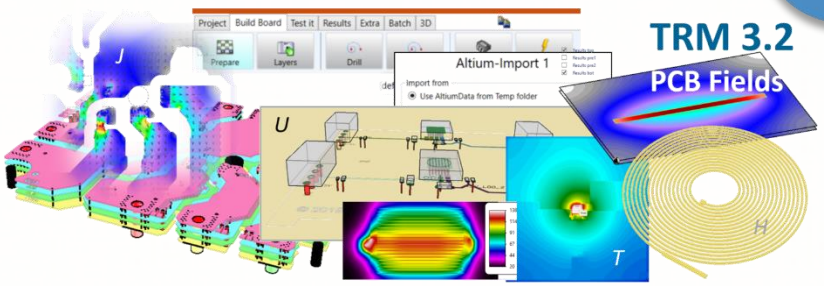
ADAM Research

TRM 3

PCB & PBA Field Solver

THERMAL RISK MANAGEMENT IN ELECTRONICS



TRM
Your Software for Thermal Analysis of Printed Circuit Boards and Assemblies

Components and currents heat the circuit board - but how hot will it get?

Will it meet the temperature limits?

You think a look at the data sheet or an AppNote is enough? …

… Never!

No data sheet in the world will be able to tell you the temperature for your board an your layout!

Our software TRM can do it and is taking pictures.

And it's easier than you think!

Components >

CAD Import >

Input >

Current >

Voltage drop >

Time dependent >

Inductance >

Technology >

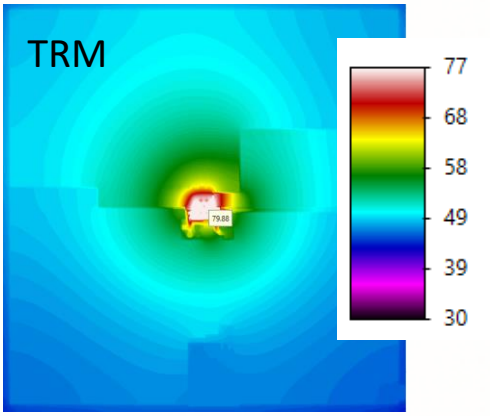
Special setups >

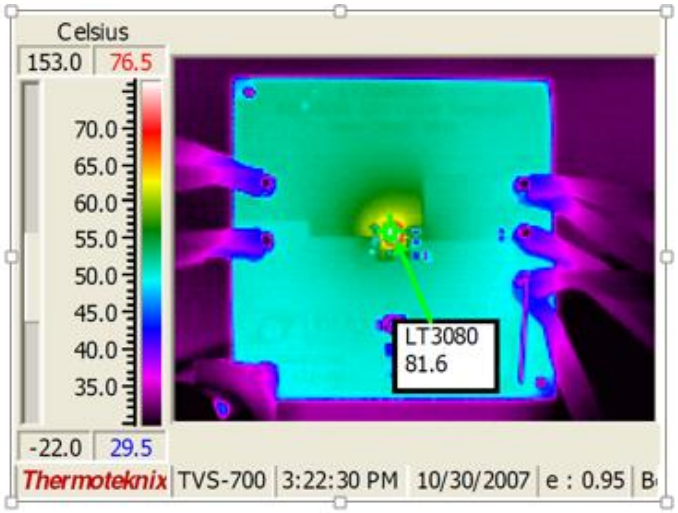
Contact >

> Components

Heat distribution is calculated 3D in the entire volume of the PCB.

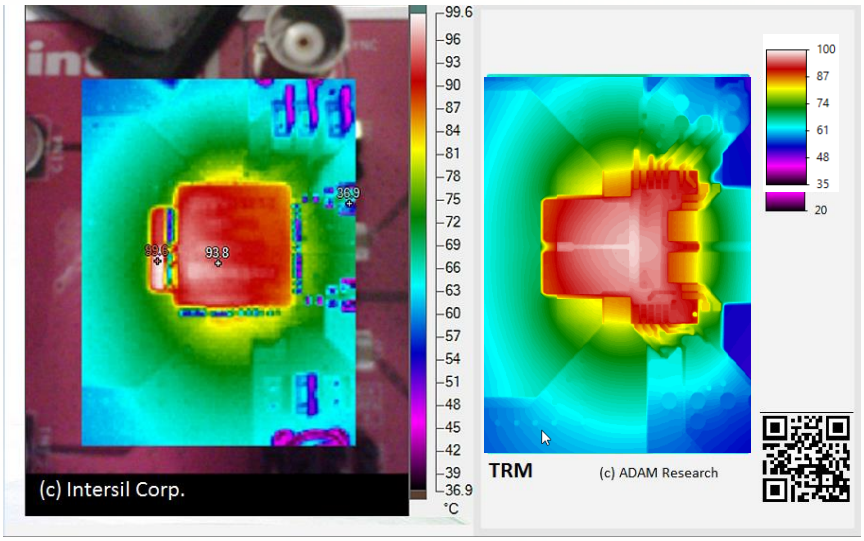
All layers, all prepregs, all via. Consistent with measurement.





https://www.analog.com/media/en/dsp-documentation/evaluation-kit-manuals/dc995A.pdf

Cooling via convection, heat sink or cold plate



Material data is stored in a customizable material database

How much power loss results in which temperature?

