DESCRIPTION THERMAL MODEL FOR PKB 4213

FLEX POWER MODULES

Contents

General

The model is based on and valid for PKB 4213 DPIHSLA (BMR 674 05/2101), which is a Through Hole Pin 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 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

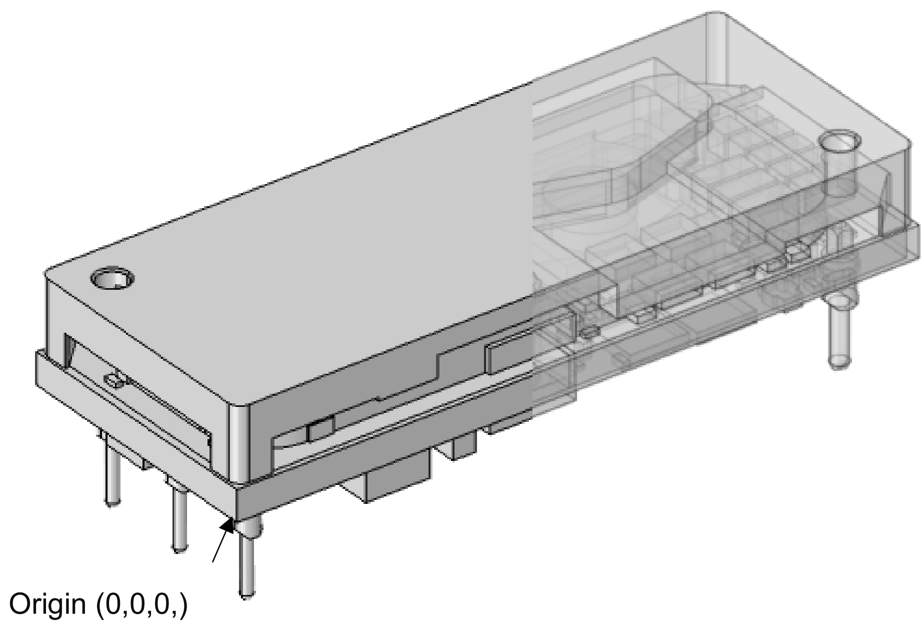

Figure 1

The geometry is to be found in Parasolid format in BMR674_simplified.zip

In the geometry all components are maintained per the original design. 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 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 1 - Power Loss Distribution*

