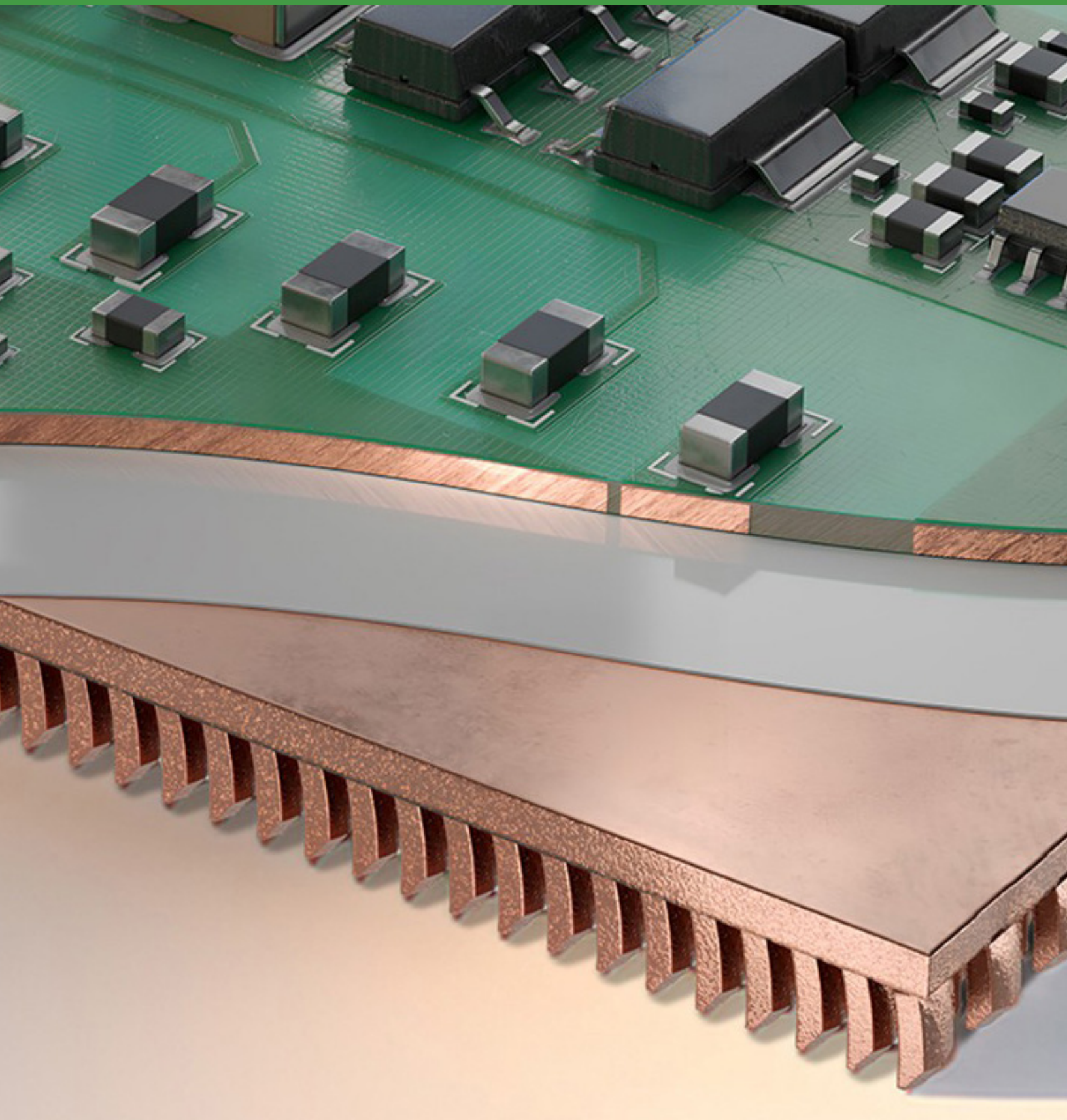
TCLAD™

Product Selection Guide



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Who we are

TCLAD is a global leader in advanced thermal management solutions for high-power electronics. With roots dating back to 1987, our story began with the pioneering development of Thermal Clad® materials — a breakthrough that set a new standard for managing heat in demanding applications. From our 100,000 sq. ft. Innovation Center in Prescott, Wisconsin, our dedicated team continues to push the boundaries of performance, quality, and reliability.

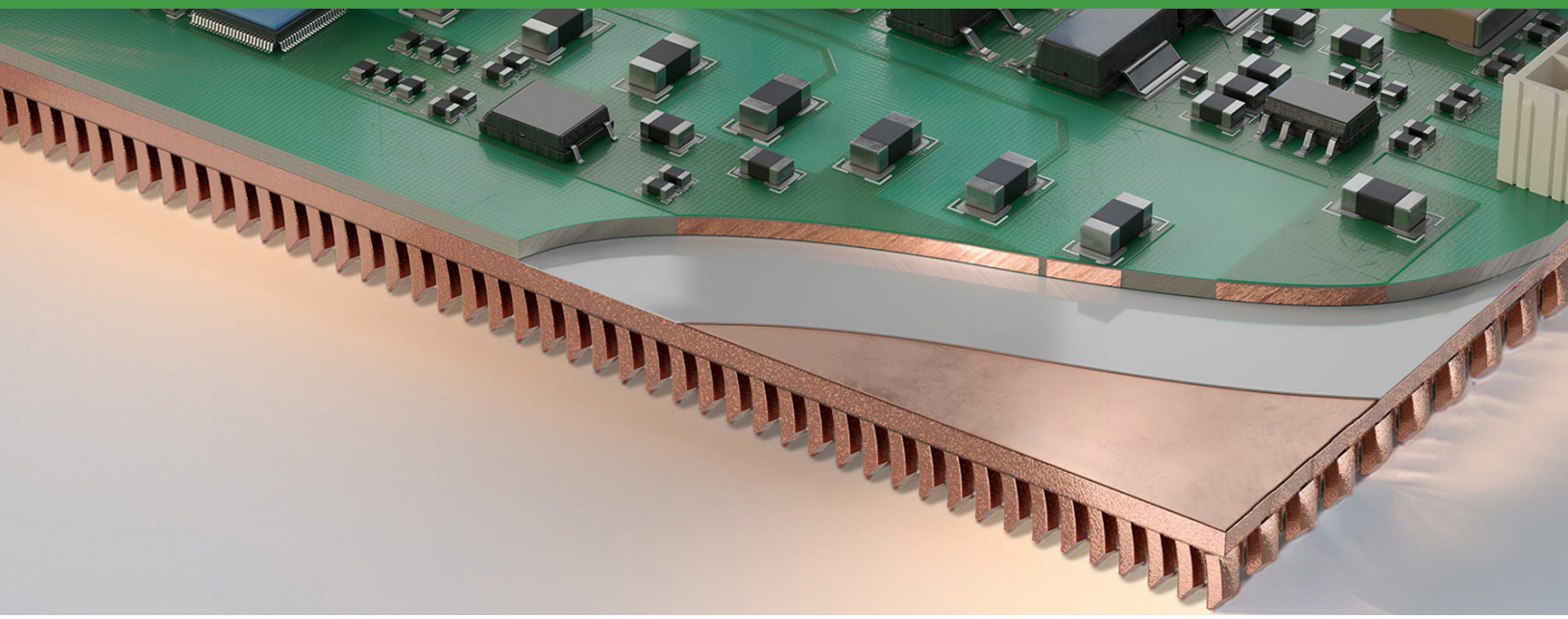
What we do

We engineer and manufacture innovative solutions for high power applications that divert heat, improve efficiency, and extend product life – enabling higher performance thermally, switching speeds, and shielding in smaller, more compact designs. Our expertise spans industries including automotive, industrial automation, aerospace, and defense. With cutting-edge materials, precision manufacturing, and rigorous in-house testing, TCLAD partners closely with customers to solve complex thermal challenges and deliver proven results.

Quality & Safety Certifications

At TCLAD, we conduct rigorous electrical and thermal testing in our state-of-the-art laboratories and undergo regular audits to ensure full compliance with the highest quality and safety standards.

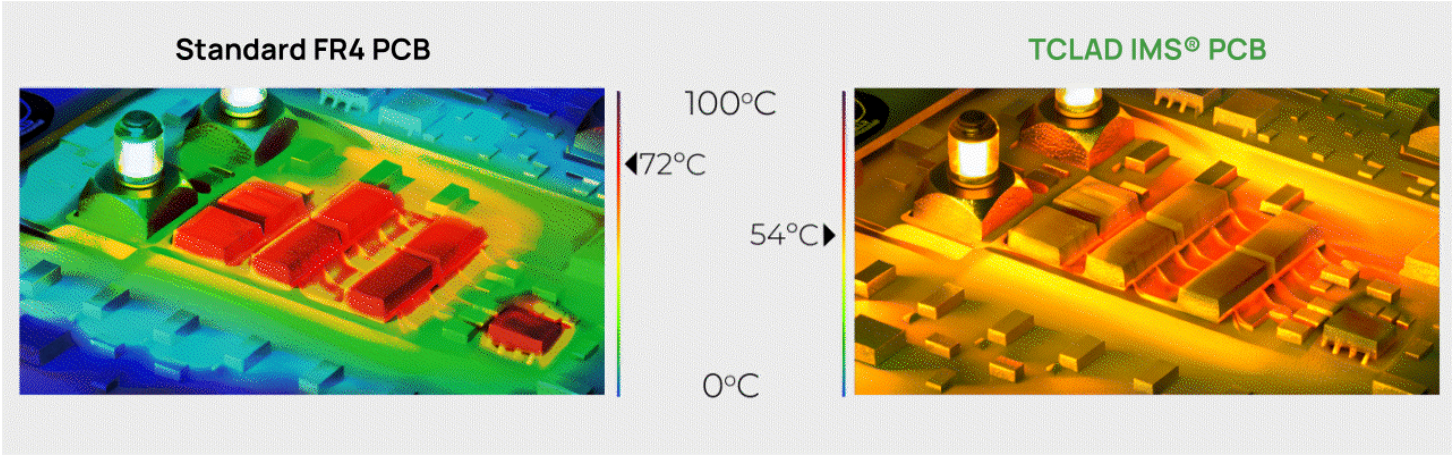
- ☑ IATF 16949: 2016
- ☑ ISO 9001: 2015
- ☑ ISO 14001: 2015
- ☑ UL 94V-0
- ☑ ULE121882
- ☑ ULE122713
- ☑ CMMC
- ☑ AS-9100
- ☑ REACH & RoHS
- ☑ DFARS
- ☑ ITAR
- ☑ NIST SP 800171



TCLAD's Insulated Metal Substrate (IMS®) solutions are purpose-built to meet the most demanding thermal challenges. Engineered for high-performance, our IMS®/Thermal Clad Metal Core PCBs (MCPCBs) dramatically reduce thermal impedance and improve heat conduction – enabling more effective and efficient heat transfer compared to traditional FR4 PCBs. Beyond enhancing thermal performance, TCLAD IMS® products offer outstanding mechanical strength, making them significantly more durable than conventional FR4 PCBs.

