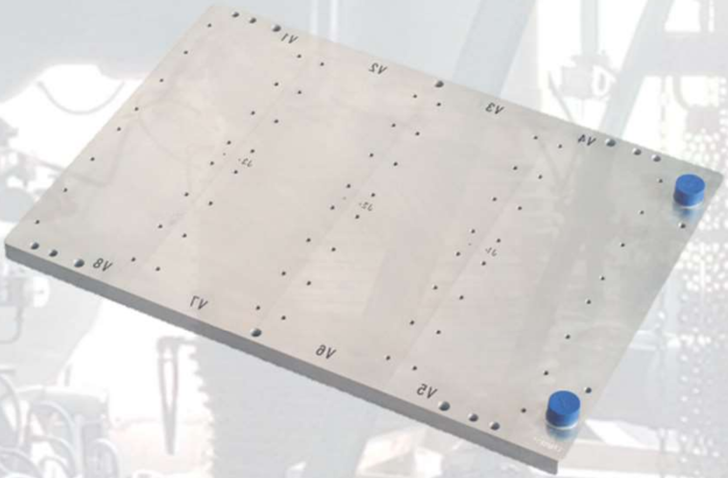
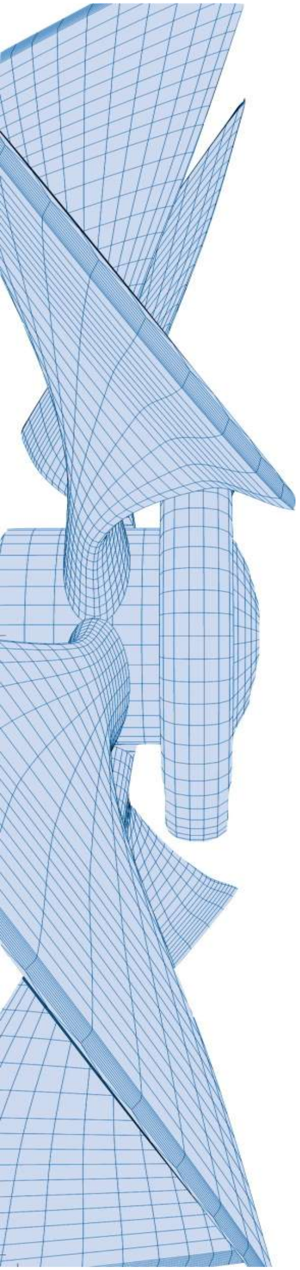
JARO Thermal

Focus On High-Power Cooling Solutions

Liquid Cooling Plates Technology Introduction





Contents

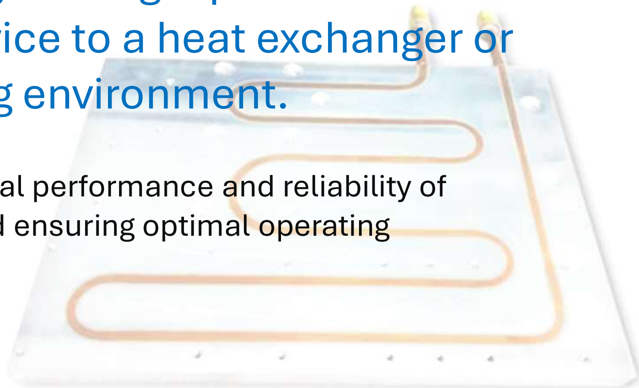
What is a Liquid Cooling Plate?

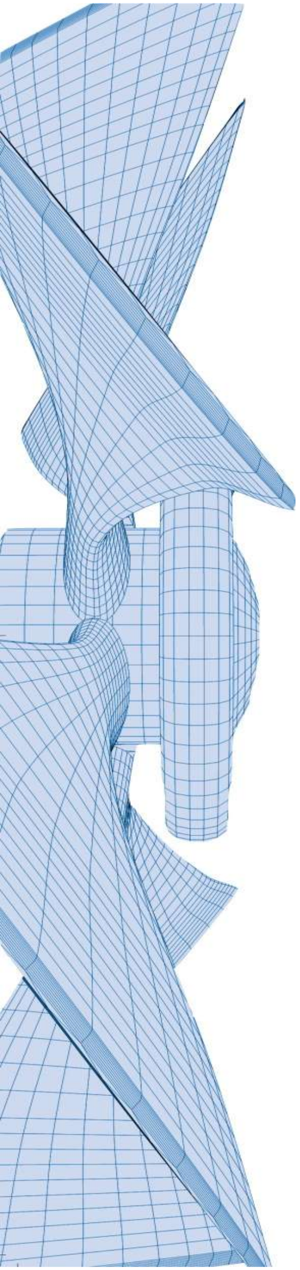
Introduction to Liquid Cooling Plate

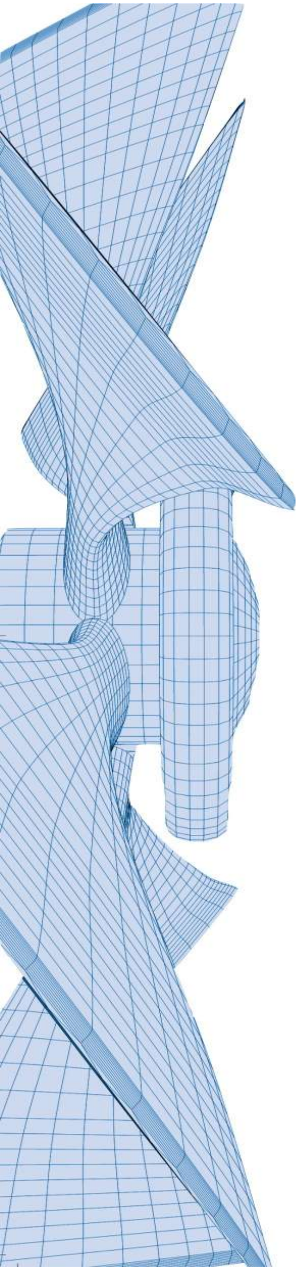
A Liquid Cooling Plate is a specialized heat dissipation component commonly used in high-power electronic devices and industrial equipment to manage heat efficiently.