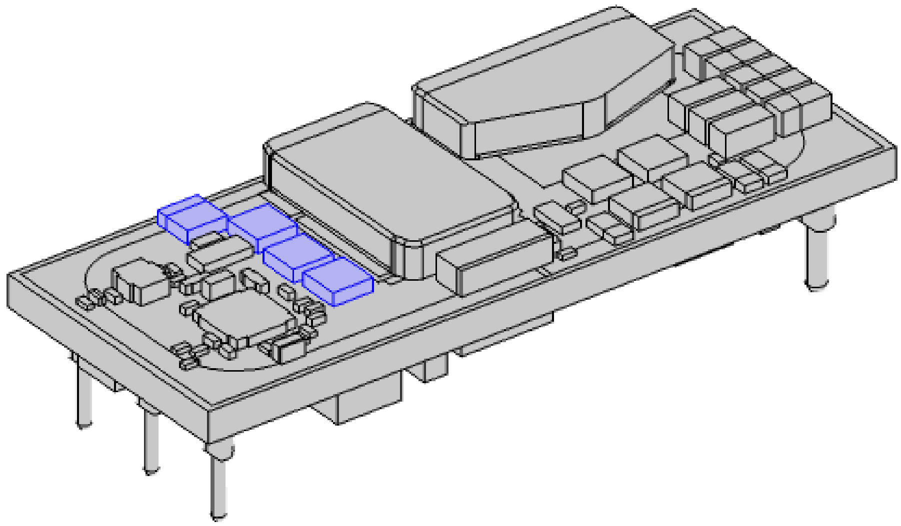

Figure 2: PRIMFET

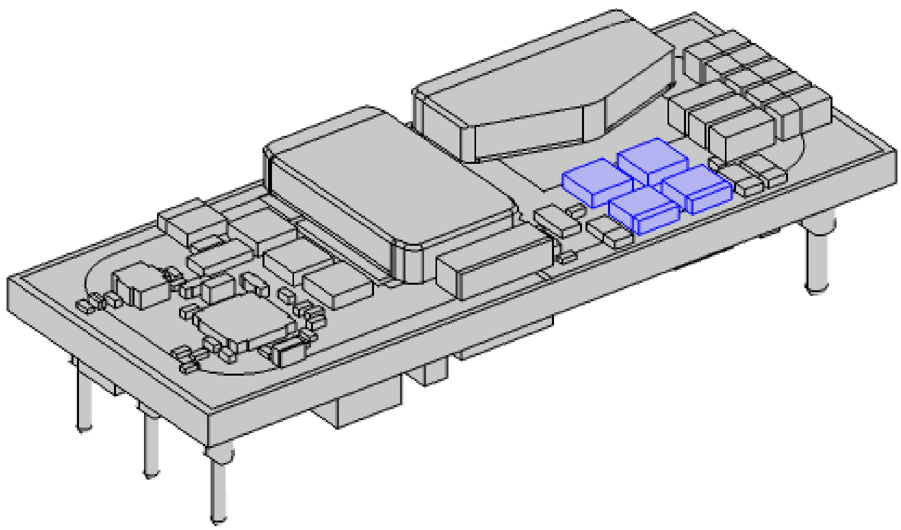

Figure 3: SECFET

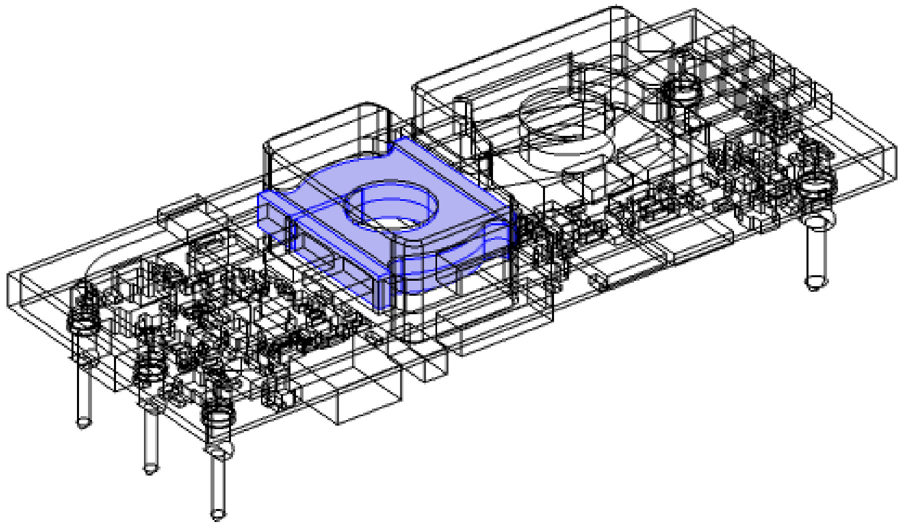

Figure 4: TRAFOWIND

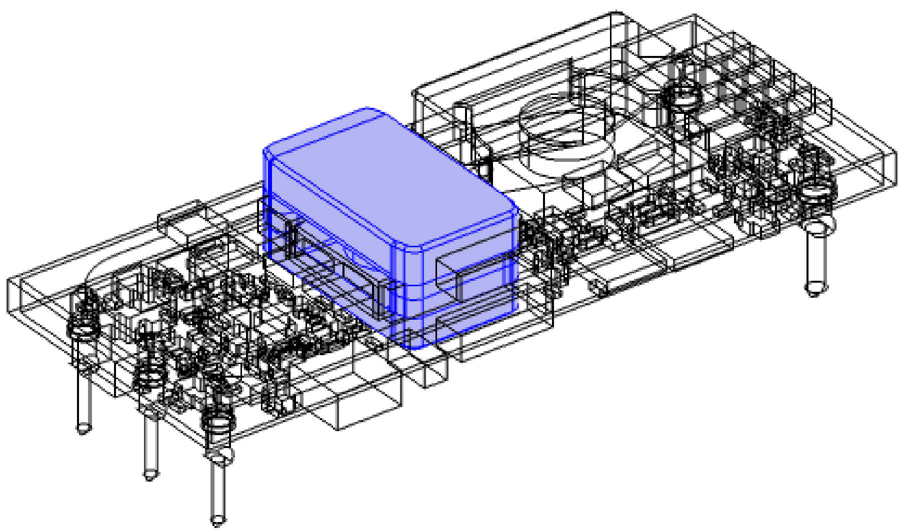

Figure 5: TRAFO

