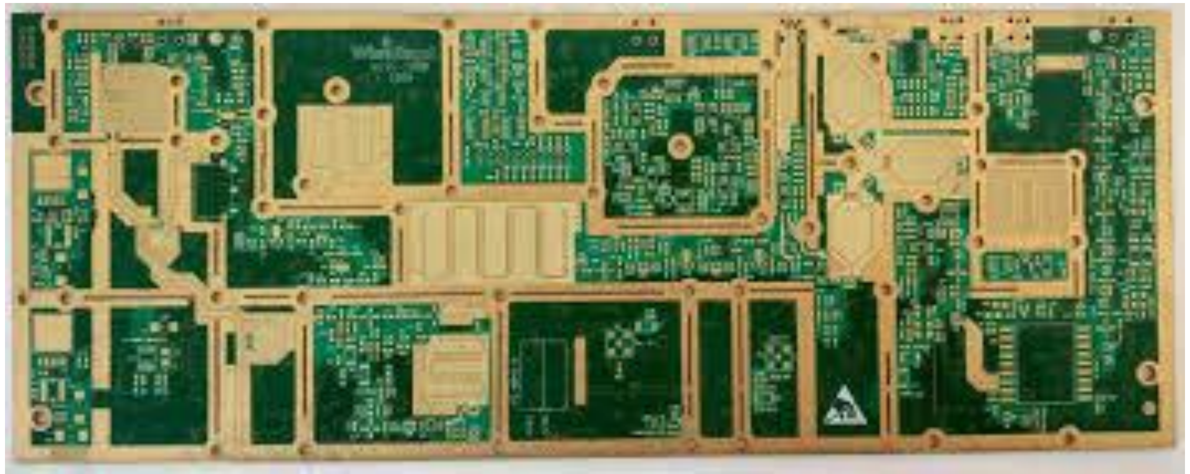
TennMax Technology Is An Enabler For Size & Weight Reduction In Mechanical & Thermal Assemblies

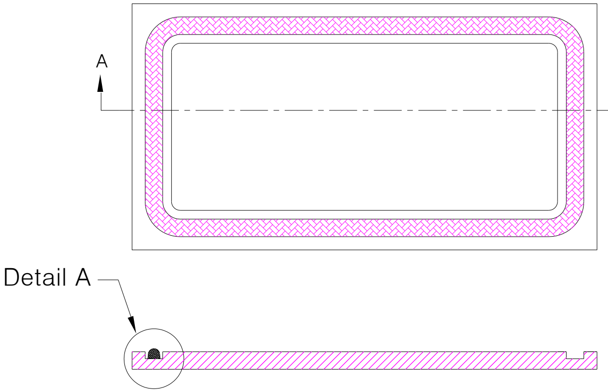
2019

Commonly used shielding methods

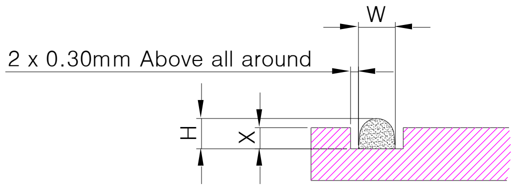
Metal shields with multiple screws to assure that the metal can be held flat to minimize gap



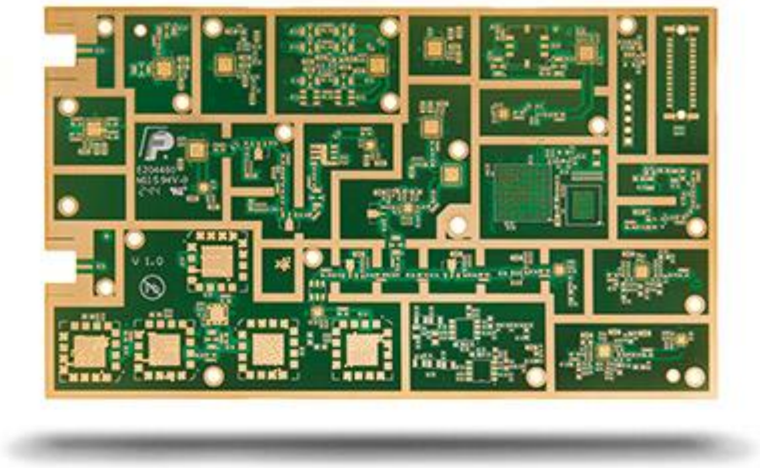
Hand Placed Conductive gaskets allow for more distance between screws but still require an extremely wide trace on the PCB



SECTION A-A

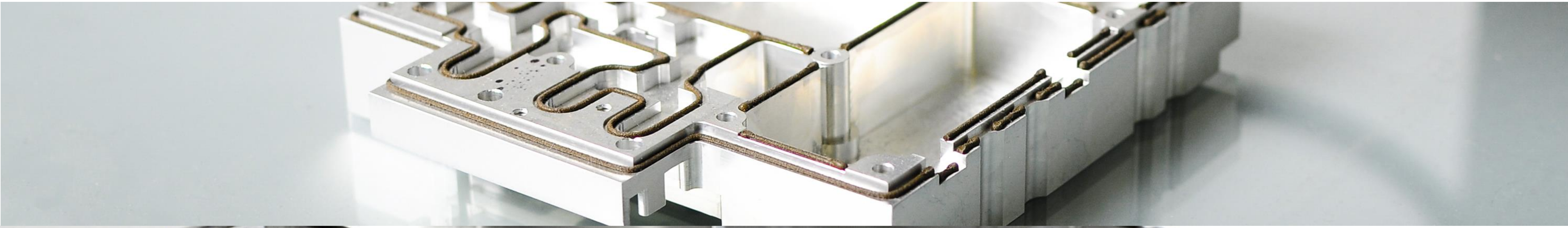


Detail A
3:1



Shielding with Thinner Walls

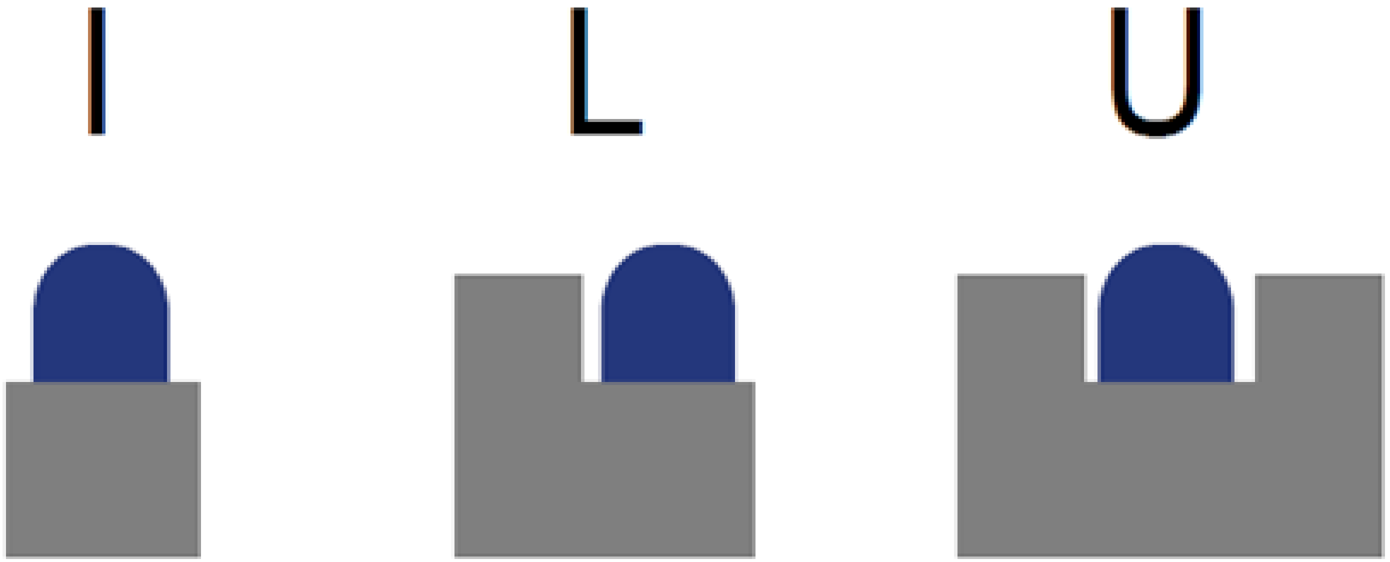
Form in place allows you to spread your screws farther apart and use thinner walls and traces