1. It typically consists of a metal plate with internal channels through which a cooling liquid, often water, flows.
2. The primary function of a Liquid Cooling Plate is to absorb heat from the device it is cooling and transfer it to the circulating cooling liquid.
3. This liquid then carries the heat away from the device to a heat exchanger or radiator, where it is dissipated into the surrounding environment.

In summary, Liquid Cooling Plates play a crucial role in maintaining the thermal performance and reliability of electronic devices and industrial machinery by efficiently dissipating heat and ensuring optimal operating conditions.







Categorized by the Process Type of Liquid Cooling Plates

Types of Liquid Cooling Plates

- **Drilling Type Cooling Plate**

After milling grooves or drilling the base plate , cover plates are added for sealing, followed by CNC machining completion.

- **Embedded Tube Cooling Plate**

After CNC milling the base plate, the bent copper pipes are riveted and secured into the grooves, followed by CNC machining of the outer shape.

- **Laser Welding Cooling Plate**

The base plate with flow path and the top cover are separately CNC machined, then sealed by laser welding.

- **FSW (Friction Stir Welding) Cooling Plate**

The base plate with flow path and the top cover are separately CNC machined, then sealed by friction stir welding.

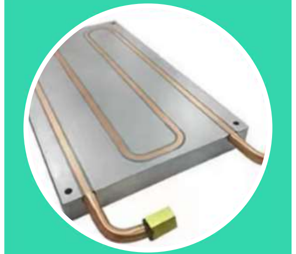
- **Vacuum Brazing Cooling Plate**

The base plate with flow path and the top cover are separately CNC machined, vacuum brazing is used for sealing welding.

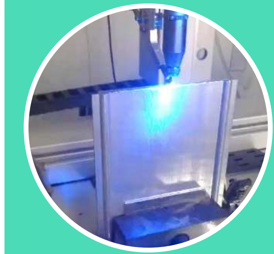
Categorized by the Process Type of Liquid Cooling Plates