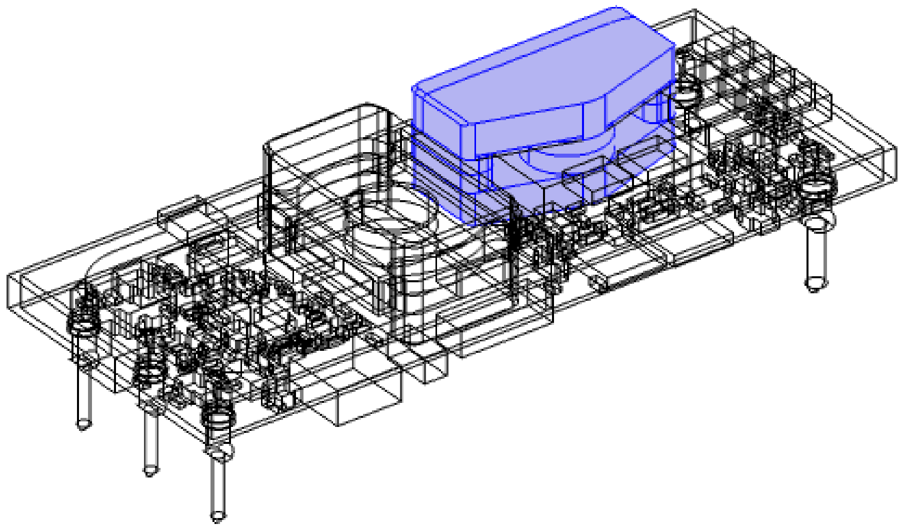

Figure 6: CHOKE

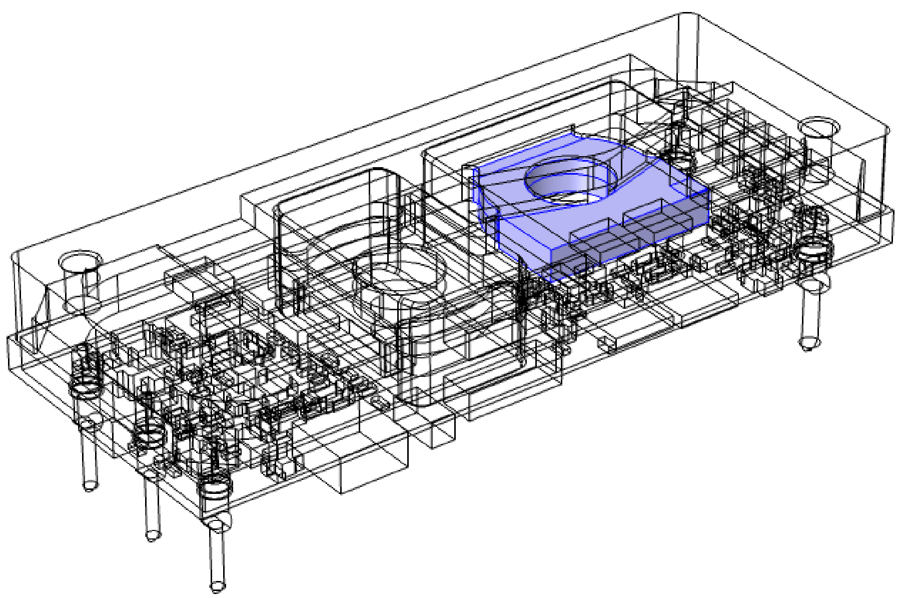

Figure 7: CHOKEWIND

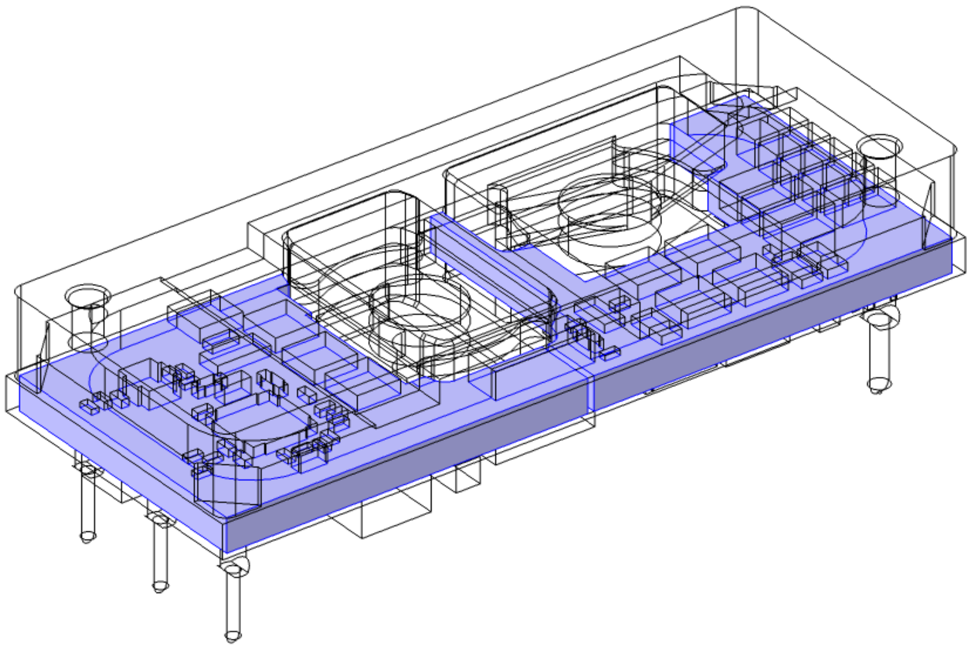

Figure 8: PCB

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.