melcom

Form In Place Gaskets

3 or 4 Axis dispensing that can place conductive material .25mm to 2mm high



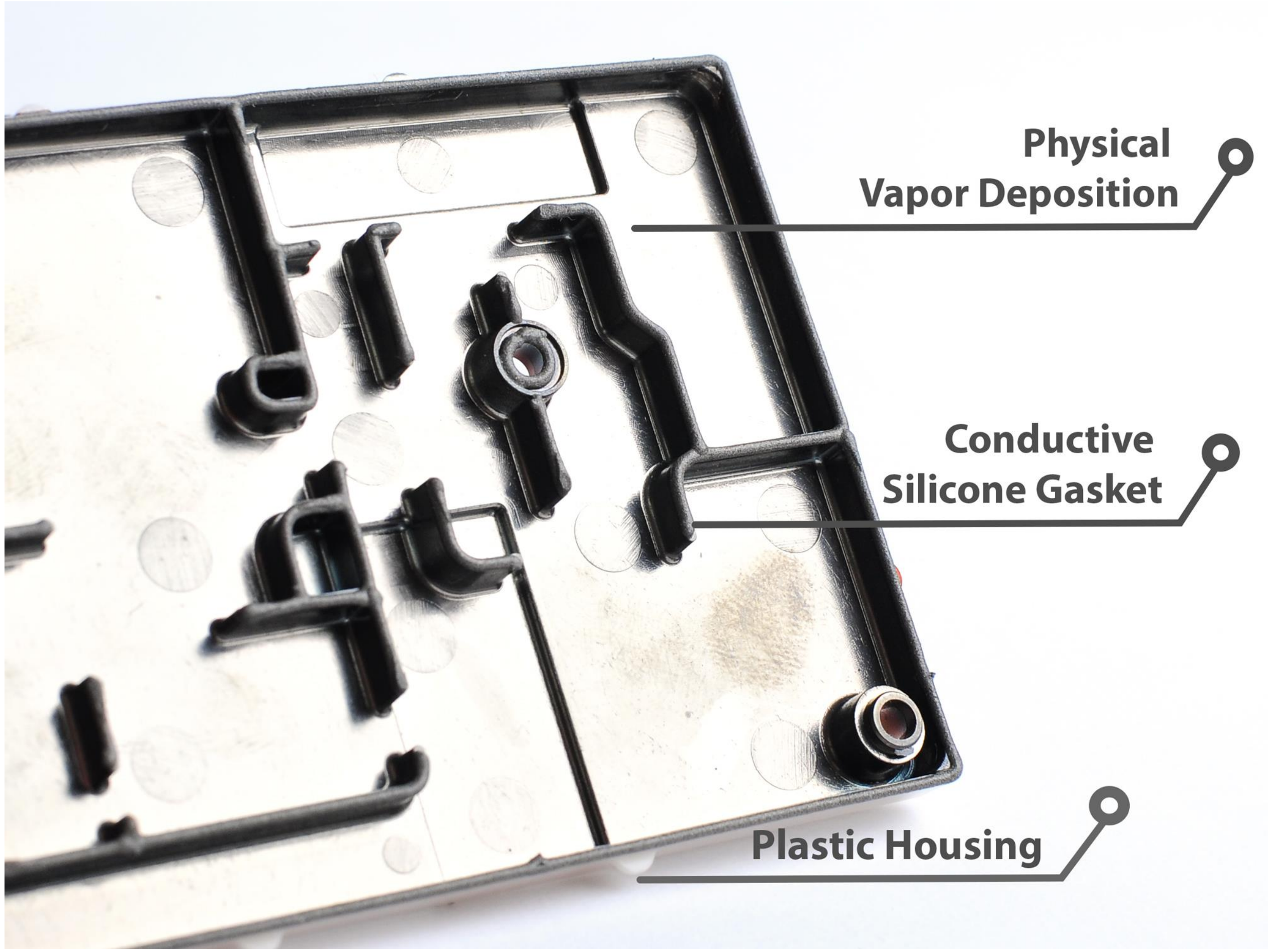
Material Options

Different Materials for Different Applications

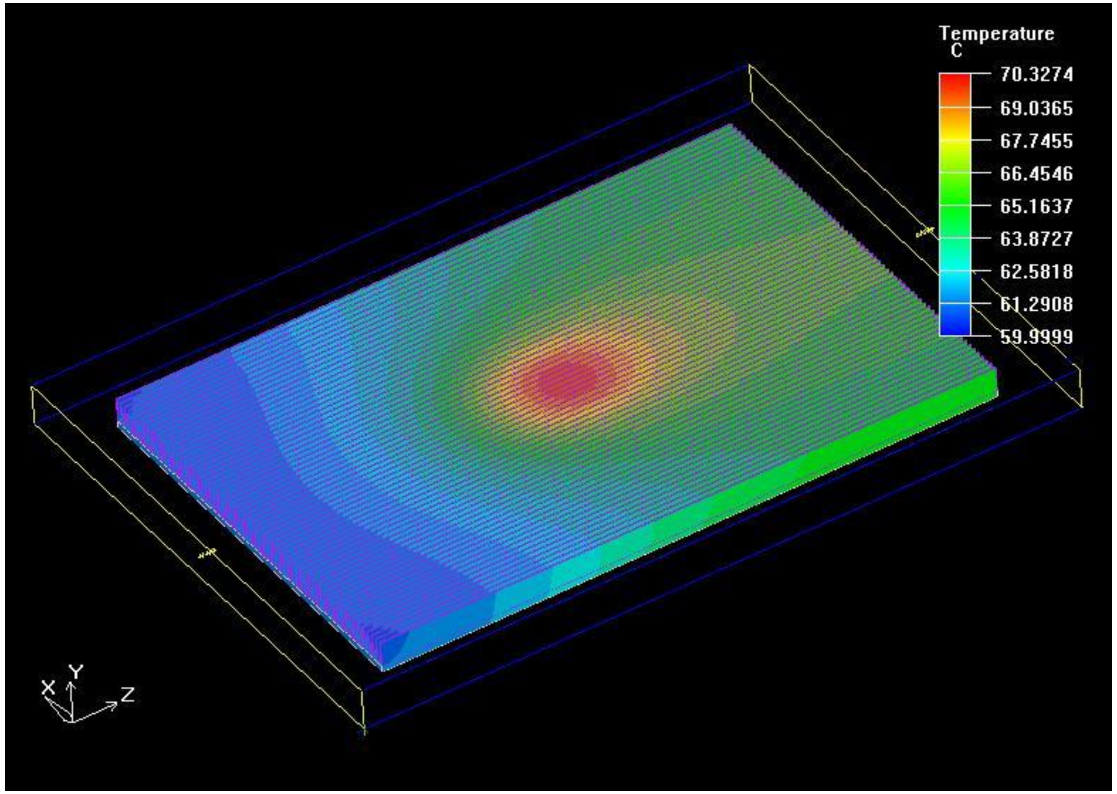
TYPICAL PROPERTIES	EMI SHIELDING GASKET											ENVIRONMENTAL SEALING GASKET						COMBO GASKET	
Part Number	F5301	F5304	F5305	F5321	F5322	F5221	F5521	F5801	F5381	F5382	F5383	F6003	F6023	F6031	F6011	F6012	F6081	F9304	F9305
Elastomer Binder	Silicone								Fluorosilicone			Silicone					Fluoro.	Silicone	
Conductive Filler	Ni/Gr	Ni/Gr	Ni/Gr	Ni/Gr	Ni/Gr	Ag/Cu	Ag/Al	Ag/Ni	Ni/Gr	Ni/Gr	Ni/Gr	N/A						Ni/Gr	
Curing System	Thermal			Moisture				Thermal				Thermal	Moisture		Thermal			Thermal	
Hardness (Shore A)	60	25	35	60	50	40	45	55	75	75	45	40	20	22	17	17	43	28	30
DC Through Resistance at 30% compression, 1mm Height (Ohm)	0.05	0.11	0.08	0.15	0.12	0.05	0.07	0.4	0.9	0.09	0.49	N/A						0.06	
Shielding Effectiveness (200MHz-10GHz)	>100dB											N/A						>100dB	
IP Class	IP66							IP65	IP66			IP68	IP67	IP67	IP67	IP67	IP68	IP68	IP68
Recom'd Bead Size (mm): Max. (Height by Width) Min. (Height by Width)	2.0x2.5 0.2x0.3	2.0x2.5 0.2x0.3	3.0x3.8 1.0x1.3	2.0x2.5 0.2x0.3	2.0x2.5 0.2x0.3	2.0x2.5 0.2x0.3	2.0x2.5 0.25x0.3	3.0x2.1 0.5x0.5	2.0x2.5 0.25x0.3	3.0x3.5 1.0x1.2	3.0x3.5 1.0x1.2	3.0x3.5 0.2x0.3	3.0x3.5 0.2x0.3	3.0x3.5 0.6x0.8	N/A	3.0x3.5 0.6x0.8	3.0x3.5 0.25x0.3	2.0x2.5 0.6x0.8	3.0x3.5 1.0x1.2
Features	Small bead application with excellent adhesion	Ultrasoft, low compressible force application	Highly compressible for large profile application	RTV version of F5301	Soft version of F5321	Extremely high conductivity, highly compressible	Excellent corrosion resistance on Aluminum substrates	Tri-Shape, ultra thin Profile	Resistance to Polar Solvent, automotive fuel, oil additives, chemicals and steam, very low outgassing, passed NASA test			UV resistant, excellent environ-mental sealing	Excellent waterproof ability, non-stick surface, flexible	RTV version of F6012, low compression force	Foam forming, highly compressible, very low compression force, dispensed in groove	Foam forming, highly compressible, very low compression force, self-standing for the design without groove	Resistance to Polar Solvent, automotive fuel, oil additives, chemicals and steam, very low outgassing, passed NASA test	Dual-function, excellent EMI Shielding performance, with improved environmental sealing property	

