DESCRIPTION THERMAL MODEL FOR BMR 465 SERIES

FLEX POWER MODULES

Contents

General

The model is based on and valid for BMR 465 0010, which is a through hole design. The mechanical structure, PCB stack-up, components and materials are similar to other products in the same family, which means that this thermal model is applicable for several products within the BMR 465 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

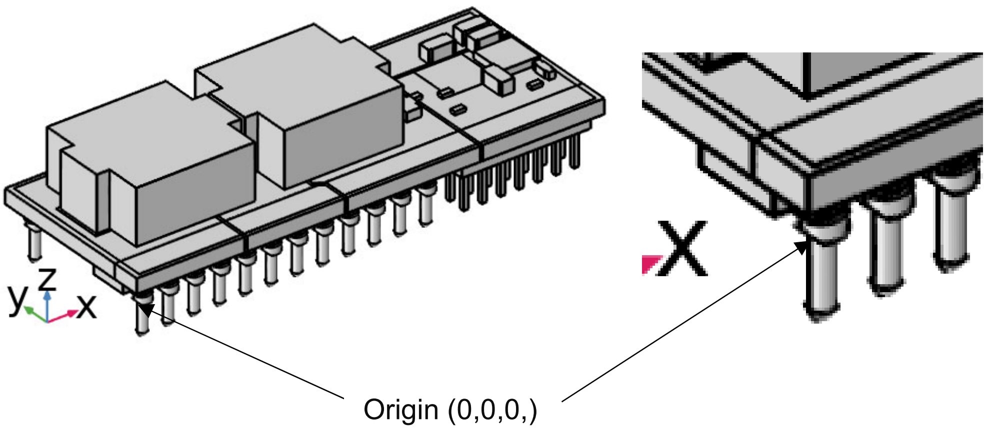

Figure 1 Origin

The geometry is to be found in Parasolid and STP format in BMR465_simplified.zip

In the geometry all components are maintained per the original design. Some minor adjustments (approx. +/- 0.05 mm) have been done to the position of some components, in order to avoid small features in the geometry. The PCB has been simplified to a bulk geometry, whilst the copper layers and vias have been taken into consideration by giving non-uniform material characteristics to the PCB.

Origin has been placed so that [0,0,0] is on the heel, in the center of lower left pin, see Figure 1.

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 1 - Power Loss Distribution*

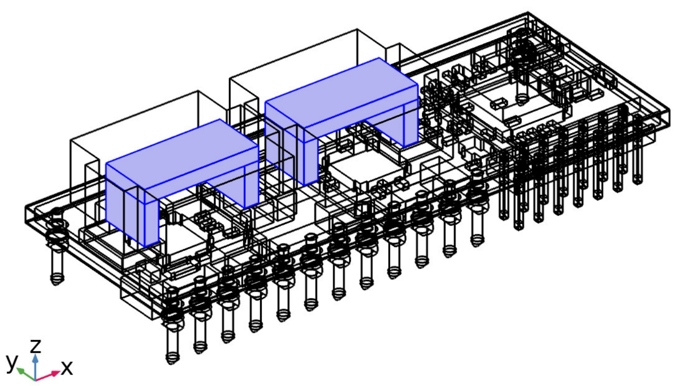

Figure 2: L1L2_Core

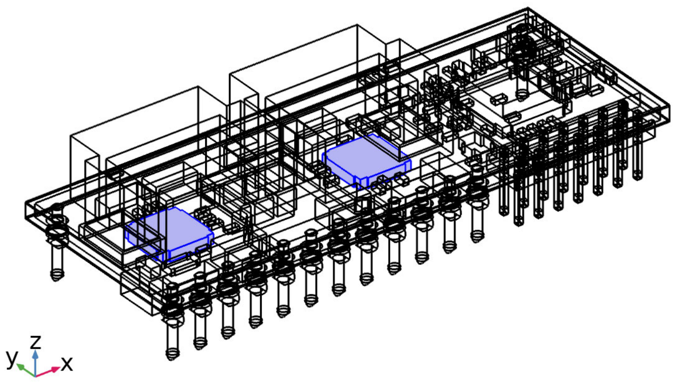

Figure 3: N2N3 (rear side)