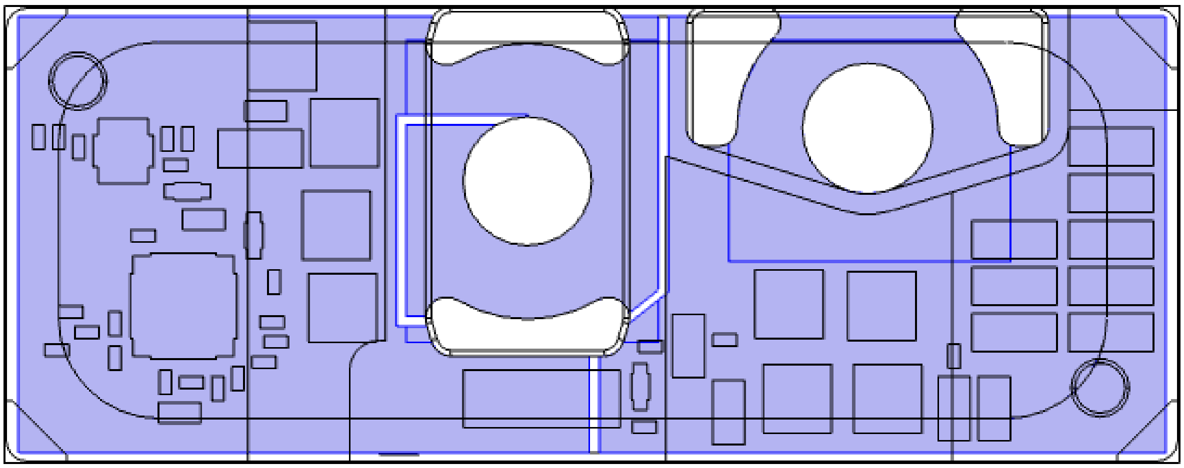

Figure 9: Solid. Heat Conductivity (43,43,2) [W/m/K]. 4 domains

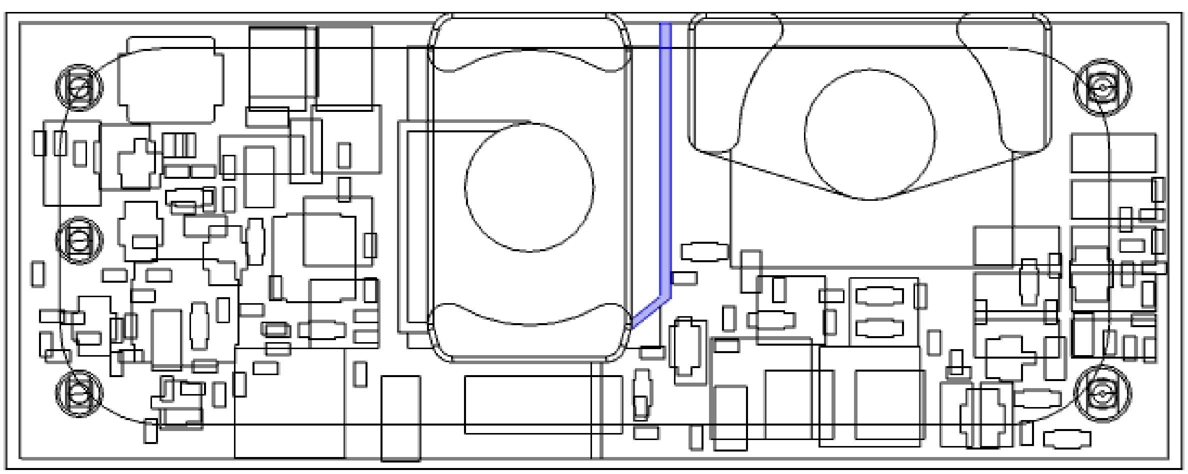

Figure 10: Solid. Heat Conductivity (4,4,0.6) [W/m/K]

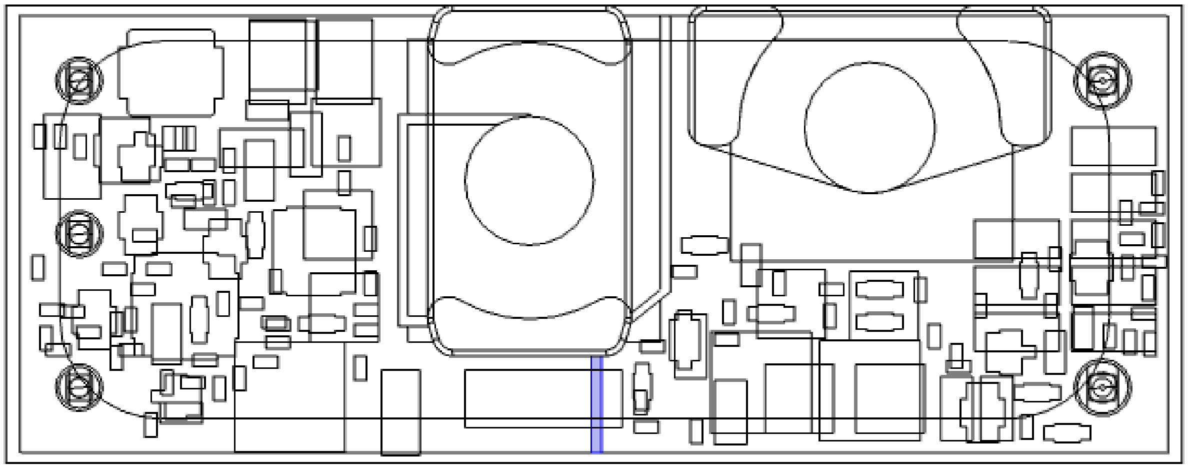

Figure 11: Solid. Heat Conductivity (0.8) [W/m/K]

