Thermal Analysis of the System

1. Three phase diode rectifier diode losses

There is no reverse recovery time in the data sheet of GUO40-12NO1 bridge diode. Therefore, conduction losses of the diode rectifier at 25 ° C and 150 °C are calculated for each one.

D: Duty cycle

N: Number of diodes

At 25 :

50.88Watt

Tjunction=25(Tambient)+Rthermal\*Ploss

At 150 °C:

44.16Watt

Tjunction=150(Tambient)+Rthermal\*Ploss

There is no total Rthermal value of rectifier diodes, therefore, the precise value cannot be obtained.

2)Buck Converter Switching and Conduction Losses

There are switching and conduction losses in buck converter diode

*F\*VF\*D*

*At 25* °C Pconduction=30\*2.51\*0.8= 62.4 W

\*trr

*At 25* °C =10\*103\*600\*250\*10-6\*25\*10-9=3.75\*10-5

At 150 °C cannot be calculated since no reverse voltage value information in the datasheet



Tjunction to heatsink= 298(25 Celcius equivalent) +1.15\*62.4=361.55 Kelvin

3)IGBT Switching and Conduction Losses

For conduction losses one will use the values from datasheet

*CE\*VCE\*D*

*At* 25 °C VCE=1.5 Volt at saturation and 1.9 Volt at T=175 °C

*At* 25 °C ICE=40µA at saturation and 2mA at T=175 °C

From the formula the conduction losses are

At 25 °C Pconduction=0.048mW

At 175°C Pconduction=3.8 mW

Moreover, there is a switching loss in IGBT devices. Switching losses can be calculated by using the formula:

From the datasheet:

At 25 °C with Tj=25°C, V C C =400V, I C =30A, V G E=0/15V, r G =10.6Ω, L σ=136nH, Cσ=39pF

Eon=0.69 mJ

Eoff=0.77mJ

At T=175 °C with Tj=175°C, V C C =400V,I C =30A, V G E=0/15V, r G =10.6Ω, L σ=136nH,Cσ=39pF

Eon=1 mJ

Eoff=1.1 mJ

Pswitching(25°C) = 10\*103 \*(1.46\*10-3) =14.6 Watt

Pswitching(175°C) = 10\*103 \*(2.1\*10-3) =21 Watt

Total losses at 25°C:

Ptotal= Pswitching + Pconduction

Ptotal(25°C) =14.65 W

Total losses at 175°C

Ptotal(175°C) =24.8 W

Total thermal resistance Rjunction-ambient=40 K/W

TJunction= TAmbient +Rja\*Ploss

Until reaching 175°C dissipated power is

Tjunction= 175+40\*9.90