Production Process Comparison

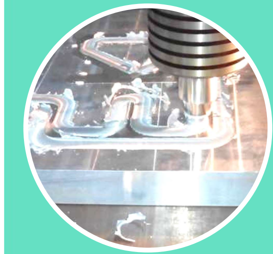
Gun Drill



Tube Embedded



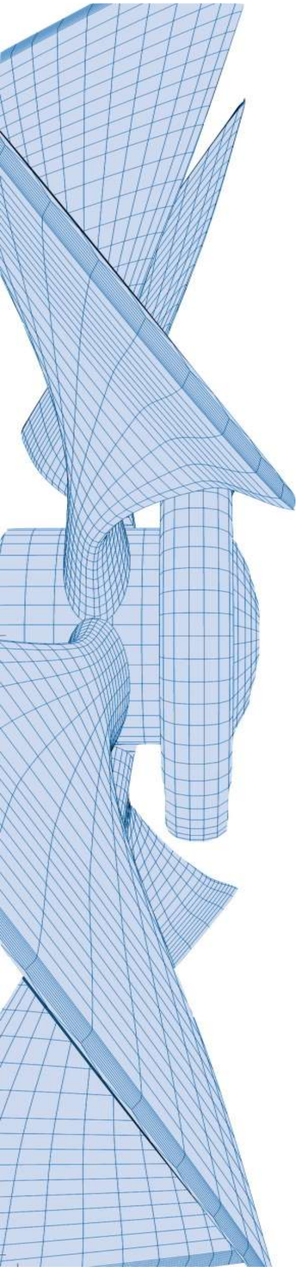
Laser Welding



Friction Stir Welding

Vacuum Brazing

Simple ⟵ **Production Process** ⟶ **Difficult**



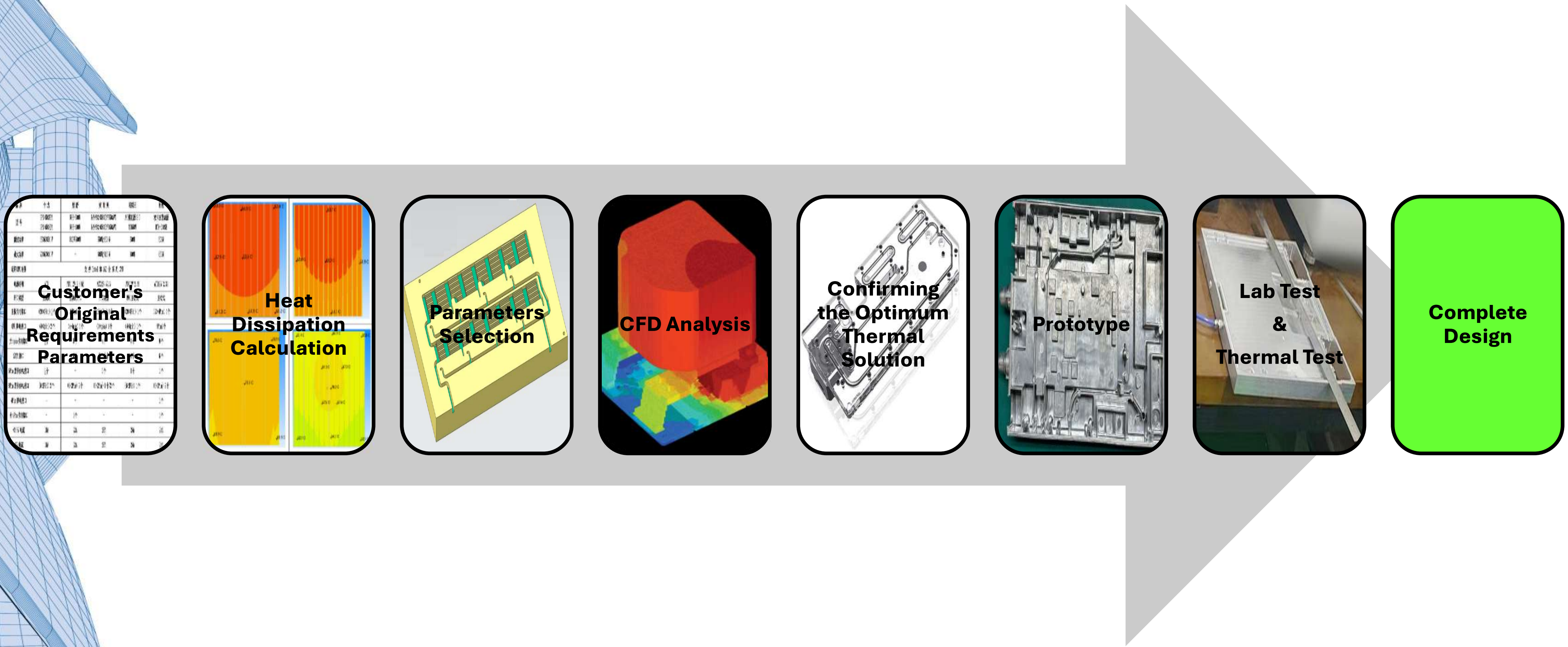
Categorized by the Process Type of Liquid Cooling Plates

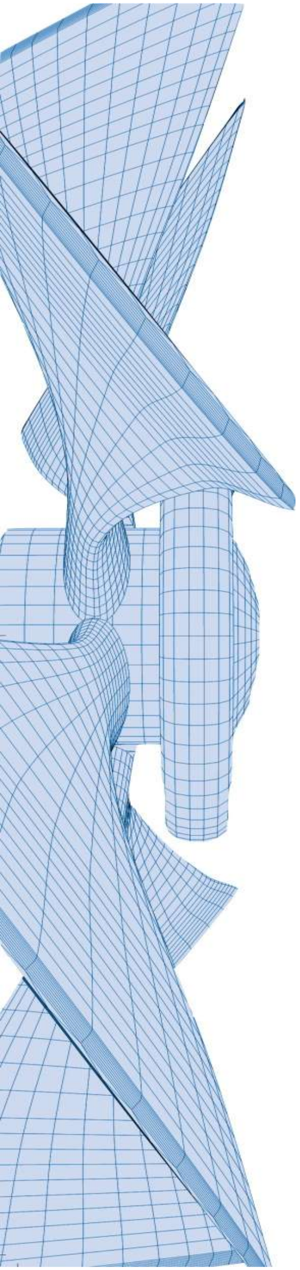
Comparison of Liquid Cooling Plates

Process Type	Advantages	Disadvantages
Drilling Type Cooling Plate	• Low manufacturing cost. • Simple production process.	• Hole size and arrangement may limit heat dissipation efficiency • Poor sealing performance
Embedded Tube Cooling Plate	• Low thermal resistance, high heat dissipation efficiency. • Suitable for mass production.	• The assembly process is more complicated than other types • Uneven heat dissipation
Laser Welding Cooling Plate	• High precision. • Fast processing speed.	• Requires high process requirements and specialized equipment. • Only suitable for surface welding.
FSW (Friction Stir Welding) Cooling Plate	• High-strength sealing welding can be achieved. • With good heat withstand capability.	• Manufacturing costs are higher. • Requires high process requirements and specialized equipment.
Vacuum Brazing Cooling Plate	• Excellent sealing and thermal conductivity. • Suitable for high-demand heat dissipation scenarios.	• The highest manufacturing cost. • Requires high process requirements and specialized equipment.

Liquid Cooling Plate

Design Process





Liquid Cooling Plate

Manufacturing Process

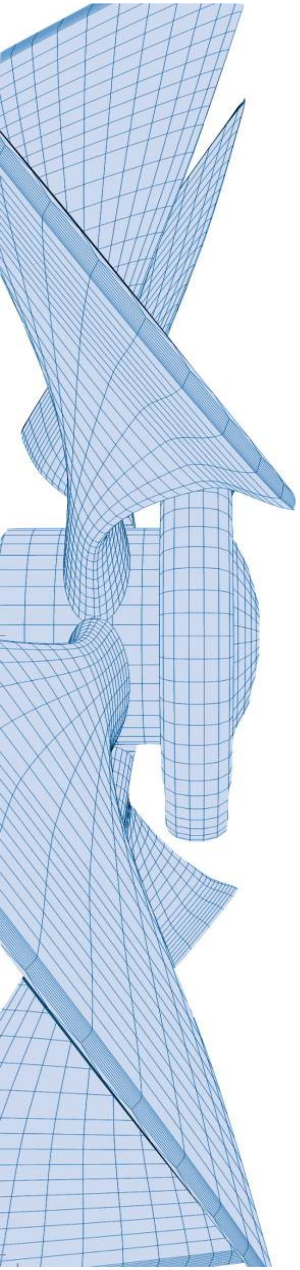
Material Selection
- Select suitable materials, typically metals such as aluminum or copper, along with other necessary auxiliary materials.

