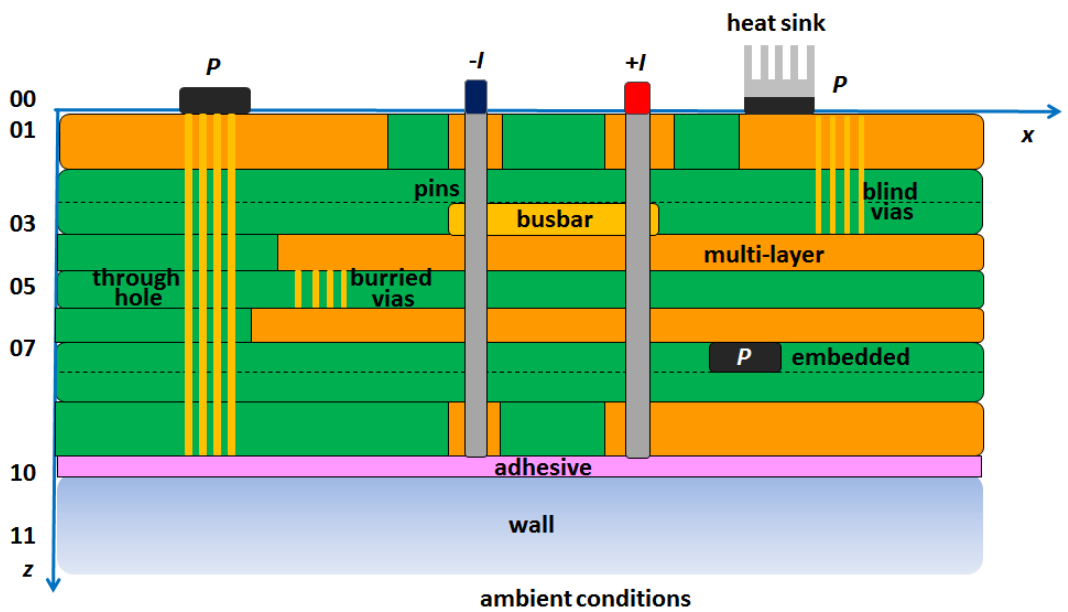
TRM APPLICATIONS GALLERY

TABLE OF CONTENT

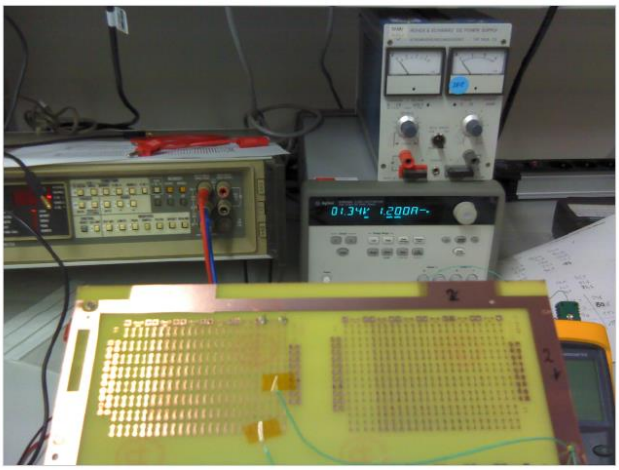
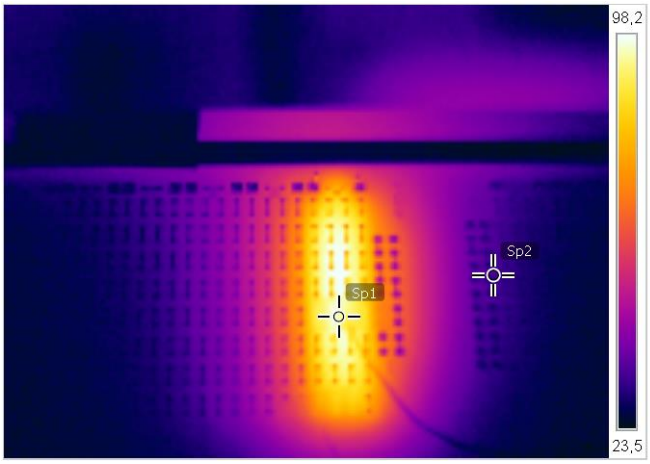
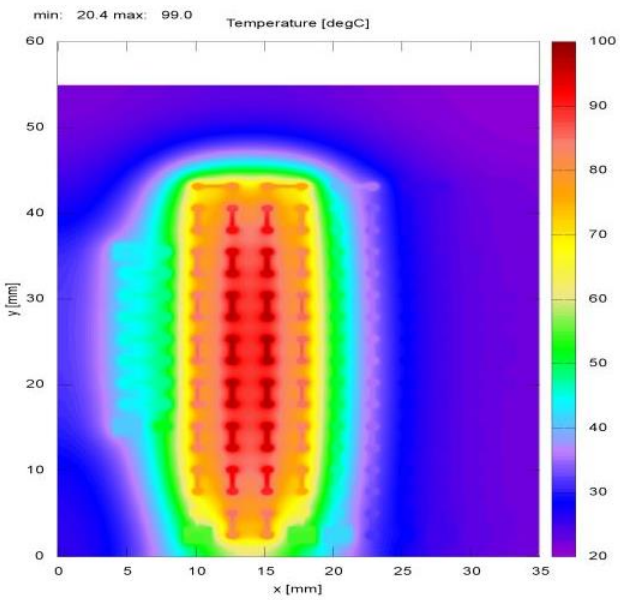
PCB features for a simulation with TRM



- Layer geometry and layout by Gerber import.
- Drilled hole pattern by Excellon import.
- Each hole type can be plated, non-plated or filled

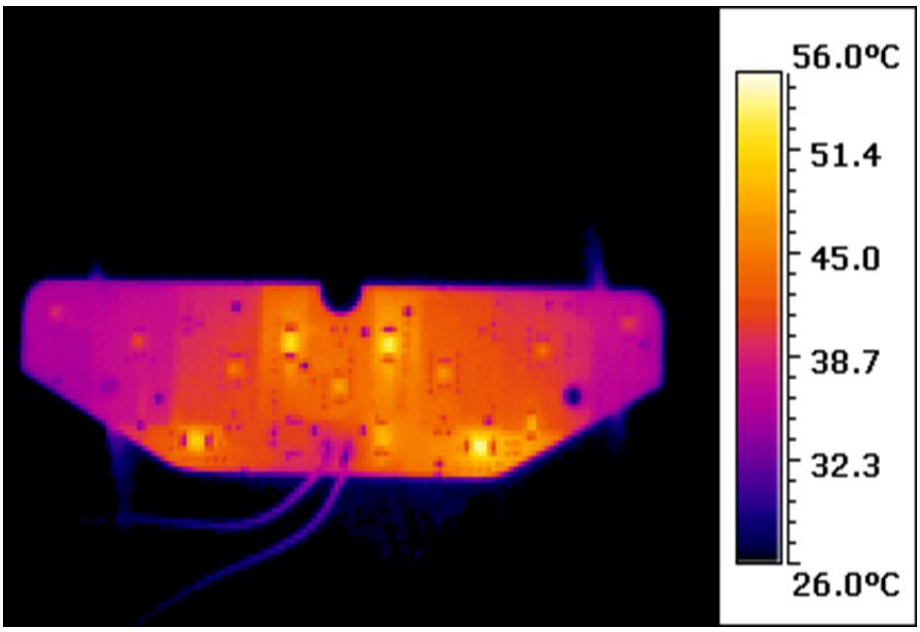
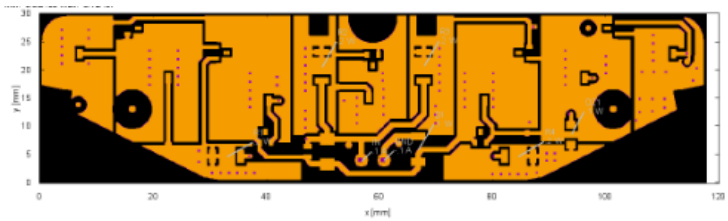
TEST BOARD FOR CURRENT-CARRYING CAPACITY

Courtesy: Tech. University Hamburg-Harburg, Research Lab Electronics. Germany

	Laboratory setup. Bilayer test board with laser trimmed traces. Current is alternating between top and bottom layer
	Infrared Image (not coated)
	TRM calculation result Top layer.

