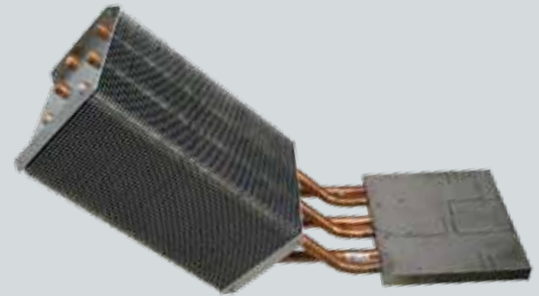




Eldre | Ferraz Shawmut | R-Theta

SOLUTIONS FOR  
POWER MANAGEMENT

# COOLING OF POWER ELECTRONICS



# BRING US YOUR TOUGHEST THERMAL APPLICATION CHALLENGE

## MERSEN WILL HELP YOU MAXIMIZE PERFORMANCE, SAFETY & RELIABILITY WITH CUSTOMIZED COOLING SOLUTIONS, SERVICES & SUPPORT

Mersen integrates its extensive cooling expertise and patented heat sink technology into semiconductor applications to make them more efficient, reliable and profitable. Mersen's engineering team will help you find innovative cooling solutions, work with you to design the performance boundaries and even simulate your Application before a prototype is built. Our unique knowledge of air, phase change and liquid cooled heat sinks enables Mersen to help you find the right thermal protection solution for your application.

### Quality and performance for various markets

Mersen has a keen understanding of the unique challenges customers face in each of the markets

we serve. We deliver extensive product expertise and unbeatable applications support, enabling its customers to optimize their market performance.

We are experts in designing, simulating, manufacturing and testing cooling solutions to serve AC and DC power electronics applications where Wide Band Gap (SiC, GaN) and Silicon (IGBT, Thyristors) technologies are used for power conversion. We cater to the unique needs of these markets & applications:

- Industrial Power Conversion
- Transportation
- UPS and Motor Drives
- Alternative Energy (wind and solar)
- Silicon Carbide (SiC) Applications
- Military and Defense
- EV/HEV
- Electrical Energy Storage
- Telecommunication



## WITH LOCAL TECHNICAL SUPPORT OFFERING CLOSE-TO-THE-CUSTOMER ASSISTANCE



La Mure  
France



Mississauga  
Canada



Shanghai  
China

With industrial operations in all three major economic regions of the globe, Mersen offers global service with close-to-the-customer support. Each location brings a specific product expertise and is ISO 9001 registered and RoHS compliant.

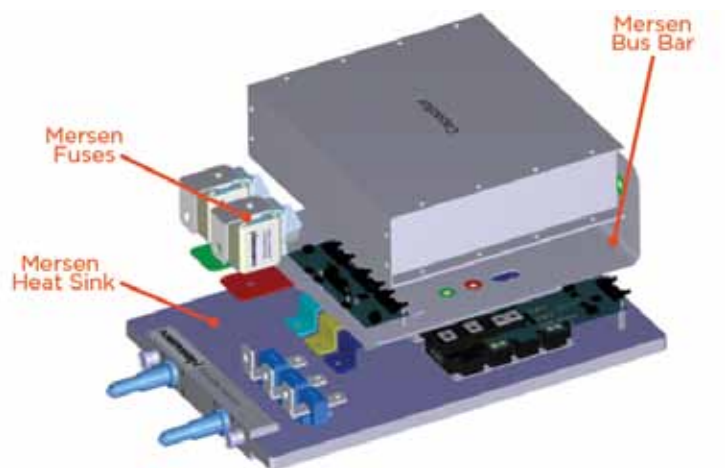
The facilities operate on a continuous improvement philosophy and a “pull” manufacturing strategy.

