**Direct Heat Triode Filament Supply Issues**

Direct Heated Triode – the cathode is the filament so both heating current and signal voltages are present

Common perceptions: AC=good but noisy, DC=quiet but cold sounding and has glare

**What is needed:**

1. low noise heating current (ie low ripple and no high frequency hash)
2. no intermodulation between signal and heating current
3. no audio signal loss through heating current device

**1. Low noise heating methods compared**

- straight-in AC. Needs hum pot to reduce hum but will still always be audible on efficient speakers. Impractical for >2.5v filaments even with hum pot. Hum pot always in the signal path and acts as shunt for signal. Filament voltage unstable as varies with line voltage and load. Fast startup stresses power tube.
- AC>>bridge rectifier>>big cap. Most basic DC supply, ripple still in 250-300mv range and needs hum pot. High frequency artifacts from solid state rectification gives nasty glare. Voltage unstable as with straight-in AC. Fast startup stresses power tube
- AC>>bridge rectifier>>>choke>> big cap. Low ripple ~80mv, suppressed high frequency hash. Voltage unstable as above, switch-on a little slower than above. Sound is good. Big choke needed and not space friendly
- AC>>bridge rectifier>>regulator. Can be voltage stable, low noise – several mv. Sound depends on implementation, needs AC voltage headroom to regulate (ie DCV out = ACV in +1 to 2v)

**2. Intermodulation issues**

- Any voltage fluctuations across the cathode are part of the output circuit (cathode-anode-output transformer). Audio signal produces music at the outputs. Any fluctuation (high/low frequency) in the heating current circuit produces noise at signal output. Such noise can modulate audio signal and create harmonics that colour (distort) the audio signal causing subjective glare, warmth, exaggerated or diminished detail etc.

**2. Audio Signal loss**

- current will always take the path of least resistance. 100% of audio signal should stay within the tube/transformer output circuit. Caps across the filament will short a percentage of audio signal. Any path with resistance lower than the net output circuit loop will reduce audio signal through that loop. Subjectively audio output quality suffers in every way.

**Regulated Supply**

- Can be implemented as 'current source' or 'voltage source' or voltage-current source (ie current source at audio frequency and voltage source at DC)
- VS: voltage source is like a battery: low output impedance and tends to maintain voltage regardless of load, irrespective of current. Good for stabilizing voltage, bad for intermodulation with audio signal as impedance of the device is low
- CS: current source has high output impedance and tends to maintain current regardless of load and irrespective of voltage. Good for preventing intermodulation and loss with audio signal as output impedance is very high. Bad for voltage stability
- VCS: voltage current source. Acts as a current source at audio frequencies but as a voltage source at DC. Benefits include voltage stability, High impedance at audio signal frequency (audio signal sees a 'brick wall' and doesn't go there). No shunting/shorting paths for audio signal, all signal stays within the audio output circuit. No humbucker or caps across cathode used in this implementation

**<u>DIY Hifi Supply Ltd Ultra Low noise VCS filament supply</u>**

- 2.5v -12v/2.5a DC output. Adjustable with on-board trimmer
- Input AC voltage should be output DCv +1.5 to 2v depending on current, less current less voltage
- output ripple typically 4mv into 300B. Output ripple varies with load
- high output impedance to limit intermodulation distortion

- input and output short-term (ie momentary) short-circuit proof
- overheat protected
- blue and amber LED function indicators (blue is powered up, amber is short circuit)

- included heatsink for standoff mounting. Can also be mounted directly to chassis for low profile positioning. In that case the chassis becomes the heat sink.
- pcb cutouts for airflow around diodes and regulator. Also cutout for bottom mounting of regulator.
- Schottky diodes
- install as directed for best sound

**The Skinny View:**

Noise on the filament gets sucked into the audio chain and amplified. Friendly noise as from AC heaters obscures detail and adds warmth – like looking into a pool of un-still tepid water.
Unfriendly noise as from a bridge rectifier + cap sprays high frequency noise everywhere. Sure, quiet but the sound? Something akin to digital gone wild – like looking into a pool of still water but not being able to see past the surface glare. And joltingly cold.

So kill the noise. Add a big choke. Peace at last. But...said choke must be BIG and where can you stow that thing? Not in my chassis.

Enter The Regulator. But electrons are lazy critters, especially the green ones (hifi electrons). We've got light green ones that carry the audio signal. We want them to go tube>>transformer and no where else. And we've got dark green ones that we just want to go regulator>>cathode and no where else. If we don't put up a brick wall between cathode and regulator, the lazy light green audio electrons get lost and/or start acting crazy as they mix with the dark green ones..

How do we get a one-way brick wall? Voltage current source regulator (VCS).
Audio electrons, all of them, stay in the signal path. And the filament supply electrons don't bother anyone. Noise is ultra low. All music, all the the time.

**<u>Application notes:</u>**

Thanks for purchasing the DIYHFS ultra low noise filament supply.
The package includes:
- 8 x 5mm standoffs and nuts
- 4 0.47ohm 10watt resistors to trim supply voltage as needed (one or two may be used before each supply)
- 2 x supply devices with heatsink, trimpot, blue and amber LED to indicate function mode

**Mounting:**
Mount the supplies for best cooling. Connect 'DC' out to connect to the tube socket pins (1 and 4 in the case of 300B/2A3/45/PX25 etc). Adjust voltage with the actual tube in place.
There are two options

1. mount the supply with installed heatsink (85mm x 50mm x 60mm tall with 40mm x 75mm mounting centres) using 5mm standoffs (supplied).
2. Or detach the 3 legged device from the heatsink and mount it leg-for-leg in the same holes from the bottom. Now it can be bent over so that the device can be directly bolted to the chassis. Make sure to use the insulator washer and strip between chassis and device. There must be no metal to metal contact. They must be electrically insulated from each other.

