DESCRIPTION
THERMAL MODEL FOR
BMR 466 SERIES

FLEX POWER MODULES

Contents

General

The model is based on and valid for BMR 466 0004, which is an LGA design. The mechanical structure, PCB stack-up, components and materials are similar to other products, which means that this thermal model is applicable for several products within the BMR 466 family.

The model is intended for steady-state thermal simulations.

Model Description

The model consists of three parts:

- 3D CAD Geometry
- Domains of power loss distribution
- Domains of material data

Below are the parts described in detail.

3D CAD Geometry

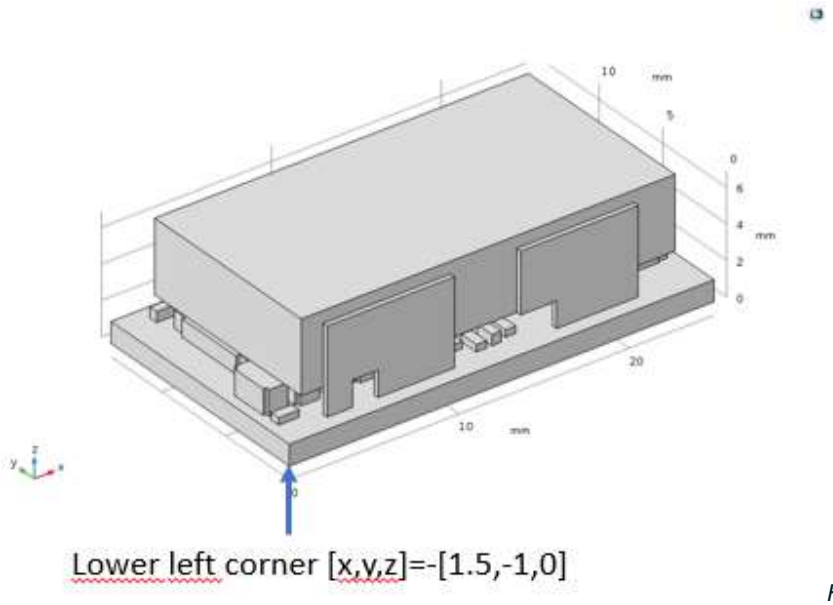

Figure 1

The geometry is to be found in STEP format in BMR4660004_simplified.stp

In the geometry all components are maintained per original design. The PCB has been simplified to a bulk geometry, whilst the copper layers and vias have been taken into consideration by non-uniform material characteristics.

Origin has been placed so that [0,0,0] is in center of LGA pad, which means lower left corner of PCB is at [-1.5,-1,0].

Unit in file: [mm]

Domains of power loss distribution

There are several sources for power loss. The power loss for each of them, at certain combinations of module voltage and current, are given in *Appendix 2 - Power Loss Distribution*

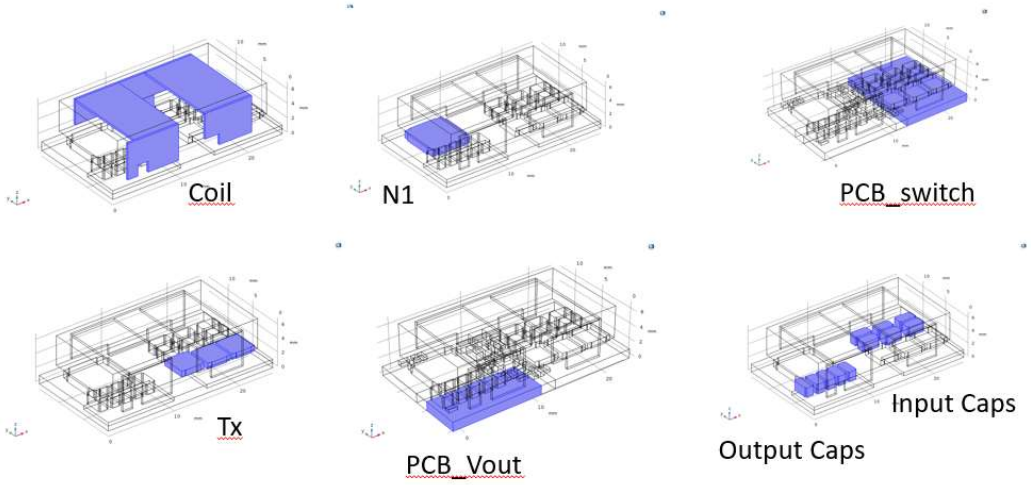

Figure 2: Domains for power loss

Domains of material data

There are several material domains. The heat conductivity for each of them is given in *Appendix 1 - Material Data.*

