DESCRIPTION THERMAL MODEL FOR PKB-D SERIES

FLEX POWER MODULES

Contents

General

The model is based on and valid for BMR 674 06/1101, which is a pin design. The mechanical structure, PCB stack-up, components and materials are similar to other products in the family, which means that this thermal model is applicable for several products within the PKB-D 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

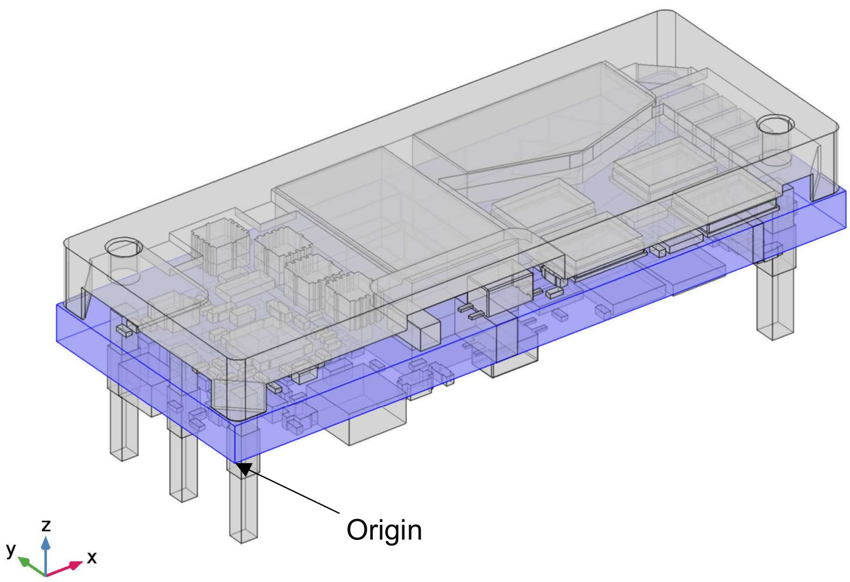

Figure 1

The geometry is to be found in STEP format in BMR67406_1101_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. Pins and ferrites are simplified into squared geometry instead of rounded.