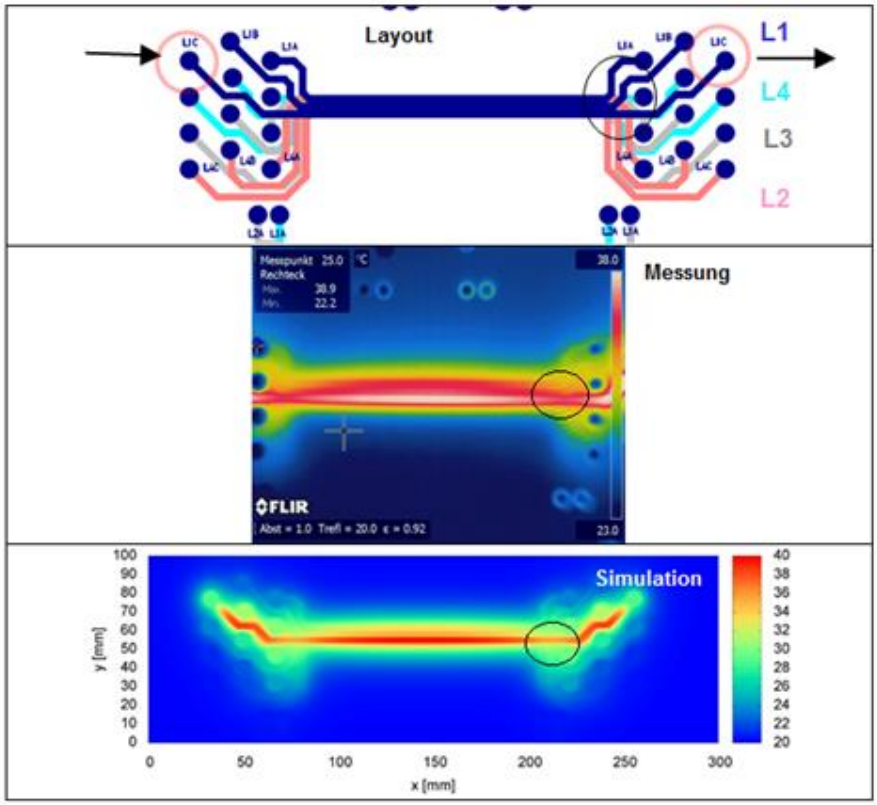
LED TEST BOARD

Courtesy: electromures S.A., Romania

	Infrared image (not coated) top layer. Pads appear dark. Bilayer Board.
	Top layer copper and drills in the TRM model
	TRM calculation result Pads appear bright.

MULTILAYER CURRENT TEST BOARD

Courtesy: Robert Bosch GmbH, Germany



4 layer test layout

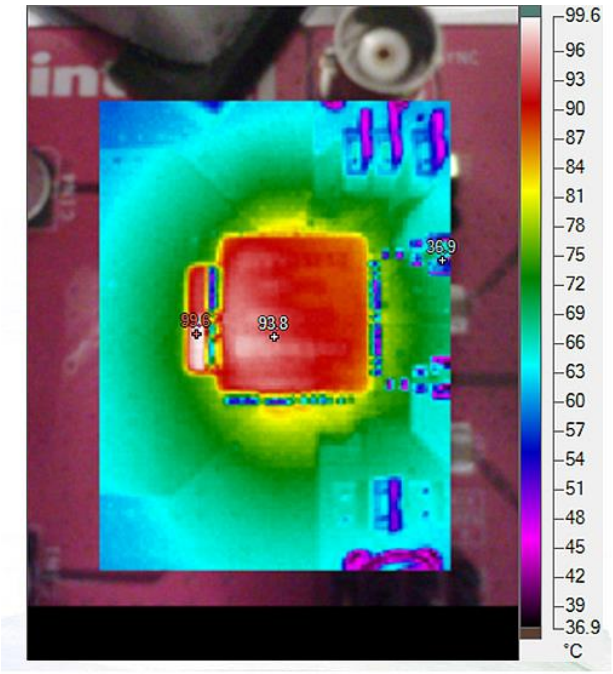
Infrared image (not coated). Only L1 trace has current.

TRM simulation result

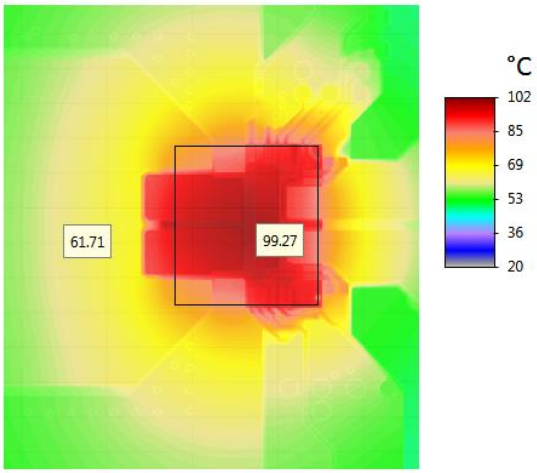
EVALUATION BOARD WITH QFN PACKAGE

Dual 20A/single 40A step-down, 100W analog power module. 4 layer board.

