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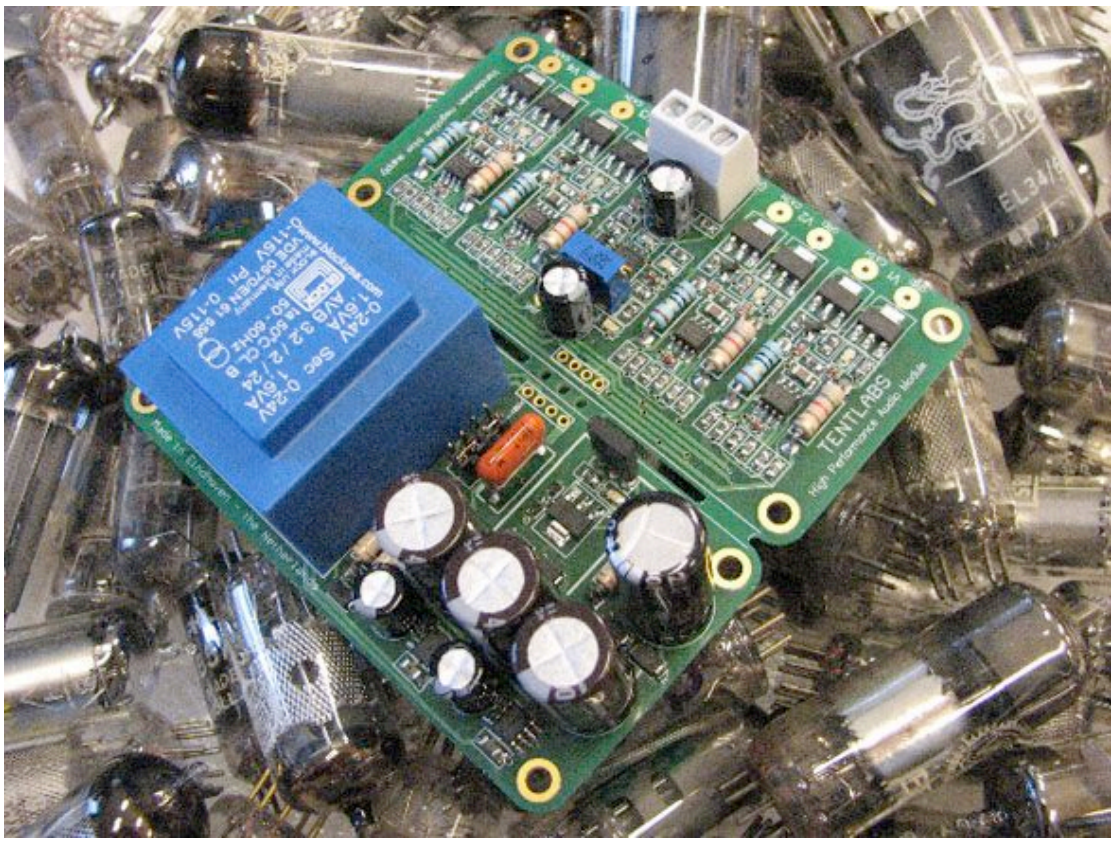
Tentlabs Application Note AN.05 – Negative Bias Supply



Introduction

This Note applies to Tentlabs negative bias supply, version V1.0 and later, delivered from February 2008 onwards. It shows how:

- They work in general
- To connect them in tube amplifiers

An FAQ is added to help trouble shooting, and the specifications are listed for reference.

The advised colors for connections are given in this note, and can be found here for reference.

Purpose

The Tentlabs / Vanderveen bias supply is designed to bias (output) tubes, such that their operating point(s) remain stable, independent of tube age, mains voltage variations and music signals, without affecting the musical and technical qualities of the amplifier.

The supplies generate a very low noise output, while maintaining the tube at its' operating point, i.e. the standing current remains stable. Result areas are:

- Higher resolution and correct staging due to lower hum and noise level
- Better bass due to near perfect (<1% error) current matching in push-pull stages
- Better imaging due to optimized left / right channel matching

Electrical safety

Within the tube equipment, during building and surely when finished, AC mains voltages and high DC voltages exist. Care should be taken as long as the cabinet is not closed and the equipment has been connected to the mains. The user remains responsible for his own and others' safety and damage of the equipment. Following the instructions however will avoid hazard and electrical shock.

