Calculation Report: Power Supply
PRO-Q2

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1 Introduction

In this calculation report a transformer is selected and the efficiency of the power supply is determined.

2 Power supply

2.1 Requirements

The power amplifier has the following specifications:

- Input: 230V AC
- Output: 2x 18V DC (25W), 2x 15V DC, 1x 5V DC
- Regulator type: Linear
- Energy efficiency: 80% or higher

2.2 Power supply design

The power amplifier needs a supply of ±18V DC. To accomodate for this the power supply will consist of a power transformer with one primary winding and two secondary windings. After the transformer comes a bridge rectifier which converts the AC signal to DC. Then finally the signal will pass through several filter capacitors to smooth out the voltage. Optionally an inductor can be used in-between the filter capacitors and the bridge rectifier to reduce the inrush current.

The pre-amplifier will run off ±15V DC which is provided by a regulator stage after the power supply. The same thing goes for the digital systems which will run off 5V DC.

2.3 Calculations

2.3.1 Power transformer

The winding turn ratio between the primary and the secondary windings of the transformer is equal to the voltage ratio.

$$\frac{U_p}{U_s} = \frac{N_p}{N_s} \tag{1}$$

The primary voltage is 230V and the secondary voltage is 18V.

$$\frac{N_p}{N_s} = \frac{230}{18} \tag{2}$$

The transformer current per secondary winding is equal to:

$$I = \frac{P}{2U} = \frac{25}{36} = 0.694A \tag{3}$$

2.3.2 Power efficiency

The energy efficiency of the power supply needs to be 80% or more. The 0.7V voltage drop of the bridge rectifier makes the power supply about 4% less efficient.

$$\eta = \frac{19 - 0.7}{19} = 0.96 \tag{4}$$

There will also be energy loss in the power transformer. The power transformer we chose is 87% efficient[2].

The linear regulators used to power the preamplifier and the digital systems are very inefficient, but, since these parts of the audio system consume very little energy compared to the power amplifier, the loss is neglectable. The power amplifier's power is not regulated.

$$\eta_{total} = 0.87 \cdot 0.96 = 0.8352 \tag{5}$$

The overall efficiency of the power supply is about 84%.

2.4 Selection of power transformer

A toroidal power transformer was chosen because it is more efficient than traditional transformers. The primary voltage is 230V and the secondary voltages are both 18V.

This transformer meets the specifications[2]:

- Multicomp MCTA050/18 (Farnell code: 9530380)

The nominal current of the secondary windings of this transformer is equal to 0.420A while the power amplifier drains 0.694A from the supply at max power. The capacitors in the power supply will smooth out the load on the transformer so it does not exceed the nominal current.

References

[1] Texas Instruments. (2004, May). "*LM1875 20W Audio Power Amplifier*" [online]. Available: http://www.farnell.com/datasheets/1703151.pdf [April 3, 2015].

[2] Multicomp. (2014, June). "*Toroidal Transformers, General Purpose*" [online]. Available: http://www.farnell.com/datasheets/1829278.pdf [April 15, 2015]