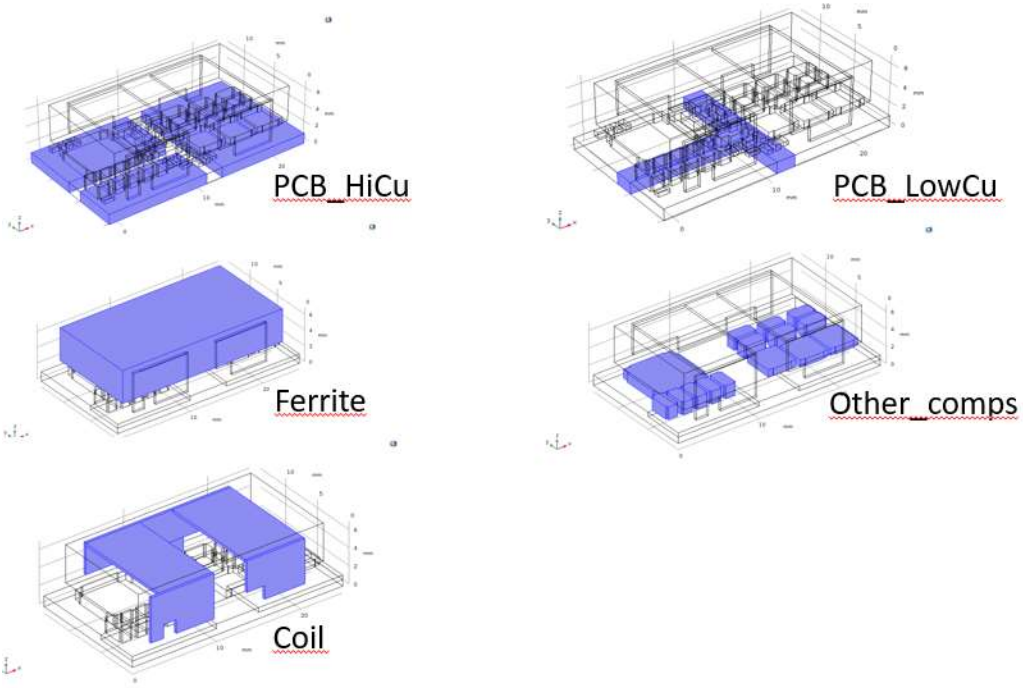

Figure 3: Domains for material data

Note 1. The heat conductivity is only intended to model the temperature distribution of the module in this application. The values should not be treated as physical true or transferable to other applications.

Note 2. There are two heat conductivities for the PCB (corresponding to internal copper structure), which are non-uniform, and there are two numbers for each, one for the conductivity in the plane (xy-) and one for the conductivity in z-direction.

The same is applicable for coil. Depending on to the way how it is attached to the PCB, the heat conductivity is also non-uniform (lower in z-direction) in order to take the mounting pads on the PCB into consideration.

Model Calibration

The model has been calibrated to give as similar temperatures as possible for V_{in}=5[V], V_{out}=1[V], I=60[A], compared to thermal verification document 2/102 65-BMR 466 0004 Rev A. All wind speeds in the document from 0.2 to 3 [m/s] have been considered. Individual component power losses per *Appendix 2 - Power Loss Distribution* were scaled linearly with the total in the range 9.0 to 9.4[W]

For air velocity calculations a k-ε turbulence model was applied, using COMSOL Multiphysics 5.3. Default settings were used and normal mesh size. Solver used algebraic multigrid method.

COMSOL Multiphysics 5.3 was also used for the heat flow calculations.

Direction of air for the calibration, per document 2/102 65-BMR 466 0004 Rev A, is in the y-direction.

Simulation temperatures are within ±2.5 [degC] compared to measured values.