Processing & Fabrication
- CNC Machining
- Pipeline Processing

Assembly & Welding
- Component Assembly: Assemble the processed components together, including installing pipelines, connectors, etc.
- Welding: Depending on requirements, welding processes are carried out to ensure secure component connections.

Testing & Quality Inspection
- Conduct testing and quality inspection on the assembled liquid cooling plate to ensure its performance meets requirements.

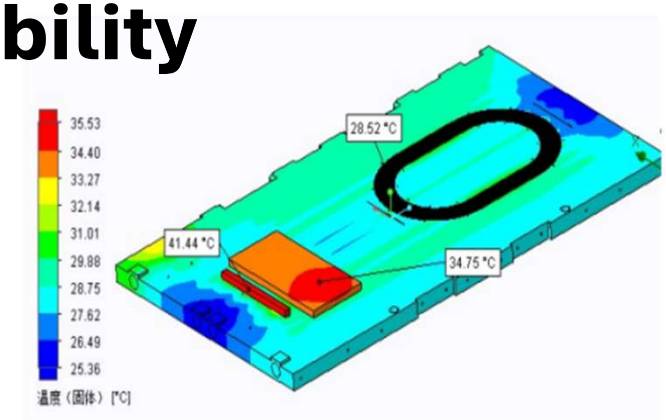
Surface Treatment
- Perform surface treatments such as painting, anodizing, etc., to enhance the corrosion resistance and aesthetics of the liquid cooling plate.



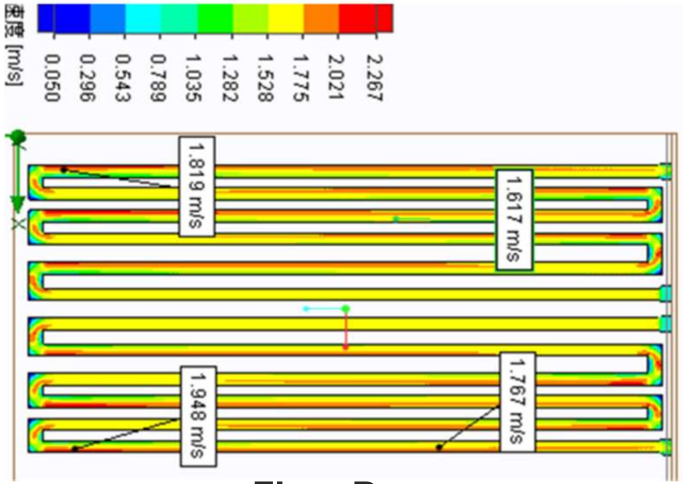
Liquid Cooling Plate

Our Thermal Design Capability

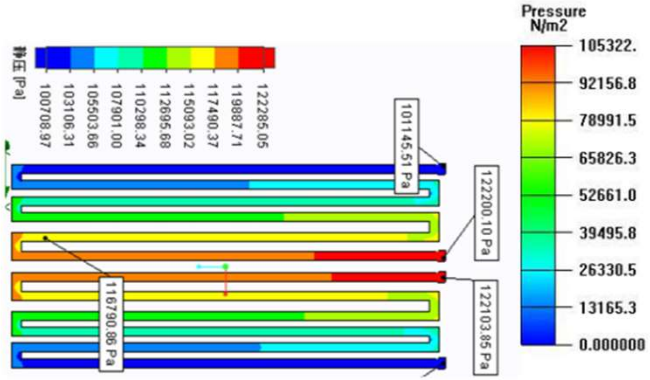
- **CFD Simulation and Analysis**
- **CAD Design**
- **Prototyping**
- **Thermal Testing**
- **In-house Training Courses**



Temperature Distribution



Flow Rate



Pressure Drop

Liquid Cooling Plate

Our Manufacturing Capability

Our full production capability are from Cutting, Grooving, Bonding, Skiving, Stamping, Lathing, Brazing, Polishing, Deburring, Assembling, FSW and CNC Machining, all the processes are finished in house with under control in lead time and quality.

CNC Workshop

Friction Stir Welding

Vacuum Brazing

Heat Pipe Workshop

Continuous Nitrogen-Protected Brazing Tunnel Furnace

Assembly Line

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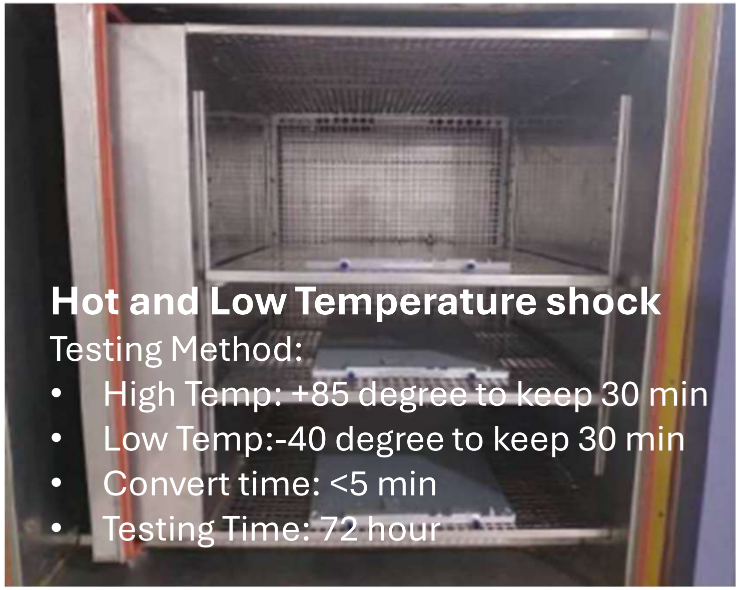
Liquid Cooling Plate

Quality Control (Leakage Reliability Testing)

We have independent laboratories and quality inspection rooms capable of conducting vacuum helium tests, water immersion ultrasonic phased array flaw detection, channel cleaning, cleanliness testing, thermal performance testing, X-ray imaging, airtightness/flow/pressure drop testing, and salt spray testing to meet high standards of product requirements.