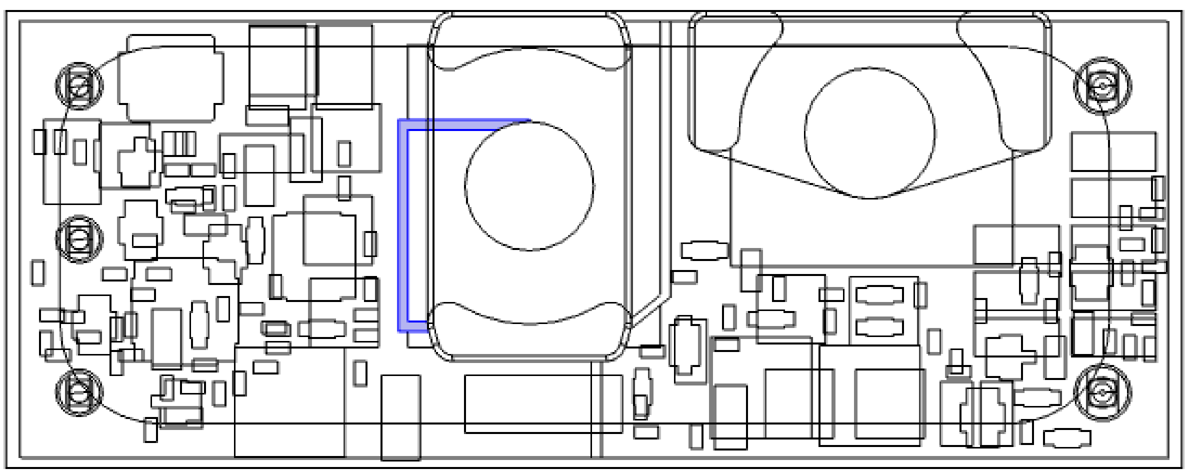

Figure 12: Solid. Heat Conductivity (1.0) [W/m/K]