- In Europe, our historic plant in La Mure, France is a center of excellence for liquid cooled solutions
- In North America, our plant in Mississauga, Canada is a center of excellence for air cooled and heat pipe solutions and is CGP certified for military projects acceptance
- In Asia, a brand-new facility in Shanghai, China manufactures both air and liquid cooled solutions Helping customers improve their global competitiveness

## INTEGRATED ARCHITECTURE DESIGN

### Straight to the Optimum Design

Mersen engineers can work with inverter manufacturers and power conversion stack designers at very early stages of design to integrate the passive components such as cooling and bus bars within the inverter. Using a variety of Multiphysics simulation toolsets, Mersen engineers can evaluate the thermal and electrical performance of the cooling solution and bus bars within the overall inverter design. This approach is called the Integrated Architecture approach and allows for the most optimum design footprint of the overall inverter assembly by sourcing the cooling and bus bar solutions along with semiconductor protection fuses all from one source: Mersen.



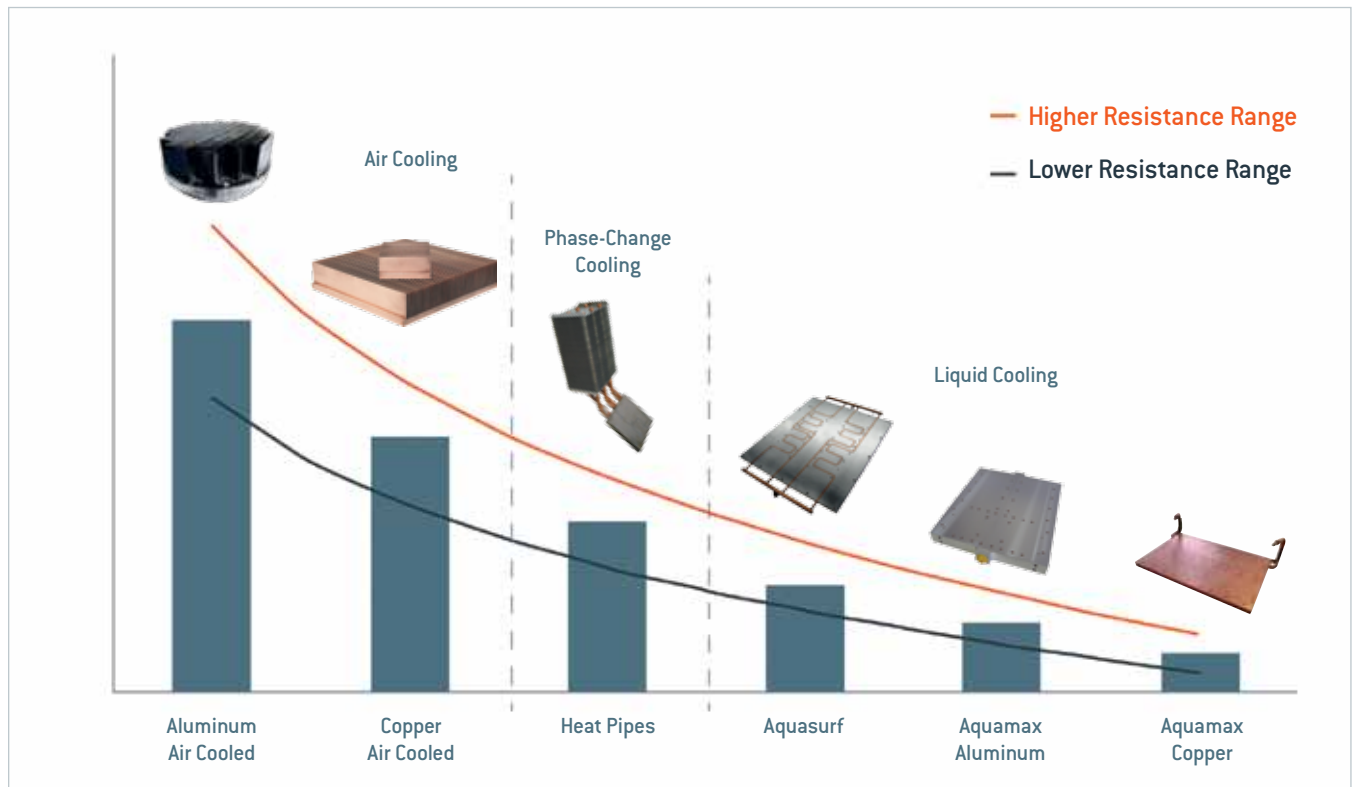
# TURN TO ONE SOURCE FOR AN EXTENSIVE LINE OF COOLING TECHNOLOGIES

## AIR, PHASE CHANGE & LIQUID COOLING

Mersen uses a number of cooling technologies (air, phase change, liquid) that can be adapted to meet almost any application in any industry. Our products are custom designed to provide you the most suitable solution for your demanding application.