The first option will suit most applications. The second option allows more heat sinking (limited only by chassis size) in case input voltage and current draw are on the high side. *As a guide: when in open air (ie chassis open) the heat sink should not get warmer than 30C above ambient temperature*. Also the second option can be used when low profile mounting is required as the heatsink is not used.

**AC supply:** Connect the suitably rated AC supply wires to the 'AC in' connectors and screw down snugly but don't overtighten. If the connector twists or breaks off, you have overtightened. These wires should be floating (ie no centre tap connected to ground.). Twist these wires together about 3 twists per inch to reduce induced hum)

**DC output:** Connect to 'DC out' and then to the tube socket pins. Note the polarity is labelled. Follow the drawing below to make the connections.

Adjust the blue trimmer to the desired DC voltage. It is preset to 5V DC with input of 7V AC. If using a tube that requires less voltage, adjust the voltage lower before inserting tubes.

*Note: there must be no cap or humpot across tube socket. This will defeat the sound as music signal will be shorted or shunted away from the output circuit. In the case of cathode bias it should be connected as shown.*

**Voltage and heat considerations:**
The device needs about 1 to 1.5V headroom to regulate with low noise and modest heating. More voltage causes more heat and possibly more noise. Less voltage limits output voltage and increases noise. As an example for a 300B amplifier 5V DC is needed on pins 1 and 4. Input AC V should be 6 to 6.5V AC, floating (ie no centre tap to ground). In that case output noise is spec'd at 4mv but in out own test amplifier we have measured as low as 1.8mv. If all else is well with the circuit output noise from the amp can be vanishingly low and reveal much hidden musical detail.
*The device comes preset at 5V output. If lower voltage is required adjust lower using the blue trimpot provided before inserting power tubes*

Option 1 - Traditional Regulator:

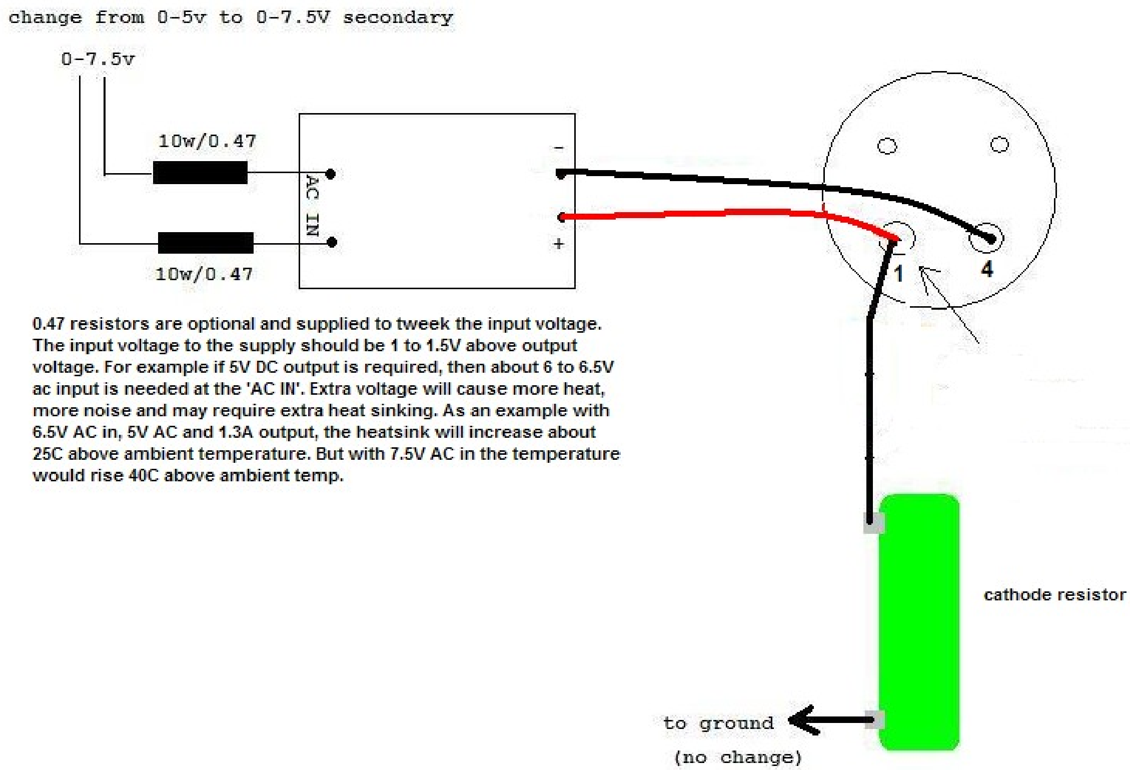
R1 = Wire Bridge (0R)
R5 = open
R7 = 0.1R
C5 = 47uF

Option 2 - VCCS Regulator:

R1 = 0.1R
R5 = 0R (bridge)
R7 = open
C5 = open

There are three large cutouts below the heatsink and one each under each pair of diodes, to optimise airflow.

In addition you can fit the regulator device from below the PCB and bolt it directly to the Chassis (given a suitable screw) with the large center hole (in the shape of the letter "D") giving access to bolt down the IC.




0.47 resistors are optional and supplied to tweek the input voltage. The input voltage to the supply should be 1 to 1.5V above output voltage. For example if 5V DC output is required, then about 6 to 6.5V ac input is needed at the 'AC IN'. Extra voltage will cause more heat, more noise and may require extra heat sinking. As an example with 6.5V AC in, 5V AC and 1.3A output, the heatsink will increase about 25C above ambient temperature. But with 7.5V AC in the temperature would rise 40C above ambient temp.