Heat Sink Design for A Power Amplifier

1. Introduction

Heat sink is important for the continuous operation of a power amplifier. Improper thermal dissipation design can shorten the amplifier life or even damage it permanently.

2. Thermal Model

Figure 1 shows a typical thermal model for power amplifier (PA) heat dissipation paths. Ra is the junction to case thermal resistance of the hottest component of the amplifier and it is always to be the last stage transistor. Re is the total thermal resistance of the rest heat sources for the amplifier. Rs is the thermal resistance, case to ambient, for the heat sink.

With this simple model, the maximum junction temperature then can be determined by the following equation, by neglecting the convection of the PA body:

$$Tj = Ta + Pa * Ra + [(Pe + Pa) – Po] * Rs \quad (1)$$

where

Ta is the ambient temperature, Pa is the total power dissipation of the hottest component, Po total RF output power, and Pe the rest total power dissipation of the PA. Consider Po is 0 Watt for Class A amplifier at worst operation condition of without output RF power.

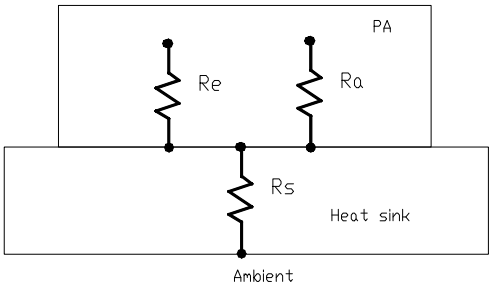

Figure 1 Thermal model

3. Example

Without losing generality, WLPA15-3045A, which is a 2-Watt GPS power amplifier, is used for the illustration.

The last stage transistor power dissipation, Pa = 9.5V x 0.4A = 3.8W, Po = 0 W, and the total power dissipation is 12V x 0.48A = 5.76W or Pe = 5.76W – 3.8W = 1.96W. For maximum ambient temperature of 85 ^{0}C and maximum junction temperature of 170 ^{0}C of the last stage transistor, the maximum heat sink thermal resistance can be calculated by equation (1):

$$170\ (^0C) = 85\ (^0C) + 3.8\ (W) * 18\ (^0C/W) + 5.76\ (W) * Rs$$

or

$$Rs = 2.88\ (^0C/W)$$

where 18 ^{0}C/W and 170 ^{0}C are Ra and maximum junction temperature allowed. These parameters are specified in the product data sheet at

http://wantcominc.com/DataSheets/WLPA/WLPA15-3045A.pdf

With known Rs, then the proper heat sink can be selected accordingly. For example, Wakefield 401K with the thermal resistance of 2.67 ^{0}C/W, heat sink can be used for WLPA15-3045A heat dissipation.

https://www.digikey.com/product-detail/en/wakefield-vette/401K/345-1048-ND/340344

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