Origin has been placed so that [0,0,0] is in the lower left corner of the PCB

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

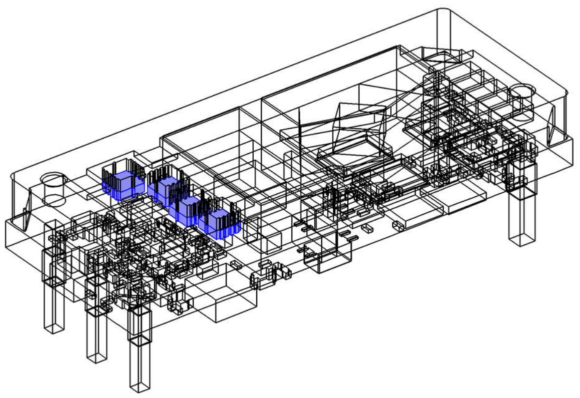

Figure 2: PRIMFET

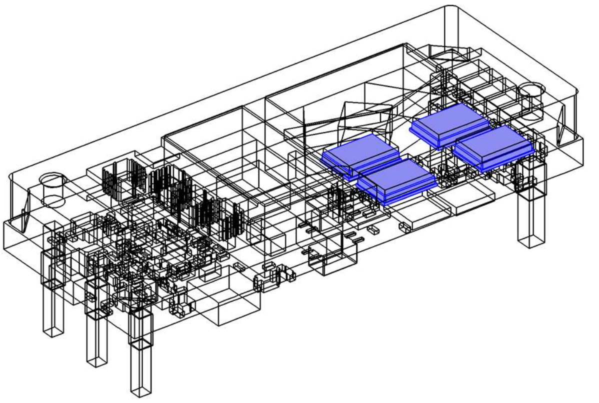

Figure 3: SECFET

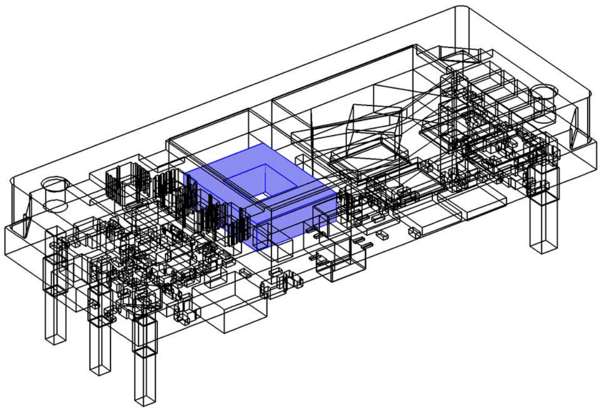

Figure 4: PRIMWIND

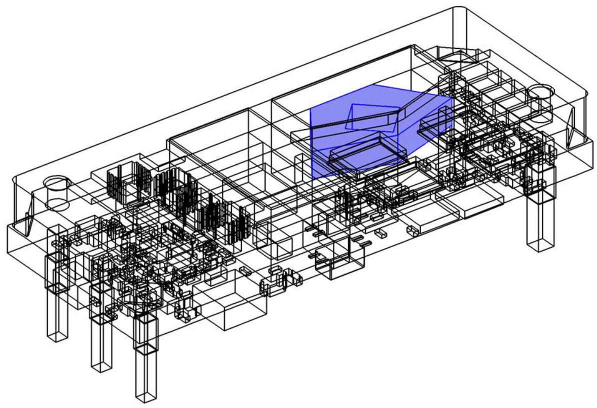

Figure 5: SECWIND

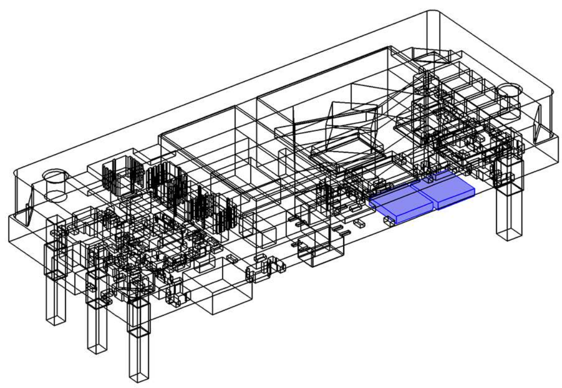

Figure 6: NX

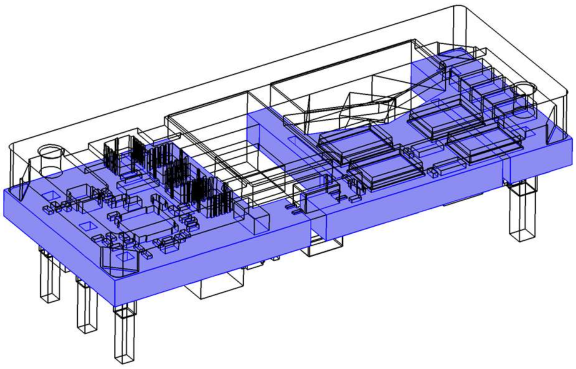

Figure 7: PCB

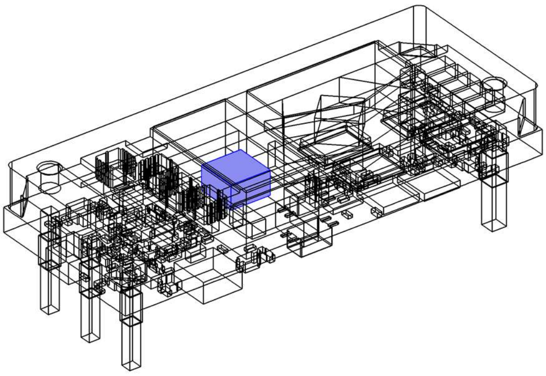

Figure 8: TRAFO

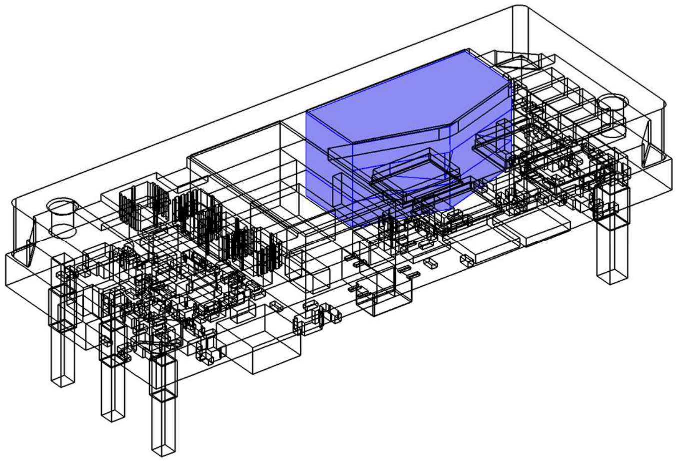

Figure 9: CHOKE

Domains of material data

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

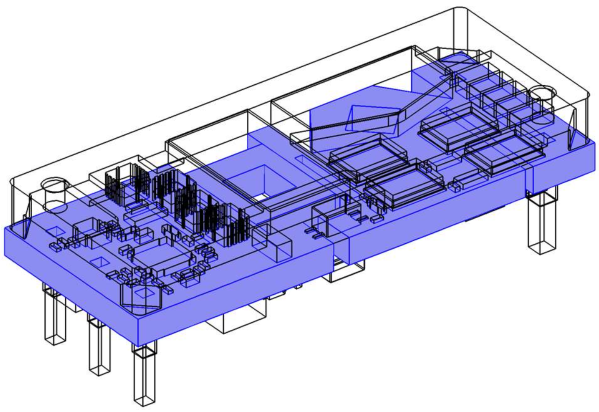

Figure 10: NormCU

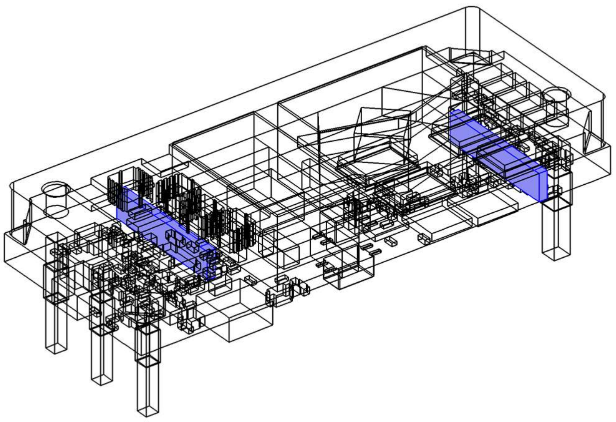

Figure 11: MedCu

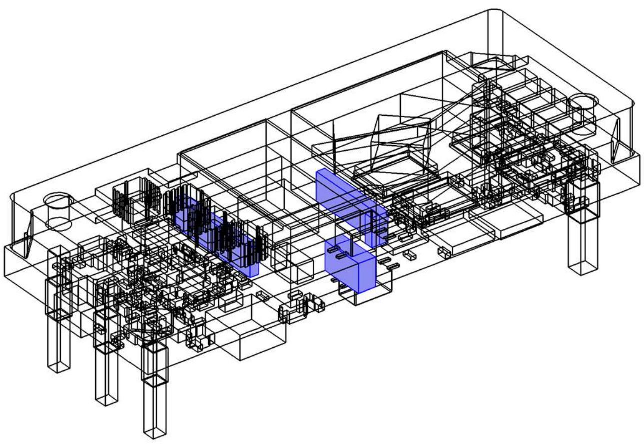

Figure 12: LowCu

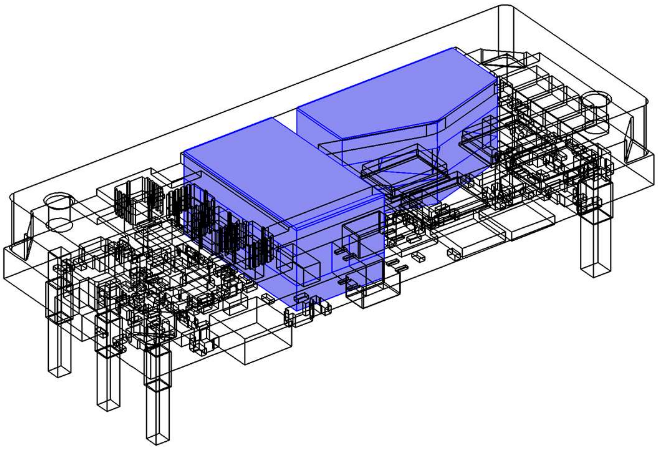

Figure 13: FERRITE