Liability

Tentlabs accepts no liability at all from any potential damage or injury that may occur when assembling, connecting or using the negative bias supply or any of its sub parts and assemblies.

Warrantee

The warrantee on the module is 5 years, assumed they are applied and used according the instructions in this Application Note.

Technology

The module contains an integrated negative power supply, which is properly filtered and stabilized to achieve clean input voltages for 4 measurement-sections (each tube needs its' own section). These measure the actual tube current around a very small window around the bias.

The output signal of each channel is then fed to the grid of the tube, such that the tube bias is set at the required current.

The maximum output voltage is -160V, enabling the use of virtually any tube including the famous 211 or a 845. Every tube can be biased up to

175mA. The outputs of the module provide linear and low output impedance to avoid interaction with the preceding driver stage driving the power tubes. Each of the 4 outputs can sink and source 1.5mA, allowing the use of relatively low grid resistors, if required.

The modules are tested and factory adjusted to 40mA each tube. Prior to, or after installation, the bias can be adjusted to customer requirements.

Installing the module

WARNING

Prior to all installations, measurements and adjustments make sure the amplifier is switched off and no high voltage is present in the amplifier.

Procedure

This Application Note describes the installation, and contains the following steps:

- Check of bias conditions – original amplifier
- Module placement
- Input wiring
- Output wiring
- Electrical check – no tubes applied
- Cathode current check - tubes applied

Bias measurement – original amplifier

The bias module has 2 output (grid) voltage ranges. One of these ranges best suits the application. The ranges are:

1: -85V to -2V

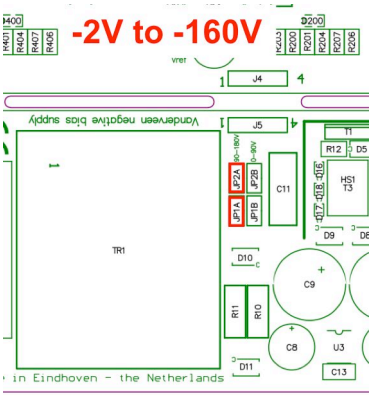
2: -160V to -2V

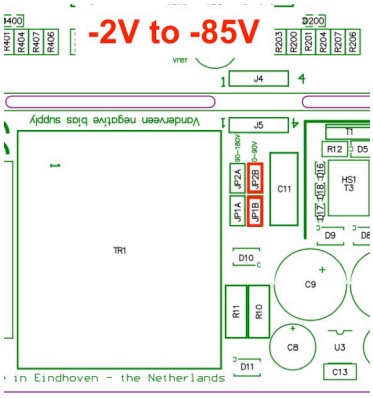
Prior to installing the module, the grid to cathode voltages of the original amplifier should be measured, to choose the correct voltage range for the new module.

Use a multi-meter (with at least 10M-ohm input impedance), and set the input range to 200Vdc. Connect the ground wire to the cathode of one tube, and the red wire to the grid of the same tube. Use clips to connect the meter probes.

Take your hands off, and switch on the amplifier. After stabilization, read the meter and write down the value. These values may differ from tube to tube, but we need a ballpark figure. Suppose you measure -47V for a KT88 or EL34. In that case you can safely use the 1st range (-85V to -2V). But, in the case of a 300b, you could measure -78V. Although -78V is within the range -85V to -2V, we advise the use of the 2nd range (-160V to -2V) to allow for enough adjustment headroom for the module. In general, make sure to have 10% headroom.

Set 2 jumpers to select the correct range, according the figure below:





Module placement

Carefully cut the remaining connections between the boards, using an appropriate saw. Finish both boards, such that no sharp edges remain.

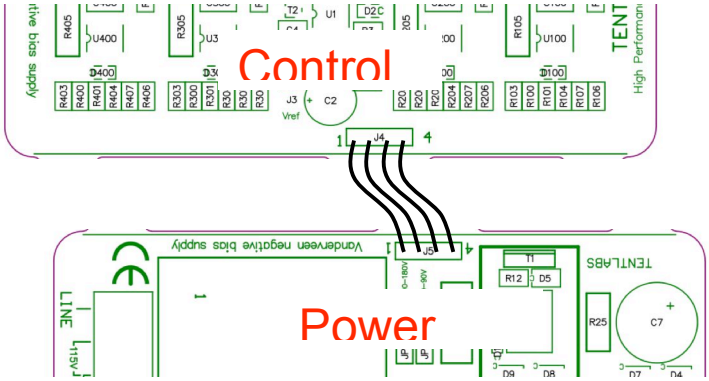
Find a place to mount the control part close to the tubes, the power supply part can be mounted elsewhere. Do position both boards such that the component sides are easy to reach.