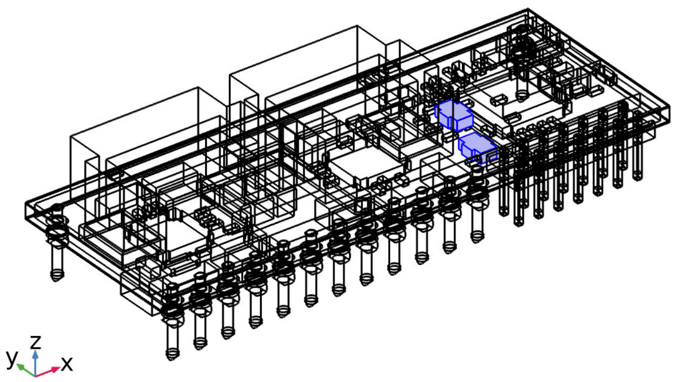

Figure 4: T1T2 (front and rear side)

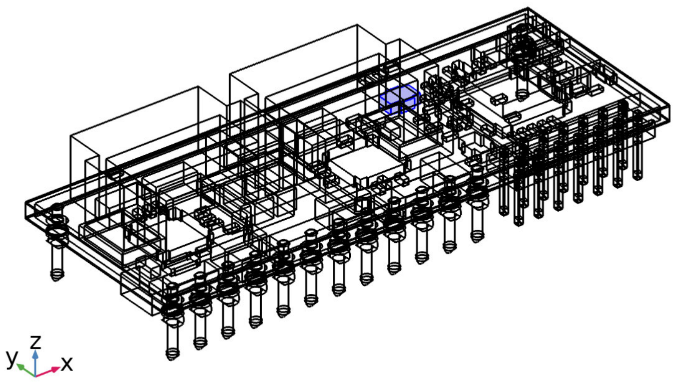

Figure 5: T3 (rear side)

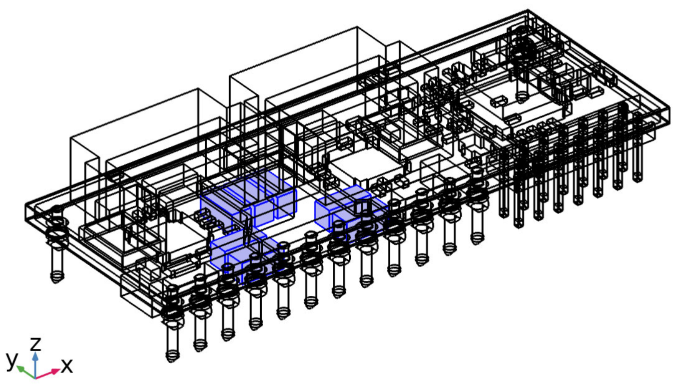

Figure 6: OutCap (rear side)

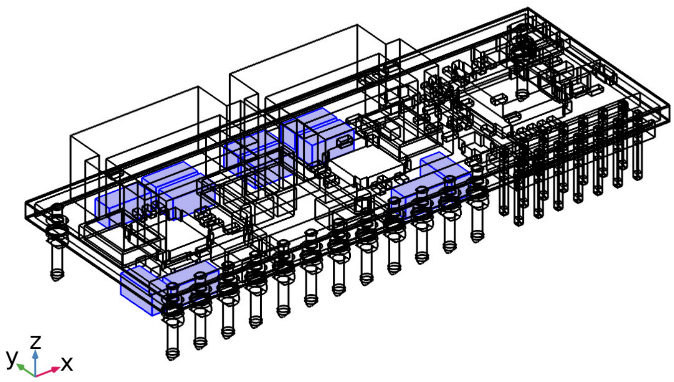

Figure 7: InCap (rear side)

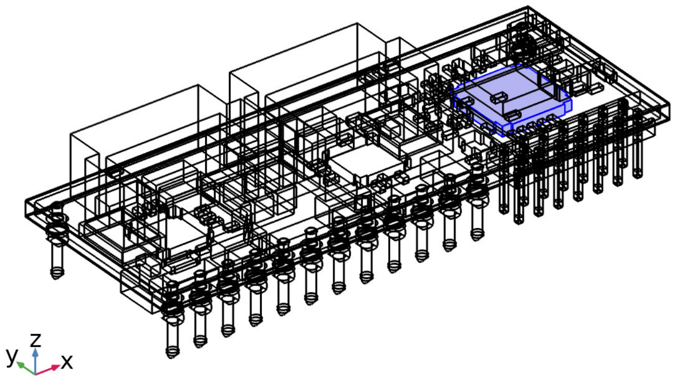

Figure 8: N1 (rear side)

