EZ Tube Mixer

HT Power Supply Design

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Introduction

The EZTube Mixer design allows mixers of many different sizes to be built. This means that the current drawn from the HT supply will vary a lot depending on the number of amplifiers powered. At present, the only PCB available for the HT supply is the HT350 which was in fact designed for a different project. This document shows you how to design an HT supply using the HT350 PCB that can power up to 20 EZTube Mixer amplifier cards.

Current Draw

The first thing to do is determine the HT current draw. EZTube Mixer Eurocard and twin line amp PCBs normally consume about 15mA from the HT line. If you modify a twin line amp to operate as a headphones amp using an ECC99 then the HT current draw for that board will be 30mA. The total current draw is simply the sum of the currents from each amp. Let's take as an example a mixer containing 10 Eurochannels and one twin line amp configured as a headphones amp. The total current draw will be:

(15 x 10) + 30 = 180mA

The HT350 can supply up to 300mA HT or 20 Eurochannels.

Specify the transformer

Having decided the HT current we need to work out the specification for the HT transformer and in particular for it secondary winding. Sowter has an excellent section on its web site giving the basic equations for working out transformer specs:

http://www.sowter.co.uk/rectifier-transformer-calculation.htm

We are using the bridge version of the capacitor input filter. Sowter gives three eqautions for this. First:

Vac = Vdc x 0.71

where Vac is the transformer secondary voltage and Vdc is the voltage across the reservoir capacitor. The HT350 design drops 30 volts in the additional three RC smoothing stages so for 300volts at the output we need 330 volts dc at the input; so Vdc is 330V. This means Vac needs to be 330 x 0.71 = 234volts. 240 volts ac gives us some margin to allow for diode drops and mains voltage fluctuation.

The next equation is Iac = Idc x 1.61

where Iac is the current rating of the transformer secondary and Idc is out current draw.

We know Idc is 180mA so Iac = 300 x 1.61 = 290mA

So a transformer with a 300mA rated secondary will do.

Lastly we have Pac = Pdc x 1.14

Pdc is 330V x 180mA = 54 watts so Pac = 54 X 1.14 = 62 watts so a 70 watt rated transformer will do. So now we have our basic spec for the transformer secondary

240Vac at 300mA

and we know the transformer will be rated at about 70 watts.

Calculate Resistor/Capacitor Values

Next we need to look at the design of the PCB. The capacitor size in the original design was chosen to ensure the ac ripple was reduced enough that it is at or below the noise level of the mixer. The HT350 PCB was designed for use in mixers using mu follower circuits like the poor man's tube gain make up stage (PMTGMU). The size of the HT350 capacitors and resistorvalues in the RC filter determine how much the ripple is attenuated and the current design provides up to 120dB of attenuation at up to 120mA. However, to maintain the 10V drop between RC stages at higher currents than this we need to reduce the value of the series resistors. Since we want 10V across each resistor, its value is just:

10000/Idc, where Idc is in mA and the resistor value is in ohms.

So to drop 10V at 180mA requires the resistors to be reduced to 56 ohms. The power dissipated in each one is nearly 2 watts so they need to be at least 5W rated types and 10W types if the maximum current of 300mA is used. Since space is limited on the HT350 PCB it is probably best to have these resistors placed horizontally leaning away from the PCB to give them adequate ventialltion.

I have simulated the power supply with 33 ohm resistors and a 300mA load and the ripple is reduced by 80dB to just under 1mV. Now in my early designs based on mu followers, the mu follower circuit itself rejects the ripple by a further 20dB so with a 300mA load there would be about 100uV of hum on the output or about about -78dBu. This is higher than the tube noise level so it is not a good result which is why the HT350 was limited to 120mA HT current.

However, the EZTubeMixer used negative feedback which also rejects HT borne ripple. So I simulated the EZTube amp with 1mV of ripple and it reduced it to about -95dBu which is

comfortably below the tube noise.

We could go one stage further and reduce the ripple further by increasing the 470uF caps to 680uF. This reduces the ripple to 0.45mV with a 300mA load and at the output of the EZTube amp it is about -105dBu which is excellent. At lower HT currents the riple would be less.

Summary

Use the equations above to work out your Idc and transformer spec.

Work out your resistor values. If your Idc is 150mA or less use 5 watt types and if is is greater use 10 watt types.

If Idc is 150mA or less use 470uF caps. Use 680uF caps if is is greater.