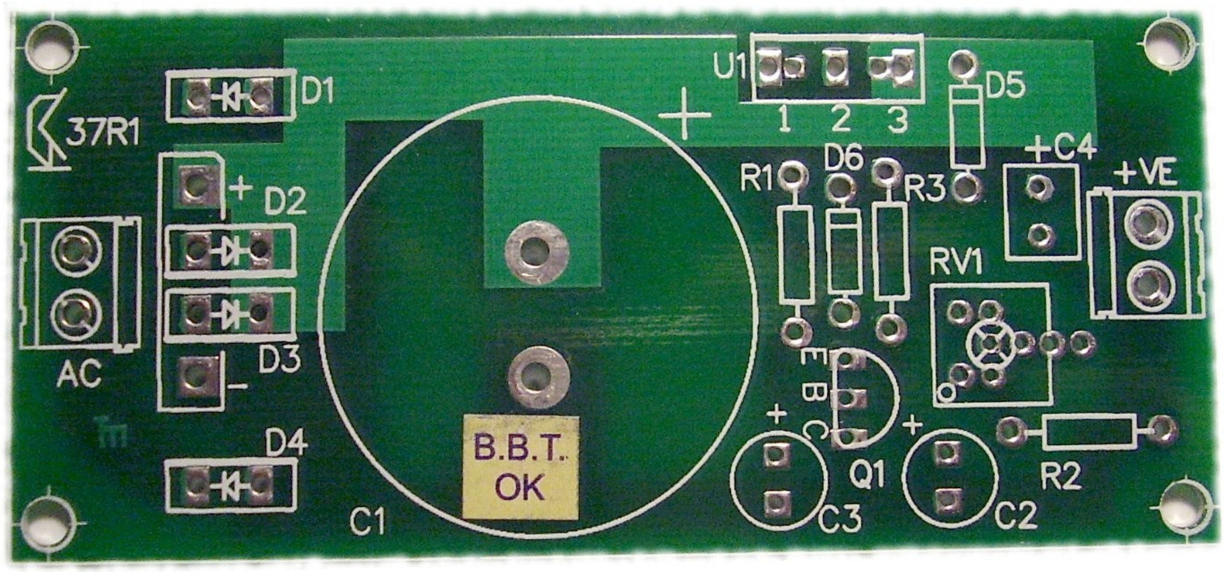
DC Heater/Filament Regulator with Soft Start PCB



Classic Valve Design

For more sensitive audio valve stages, a DC heater supply voltage is often looked at as the only reasonable alternative to maintaining low hum and noise. This is especially true of direct heated tubes, or tubes “pushed” into low level audio service because of their superior electrical characteristics, yet the designers never considered that function and the tube may have less than stellar heater-cathode isolation (television VHF tubes fall into this category).

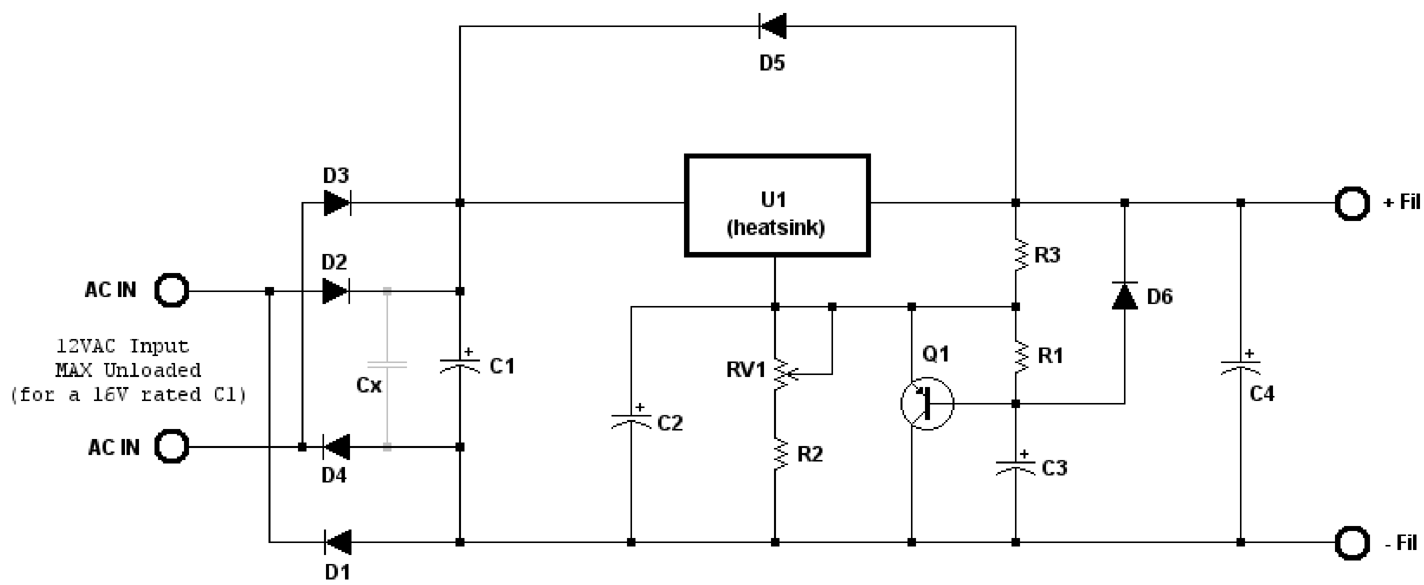
There are three basic ways to address this hum reduction – **1)** lift the heaters in indirectly heated tubes to a positive voltage where the filament ripple can't overcome this bias (impossible to apply in a directly heated tube), **2)** use a DC constant current to the tube heaters (parts count goes way up if you have a lot of valves in your circuit, as you'd need properly one CCS per valve, lest one valve hog more if they were paralleled) or **3)** DC regulate the heater supply.

