THERMACORE EUROPE
Thermal Management Solutions
AAVID
THERMAL DIVISION OF BOYD CORPORATION

k-CORE®

Aavid Thermacore Europe is based in the UK and have established a design and manufacturing leader at the European level for the K-Core APG solid conduction technology. The method uses encapsulated graphite to spread the heat in high-power electronics applications in aerospace, space, military and commercial applications. For European Customers, All designs, CFD, manufacturing, hipping are processed in Europe. The Technology readiness levels (TRLs) is TRL 9 for Space and Aerospace

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k□CORE®: A NEW DIMENSION IN CONDUCTIVE HEAT TRANSFER

With ever-increasing electronics power and miniaturization, designing a new generation of products for specialized, demanding applications requires a new dimension in heat transfer. That new dimension is the k-Core® heat transfer system, which uses encapsulated Annealed Pyrolytic Graphite (APG) to create high-conductivity thermal spreading. Using an APG insert within an encapsulant (options include aluminum alloys, copper alloys, ceramics and composites), k-Core allows you to achieve the simplicity and reliability of a conduction-based solution without adding mass, even as power density increases. It's a highly conductive, thermally efficient and lightweight solution that gives you:

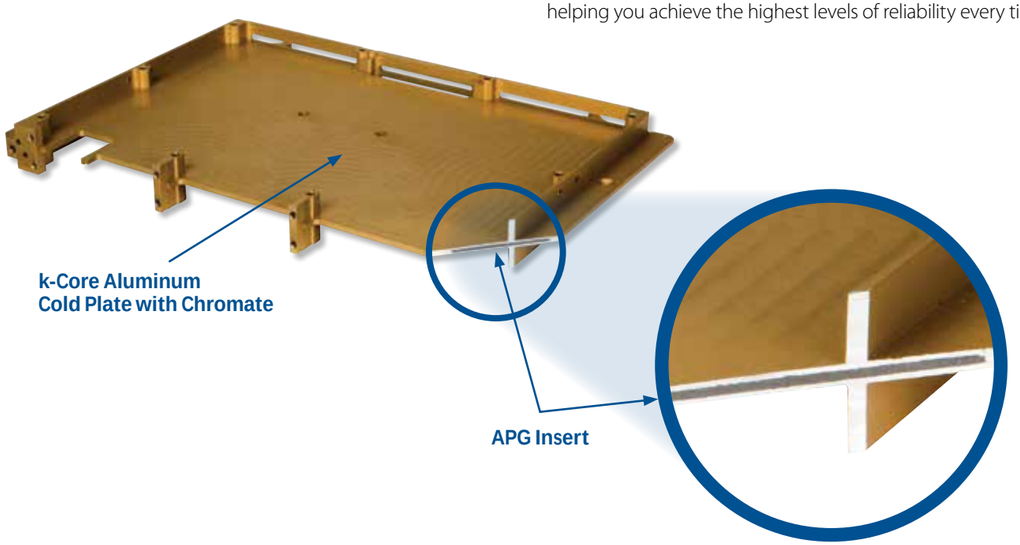
- Up to three times the conductivity (k) of solid copper with lower mass than aluminum* (reference table on page 2)
- Tailored coefficients of thermal expansion (CTE) and structural properties by selecting the encapsulant material
- "Drop-in" replacement for conventional solid conduction solutions
- Allows high conductivity thermal via to be added in high heat flux, "out-of-plane" areas
- Unaffected by gravity or acceleration — allows standard machining, finishing and plating processes typical for all metal parts
- Custom machined profiles to accommodate electronic board "skyline" component geometry
- 3D designs available with graphite layers of multiple planes (includes offset and orthogonal)
- Applications ranging from cold plates, VME cards, PCBs, chassis, spacecraft payload doublers and radiators

* Encapsulate material assumed to be Aluminum

PARTNER WITH THERMACORE. AND MAKE GREAT DESIGNS BETTER

Turn your thermal challenge into an opportunity to create an exciting new generation of rugged, reliable products by collaborating with a dedicated, specialized Thermacore engineering team. We know how to support your design ideas by creating specialized k-Core® thermal solutions — including cold plates and heat spreaders — to exact specifications for your needs.

Our engineering skill and experience helps you extend your product capabilities. Our team will work hand in hand with yours, every step of the way, from concept through production. We understand how vital it is to keep every team member in constant touch with your project, to keep it on track and continuously moving forward. We've developed specialized project management skills and processes to keep everyone informed, helping you achieve the highest levels of reliability every time.



