Calculation Report: Monolithic Power Amplifier PRO-Q2

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EQ2.a
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1 Introduction

In this calculation report, the monolithic power amplifier is determined and calculated.

2 Monolithic Power Amplifier

2.1 Requirements

The power amplifier has the following specifications:

- Input impedance of at least 50kΩ
- Output power: 15W sine in $R_{load} = 8\Omega$ at 1kHz
- Frequency range: 10Hz to 100kHz (−3 dB) at $P_{load} = 0.5W$ in 8Ω

2.2 Chosen Power Amplifier

For the power amplifier, the LM1875 (Farnell-code: 1468913) was chosen. This specific power amplifier has been chosen because the LM1875 meets the specified requirements. The amplifier is also designed to suppress low-frequency noise such as the 50Hz hum originating from the mains, as seen in figure 7 of the datasheet. This is an important property when it comes to the performance of audio amplifiers.

2.3 Calculations

Since the LM1875 is used as an inverting amplifier, the impedance Z_{in} will be equal to R_1 as depicted in the following diagram.

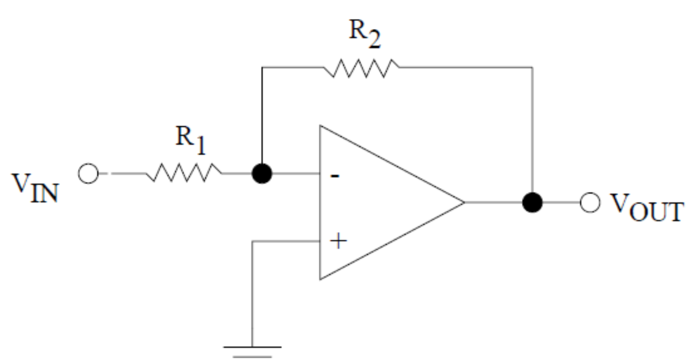

Figure 1: Inverting amplifier diagram

Z_{in} is required to be at least 50kΩ. Thus, the chosen value of R_1 will have to be at least 50kΩ in order to meet the specified requirement.

For determining the maximum output voltage and current, it is assumed the amplifier drives an 8Ω load at 15W.

The formula for the power equals to:

$$P = U \cdot I \tag{1}$$

Therefore the following formulas can be derived:

$$U_{OUT,eff} = \sqrt{P \cdot R} = \sqrt{15 \cdot 8} = 11V \tag{2}$$

$$U_{OUT,max} = U_{OUT,eff} \cdot \sqrt{2} = 15.556V \tag{3}$$

$$I_{OUT,eff} = \sqrt{\frac{P}{R}} = \sqrt{\frac{15}{8}} = 1.37A \tag{4}$$

$$I_{OUT,max} = I_{OUT,eff} \cdot \sqrt{2} = 1.94A \tag{5}$$

The amplifier has a bandwidth of 70kHz at 20W output power. However, the desired dynamic range of 10Hz to 100kHz can be easily achieved at lower power outputs. No additional calculations need to be done for the power amplifier in order to realize a frequency range of 10Hz to 100kHz. The dynamic range can be controlled through software since the filters on the preamplifier are controlled by the digital control unit. According to the datasheet from LM1875 [1] the supply voltage needs to be approximately $\pm$18V to accomodate to the 15W output power.

With this information, the voltage gain can be determined by using the following formula:

$$A = \frac{U_{out}}{U_{in}} \tag{6}$$

Since $U_{out} = U_{out,max} = 15{,}556$V and $U_{in} = 18$V (the voltage delivered by the supply), the gain will be $\frac{15{,}556}{18} \approx 0.864$. Expressed in decibels, this is equal to $20 \cdot \log(\frac{15{,}556}{18}) \approx -1.27$dB.

It is now possible to deduce the output impedance Z_{out} by using the following equation:

$$\frac{U_{out}}{U_{in}} = \frac{Z_{out}}{Z_{in}} \tag{7}$$

Filling in the known values, Z_{out} can be determined as follows:

$$\frac{15,556}{18} = \frac{Z_{out}}{50 \cdot 10^3} \Longrightarrow Z_{out} = 50 \cdot 10^3 \cdot \frac{15,556}{18} \approx 43211\Omega \tag{8}$$

References

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