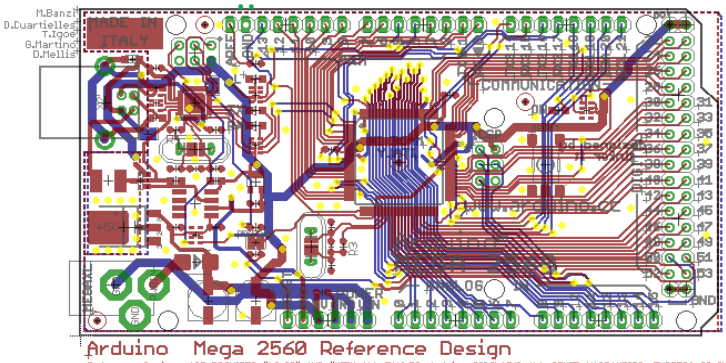
Which temperature corresponds to which power loss?

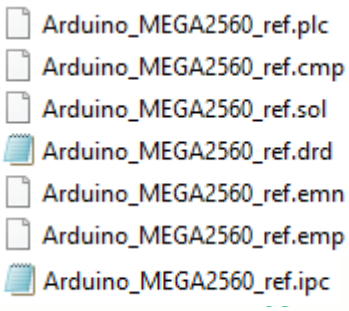
http://www.intersil.com/content/dam/Intersil/documents/an19/an1922.pdf

https://www.adam-research.de/pdfs/TRM_CaseStudy1.pdf

> CAD Import 1/2

From.

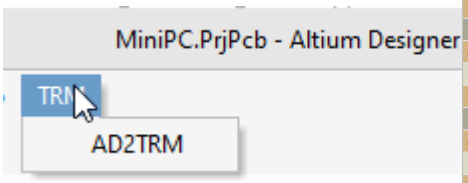




... in less than a minute.

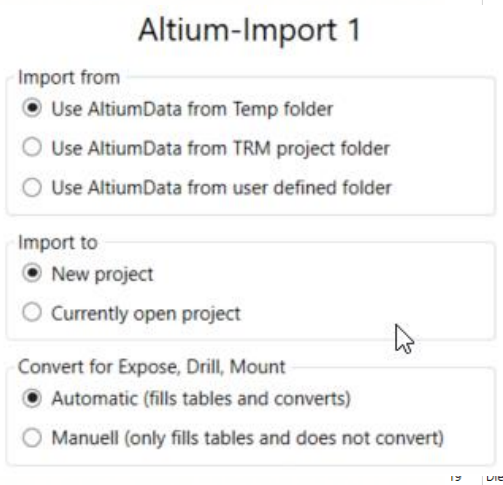
> CAD Import 2/2

For **Altium Designer®** ...



1	1_Top		Signal	1oz	0.045mm		
	Dielectric 1	TU-883	Core		0.1mm	3.6	
2	2_int1_(gnd)		Signal	1/2oz	0.017mm		
	Dielectric 2	TU-883	Prepreg		0.1mm	3.6	
3	3_int2_(power)		Signal	1/2oz	0.017mm		
	Dielectric 3	TU-883	Core		0.1mm	3.6	
4	4_int3_(gnd)		Signal	1/2oz	0.017mm		
	Dielectric 4	TU-883	Prepreg		0.12mm	3.6	
5	5_int4_(sign)		Signal	1/2oz	0.017mm		
	Dielectric 5	TU-883	Core		0.12mm	3.6	
6	6_int5_(power)		Signal	1/2oz	0.017mm		
	Dielectric 6	TU-883	Prepreg		0.12mm	3.6	
7	7_int6_(sign)		Signal	1/2oz	0.017mm		
	Dielectric 7	TU-883	Core		0.12mm	3.6	
8	8_int7_(power)		Signal	1/2oz	0.017mm		
	Dielectric 8	TU-883	Prepreg		0.12mm	3.6	
9	9_int8_(gnd)		Signal	1/2oz	0.017mm		
	Dielectric 9	TU-883	Core		0.12mm	3.6	
10	10_int9_(sign)		Signal	1/2oz	0.017mm		
	Dielectric 10	TU-883	Prepreg		0.12mm	3.6	
11	11_int10_(gnd)		Signal	1/2oz	0.017mm		
	Dielectric 11	TU-883	Core		0.12mm	3.6	
12	12_int11_(sign)		Signal	1/2oz	0.017mm		
	Dielectric 12	TU-883	Prepreg		0.12mm	3.6	
13	13_int12_(gnd)		Signal	1/2oz	0.017mm		
	Dielectric 13	TU-883	Core		0.1mm	3.6	

