## Heatsink Selection

Due to resistance, Rds on the MOSFET and switching losses, the temperature of the component increases. This situation affects the performance of the circuit, even it may cause the MOSFET to burn. Clearly, this kind of a problem results a non-working circuit design. That’s why temperature analysis has to be made and suitable heatsink should be selected. In the following subsection this thermal analysis has been explained in detail.

### Thermal Analysis

As mentioned before, there are two types of losses that cause temperature increase. The first one is conductor loss and the reason of this loss is the resistance, Rds on the MOSFET. This power loss can be calculated as follows.

In the above equation D represents the duty cycle and it can be found with the common formula for buck converters as can be seen as follows.

In this project these values are not constant; however, we can use their approximate values, and the duty cycle can be calculated.

The drain-source resistance is given in the datasheet of the selected MOSFET as 2.2Ω. Finally, the desired output current is 2A. The reason why the current must be multiplied with the duty cycle is that when the switch is off position there is no current flow passing through the MOSFET and hence there is no conduction power loss. In short, the conduction power loss can be calculated as follows.

The second power loss type is switching loss. Clearly, the reason of this power loss is switching operation and it directly proportional with the switching frequency, sum of rise and fall time. The switching power loss can be calculated as follows.

Then the total power loss can be calculated as follows.

This power loss causes the temperature increase. Assuming the ambient temperature is 25⁰C, the junction temperature without a heatsink can be calculated as follows.

In the above equation, represents the resistance between junction to ambient, and this value is also given in the datasheet of the MOSFET. All the thermal parameters of MOSFET can be seen in the following Figure X.

![tablo içeren bir resim

Açıklama otomatik olarak oluşturuldu]()

Figure Thermal Parameters of the Selected MOSFET

Clearly, the operating temperature is very high and most probably the MOSFET cannot withstand this temperature value. Therefore, using a heatsink to decrease the operating temperature could be a good solution for this problem. Following equation shows the calculation of minimum thermal resistance of the heatsink, for below than 100⁰C operating temperature.

While selecting a proper heatsink, there are some important things that should be considered. These important points have been listed as follows.

* *Thermal resistance of the heat sink*: As calculated above the thermal resistance value affects the operating temperature which directly affects the performance of the temperature. Therefore, smaller thermal resistance value means better performance.
* *Size of the heatsink:* In the PCB design, heatsink is one of the biggest components. To minimize the design, a high size heatsink should not be selected.
* *Suitable with TO-220 pack:* The heatsink also should be suitable with the selected MOSFET in the buck converter. As mentioned before, the pack of the MOSFET is TO220. Therefore, suitability is also important to integrate the heatsink to the design.

Considering the above points, the selected heatsink model is ML8G which is manufactured by AAVID THERMALLOY. Dimensions of this heatsink is 12.3x29x35mm (LxWxH). It is suitable with TO-220 package and has 13 ⁰C/W thermal resistance. After selecting the heatsink, the operating temperature can be calculated as follows.

As a result, as can be seen in the above calculation, the operating temperature has been decreased from 227.43⁰C to 74.6⁰C by using the selected heatsink.