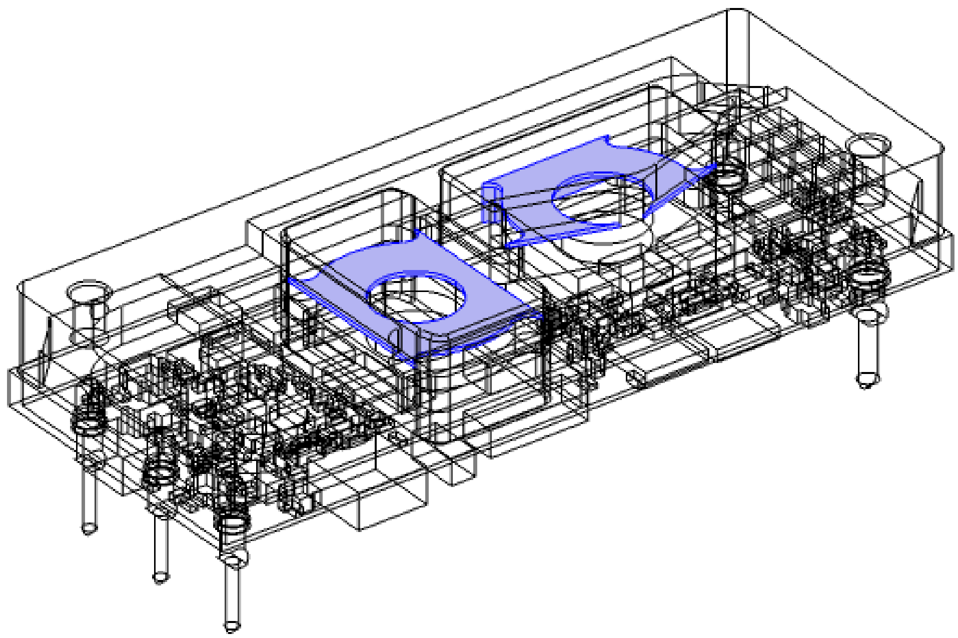

Figure 13: Solid. Air (Insulation). 3 domains

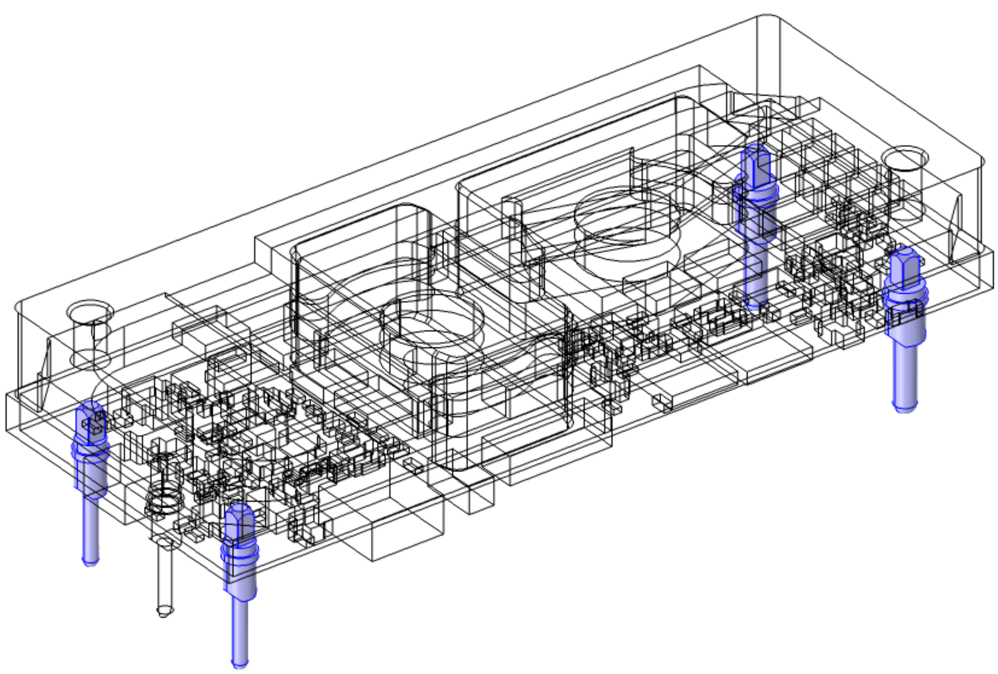

Figure 14: Solid PINS. Heat Conductivity (355) [W/m/K]. 4 domains

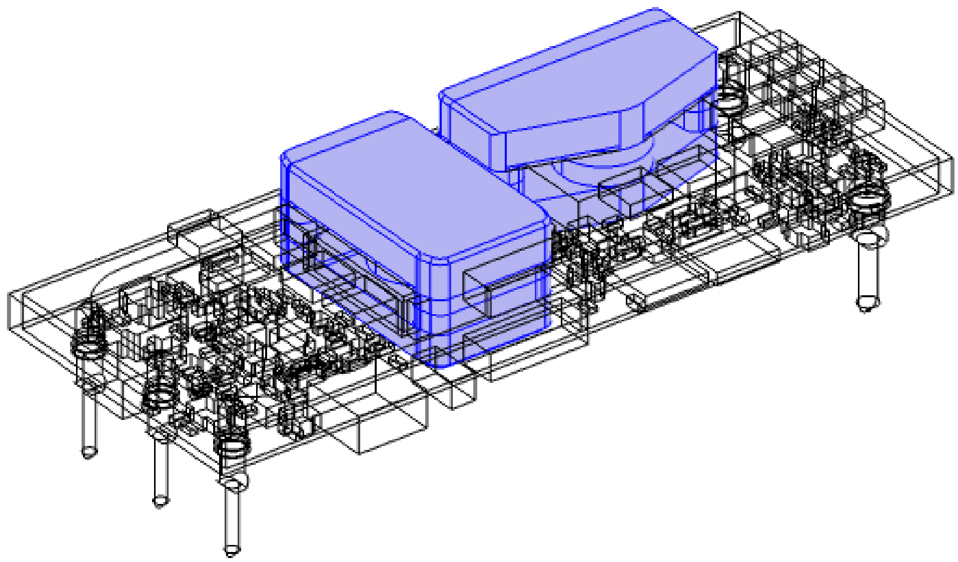

Figure 15: Solid FERRITES. Heat Conductivity (0,0,2) [W/m/K]. 2 domains

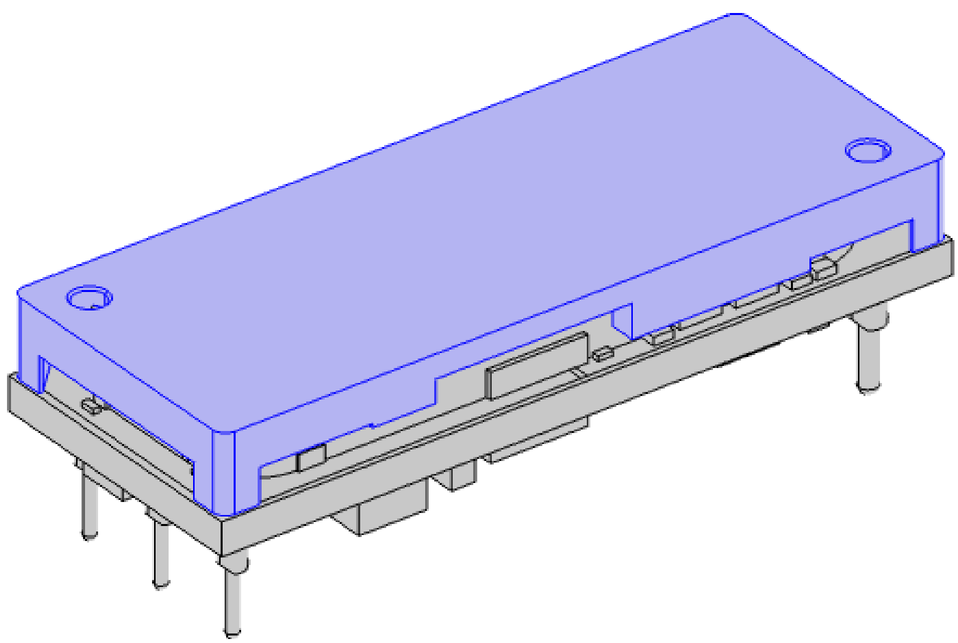

Figure 16: Solid BASEPLATE. Heat Conductivity (201) [W/m/K]