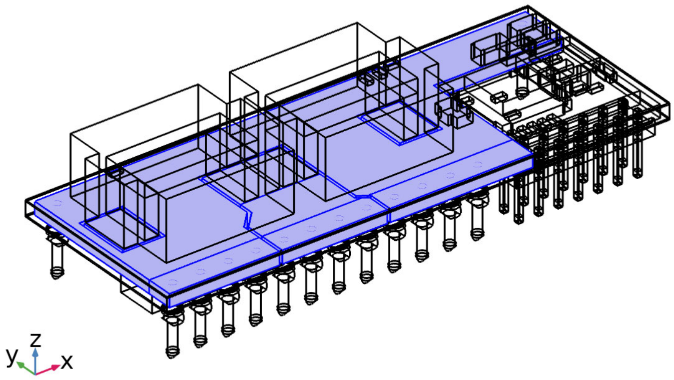

Figure 9: PCB

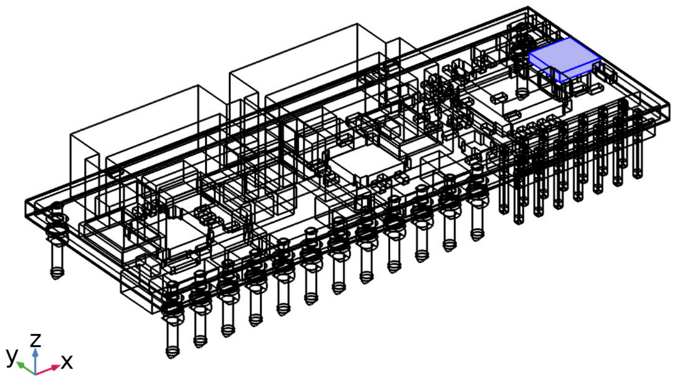

Figure 10: N4

Domains of material data

There are several material domains. The heat conductivity for each of them is given either as isotropic, or anisotropic values in x-,y-, and z-direction (x,y,z) in the figures following.

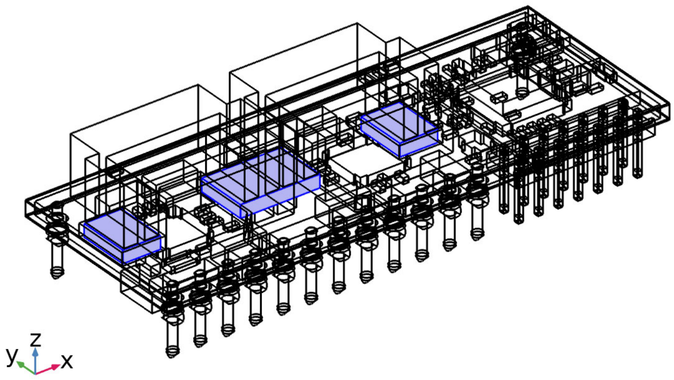

Figure 11: Heat Conductivity (90,90,10.5) [W/m/K]

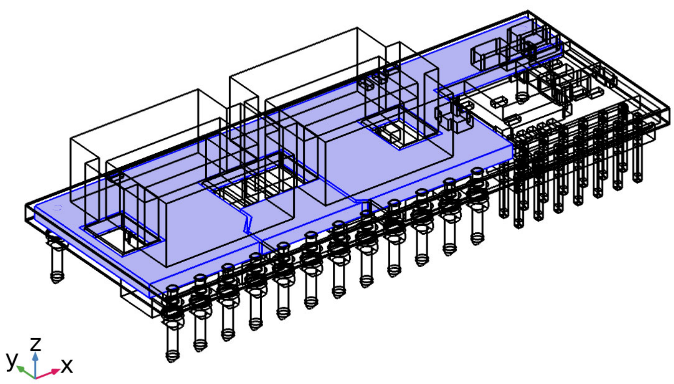

Figure 12: Heat Conductivity (90,90,3) [W/m/K]

