DESCRIPTION THERMAL MODEL FOR BMR 458 SERIES

FLEX POWER MODULES

Contents

General

The model is based on BMR 458 0002, which is an open frame, single 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 BMR 458 family.

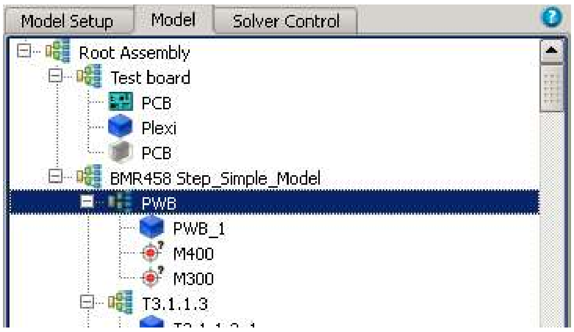
The model is intended for steady-state thermal simulations.

Model Description

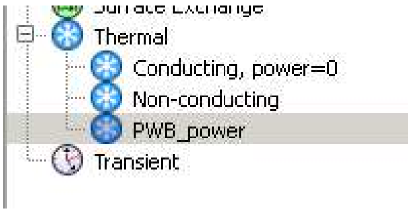
The model is a readymade Flotherm 11.1 model. It was created by importing a CAD model in STEP format through the MCAD bridge. Components and pins (for example remote control and the digital connector) that are not contributing to the heat transfer, have been removed from the geometry. The model consists of three major components:

The PCB and components

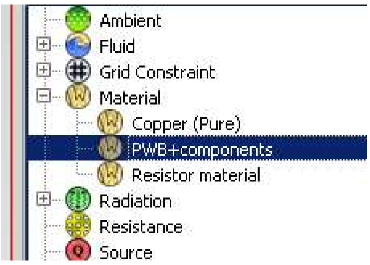
All module power is dissipated in the module PCB, in the model this is called “PWB_1”



To change the dissipated power, alter the power of the thermal attribute “PWB_power”



All the components and the PCB have the same conductive material properties, the material is called “PWB+components”. This material is orthotropic, and the values are based on the bulk conductivity of the module PCB.

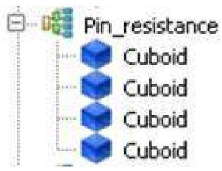


The pins

The pins are modelled as pure copper and the mechanical parts are located in the following assemblies (marked in blue)

The pin/PCB attachment region

The pin/PCB attachment region is contained in the assembly “Pin_resistance”



These cuboid elements have all the same isotropic material properties, called “Resistor material”

The conductivity of this material has been used to calibrate the model thermal behavior to match measurement results.

Model Calibration

The model was calibrated based on measurements of the thermal behavior of the BMR 458 module conducted at several cooling air flow speeds. Two temperatures from the measurement, the maximum module temperature (regardless of position), and the temperature of the V0+ pin attachment point to the module, were used in the calibration. The purpose of the calibration was to ensure that the balance of the conductive heat transfer through the pins and the convective heat transfer to the cooling air was almost correct. The temperature distribution on the module itself was not taken into consideration. In order to have a model with accurate heat distribution on the module itself, a significantly more complex model of the BMR 458 must be used, which will be prohibitively expensive from a computational point of view when used in a larger simulation model.

Model Usage

Import the *.pdml file into the desired project.

Set the dissipated power by altering the thermal attribute “PWB_power”.

Make sure that the mesh adequately resolves the module. If a cooling airflow is present over the model (forced convection), the wake region of the module may require attention as well to ensure simulation convergence.

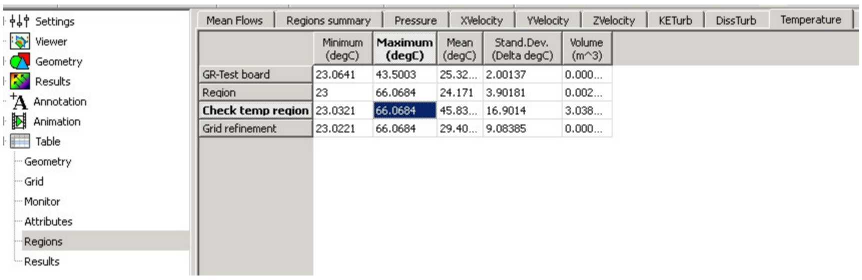
In our calibration effort, the LVEL K-epsilon turbulence model provided the best convergence characteristics in forced convection but this will be strongly dependent on the actual simulation case.

The following things can be expected when using this model of the BMR 458 in a larger simulation model:

The balance between conducted/convected heat transfer should be approximately correct. This means that the thermal effect of the BMR 458 on the larger model should be approximately correct.

The maximum module temperature can be obtained by checking the maximum temperature of the “Check temp” region in the model.