See the Difference with TCLAD IMS®

Independent testing proves TCLAD IMS® improves heat spreading, effectively lowering temperatures of critical components.

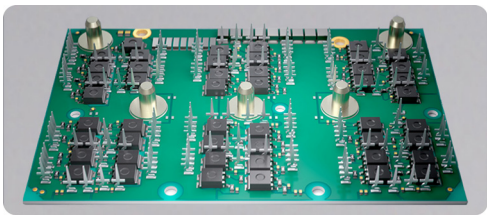


TCLAD IMS® reduces hardware and production costs by simplifying PCB design and assembly.

Standard FR4

- **66** Thru-Hole FETs
- **15** High Profile Capacitors
- **9** High Profile Bus Bars
- **3.4 lbs** Total Weight

TCLAD IMS®

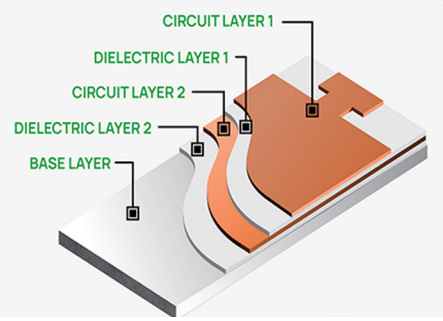


- **48** Surface Mount FETs
- **9** Low Profile Capacitors
- **5** Low Profile Bus Bars
- **0.82 lbs** Total Weight

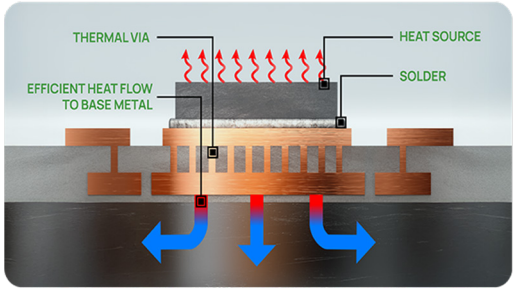
Anatomy of TCLAD IMS® PCB

Standard IMS® construction consists of:

- **Circuit Layers:** Etched copper circuitry, with typical thicknesses ranging from 0.5 oz. to 10 oz. (17 – 360 µm). 1-2 circuit layers are most common with advanced capability for higher layer counts.
- **Dielectric Layers:** Provide excellent electrical insulation and outstanding thermal conductivity. Our patented dielectrics are formulated with polymer and ceramic. The dielectric layer also serves to bond the base metal and circuit layers together.
- **Base Layer:** Typically made of aluminum or copper, with thicknesses tailored to meet specific application demands. This layer functions as a heatsink or heat spreader, playing a critical role in TCLAD IMS® thermal management.



IMS® enhances heat dissipation & EMI shielding



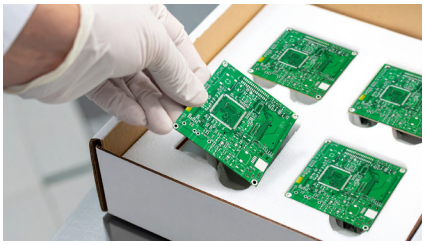
Thermal vias reduce thermal impedance

Thermal Clad Materials for IMS®/Metal Core PCBs (MCPCBs)

TCLAD offers a broad portfolio of IMS® dielectric materials available for direct purchase. We can also collaborate with you to custom-configure solutions that meet your specific requirements. From design concept and rapid prototyping to final production, we support every stage of development to ensure peak performance and manufacturability.

Copper or Aluminum Base Metals

Broad Portfolio of Patented Dielectric Materials



Custom IMS® Circuit Fabrication

Where IMS® Excels

- Power Converters
- Power Rails
- High-Power LEDs
- Motor Drives
- Automotive Electronic Control Unit
- Motor Controllers
- Solid-State Relays
- High-Voltage Devices
- Aerospace & Defense Applications
- Power Supply - Radar, Drone, & Direct Energy Weapons

Key Benefits of TCLAD IMS®

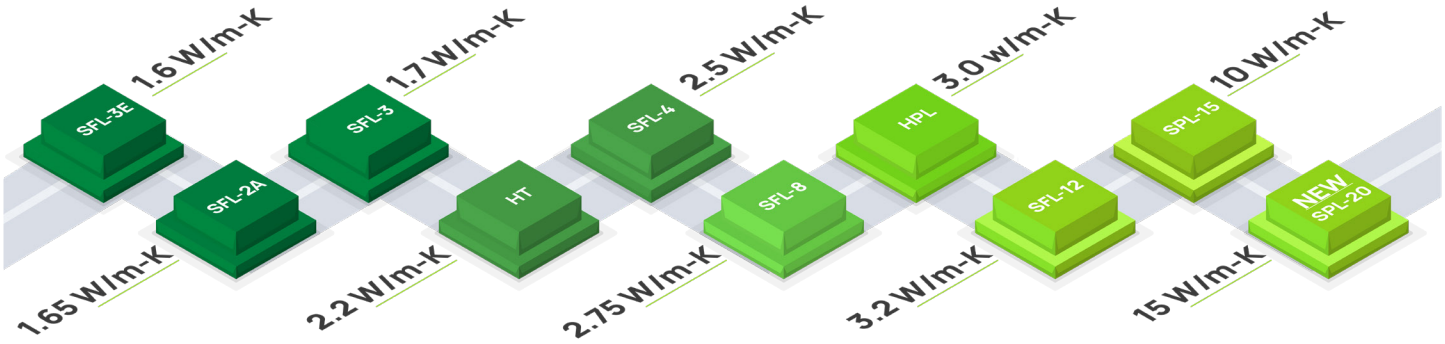
- RoHS & REACH compliant, halogen-free, PFAS-free
- Lowers component operating temperatures
- Very low moisture absorption & outgassing
- Extends component life
- Supports higher power densities
- Enables smaller & uniquely shaped PCB designs
- Shielding for high power switching, increased switching speeds (up to 6x)
- Minimizes need for heatsinks, mounting hardware, and Thermal Interface Materials (TIMs)
- Supports high-current & high-voltage applications
- Improves mechanical durability and long-term reliability
- Supports higher power densities
- Reduces assembly complexity and cost

Thermal Clad Dielectrics

TCLAD offers the industry's most extensive range of dielectric materials, providing unmatched design flexibility across a variety of PCB formats – from insulated metal substrate (IMS®), to prepreg (PP) composites, Thermal Conductive Thin Core series (TCC) and Resin Coated Copper (RCC) foil.

High-Performance Dielectrics by TCLAD

Engineered for High-Power IMS®/MCPCB Applications



Where Thermal Clad Dielectrics Excel

- High-Power IMS® & MCPCBs
- EV Power Modules & Fast Chargers
- Solar Power Inverters & Optimizers
- Robust Eutectic AuSn Die Attach
- High-Reliability ENEPIG Surface Finishes
- Wide-Bandgap GaN & SiC Applications
- Harsh Environment Defense Applications

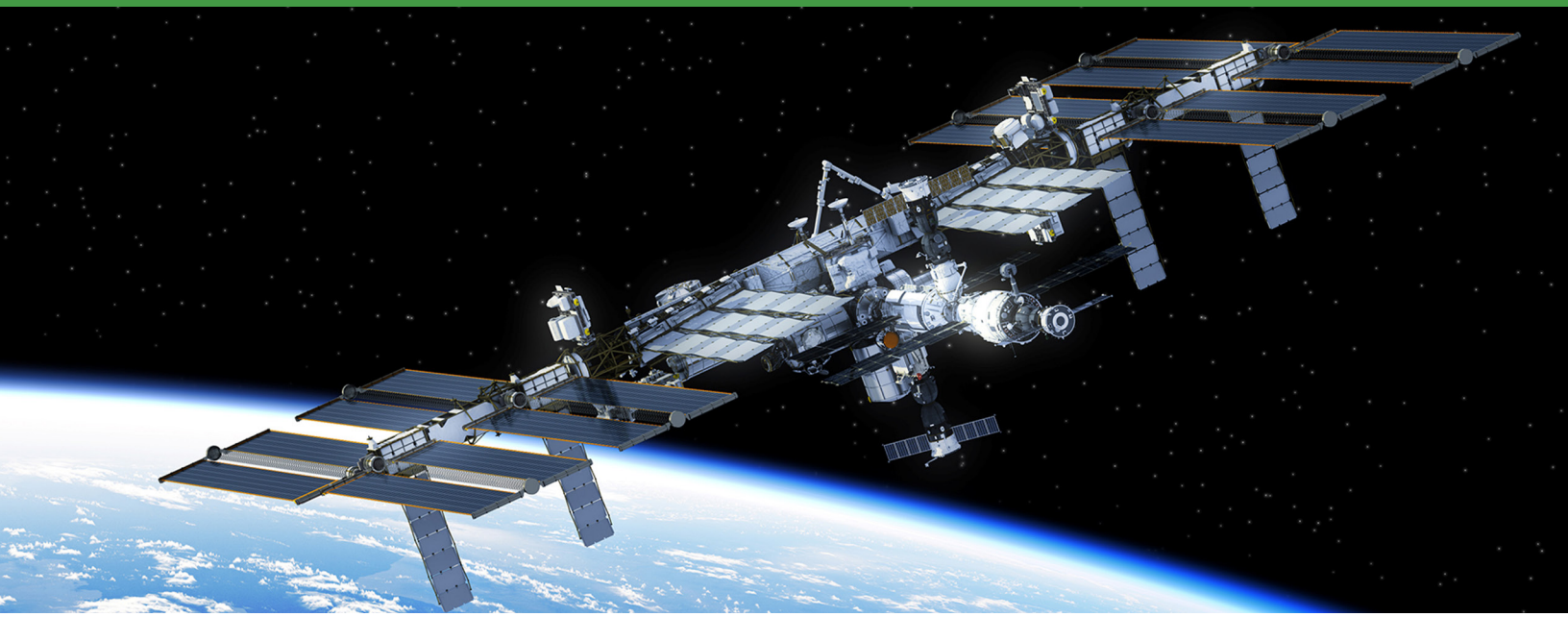
Key Benefits of Thermal Clad Dielectrics