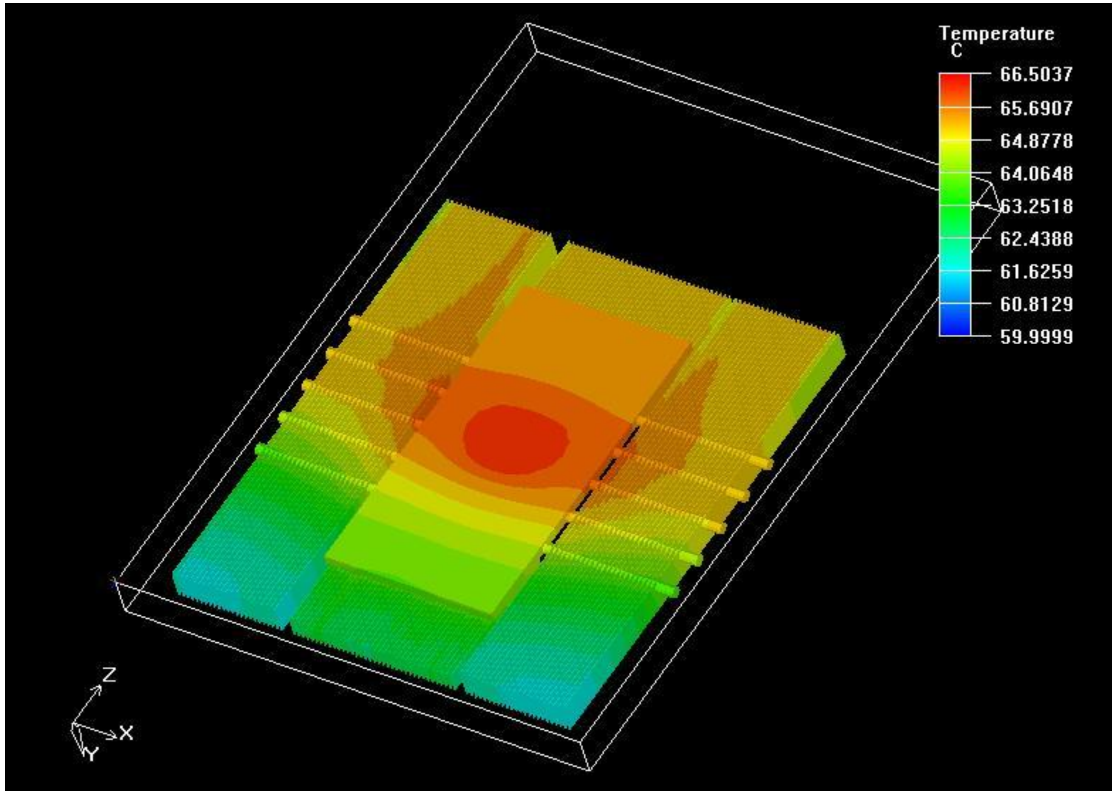
Additional Weight Reduction

Housing can be made with Metallized Plastic or Magnesium



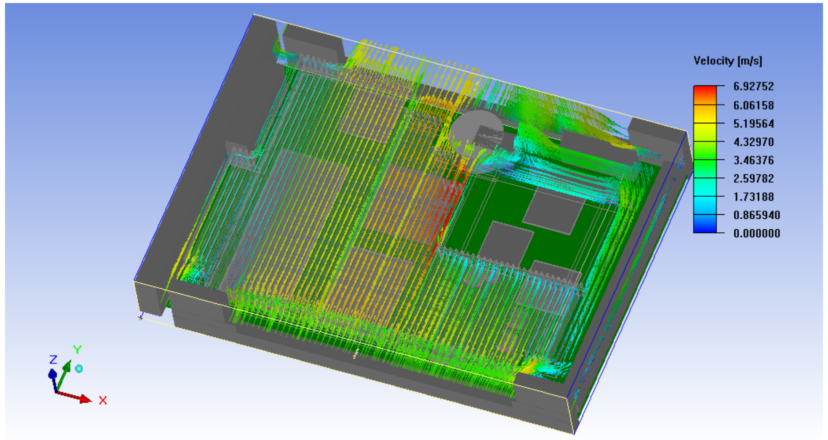
Proper thermal design can significantly impact your system size and weight



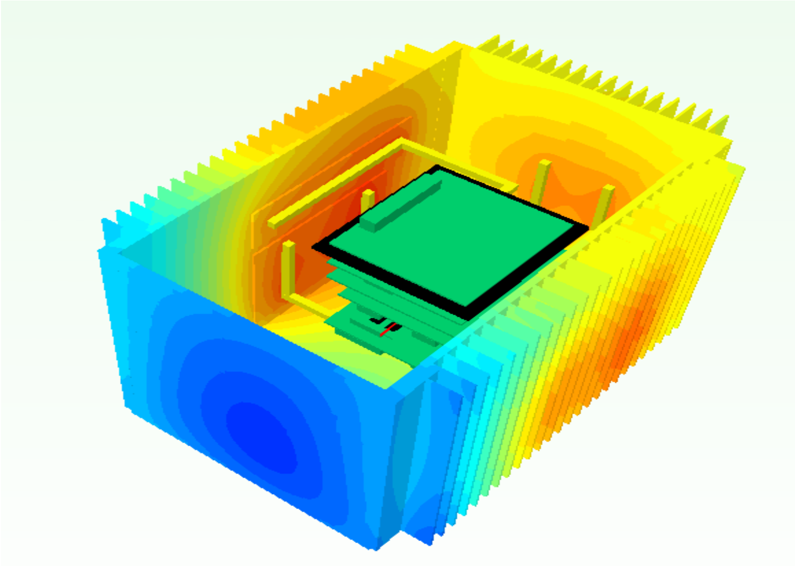


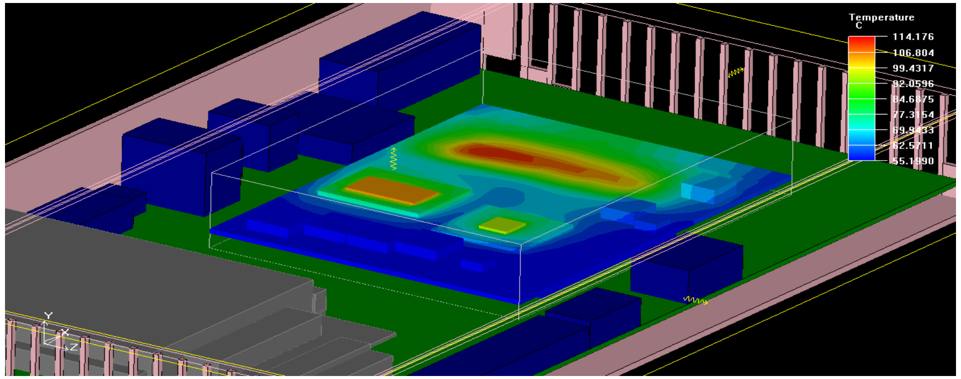
What is typically reviewed

- Full system thermal solution, including airflow recommendations
- Board level thermal design
- Chips power mapping
- Designs to keep IC’s within specified temperature range
- Complete mechanical designs to optimize for
  assembly/weight/strength/surface treating requirements
- Additional EMI and environmental design capabilities



Thermal design and simulation report will ideally include:
Temperature Map/ Airflow Map/Pressure Map/ Structure design / 3d drawing/ Heatsink/ Thermal Module/Weight





Typical manufacture Techniques

Heat pipes

Capillary structure :Sinter

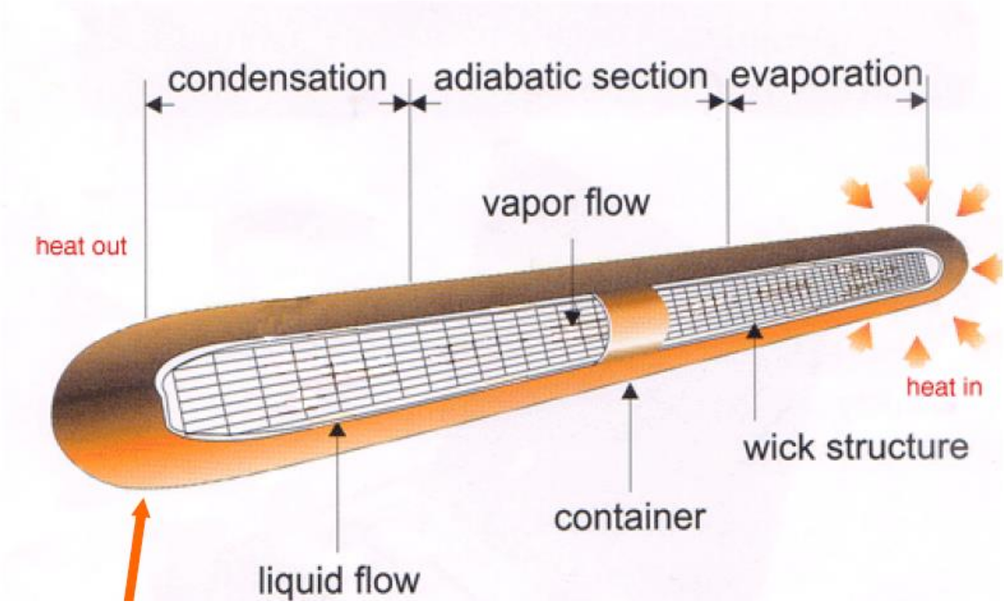
Work liquid: Plasma water

Wall material: Copper C1020

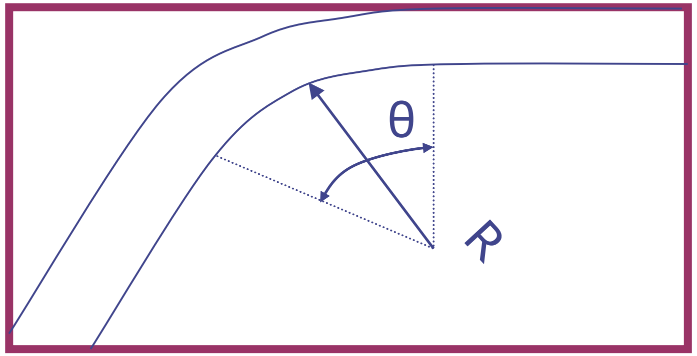
Work temperature :30-250C

Surface treating:
Ni plating(silver)
Chemical coating(Golden).
To be soldered with Al /Copper Alloy.

