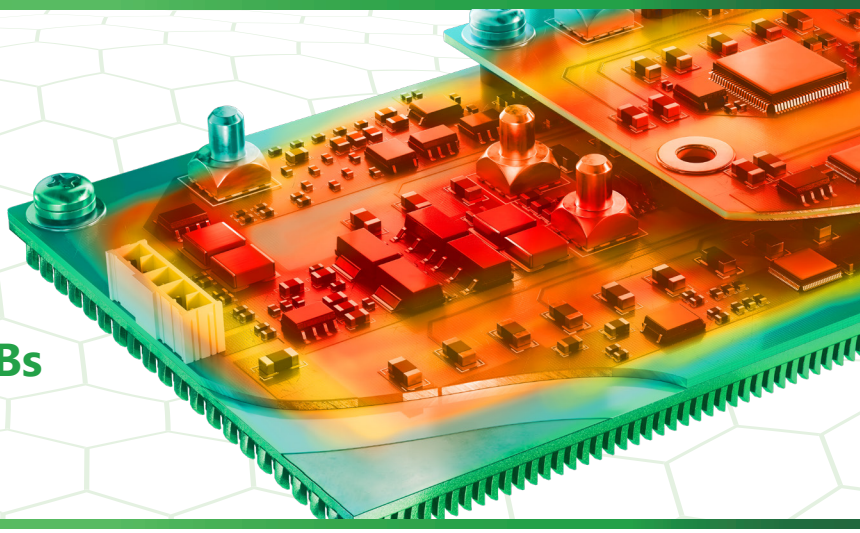
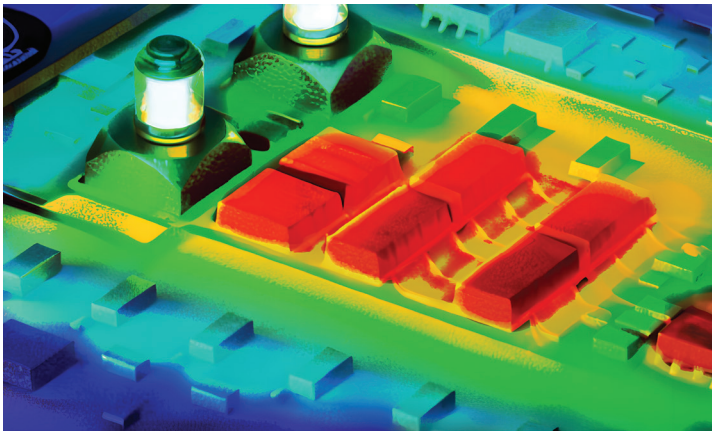
TCLAD™

Hot Spots & Cool Tricks: Taming Heat in High-Power PCBs



At TCLAD, we specialize in thermal management and are constantly pushing the limits of PCB thermal performance. Our latest innovation is a new PCB substrate built with SFL-12, our proprietary high-performance dielectric. A compelling alternative to standard FR4, SFL-12, offers outstanding thermal conductivity, electrical isolation, and mechanical strength. We're currently testing this novel approach for high-power applications – and the early results are promising.



Standard FR4

To put our innovation to the test, we've partnered with Freedom CAD for PCB design and Revco Products for board assembly, building identical test circuits using both standard FR4 and our SFL-12 dielectric material. We're now collaborating with Professor Martin Anselm at the Department of Manufacturing and Engineering Technology at Rochester Institute of Technology (RIT), where thermal performance testing is underway.

HOW WE BUILT IT

Test boards feature a six-layer stackup with a symmetrical layout divided into four quadrants. In each quadrant, four identical SOT223 power transistors serve as heat-generating components. To optimize heat dissipation, the design includes dedicated ground planes and thermal vias that spread heat between the top and bottom layers. Additionally, each quadrant is equipped to test Surface Mount Thermal Bridge (SMTB) components, allowing us to evaluate several of TCLAD's SMTB heat-spreading solutions.

TEST BOARD CONSTRUCTION

The SFL-12 test board is built with152µm cores of SFL-12 dielectric, reinforced with glass fiber for enhanced structural strength.

Copper thicknesses throughout both the FR4 and SFL-12 boards are as follows:

- **Layer 1:** 17µm copper foil + 25µm plating
- **Layers 2 – 5:** 35µm copper foil
- **Layer 6:** 17µm copper foil + 25µm plating

Total finished thickness of both the FR4 and SFL-12 test boards, including solder mask, is 1,593µm.