Courtesy: Intersil™ Corp., Milpitas, USA

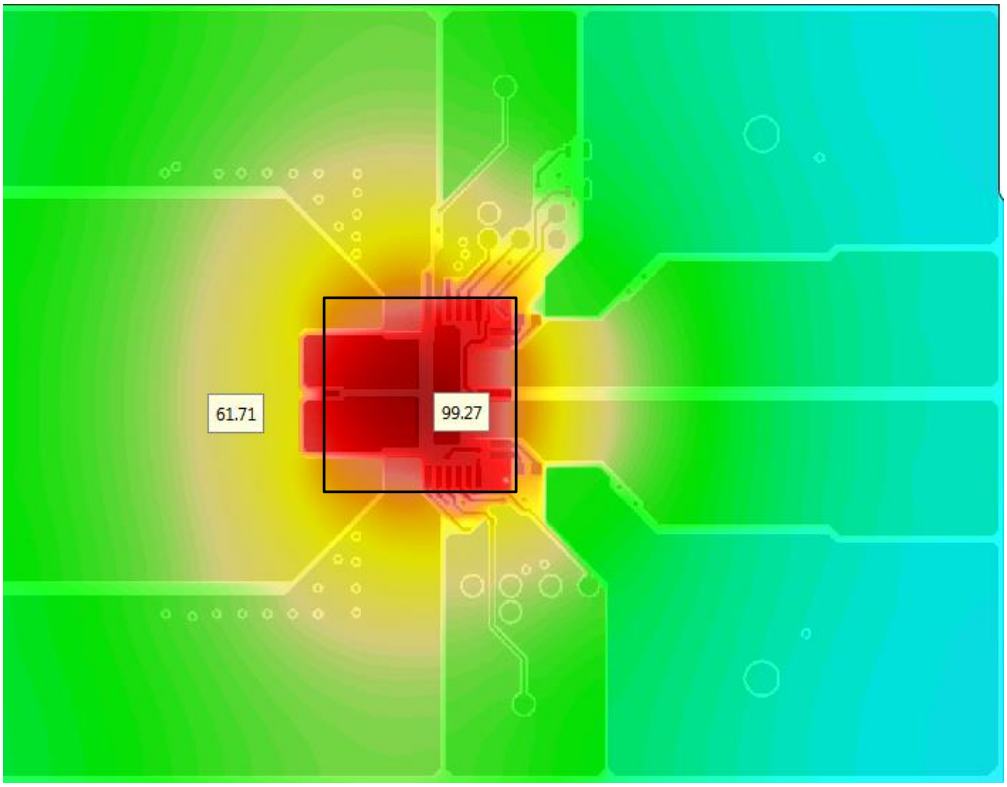


Infrared image



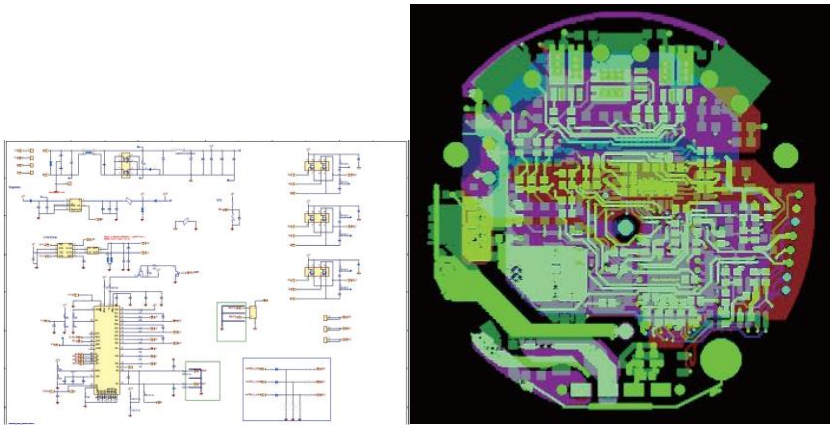
TRM simulation with package outline

View through the component into Layer 1

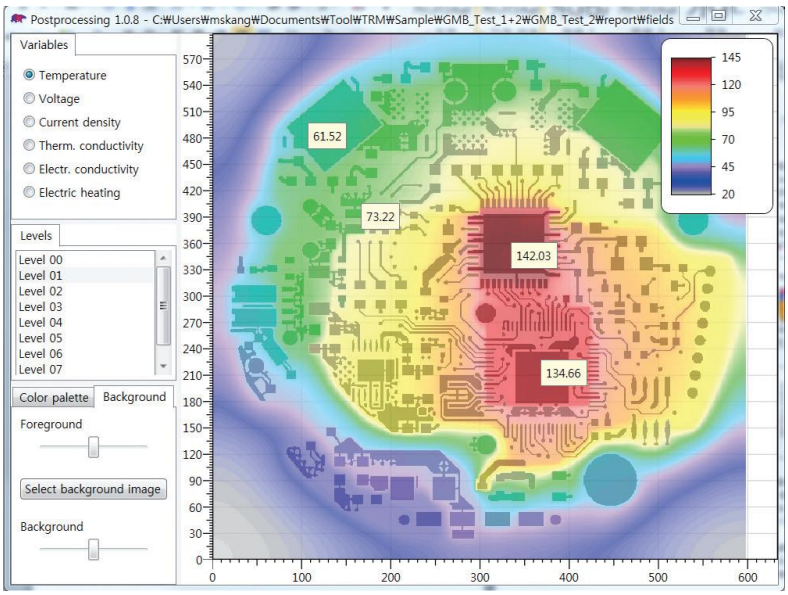


The temperature field correlates with the design

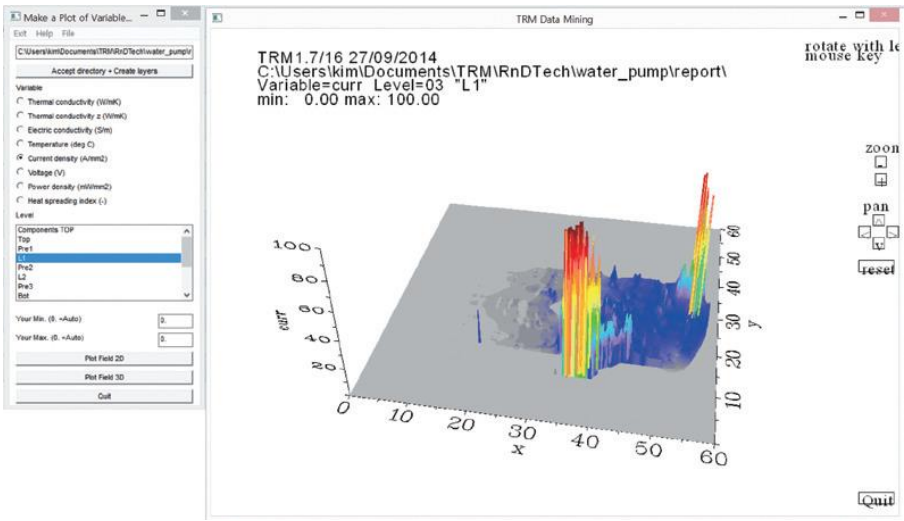
AUTOMOTIVE DRIVE CONTROLLER



Schematics and layout



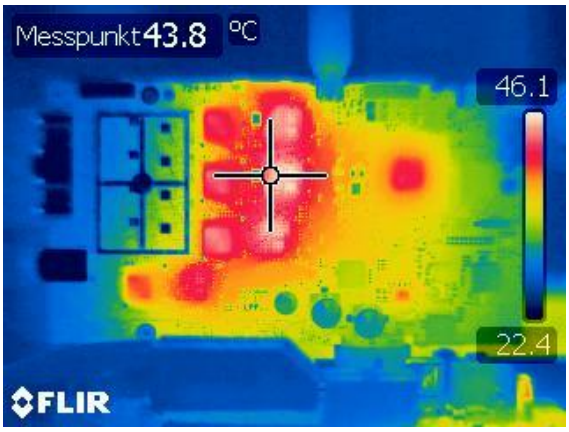
Top layer



Current density on GND

ENTERTAINMENT BOARD

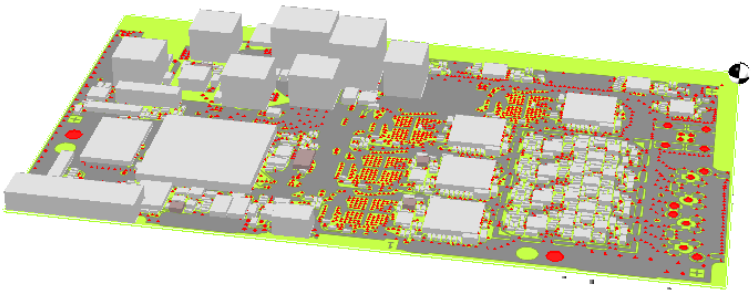
Laminar forced convection cooling at 1.7 m/s and 25 C room temperature.



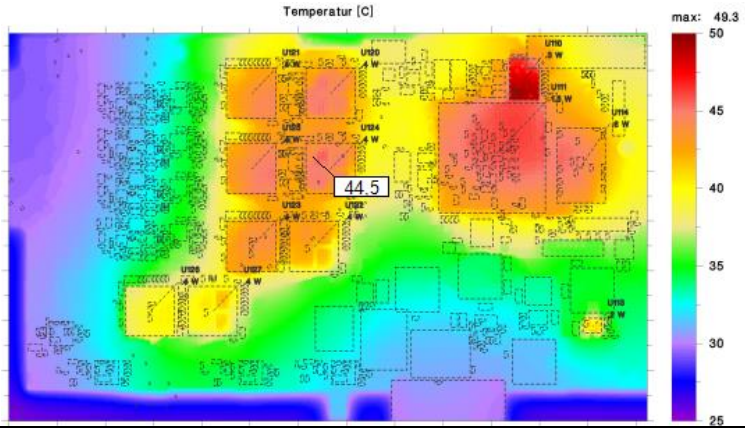
Board in design phase.

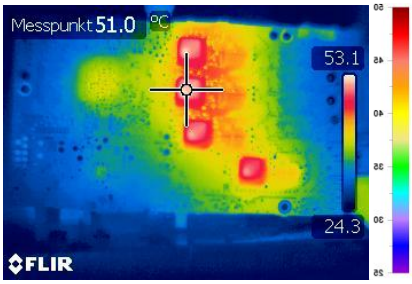
Top layer.

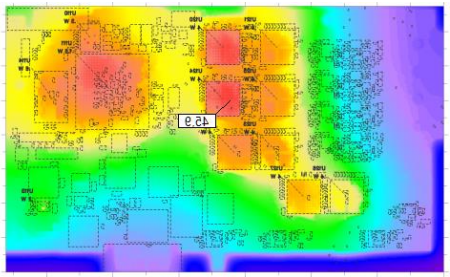
Infrared image of the uncoated board. Emissivity is not defined and not a constant.



View from rear.