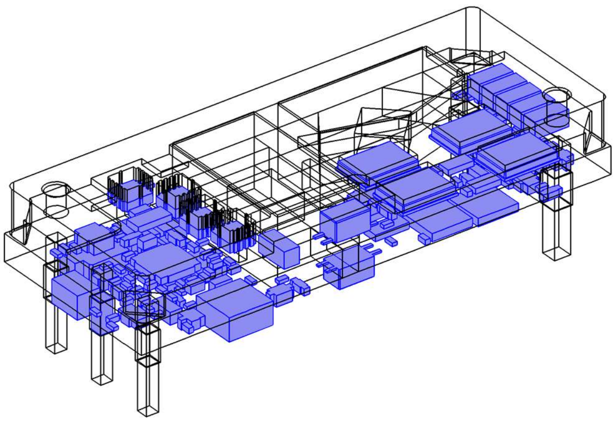

Figure 14: COMPS

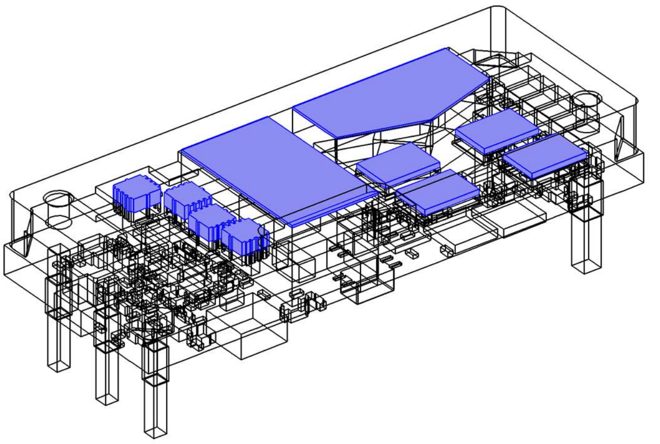

Figure 15: GAPFILLER

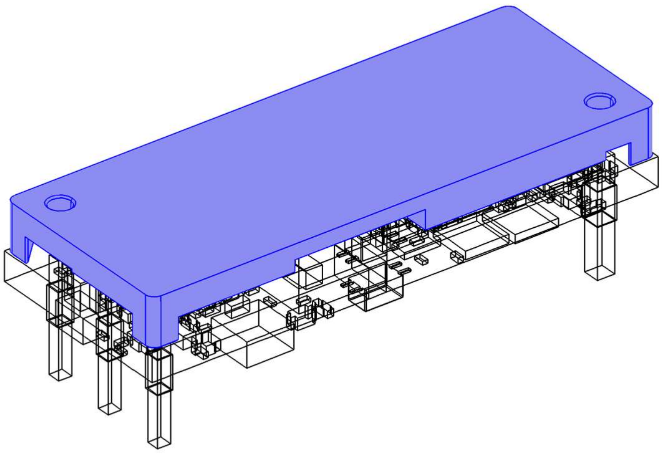

Figure 16: BASEPLATE

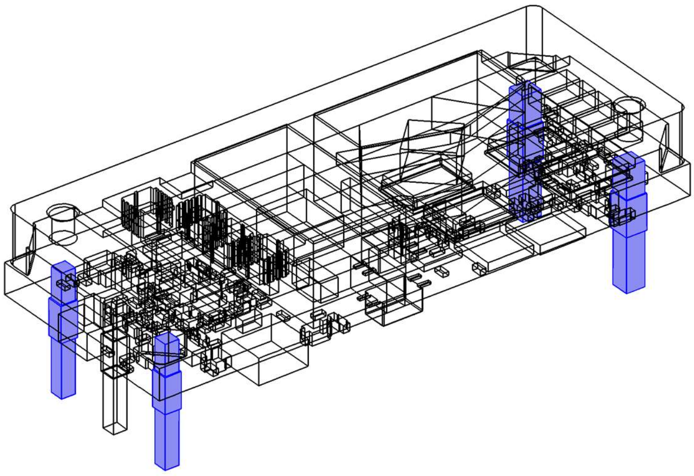

Figure 17: PINS

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 three 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 also goes for the FERRITE. Depending how it is attached to the PCB, the heat conductivity is also non-uniform (lower in xy-direction) in order to take the routed slots around the transformer and choke into consideration.

Model Calibration

The model has been calibrated to give as similar temperatures as possible for V_{in}=52.4[V], V_{out}=12[V], I=33.8[A], 1.5 [m/s], compared to thermal verification document 1/102 65-BMR 674 06/1101 Rev PA1.

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 1/102 65-BMR 674 06/1101 Rev PA1, is in the y-direction.

Simulation temperatures are within $\pm$2.75 [degC] compared to measured values.

Model Usage

Import the file BMR67406_1101_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 *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 674 06/1101 Rev PA1

Product number and r-state history

Flex product number IPM 101 45, R1A 2018-04-05

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 B 2018-10-30

Appendix 1 - Material Data

Material data for PKB-D.

Heat Conductivity [W/m/K]		
Domain	**x-, y-**	**z-**
NormCu	100	10
MedCu	50	0.7
LowCu	2	0.4
FERRITE	0.1	3
COMPS	30	30
GAPFILLER	1.5	1.5
BASEPLATE	238	238
PINS	380	380

Appendix 2 - Power Loss Distribution

Power loss distribution for BMR 480.

V_{in}= 52.4[V] V_{out}= 12[V] I_{out}=33.8[A]

Domain	Power loss per domain (W)	Number of domains	Subtotal power loss (W)
PRIMFET	0.75	4	3
SECFET	1.475	4	5.9
PRIMWIND	4.02	1	4.02
SECWIND	1.87	1	1.87
Nx	0.6	2	1.2
PCB	3.4	1	3.4
TRAFO	1	1	1
CHOKE	0.5	1	0.5
		Total (W)	**20.89**