DESCRIPTION THERMAL MODEL FOR BMR4912511/858

FLEX INC.

Contents

General

The model is an estimation for the thermal behavior of BMR 491 2511/858H, which is a through hole pin design.

The model is intended for steady-state thermal simulations.

Model Description

The model is a readymade Flotherm 11.1 model. The model consists of four major components:

3D CAD Geometry

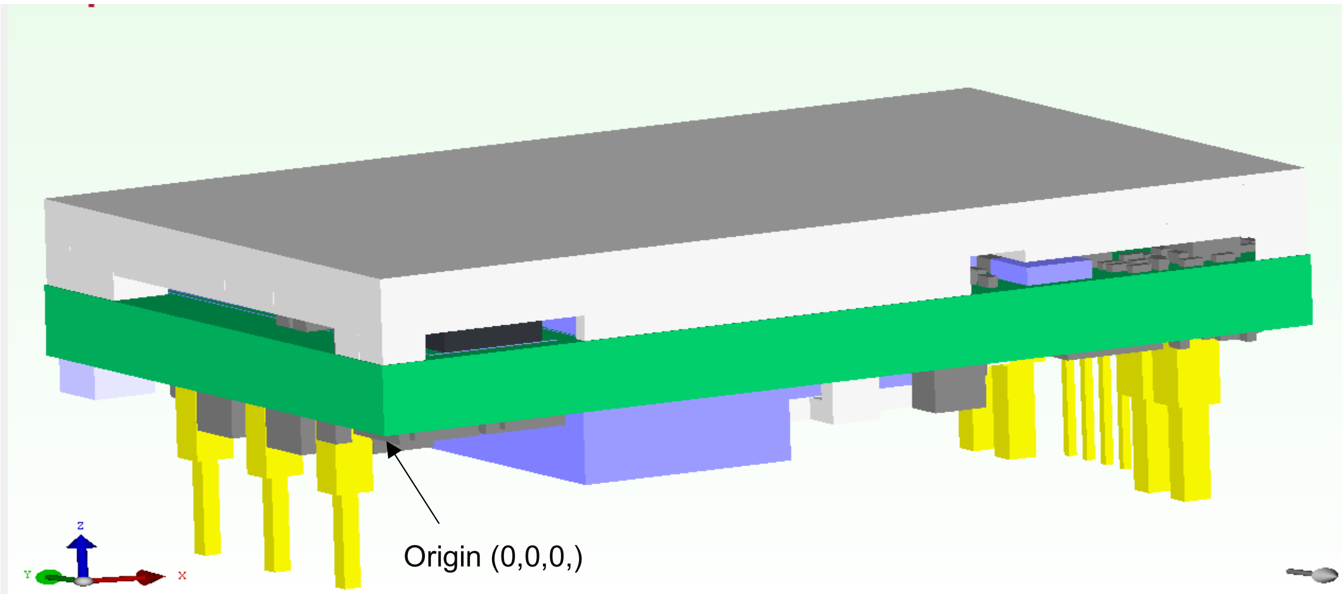


Figure 1 Model origin in lower left corner of PCB and axis orientation.

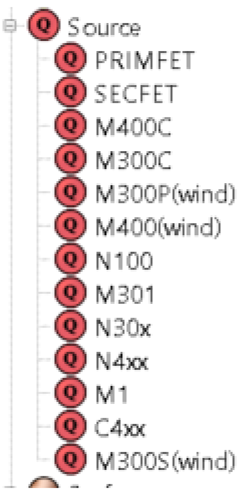
Origin has been placed so that [0,0,0] is in the lower left corner of the PCB.

Unit in file: [mm]

In the geometry most components are maintained per original design but have been simplified in FloMCAD to cuboids and prisms. The PCB has been simplified into 7 layers. Layers 1-2, 13-14 have been created through FloEDA, with medium high definition. This is to capture the steep temperature gradients. Areas of low or high conductivity have been added. In order to prevent flow calculations in tight spaces, solid domains with conductivity similar to air have been added as Flow Blockers.