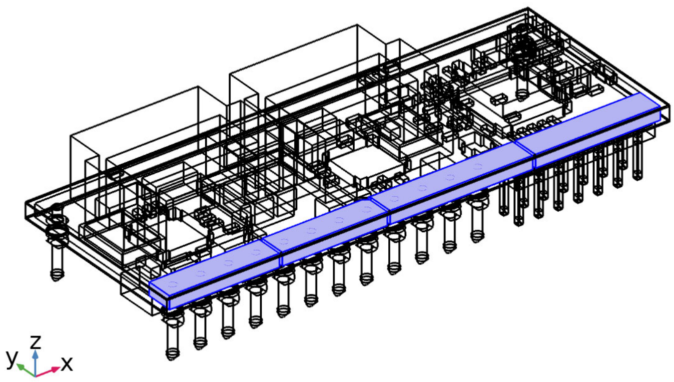

Figure 13: Heat Conductivity (90,90,6.3) [W/m/K]

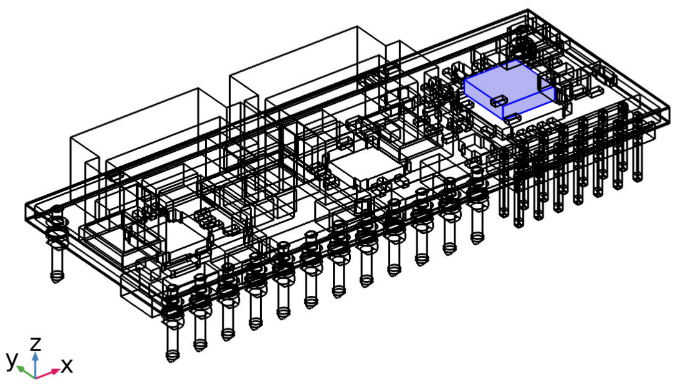

Figure 14: Heat Conductivity (90,90,14) [W/m/K]

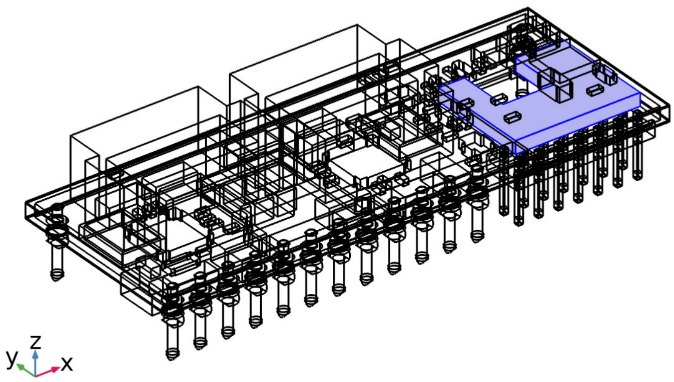

Figure 15: Heat Conductivity (90,90,1) [W/m/K]

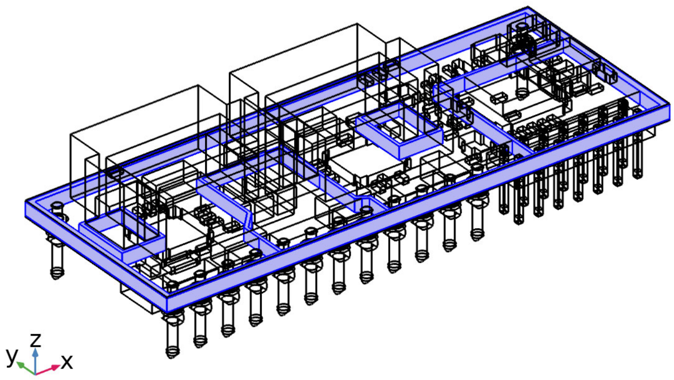

Figure 16: Heat Conductivity (1,1,0.3) [W/m/K]

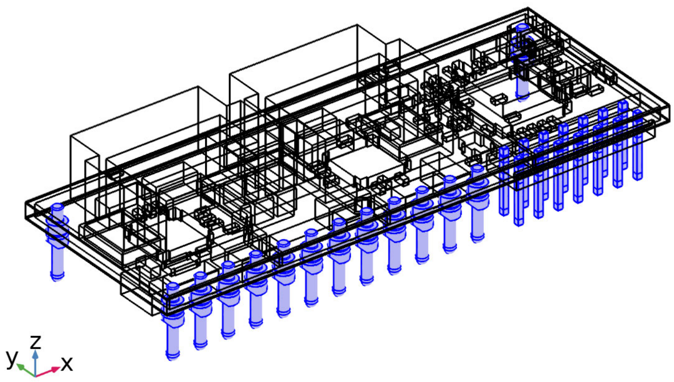

Figure 17 : Heat Conductivity 355 [W/m/K]