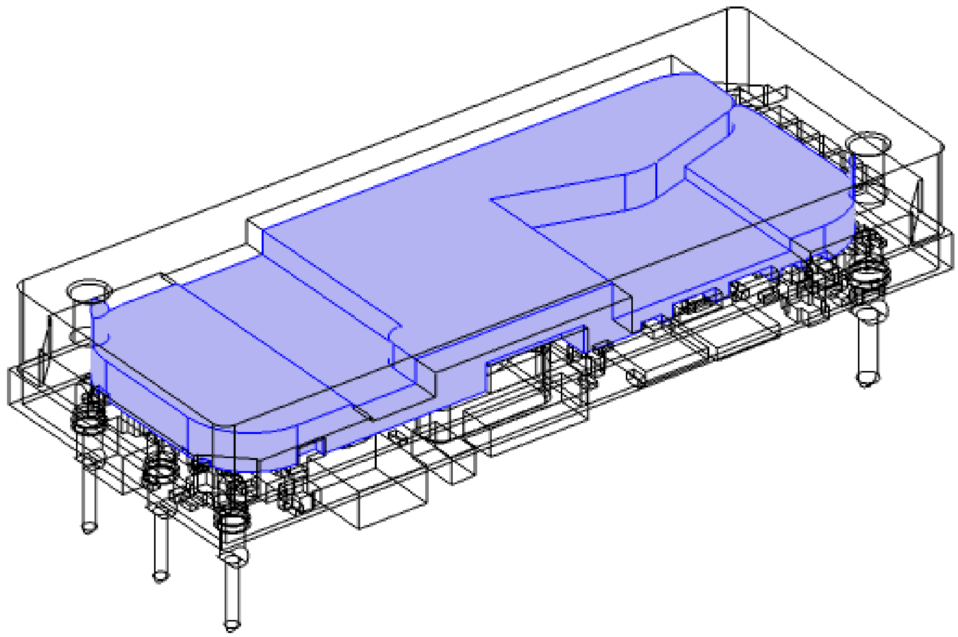

Figure 17: Solid GAPFILLER Heat Conductivity (1.5) [W/m/K]

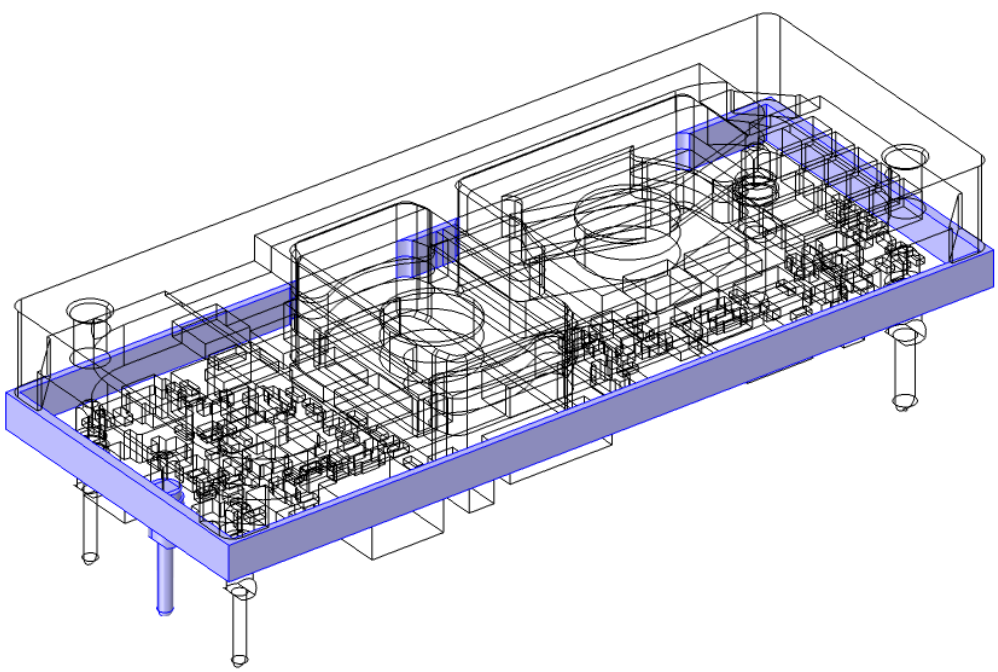

Figure 18: Solid FR4. Heat Conductivity (0.27) [W/m/K]. 3 domains. (Incl. one pin which has limited connection to internal layers)