Domains of power loss distribution

There are several sources for power loss. The power loss for each of them, at certain module total power, are given in *Appendix 1 - Power Loss Distribution.*



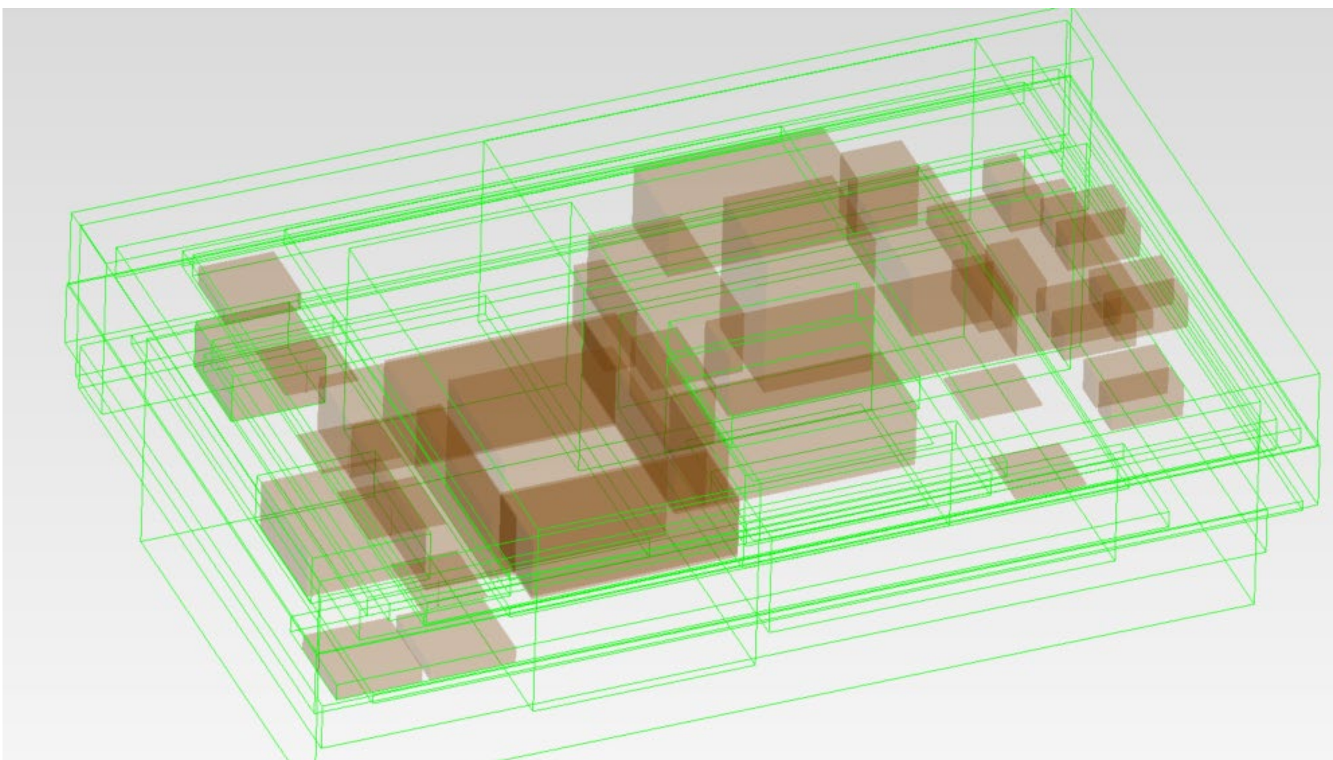


Figure 2: Heat Sources

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.

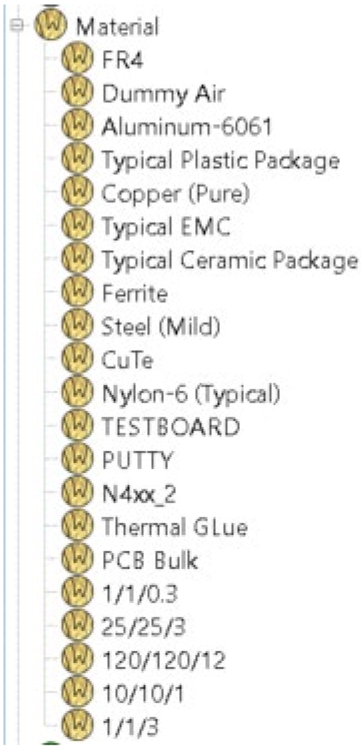


Figure 3. Domains of material data

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.

Monitor points

The model comes with predefined monitor points. The probe points are chosen to correspond to the thermal verification measurements. They are not intended to serve as pass/fail criterions.

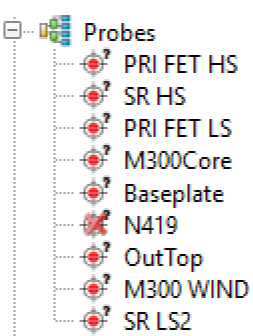


Figure 4. Probe points.

Model Calibration

Model Calibration

The model has been calibrated to give temperatures as similar as possible compared to thermal verification document BMR4912511 HS thermal.xlsm, 1 inch heat sink, 2[m/s], Vin=54[V], Vout=12[V], Iout=108[A]. The calibration was done using power loss settings per Appendix 1 - Power Loss Distribution.

Simulated temperatures are within -0.6/+5[C] compared to measured values.