... With wizard even more comfortable

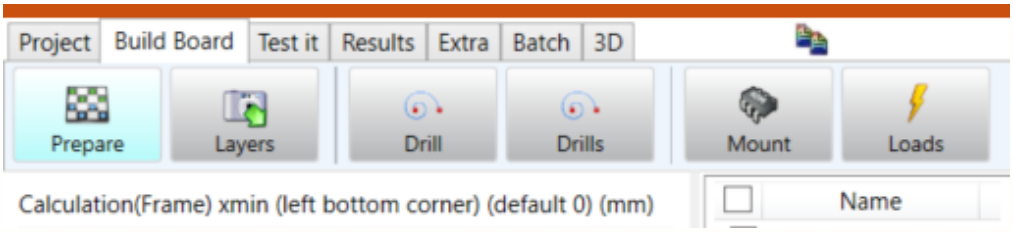


Level	Name	Type	File	View	FR4 whi	Thick (um)	Conductor	Dielectric
0	Top Layer	ger	MiniPC.GTL	Ansehen	☑	45	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	100	Cu$TRM	FR4$TRM
	Layer 1	ger	MiniPC.G1	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	100	Cu$TRM	FR4$TRM
	Layer 2	ger	MiniPC.G2	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	100	Cu$TRM	FR4$TRM
	Layer 3	ger	MiniPC.G3	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
	Layer 4	ger	MiniPC.G4	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
	Layer 5	ger	MiniPC.G5	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
	Layer 6	ger	MiniPC.G6	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
	Layer 7	ger	MiniPC.G7	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
	Layer 8	ger	MiniPC.G8	Ansehen	☑	17	Cu$TRM	FR4$TRM
	ectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
	Layer 9	ger	MiniPC.G9	Ansehen	☑	17	Cu$TRM	FR4$TRM
19	Dielectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
20	Mid Layer 10	ger	MiniPC.G10	Ansehen	☑	17	Cu$TRM	FR4$TRM
21	Dielectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
22	Mid Layer 11	ger	MiniPC.G11	Ansehen	☑	17	Cu$TRM	FR4$TRM
23	Dielectric	pre		Ansehen	☑	120	Cu$TRM	FR4$TRM
24	Mid Layer 12	ger	MiniPC.G12	Ansehen	☑	17	Cu$TRM	FR4$TRM
25	Dielectric	pre		Ansehen	☑	100	Cu$TRM	FR4$TRM
26	Mid Layer 13	ger	MiniPC.G13	Ansehen	☑	17	Cu$TRM	FR4$TRM
27	Dielectric	pre		Ansehen	☑	100	Cu$TRM	FR4$TRM
28	Mid Layer 14	ger	MiniPC.G14	Ansehen	☑	17	Cu$TRM	FR4$TRM
29	Dielectric	pre		Ansehen	☑	100	Cu$TRM	FR4$TRM
30	Bottom Layer	ger	MiniPC.GBL	Ansehen	☑	45	Cu$TRM	FR4$TRM

Moreover: Takes the netlist, pads and special TRM parameters from .SchDoc

> Input

- The user interface follows the production process



- **TRM** offers something for layout beginners and experts.

Import layer stack, your Gerber, placement and drill files into **TRM** and add current and power dissipation. Manually or via xls.

Level	Name	Type	File	View	FR4 white	Thick (um)	Conductor	Dielectric
1	L1	ger	Arduino_MEGA2560_ref.cmp	View	☑	35	Cu$TRM	FR4$TRM
2	pre1	pre		View	☑	1530	Cu$TRM	FR4$TRM
3	L2	ger	Arduino_MEGA2560_ref.sol	View	☑	35	Cu$TRM	FR4$TRM

Each drilled hole can be edited

Drillfile	View	Tech
Arduino_MEGA2560_ref.drd	View	TH

x	PTH4exc	44.292	25.4	0.406	TH
x	PTH5exc	47.467	26.162	0.406	TH
x	PTH6exc	45.054	30.226	0.406	TH
x	PTH7exc	45.435	32.004	0.406	TH
x	PTH8exc	38.577	34.163	0.406	TH
x	PTH9exc	36.672	32.385	0.406	TH
x	PTH10exc	31.084	36.195	0.406	TH
x	PTH11exc	26.004	38.1	0.406	TH
x	PTH12exc	21.686	35.687	0.406	TH
x	PTH13exc	21.051	38.227	0.406	TH