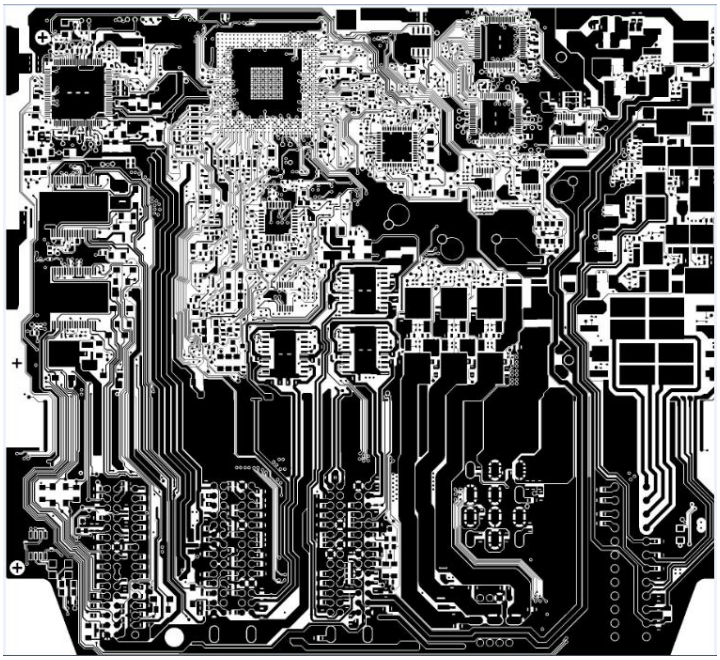






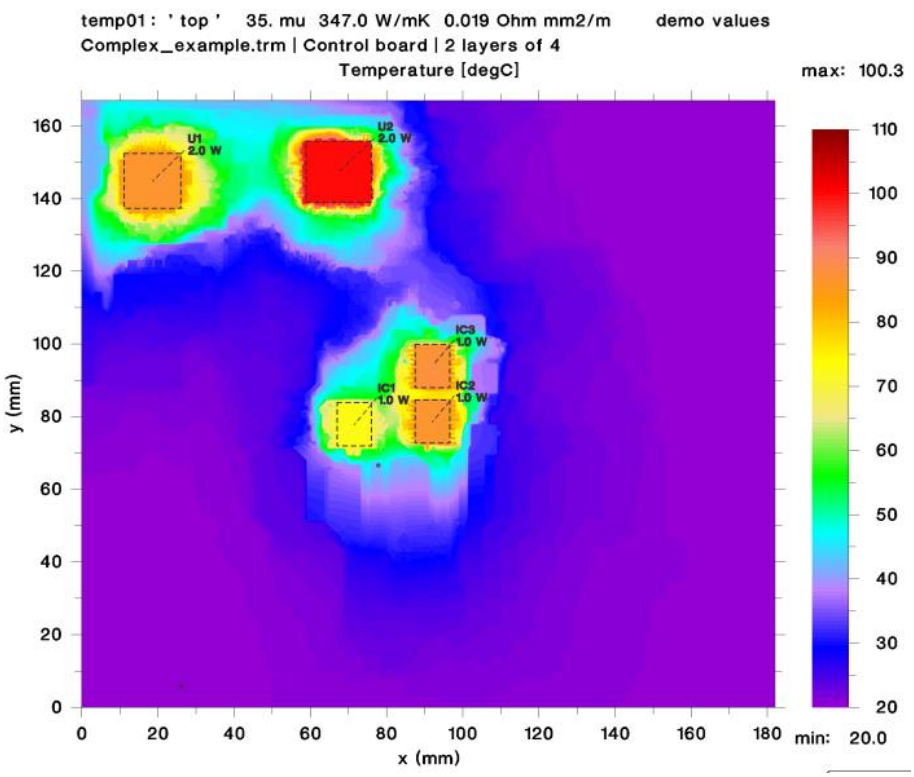
Bottom layer

8-LAYER INDUSTRIAL CONTROLLER BOARD



Calculation top layer of a 8 layer TRM model.

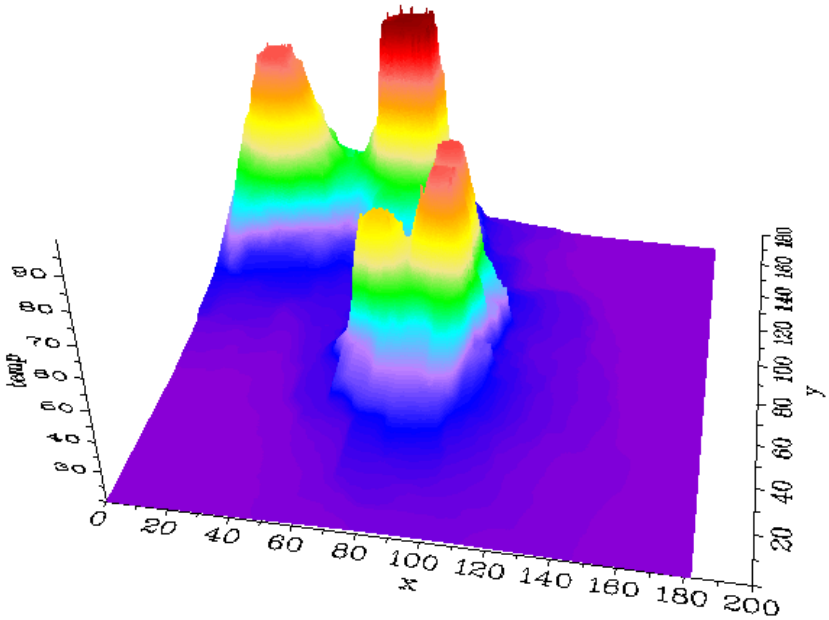
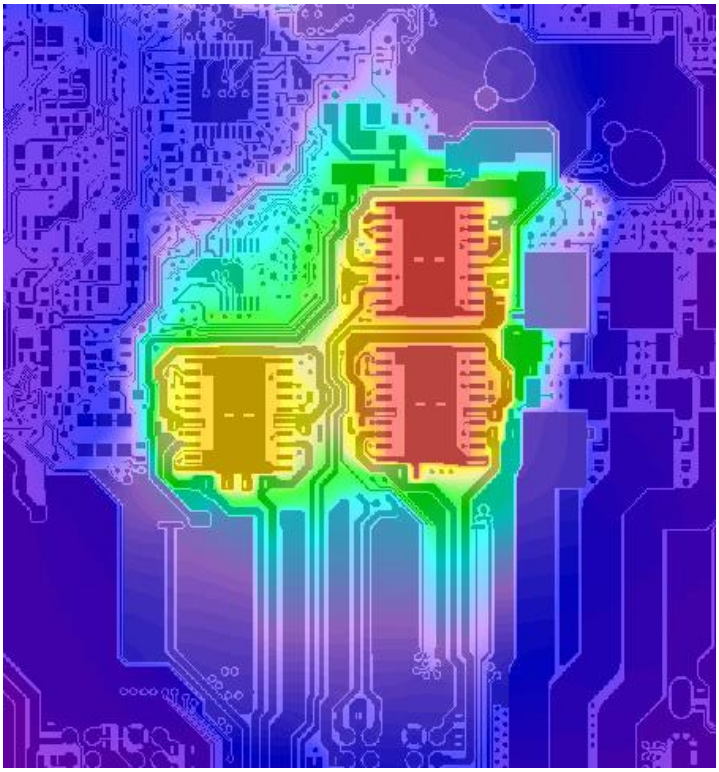
3440 drills.



Test result with 5 heat sources.

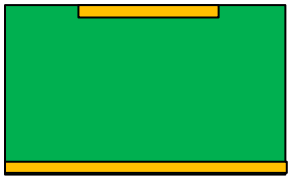
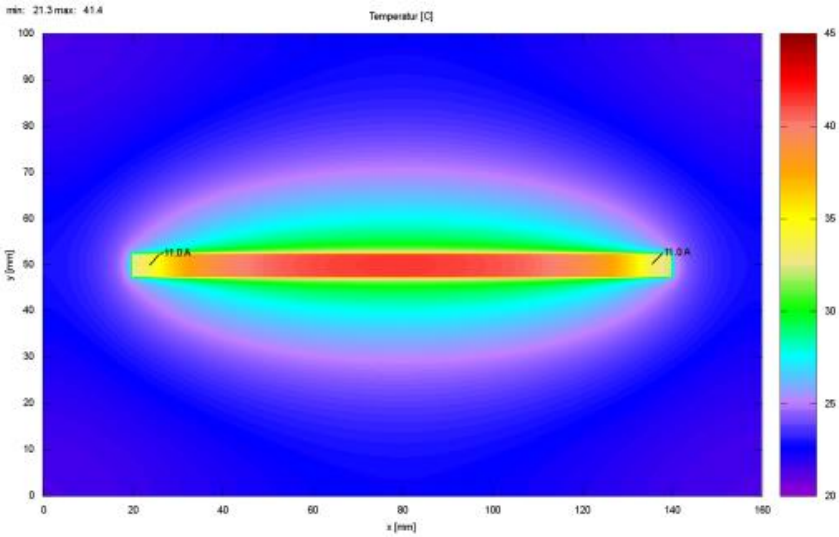
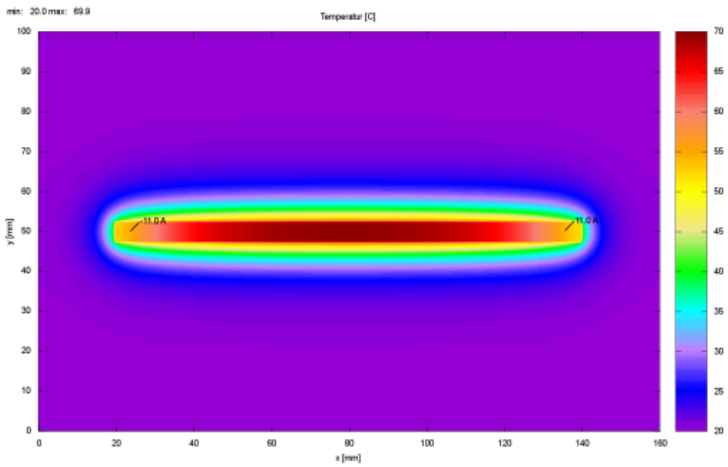
U1 and U2: 2 Watt