Cooling Technology	Characteristics
<b>Air Cooling</b>	Mersen's air cooled heat sinks come in a variety of sizes and materials. Our Fabfin® design incorporates our patented swaging technology so that the fins are mechanically secured to the base plate, eliminating the need for less efficient bonding or gluing agents.
<b>Embedded Heat Pipe</b>	By incorporating heat pipes onto the surface of an air cooled heat sink, high concentration of heat from power electronics can be spread out over a larger area very quickly. This cooling technology is ideal for SiC and Power Amplifier applications.
<b>Heat Pipe Assembly</b>	Our Heat Pipe Technology provides a robust, long lasting and self-sustaining cooling solution in applications where more cooling performance than standard air cooled heat sinks is required
<b>Liquid Cooled Cold Plates</b>	Mersen's Cold plates are selected where there is availability of coolant and/or superior cooling performance is required. Both tube and vacuum designs are available.

### Thermal Management Road Map



## HIGH-PERFORMANCE HEAT SINKS



### Our Swaging Process - for maximum thermal conductivity

Developed and patented by our Mississauga plant, our swaging process boosts the efficiency of air cooled heat sinks with thinner, longer fins on denser or mixed metals to get maximum thermal conductivity while keeping weight down. The swaging technology used on our Fabfin® heat sinks eliminates bonding or gluing interfaces between fins and base plate thus providing a much more robust design, suitable for use in higher operating temperature in Silicon Carbide (SiC) Applications. The glue-less swaging design ensure long life time in harsh environments.



### Fabfin® - uses patented swaging technology

- The Fabfin heat sink stands out from ordinary extruded heat sinks because of its increased surface area, giving it excellent performance. Using a swaging process means a variety of its higher fins and increased height-to-space ratio types of fins can be used.
- The Hollowfin heat sink uses the same technology but the fins are processed further to increase their density on the baseplate.

### Advantages

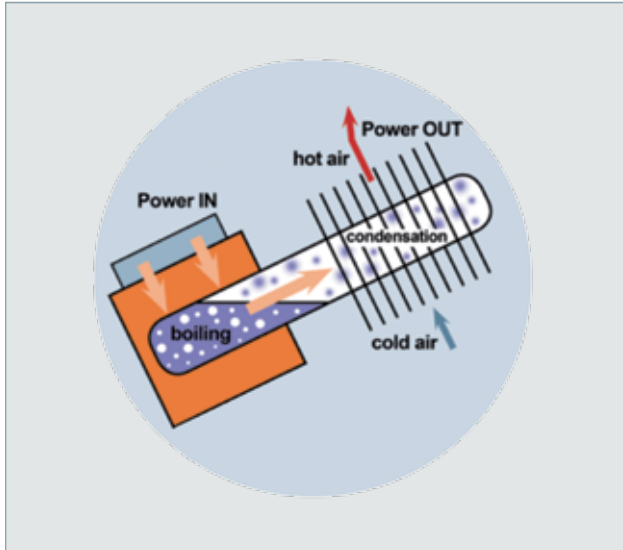
- Multiple fins joined to baseplate by swaging process
- Metal to metal construction. Al/Al Cu/Al Cu/Cu
- No epoxy/glue used in fabrication process
- Extremely robust fabrication
- No thermal barrier at fin to baseplate joint
- Fin height to spacing ratio much greater than extrusion
- -40C to + 350C storage and operating range
- Capable of withstanding various shock and vibrations industry requirements

Extensive air cooling solutions to meet unique challenges are also available in mixed metal, dual baseplate, integrated and extrusion\* models.



