DESCRIPTION
THERMAL MODEL FOR
BMR316

FLEX INC.

Contents

General

The model is an estimation for the thermal behavior of BMR316. The model is intended for steady-state thermal simulations.

Model Description

The model is a readymade FloTherm 2024 model, as a *.pack file. The model consists of the three major components:

3D CAD Geometry

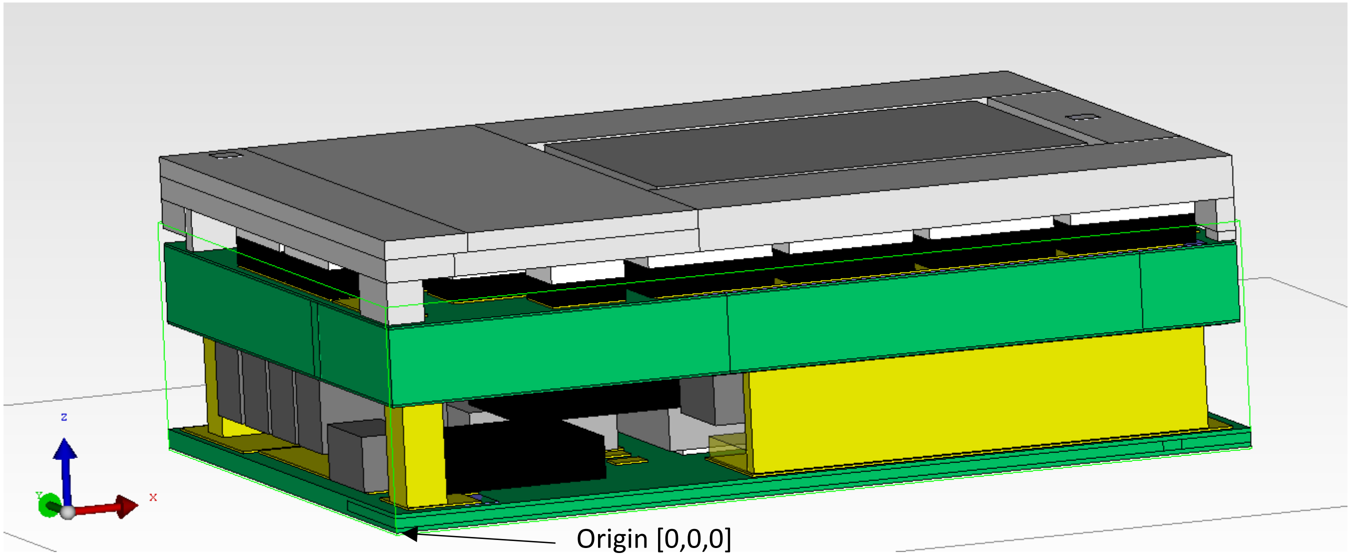


Figure 1. 3D geometry of the model

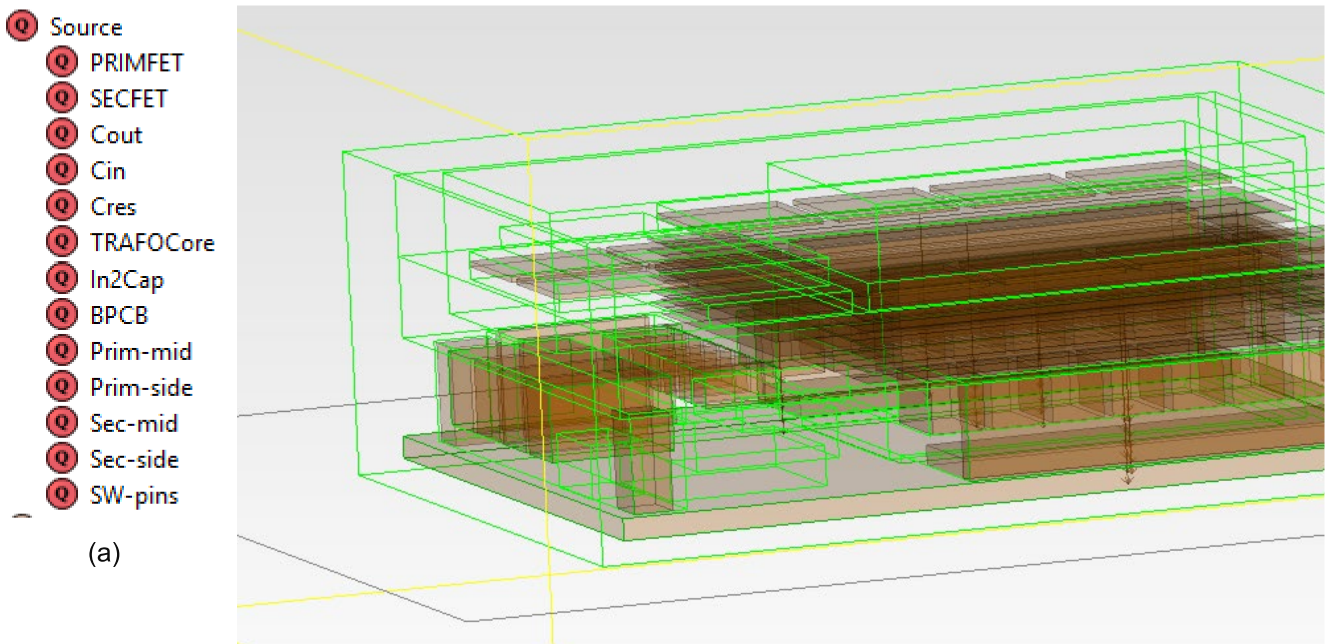
3D geometry is created by importing a CAD model in STEP format through the MCAD bridge. The PCBs have been simplified to a bulk geometry where the copper layers and vias have been taken into consideration by assigning anisotropic material properties to the PCBs domains.

Origin has been placed so that [0,0,0] is in the lower left corner of the bottom 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 module total powers, are given in *Appendix 1 - Power Loss Distribution*



(b)

Figure 2: Power loss setting: (a) list of heat sources (examples), and (b) heat sources distribution in the model

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) per the following list.

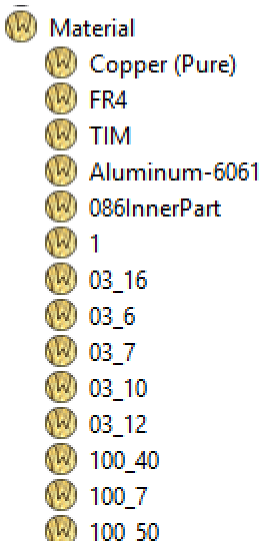


Figure 3. Domains of material data, examples

Note. The given heat conductivities are only intended to model the temperature distribution of the module in this application. The values should not be treated as physically true or transferable to other applications.

Model Calibration

The model has been checked against measurements done in August 2024 on BMR316P1B. The result can be seen in Figure 4. For the comparison a cold wall, thermal gap pad (1 mm, 8 W/m/K) and a test board was used, Figure 5. These are kept in the *.pack file but are not part of the model itself and should be deleted when using the model in a project.