Netlist and pins/pads for Amps

Type	Compfile	Supplfile
ipc	isl8240meval4za_ipc356.ipc	

316	PGOOD~U1-24	22.85	5.085	0.64	-1	2	1	1	Cu$TRM
317	PHASE1~U1-12	10.259	2.019	4.796	-1	2	1	1	Cu$TRM
318	PHASE2~U1-10	10.439	8.141	4.796	-1	2	1	1	Cu$TRM
319	SYNC~J2-1	23.876	35.088	1.829	-1	2	1	99	Cu$TRM
320	SYNC~RFSET-2	20.244	14.732	0.892	-1	2	99	99	Cu$TRM

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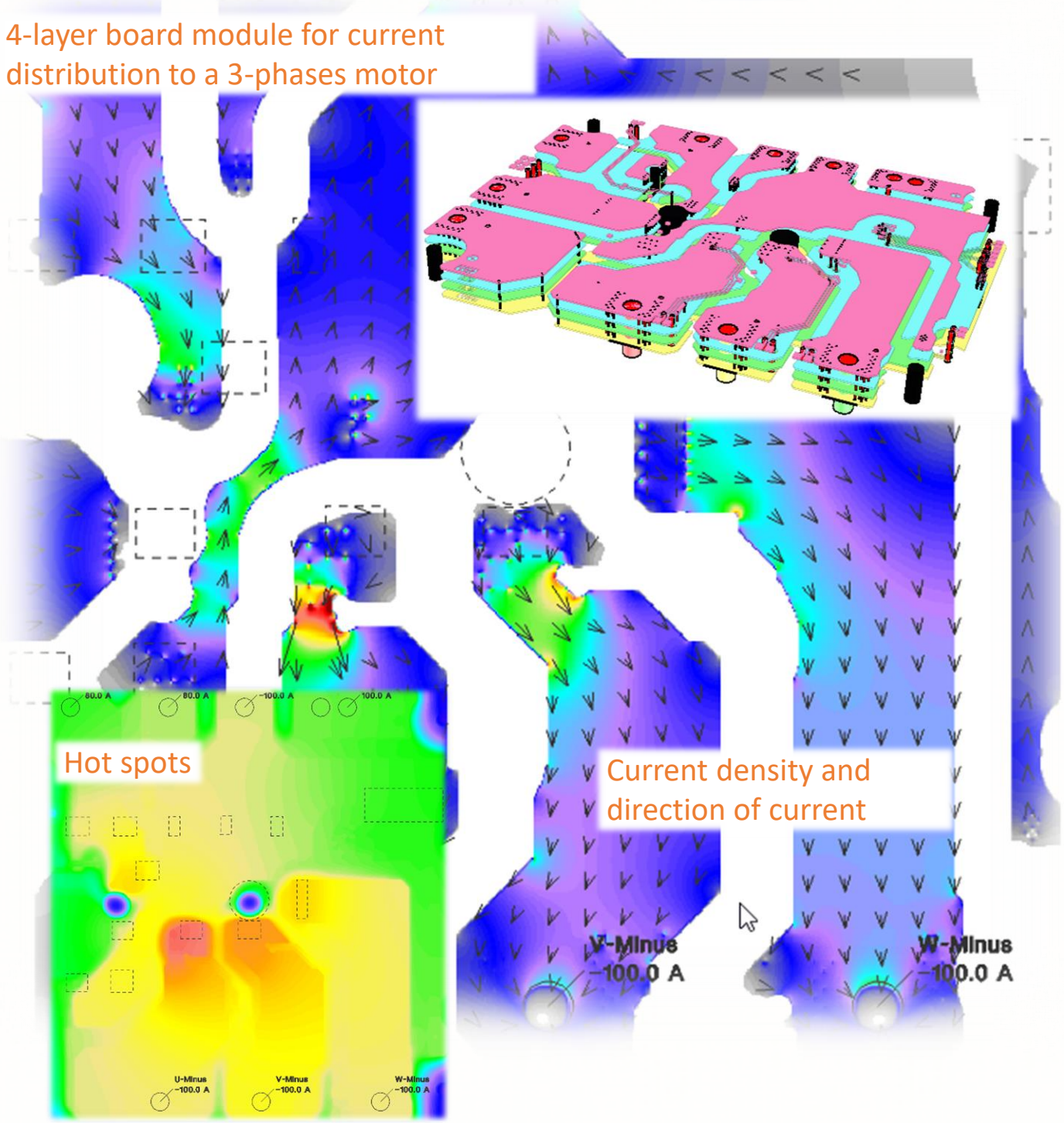
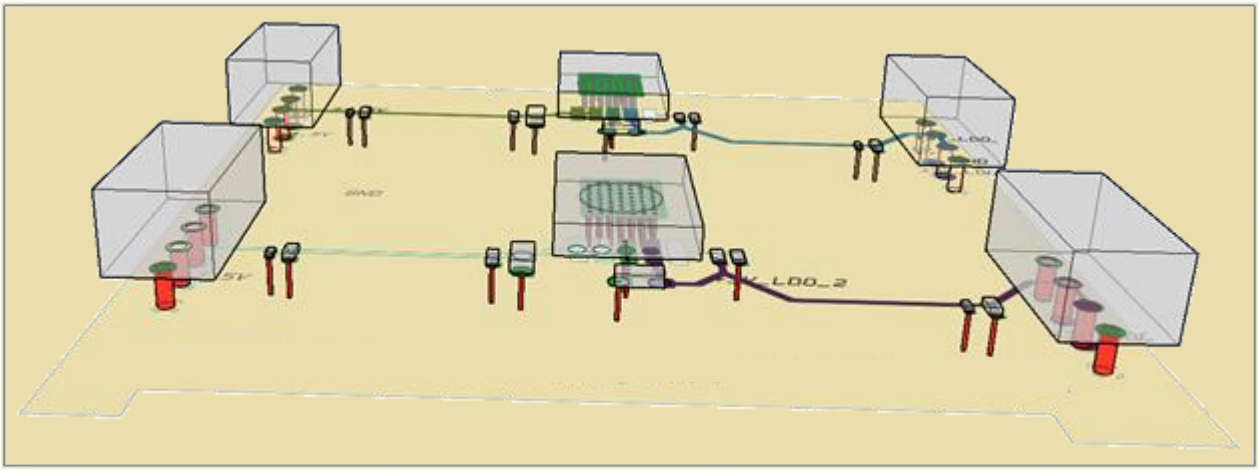
> Current and Temperature

