FURUKAWA ELECTRIC

FURUKAWA ELECTRIC GROUP

Total Thermal Solution

Heat Diffusion and Cooling Products

Over Forty years ago, Furukawa Electric introduced thermal solution that can change the world.
It did not happen over night…
Our technology and solution is an outcome of decades and decades of creation, trial and error, and continuing pursuit of customer's true value.

Philosophy

Furukawa Electric Thermal Management Solutions & Products Division will Dedicate It's Thermal Technology for Customer's Value Improvement and Social Contribution.

Today, Furukawa Electric is still the leading innovator of thermal solutions. We continue to be our customer's strong partner to go beyond expectations and create new value.

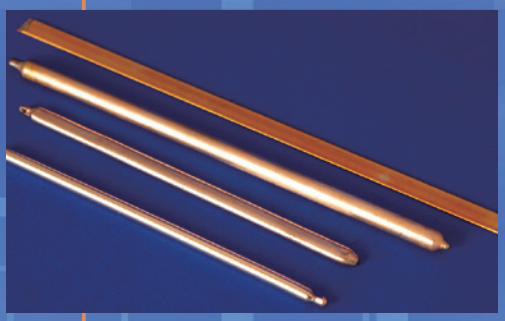
History of Thermal Innovation

Invention of Heat Pipe

1963
"Heat Pipe" is invented by George Grover Los Alamos National Laboratory, USA)
1965
First application of heat pipes on NASA's satellite temperature control system.

Introducing Heat Pipes to the Market

1985
Furukawa Electric introduces "Heat Pipe Heat Sink" to the market for efficient cooling of IGBT and power control device.
Furukawa launches "Air Kicker", a heat exchanger for sealed chasis.



1960's

1970's

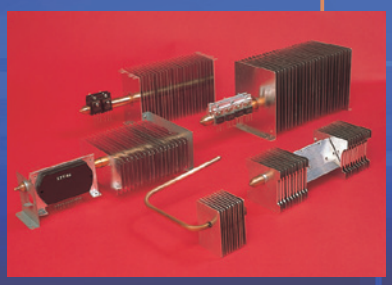
1980's

1990's

Start of Production

1970
Furukawa using it's strength as copper company begins mass production of copper heat pipe in Osaka, Japan

Pioneer Products
1975
Furukawa launches Heat exchanger for plant cultivation "Heat Econ"
Furukawa launches heat sink for audio amplifier "Heat Kicker".

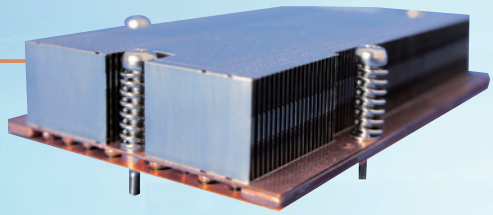


Proof of High Reliability

1990
After cycles of high standard reliability test for space usage, Furukawa Electric supplies heat pipe for H-II rocket

Fin Goes Solder Less

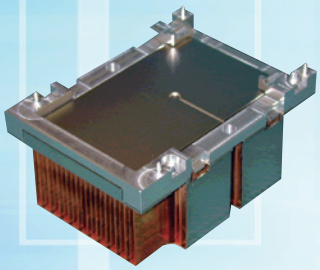
1999
Solder less solution "Crimped Fin" was first introduced by Furukawa Electric and patented in Japan and USA.
"Crimped Fin" later became Intel's reference heat sink.



From Vapor Chamber to Heat Spreader

2000

World's first vapor chamber manufactured by Furukawa Electric. Furukawa Electric Electric replaces vapor chamber with it's original "Heat Pipe Heat Spreader" for desk top and server CPU cooling.



1/4 Share Reached

2010

Reaching 25% world share of server heat sink.

Milestone

2012

Shipping 200 million pcs of heat sinks in cumulative total.

2010 ~

2000's

Very First Medical Application

2013

Furukawa Electric introduces heat sink for endoscope LED light source.

Going Even Thinner…

2013

World's thinnest heat pipe (0.6mm thickness) is introduced for smart phone CPU cooling.

Zero Heat Pipe Claim

2014

From day one of market launch to today, Furukawa Electric's heat pipe has never been claimed defective.

Moving to China

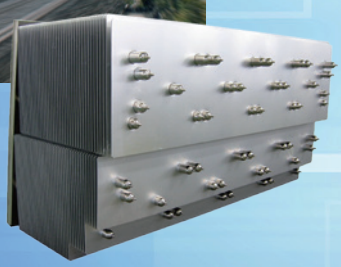
2002

First mass production plant opens in Suzhou, China .

