THERMAL MODEL

BMR321

FLEX INC.

Contents

General

The model is an estimation of the thermal behavior of BMR321, which is a SMD 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 BMR321 series.

The model is intended for steady-state thermal simulations.

Model Description

The model is a readymade Flotherm 2024 model provided as a pack-file to be imported as a project. User can then export relevant parts to be used in an application project. The model consists of three major components:

3D CAD Geometry

In the geometry most components are maintained per the original design but have been simplified in FloMCAD to cuboids. The PCB inner layers have been modeled as a bulk, while heat conducting areas on outer layers are kept close to original design. To capture the vias, they are grouped into domains with thermal properties scaled according to the number and type of vias present in the areas respectively.

Unit in file: [mm]

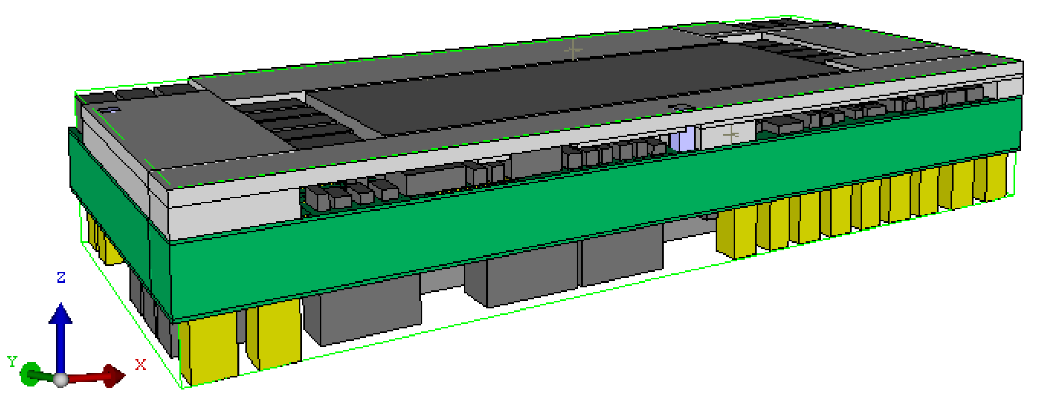


Figure 1

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.*

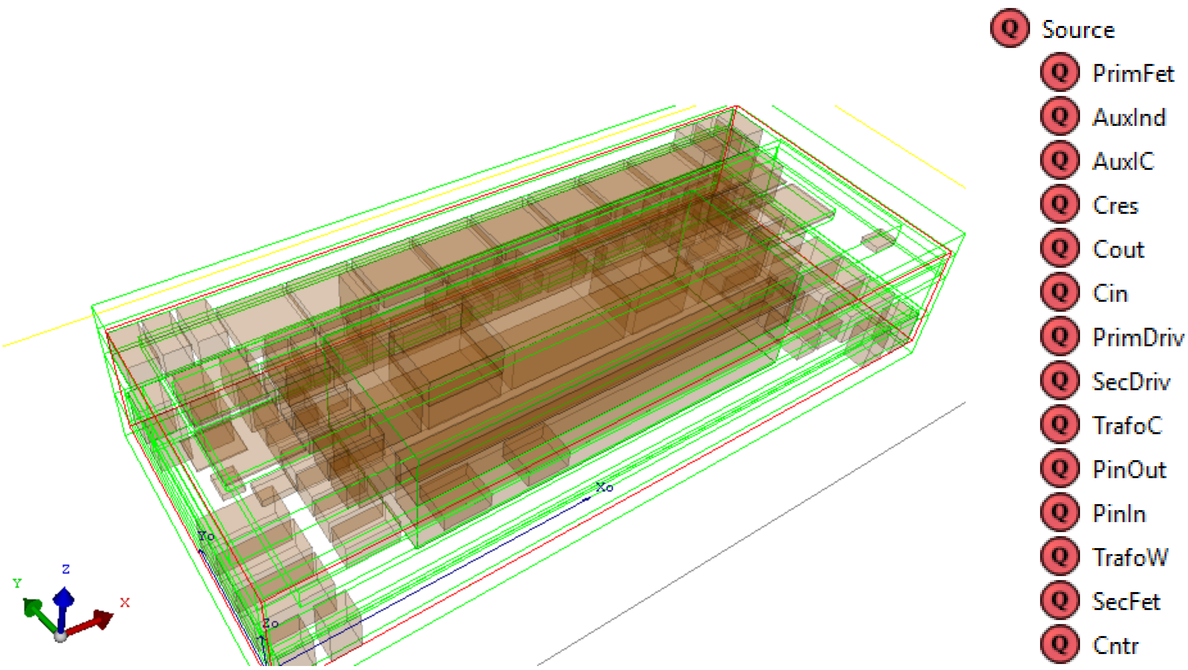


Figure 2 Domains of power losses

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.

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.

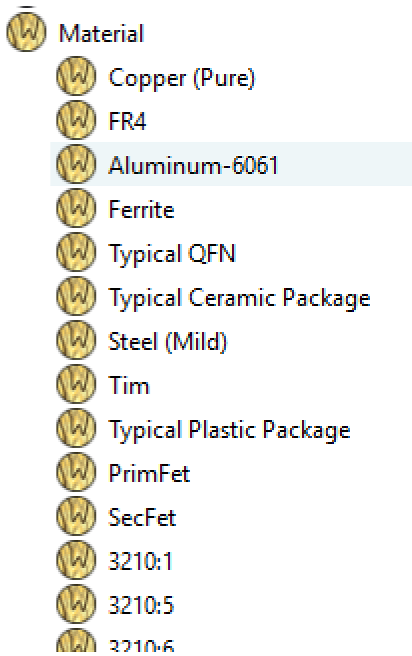


Figure 3: Materials

Model Calibration

The model has been calibrated to give temperatures as similar as possible for V_{in}=54[V], V_{out}=6.5[V], I_{out}=111[A], compared to thermal verification document *BMR321 PCB BP and PWR measurement*. Total Ploss=24.9[W].

