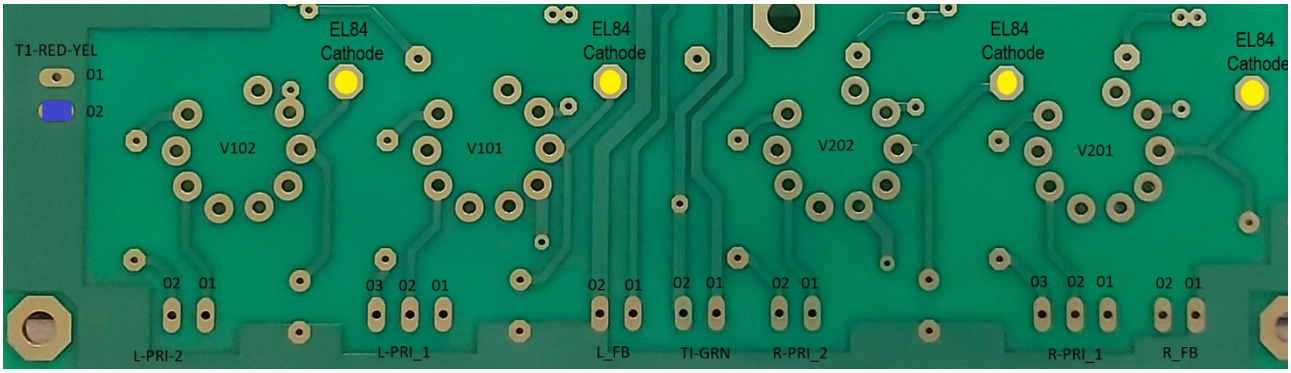
The patron's amp measured 6.1 volts on connector T1-GRN, pins 1 & 2 and 4.8 volts on connector T1-YEL, pins 1 & 2 (blue circles). These are ideal voltages for the heaters, as slightly under-running them helps increase tube life.



Measure the DC voltage at connector T1-RED-YEL, pin 2 and connector L-PRI_1, pin 1 (blue circles), it should be around 320 volts.
Make a note of the voltage. It will be used later to calculate tube power dissipation.

Turn up the volume control, if used, or remove the shorting plugs. Touch the centre conductor of the input jacks, one at a time. A buzz should be heard from each speaker in turn.

Now connect a source to the RCA inputs, music should be heard from the speakers. Pause the music player or mute the source. If all is well one more measurement remains.



We now need to measure the D.C. voltage on each cathode of the four EL84 valves.
As shown above, measure between connector T1-RED-YELLOW, pin 2 (blue square) and on pin 3 of the EL84's (yellow circles). There should be between 11 and 12 volts.

The power dissipated by the valves can be calculated as follows: -

Subtract the measured cathode voltage from the voltage on connector L-PRI_1, pin 1, i.e. B+.
Example: -

```
   320.0V      B+ (connector L-PRI_1, pin 1)
-  011.8V      Cathode voltage
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   308.2 volts
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Now divide the cathode voltage by the resistor values of R111, R116, R211, R216 (270 Ω in Tubelab's design) to calculate the current in the valve.
As per example: -

11.8V ÷ 270 ohms = 0.044 Amps (0.0437)

If we multiply the current - 0.044 Amps by the 308.2 volts, it'll show us the power dissipated.

```
   308.2
X  0.044
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  13.47 Watts
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A more thorough explanation of output tube biasing can be seen in the Wall of Sound article:
https://wallofsound.ca/audioreviews/amplification/output-tube-biasing-anintroduction-part-2/

When we compare the measured dissipation, 13.47 watts, with the typical maximum dissipation of Russian-made EL84s of 16.2 watts (Tung-Sols are made in Russia) these valves are running at 83% of their max. dissipation. This is a bit high and the Wall of Sound parts gives alternative values for resistors R111, 116, 211 & 216 that will ease back on dissipated power. This will be especially important if using JJ EL84 tubes, as their dissipation limit is 12 watts.
See page 9 of Part-1-Attachment-2-US-Dollar-List-Revised.pdf

If using other types of Output Transformers, you'll need to carefully check the cable connections.
See Tubelab SPP first timer build | Page 17 | diyAudio post 302, 304, 319, 323