# PHASE CHANGE SOLUTIONS: HEAT PIPE ASSEMBLIES

## FOR FAST-ACTING COOLING PERFORMANCE



### Heat pipes - instantaneous cooling action

The high heat losses from press-pack, IGBT or SiC power devices can easily be conveyed outward via heat pipe cooling units. A heat pipe is a device that uses “phase change fluid” to efficiently conduct large amounts of heat between two solid surfaces.

A heat pipe consists of an enclosed tube containing a liquid (methanol, water) in a vacuum. The liquid absorbs thermal energy from the heat sources and boils rising towards the condenser. Air cools the condenser section, condensing the fluid back to a liquid which travels back to the evaporator by gravity. This is a sealed self sustaining process.



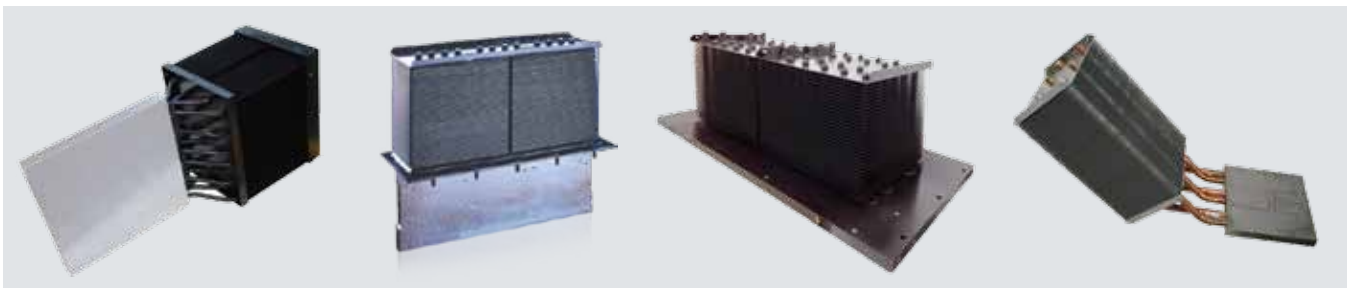
### Best fit and function every time!

All heat pipes assemblies are custom built in house to meet customers unique specifications:

### Advantages

- High thermal performance – superior to standard air cooled products
- Convection boiling resulting in instant cooling action
- Uniform temperature distribution under components
- Easy maintenance compared to liquid cooling systems, as heat pipes are self sustained devices and require no external water pumps or tubing
- Used in Transportation, Military, or any application requiring a robust cooling solution

### A range of phase change cooling solutions to meet your needs:



## WORLD LEADER IN LIQUID COOLING SOLUTIONS



### Our vacuum brazing offers reliability and lasting performance

Power electronics components (SiC, IGBTs, thyristors) need a cooling solution that is both effective and reliable, especially when installed in a confined space. To ensure maximum reliability, Mersen has mastered vacuum brazing technology for liquid cooled solutions to achieve guaranteed water tightness with no seams, robustness, corrosion free, and excellent thermal performance.

### Aquamax® - Aluminum and Copper

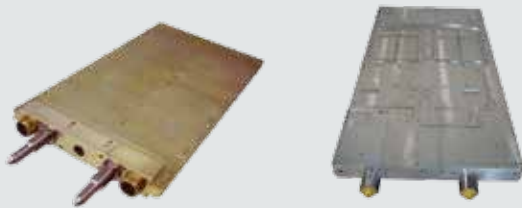
Aquamax technology in copper and aluminum versions provides maximum thermal performance employing proprietary channeling techniques to optimize coolant velocity at low head loss while providing uniform temperature across the mounting surface. Precision machining techniques used at the vacuum braze, flux free, interface ensure leak and corrosion free construction.

### Aquamax® - Copper / Nickel

Mersen's Copper Nickel 90/10 and 90/30 alloys Aquamax Cold Plates offer excellent resistance to seawater and other harsh water types used as coolant fluid in applications such as marine, power generation and water treatment plants.