Thermal conductivity:
8000-10000 W/MK



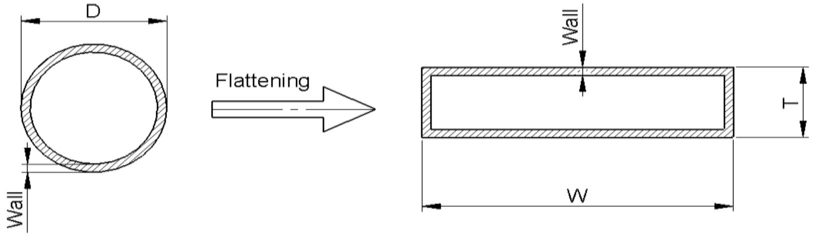
Bending Suggestion (If want smaller bending radius, Need engineering confirmation)



R-Angle				
	Min. R	Suggested	Min. Bending Angle	Suggested
ϕ 3	9	12	90°	120°
ϕ 4	12	16		
ϕ 5	15	20		
ϕ 6	18	24		
ϕ 8	24	32		
ϕ 9	27	36		
ϕ 9.35	28	37		

Heat Pipe dimensional data

Thermal Performance
(Q-max of heat pipe at 150mm length)



TennMax Dimensions Heatpipes

Diameter (D)	Thickness (T)	(T) Tolerance)	Width (W)	(W) Tolerance	Wall thickness	Power ±10%
Ø 3mm	2.0	+0.05/-0.10	3.65	±0.15	0.50	9 W
	2.5	+0.05/-0.10	3.32	±0.15	0.50	13 W
	3.0	+0.05/-0.10	Round	±0.15	0.50	14W
Ø 4mm	2.0	+0.05/-0.10	5.23	±0.15	0.50	16W
	2.5	+0.05/-0.10	4.96	±0.15	0.50	17W
	3.0	+0.05/-0.10	4.65	±0.15	0.50	17W
	4.0	+0.05/-0.10	round	±0.15	0.50	17W
Ø 5mm	1.0	+0.05/-0.10	7.50	±0.15	0.25	6W
	1.5	+0.05/-0.10	7.10	±0.15	0.25	10-11W
	2.0	+0.05/-0.10	6.82_6.84	±0.15	0.50	20W
	2.5	+0.05/-0.10	6.53	±0.15	0.50	31W
	3.0	+0.05/-0.10	6.26	±0.15	0.50	41W
	3.5	+0.05/-0.10	5.95	±0.15	0.50	45W
	4.0	+0.05/-0.10	5.63	±0.15	0.50	45W
	5.0	+0.05/-0.10	round	±0.15	0.50	45w
Ø 6mm	1.0	+0.05/-0.10	9.00	±0.15	0.25	7W
	1.5	+0.05/-0.10	8.70	±0.15	0.25	12W
	2.0	+0.05/-0.10	8.45	±0.15	0.50	28W
	2.5	+0.05/-0.10	8.16	±0.15	0.50	45W
	3.0	+0.05/-0.10	7.84	±0.15	0.50	55W
	3.5	+0.05/-0.10	7.57	±0.15	0.50	57W
	4.0	+0.05/-0.10	7.3	±0.15	0.50	57W
	6.0	+0.05/-0.10	round	±0.15	0.50	57W
Ø 8mm	2.0	+0.05/-0.10	Undone	±0.15	0.50	31W
	2.5	+0.05/-0.10	11.39	±0.15	0.50	62W
	3.0	+0.05/-0.10	11.15	±0.15	0.50	71W
	3.5	+0.05/-0.10	10.83	±0.15	0.50	75W
	4.0	+0.05/-0.10	10.60	±0.15	0.50	80W
	4.5	+0.05/-0.10	10.27	±0.15	0.50	85W
	5.0	+0.05/-0.10	10.01	±0.15	0.50	85W
	8.0	+0.05/-0.10	round	±0.15	0.50	84W

Heat Pipe assembly

Heat Pipe Module

Heat pipe assembly can be done two ways

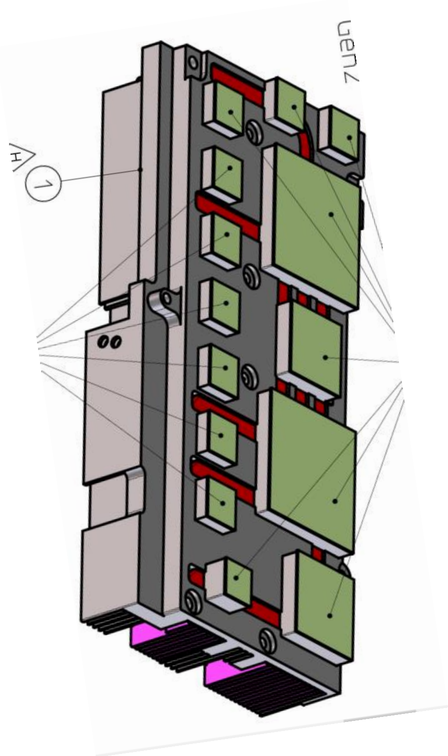
1. By soldering into al/copper base to conduct heat from high power chips, reduces the overall size of the whole heatsink base. Increases heatsink cooling efficiency to lower overall system temperatures.

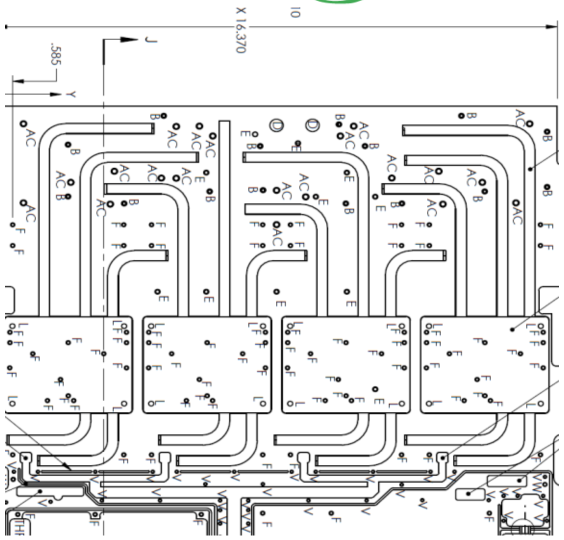
Need to use Copper/Al spreader to contact chip, size should be the same as the chip. Copper spreader thickness shall be 1-2mm.

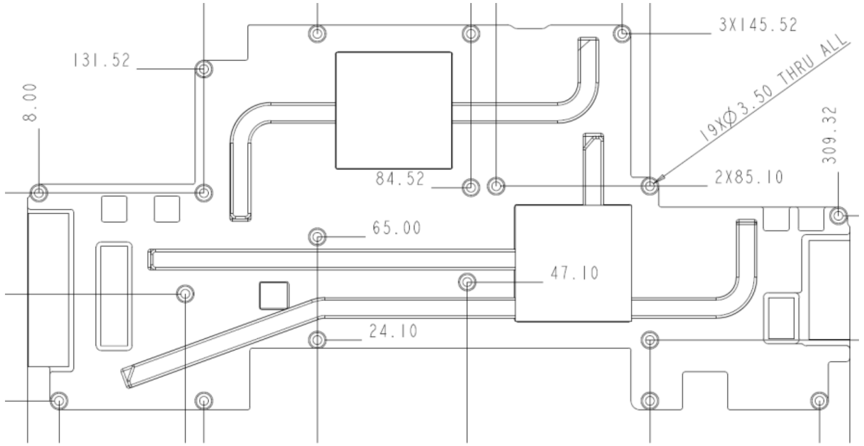
Heat pipe should not interfere with holes/threads.

Al heatsink / Steel part requires Ni plating for the solder process.

Copper part should be Ni plated or Chemical coated for solder process





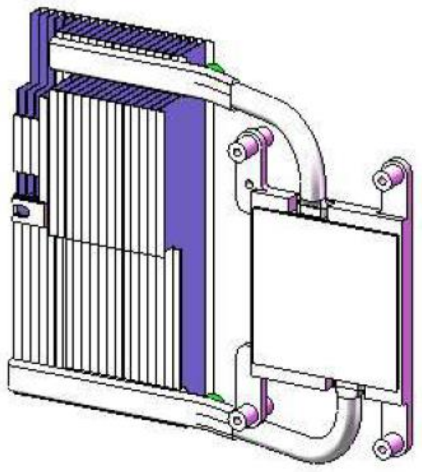


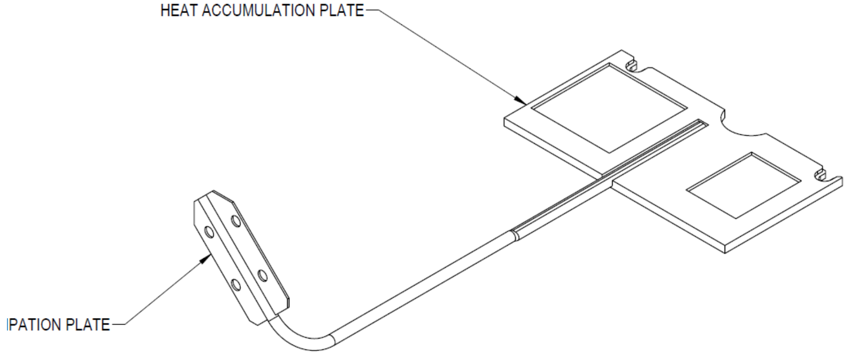
Heat Pipe assembly

2. Heat pipes are soldered with spreader and fins because of 2 main reasons

2.1Heat pipe can conduct heat from chips to fins or enclosure case to a location that has better conditions for cooling components.