Figure 1. SFL-12 PCB stackup

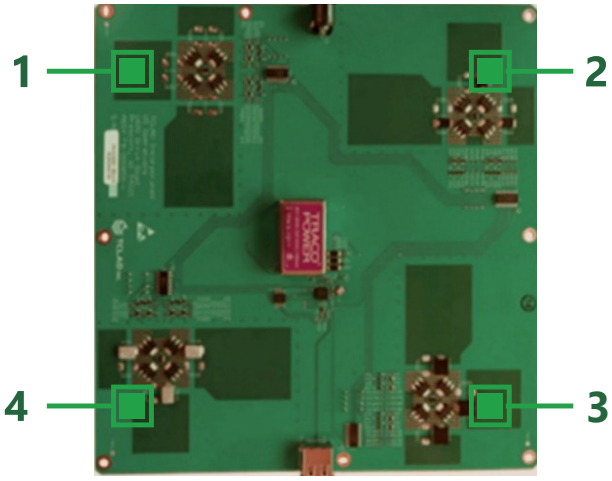


Figure 2. FR4 Test Board (6-layers, 4-quadrants)

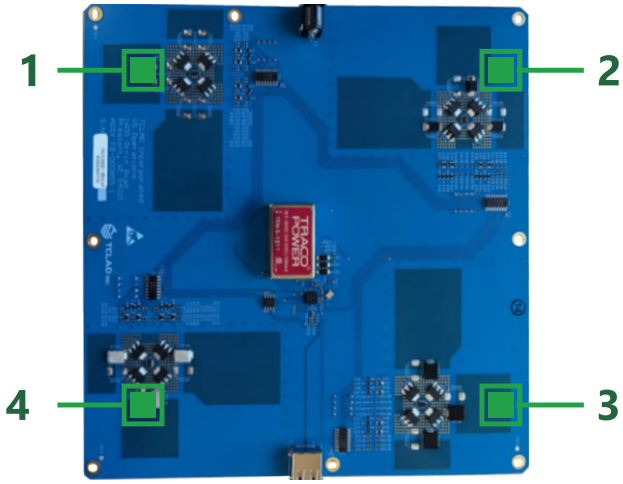
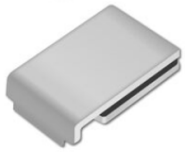


Figure 3. SFL-12 Test Board (6-layers, 4-quadrants)

- **Quadrant 1 (lower left):** Contains four SOT223 transistors with no thermal bridges
- **Quadrant 2 (upper left):** Includes four SOT223 transistors and three SMTB components (P/N SMTB2114P30E)
- **Quadrant 3 (upper right):** Includes four SOT223 transistors and three SMTB components (P/N SMTB3123P30E)
- **Quadrant 4 (lower right):** Includes four SOT223 transistors and three SMTB component (P/N SMTB2920P30M)

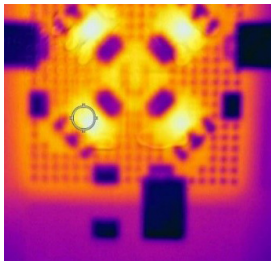
TEST BOARD COMPONENTS

Quadrant	Component	Quantity	Features	Image
1 – 4	SOT223 ZETEX - P/N FZ493	4	BV_{CEO} >100V I_C = 1A	
1	No Thermal Bridges	-	-	-
2	Thermal Bridge P/N SMTB2114P30E	3	Θ= 4.0°C/W Molded Package	
3	Thermal Bridge P/N SMTB3123P30E	3	Θ= 1.1°C/W Molded Package	
4	Thermal Bridge P/N SMTB2920P30M	3	Θ= 0.7°C/W Lead Frame Pack-age	

FIRST GLIMPSE AT TESTING

To evaluate thermal performance, RIT is using a FLIR thermal imaging camera to capture accurate, non-contact temperature measurements.

Below is a first look at the results, comparing maximum component temperatures in each quadrant between the standard FR4 board and the SFL-12 test board.



FLIR Thermal Image

INITIAL RESULTS

Quadrant	Max Temp FR4 test board	Max Temp SFL-12 test board	ΔT
1	279°F (137.2°C)	231°F (110.6°C)	-48°F (-26.6°C)
2	251°F (121.7°C)	224°F (106.7°C)	-27°F (-15.0°C)
3	245°F (118.3°C)	222°F (105.6°C)	-23°F (-12.7°C)
4	237°F (113.9°C)	215°F (101.7°C)	-22°F (-12.2°C)

This early data clearly demonstrates a consistent reduction in maximum component temperatures when using SFL-12, an encouraging result for high-power PCB applications.

Comparing Quadrant 1 and Quadrant 4 on both the FR4 and SFL-12 test boards highlights the impact of thermal bridges.

- **On the FR-4 board,** adding thermal bridges lowered the maximum temperature by as much as 42°F (23.3°C)
- **On the SFL-12 board,** the same thermal bridges provided an additional 16°F (8.9°C) reduction

PROMISING FIRST STEPS TOWARD A COOLER, MORE POWERFUL FUTURE

These early results show the strong potential of combining advanced dielectrics materials like SFL-12 with Surface Mount Thermal Bridges (SMTBs) for heat management. We are excited by these initial results and look forward to completing testing and analyzing the data in more depth.

Our goal is to validate SFL-12 as a drop-in replacement for standard FR4 — delivering substantial thermal performance improvements without requiring costly redesign. Based on what we've seen so far, SFL-12 could be a game changer for high-powered applications. Contact us to learn how we can implement this exciting thermal management solution in your system!

To learn more about TCLAD visit **tclad.com**

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Across the Board, Around the Globe, TCLAD is the most recognized IMS thermal management material for performance and reliability.

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