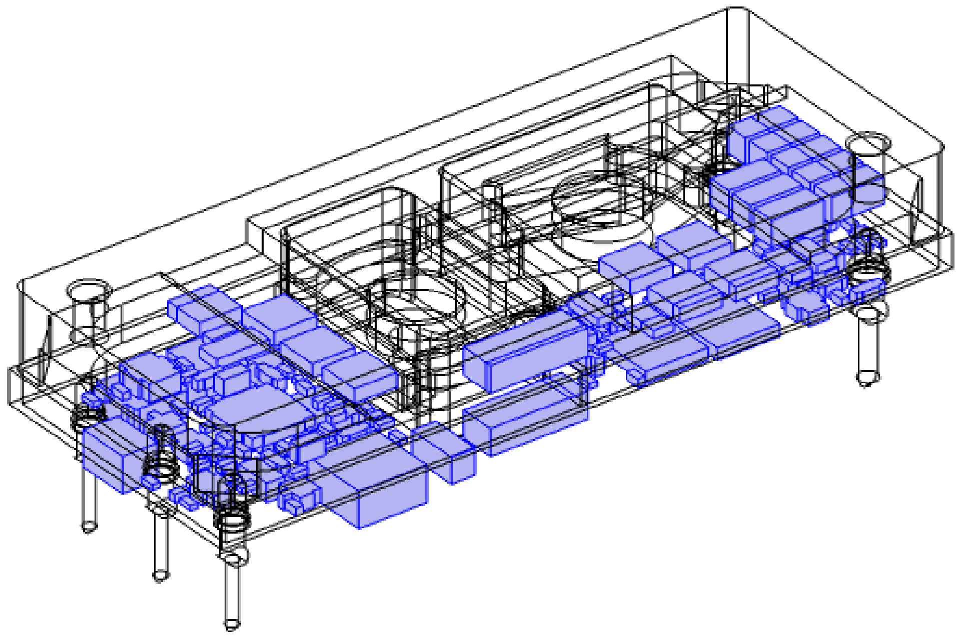

Figure 19: Solid COMPS). Heat Conductivity (30) [W/m/K]. Remaining domains.

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}=53[V], V_{out}=12[V], I_{out}=24.2[A], 4 [m/s], compared to thermal verification document 2/102 65-BMR674 05 Rev A.

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. Solver used algebraic multigrid method. An airbox with dimensions 254*254 [mm^2] were used. Module placed in center of box. Board spacing 20 [mm].

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

Direction of air for the calibration, per document 2/102 65-BMR674 05 Rev A, is in the y-direction.

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

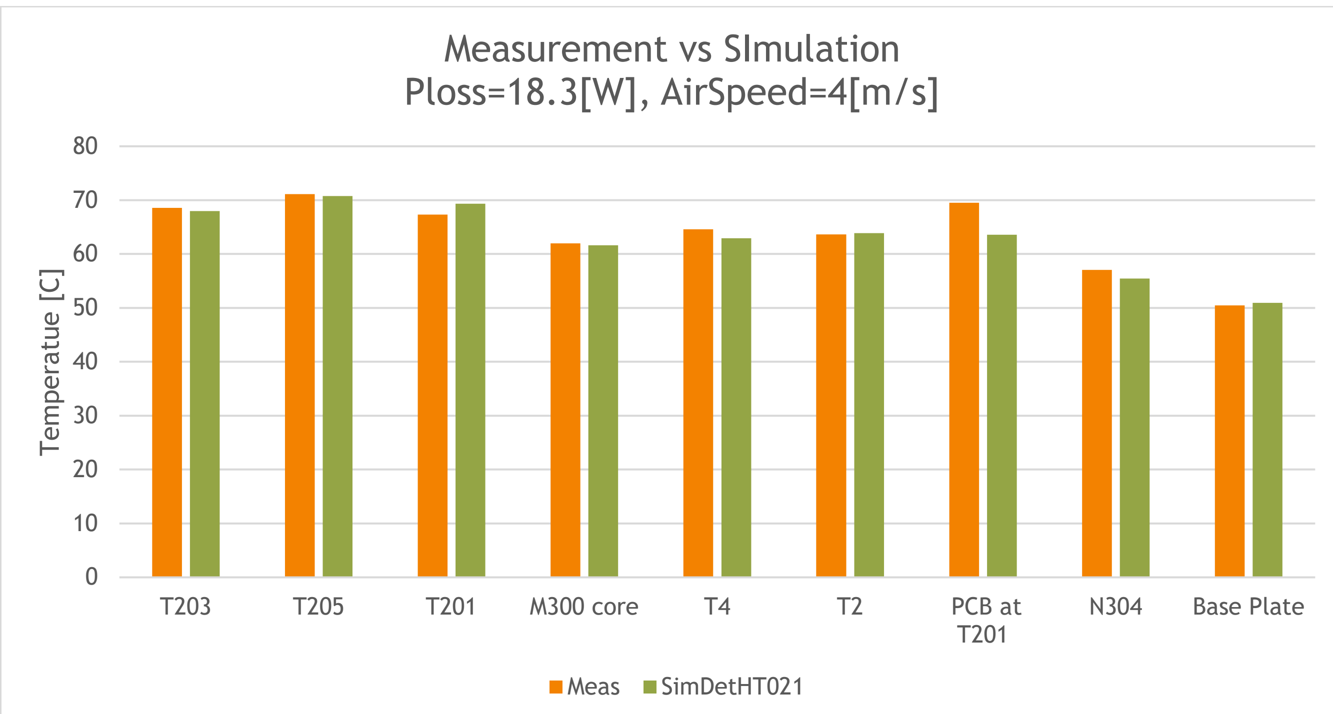

Figure 20: Model calibration result.

Model Usage

Import the geometry in Parasolid format x_b, from BMR674_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 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 2/102 65-BMR674 05 Rev A

Product number and r-state history

Flex product number IPM 101 52, R1A 2019-06-12

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

A	2019-06-12	New Document

Appendix 1 - Power Loss Distribution

Power loss distribution example for BMR 674.

V_{in}= 53V V_{out}= 12V I_{out}=24.2A

Domain	Power loss per domain (W)	Number of domains	Subtotal power loss (W)
PRIMFET	0.9375	4	3.75
SECFET	1.3725	4	5.49
TRAFOWIND	2.196	1	2.196
TRAFO	2.379	1	2.379
CHOKEWIND	3.66	1	3.66
CHOKE	0.415	1	0.415
PCB	0.4	1	0.4
		Total (W)	**18.3**