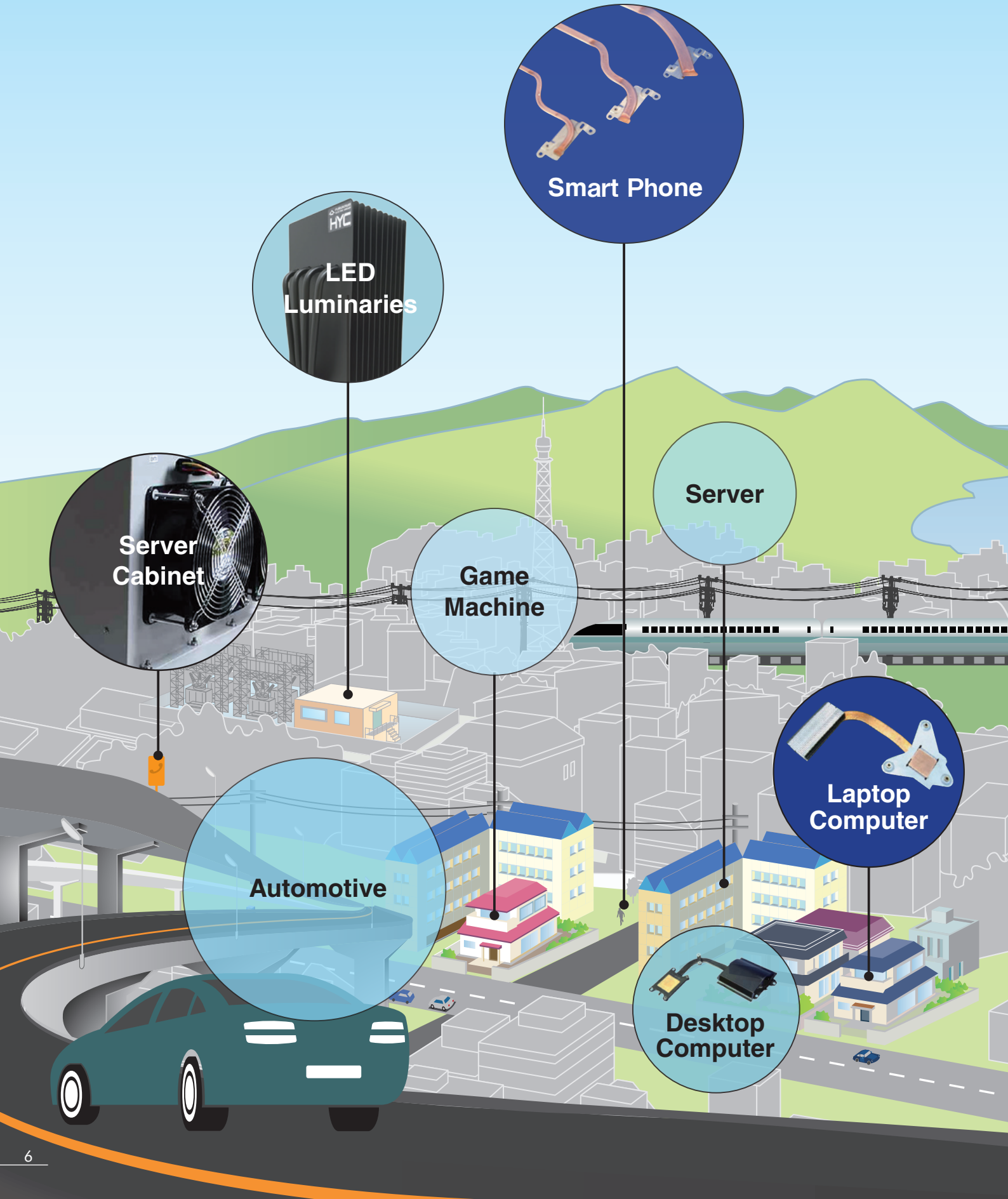
Making a Record

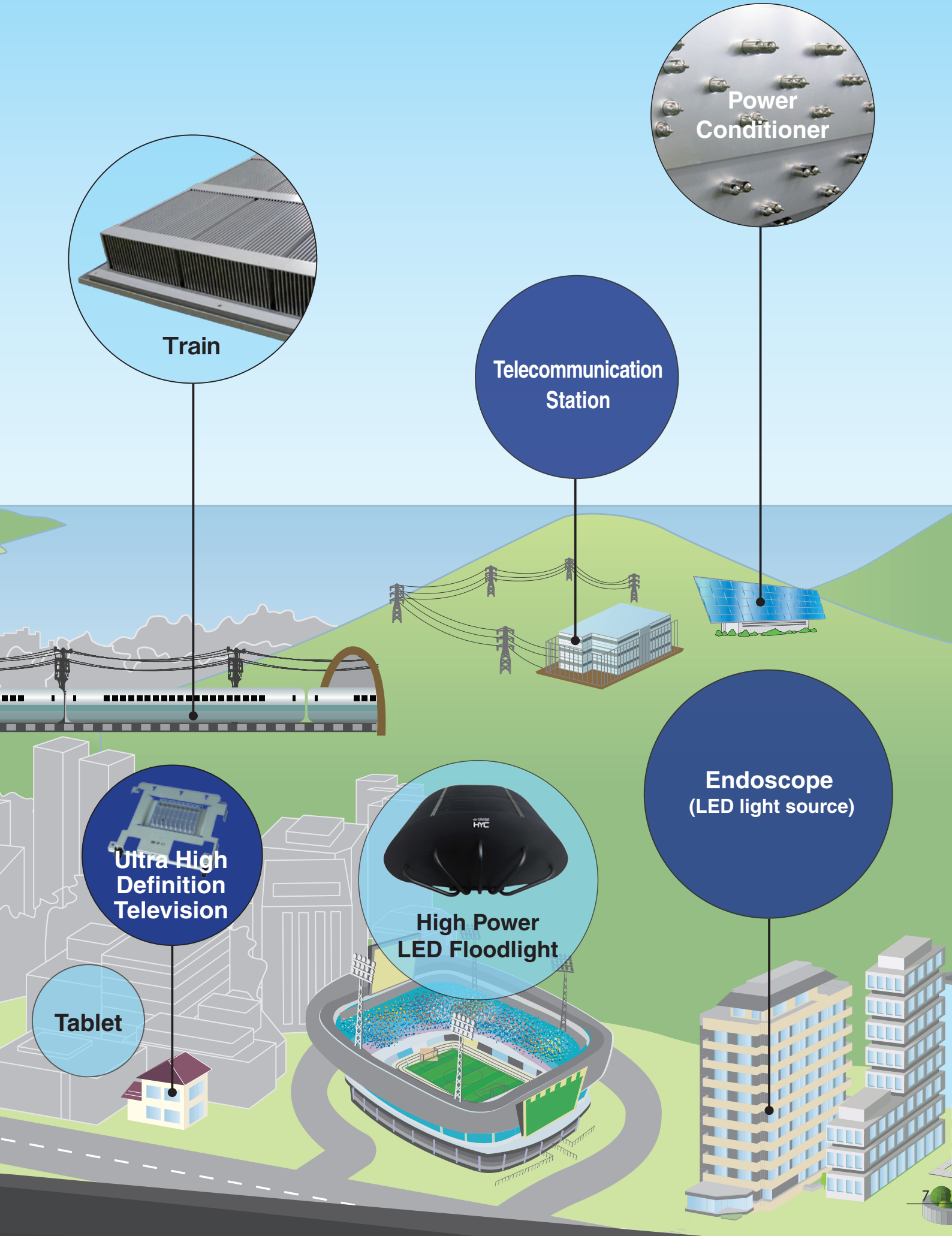
2005

Furukawa Electric hits US$ 80M annual sales record.

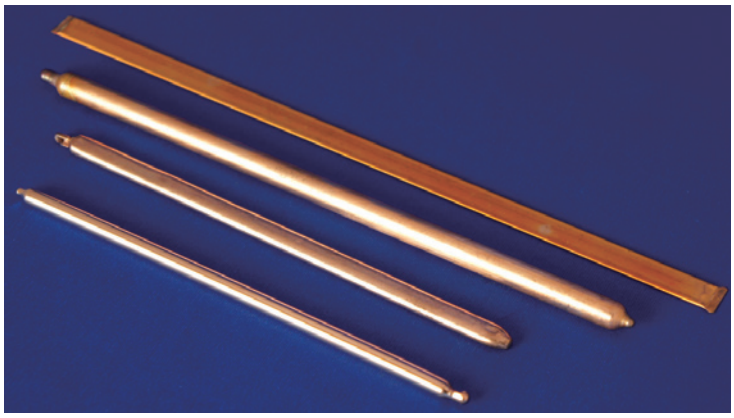


Heat Sink For Essential Performance and Stability...

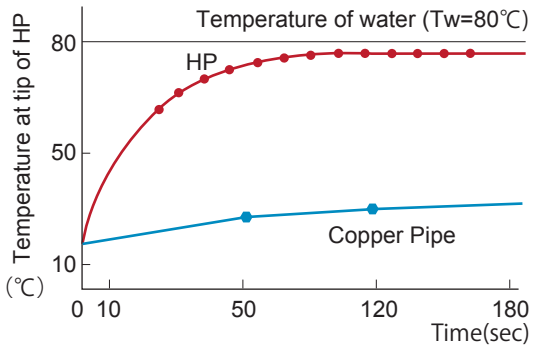



Power Conditioner
Train
Telecommunication Station
Ultra High Definition Television
High Power LED Floodlight
Endoscope
(LED light source)
Tablet

Heat Pipe

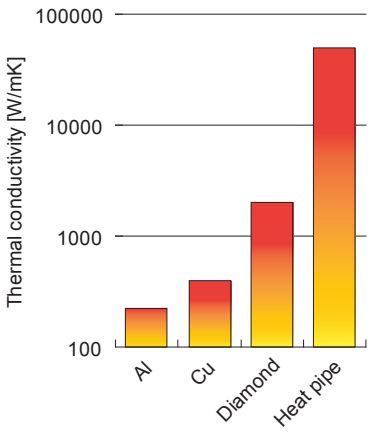


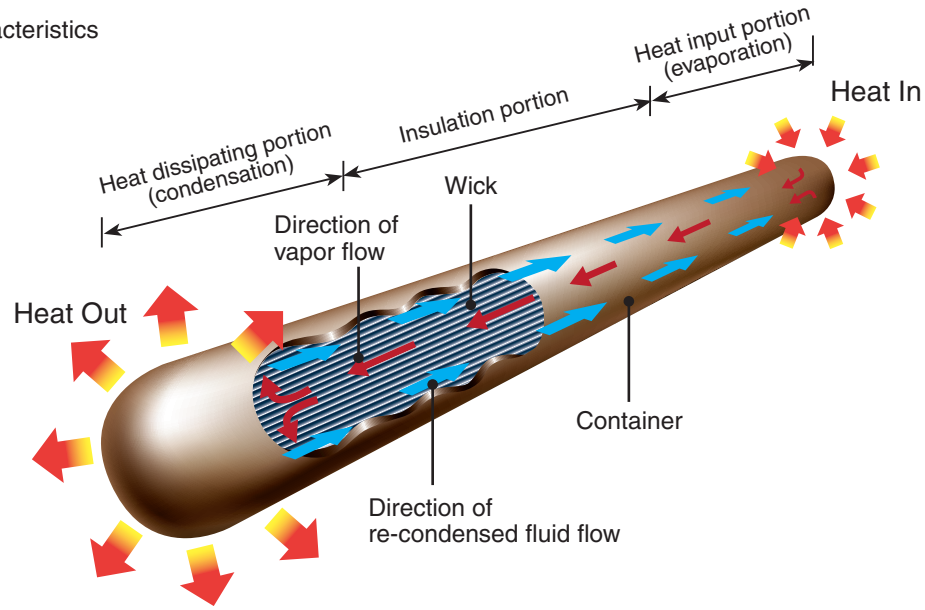
Thermal response characteristics of heat pipe(HP)



Heat Pipe Features:

- High thermal conductivity(1000 times greater than silver)
- Rapid thermal response
- Uniform temperature distribution Characteristics
- Lightweight
- Variable heat flux
- High reliability
- Maintenance-free