IC1-3: 1 Watt

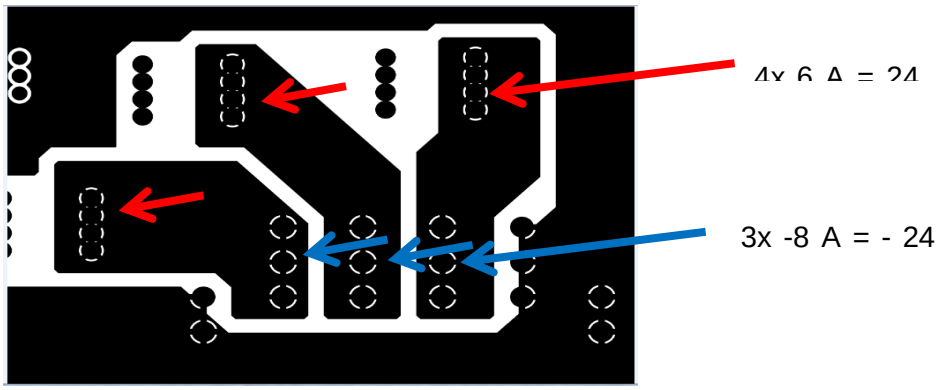
	3D impression of temperature
	Mix of temperature result plot and computational layout plot around IC1 to IC3

IPC-DESIGN CHARTS – EFFECT OF HEAT SPREADING

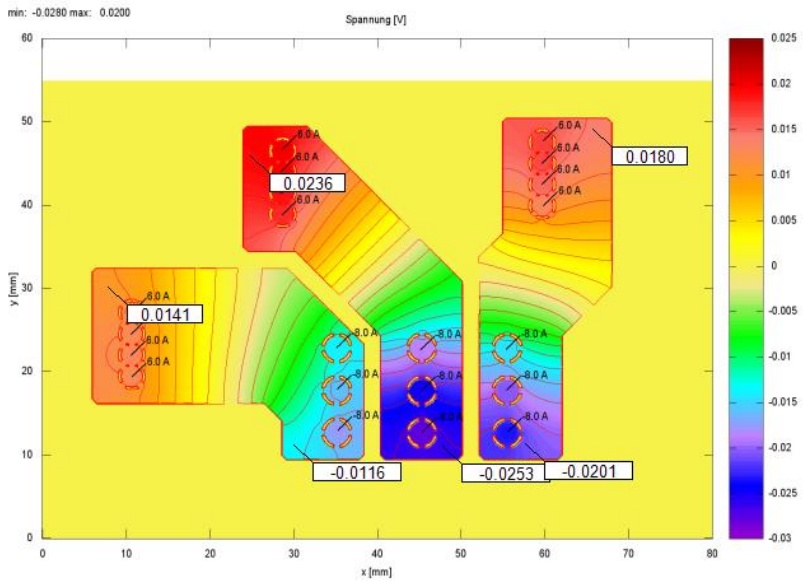
Read also: http://ultracad.com/articles/pcbtempr.pdf

	IPC-2221 setup 35 mu (1 oz) top layer and 1 oz bottom plane
	Trace width 5 mm 11 A produce +20 K
	IPC-2125 setup 35 mu top layer. Single layer board.
	Trace width 5 mm 11 A produce +50 K

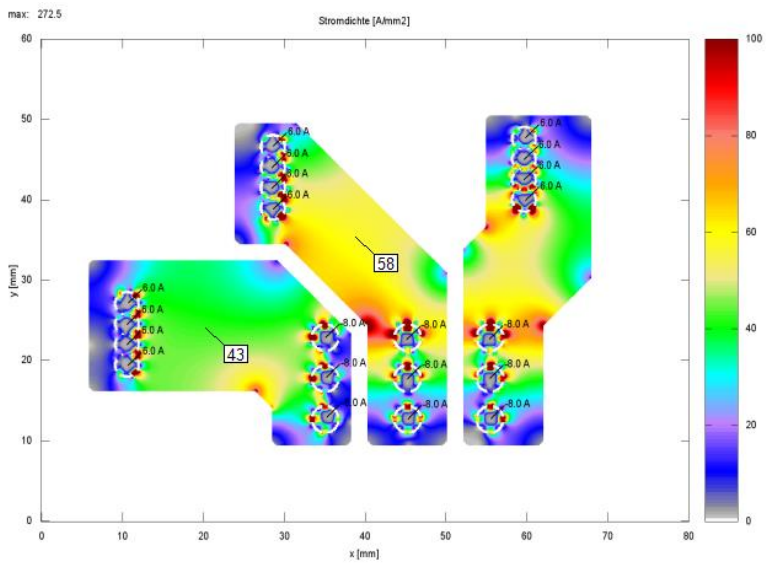
CURRENT AND THERMAL RELIEFS



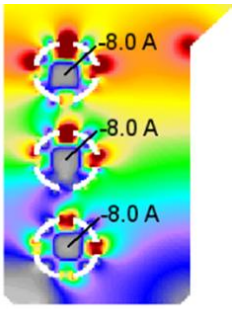
Part of the layout around connector pins

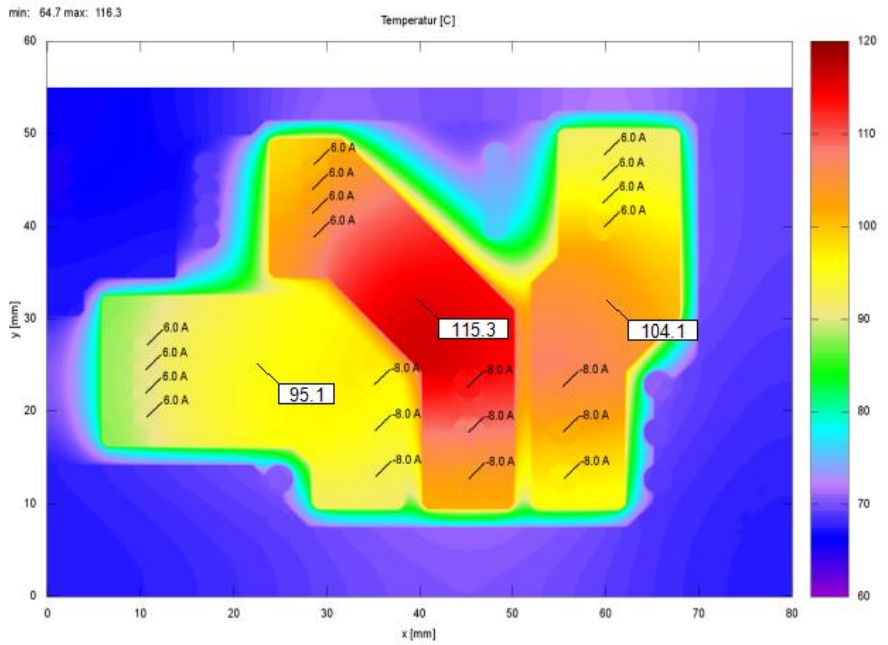


Equipotential lines (Volt)

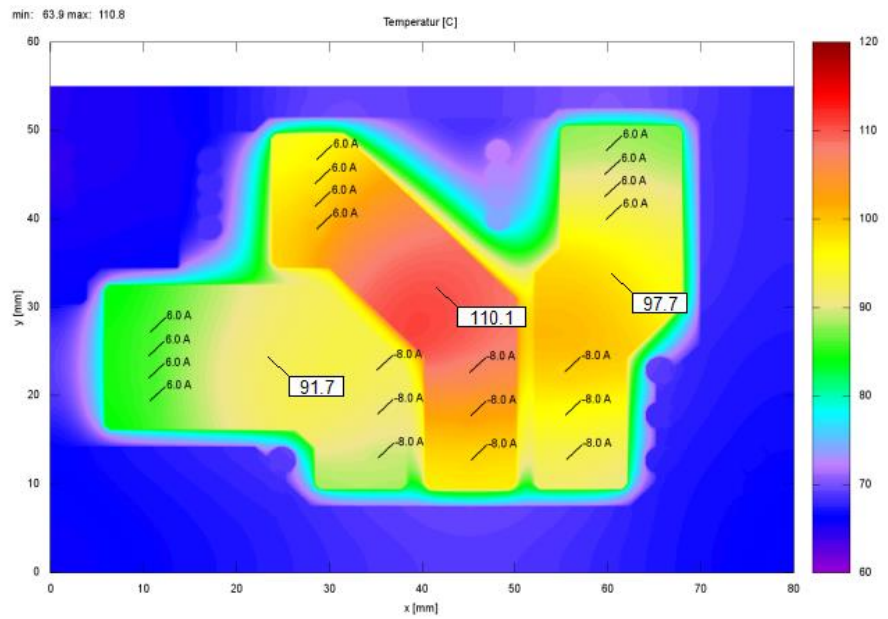


Current density (Ampere/mm²)