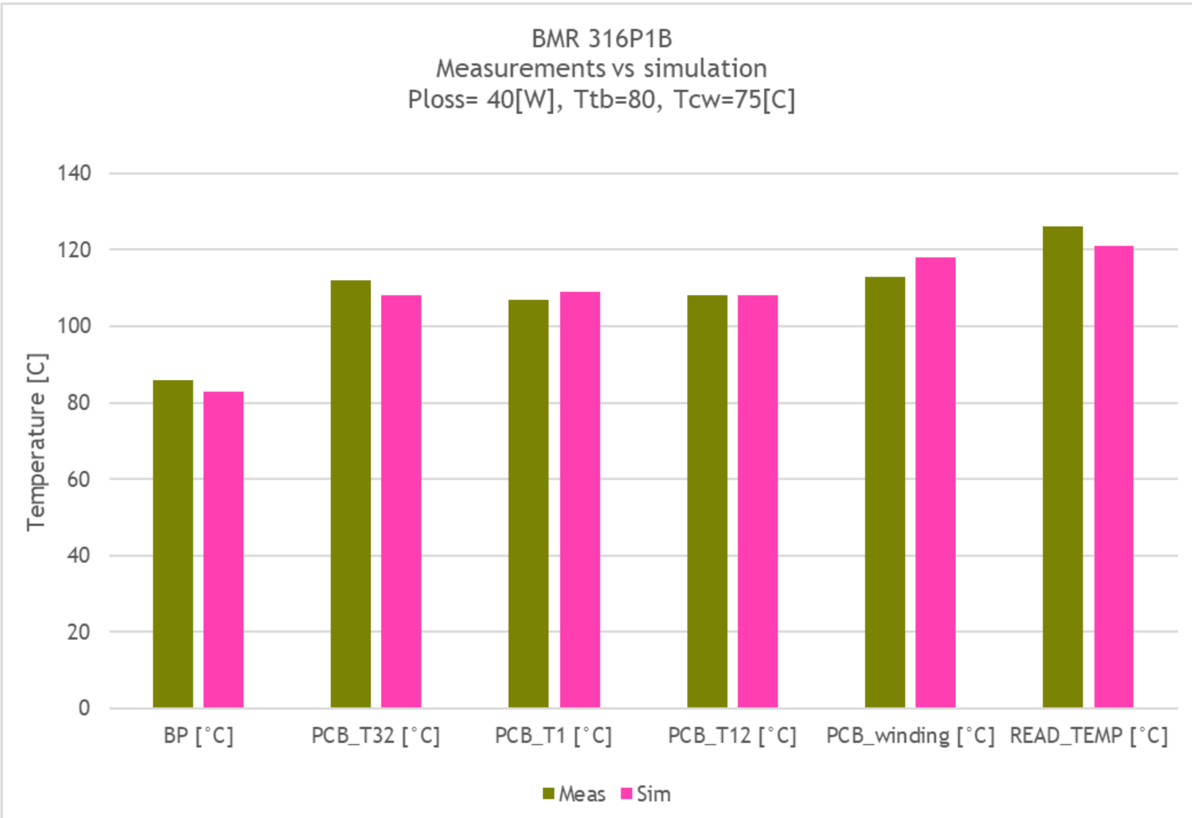


Figure 4 Results from comparison of simulation versus measurements.