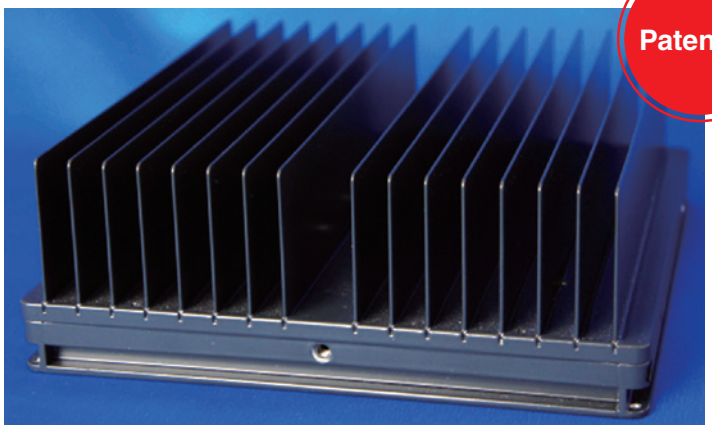


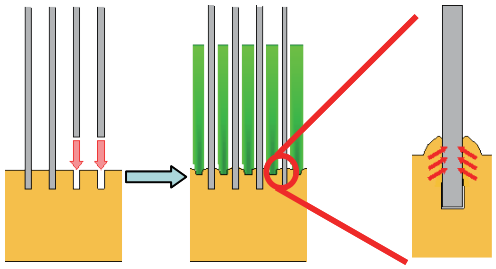
Inner Structure	Cross Section View	Pipe Diameter (mm)	Characteristics
Groove Wick		3/4/5/6/6.35/8/9.53/ 12.7/15.88/19.05/22.23	Low thermal resistance
Sintered Wick		4/5/6/8/10	Orientation friendly (Top heat solution)
Thinner Sintered Wick		5/6/8/10	Thinner thickness with higher heat transfer rate
Hybrid Wick		6/8/10	Higher heat transfer rate than other heat pipes with same diameter
Mesh Wick (t<1mm)		2/3/5/6	Ultra thin thickness, under 1.0mm

＊ Heat pipe is not for sale as single unit

Crimped Fin Design

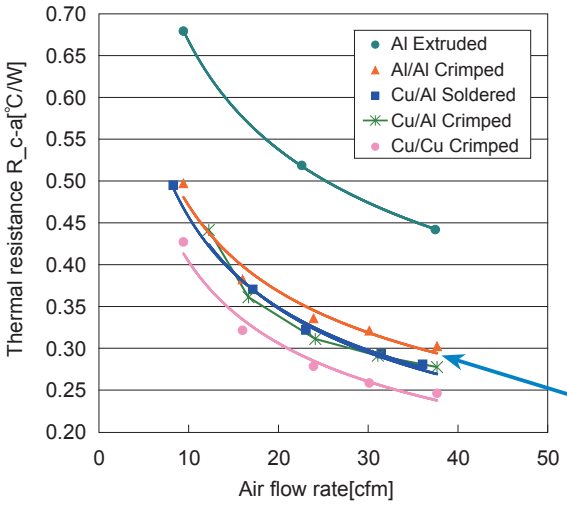
Crimped Fin Structure



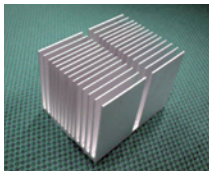


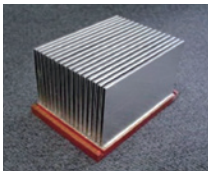
- Base and fins are mechanically attached without adhesive and solder.
- Customer has the flexibility to choose fin size, number, thickness depending on required performance

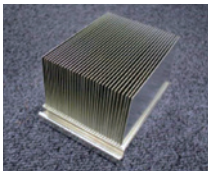
Thermal Performance Comparison
(Extrusion / Soldered / Crimped Fin)

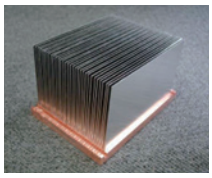


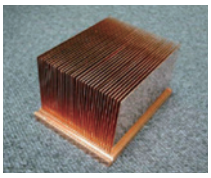
Material (Base / Fin)


Al Extruded


Cu/Al Soldered


Al/Al Crimped

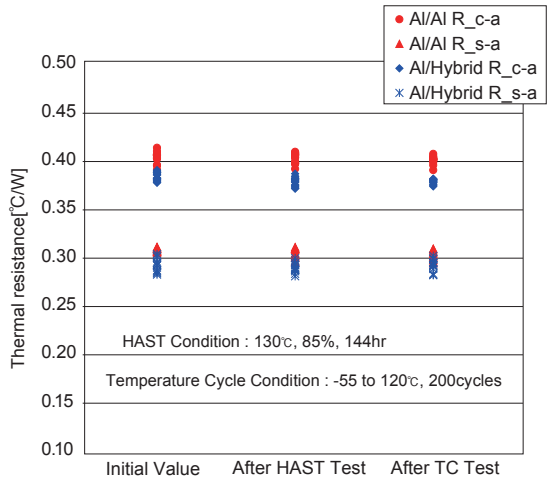

Cu/Al Crimped

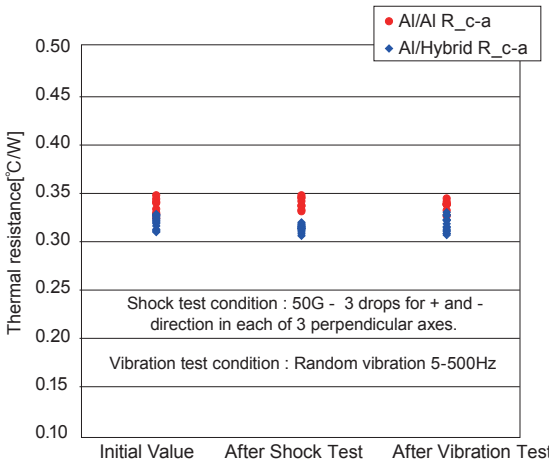

Cu/Cu Crimped

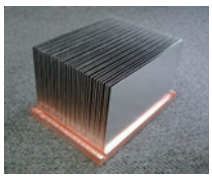
Aluminum crimped fin solution performs / 30% better than aluminum extrusion

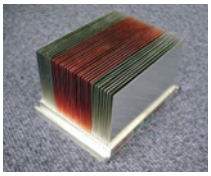
Proof of Reliability

These test results show crimped fin's high reliability and consistent quality.