- Low z-axis expansion for stability under thermal cycling
- Supports thin stack-up designs for compact assemblies
- Solvent-free, low-VOC options for sustainable manufacturing
- High electrical insulation and breakdown strength
- Lead-free process compatibility
- Durable and reliable for long-term performance
- Semi-flexible bond layer absorbs stress and strain
- Built for extreme automotive, military, and aerospace conditions

RoHS compliant

Thermal Clad Products	Typical Thickness	Thermal Conductivity (W/m-K)	Thermal Resistance (°C-in²/W)	Breakdown Voltage (KVAC)	Glass Transition (Tg°C)	CTE in XY/Z <Tg (µm/m°C)	CTE in XY/Z <Tg (µm/m°C)
SFL-3E	4.0 mil (100µm)	1.6	<0.13	7	55	24	37
SFL-2A	4.0 mil (100µm)	1.65	<0.13	6	130	20	30
SFL-3	4.0 mil (100µm)	1.7	<0.12	6	140	25	32
HT	3.0 mil (76µm)	2.2	0.05	8.5	150	25	95
	4.0 mil (100µm)	2.2	0.077	9.3	150	25	95
	6.0 mil (152µm)	2.2	0.11	11	150	25	95
	9.0 mil (225µm)	2.2	0.16	20	150	25	95

Thermal Clad Products	Typical Thickness	Thermal Conductivity (W/m-K)	Thermal Resistance (°C-in²/W)	Breakdown Voltage (KVAC)	Glass Transition (Tg°C)	CTE in XY/Z < Tg (µm/m°C)	CTE in XY/Z < Tg (µm/m°C)
SFL-4	4.0 mil (100µm)	2.5	0.11	5	150	16	25
SFL-8	4.0 mil (100µm)	2.75	0.08	5	150	28	35
HPL	2.0 mil (50µm)	3.0	0.026	7.7	185	35	85
	4.0 mil (100µm)	3.0	0.031	12.2	185	35	85
	6.0 mil (152µm)	3.0	0.039	17.4	185	35	85
SFL-12	4.0 mil (100µm)	3.2	0.06	5	180	15	18
SPL-15	4.0 mil (100µm)	10.0	<0.015	4	270	11.7	24.3
SFLG-8	4.0 mil (100µm)	1.85	0.09	5	150	28	35
SFLG-12	4.0 mil (100µm)	2.8	0.065	5	180	15	18



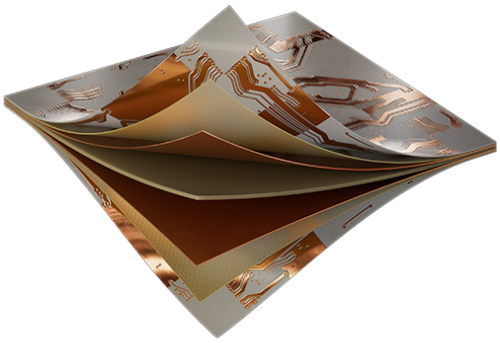
Innovative Board-Level Thermal Management Solutions

At TCLAD, our Engineers are constantly developing new methods to manage and reduce heat. As the demand for high-performance, power-dense systems increases, system designers need innovative materials and technologies to create compact, robust solutions that withstand extreme conditions, operate at higher temperatures, voltages, and switching frequencies – all while maintaining long-term efficiency and reliability. Effective thermal management is key to overcoming these challenges.

Multi-Layer Circuit Stacks with Thermal Clad Dielectrics

Thermal Clad dielectric film is easy to laminate, simplifying the fabrication of advanced multi-layer circuit boards. By vertically stacking copper foils with glass-fiber-reinforced dielectric layers, we create complex circuit structures that deliver superior thermal conductivity, electrical isolation, and mechanical strength. When paired with a copper base plate, blind vias can be implemented to create conductive pathways between circuit layers and the base – boosting thermal conduction and electrical performance.

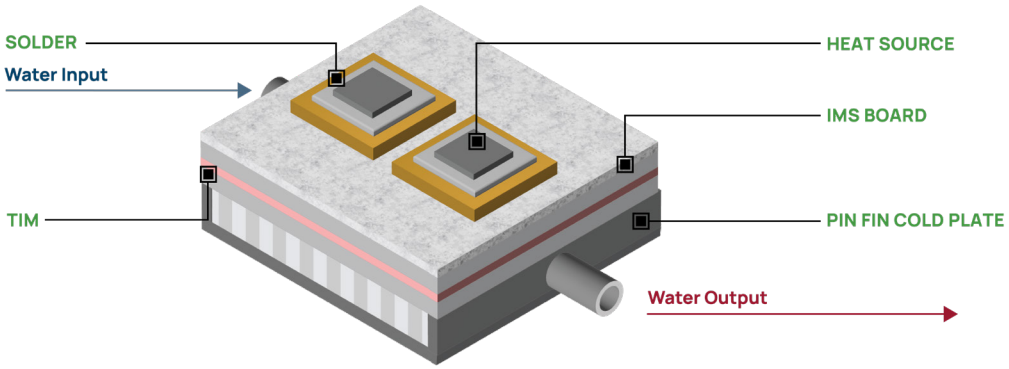
Ideal for high-power and high-frequency RF applications that demand low dielectric constant and minimal loss tangent, this cost-effective additive buildup process serves as a drop-in replacement for standard FR4. It delivers substantial thermal performance improvements without the need for costly redesign.



Multi-Layer Thermal Clad PCB

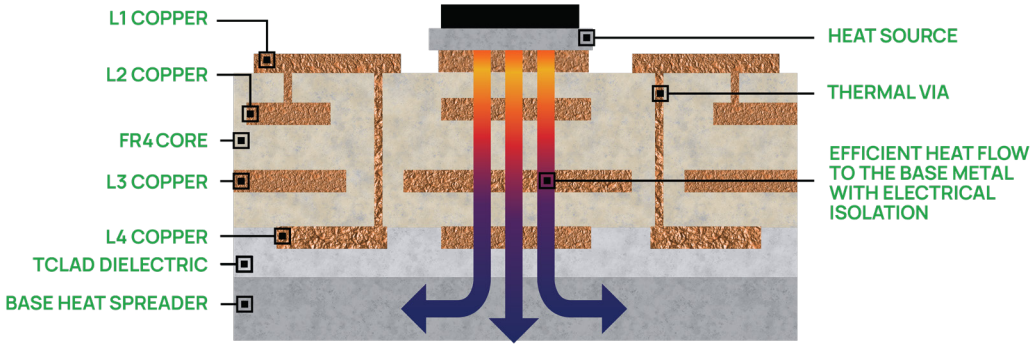
High-Performance Liquid Cooled IMS®

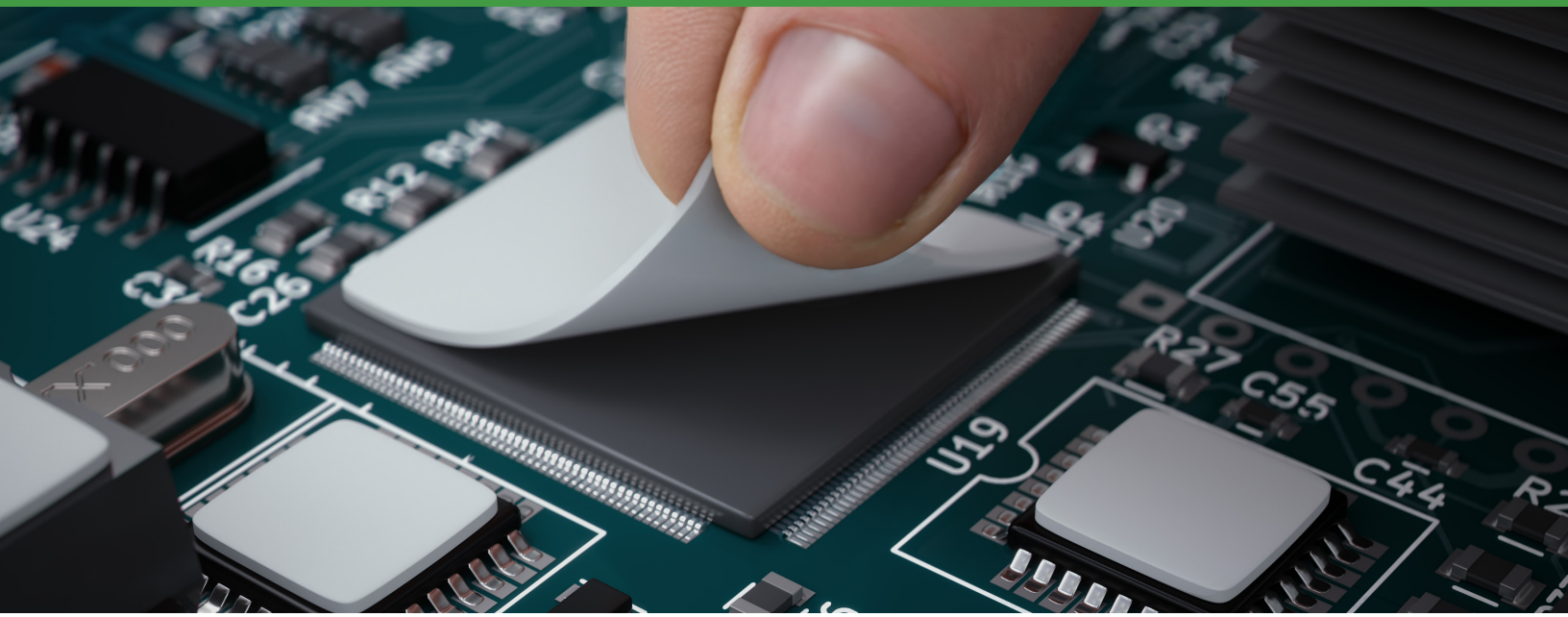
Our Liquid Cooled IMS® solutions offer a highly efficient method of reducing thermal resistance and enhancing overall cooling performance. These advanced designs integrate liquid cooling with a pin-fin or metal-foam cold plate and an IMS® PCB to maximize heat transfer to the cooling fluid. They are compatible with water cooling and can be further enhanced using TCLAD's proprietary liquid dielectric cooling fluid, delivering superior thermal performance for the industry's most demanding applications.