Automatic testing platform of leakage/pressure drop/flow for liquid cold plate, pressure adjustable 0-3MPA, automatic Leakage alarm, 100% full pressure testing before shipment.



Hot and Low Temperature shock

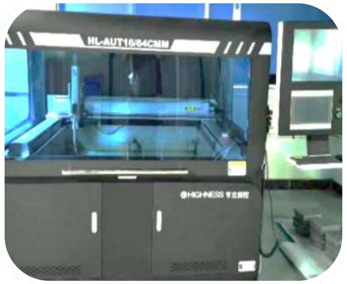
Testing Method:

- High Temp: +85 degree to keep 30 min
- Low Temp:-40 degree to keep 30 min
- Convert time: <5 min
- Testing Time: 72 hour

Liquid Cooling Plate

Testing Instruments & Equipment

Pressure Pulse Testing Platform



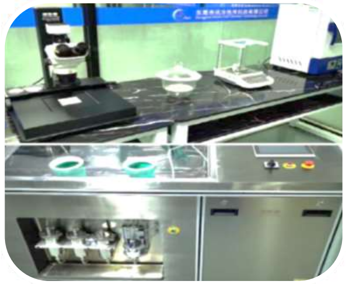
Water Immersion Ultrasonic Flaw Detection Facility

Hot & Cold Shot Chamber

Burst Testing Platform

Thermal & Humidity Testing Chamber

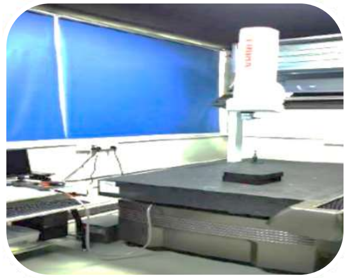
Vacuum Helium Testing Facility



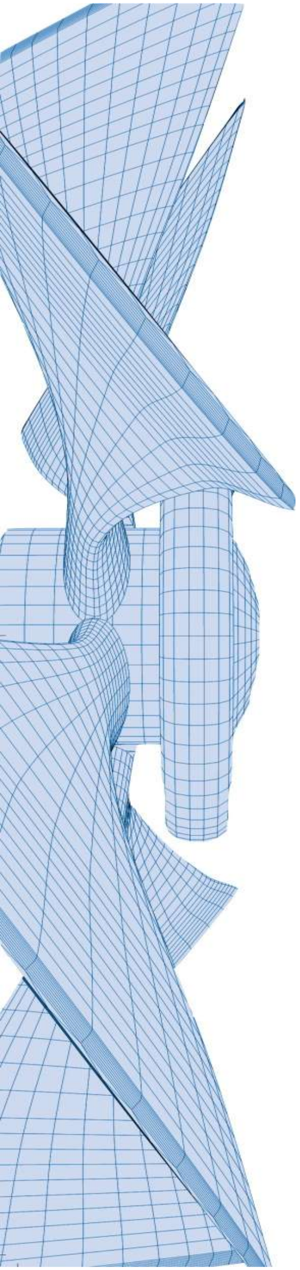
Cleanliness Testing & Analysis Facility

X-ray Imaging Chamber

Salt Spray Testing Chamber



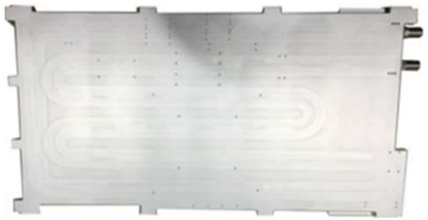
3D CMM



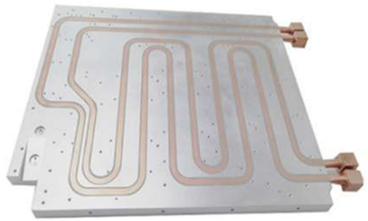
Liquid Cooling Plate

Product Display

Brazed Liquid Cooling Plate Heat Sink

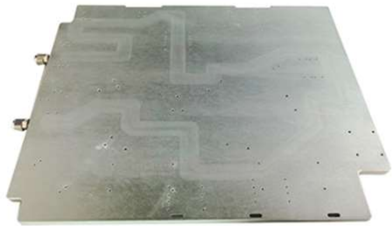


Liquid Cooling Plate