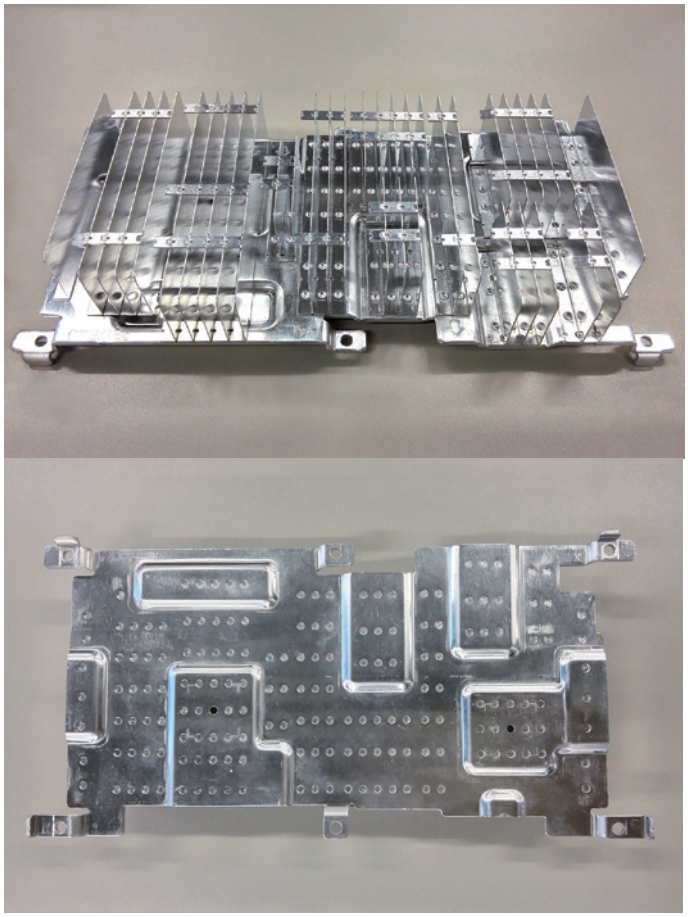


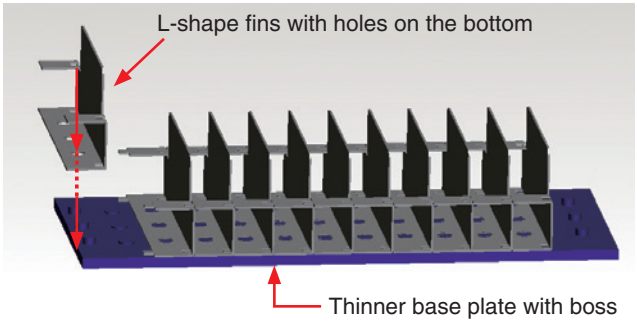

Cu base/Al fin


Al base/Hybrid fin

Eco-Fin®

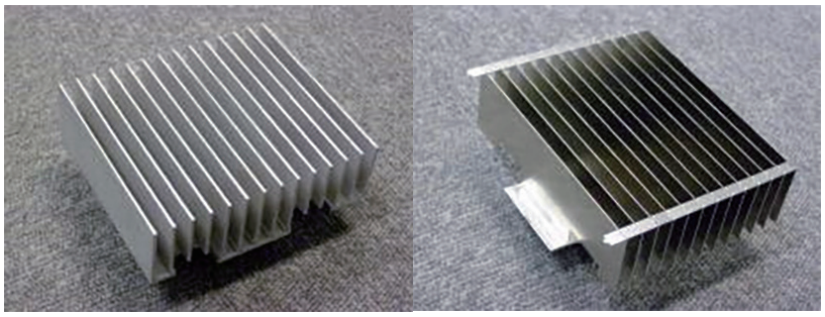
Eco-Fin Structure





- Fin hole and base plate's boss is mechanically connected by caulking.
- Fin and base plate is thinner than extruded heatsink.
- Thermal conductive adhesive tape can be used.
- More design flexibility of fin layout and base plate (convexo-concave shape)
  → Lighter and higher performance heatsink.

Comparison : Extruded heatsink and Eco-Fin



Extruded heatsink　　Eco-Fin

Testing Condition

Input Power : 5.8W Cooling Method : Natural Convection Position : Horizontal

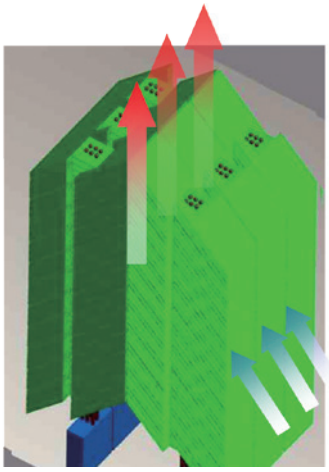
	Extruded Heatsink	Eco-Fin	Difference
Weight (g)	265.0	68.1	−196.9 (74%Improved)
Thermal Resistance (C/W)	2.72	2.43	−0.29 (11%Improved)

Heat Pipe Fin Stack Design

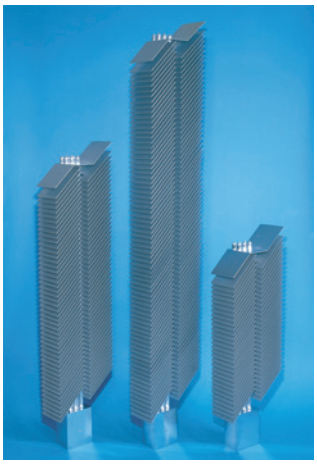
Heat Pipe Heat Sink…..

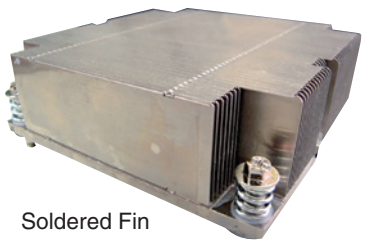
Heat pipe heat sink design is an ultimate cooling solution which can be applied for various products. By using heat pipes to assist efficient heat transfer from the heat source to heat spreader base and thermal radiation area such as fin, the performance and quality of the product can enhance significantly. Our experienced thermal designers are capable of proposing the best design depending on customer's product concept and granted space / condition for cooling.

In general, the design of a heat pipe heat sink can be classified into two main categories. One, Heat Pipe Fin Stack Design and two, Heat Pipe Embedded Design.

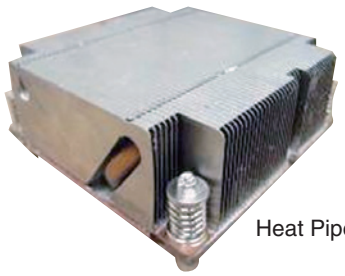


Heat Pipe Fin Stack Design:
Heat pipe fin stack design is most recommended for cooling products with vertical height but limited space in width. When the distance between heat source and cooling area is relevantly distant, the efficiency of heat transfer and cooling drops in proportion. In such case, heat pipe with it's advantage of high thermal conductivity is capable of transferring heat from the heat source to the tip of the fins where the heat pipe is in contact.