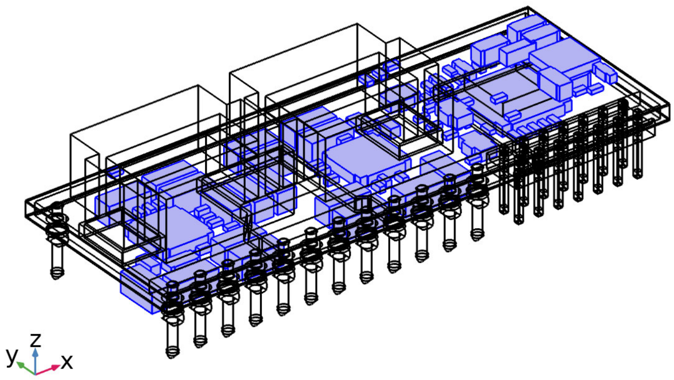

Figure 18: Heat Conductivity 30 [W/m/K]

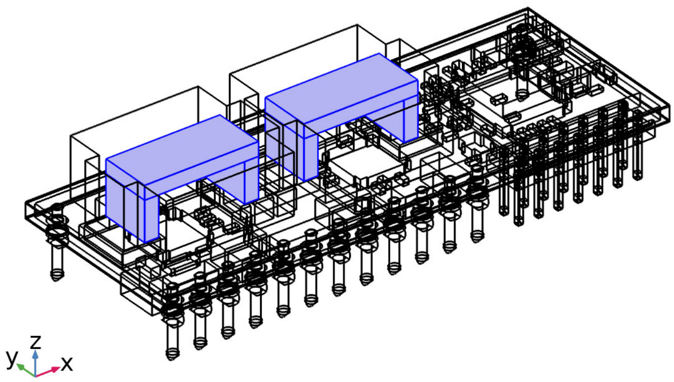

Figure 19: Heat Conductivity 400 [W/m/K]

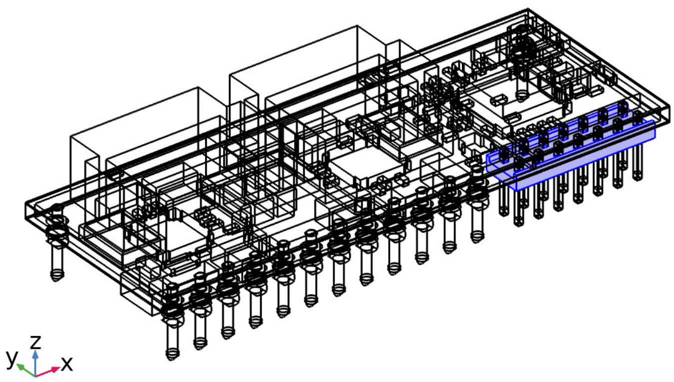

Figure 20 Heat Conductivity 0.26 [W/m/K]

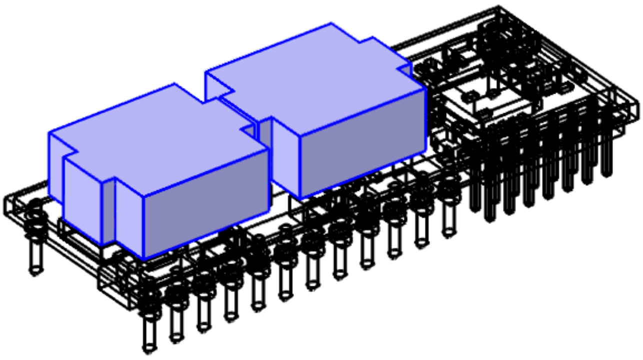

Figure 21 Heat Conductivity 5 [W/m/K]

Note. The given 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.

Model Calibration

The model has been calibrated to give temperatures as similar as possible for V_{in}=12[V], V_{out}=1[V], I=90[A], 1.5 and 3 [m/s], compared to thermal verification document 1/102 65-BMR 465 0010 Rev A. The calibration was done using a simplified bulk geometry for the test board, with heat conductivity 140 [W/(m*K)] in the xy-plane, and 10 [W/(m*K)] in z-direction. Test board dimensions are 254x254 [mm^2].