- Friction Welded Flow Path



Copper Tube Embedded Heat Sink

Friction Welded Liquid Cooling Plate

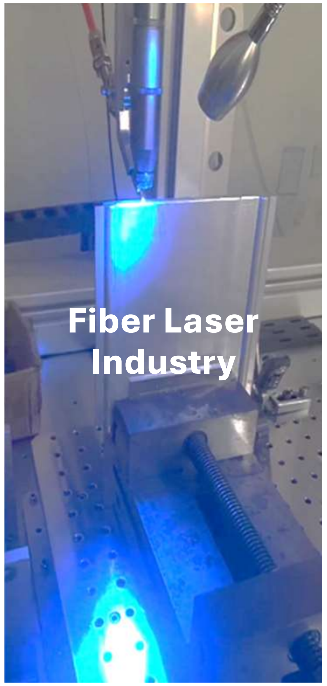


Friction Welded Liquid Cooling Plate

Friction Welded Liquid Cooling Plate
Casing Components

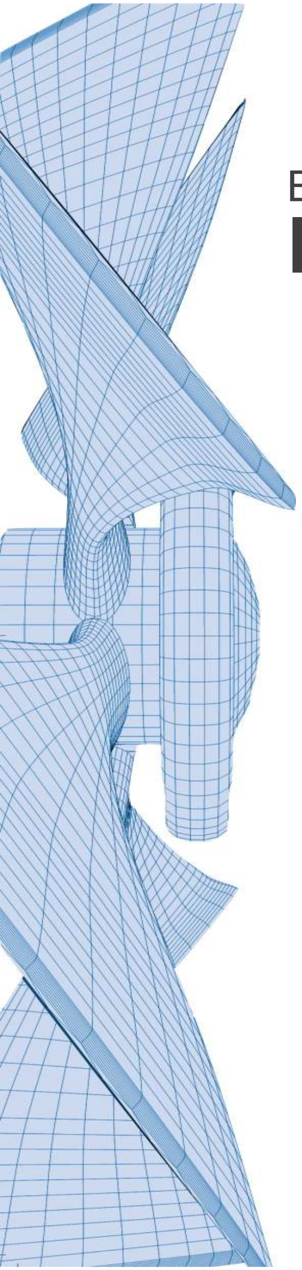
Liquid Cooling Plate

Industrial Application



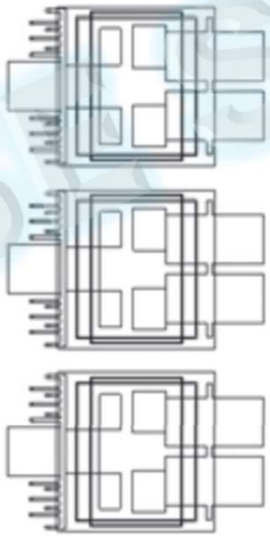
Electric Vehicle Controller (IGBT) Cooling Solution

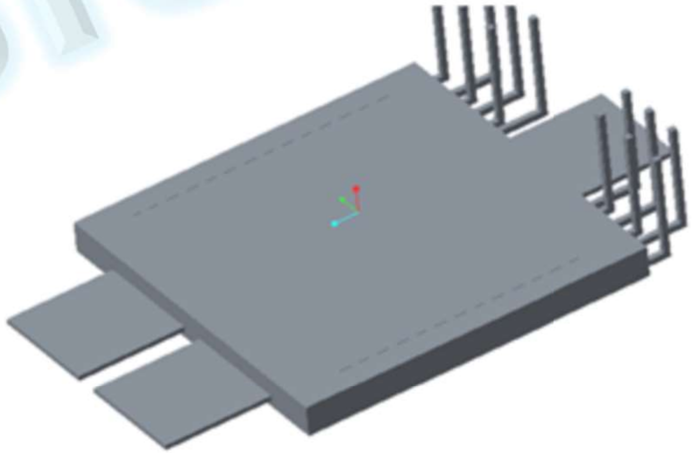
Introduction to Electric Vehicle Controller



The three major components of new energy vehicles are the motor, motor controller, and battery. Direct current from the battery pack is converted into sine waves through an inverter bridge to drive the motor. The power of the motor controller is designed based on the motor's requirements, with the main power unit being the IGBT. As the core of the motor controller, the thermal management of the IGBT is a crucial aspect in the development of the motor controller.

CASE STUDY





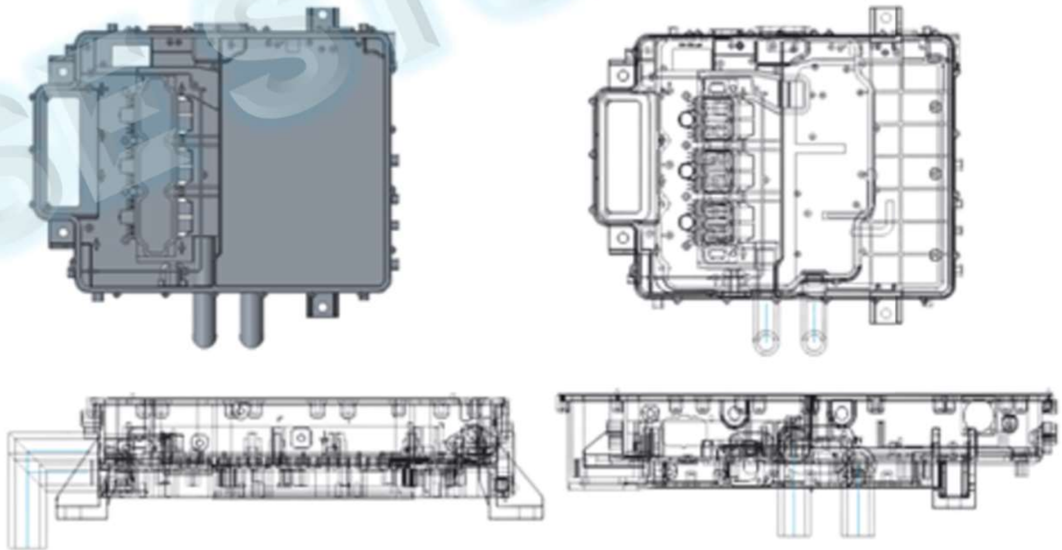
Electric Vehicle Controller (IGBT) Cooling Solution