Integrated FR4 & IMS® Constructions

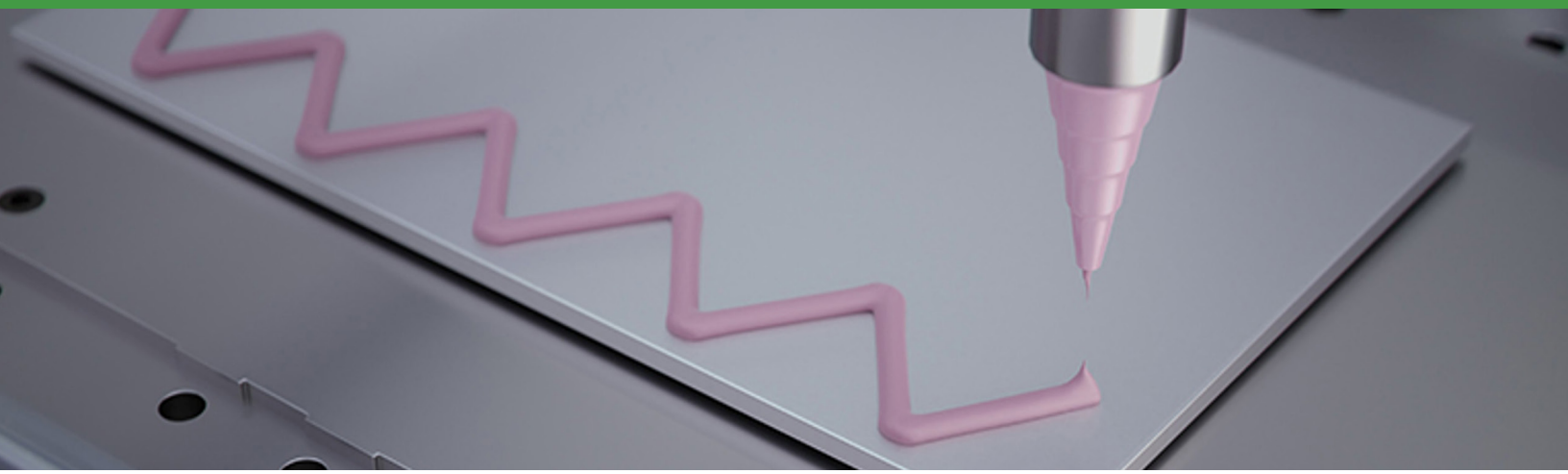
This hybrid thermal management solution combines the familiarity of FR4 with the advanced performance of IMS® technology. By maintaining standard FR4 layouts, this solution streamlines the transition to improved thermal performance with IMS®. The integration of Thermal Clad dielectric and base metal enhances heat dissipation, increases mechanical strength, boosts component reliability, and delivers effective EMI shielding.





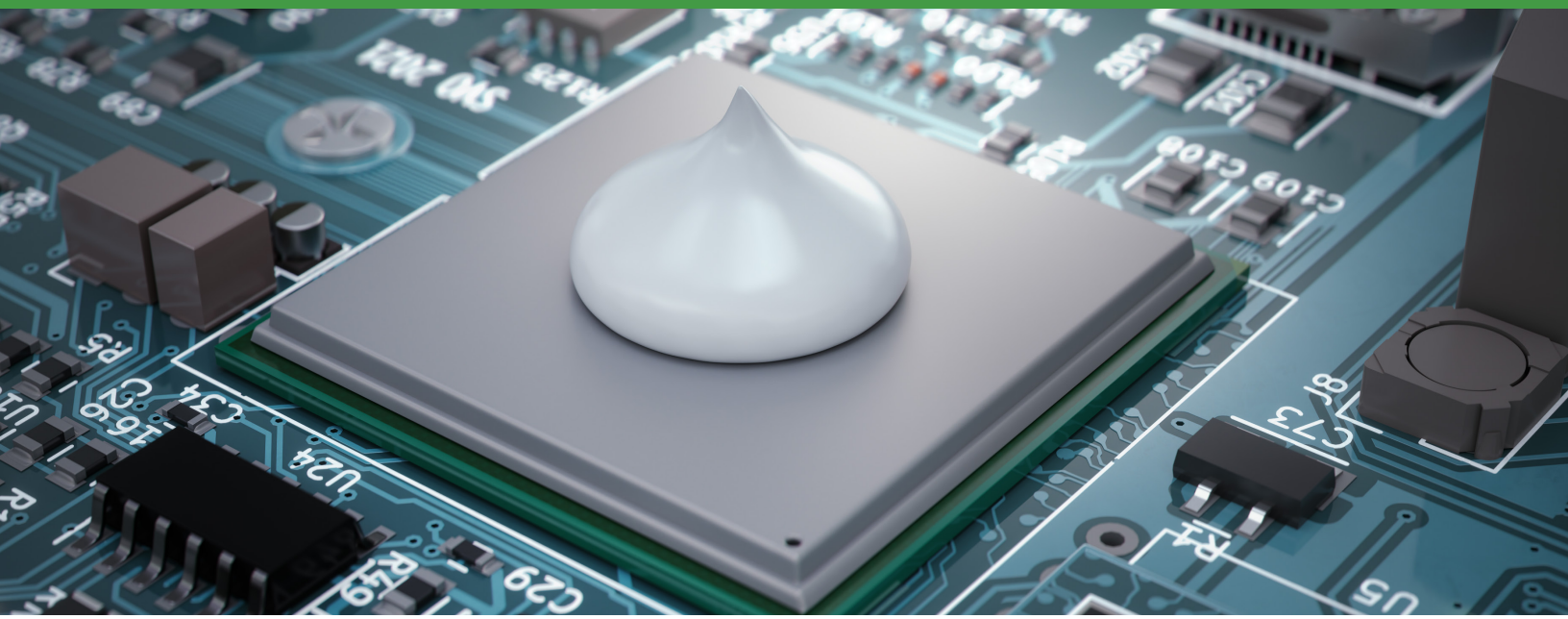
TCLAD Thermally Conductive Filler Pads (TCFPs) are soft, highly conformable, materials designed to absorb shock and vibration while effectively filling air gaps between uneven surfaces. Formulated with a silicone base and thermally conductive fillers, these pads deliver excellent thermal conductivity. Available in sheets or custom-cut shapes and a variety of thicknesses, our TCFP materials provide versatile and reliable solutions for diverse thermal management applications.

TCFP Pad Series	Typical Thickness (mm)	Thermal Conductivity (W/m-K)	Dielectric Constant (@1 GHz)	Shore Hardness
TCFP 2.0	0.5 - 10	2.0	6.5	30
TCFP 3.0	0.5 - 10	3.0	6.8	45
TCFP 4.0	0.5 - 10	4.0	7.0	45
TCFP 5.0	0.5 - 10	5.0	7.3	50
TCFP 5.1	0.5 - 2.0	5.0	7.3	50
TCFP 6.0	0.5 - 10	6.0	7.7	55
TCFP 8.0	0.5 - 10	8.0	8.1	55
TCFP 10.0	0.5 - 4	10.0	9.9	55
TCFP 10.0US	0.5 - 4	10.0	9.8	15
TCFP 12.0	0.5 - 4	12.0	9.9	55
TCFP 15.0	0.5 - 4	15.0	10.5	55



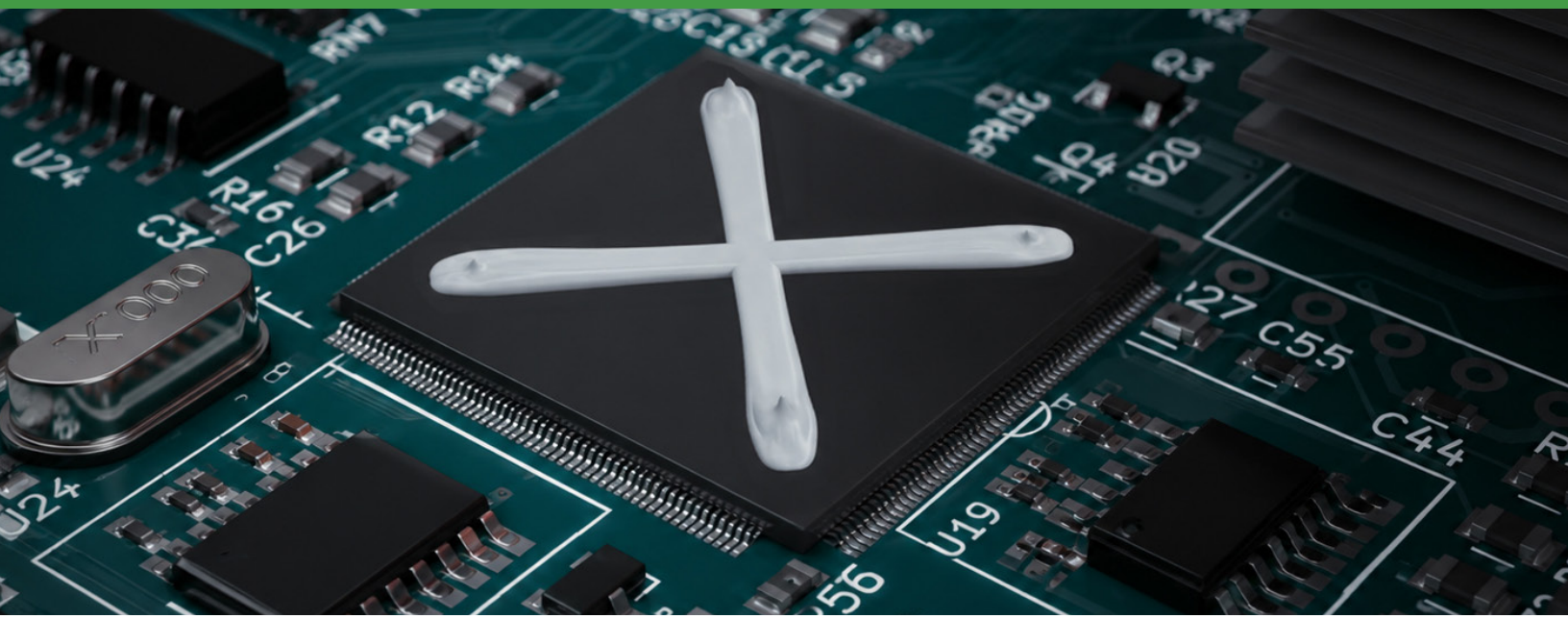
TCLAD Thermally Conductive Filler Liquids (TCFLs) are two-part liquid systems that are mixed prior to application. Once blended, the material is pressure-dispensed to eliminate air gaps, then cured into a solid form for long-term performance. In their liquid state, TCFLs are compatible with both automated and manual dispensing systems, conform easily to complex surface topographies, and provide excellent surface wetting. The TCFL-RW option is a reworkable formulation, allowing it to be easily peeled off after curing.