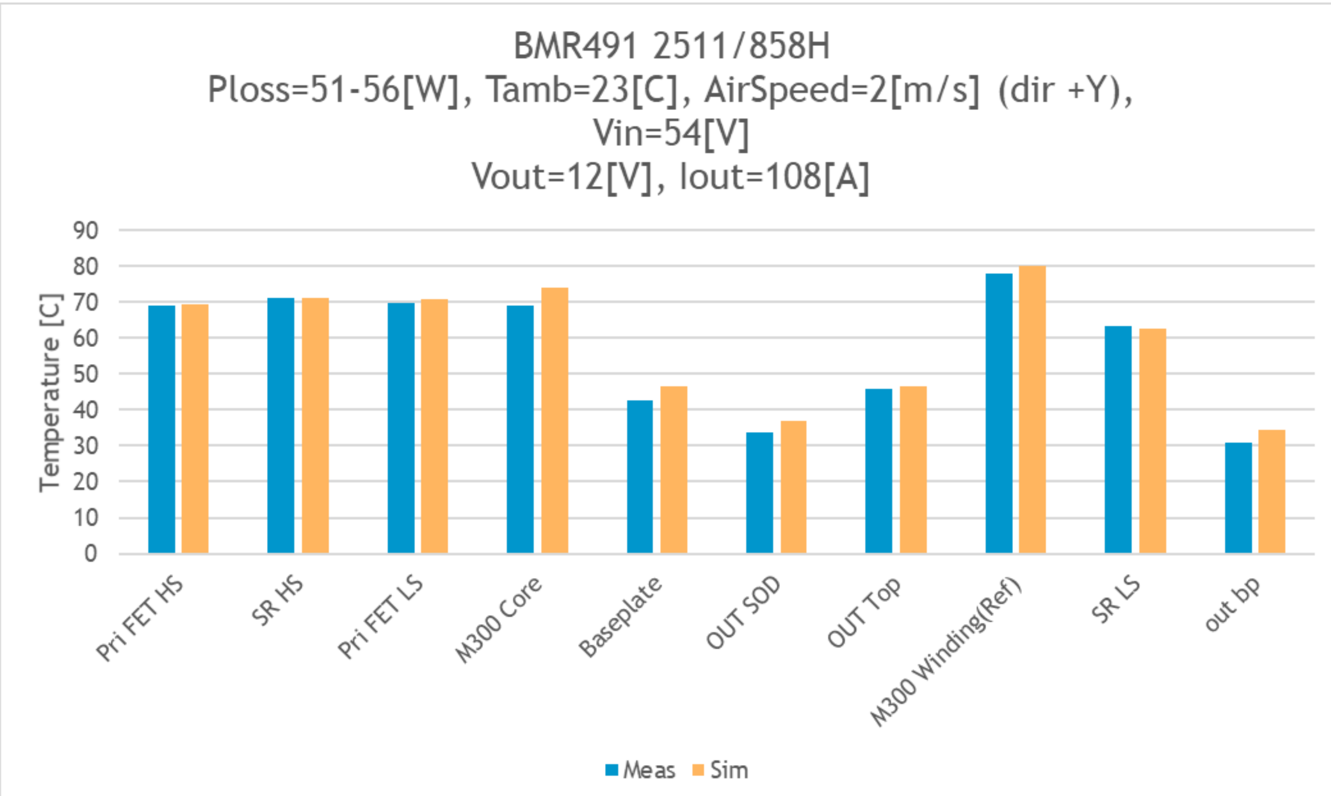


Figure 5: Model calibration result.

Type	Power dissipation	Amb	Pri FET HS	SR HS	Pri FET LS	M300 Core	Base plate	OUT SOD	OUT Top	M300 Winding (Ref)	SR LS	out bp	Air velocity
Meas	51.3	23.2	69.1	71.0	69.6	69.1	42.6	33.9	46.0	78.0	63.2	30.9	1.9
Sim	56.5	23.2	69.5	71.3	70.7	74.0	46.6	36.9	46.4	80.1	62.7	34.5	2.0

Table 1 Measured versus simulated temperatures.

The calibration was done by setting up a similar environment as used in the measurements: A 254x254x2.3 [mm^3] testboard, conductivity [120,120,1] [W/m/K], put in an enclosure with 40 [mm] spacing from testboard. A 1 ‘’ Al-heatsink, with 20x0.9[mm] fins was applied to top of module. Air guides was placed 6.35 [mm] from the module parallel to airflow. AirSpeed measured approx. 50 [mm] upstream from module. See Figure 6 for reference. The calibration model is also provided in *calibration.pdml file.

Note: probe points out SOD and out bp are only used for the calibration of the model but are kept here for reference.