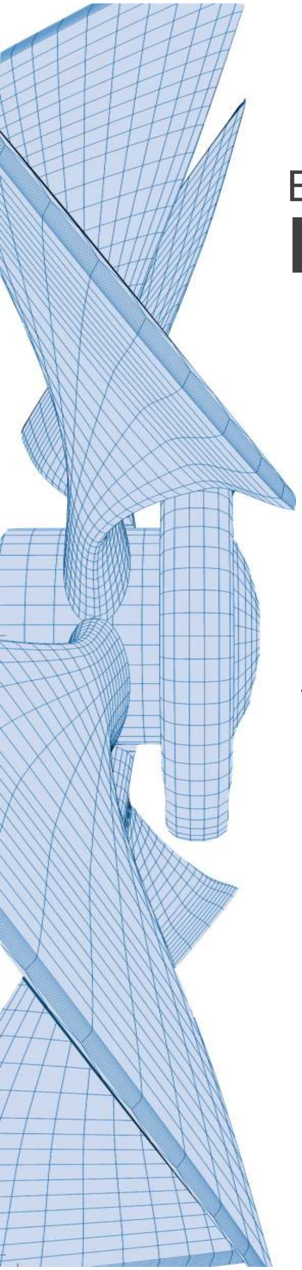
Processing Technology Introduction

The shell of the motor controller is generally produced using die-casting technology. However, with the increasing power density of motor controllers and the growing demand for cost-effectiveness (the main cost of motor controllers being in the IGBT module), combination processes are becoming more common in the design of motor controller waterways.

For example, a commonly used process in our company is to combine two die-castings together through friction stir welding, or to combine profile waterways with die-cast shells, and so on.

CASE STUDY





Electric Vehicle Controller (IGBT) Cooling Solution

Flow Path Design & Material : ADC12

Related Parameter Settings:

- Power: 350.85W

- Boundary Conditions:

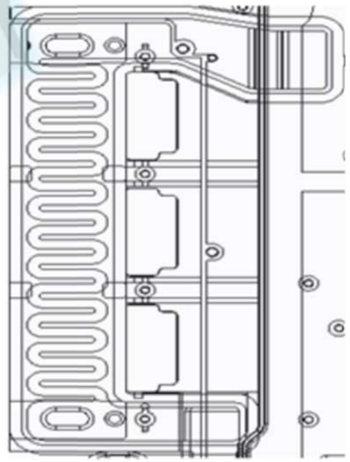
Coolant: 50% volume ratio ethylene glycol aqueous solution
Coolant Temperature: 65°C
Volume Flow Rate: 8L/min

- Design Requirements:

Flow Resistance < 80Kpa
IGBT Junction Temperature (Rated Condition) < 110°C
IGBT Junction Temperature (Peak Condition) < 160°C

CASE STUDY

Top Part
Die-Cast Flow Path

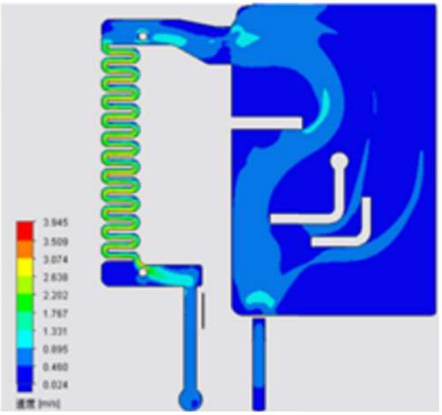


Main Cabinet
Die-Cast Flow Path

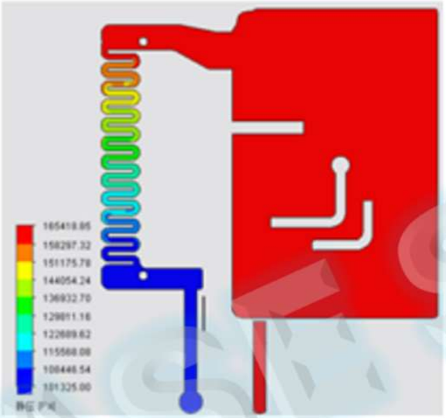
Electric Vehicle Controller (IGBT) Cooling Solution