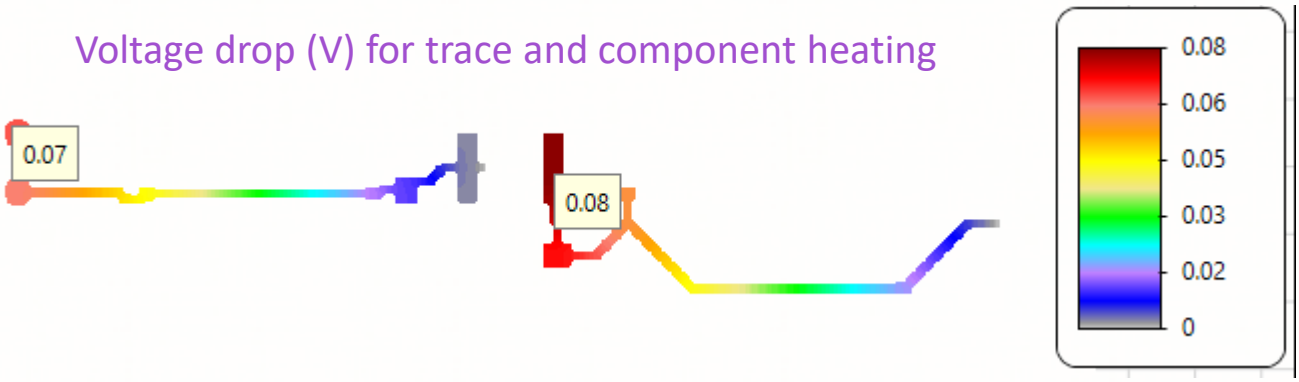
4-layer board module for current distribution to a 3-phases motor



