Calculation Report: Heat Sink Power Amplifier PRO-Q2

Daan Conijn, 13023217
Andrew Lau, 13058339
Kevin Oei,13090062
Koen van Vliet, 13093053
Group 1

EQ2.a
EQ2.c

April 4th, 2015

1 Introduction

In this calculation report the heat sink of the selected monolithic power amplifier is calculated.

2 Calculation: Heat Sink Power Amplifier

The power amplifier that is chosen for the active loudspeaker is LM1875 (Farnell code: 1468913).

Fig. 1 gives insight on how the heat sink and power amplifier are connected with each other.

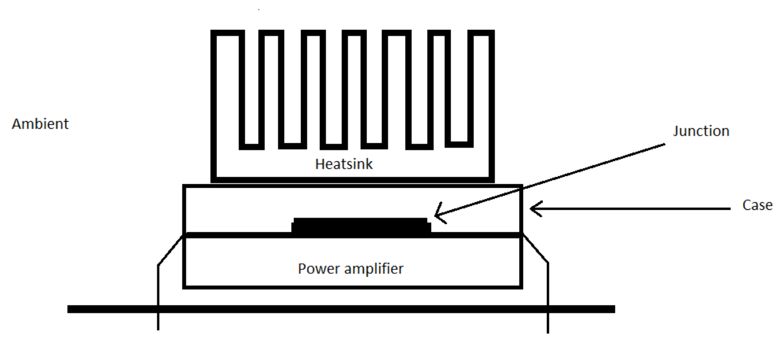

Figure 1: A sketch of the heat sink and power amplifier

Imagine that the maximum junction temperature of the power amplifier can reach up to 150°C and that the ambient temperature goes up to 25°C. The power dissipation for an 18V power supply and an output power of 15W is equal to 10W. The power dissipation can be found in a graph called "Power Dissipation vs Power Output" in the datasheet of LM1875. The total junction-to-ambient thermal resistance must be less than[1]:

$$\theta_{ja} = \frac{T_{JMAX} - T_{AMB}}{P_Q} = \frac{150 - 25}{10} = 12,5000^{\text{o}}C/W \tag{1}$$

- $T_{JMAX}$is the maximum junction temperature that the power amplifier can handle before shutting down.
- $T_{AMB}$is the ambient temperature of the power amplifier.
- P_Q is the quiescent power dissipation of the amplifier.

The thermal resistance of a metal-metal interface when dry equals to:

$$\theta_{metal-to-metal} = 1,2^{\text{o}}C/W \tag{2}$$

The thermal resistance of the heat sink equals to:

$$\theta_{heatsink} = \theta_{ja} - \theta_{metal-to-metal} = 12,5^oC/W - 1,2^oC/W = 11,3^oC/W \quad (3)$$

To check whether the calculations are correct, the temperature of the junction is determined as a result of the thermal resistance.

The formula used to calculate the maximum average power of the power amplifier, LM1875, is found in the datasheet. The maximum average power that the power amplifier will be required to dissipate before overheating is approximately [1]:

$$P_dMAX = \frac{V_S^2}{2\pi^2 R_L} + P_Q = \frac{18^2}{2\pi^2 \cdot 8} + 10 \approx 12.05W \quad (4)$$

- V_S is the total power supply voltage across the power amplifier.
- R_L is the load resistance.
- P_Q is the quiescent power dissipation of the amplifier. The power dissipation can be found in a graph called "Power Dissipation vs Power Output" in the datasheet of the LM1875.

$$P_Q = 10W \quad (5)$$

The new maximum junction temperature is:

$$T_{JMAX} = P_dMAX \cdot \theta_{ja} = 12,05 \cdot 12,5 = 150,625^oC \quad (6)$$

150.625°C is slightly higher than 150°C and therefore the new junction-to-ambient thermal resistance equals to:

$$\theta_{ja} = \frac{150,625 - 25}{10} = 12,5625^oC/W \quad (7)$$

The new ϑ_{ja} (12.5625°C/W) is approximately equal to 12.5000°C/W, which means that the calculations of the heat sink meets the required specifications.

Therefore the new thermal resistance of the heat sink equals:

$$\theta_{heatsink} = \theta_{ja} - \theta_{metal-to-metal} = 12.5625^oC/W - 1,2^oC/W = 11.3625^oC/W \quad (8)$$

3 Conclusion

A heat sink with a thermal resistance lower than 11.3625 $^{\circ}$C/W must be used in order for the power amplifier, LM1875, to function properly without overheating and shutting down.

References

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