2.2The space upon chips is too small to put a heatsink. Use copper spreader and heat pipe to conduct heat to larger heatsink in a different part of the system.



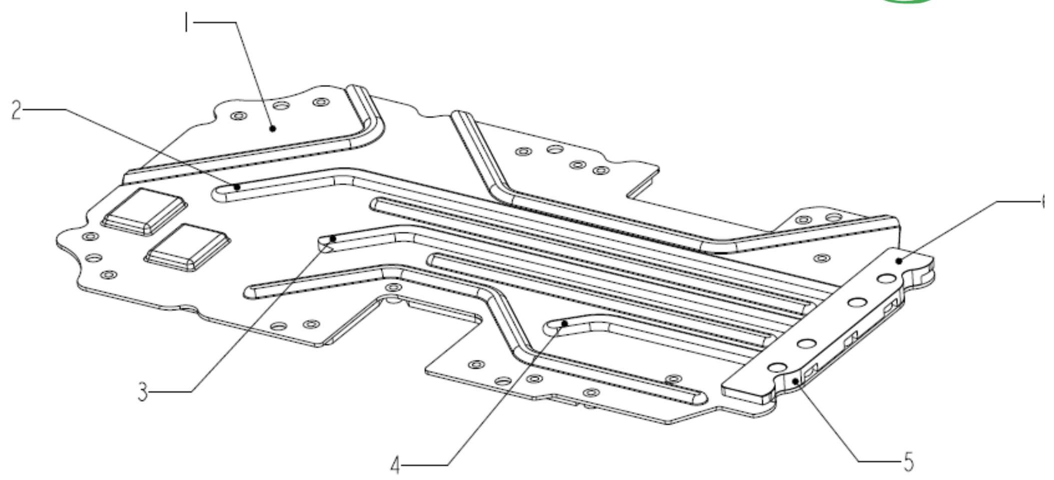


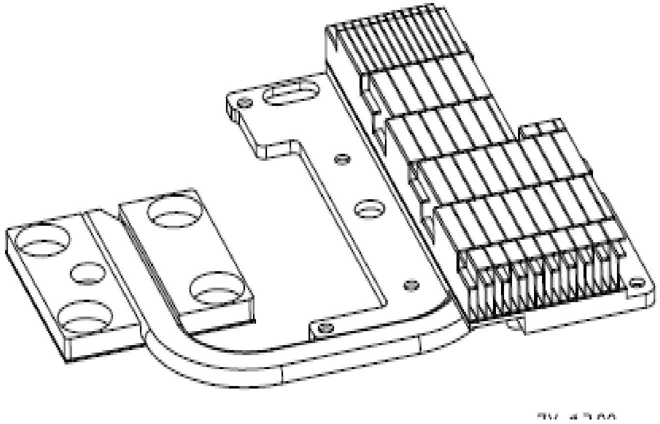
Heat Pipe / Sink

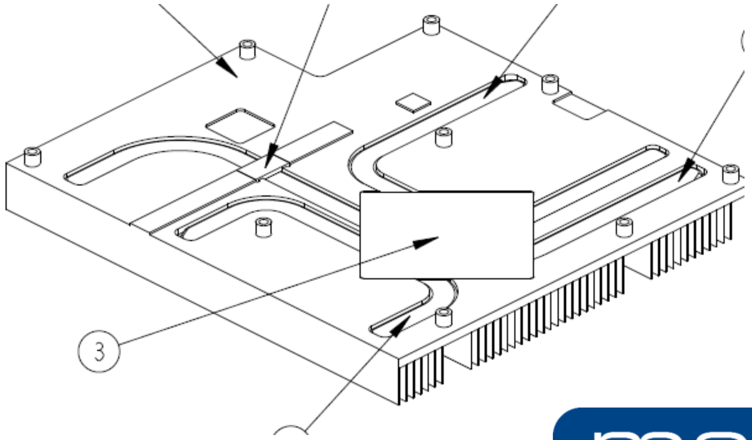
Heat Pipe Module

Heat pipe could be soldered with all kinds of heatsinks/fins . Only can be soldered with low and mid temperature solder paste.

Extrusion heatsink/ Metal part machined/Die casting part/Stamped fins.







Solder Paste

Low temperature solder paste

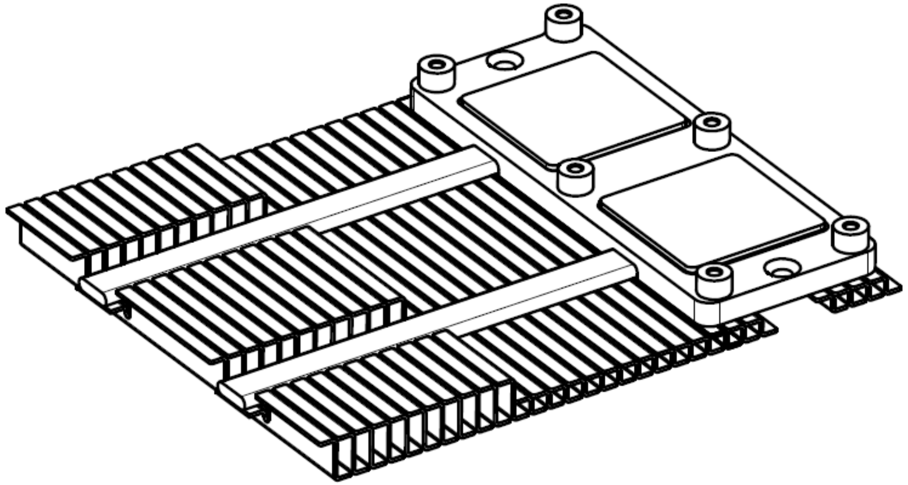
Melting point: 138C. For consumer electronic products, such as NB, Rourwe, PC.

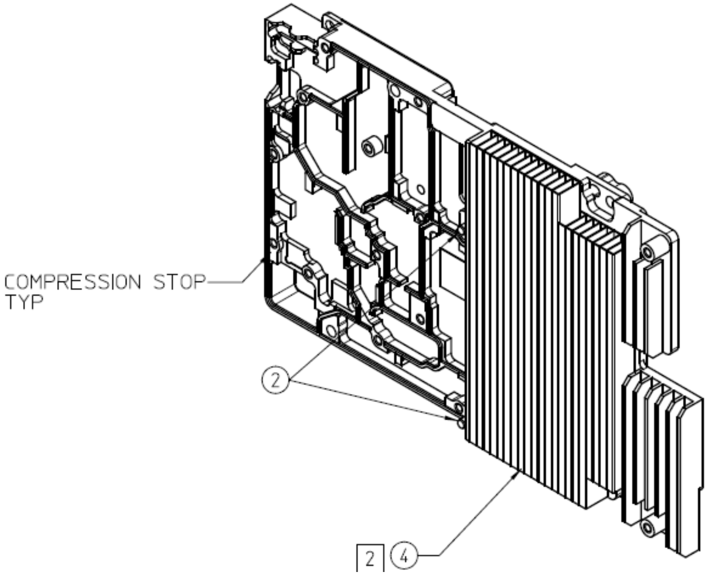
Mid temperature solder paste

Melting point: 178C . For communication/ Medical/Military electronic products.