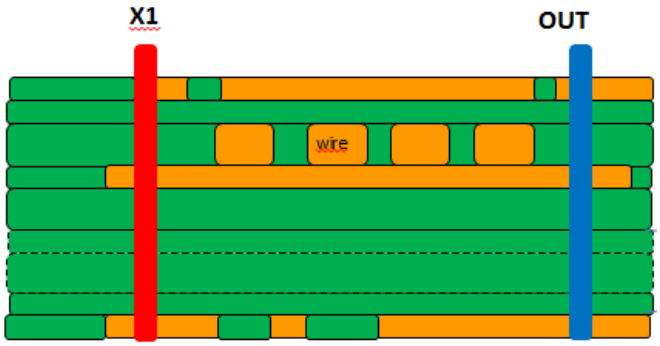
Temperature with thermal reliefs



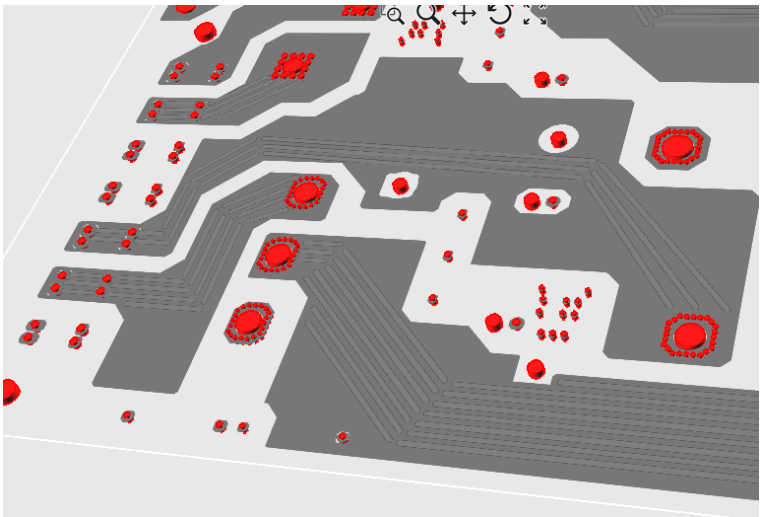
Temperature without thermal reliefs

BUSBARS

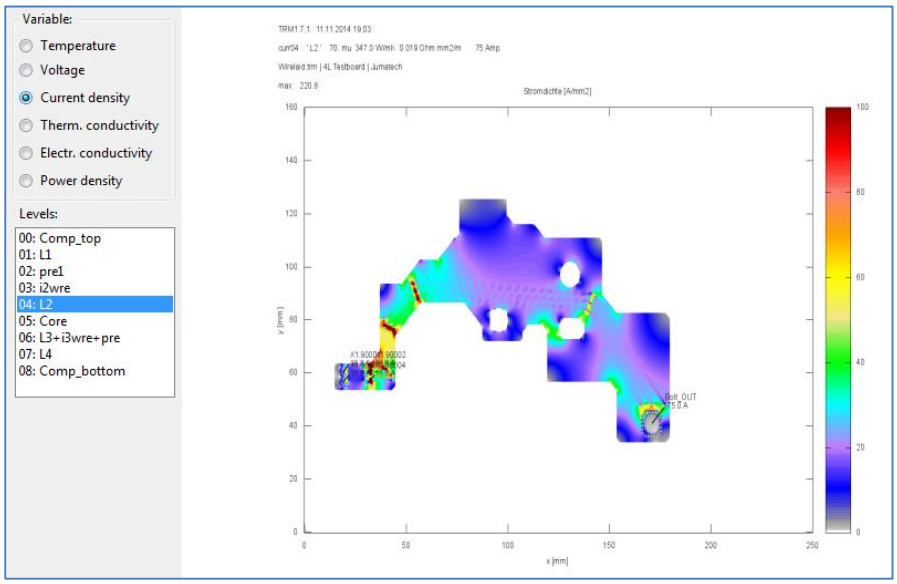
Courtesy: Jumatech GmbH, Germany



Busbars enlarge locally the cross-section of a power plane.



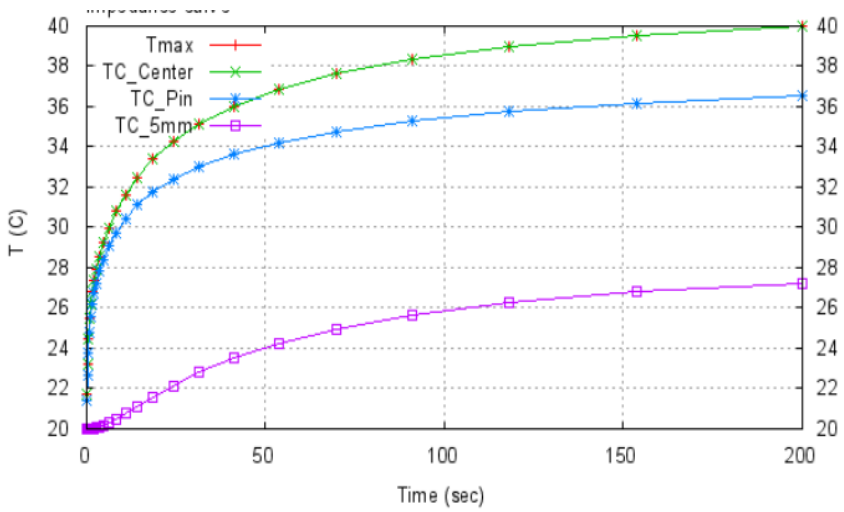
Watch the extra wires to support the flow of high currents



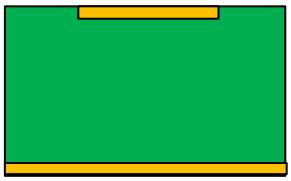
Overall current density is lower in regions of busbars

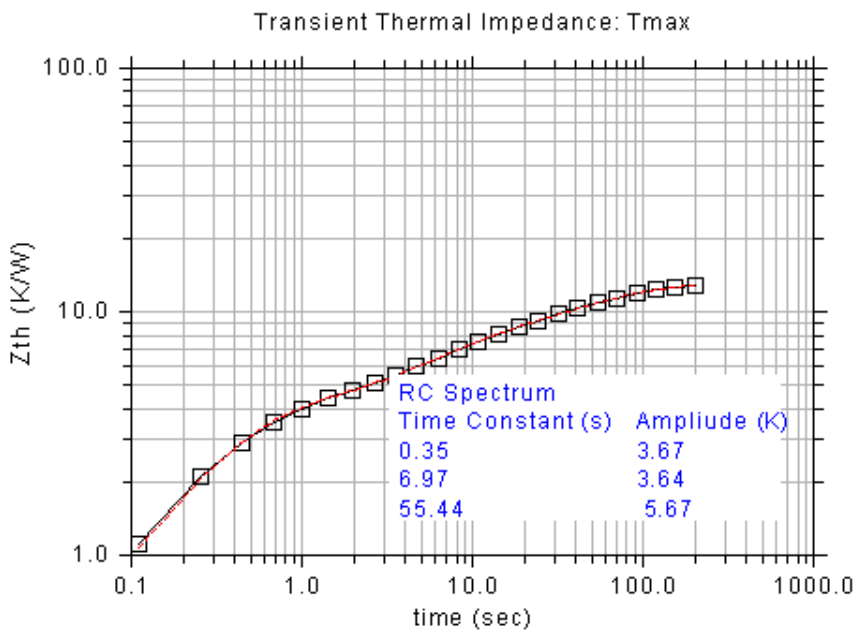
As a result temperature sinks.