TCFLs	Viscosity Mixed (cP)	Thermal Conductivity (W/m-K)	Dielectric Constant (@1 GHz)	Shore Hardness
TCFL 2.0 LD	150,000	2.0	6.0	50
TCFL 3.5	250,000	3.5	7.5	50
TCFL 3.5 LV	350,000	3.5	7.5	50
TCFL 4.0S	150,000	4.0	7.5	50
TCFL 5.0	280,000	5.0	8.0	60
TCFL 5.0 RW	350,000	5.0	8.0	50
TCFL 6.5	300,000	6.5	8.1	50
TCFL 8.0	450,000	8.0	8.3	60
TCFL 10.0	320,000	10.0	8.0	60
TCFL 14.0	420,000	14.0	9.0	60



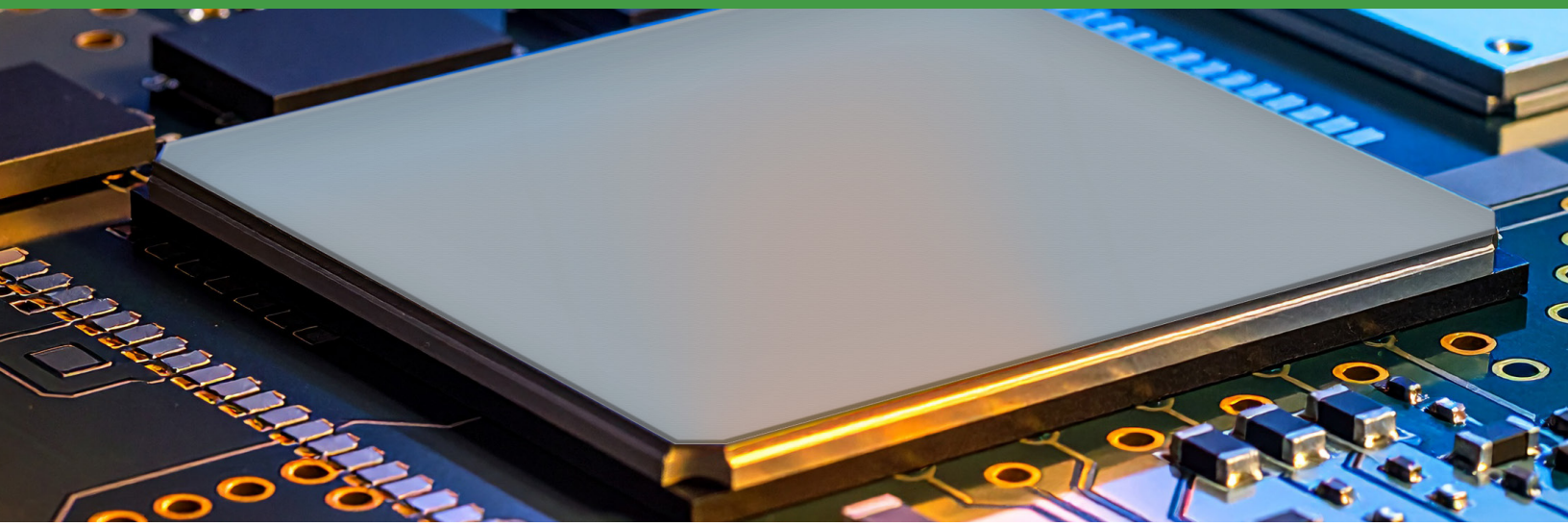
TCLAD's Thermally Conductive Grease Series (TCGS) delivers excellent heat dissipation, minimal bondline thickness, and superior wet-out performance. Designed to provide low interfacial resistance and extremely low thermal impedance, these greases are ideal for high power density applications, where a thin bondline is essential for optimal thermal conductivity. TCGS require no curing and are compatible with both automated dispensing and screen-printing processes.

TCGS Grease Series	Viscosity (cP)	Thermal Conductivity (W/m-K)	Typical Application Thickness (µm)
TCGS 2.0	< 90,000	2.0	30
TCGS 3.5	< 220,000	3.5	45
TCGS 5.0	< 220,000	5.0	45
TCGS 6.0	< 350,000	6.0	50



TCLAD's Thermally Conductive Adhesive are high-performance adhesive materials designed to provide both strong mechanical bonding and efficient heat transfer in electronic assemblies. Available in one-part and two-part formulations (with and without silicone based), TCA eliminates the need for mechanical fasteners while delivering reliable thermal management, excellent adhesion, and long-term durability. Ideal for bonding heatsinks, power devices, LEDs, automotive electronics, industrial equipment, and AI computing applications, TCLAD TCA products offer a range of thermal conductivities and cure options to meet diverse manufacturing and performance requirements.

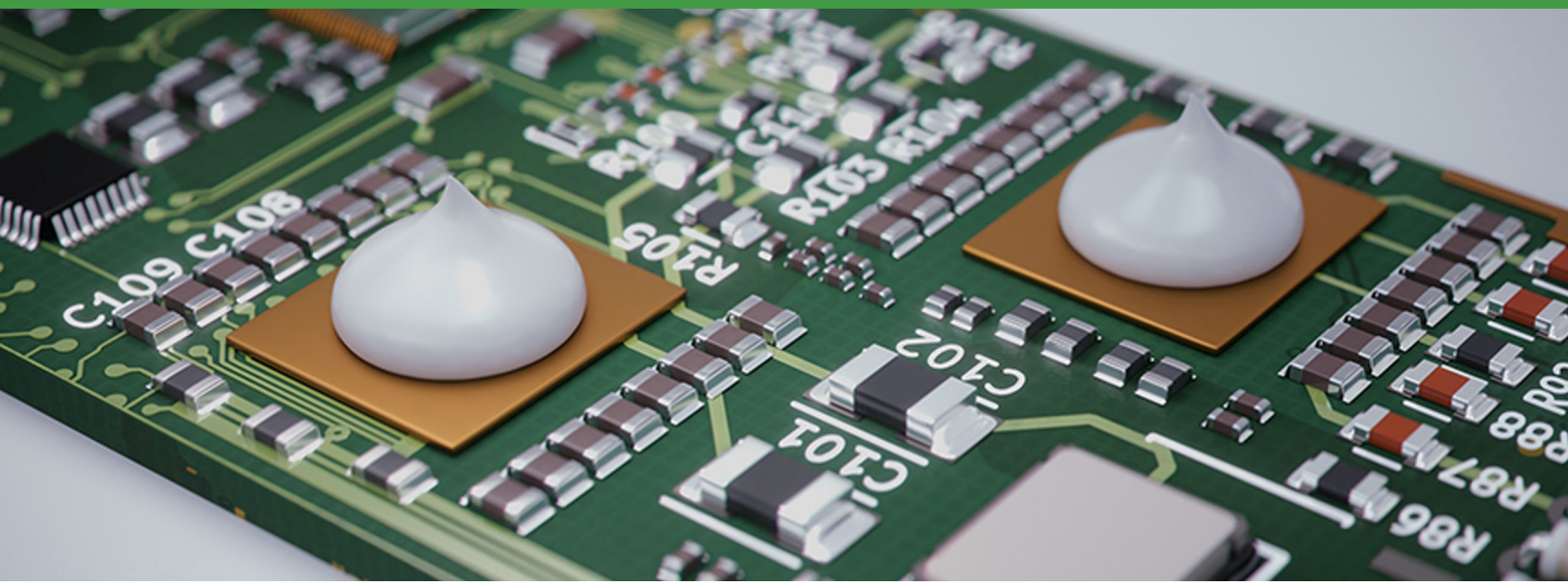
TCA Adhesives	Thermal Conductivity (W/m-K)	Chemistry	1 Part / 2 Part	Adhesion Al to Al
TCA 2.0	2.05	Silicone base	1 Part	4.1 MPa
TCA 2.1	2.1	Silicone base	2 Part	4.8 MPa
TCA 2.9	2.9	Polyurethane base	2 Part	3.46 MPa
TCA 3.5	3.5	Silicone base	2 Part	0.6 MPa



TCLAD's Phase Change Materials (PCMs & HCAs) absorb and release thermal energy as they transition from a solid to a wax-like state, offering a cleaner, easier-to-handle alternative to thermal greases. They are simple to apply — just remove the liner from one side, place the material onto the target surface, peel off the second liner, and press the mating surface together.

Heat Conductive Adhesives (HCAs) are a type of PCMs with built-in adhesive strength, enabling both efficient heat transfer and component bonding without additional adhesive layers.