The result of the calibration can be seen in Figure 4 where three different board and cold wall temperature combinations are presented.

Figure 4: Result of calibration.

Model Usage

Load the pack file. Export the BMR321A assembly in desired format, then import this into desired project.

Assign power losses per table in *Appendix 1 - Power Loss Distribution* to the sources in section *Domains of power loss distribution*. Default settings are for V_{in}=54[V], V_{out}=6.5[V], I_{out}=111[A], T≈100[C]

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.

The module temperatures can be monitored in predefined monitor points, which corresponds to the measured points in the thermal verification. These temperatures are not intended for pass/fail criteria.

Additional Information

Model has been constructed with SI units.

Reference

Wind tunnel report BMR321 *1/102 65-BMR 321 rev PA1*
Liquid cooling measurements *BMR321 PCB BP and PWR measurements.xlxs*
Flotherm model *19010-BMR321A.pdml*

Product number and r-state history

BMR321 P1B

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

Revision	Revision information	Date	Responsible
A	New document	2024-05-10	KARLADRU
B	Minor updates	2025-06-10	KARTWAER

Appendix 1 - Power Loss Distribution

Power loss example for BMR321 P1B for V_{in}=54[V], V_{out}=6.5[V], I_{out}=111[A], T≈100[C]

Source	Number of domains	Per domain [W]	Per domain [mW/mm³]	Total [W]
PrimFet	4	1.075		4.3
AuxInd	1	0.09		0.09
AuxIC	1	0.09		0.09
Cres	22	0.002		0.044
Cout	20	0.055		1.1
Cin	6	0.047		0.282
PrimDriv	4	0.08		0.32
SecDriv	2	0.3		0.6
TrafoC	8	(*)	3.791	3.46
PinOut	12	0.032		0.384
PinIn	4	0.008		0.032
TrafoW	6	(*)	12.84	10.92
SecFet	8	0.4		3.2
Cntrl	1	0.08		0.08
Total [W]				**24.9**

(*) Defined as Source/Volume.

Appendix 2 - Supplementary regression model.

The measured data can be fitted within +/- 3 [C] using the following formula:

$T_j=A_j*T_{tb}+B_j*T_{cw}+C_j*P_{loss}$

T_{tb}=Board temperature [C]
T_{cw}=Cold wall temperature [C]
P_{loss}=Module power loss [W]

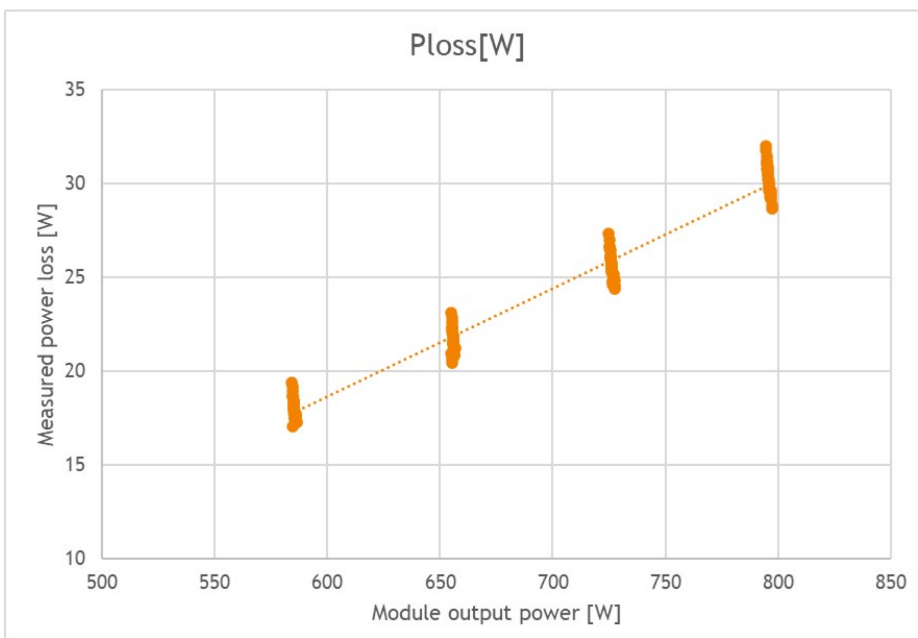
Where for the measured points the coefficients are

	FeBot	Thermist	N200	SecFetPCB	FeTop	PriFetPCB
A_j[C/C]	0.306	0.298	0.375	0.108	0	0.087
B_j[C/C]	0.858	0.707	0.706	0.891	1.036	0.909
C_j[C/W]	0.593	0.715	0.663	0.510	0.083	0.383

For example: At module power loss=24.8[W], board temperature=60[C] and cold wall temperatures=70[C], the temperature of SecFetPCB is calculated to be

T=0.108[C/C]*60[C]+0.891[C/C]*70[C]+0.510[C/W]*24.8[W]=81.5[C], which is close to the measured temperature of 82[C]

Module power loss can be estimated approximately from the below graph:



Data is obtained within the range 60[C]-100[C] on board and cold wall. A ≈0.7[mm] gap pad (10[W/m/K]) was used between cold wall and baseplate.