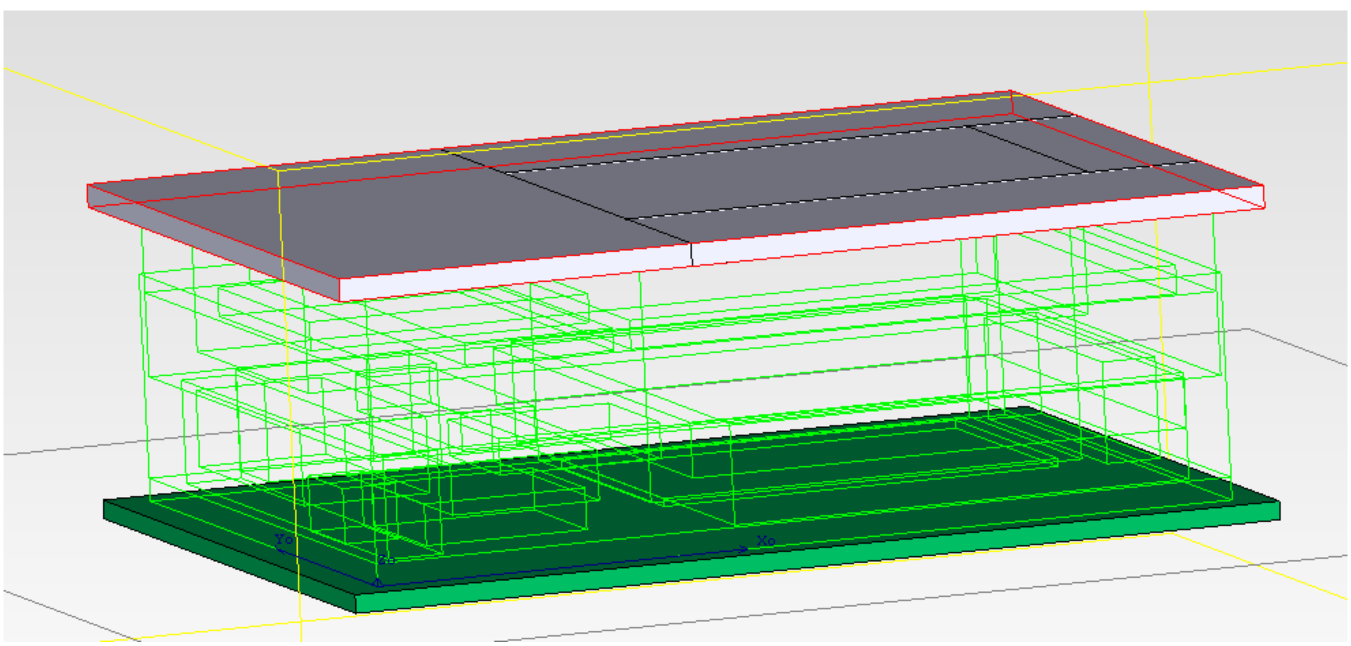


Figure 5 Verification assembly. Should be deleted when model is used.

Model Usage

Load the *.pack file and export the BMR316P1B_A part (omitting the verification set-up assembly) in desired format. Import this into the target project. Adjust the dissipated power by altering the thermal sources per Figure 2, according to Appendix 1 - Power Loss Distribution. Default settings are for output voltages and currents according to 40[W] power loss, at temperatures around 100 [C].

The *.pack file includes assembly used for constructing the model, consisting of a cold wall, gap pad and a test board, see Figure 4. Connected to this assembly is two thermals, CW and TB. These are provided for reference only and should be deleted before using the model.

The localized grids and grid constraints are not necessary parts of the model. Choose grid settings per best practice in FloTherm.

If the model is rotated, make sure that the orientation of the orthotropic materials properties is preserved (also rotated).

Do not change the order of power sources and geometry objects, as this can change the power and material settings.

Additional Information

Model has been constructed with SI units.

References

19010-BMR316P1B_A.pack
4/10265-BMR316 PA2
5/0363-FCP 100 0040/1 PA4

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	2024-08-30	New Document
A1	2024-09-03	Decomposition of two-resistor model in Appendix 2
B	2024-09-16	Added power loss distribution for 600W
C	2025-03-04	Minor format changes
D	2025-04-07 – Total Power loss in table page 9 updated	

Appendix 1 - Power Loss Distribution

BMR 316P1B Default power loss distribution for Vin=54V, Pout=1000W, temperature ~100[C]

Domain	Number of domains/ boundaries	Domain volume [mm^3]	per domain [W]	per volume [mW/mm^3]	Subtotal power loss [W]
Prim_Fets	4		1.939		7.756
Sec_Fets	8		0.798		6.384
Cres	7		0.041		0.287
Co	16		0.050		0.800
Prim_Driv	2		0.300		0.600
Cin	4		0.05		0.200
Aux_IC	1		0.100		0.100
Sec_Driv	2		0.600		1.200
Trans_wind				43.78	18.180
Trans				26.71	3.300
Cntr	1				0.090
PCB_bottom	1				0.797
				Total (W)	**39.69**

Additional power loss distribution for Vin=51V, Pout=600W, temperature ~100[C]

Domain	Number of domains/ boundaries	Domain volume [mm³]	per domain [W]	per volume [mW/mm³]	Subtotal power loss [W]
Prim_Fets	4		0.55		2.2
Sec_Fets	8		0.28		2.3
Cres	7		0.05		0.35
Co	16		0.052		0.84
Prim_Driv	2		0.300		0.600
Cin	4		0.05		0.200
Aux_IC	1		0.100		0.100
Sec_Driv	2		0.600		1.200
Trans_wind					10.77
Trans_core					2.4
Cntr	1				0.090
PCB_bottom	1				0.797
				Total (W)	**21.85**

Appendix 2 – Two resistor model.