Flow Field Distribution Map

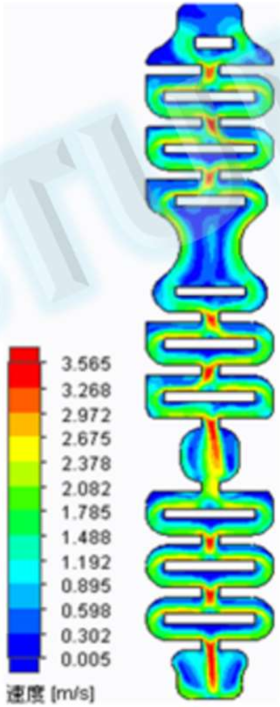
Main Flow Path Velocity Field



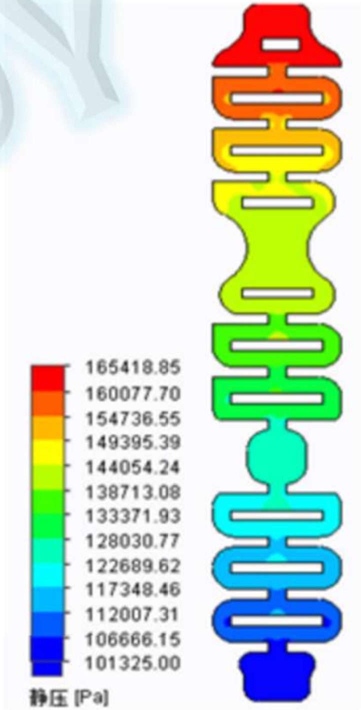
Main Flow Path Pressure Field



Main Flow Path Velocity Field



Main Flow Path Pressure Field

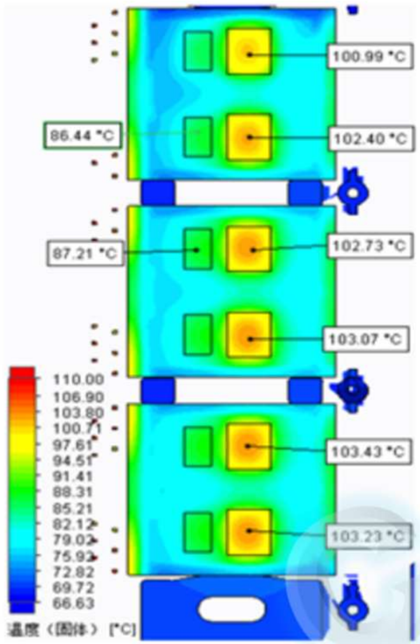


- **The flow resistance of the channel is approximately 65Kpa, which is less than 80Kpa, meeting the requirements.**

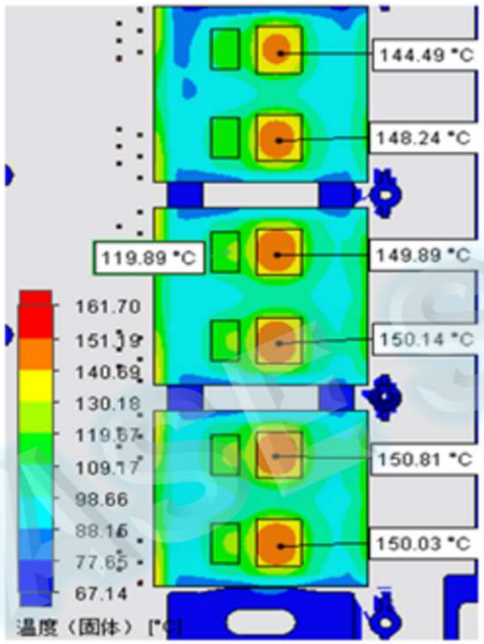
CASE STUDY

Electric Vehicle Controller (IGBT) Cooling Solution

Temperature Field Distribution Map



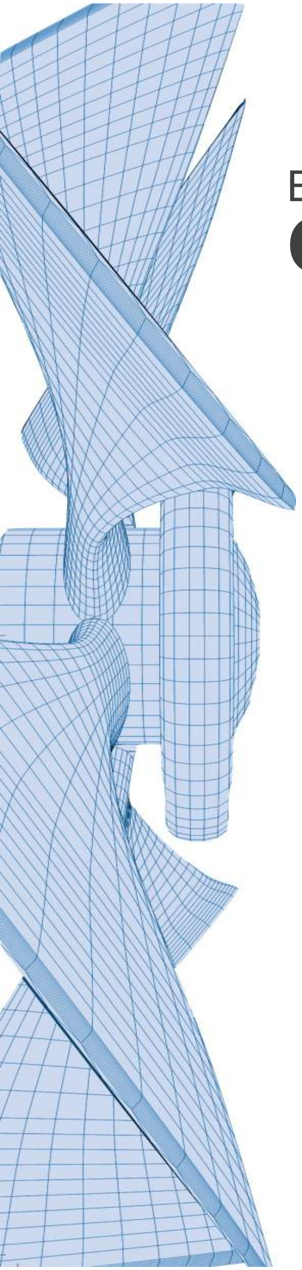
Rated Current



Peak Current

- **At rated current, the IGBT junction temperature is 103.4°C, and the diode junction temperature is 87.2°C, both lower than 110°C, meeting the requirement.**
- **At peak current, the IGBT junction temperature is 150.8°C, and the diode junction temperature is 120°C, both lower than 160°C., meeting the requirement.**

CASE STUDY



Electric Vehicle Controller (IGBT) Cooling Solution

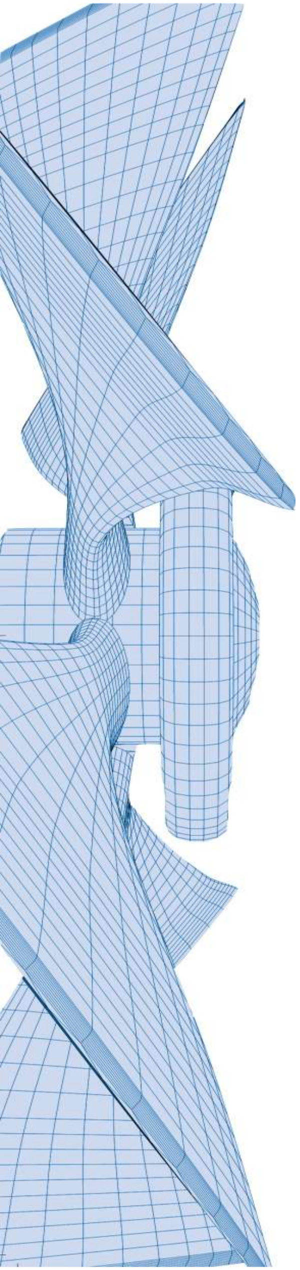
Conclusion

1. **Through simulation, it is found that the flow resistance of the channel is approximately 65Kpa, which is lower than the requirement of 80Kpa.**

2. **Under the rated current condition, the IGBT junction temperature is 103.4°C, and the diode junction temperature is 87.2°C, both lower than 110°C, meeting the requirement.**

3. **Under the peak current condition, the IGBT junction temperature is 150.8°C, and the diode junction temperature is 120°C, both lower than 160°C, meeting the requirement.**

CASE STUDY



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