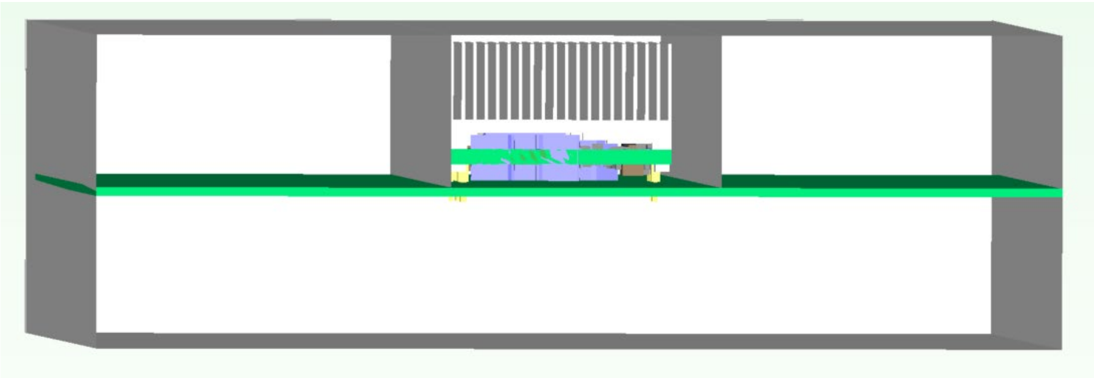


Figure 6 Simulation model used for calibration (view in direction of neg Y)

Model Usage

Import the *module.pdml file into the desired project.

Adjust the dissipated power by altering the thermal sources per Figure 2, according to Appendix 1 - Power Loss Distribution. Default settings are for Vin=54[V], Vout=12[V], Iout=108[A], T≈60[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.

As the model contains detailed layer patches, the number of grid cells can grow large. In order to facilitate simplifications, as well as serve as a verification of the installation of the model, the model used for calibration (i.e., module mounted in wind tunnel) is included as supplementary information, found in *calibration.pdml file.

Additional Information

Model has been constructed with SI units.

Reference

BMR4912511858_datafile.pdml
BMR4912511858_calibration.pdml

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	2022-09-30	New document.
B	2024-10-07	Added 600W and 900W to power loss tables (appendix 1).

Appendix 1 - Power Loss Distribution

Power loss distribution examples for BMR4912511/858.

V_{in}= 54[V], V_{out}= 12[V], I_{in}= 25[A], I_{out}= 108[A], $T_{ref} \approx$ 60℃

Domain	Number of domains	Per domain [W]	Total [W]
PRIMFET	4	3.568	14.272
SECFET	12	1.312	15.744
M300Core	1	3.6	4.2
M300P	(*)	(*)	6.5
M300S	(*)	(*)	9.1
M400Core	1	0.824	0.824
M400W	(*)	(*)	3
M1	1	0.656	0.656
M301	1	0.1	0.1
N100	1	0.2	0.2
N30x	2	0.2	0.4
N4xx	1	0.27	0.54
C4xx	11	0.1	1.1
Total [W]			**56.6**

(*) Defined as Source/Volume. Adjust source so that the total adds up.

V_{in}= 54[V], V_{out}= 12[V], I_{in}= 11.5[A], I_{out}= 50[A], T_{ref} ≈ 60℃

Domain	Number of domains	Per domain [W]	Total [W]
PRIMFET	4	0.765	3.06
SECFET	12	0.281	3.37
M300Core	1	3.284	3.28
M300P	(*)	1.703	1.39
M300S	(*)	9.452	1.95
M400Core	1	0.824	0.82
M400W	(*)	0.578	0.64
M1	1	0.513	0.51
M301	1	0.1	0.1
N100	1	0.2	0.2
N30x	2	0.16	0.32
N4xx	2	0.27	0.54
C4xx	11	0.1	1.1
Total [W]			**17.3**

(*) Defined as Source/Volume. Adjust source so that the total adds up.

V_{in}= 54[V], V_{out}= 12[V], I_{in}= 17.3[A], I_{out}= 75[A], T_{ref} ≈ 60℃

Domain	Number of domains	Per domain [W]	Total [W]
PRIMFET	4	1.721	6.88
SECFET	12	0.633	7.59
M300Core	1	4.2	4.2
M300P	(*)	3.831	3.13
M300S	(*)	21.224	4.39
M400Core	1	0.824	0.82
M400W	(*)	1.301	1.45
M1	1	0.316	0.32
M301	1	0.1	0.1
N100	1	0.2	0.2
N30x	2	0.136	0.28
N4xx	2	0.27	0.54
C4xx	11	0.1	1.1
Total [W]			**31.0**

(*) Defined as Source/Volume. Adjust source so that the total adds up.