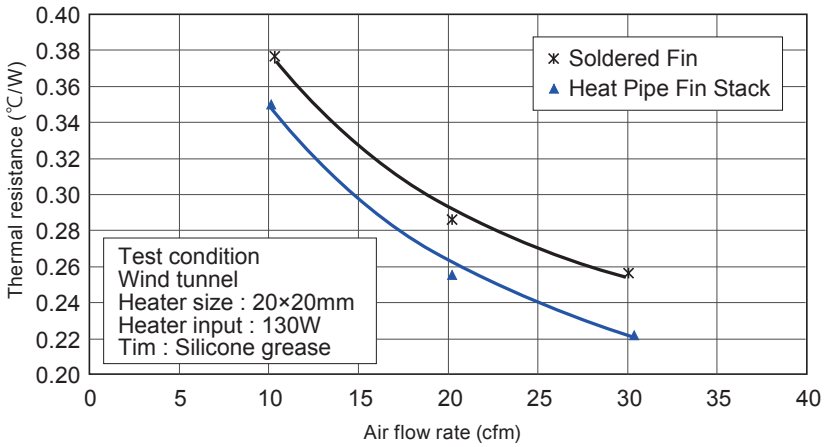




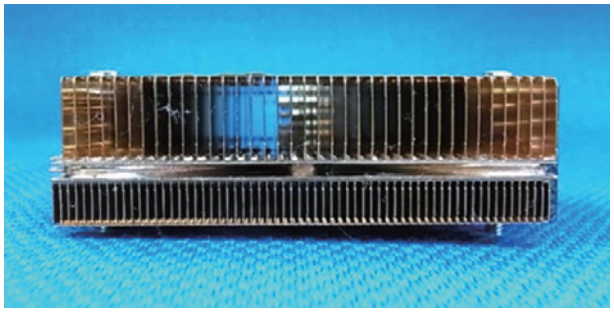
Soldered Fin

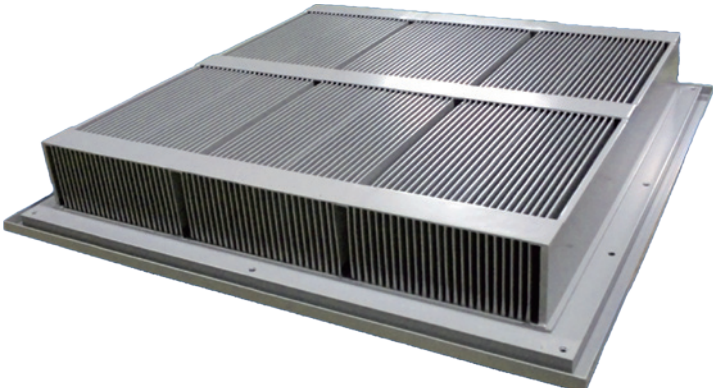


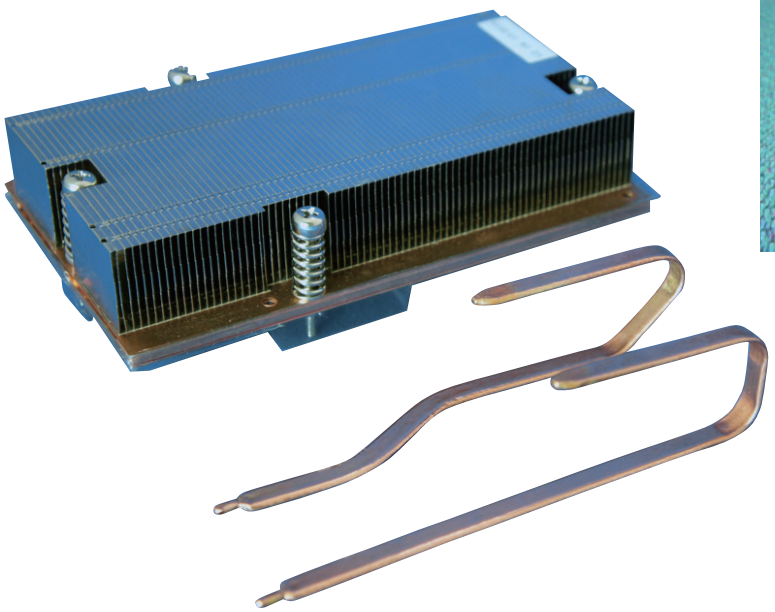
Heat Pipe Fin Stack

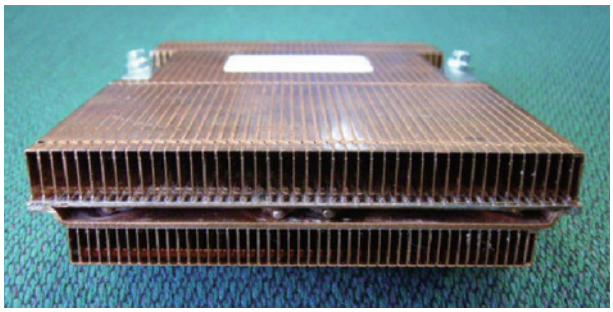


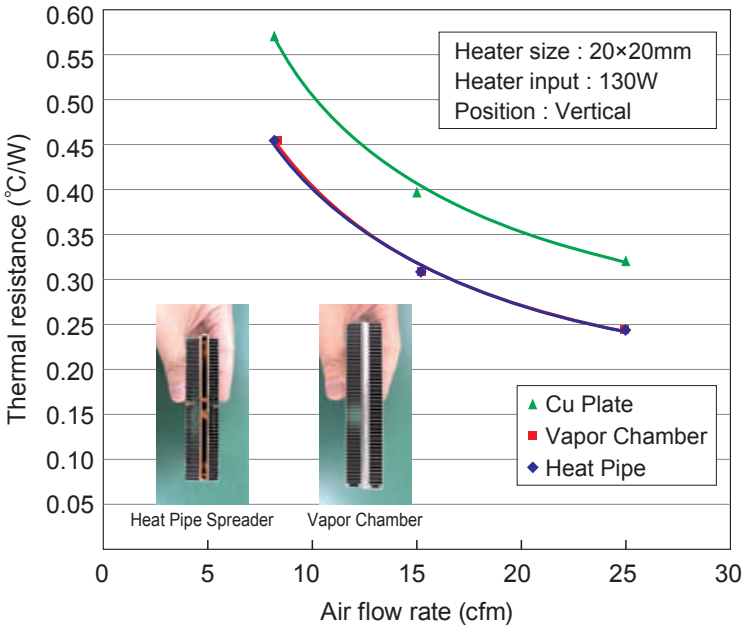
Heat Pipe Embedded Design









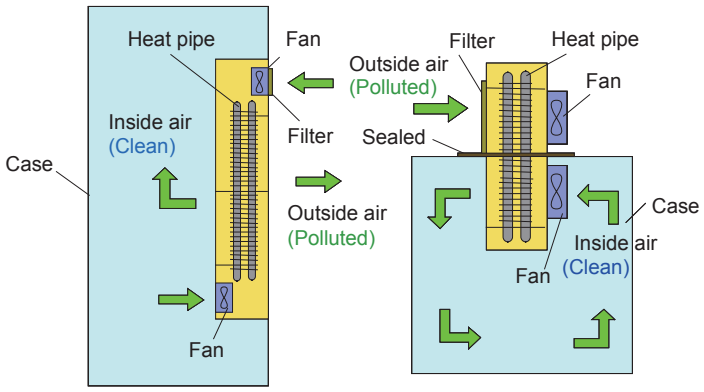


Heat Pipe Embedded Design:
Heat pipe embedded design is most recommended for cooling products with height constraints. In order to secure enough cooling area (fin area), the heat sink needs to spread out in horizontal orientation. However, the heat source is not always as wide as the heat sink itself which creates a concentration of heat in certain area in the base of the heat sink. In such case, by embedding heat pipe in the base area, it can assist to spread heat evenly in the base and consequently transferring heat evenly to the fins to maximize efficiency of heat dissipation.

Vapor chamber which is a planar-type heat pipe is also a well known heat spreader often used in high-end applications.

A thermal performance comparison data of copper plate, vapor chamber and heat pipe embedded design shows that heat pipe embedded solution has lower thermal resistance than plain copper plate and performs as well as vapor chamber. Although Furukawa Electric was the first company to manufacture vapor chamber in the early 90's , we now recommend most customers to choose heat pipe embedded design because of the flexibility of design as well as cost optimization.

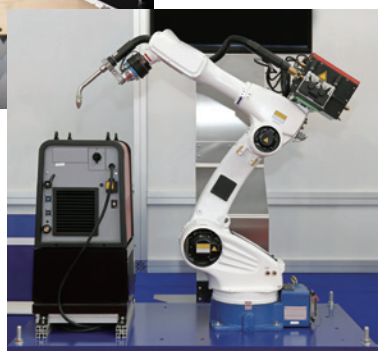
Air Kicker



Door Installation type　　Ceiling Installation type

The Air Kicker is a heat pipe-type cooler for cabinets that was developed as the cabinets on the control panels and operation panels of mainly robots and machine tools have become more air-tight.
Transferring heat with the heat radiating unit using heat pipes, while keeping the cabinet air-tight, separates the inside and outside of cabinet and cools the high-temperature air inside a cabinet that has low-temperature air outside.
The Air Kicker for outdoor use, which was developed for cabinets placed outdoors, has been used with numerous LED road signs and telecommunication base stations, and has been widely accepted for dealing with heat in elongating service lives and enhancing the reliability of precision equipment to be used for long periods. Please do not hesitate to consult Furukawa Electric for equipment of non-standard specifications.

Laser machinery



Welding robots

General Specifications

Model	Door-mounted type							
Model number	D7Z1R280L	D8Z1R350L	D4Z2R27OL	D6Z2R270L	D8Z2R270L	D10Z2R270L	D10Z2R460L	D13Z2R460L
Heat exchange※1 (W)	140/160	200/240	320/380	480/580	680/800	900/1060	1460/1740	2000/2400
Characteristic coefficient Ψ (W/℃)	7/8	10/12	16/19	24/29	24/40	45/53	73/87	100/120
Dimensions (height × width × thickness) (mm)	344x177x70	400x200x70	655x188x85	655x264x85	655x340x90	655x415x90	920x423x130	920x538x130
Weight (kg)	3	4	5	7	9	13	19	24
Number of fans used (fans per unit)	2	2	2	2	2	4	4	4
Fan electricity consumption※2 (W)	15/14	15/14	20/18	50/48	50/48	40/35	40/35	40/35

Model	Celling-mounted type				
Model number	C5Z2R300L	C5Z3R300L	C8Z3R36OL	C10Z3R440L	C13Z3R460L
Heat exchange※1 (W)	320/350	550/600	1190/1300	1650/1800	2220/2400
Characteristic coefficient Ψ (W/℃)	16/17.5	27.5/30	59.5/65	82.5/90	110/120
Dimensions (height × width × thickness) (mm)	346x195x100	346x195x140	407x310x140	487x385x140	507x500x140
Weight (kg)	6	8	11	25	28
Number of fans used (fans per unit)	2	2	4	4	6
Fan electricity consumption※2 (W)	20/18	50/48	40/35	40/35	40/35

● Door(side)-mounted type is available in indoor and outdoor models

※ Note1 : Performance when △T=T1-To=20℃ T1=mean temperature in the case,To=outsaide air temperature
※ Note2 : power consumption is for 60Hz/50Hz
※ Ambient temperature : normal temperature of 60℃ or less
※ Door(side)-mounted type comes in outdoors and indoors models
※ Painting : Mansel 5Y 7/1 or no paint (zinc-steel plating)

Please contact us for futher information about products with nonstandard dimension or performance.