TRANSIENT HEATING



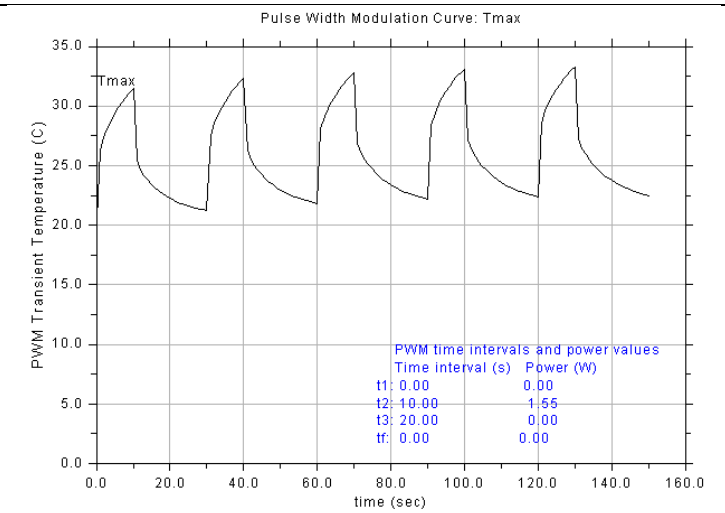
Transient heating of a 5 mm trace in IPC-2221 configuration





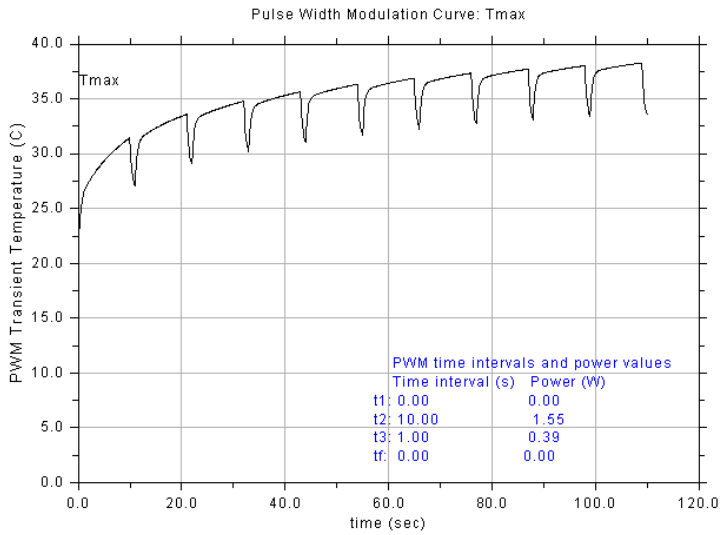
Impedance curve with derived thermal RC ranks

PULSE-WIDTH-MODULATION BY POSTPROCESSING OF A POWER STEP PROFILE

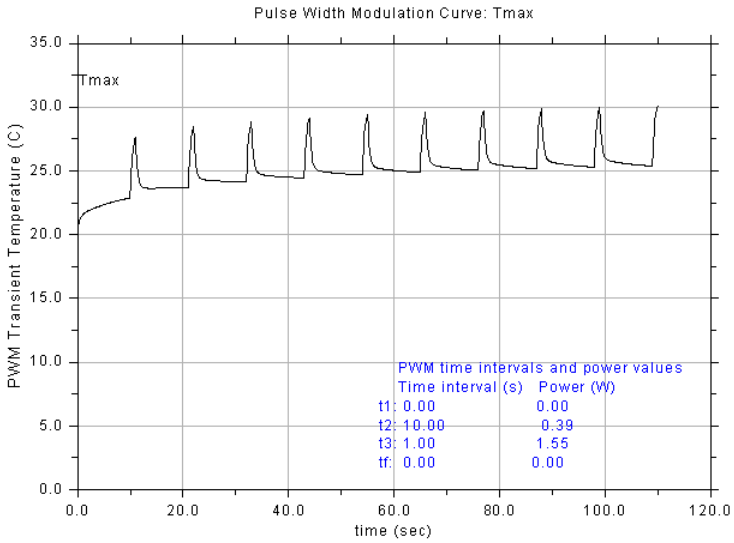


5 mm trace on IPC-2221 board

11 Amp 10 sec
0 Amp 20 sec

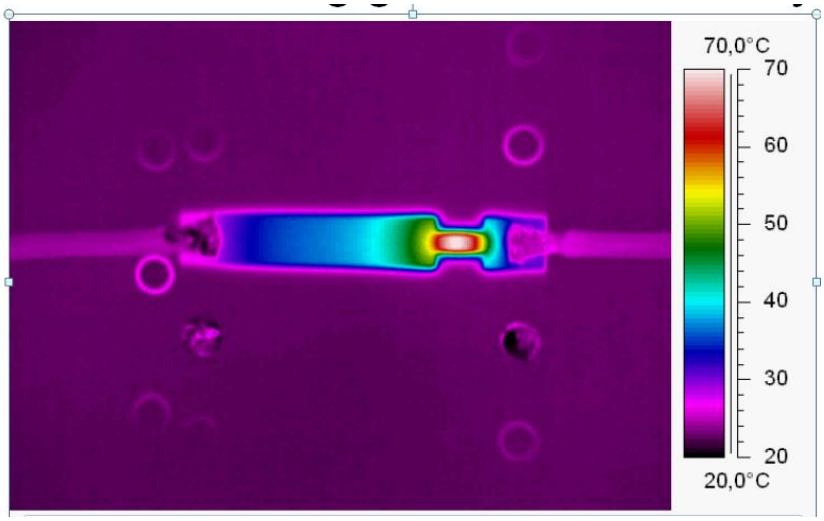
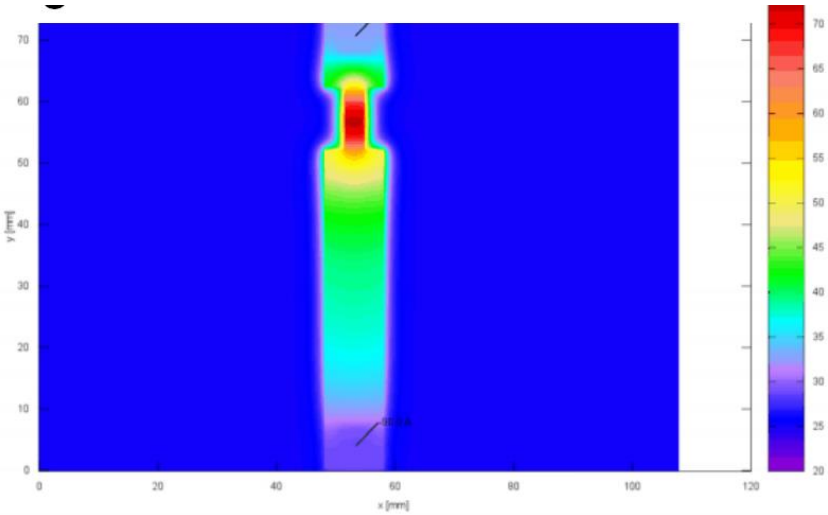
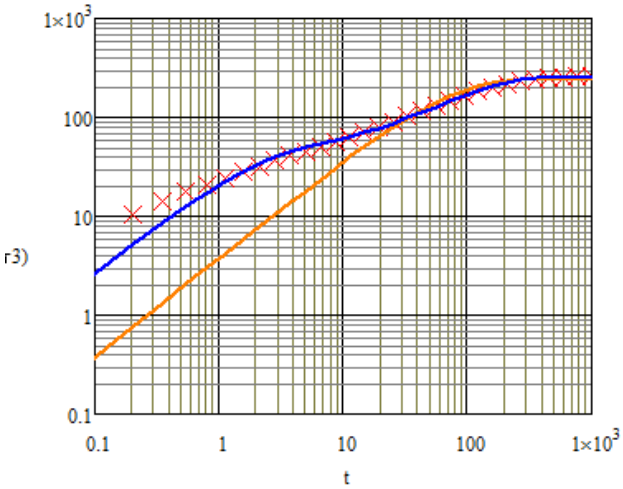


11 Amp 10 sec
5 Amp 1 sec



11 Amp 1 sec
5 Amp 10 sec

TRANSIENT SHORT-CIRCUIT ANALYSIS

	Thermography (one frame in animated record)
	TRM Simulation
	Heating Curve of the hotspot in log-log system