Model is calibrated using data from thermal report 2/102 65 BMR 466 0004 Rev A, Io=60A

Vi = sys			Io = 60 A					
5 V		temp. limit	nat conv	0.5 m/s	1.0 m/s	1.5 m/s	2.0 m/s	3.0 m/s
Air velocity	(m/s)	--	0.1	0.5	1.1	1.5	2.0	3.0
Output power	(W)	--	60.0	60.0	60.0	60.0	60.0	60.0
Efficiency	(%)	--	86.5	86.6	86.7	86.8	86.9	87.0
Power dissipation	(W)	--	9.4	9.3	9.2	9.1	9.1	9.0
Max ambient	(°C)	--	67.6	73.6	76.7	79.5	81.5	85.3
Thermal resistance	(°C/W)	--	6.1	5.6	5.3	5.0	4.8	4.4
1. Amb	(°C)	--	22.1	22.5	23.0	23.2	23.2	22.6
2. T4	(°C)	125	79.2	73.6	70.8	68.0	66.1	61.8
3. pcb	(°C)	125	73.6	68.0	65.2	62.5	60.3	55.9
4. T8 (Ref)	(°C)	125	79.5	73.9	71.3	68.7	66.7	62.3
5. T9	(°C)	125	78.8	73.3	70.6	67.8	65.6	61.1
6. N1	(°C)	120	57.1	52.1	49.8	47.7	46.2	42.9
7. L1	(°C)	120	71.7	64.1	60.8	57.7	55.0	48.7
8. GND pin	(°C)	125	48.6	43.8	41.9	40.1	39.0	36.3
Air velocity	(m/s)	--	0.1	0.5	1.1	1.5	2.0	3.0
Vin	(V)	--	5.0	5.0	5.0	5.0	5.0	5.0
Iin	(A)	--	13.9	13.9	13.8	13.8	13.8	13.8
Vout1	(V)	--	1.0	1.0	1.0	1.0	1.0	1.0
Iout1	(A)	--	60.0	60.0	60.0	60.0	60.0	60.0
Vout2	(V)	--						
Iout2	(A)	--						
Vout3	(V)	--						
Iout3	(A)	--						

Table 1 Data from 2/102 65-BMR 466 0004 Rev A

Model Usage

Import the file BMR4660004_simplified.stp into the desired project.

Assign power losses per table in *Appendix 2 - Power Loss Distribution* to the domains in section *Domains of power loss distribution*. If requested to run a different power loss within the same voltage and current, it is possible to scale the individual values.

Set the heat conductivity per *Appendix 1 - Material Data* to the domains showed in. Please make sure the non-uniform values are given in the correct direction so that the model z- corresponds to z-direction in your coordinate system.

Additional Information

Model has been constructed with SI units.

Reference

Thermal report 2/102 65 BMR 466 0004 Rev A

Product number and r-state history

Flex product number IPM 101 44, R1A 2017-10-06

Disclaimer

The model and model documentation described herein are provided for the sole purpose of facilitating thermal modeling of a structure where the referenced product is included. It should not and cannot be interpreted neither as a detailed description of the product itself, nor as a statement of the product's performance.

The model has been constructed on a best effort basis, but we cannot accept liability for any discrepancy between model predictions and actual values.

Revision history

Rev A 2017-10-06
Rev B 2018-10-24 New layout. Minor text updates.

Appendix 1 - Material Data

Material data for BMR 466.

Heat Conductivity [W/m/K]		
Domain	**x-, y-**	**z-**
PCB_HiCu	100	4
PCB_LoCu	25	4
Coil	385	75
Ferrite	3	3
Other_comps	30	30

Appendix 2 - Power Loss Distribution

Power loss distribution for BMR 466.

V_{in}= 5 [V] V_{out}= 1 [V] I_{out}=60 [A]

Domain	Power loss per domain (W)	Number of domains	Subtotal power loss (W)
PCB_Vout	0.111	1	0.111
PCB_switch	0.111	1	0.111
N1	0.719	1	0.719
Coil	1.461	1	1.461
Tx	1.993	3	5.979
InputCaps	0.1015	6	0.609
OutputCaps	0.0222	5	0.111
		Total (W)	**9.101**