PCM Series	Typical Thickness (mm)	Thermal Conductivity (W/m-K)	Transition Temperature (°C)	Continuous Use Temp (°C)	Shear Strength (MPa)
PCM 3.5	0.127	3.5	50	-40 to 125	–
	0.205	3.5	50	-40 to 125	–
	0.254	3.5	50	-40 to 125	–
	0.381	3.5	50	-40 to 125	–
PCM 2.5PI	0.127	2.5	50	-40 to 130	–
	0.205	2.5	50	-40 to 130	–
	0.254	2.5	50	-40 to 130	–
PCM 3.5P	0.02	3.5	50	-40 to 125	–
PCM 5.0	0.254	5.0	50	-40 to 125	–
PCM 8.5	0.254	8.5	45	-40 to 130	–
PCM 9.6	0.254	9.6	45	-40 to 130	–
HCA 2.0	0.254	2.0	60	-50 to 120	0.7
HCA 4.0	0.254	4.0	60	-50 to 120	0.3
HCA 5.0	0.254	5.0	60	-50 to 120	0.3



TCLAD Thermally Conductive Gel Liquids (TCGLs) are engineered for low-stress thermal management and offer easy rework and process flexibility. Ideal for assemblies with delicate components, these one-component, conformable gels are compatible with both automated and manual dispensing systems.

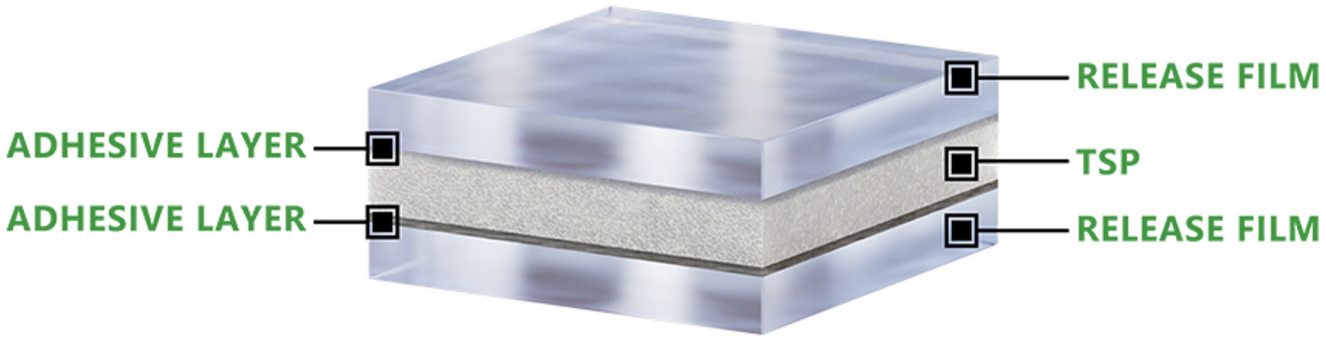
TCGL Gel Liquids	Minimum Bondline (cP)	Thermal Conductivity (W/m-K)	Dielectric Constant (@1 GHz)	Continuous Use Temp (°C)
TCGL 2.0 LP	0.06	2.0	3.7	-50 to 200
TCGL 2.0 RW	0.15	2.0	3.7	-50 to 200
TCGL 4.0	0.15	2.0	7.5	-50 to 200
TCGL 4.0A	0.04	4.0	7.5	-50 to 200
TCGL 4.0 LO	0.11	4.0	7.5	-50 to 200
TCGL 6.5C	0.14	6.5	8.0	-50 to 200
TCGL 7.0	0.1	7.0	8.0	-50 to 200
TCGL 10.0	0.12	10.0	9.8	-50 to 200
TCGL 12.0	0.12	12.0	10.0	-50 to 200
TCGL 15.0	0.25	15.0	–	-50 to 200

TCLAD Thermal Potting Materials (TPMs) are two-part systems, that once mixed and dispensed, function as both filler and encapsulant — protecting sensitive electronics from environmental factors such as dust and moisture. Formulated to efficiently conduct heat away from components like power-transistors to a heatsink or heat spreader, they deliver excellent thermal dissipation while enhancing mechanical integrity.

TPM Potting Compound	Cure Time	Thermal Conductivity (W/m-K)	Dielectric Constant (@1 GHz)	Shore Hardness	Tensile Strength (MPa)
TPM 0.5	4 hrs @ 25°C 10 min @ 150°C	0.5	6.6	5 (C)	0.2
TPM 1.0	4 hrs @ 25°C 10 min @ 150°C	1.0	6.8	45 (A)	1.3
TPM 2.0	4 hrs @ 25°C 10 min @ 150°C	2.0	6.8	65 (C)	0.9
TPM 3.0	4 hrs @ 25°C 10 min @ 150°C	3.0	7.1	65 (C)	0.6
TPM 4.0	4 hrs @ 25°C 10 min @ 150°C	4.0	7.5	65 (C)	0.5

TCLAD Thermal Insulation Pads (TIPs) are highly flexible, silicone-based materials designed to improve heat transfer while providing effective electrical isolation and toughness. Typically clamped between heat generating components and a heatsink, TIPs help protect temperature-sensitive components by minimizing thermal resistance. These pads are ideal for power semiconductor applications where dielectric strength is important for withstanding high voltage.

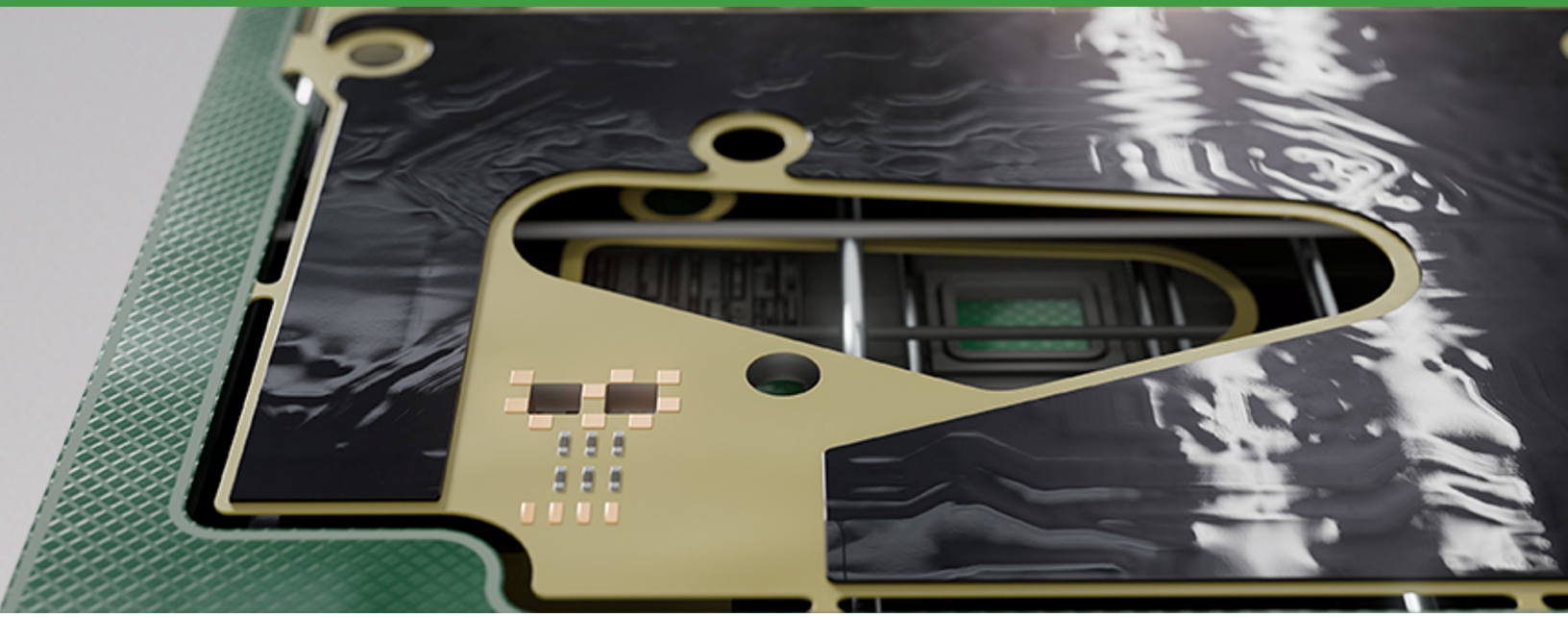
TIP Insulation Pads	Typical Thickness (mm)	Thermal Conductivity (W/m-K)	Dielectric Constant (@1 GHz)	Flame Rating (UL 94)
TIP 1.0	0.23	1.0	6.0	V-0
TIP 1.6	0.2	1.6	6.0	V-0
TIP 3.5	0.25	3.5	6.0	V-0
TIP 5.0	0.2	5.0	6.0	V-0



TCLAD Thermal Set Pads (TSPs & TSPF-H) are thermally conductive, electrically insulating materials designed to cure with heat and form strong, reliable adhesive bonds while efficiently transferring heat. TSPs are epoxy-based thermal bonding sheets engineered to maximize heat transfer while providing excellent adhesion and mechanical strength. They are ideal for applications requiring reliable thermal management combined with a durable structural bond. TSPF-H products are based on a fluorine-resin system and feature a soft, rubber-like, compressible structure. They provide excellent thermal dissipation while accommodating mechanical tolerances and movement, making them well suited for applications requiring flexibility, durability, and reliable thermal performance.

Both product families utilize high-performance thermally conductive fillers and are available in thin sheet formats, rolls, or custom die-cut shapes. Double-sided adhesive construction enables easy positioning and bonding between components while improving thermal transfer. Packaging options include bulk, trays, and reels, providing flexibility for prototyping through high-volume automated production.

TSP Set Pads	Cure Time	Thermal Conductivity (W/m-K)	Peel Strength (kgf/cm)
TSP 3.0	5 min @ 120°C	3.0	> 1.2
TSP 8.0	5 min @ 120°C	8.0	> 1.2
TSP 12.0	5 min @ 120°C	12.0	> 1.2
TSPF-H	5 min @ 120°C	8.6	> 4.0



TCLAD Thermally Conductive Inks (TCIs) are epoxy-based liquid materials that combine excellent thermal conductivity with reliable electrical insulation. Designed for tight spaces and complex geometries, TCIs offer excellent process flexibility and are compatible with dispensing, stencil printing, and spray-coating processes.