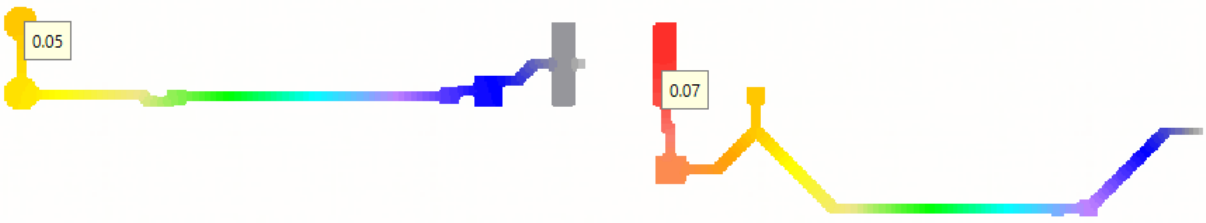
> Voltage Drop and Temperature



Voltage drop (V) for trace and component heating

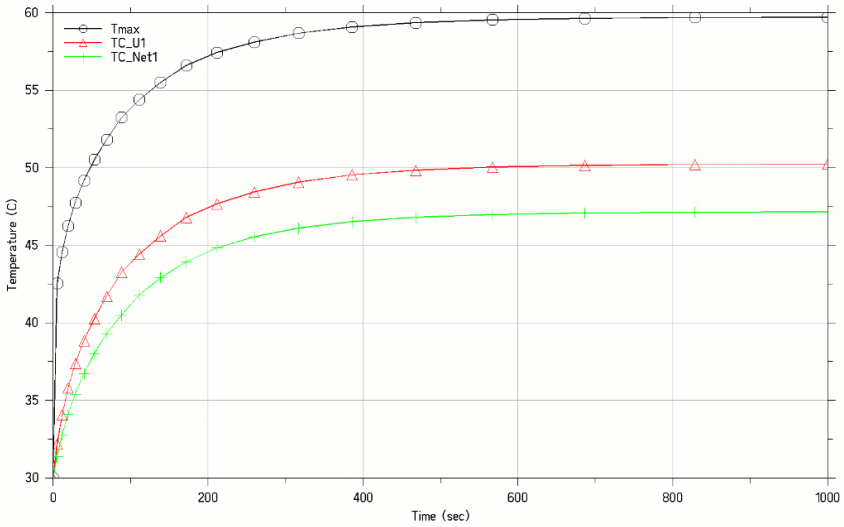


Voltage drop (V) at 20°C

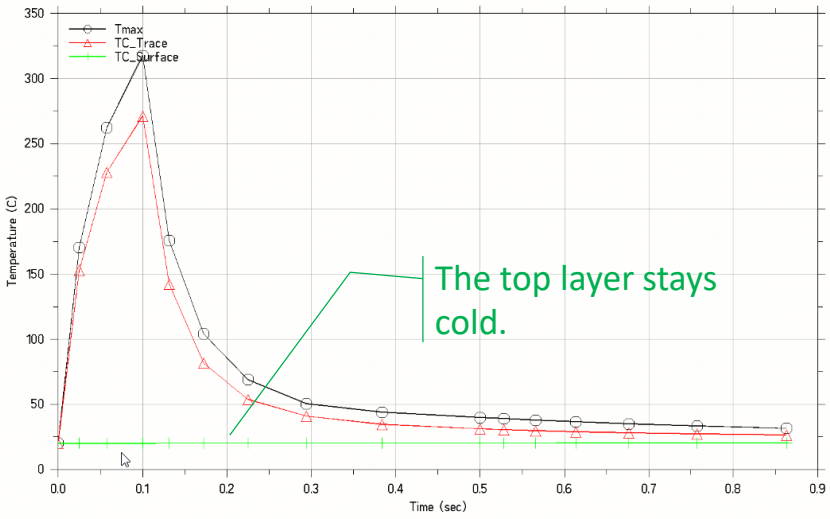


> Transient

Heating curve with permanent losses and currents

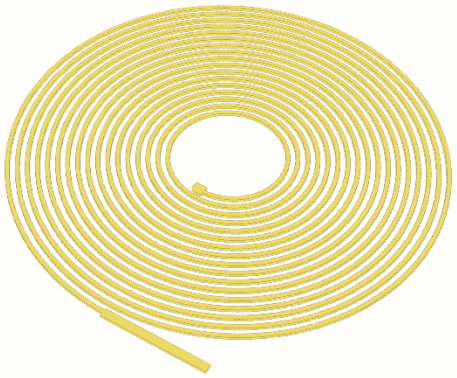


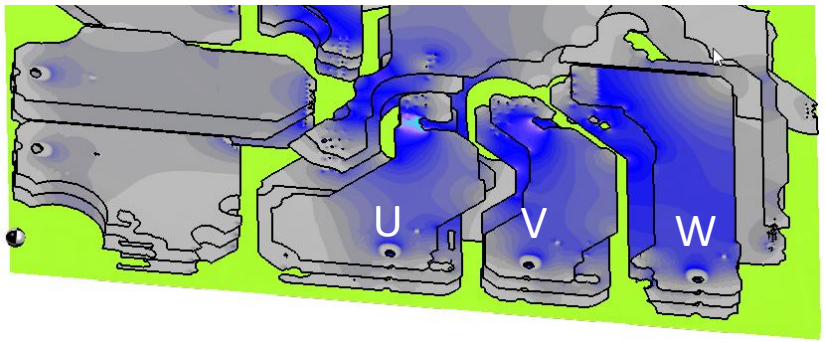
100 ms current surge in an inner layer



> Inductance (Inductivity)