Mount both boards using standoffs and assure that:

- Both boards are at least 6 mm above any conducting part
- The power supply part is not mounted close to heat sources
- The control module is mounted close to the power tube sockets

After installation, the boards shall be interconnected, using 4 wires (about 0.15mm diameter) between connectors J4 and J5. Make sure to respect the wire order; do not mix the wires.

To avoid errors, the wires at both connectors are numbered (1 to 4) on both boards. Connect wire 1 to wire 1, wire 2 to 2 etcetera. It helps to use different colors, and follow the colors of the rainbow, for instance. Below drawing indicates inter-wiring.



Mains Input wiring

The bias module needs mains voltage to operate. The mains input wiring is not limited to length.

Input voltage requirements

Input AC voltage

- 115V setting: 105 to 130V
- 230V setting: 210 to 260V

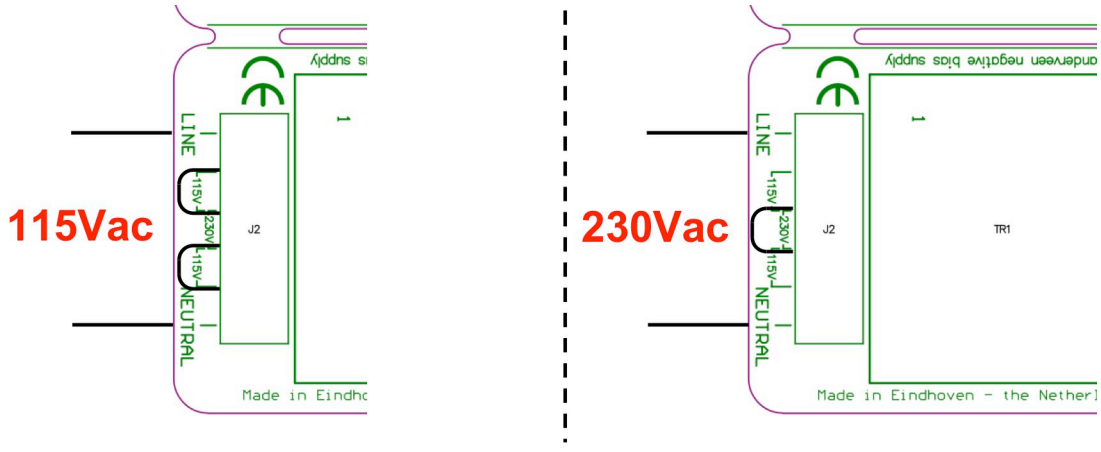
WARNING

Operating your amplifier without the mains connected to the bias module will damage your tubes.

Make sure the bias module is not switched off in case your amplifier is switched into standby mode.

The mains input needs to be wired according your countries mains voltage.

- 115V operation: place 2 wire links as shown left
- 230V operation: place 1 wire link according the picture right



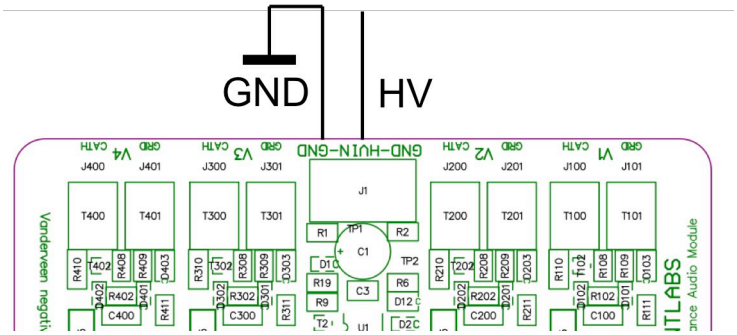
For your convenience, the wire links are indicated at the module as well.

Input wiring - Ground

The bias module needs to be connected to ground, to enable current to flow. This is very important. Find the ground connection where normally the cathode resistors used to be connected. Connect a single wire from that point to either one of the ground inputs at connector J1. Use isolated wire (1mm), preferably **black**.

Input wiring – High voltage

The module senses the high voltage, in order to provide a slow start of the bias current settings, only after high voltage is present. Therefore the high voltage of the output stage needs to be connected to the HV input of the module, at the HV input of connector J1. Use isolated wire (1mm), preferably **red**.