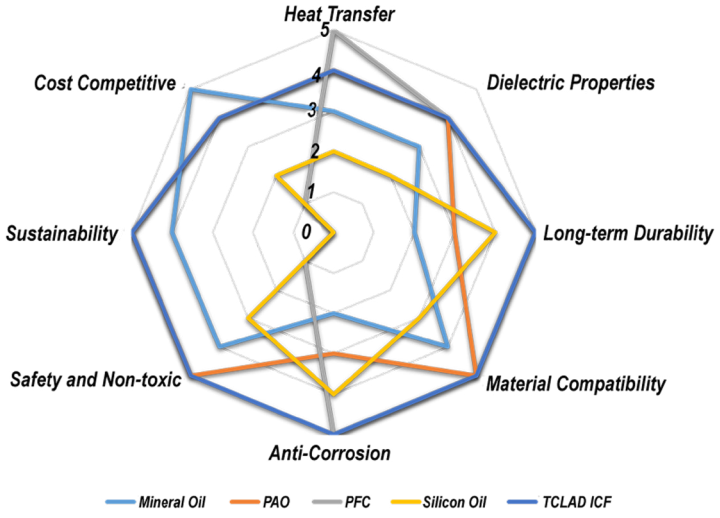
TCIs provide a versatile, printable thermal management solution that enables three-dimensional heat dissipation and conforms to complex component surfaces. They are well suited for applications such as passive components, metal enclosures, and other space-constrained designs where conventional thermal interface materials may be difficult to apply.

With their combination of thermal performance, electrical isolation, and design flexibility, TCLAD TCIs enable new approaches to advanced thermal management and help optimize heat dissipation in increasingly compact electronic designs.

TCI Printable Inks	Cure Time	Thermal Conductivity (W/m-K)	Operating Temperature Range
TCI-B-C40	1 hr @ 150°C	1.5	-40°C to 150°C
TCI-B-C160	1 hr @ 150°C	2.5	-40°C to 150°C
TCI-B-C260	1 hr @ 150°C	3.0	-40°C to 150°C
TCI-G-1000	1 hr @ 150°C	8.0	-40°C to 150°C
TCI-C60B-2K	90 min @ 90°C	1.5	-40°C to 150°C

Safe & Seriously Cool Immersion Fluids by TCLAD

TCLAD immersion cooling fluids are high-performance liquid dielectrics engineered for efficient thermal management of densely packed, high-heat generating electronic systems. These fluids do not conduct electricity and are non-corrosive, allowing safe submersion of electronic equipment and direct heat transfer at the source.



TCLAD Immersion Cooling Fluids (ICFs)

TCLAD's proprietary immersion cooling fluids provide an efficient, cost-effective and environmentally sustainable solution for managing high thermal loads in power–dense electronic systems. These advanced ester-based dielectric fluids are non-toxic, non-corrosive, and engineered for long-term operational reliability in mission-critical applications where sustainability is a priority.

By fully submerging heat-generating components in a thermally conductive, electrically insulating dielectric fluid, heat is removed directly at the source. As the fluid absorbs thermal energy, it becomes less dense and rises, creating a passive convection loop that circulates the fluid without pumps or moving parts. For applications requiring enhanced heat transfer, pumps can be added to accelerate fluid movement and cooling.

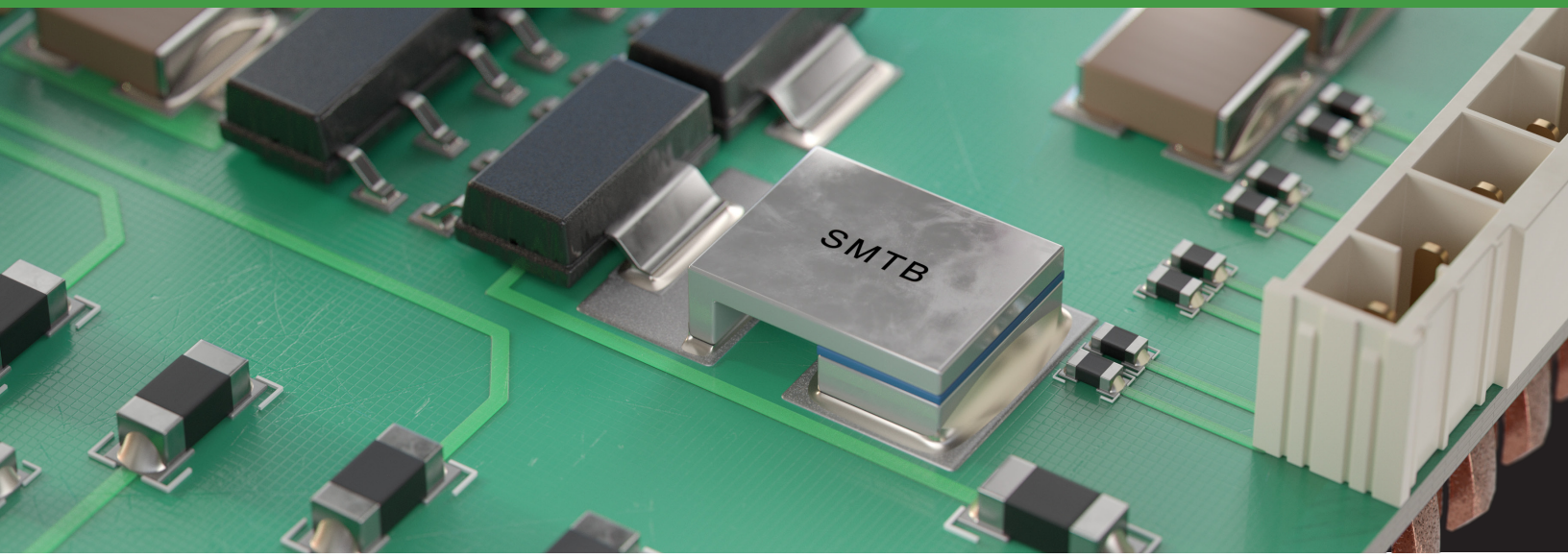
Due to their lower viscosity and higher density, TCLAD's ester-based immersion fluids outperform traditional alternatives such as mineral oil, polyalphaolefin (PAO), perfluorocarbon (PFC), and silicone oil — offering superior thermal performance and environmental benefits in a single solution.

Where ICF Excels

- Data Centers, AI, Crypto Mining
- Energy Storage Systems, Batteries
- Transformers & Compressors
- Telecom & Datacom
- HVAC Systems

Key Benefits of TCLAD Immersion Cooling Fluids

- RoHS & REACH compliant, halogen-free, PFAS-free
- Non-toxic, recyclable raw material, nonflammable, sustainable chemistry
- Supports high-power, high-temperature applications
- Enables uniform temperature for higher operational efficiencies
- Compatible with a wide variety of materials
- Reduces energy usage

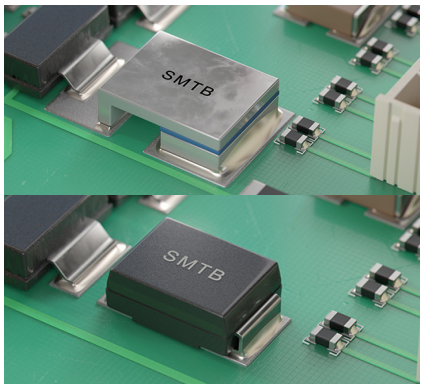


Innovative Thermal Bridge Devices by TCLAD

TCLAD's surface-mountable thermal bridge (SMTB) technology greatly improves heat spreading capacity across printed circuit boards (PCBs), reducing hotspots and enhancing overall thermal dissipation efficiency. This advancement enables designers to reduce system size and cost by eliminating the need for bulky heatsinks and complex thermal management methods.

SMTB Device Formats: Open Lead Frame & Molded

TCLAD SMTBs are available in two formats. Open lead frame devices offer a compact, cost-effective way to channel heat away from hotspots, while molded devices pair a lead frame structure with a thermally conductive core and high-performance polymer composites to act as compact, efficient heatsinks. Both connect to a ground plane or chassis through PCB traces or grounding pads, making them ideal for dissipating heat in high-power, high-density boards.



Chip-Style / Resistor-Type Surface Mount Thermal Bridge

TCLAD's chip-style SMTBs are available in standard SMT sizes including 0603, 0508, 0612, 1206, 1225, and 2512, these electrically insulating devices use a high-thermal-conductivity aluminum nitride substrate to transfer heat between PCB locations while maintaining electrical isolation. Their compact footprint and low capacitance make them well suited for space-constrained, high-density, and high-frequency applications.

Putting TCLAD Thermal Bridges to the Test

TCLAD surface-mountable thermal bridges (SMTBs) are engineered to divert heat away from critical hotspots in power electronics. Validated by independent testing, SMTBs deliver the heat-management performance critical electronics demand. Thermal Bridge solutions on FR4 boards alone can achieve 15–23°C temperature reduction in this study.

Test Setup

An FR4 and SFL-12 test board were divided into four identical quadrants, each populated with four SOT-packaged, heat-generating components — ideal for simulating high thermal stress conditions.

Each quadrant featured a different SMTB configuration:

Quadrant 1 (Lower Left):
No thermal bridges (control)

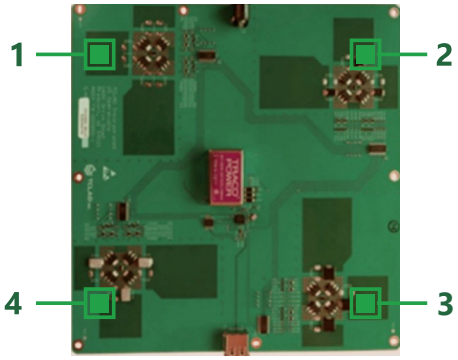
Quadrant 2 (Upper Left):
Three SMTBs (P/N SMTB2114P30E)

Quadrant 3 (Upper Right):
Three SMTBs (P/N SMTB3123P30E)

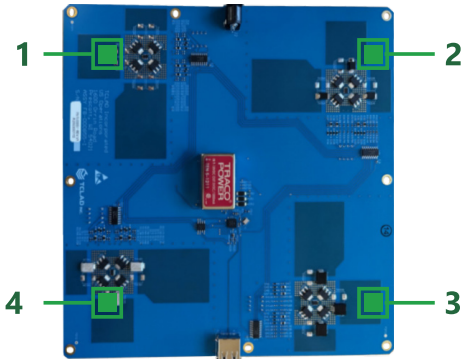
Quadrant 4 (Lower Right):
Three SMTBs (P/N SMTB2920P30M)

Thermal imaging was performed using a FLIR infrared camera, ensuring accurate, non-contact temperature measurements across all quadrants.