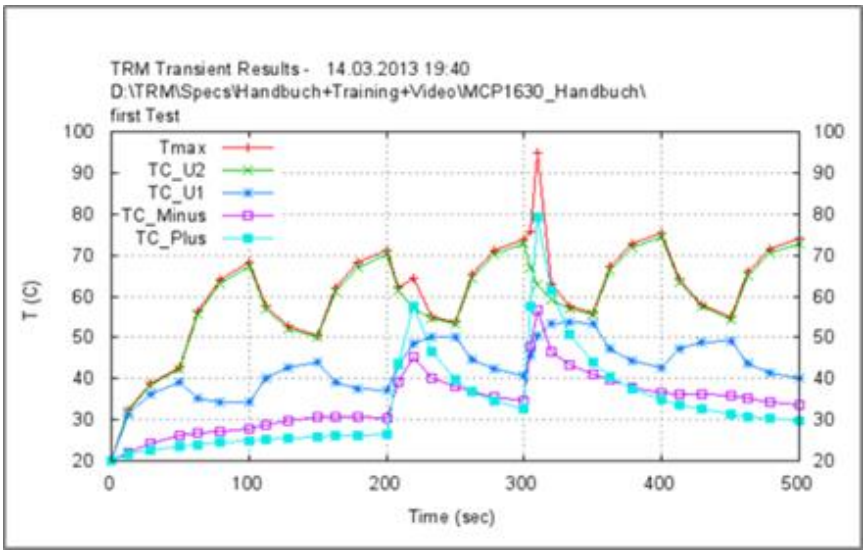
ARBITRARY POWER AND CURRENT STEPS FROM MS-EXCEL FILE

	A	B	C	D	E
1	time	MINUS	PLUS	U1	U2
2	0	-5	5	0.2	0.1
3	50	-5	5	0.1	0.2
4	100	-5	5	0.2	0.1
5	150	-5	5	0.1	0.2
6	200	-20	20	0.2	0.1
7	220	-5	5	0.2	0.1
8	250	-5	5	0.1	0.2
9	300	-30	30	0.2	0.1
10	310	-5	5	0.2	0.1
11	350	-5	5	0.1	0.2
12	400	-5	5	0.2	0.1
13	450	-5	5	0.1	0.2
14	500	*-5*	*5*	***0.2***	***0.1***
15					

Input .xls file to switch power or current states of some components.

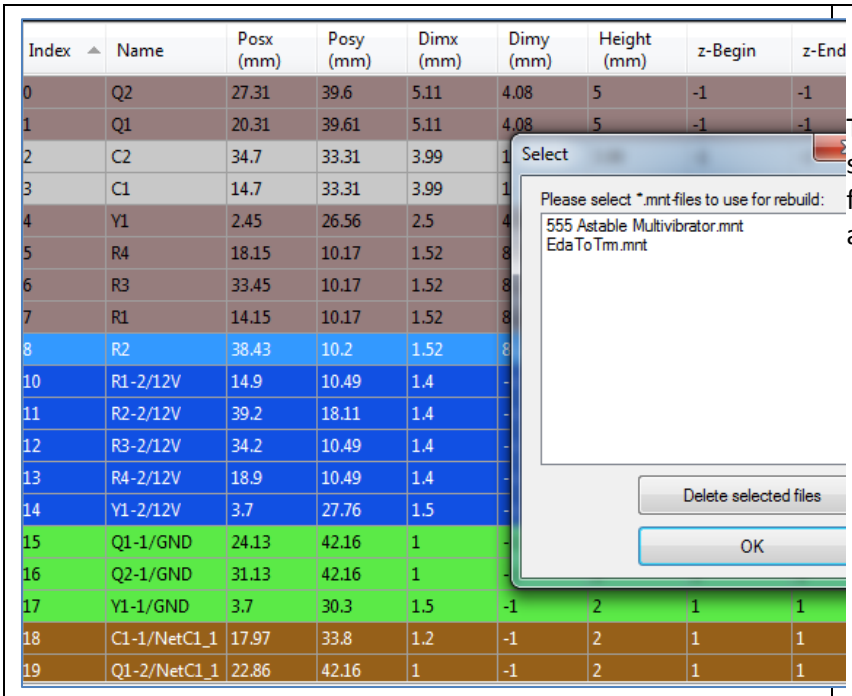
U1 and U2 are components, their values in Watt.

PLUS and MINUS are pins, their values in Amp.

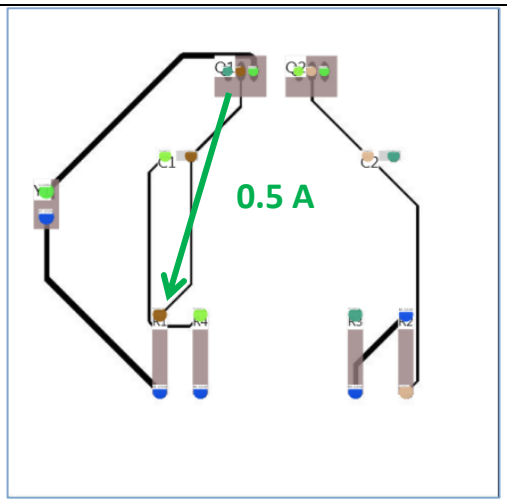


Transient record of virtual thermal couples due to current and power values from .xls above (plot is created automatically).

ALTIUM DESIGNER INTERFACE WITH THERMAL WIZARD

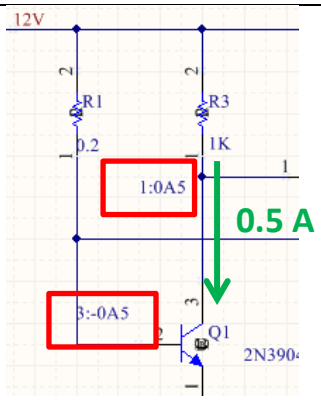


The interface places an Altium script file, creates a set of fabrication data and converts to an import file.



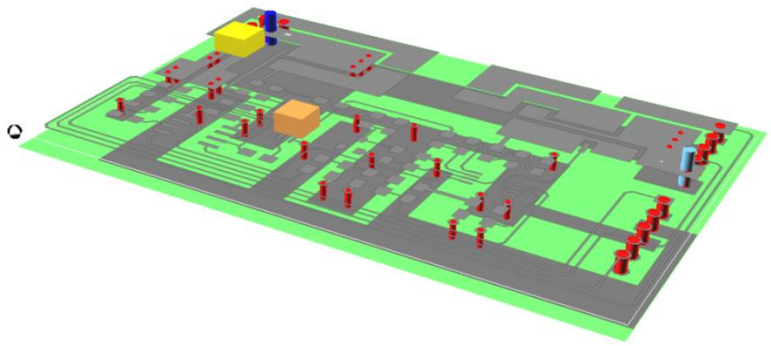
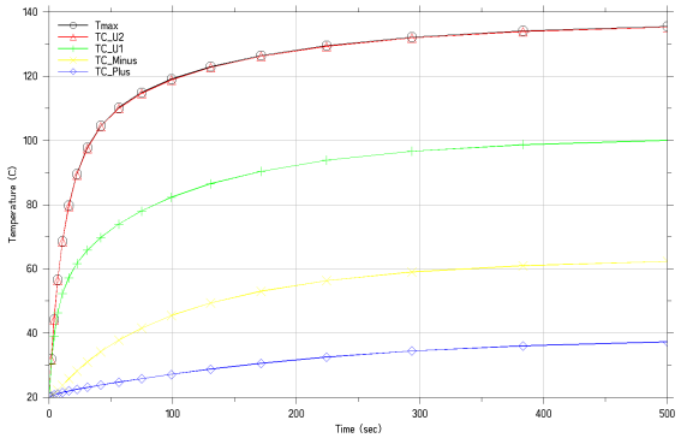
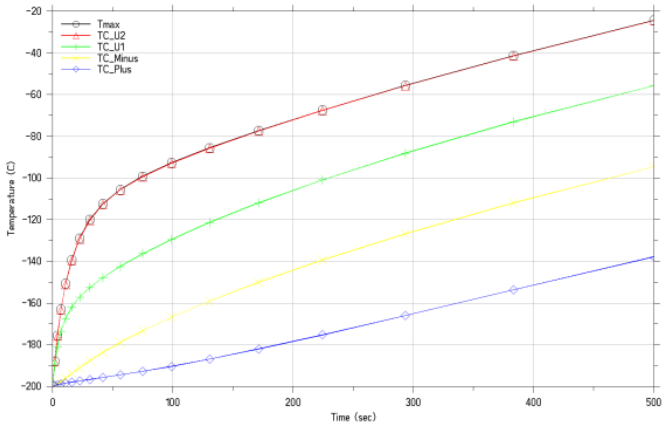
Pads no longer have to be placed manually.

Net color and pad color agree.



Values for electric currents can be supported net by net in the Altium project schematics.

VACUUM COOLING

	3D view of a 2-layer printed board model “MCP1630” with 2 surface mounted components U1 (yellow) and U2 (orange). Grey contours are layout data. Plated drilled holes in red cylinders.
	Stefan-Boltzmann heating curve in vacuum at T_a=20 °C. Curve looks very similar to a heating curve with Newtonian cooling.
	Stefan-Boltzmann heating curve in vacuum at T_a=-200 °C. With characteristic difference.