### Benefits

- Monolithic piece (excellent thermal conductivity)
- Optimized cooling path while keeping pressure drop low
- High thermal performances make Aquamax suitable for SiC applications
- Leak and corrosion free construction to last decades
- High pressure withstanding
- Flexibility in flow path designs



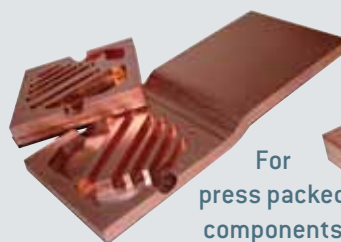
For screw mounted components



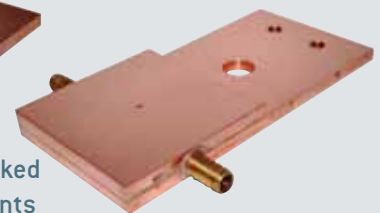
For press packed components



For screw mounted components



For press packed components

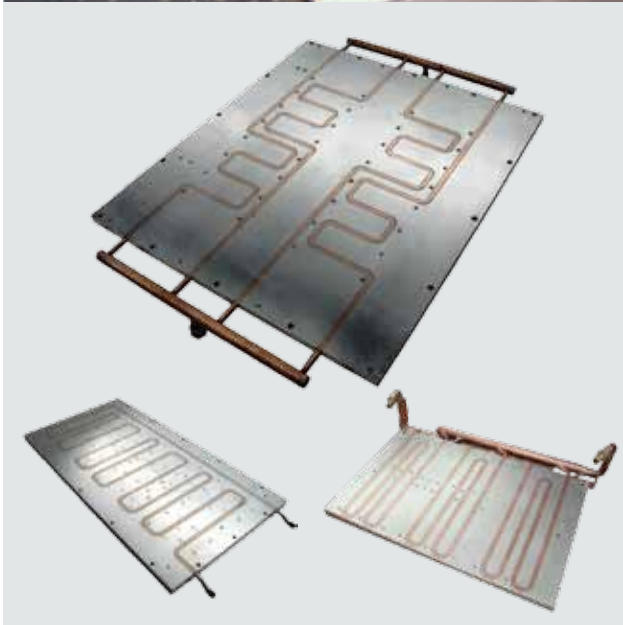


## COST-EFFECTIVE SOLUTION WITH DESIGN FLEXIBILITY



### Aquasurf

Aquasurf technology offers low to medium performance requirements at cost effective solutions. Flexibility in design, customized tube patterns, two-sided cooling options on tube material (copper, aluminum and stainless steel) are all part of the many advantages of the Aquasurf line of cold plates. Copper, aluminum or stainless steel tubes are embedded in the surface of an aluminum plate to provide the lowest thermal resistance between the semiconductor mounting surface and the cooling liquid. Tubes can be bent into complex arrays to ensure the cooling surface is directly under the semiconductor chips.



### Benefits

- Cost-effective design
- Lower weight than all-copper solution
- Flexibility in the tube layout and configurations
- Aluminum, copper and stainless steel available
- Tubes mounted flush with surface to minimize thermal resistance to cooling fluid
- Two-sided cooling

### More options for achieving the lowest thermal resistance...



Copper tubes

Aluminum tubes

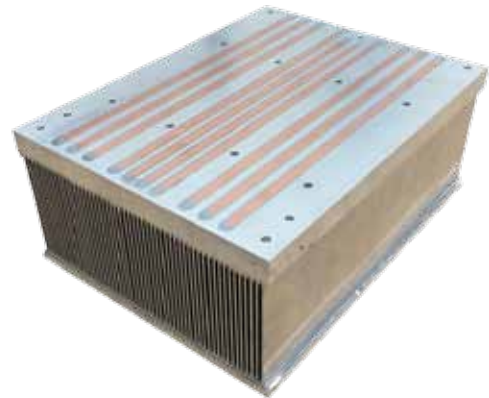
Stainless steel tubes



## DEDICATED COOLING SOLUTIONS FOR HIGH POWER DENSITY APPLICATIONS

### Designed for for High Power Density Applications such as SiC Applications

Compared to silicon devices, SiC devices switching can exceed several 100s of kHz, offering substantial improvements in power losses. SiC devices also present enhanced power density and higher operation temperature, making them a very attractive alternative to bigger and less efficient silicon family of devices. As the overall footprint of inverters with SiC devices shrink, the cooling aspect of the system becomes a new challenge. Mersen has been preparing for this challenge and has developed embedded heat-pipe heat sinks to extract concentrated heat from areas under the SiC devices and to disperse that heat over a larger surface area before the heat is passed on to the ambient environment.