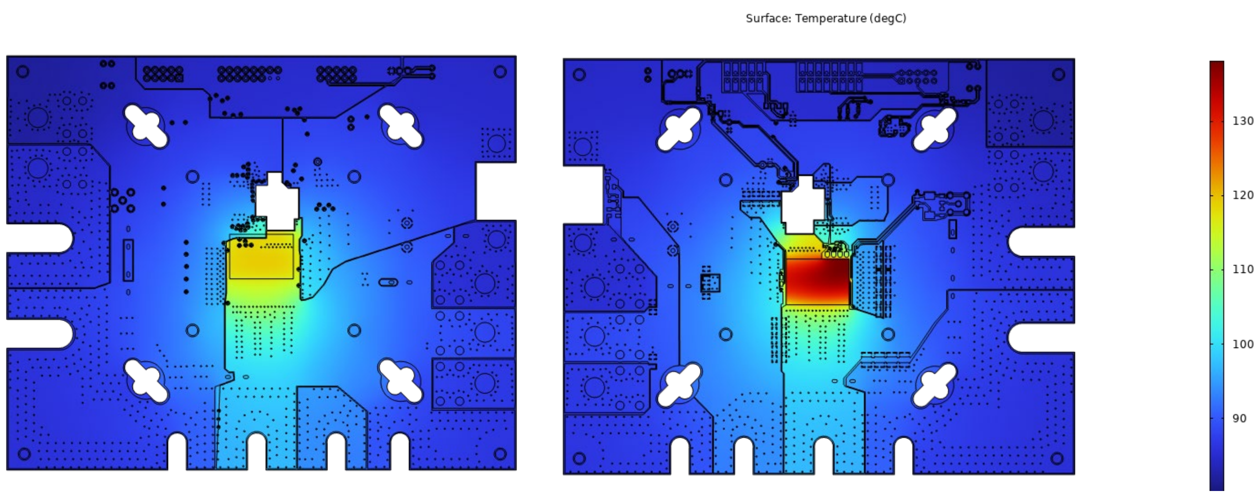
The measured data in 4/10265-BMR316 PA2 can be re-created using a two-resistor model, with thermal impedances

- Junction-to-case=1.69[K/W]
- Junction-to-board=3.29[K/W] (measurements “as is”, including the test board in series)
- Junction-to-board=1.98[K/W] (excluding test board per explanation below.)

In this case ”junction” is refers to be READ-temperature, as it is the hottest point. “Case” is the base plate. The temperature of the base plate is not entirely even, so the position of a probe can affect the result. The position of the probe used to create the two-resistor model is shown in document 4/10265-BMR316 PA2.

Measured values are recorded with boundary temperatures in the range 60-90[C] and 577-1112[W] output. The model temperatures are within +/-3.6[C] compared to measured temperatures in this span. The reason for discrepancies is mainly since BMR 316 is not one-dimensional neither when it comes to heat generation, nor its distribution.

Since the measurements included a test board, and the temperature of it was recorded between board and gap pad on the opposite side of the module, it is unavoidable that the thermal resistance of the test board is included in the measured result. To better understand the capability of the module itself, an estimation based on simulations have been done of the test board thermal resistance. For example, at 10[W] heat excited on top of the test board, the temperature rise is 13.14[C] from back to front. This indicates a thermal resistance of 1.314[K/W] for the test board.



Result from a detailed simulation of the temperature distribution in the test board when exciting 10[W] at the location of the module (right). Bottom temperature controller (left) set to 100[C] and a 1[mm] gap pad 8[W/m/K] used between controller and test board. Convective heat flux 5[W/m^2/K], Tref=25[C]) set to all free surfaces.

In a two-resistor model, the thermal resistance of the test board will act in series with the junction-to-board resistance. The part corresponding to the module is then 3.29-1.31=1.98[K/W]. This value corresponds well to a detailed finite element model of BMR316P1B, in which the value turns out to be 1.95[K/W].