Input wiring – Cathodes

First, we analyze the original cathode connections of the output tubes. They use either:

A relatively big cathode resistor usually decoupled with a capacitor. In this case the grid resistor goes to ground.

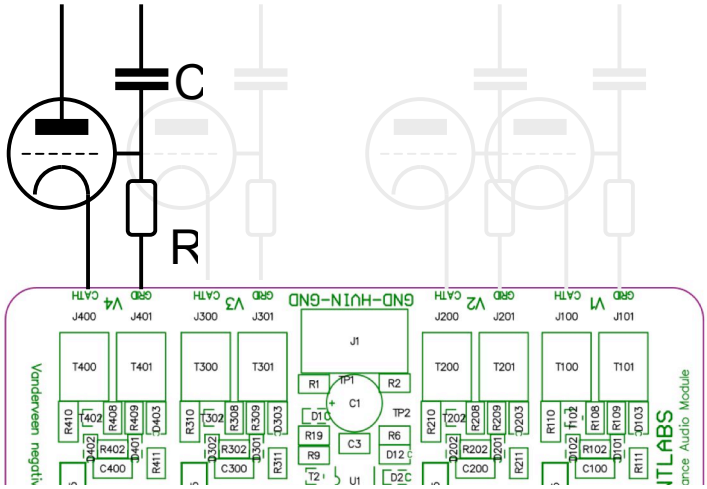
or

A small (say 10 ohm) resistor connected to ground. In this case the grid resistor goes to a negative bias voltage, usually adjustable with a trimmer.

Cut the original cathode connection; Trace the cathode connection from the tube socket to the original cathode resistor and cut the wire or trace close to the socket(s). You may leave the original cathode resistors / capacitors in place, but make sure no loose wires stay hanging around in your amplifier.

For your reference, follow the drawing at the next page. For the sake of clarity, only one tube is shown, but up to 4 tubes can be connected to the module.

Connect each cathode to a cathode connection of the bias module. Use a yellow wire (0.5mm). Keep a logical connection, i.e. from left to right. You may want to number the tubes, according the numbering of the sections on the module.



Output wiring – Grids

The original grid resistors of the output tubes used to be connected to either:

Ground

or

A negative bias voltage

Keep the grid resistor connected to the grid (or grid stopper resistance – not shown) and cut the grid resistor connection to either ground or negative voltage; this is best done by following the grid connection from the tube socket onwards.

Connect each grid resistor to a grid connection of the bias module. Use isolated green wiring (0.5mm), and respect the order of the connections earlier made……

Warning

The cathode and grid of any tube shall be connected to the same section of the module

If grids and cathodes are mixed up, your tubes will be overloaded after switching on.

Testing time

Remove all output tubes from your amplifier. Put the amp on its feet, and connect the multimeters' black probe to ground (ground speaker binding posts work fine here).

Lookup the tube socket connections for cathodes and grids. Be aware to count counterclockwise when looking at the tube side of the sockets. Write down the connections, i.e for an EL34 cathode = pin 8, grid = pin 5.

Keep the amplifier switched off.

Cathode connections check

Switch the meter to ohms, range 200 ohm. Check each cathode connection, it should indicate 10 ohm.

Grid connections check

Set the multimeter to DC volts, range 200V or higher. Put the red probe in the grid connection of the tube socket.

Switch the amplifier on.

At first the voltage should be fully negative (-160V or -85V, depending on the selected range). After about 1 minute, the negative voltage should become less and less, and approach near zero volt (usually -2V).