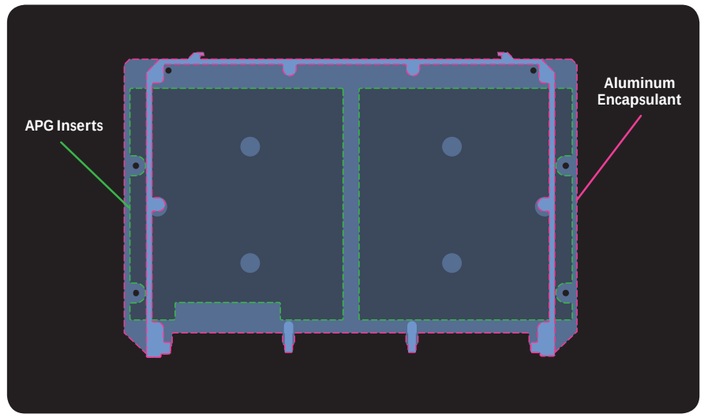
PROVEN IN THE LAB. DEMONSTRATED IN PRODUCTION

The superiority of k-Core® thermal conductivity is well-proven via finite element analysis and actual qualification test data. Tests have shown that lightweight, high-performance APG-based k-Core products offer up to three times the conductivity of copper (6x aluminum), with a reduction in mass of 11% when encapsulated in aluminum. And components such as VME cards for military communications can be kept 80% cooler with k-Core than with aluminum alone. This kind of performance helps you design electronic components with confidence and keep up with trends toward higher power, reduced volume and lower mass.

Here's a comparison of the performance of the k-Core system within various encapsulant materials versus the same materials when the k-Core system with APG insert is **not** present.

Encapsulant Material	Thermal Conductivity (W/mK)			Density (g/cm3)			Coe□cient of Thermal Expansion (CTE) (ppm/K)	Specific Conductivity (conductivity/ density) (W/m·K/g/cm3)		
	w/o APG insert	with k-Core	Improvement	w/o APG insert	with k-Core	Change		w/o APG insert	with k-Core	Improvement
Conventional										
Aluminum (6061)	173	987	5.7x	2.8	2.5	-11.0%	23.6	62	398	6.4x
Copper (OFHC)	394	1076	2.7x	8.9	4.9	-44.0%	16.9	44	219	4.9x
Magnesium (AZM)	79	950	12.0x	1.8	2.1	15.0%	27.3	44	457	10.4x
Beryllium	220	1006	4.6x	1.8	2.1	15.0%	13.5	122	484	4.0x
Aluminum Beryllium (62% Be)	210	1002	4.8x	2.1	2.2	0.5%	13.9	100	455	4.6x
Low CTE										
Kovar	14	924	66.0x	8.4	4.7	-44.0%	5.9	2	196	117.4x
Copper-Moly (15 Cu 85M)	195	996	5.1x	10.1	4.9	-51%	7.0	19	203	10.5x
Copper-Tungsten (15Cu 85W)	175	988	5.6x	16.2	7.8	-54%	8.0	11	127	11.7x
AlSi (Si Fraction Dependent)	120–150	918–980	6.5x–7.7x	2.4–2.6	2.3–2.4	4%–8%	8.3–17.0	50–58	399–408	7x–8x
Advanced										
Carbon Fiber Composite (Quasi-ISO layup)	25–330	928–1050	3.2x–3.7x	1.8	2.0	11%	-1.0–3.0	14–183	462–535	2.9x–33x

From one-of-a-kind spacecraft components that satisfy specific and demanding requirements to the production of thousands of cold plates and heat spreaders to a given specification, Thermacore has the expertise and experience to solve your thermal management challenges.



Actual X-ray of an aluminum cold plate with two k-Core inserts. The k-Core inserts spread and transport the heat from the interior of the cold plate to the edges which typically interface with a liquid cooled chassis wall.

MASTER THERMAL CHALLENGES WITH k-CORE® SPREADERS

When you need to lower the temperatures of high-power density systems (e.g., radars, power converters and laser diodes) quickly and efficiently, Thermacore's k-Core® thermal spreaders are ideal. Thermal spreaders extract heat from heat-generating electronic components that typically consist of concentrated heat loads and move it to a remote heat sink location for eventual dissipation. The resulting thermal spreading effect dissipates heat quickly — and significantly reduces both peak temperatures and temperature change (ΔT) compared with traditional aluminum solid designs. The result: increased electronic device life, reliability and safe high-power operation.

Thermal spreaders from Thermacore offer higher performance with lower weight (75% lower mass than solid copper). This helps you significantly reduce your final product's weight.