The Results

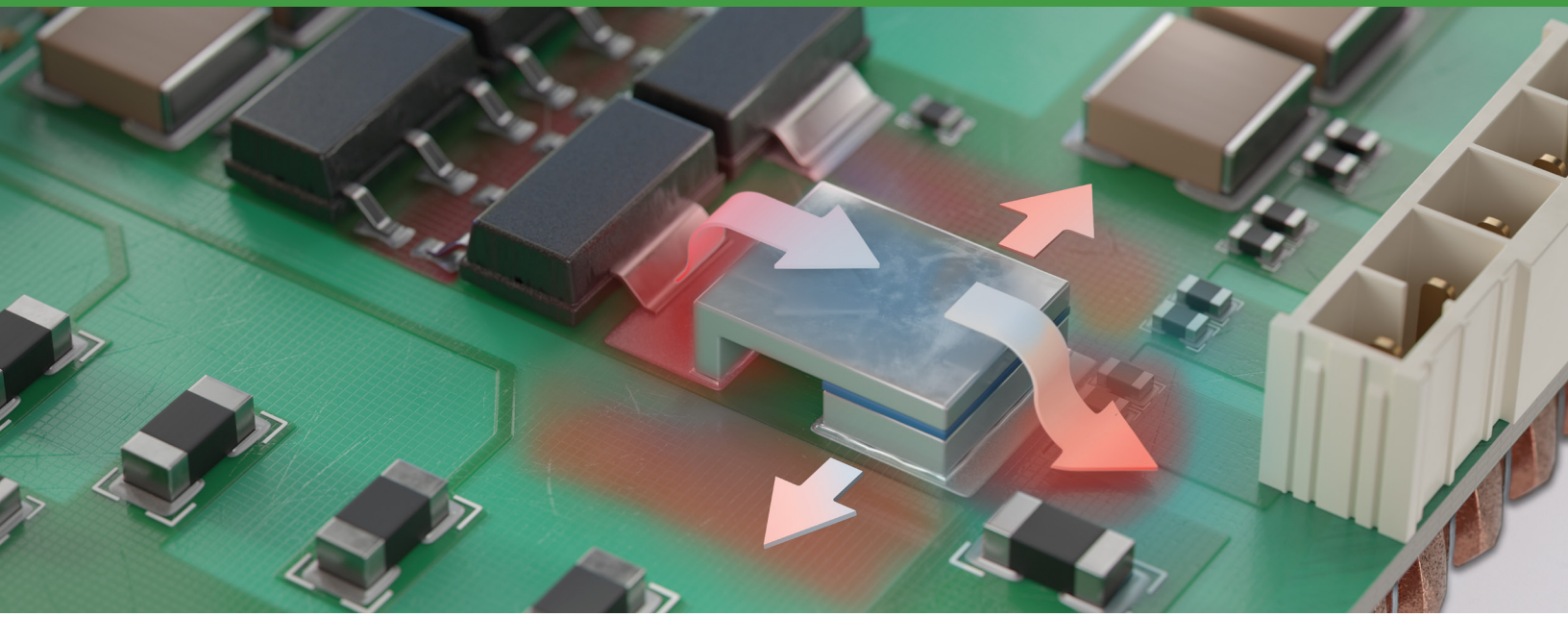


FR4 Test Board (6-layers, 4-quadrants)



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

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)



TCLAD SMTBs: Reliable Thermal Control Under the Toughest Conditions

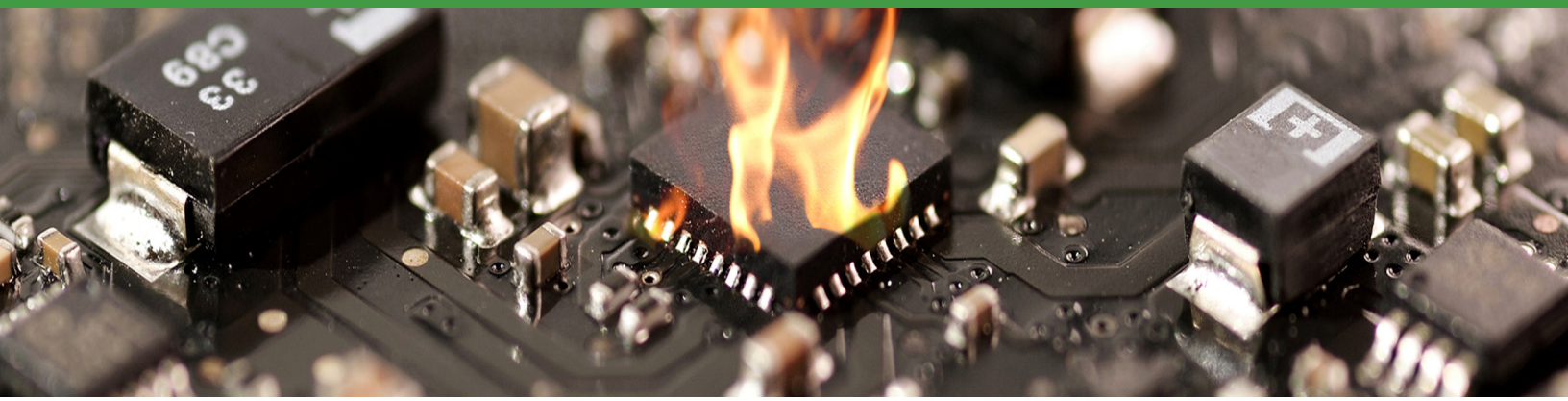
TCLAD surface-mountable thermal bridges (SMTBs) made a measurable impact – reducing component temperatures by up to 42°F (23.3°C) compared to the control quadrant without thermal bridges. Larger SMTB devices provided even greater cooling, with the large open lead frame (P/N SMTB2920P30M) showing the most significant effect.

Where TCLAD SMTBs Excel

- High-Power Electronics
- Power Supplies & Converters
- PIN & Laser Diodes
- Electric Motors
- Temperature Sensors
- High-Speed Computing

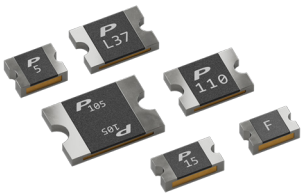
Key Benefits of TCLAD SMTBs

- Compatible with Surface-Mount Technology & Processes
- Simple Integration into Standard PCB Layouts
- Wide Operating Temperature Range (-55°C to 150°C)
- High Voltage Withstand
- Low Thermal Resistance
- Low Capacitance/Ideal for High-Frequency RF Applications
- Tape & Reel Packaging for Automated Pick-and-Place Assembly



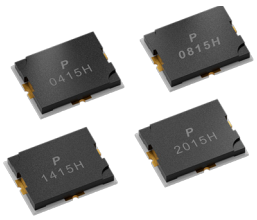
Circuit Protection That Goes Beyond Cooling

TCLAD offers a comprehensive portfolio of overcurrent protection devices, empowering Engineers to monitor load currents and respond quickly to potentially damaging electrical events. Trusted across a wide range of industries and applications, our circuit protection solutions enhance system reliability, improve efficiency and support user safety.



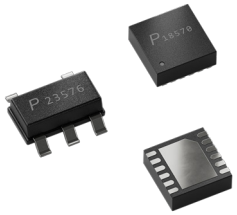
EVERFUSE PPTC Devices

EVERFUSE devices are among the industry's smallest, surface-mount, self-resettable overcurrent protection fuses. They utilize positive temperature coefficient (PTC) material that rapidly increases in resistance (and temperature) when exposed to excessive current. Once the fault is cleared, the device cools down and returns to its low-resistance state, automatically restoring normal circuit operation.



Current Limiting Module (CLM)

A compact, surface-mount device that protects against both overcurrent and overcharge. It pairs a fuse element with a resistive heater – triggered by an IC or FET on overvoltage detection – to interrupt current and isolate the fault.

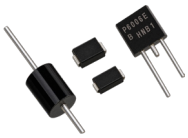


Electronic Fuses (eFuse)

An integrated circuit that combines overvoltage, overcurrent and overtemperature protection in one package using an internal MOSFET. It simplifies design while improving control, accuracy and response time.

Advanced Overvoltage Protection

TCLAD offers overvoltage protection solutions that safeguard sensitive circuits from voltage transients, surges, lightning strikes, and electrostatic discharge. By safely clamping or diverting excess energy, these devices help prevent damage, improve system reliability, and extend product lifespan.



Thyristor Surge Suppressor (TSS)

Protects telecommunication equipment — modems, line cards, fax machines and other CPE — from surge event on the line, helping equipment meet GR-1089, ITU-T K.20/K.21/K.45, IEC 60950, UL 60950 and TIA-968.

Metal Oxide Varistor (MOV)

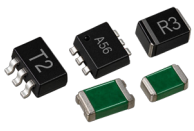
A voltage-dependent resistor — high resistance at normal operating voltage, dropping sharply as voltage rises. MOVs shunt transient current away from sensitive components as control, compensation or protection elements.

Gas Discharge Tube (GDT)

Ceramic tubes filled with noble gases and sealed between two electrodes. A high-voltage surge is dissipated through a glow discharge path inside the tube, while high insulation resistance and low capacitance and leakage keep normal operation unaffected.

TVS Diodes (Transient Voltage Suppressor)

Silicon avalanche devices that protect circuits against transients and overvoltage threats such as EFT and ESD. Fast response time, excellent clamping capability low capacitance and low leakage current, in uni-directional and bi-directional configurations across a wide range of packages, working voltages and power ratings.



ESD Protection Devices

Excellent clamping with low leakage, low capacitance and fast response time for voltage-sensitive components. Their small size suits HDMI, DisplayPort and MDDI interfaces, and replace multilayer varistors (MLVs) in phones, notebooks, tablets, set-top boxes and LCD TVs.

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.