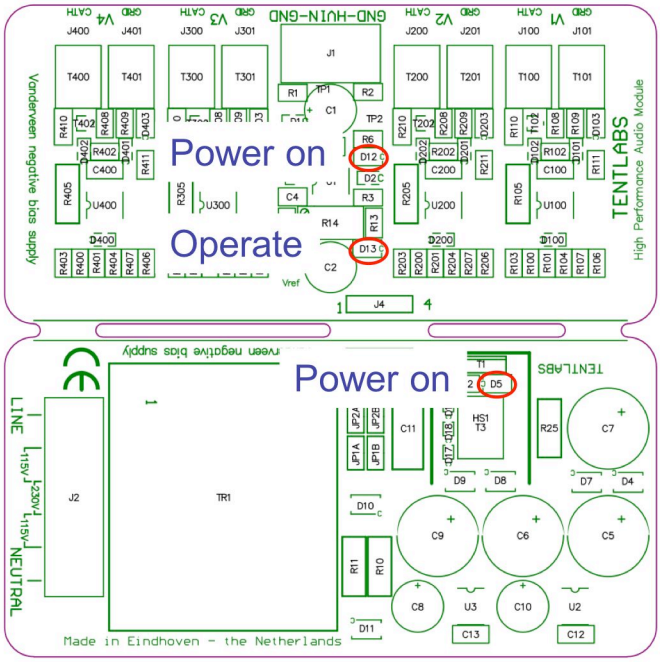
Repeat this grid connection check for each output tube. Switch off the amp, wait for 5 minutes and check next grid.

Warning

If the voltage is not fully negative at first startup, an error is present. Do not proceed, as this may damage your tubes or amplifier

Indicators

The following LEDs indicators are present on the board:



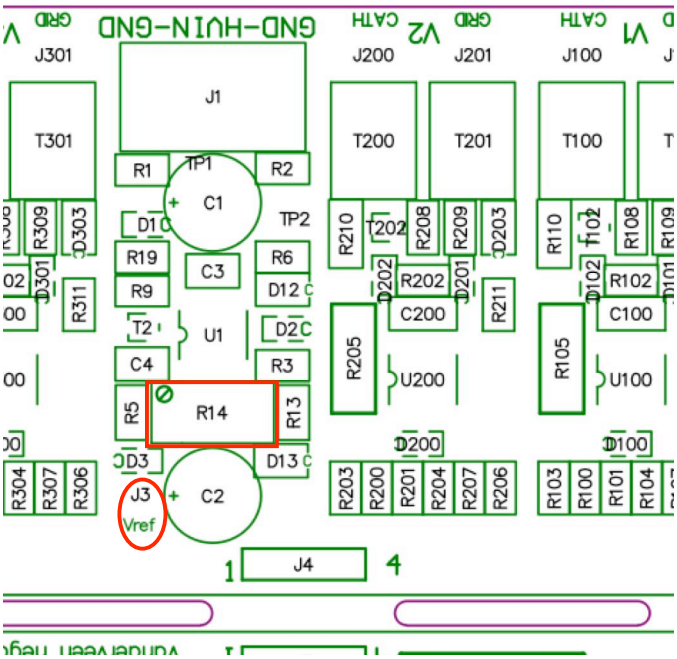
Both power on LEDs immediately light up after switch on

The operate LED comes on after some 45s after power up, when the units starts to regulate the tube current.

Switch the amplifier off.

Double check whether you haven't mixed up cathodes and grids by following each pair of wires from tube socket to module.

The bias module is factory adjusted so that the output tube bias currents become 40mA. This value can be changed according user requirements, by tuning trimmer R14:



To decrease the bias current: Turn the trimmer *counter*clockwise

To increase the bias current: Turn the trimmer clockwise

At testpoint J3, an indication of the cathode current can be measured; this is explained at the next page.

Cathode current adjustment

The amplifier is still without output tubes. Put the amp down, or on its side, such that the multimeters black probe can be connected to the remaing ground connection of connector J1. Swith the multimeter to a range of 2Vdc or higher.

Know the required bias value in mA and multiply by 10 to obtain a reference value in mV. Example:

Bias current (each tube): 30 mA. Reference value = 300 mV

Take a screwdriver that allows trimming of trimmer R14 (see drawing at previous page). Switch the amplifier on, and probe at the reference point J3. Turn the trimmer until you reach the desired value.

Swith the amplifier off, and put the output tubes back in their sockets.