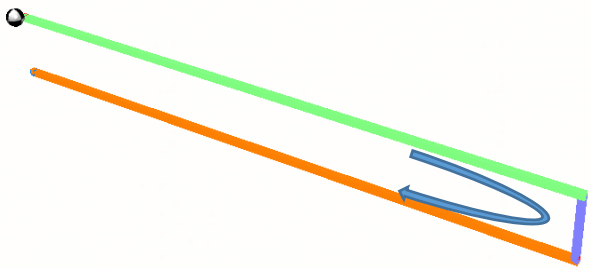
TRM: 6.0 µH
EM software: 5.9 µH
Measured: 5.07 µH

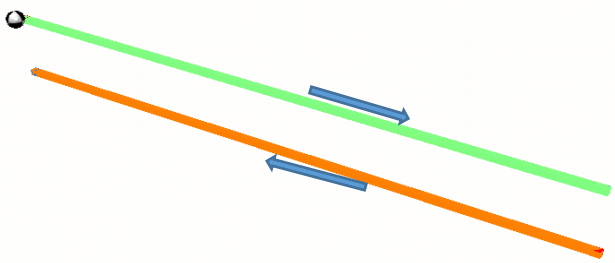




$$\mathbf{L} = \begin{pmatrix} 9.4 & 5.1 & -7.4 \\ 5.1 & 17 & -5.7 \\ -7.4 & -5.7 & 38 \end{pmatrix} \text{nH}$$

Comparison with textbook





Textbook Dual line	TRM
$L \approx \frac{\mu\ell}{4\pi}\left(1 + \text{In}\left(\frac{d-a}{a}\right)\right)$ = 128 nH	L=122 nH

Textbook	TRM
Single line $Lself \approx \frac{\mu\ell}{2\pi}\left(\text{In}\left(\frac{2\ell}{w+t}\right) + \frac{1}{2}\right)$=102	L_{11}=L_{22} = 102 nH
	Self- and counter-inductance $\mathbf{L} = \begin{pmatrix} 102 & -41 \\ -41 & 102 \end{pmatrix}$ nH
Dual line $L \approx \frac{\mu\ell}{4\pi}\left(1 + \text{In}\left(\frac{d-a}{a}\right)\right)$= 128 nH	Total of matrix elements 102+102-41-41= *122* nH

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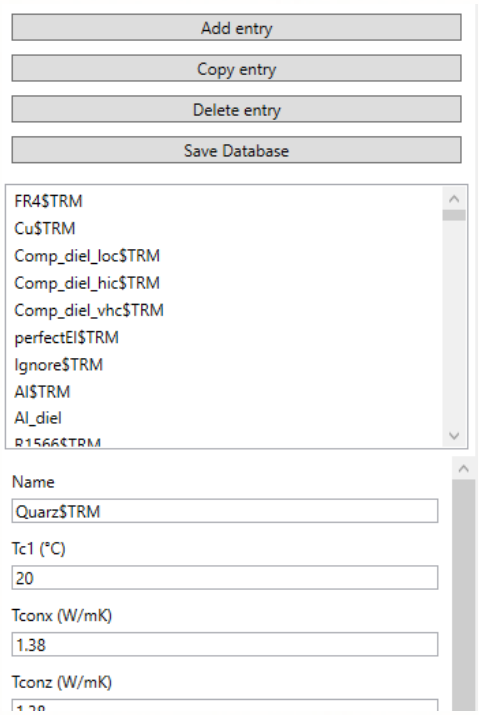
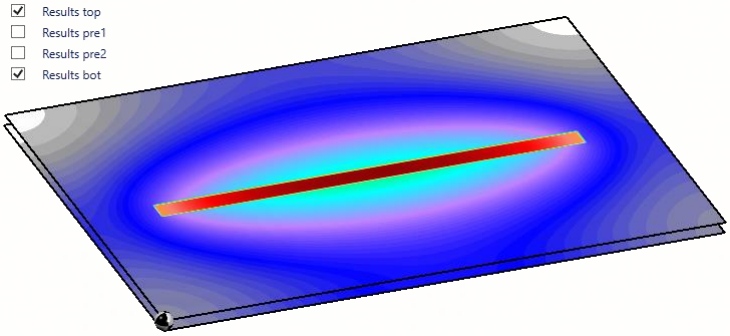
> Technology

TRM is also for purely technological investigations: even without layout data.