High temperature solder paste

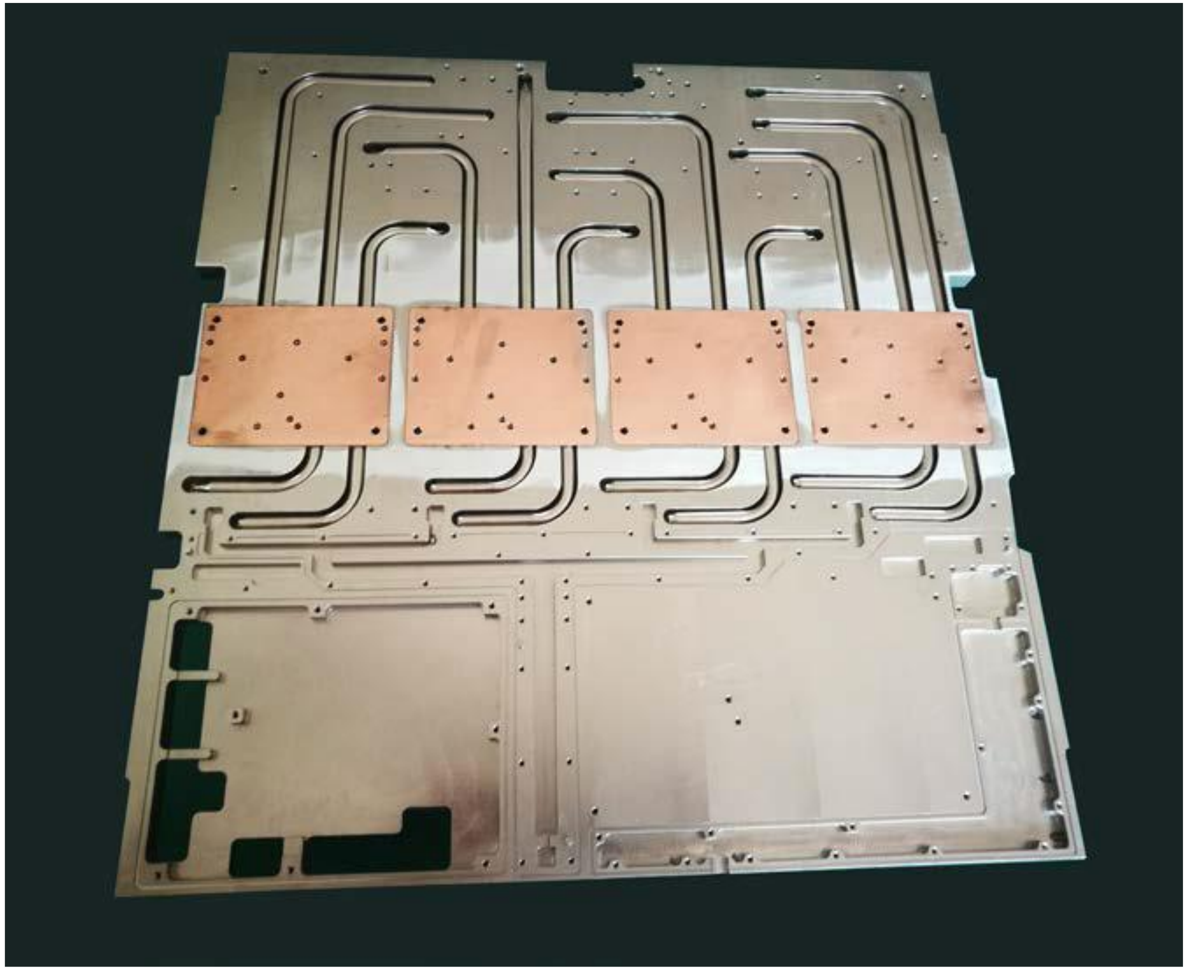
Melting point:238C, For special electronic products. Heat pipes can't be soldered with high temperature solder paste. High temperature couls hurt heat pipes if left in the oven over an extended period of time.





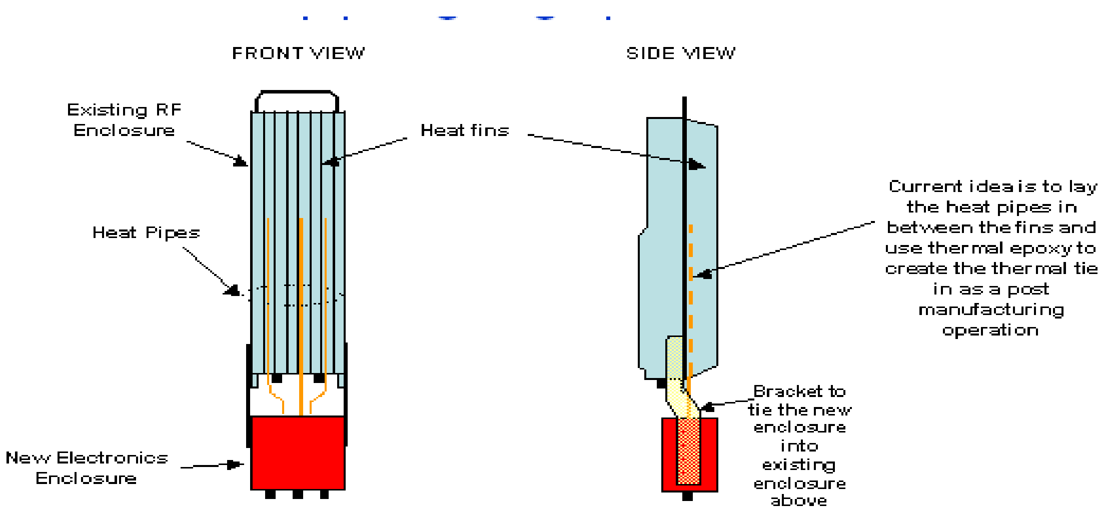
Large Amplifiers

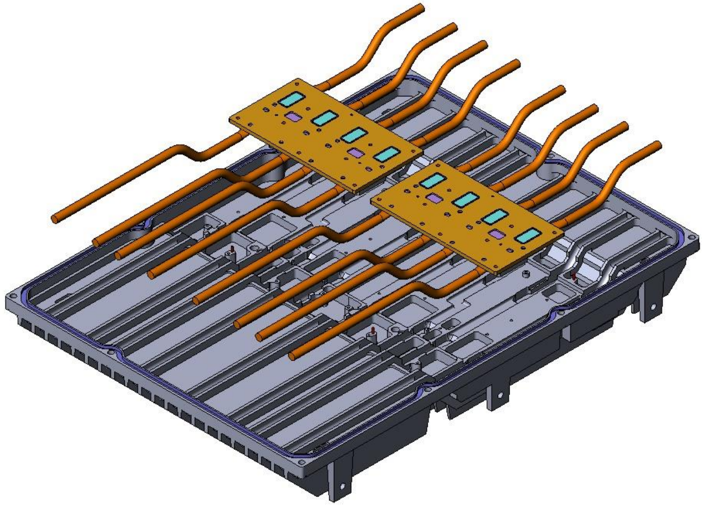
Amplifier sinks can see significant size and weight savings

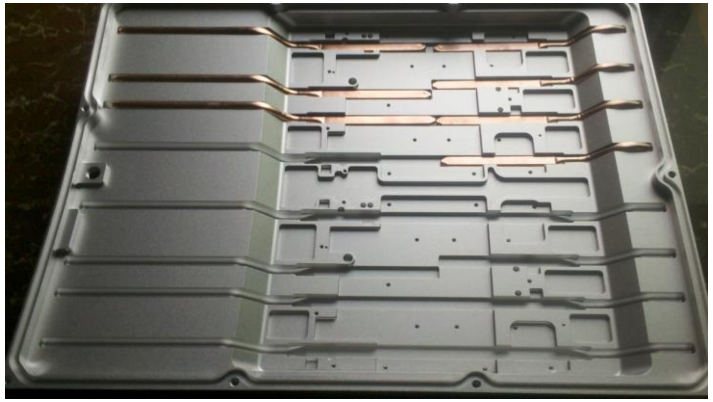


Embeding Heat Pipes into Housings

External housings can also use Heat Pipes to remove heat







Vapor Chamber

VC material: Copper C1100

Working temperature: 30-200C

Solder with Al base and fins/heatsink

Surface treating: Ni plating or Chemical coating

Shape and size need to be designed per requirements.

Orientation/fill hole location shall not affect VC performance.

Fin Options

Fins

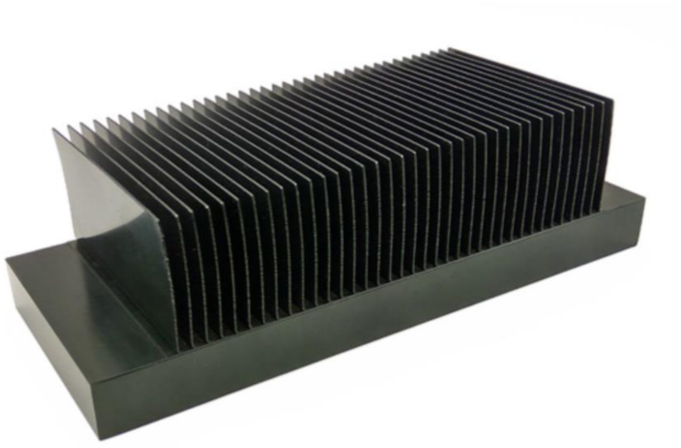
- Crimped fins(Al or Copper)
- Skiving fins(Al or Copper)
- Folded fins(Al or Copper)
- Extrusion fins(Al)

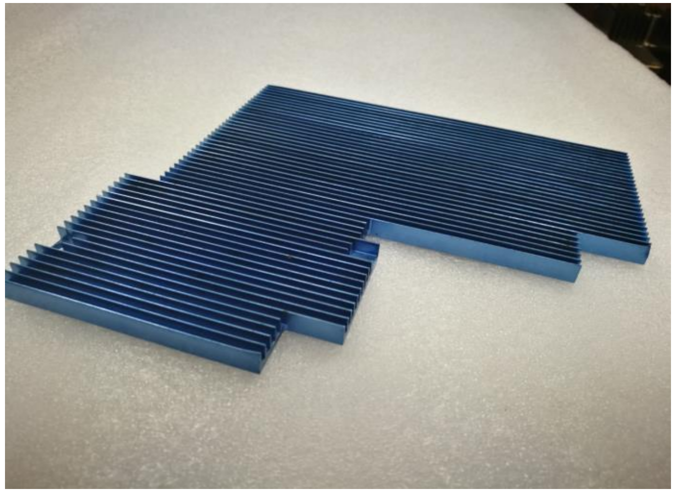
Density - Crimped fins>Skiving fins>folded fins>extrusion fins

We do not suggest Skiving fins for Communication /Military/Medical instrument/Outdoor products primarily due to reliability. Skiving fins are fragile.