Cathode current check

Place the amp such that

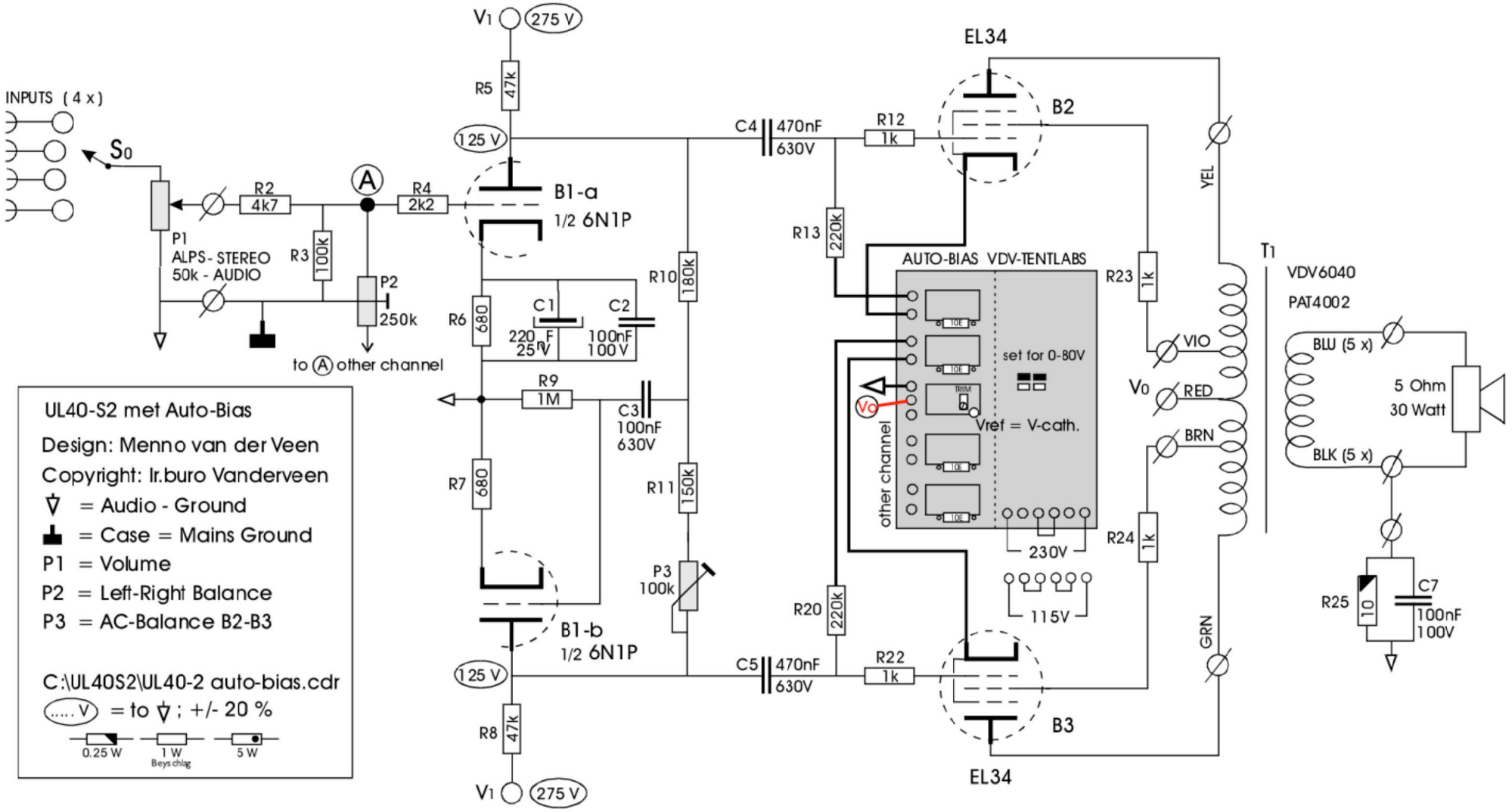
- It is stable
- The output tubes can remain in place
- Their cathodes can be probed

- Connect the black probe to the module ground, leave the range in 2Vdc.
- Switch the amplifier on, and wait at least 1 minute to let the amps and currents stabilize.
- Probe each cathode with the red probe. The meter should read the reference value within 2%. If desired, one may optimize the current setting a bit.

All cathodes should read the same reference value, usually within 0.5%.

This ends the adjustment procedure, time for some serious listening !

For your convenience, the next page shows a typical application circuit



1) See for the newest information and applications and updates: www.mennovanderveen.nl and www.tentlabs.com

2) For UL40-S2 and standard pentodes: set the maximum negative supply jumpers to 0-80 position

3) For specific triodes, a larger maximum negative supply is needed for: set the jumpers to the 0-160 V position

4) You can measure the quiescent current of each tube by measuring the voltage over each large 10 Ohm resistor

5) You can also determine the quiescent current by measuring Vref to ground and devide by 10 Ohms. The results of 4) and 5) are equal

FAQ

Specifications Electrical

Mechanical

All specs and parameters subject to change without prior notice