Power Kicker for Railway / Power Conditioner

Below 10,000W semiconductor for Railway / Subway

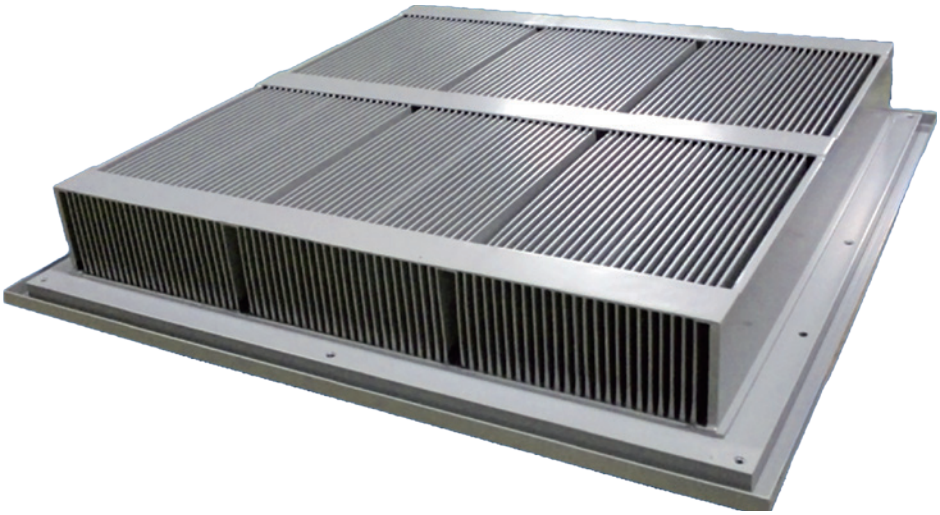
Application:
Thermal control is indispensable for emission control semiconductor to perform it's function. Especially for power module like Insulated Gate Bipolar Transistor (IGBT) which dissipates kilo watts of heat, a thermal solution must be designed in capable of cooling such amount of heat as well as being reliable in long term for stable energy supply. For power and design efficiency, power module itself is becoming smaller and compact while heat dissipation is no less. It is known that high heat density is a tough task for thermal solution in general.

Design Concept:
Furukawa Electric recommends power kicker (heat pipe heat stack solution) especially if there is limited space horizontally but more space available vertically. Heat pipe solution in general is also recommended to be used when heat generating element has un-even thermal extent which causes a "hot-spot". To prevent corrosion in out-door use, anticorrosion treatment such as nickel plating is highly recommended as an industry standard.

Material:
Aluminum Fin / Aluminum Base / Heat Pipes (Copper) / Ni Plating

Heat Pipe Embedded Blower Less Solution for High Speed Rail

10,000W to 20,000W semiconductor for Railway/Subway



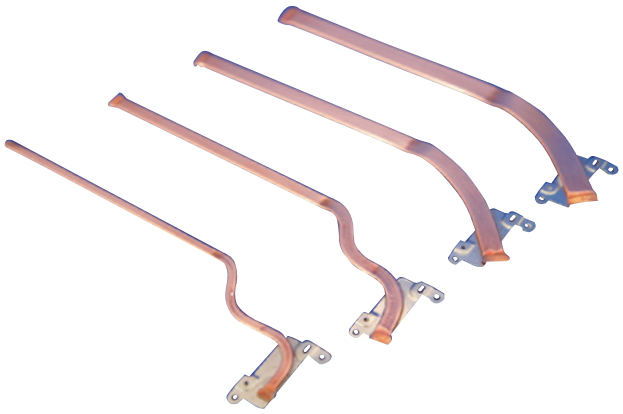
Application:
Thermal control is indispensable for emission control semiconductor to perform it's function. Especially for power module like Insulated Gate Bipolar Transistor (IGBT) which dissipates kilo watts of heat, a thermal solution must be designed in capable of cooling such amount of heat as well as being reliable in long term for stable energy supply.

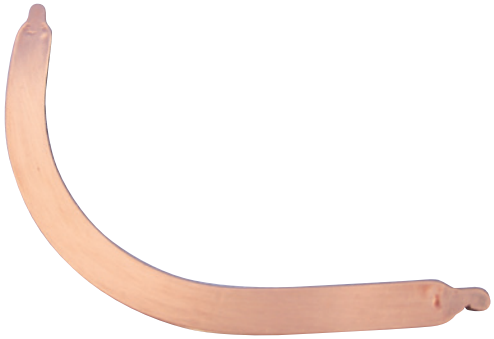
Material:
Aluminum Extrusion/ Heat Pipes (Copper) / Ni Plating

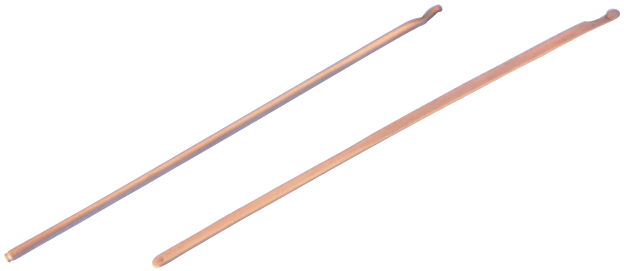
Design Concept:
Furukawa Electric recommends heat pipe embedded blower less solution especially if there is limited space vertically but more space available horizontally. This specific solution has been applied for high-speed railway that use the wind flow during transportation instead of using fans for forced convection. Heat pipe solution in general is also recommended to be used when heat generating element has un-even thermal extent which causes a "hot-spot". To prevent corrosion in out-door use, anti-corrosion treatment such as nickel plating is highly recommended as an industry standard.

Ultra Thin Heat Pipe Solution for Smart Phone / Tablet

1W to 10W CPU / chipset for Smart Phone / Tablet







Material:
Copper Heat Pipe/Aluminum Plate

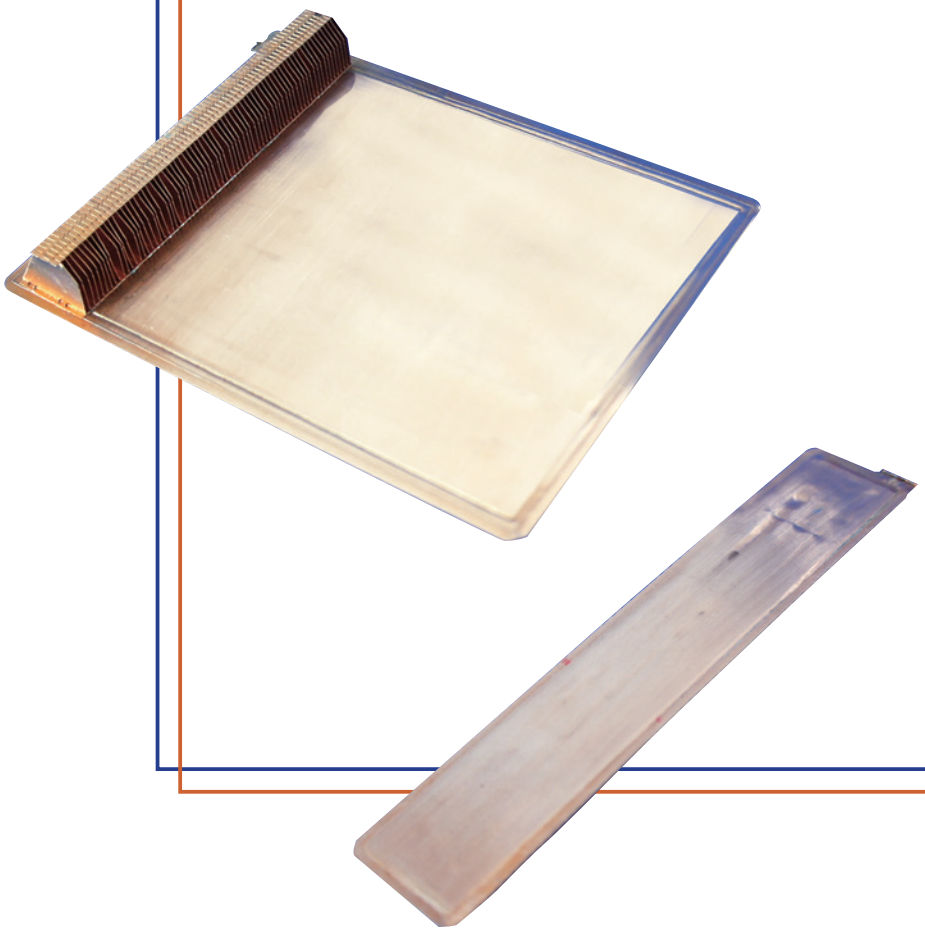
Application:
High performance smart phone and tablet are evolving to replace laptop computer especially in the consumer market. Thermal control of the CPU installed in these devices is critical to keep high and stable function though the physical space to allow heat sink installation is very limited. Most of these devices do not have a fan or an outlet to release hot air. Spreading the heat from hot spot to cooler wider area of the chassis is a general measure taken in smart phone and tablet.