Skiving heatsink : fins thickness:0.3/0.4/0.5mm ;fins space:1mm(fin height:45mm)

Extrusion heatsink: fins thickness: 0.6mm;fin space:1.5mm(fins height:25mm)





Fin Comparisons

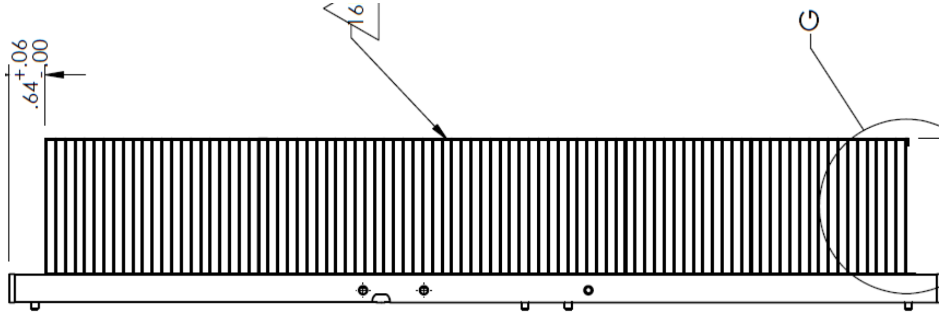
Cost:
Crimped fins>Skiving fins>folded fins>extrusion fins.

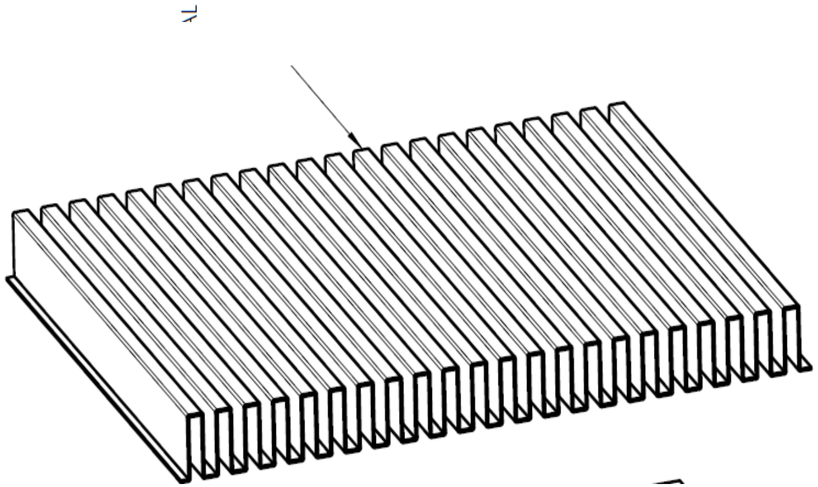
Thermal performance:
Crimped fins>Skiving fins>folded fins>extrusion fins

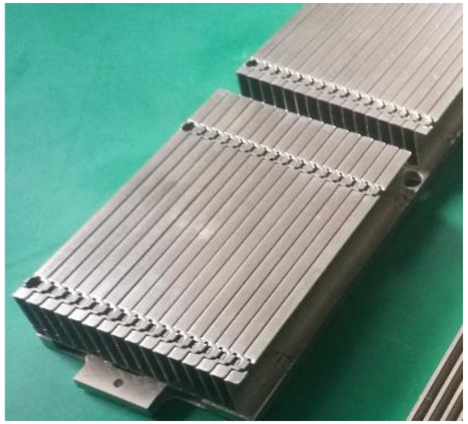
Crimped fins: fins thickness:0.3-1.0mm;fins space:1.2mm(no height limit)

Folded fins: fins thickness:0.3-0.6mm; fins space:2mm(fin height: 30mm)

Crimped fins have clips because tooling and assembly. It shall not affect structure and thermal performance. It shall not be drawn in drawing.





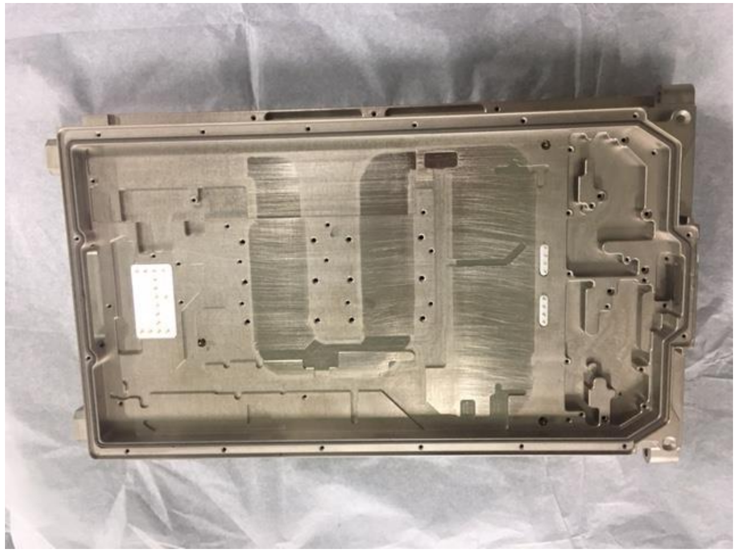


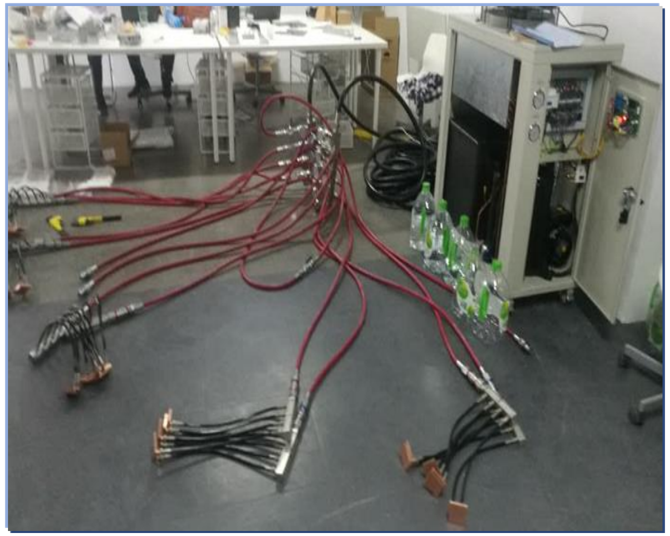
Water cooling

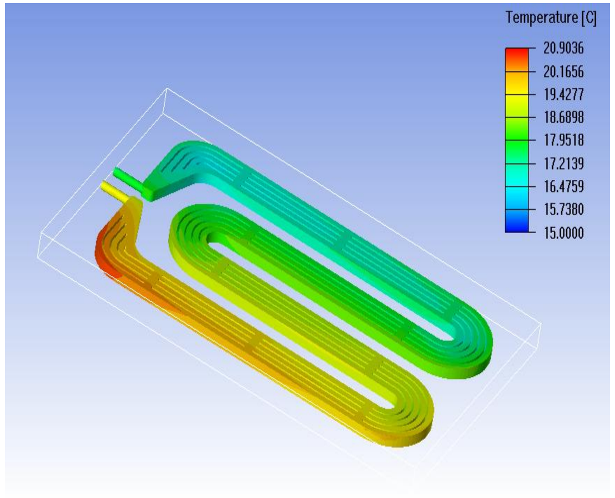
- Design and simulate for customer.

 Friction stir welding technics is the best and safest solution for electric vehicle cooling system/battery package cooling system.

 Friction stir welding only can be used for Al-Al welding.







Thermal Materials

The correct thermal materials can also impact overall efficiency

TYPICAL PROPERTIES	GP1000	GP2000	GP3000	GP5000	GP7000	GP8000	GPE000	GP-CP5000
Form	Thermal Conductive Gap Filler Pad							Thermal & Electrical Conductive Pad
Color	Light Gray	Blue	Gray	Light Blue	Cyan	Light Gray	Light Gray	Light Gray
Thickness Range	0.13 - 10mm				0.25 - 10mm			0.15, 0.25, 0.50, 0.75, 1.00mm
Specific Gravity	2.00 g/cm³	2.20 g/cm³	2.60 g/cm³	2.90 g/cm³	3.00 g/cm³	2.50 g/cm³	2.45 g/cm³	2.54 g/cm³
Thermal Conductivity	1.0 W/m-K	1.5 W/m-K	2.0 W/m-K	3.0 W/m-K	5.0 W/m-K	7.8 W/m-K	11.0 W/m-K	1.5 W/m-K
Multilayer Capable	0.5mm up							N/A
Insulation Properties	High	High	High	High	High	Low	Low	Conductive, DC Through Resistance <0.5 ohm
Flammability Rating	UL 94V-0							UL 94V-0
Operating Temp. Range	-55 to 200°C							-55 to 200°C
Standard Hardness (H1)	46 Shore OO	46 Shore OO						25 Shore A
Ultrasoft Hardness (H0)	N/A	36 Shore OO						N/A
Ubersoft Hardness (HU)	N/A	26 Shore OO						N/A

Thermal Jelly

For some applications, dispensable thermal material may be an option

TYPICAL PROPERTIES	GP3F7120	GP5F7121	GP7F7123	GP6F7124	GP8F7125	GP8F7125HI	GPEF7126	GPEF7126HI	GP5F7121NS	GP7F7123NS
Form	Thermal Conductive Dispensable Silicone Jelly								Non-Silicone Jelly	
Color	Black	Brick Red	Gray	Violet	Gray	Gray	Gray	Gray	Gray	Gray
Specific Gravity	2.80g/cm3	3.00g/cm3	3.06g/cm3	3.15g/cm3	2.34g/cm3	3.30g/cm3	2.50g/cm3	3.30g/cm3	3.00g/cm3	3.22g/cm3
Thermal Conductivity	2.0 W/m-K	3.0 W/m-K	5.0 W/m-K	6.0 W/m-K	8.0 W/m-K	8.0 W/m-K	11.0 W/m-K	11.0 W/m-K	3.0 W/m-K	5.0 W/m-K
Thermal Impedance @ 50 psi (oC-in2/W)	0.079	0.074	0.064	0.062	0.059	0.052	0.054	0.049	0.067	0.062
Insulation Properties	High	High	High	High	Low	High	Low	High	High	High
Flammability Rating	UL 94V-0								UL 94V-0	
Cont. Working Temp.	-55 to 200°C								-40 to 150oC	
Volume Resistivity	1X1014 Ohm-cm								1X1014 Ohm-cm	