Please note that there might be a need for a manual correction of the temperature, due to chosen reference point. See below under “reference”.



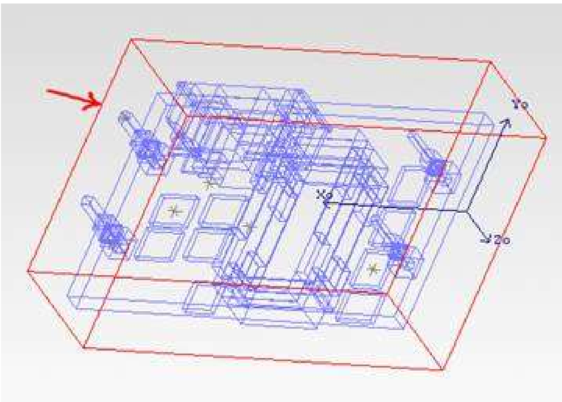
	Minimum (degC)	Maximum (degC)	Mean (degC)	Stand.Dev. (Delta degC)	Volume (m^3)
GR-Test board	23.0641	43.5003	25.32...	2.00137	0.000...
Region	23	66.0684	24.171	3.90181	0.002...
Check temp region	23.0321	66.0684	45.83...	16.9014	3.038...
Grid refinement	23.0221	66.0684	29.40...	9.08385	0.000...

Additional Information

Model has been constructed with SI units.

Cell count in our development model for the BMR 458 0002 is approximately 300000 for the module (number is based on similar models). This should only be used as a reference and not as an absolute true number. The number of cells used to discretize the model depends on the specific environment.

Origin of the model is located as the image below shows:



Reference

Model is calibrated by using data from thermal report 1/102 65 BMR 458 0002 Rev A, Io=50A

2.7 Raw data

Vin = 53 V

Vout = 12 V		temp. limit	Io = 50 A nat conv	0.5 m/s	1.0 m/s	1.5 m/s	2.0 m/s	3.0 m/s
Air velocity	(m/s)	--	0.2	0.4	0.9	1.5	2.0	2.9
Output power	(W)	--	480.5	510.7	540.8	600.9	601.2	601.8
Efficiency	(%)	--	94.9	94.8	94.8	94.4	94.5	94.7
Power dissipation	(W)	--	25.9	28.1	29.9	35.8	34.8	33.4
Max ambient	(°C)	--	26.2	27.2	34.3	27.8	41.0	56.2
Thermal resistance	(°C/W)	--	3.6	3.3	2.9	2.6	2.3	2.0
1. Tamb	(°C)	--	24.7	24.2	24.4	24.6	24.4	24.3
2. Vout+ Pin under	(°C)	125	68.7	65.3	59.5	59.9	54.0	47.5
3. M300 wind	(°C)	125	123.5	122.1	115.1	121.7	106.0	92.0
4. M1	(°C)	125	89.3	86.7	80.9	82.4	72.5	61.1
5. M400 winding	(°C)	125	114.7	112.9	107.1	112.5	100.7	86.1
6. T1	(°C)	125	109.0	106.0	100.0	105.7	95.6	83.4
7. Vout+ pin ovan	(°C)	125	95.7	92.8	86.9	89.8	80.2	68.3
8. T401 (Ref)	(°C)	125	117.8	115.8	109.7	116.2	105.1	90.8
9. T407	(°C)	125	122.0	121.0	114.8	121.2	108.3	93.1
Air velocity	(m/s)	--	0.2	0.4	0.9	1.5	2.0	2.9
Vin	(V)	--	52.6	52.6	52.5	52.4	52.5	52.5
Iin	(A)	--	9.6	10.3	10.9	12.1	12.1	12.1
Vout1	(V)	--	12.0	12.0	12.0	12.0	12.0	12.0
Iout1	(A)	--	40.0	42.5	45.0	50.0	50.0	50.1
Vout2	(V)	--						
Iout2	(A)	--						
Vout3	(V)	--						
Iout3	(A)	--						
	Min ma		1.5	2.9	9.9	3.3	16.7	31.9
	Deratin							

wind flow from **negative to positve**

Yellow: derating component, closest to max allowed temperature.

Grey: windtunnel templimit reached. Iout derated.

Important notice: The reference point for the calibration of the model is where the Vout+ Pin are attached to the module, whilst the measurements are taken at the location where the pin is attached to the test board. Therefore, it is recommended to add a thermal resistance for the conductive transfer over the pins of approx. 0.4 [K/W] in case that the reference point is the application board. This will be corrected in coming revisions of the model.

Product number and r-state history

Flex product number IPM 101 43/1, R1A 2017-03-24

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 A 2017-03-24

Rev B 2018-10-30 Format change. Clarification that is a readymade Flotherm 11.1 model