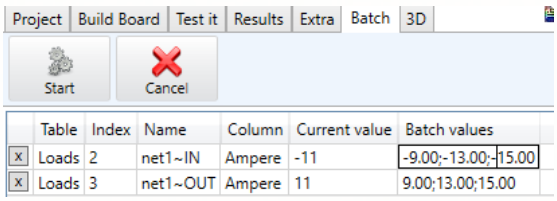
Materials database



IPC-2221 like trace with copper flooding



Batch runs



Going in depth with tables

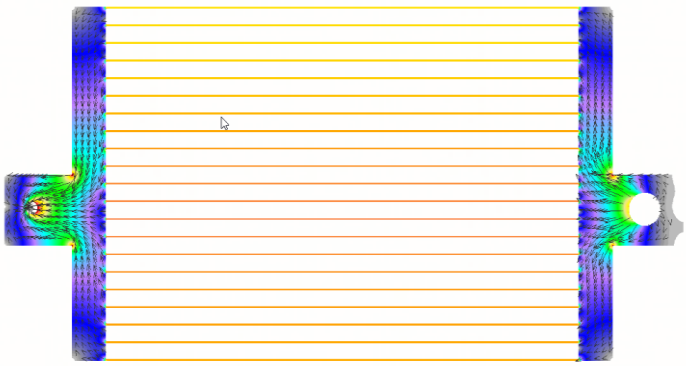
```
Report by levels
  1 Top Layer            0.088 W
  2 Dielectric           0.000 W
  3 Mid Layer 1          0.020 W
  4 Dielectric           0.001 W
  5 Mid Layer 2          0.014 W
  6 Dielectric           0.000 W
  7 Bottom Layer         0.004 W
Total Joule Heat=  0.127 W
```

```
Report of Electric Results per Net
  Net              Flux(A)>0     Vmin(V)      Vmax(V)     Vdrop(mV)    RDC(mOhm)    PJoule(W)
 1 AGND              10.000       0.000        0.013       12.960        1.296        0.127
   Total Heat                                                                        0.127
```

> Special Setups

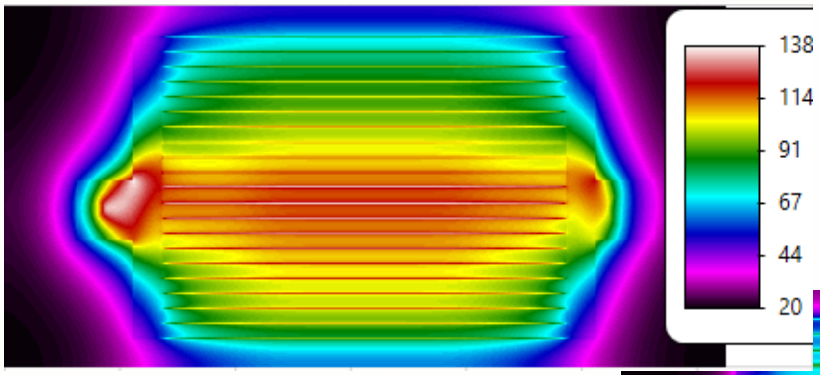
Heating foil @12 V

@12 V → 3.9 A , 47 W

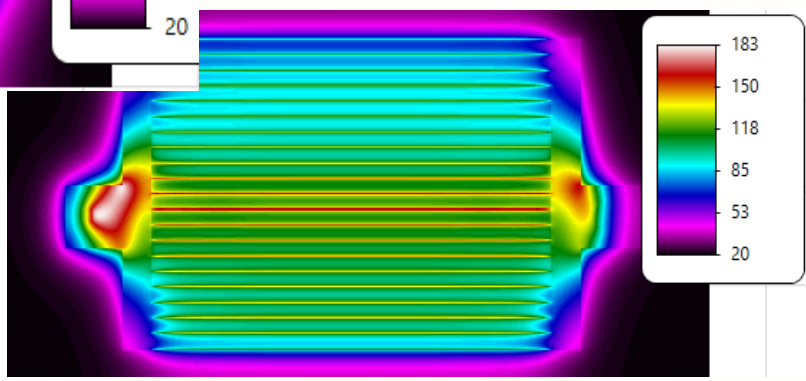


Heating foil on substrates

0.5 mm glass



0.5 mm plastic



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TRM is more than just software

Software cannot do the thinking for you ...

... but by watching and experimenting you will learn a lot about your board and the technologies used

- How to do thermal design
- Weak points
- Alternatives
- Savings potential
- Ideas for the next design

Beyond that

- See and understand Thermal Management
- Test the benefits of new products
- Learn how to read and evaluate thermal datasheets and AppNotes

Contact to evaluate:

support@adam-research.com
www.adam-research.com

or distributors in various countries

ADAM Research
Calculations and Services
Dr. Johannes Adam
Theodor-Heuss-Strasse 12
69181 Leimen, Germany