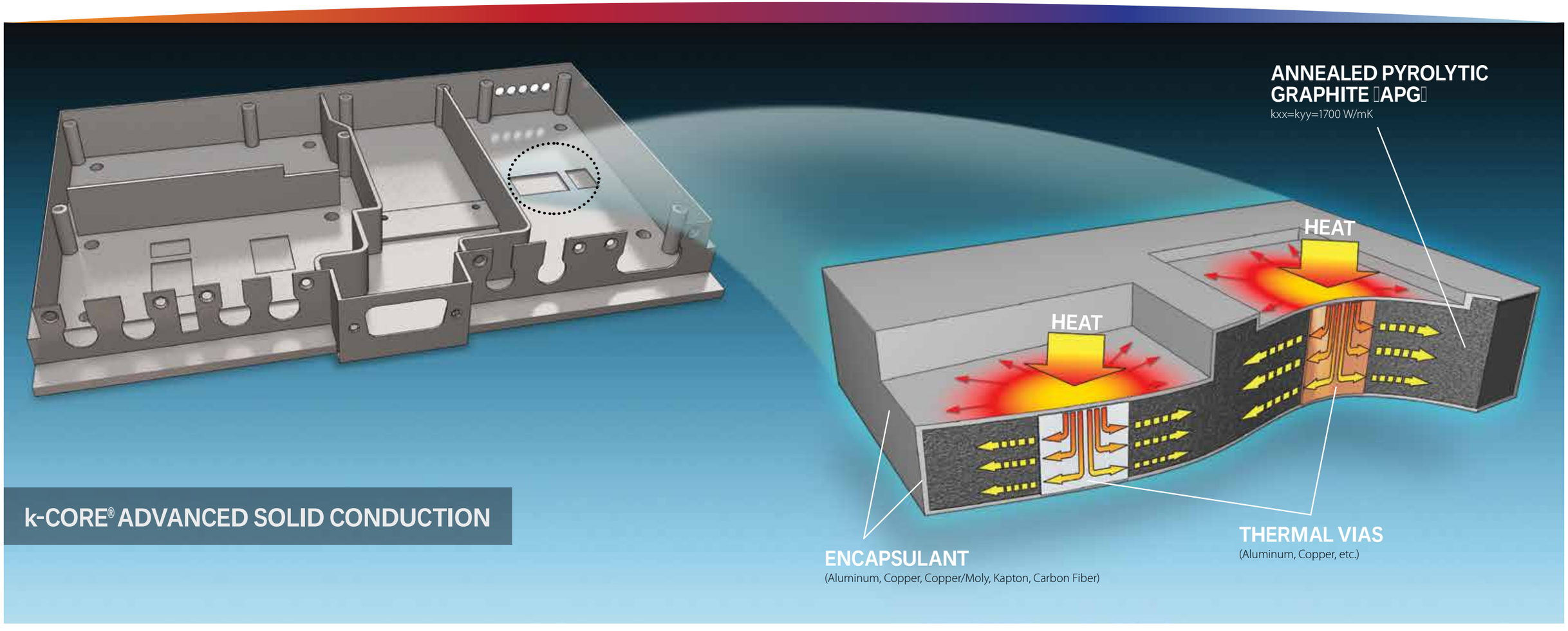
NEW PERFORMANCE FROM PROVEN THERMAL MATERIALS

k-Core® cold plates with encapsulated APG, compared to conventional thermal management materials (such as aluminum and copper), deliver superior performance and low mass. You can attain up to six times the conductivity (k) of aluminum with 11% less mass using the k-Core system*. The k-Core system also provides the flexibility to tailor exact CTE to meet your unique thermal and structural system requirements. The k-Core system's passive heat transfer technology operates without moving parts, giving you extra reliability and lower maintenance.

k-Core can be encapsulated in a full range of conventional thermal management metals and materials — the kind of proven materials which you're familiar with in thermal applications. k-Core heat transfer products also provide high-quality "drop-in" replacements for solid metal conductors. That lets you reduce electronic component temperatures even under harsh conditions and in cramped spaces, greatly prolonging the life of your most valued systems. Thermacore's design team will work with you to select the right materials for each application. For high-power applications, Thermacore designers can also create k-Core heat spreaders with thermal vias to increase the through-the-thickness conductance of APG if needed.

Sign up with our Thermacore Design Center and start making your next great idea even better — with the help of our thermal design calculators as well as a host of technical papers and datasheets. **www.thermacore.com/design**

* When compared to solid aluminum



k-CORE® ADVANCED SOLID CONDUCTION

THERMACORE
Thermal Management Solutions

FOR THE TOUGHEST THERMAL APPLICATIONS

Thermal engineers worldwide turn to Thermacore's high-conductivity k-Core® system with annealed pyrolytic graphite (APG) technology to meet the most difficult challenges with specialized, high-performance heat transfer solutions. k-Core adds a new level of high-tech, reliable cooling for the aerospace, transportation and defense industries. Every day, Thermacore extends technological capabilities for leading-edge organizations worldwide.

As a global technology leader, Thermacore offers facilities throughout the United States and Europe, including state of the art AS 9100 and ISO-certified manufacturing centers. And their capabilities continue to grow. Through a broad range of services, Thermacore is ready to break through your own thermal barriers, using technologies they helped bring to life.

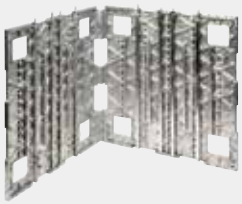
THERMACORE TECHNOLOGIES

- Aluminum Vacuum Brazements
- Cold Plates
- Heat Exchangers
- Heat Pipe and Loop Heat Pipe Assemblies
- Heat Spreaders
- Intelligent Thermal Management Systems (iTMS)
- k-Core® Annealed Pyrolytic Graphite (APG)
- Liquid Cooling Systems
- Material Development, Characterization and Testing
- Vapor Chambers
- k Technology Spotlight

K□CORE TECHNOLOGY SPOTLIGHT

Cold Plat… Chromate Finish

Cold P… "Skyline" Surface, Anodized Finish



Spacecraft Radiator Segment with Embedded Heat Pipes

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DESIGNED AND MADE IN THE UK

AAVID
THERMAL DIVISION OF BOYD CORPORATION