Design Concept:
Ultra thin heat pipe was developed to transfer small amount of heat (1W~10W) where space is extremely limited. The thickness of the heat pipe is less than 1mm (minimum 0.6mm) while the smallest diameter is 2 mm. Heat pipe can also be curved to an extent of minimum radius depending on the diameter of the heat pipe.

Advantage:
Hot spot temperature is 20% less than aluminum plate, 15% less than graphite sheet. Less cost than graphite sheet.

Ultra Thin Vapor Chamber for Smart Phone / Tablet (Under Development)

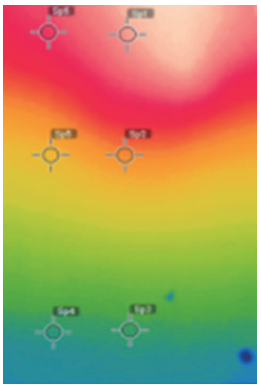
1W to 10W CPU / chipset for Smart Phone / Tablet



Material: Copper

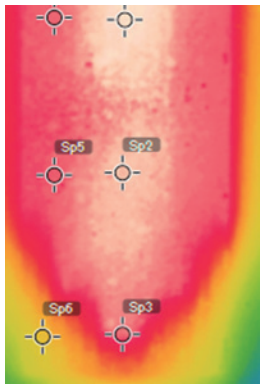
Design Concept:
Ultra thin vapor chamber is an extremely thin heat spreader (less than 0.5mm) with design flexibility for solving hot spot in slim devices such as smart phone and tablet computer.
By using our ultra thin vapor chamber, the user will experience an even spread of heat in the chassis and will no longer feel the uncomfortable hot spot in one area of their portable device. This product is currently under development. Mass production is coming soon.

SUS plate + graphite



SUS plate + heat pipe

Ultra thin vapor chamber



Temperature distribution shows Ultra Thin Vapor Chamber has even spread of heat

High Power LED Lighting Heat Sink (HYC)

400~500W LED (1KW Halogen equivalent)
High Beam Flood Light for Stadium / Athletic Field

Application:
For energy consumption saving and long term use, replacing conventional halogen lamp by LED light source is an obvious movement. Unlike fluorescent lamp, LED light source does not release energy via radiation. 80% of the consumption energy is directly converted to waste heat which makes LED lighting necessary to include cooling measure in its apparatus.

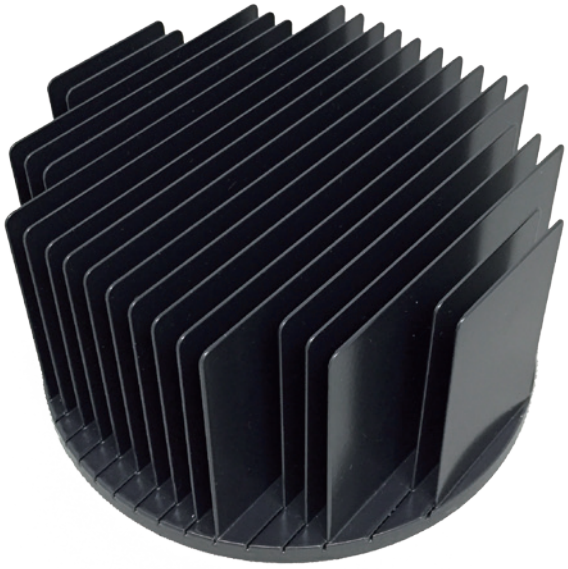
Design Concept:
High Power LED Lighting Heat Sink (HYC) is recommended for transferring and spreading heat from high density layout of LED chips. By creating natural air flow using chimney effect, HYC is an optimal solution for natural convection. We highly recommend not using a fan or blower with LED lighting because not only adds extra cost but maintenance will be required after certain period of time while advantage of using LED is in it's long product life over 40,000 hours.

Material:
Aluminum Fin / Aluminum Base / Heat Pipes (Copper) / Ni Plating

200W~300W LED High Bay Heat Sink

Crimped Fin Solution for LED Lighting

Over 100W Industrial Use Ceiling Light

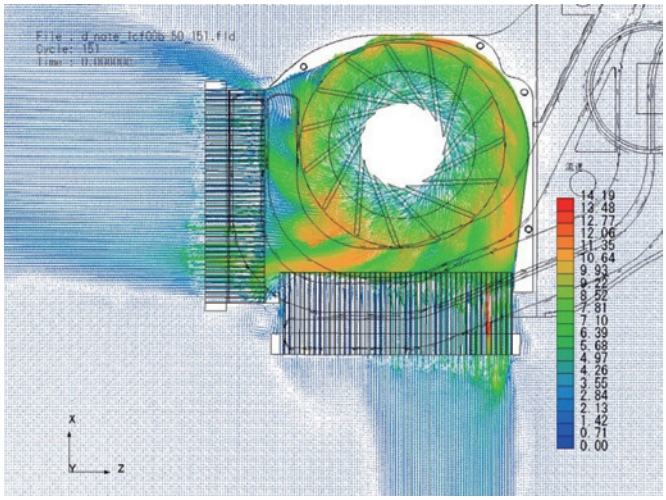


Application:
For energy consumption saving and long term use, replacing conventional halogen lamp by LED light source is an obvious movement. Unlike fluorescent lamp, LED light source does not release energy via radiation. 80% of the consumption energy is directly converted to waste heat which makes LED lighting necessary to include cooling measure in its apparatus.

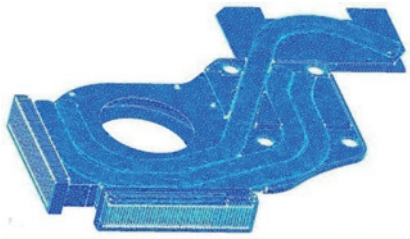
Design Concept: Crimped fin (mechanical attachment of fin and base) is recommended for replacing conventional solid heat sink such as die-cast and extrusion for any kind of LED lighting. Many lighting users prefer lighter and more compact apparatus especially for high-power lighting such as industrial ceiling light or flood light. Even for home and store users, it is obvious that a diecast heat sink is adding weight compared to conventional halogen or mercury lamp. By reducing the weight of lighting, in the end it helps reduce the installation cost which could add premium value over competitor's lighting with die-cast heat sink. It is proven that crimped fin can reduce up to 70% of weight compared to solid heat sink and yet thermally performs even better than die-cast or extrusion.