The option in #2 has the added benefit of reducing the cold-heater surge on power up. This adds to the longevity of the valves in your circuit. However, if we add soft-start circuitry to option #3, you can have the best of both - reduced turn-on surge, low parts count and a low noise, low ripple heater power supply that can be floated or grounded as you, the designer, see fit.

The regulator offered here gives you the opportunity to create for yourself a stable and reliable design based on the LM117/317T/138/338T (and other manufacturer equivalents) for total currents up to 1.5A continuous for the LM317 and 5A continuous for the LM338T.

The schematic provided below gives you component values for the most common heater supply voltages found in audio tubes today.

NOTE: The AC input voltage should be at least 4V higher than the required filament voltage, otherwise the regulator will “drop-out” and not regulate!



D1 - D4: TO-220 cased fast recovery rectifiers, MUR820 or BYW29E, or the like.
Bridge rectifier KBU606 or equiv. may be used in place of discrete.

D5, D6: 1N4004 or any of the 1N400x series.

U1: LM317T for up to 1.5A continuous, LM338T for up to 5A continuous.

Q1: 2N2907, 2N4403, 2N3906, etc.

C1: 10,000uF, 16V, electrolytic.

C2: 22uF, 16V, electrolytic.

C3: See Table.

C4: 1uF, 16V, tantalum.

Cx: 100n film tacked across C1's terminals (not required if C1 is low ESR type).

R1: 6.8K, 1/2W carbon film.

R2: See Table.

R3: 220 ohms, 1/2W, carbon film.

VR1: 100 ohms. Bourns 3296W-1-101LF 25 turn trimmer is perfect.

C3 Table

Output Voltage		C3 Value for Seconds Delay to Full +Fil
2.5V	-	1000uF ~ 8S, 2200uF ~16S
5.0V	-	220uF ~ 7S, 470uF ~ 14S
6.3V	-	220uF ~ 10S

R2 Table

Output Voltage		R2 Value for RV1 Centred at loaded output
2.5V	-	150 ohms
5.0V	-	560+33 ohms in series
6.3V	-	820 ohms

Components are chosen so RV1 is about centre of its range for designed output voltage and gives you a fine control that won't be hideously sensitive to the touch if a higher value trimmer were used.

C4 is critical to the way the regulators transient response is affected. If you are using another type of regulator in this circuit (like the really high current ones from Linear Technology), consult that regulators data sheet for what's appropriate capacitance and type here.

Increasing the value of C4 will be of no benefit and in fact will impede the regulators designed abilities.

If you wish to increase the regulators output voltage capability, you will need to increase the voltage rating on capacitors as appropriate and make the RV1 + R2 pair follow the formula:

$$V_{out\text{-}max} = 1.25*(1+((RV1+R2)/R3))$$

Or for the centre-trimmer value, use RV1/2 in the formula above.

Regulator dissipation goes up as the Vin-Vout difference increases, so wisdom indicates using the lowest input voltage to the regulator to maintain regulation under maximum load is the best course.