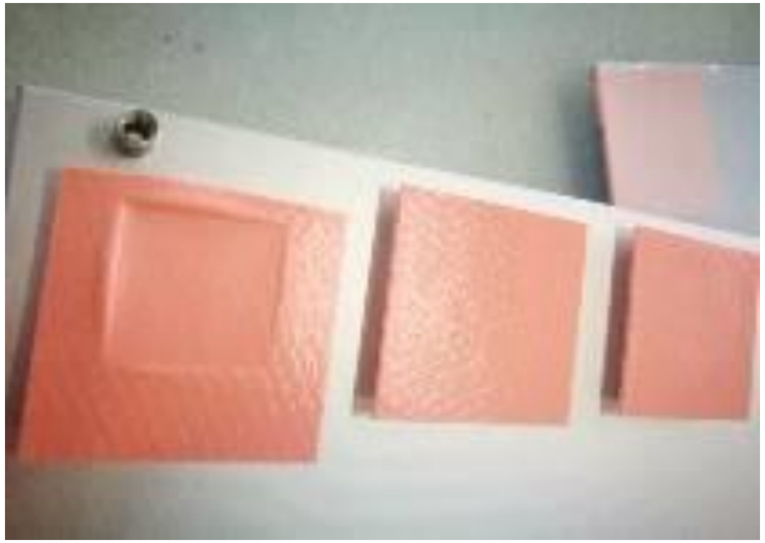
Determining TIM thickness

When there is only one chip and pad.
It is common to use 0.25mm or 0.5mm thick thermal pad.

Thermal pad compression suggestion: 0%-40%
When thermal pads quantity exceed 2pcs.
Gap between chip and heatsink base:
0.25mm ——Use 0.5mm thick thermal pad
0.5mm——Use 0.75mm thick thermal pad
0.75mm——Use 1mm thick thermal pad
If the chip can’t contact the thermal pad (See picture to the right), you may need to change the pad height.

Thermal jelly thickness shall be thicker than chip height tolerance + gap
Chip height tolerance +/-0.2mm ; the gap shall be 0.3+/-0.2mm(0.1-0.5mm).
Thermal jelly height shall be 0.65mm.

The chip has an extensive height tolerance(exceed +/-0.2mm) another option could be to use thermal Jelly.



How to calculate thermal pad thermal resistance

（**Fourier's law**）

$Q = kA(T_1 - T_2)/L$

Where

Q = Heat Transfer Rate （Watts）

A = Cross-sectional area of heat transfer （thermal pad area;m^2）

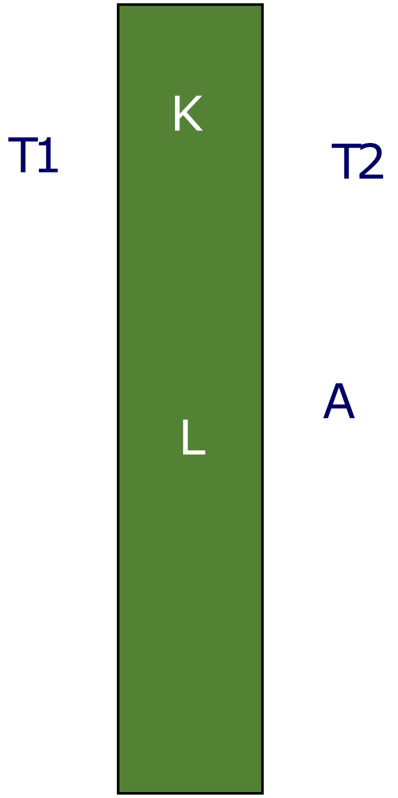
$T_1 - T_2$ = Temperature Difference（℃）

L = Conduction path length （thermal pad thickness after compression; m）

K = Thermal conductivity of the material （W/m℃）

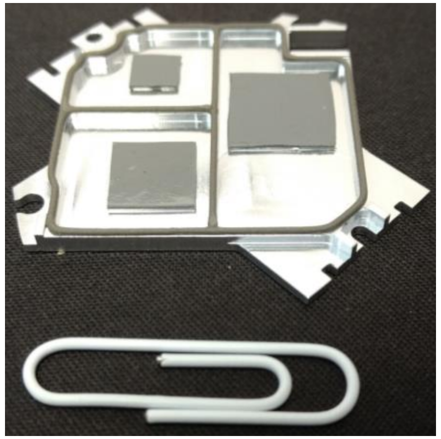
Θ---thermal pad thermal resistance

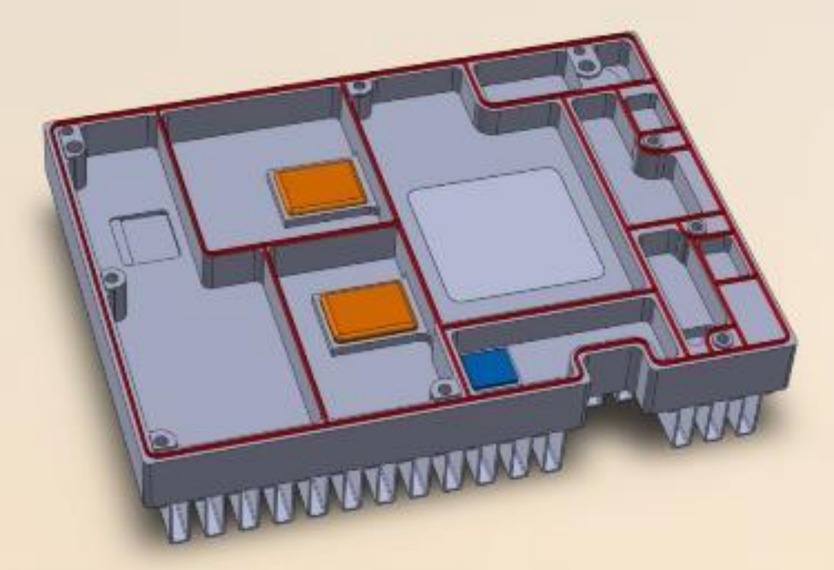
θ=L/(A*K)

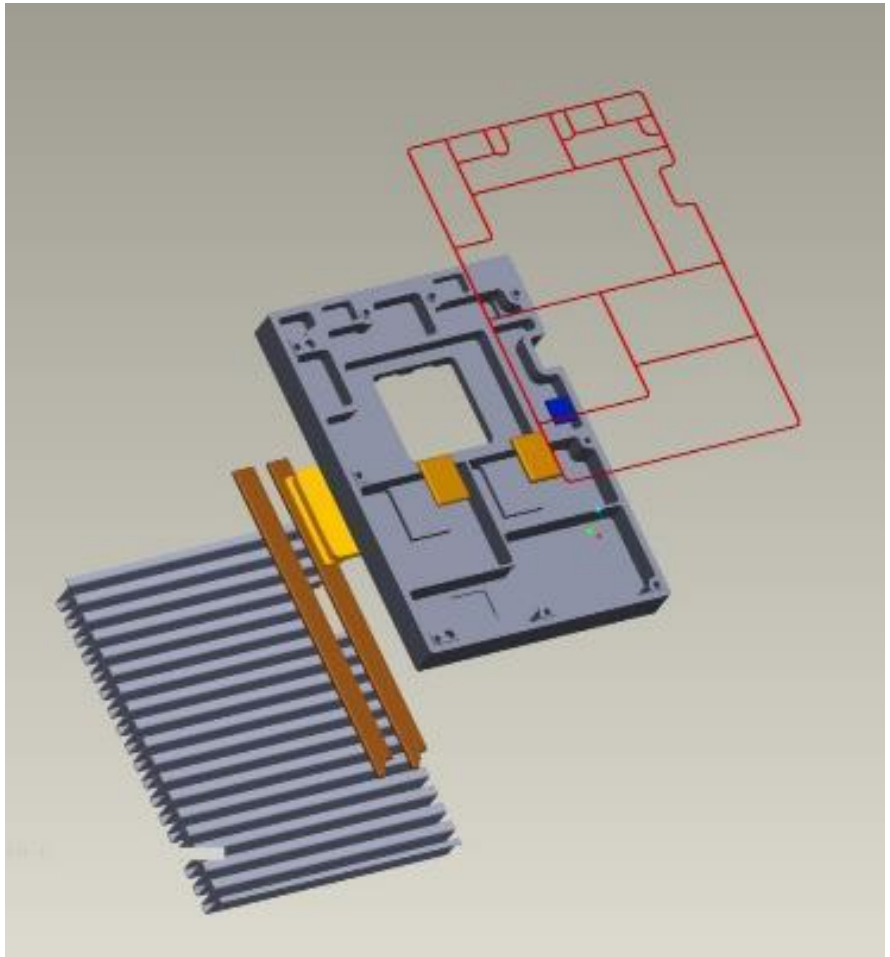


For maximum space and weight savings you can combine the sink and shield into one part

- Traditional gasket with Aluminium and FIP
- Folded or standard fins
- Thermal Pads
- Heat-pipes







Contact

Thank you

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