For air velocity calculations a low Re k-ε turbulence model was applied, using COMSOL Multiphysics 5.4. Default settings were used and coarse mesh size.

COMSOL Multiphysics 5.4 was also used for the heat transfer calculations.

Direction of air for the calibration, per document 1/102 65-BMR 465 0010 Rev A, is in the negative y-direction.

Simulation temperatures are within ±3 [degC] compared to measured values.

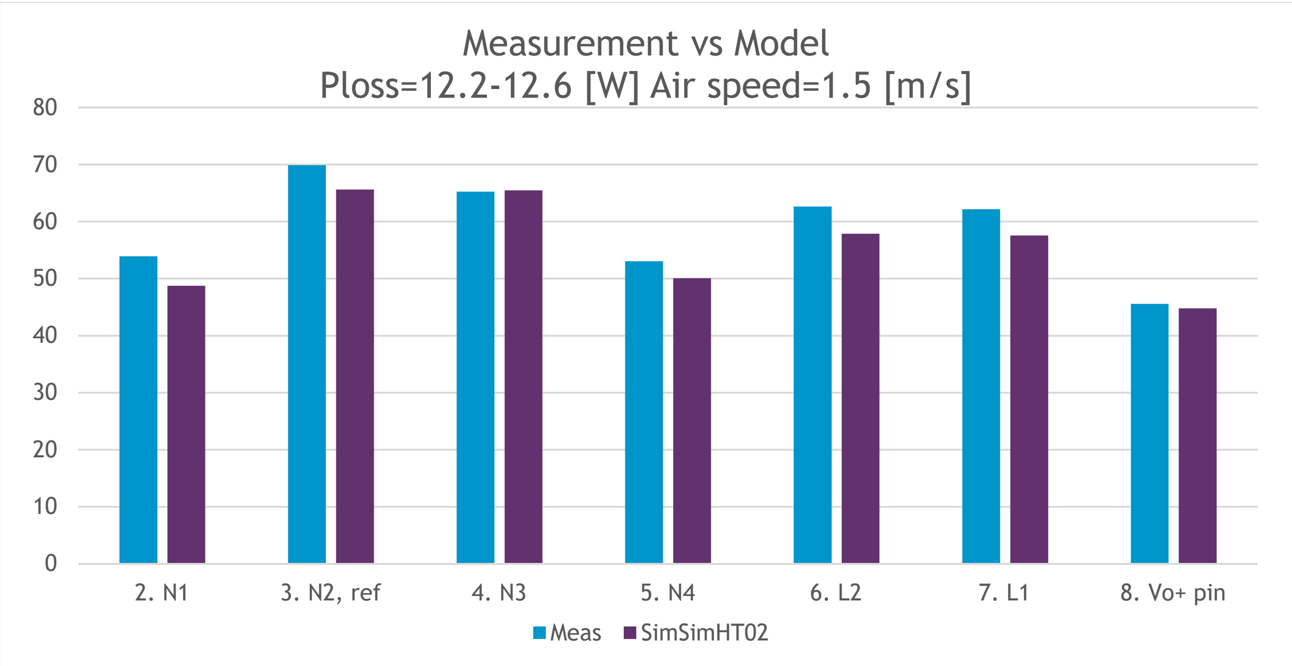

Figure 22: Model calibration result

Model Usage

Import the preferred file format, stp or Parasolid x_b, from BMR465_simplified.zip into the desired project.

Assign power losses per table in *Appendix 1 - 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 Figure 11 to Figure 20 to the domains showed in

Domains of material data. 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 1/102 65 BMR 465 0010 Rev A

Product number and r-state history

Flex product number IPM 101 49, R1A 2019-03-15

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

Appendix 1 - Power Loss Distribution

Power loss distribution example for BMR 465.

V_{in}= 12V V_{out}= 1V I_{out}=90A

Domain	Power loss per domain (W)	Number of domains	Subtotal power loss (W)
N1	0.1	1	0.1
N2N3	1.862	2	3.724
N4	0.392	1	0.392
T1T2	0.125	2	0.25
T3	0.16	1	0.16
L1L2	2.355	2	4.71
InCap	0.0042	11	0.046
OutCap	0.0093	7	0.065
PCB	2.758	1	2.758
		Total (W)	**12.205**