Embedded Heat Pipes Heat Sinks for SiC applications

Our swaged Embedded Heat Pipe air cooled heat sinks use no glue or bonding agents for fin assembly, making them ideal for higher temperature SiC applications. As more cooling performance is required our cold plates provide superior cooling to ensure optimum performance of the SiC devices.

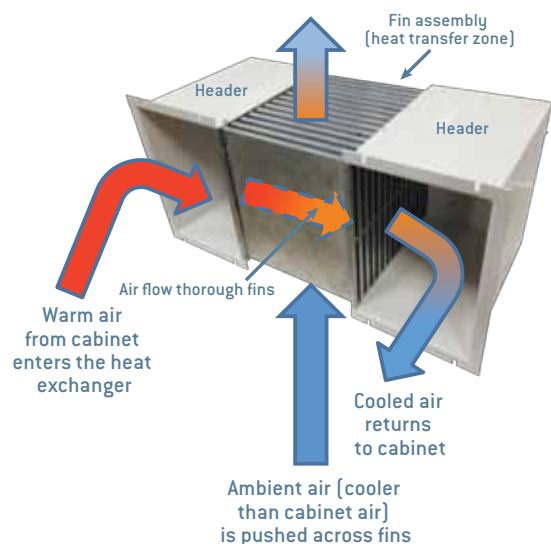
## AIR-TO-AIR HEAT EXCHANGERS FOR CABINET COOLING

### Simple. Efficient. Robust.

Many active or passive devices such as drives, capacitor banks, breakers and power supplies generate unwanted heat inside an electrical cabinet or enclosure. As the temperature rises, users may be forced to consider derating power load to avoid risk of premature device failures. Due to presence of pollutants or dust particles, in many cases outside air can not be brought in to cool the cabinets. Mersen Air-to-Air Heat exchangers are built to cool the air inside an electrical enclosure without mixing the inside air with outside air. Thus providing a completely sealed cooling solution.

#### Benefits

- Keeps contaminated air from entering the cabinet
- Helps to eliminate derating of power devices inside the enclosure
- Provides best fit / performance
- Long operational life with no required maintenance
- Maximizes cabinet interior space



## REDUCE YOUR DESIGN TIME WHILE INCREASING THE RELIABILITY OF YOUR FINAL PRODUCT

R-Tools is a no-charge, on-line simulation software that allows users to model the optimum air-cooled heat sink solution tailored to their project requirements. The simulation results aid in reducing design time and increasing the reliability of the finished heat sink product, all before the first prototype is even built.

The program is designed to generate a simulation of the most efficient heat sink model by asking the user to input parameters of their application such as the temperature boundaries, size of the heat source IGBT, SCR etc., layout of the power electronics, and several other design criteria. The program's simulation engine will then output an air cooled heat sink design along with 3D visualization tools to provide users an overview of the heat sink thermal behavior and heat spread over the surface of the heat sink. This results in a more accurate technical solution compared to traditional data sheets and graphs.

The final heat sink simulation results can then be saved online or shared via email. Users can also generate a full project report that can be saved as a PDF file and formatted for printing.

Running on internet browser, R-Tools is available to users around the clock, 24/7. The program is free to register and to use with unlimited projects and no expiry date.