Material: Anodized Aluminum Fin / Anodized Aluminum base

Numerical Analysis Technology

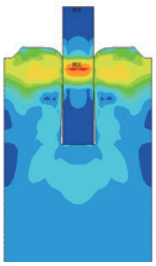


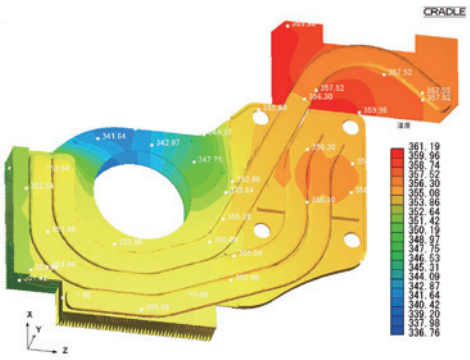
Hydro Dynamics (Screw-tetra)



- Hydro Dynamics
- Thermodynamics
- Structural Mechanics

Can be analyzed





Structural Mechanics (Ansys)

Thermodynamics (Stream, Fluent)

Reliability Test Apparatus

Temperature cycle

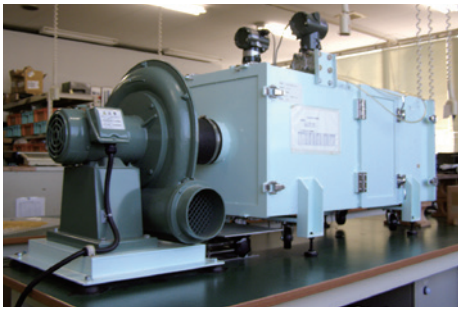
Heat shock

Pressure cooker (For HAST)

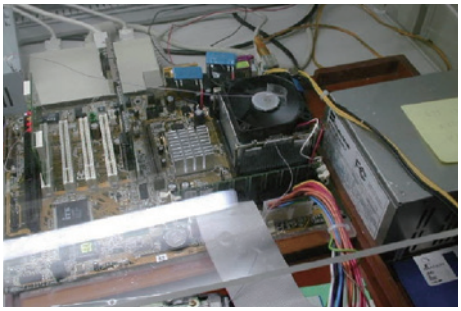
Shock & vibration

Radiation temperature controlled box

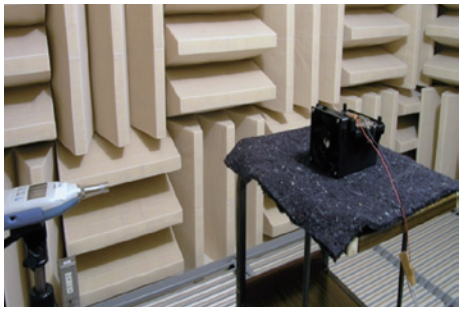
Measuring Apparatus



Wind tunnel

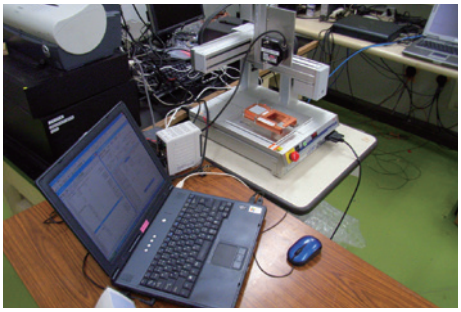


System test board



Semi-anechoic room

CMM



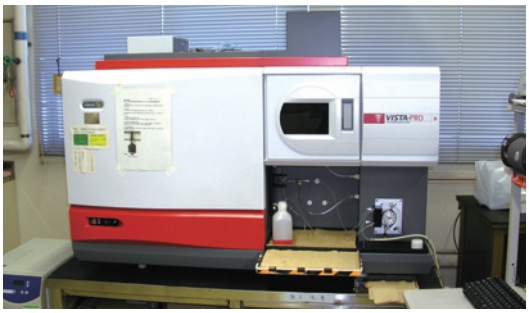
Non-contact measurement

Loading force measurement

Analysis Equipments

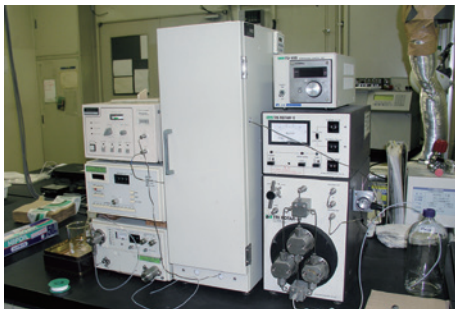
EPMA: Electron Probe Micro-analyzer (structural and composition distribution analysis)

XRF:X-ray Fluorescence Analysis (elemental analysis)

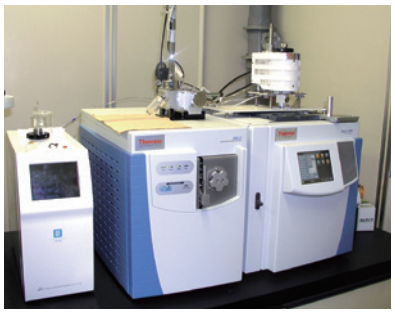


ICP: Inductively Coupled Plasma (elemental analysis for gas)

FT-IR: Fourier-Translation Infrared Spectroscopy (elemental analysis for organic compound)



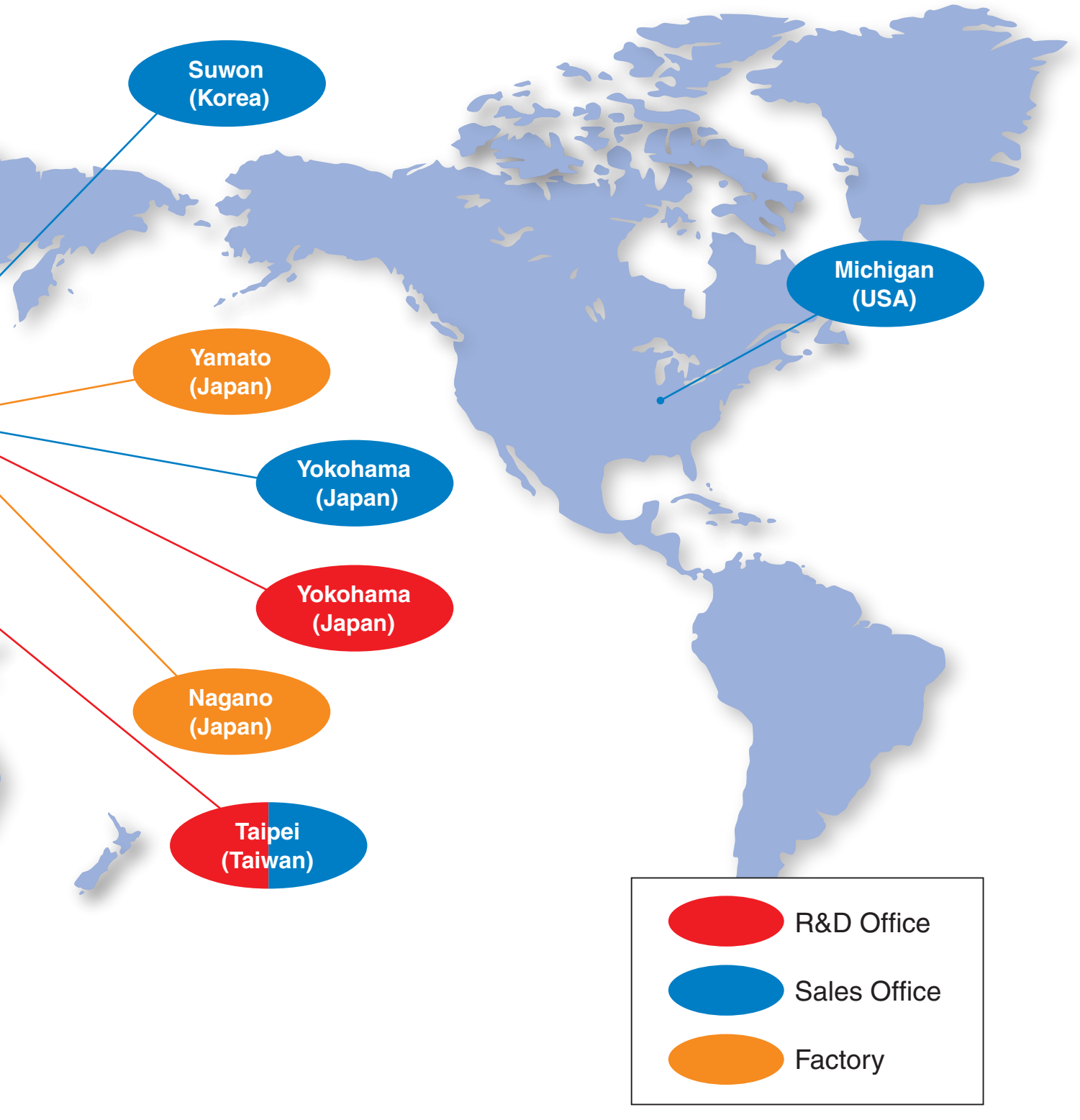
HPLC: High Performance Liquid Chromatography (qualitative and quantitative analysis for liquid)



GC: Gas Chromatograph (qualitative and quantitative analysis for gas)

Global Network

From our headquarter located in Tokyo, we develop and offer innovative solutions for customers worldwide. With multiple sales office in Asia, North America and Europe, all information is integrated to our expert designers in Japan and Taiwan to overcome thermal challenges facing our customers. From our manufacturing sites in China and Japan, Furukawa Electric owned logistic network supports safe and efficient delivery to world wide destinations.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