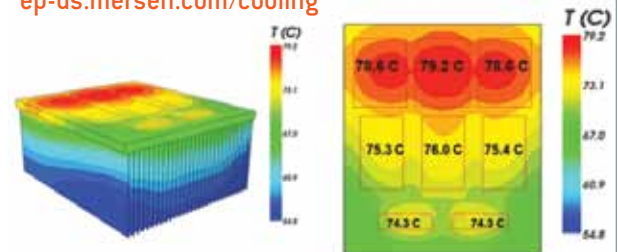
### Benefits

- Understand and communicate the thermal behavior of your designs with the aid of visualization tools
- Quickly & accurately model various heat sink configurations
- Convenient 24/7 online access
- Easy to use
- Test various designs before committing valuable resources

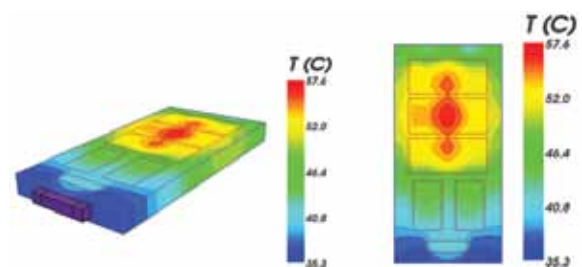


Visit R-Tools online at:

[ep-us.mersen.com/cooling](http://ep-us.mersen.com/cooling)

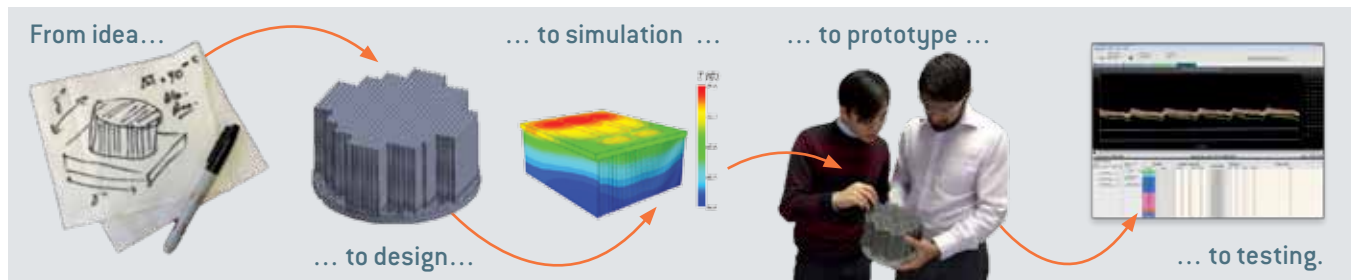


Air Cooled Thermal Data



Liquid Cooled Thermal Data

## FROM DESIGN, TO PROTOTYPE, TO PRODUCTION



Mersen is ready to assist customers throughout the development of the solution they need: from the earliest stages of identifying needs right through production and logistics at the end of the process. Participation in thermal research groups and design work on several demanding thermal applications all over the globe, means we can offer the widest variety of adapted competitive designs.

Mersen is capable of completing thermal testing for all air cooled products and heat pipe assemblies in-house using their new thermal lab.

**Mersen designs, builds and thermal test prototypes to ensure our customers' performance needs are met.**

Find out how we can help you, contact us today at:

### North America - Canada

Email: [Thermal.MIS@thm.mersen.com](mailto:Thermal.MIS@thm.mersen.com)  
Applications Support Tel: +1 (905) 795-0077

### Europe - France

Email: [cooling.lmr@mersen.com](mailto:cooling.lmr@mersen.com)  
Applications Support Tel: +33 (0)4 76 81 45 45

### Asia - China

Applications Support Tel: ++86 216 760 2388

### Wind Tunnel Testing Lab



### Test Data collection and reports



### Prototype and Production Quality Assurance



### Close collaboration with customer at every stage of design





MERSEN IS A GLOBAL EXPERT  
IN ELECTRICAL POWER AND  
ADVANCED MATERIALS

#### NORTH AMERICA

**CANADA**  
Mersen Toronto  
6220 Kestrel Road  
Mississauga, Ontario  
Canada L5T 1Y9  
T : +1 (905) 795 0077

#### EUROPE

**FRANCE**  
Mersen France SB S.A.S.  
15 rue Jacques de Vaucanson  
F-69720 Saint-Bonnet-de-Mure  
T : +33 4 72 22 66 11

#### ASIA

**CHINA**  
Mersen Shanghai  
No.55-A6. Shu Shan Road  
Songjiang 201611 Shanghai  
T : ++86 216 760 2388



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