“Heat Sink Technologies”

Mark Pelillo, *Director of Engineering*
Mark Pelillo is the Director of Engineering at Wakefield-Vette. Mark has been in the electronics cooling design industry for over 25 years and has been a pivotal part in introducing new technologies to the marketplace. Mark earned his engineering degree at Clarkson University. Mark has been with Wakefield-Vette since 2005, where he leads the engineering team. This team supports existing customer challenges, while researching and introducing new technologies to market. Mark’s vast experience not only with design but in manufacturing, allows Wakefield-Vette’s customers to improve their thermal performance while simplifying the manufacturing steps to meet specifications.

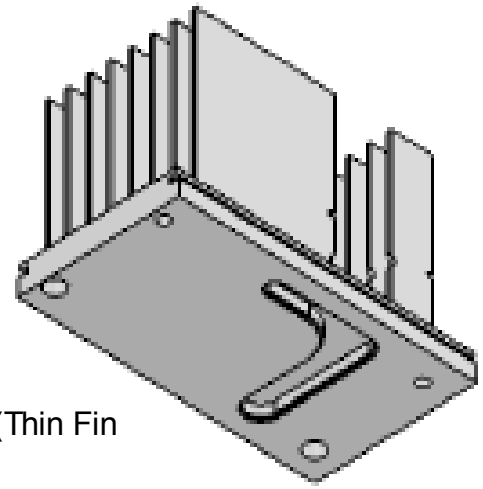
Wakefield-Vette

- Wakefield-Vette has been in continuous operations since 1952, providing thermal solutions across multiple industries, from international Fortune 50 companies to small and medium sized businesses. These industries include Power Conversion, Information Technology, Renewable Energy, Telecommunications, Transportation, Aerospace/Defense, LED Lighting, Factory Automation, Consumer, and Medical.

Extrusions

THE Heat Sink Alloy – Aluminum 6063-T5

- Lowest Cost
- Tolerances per Aluminum Assoc.

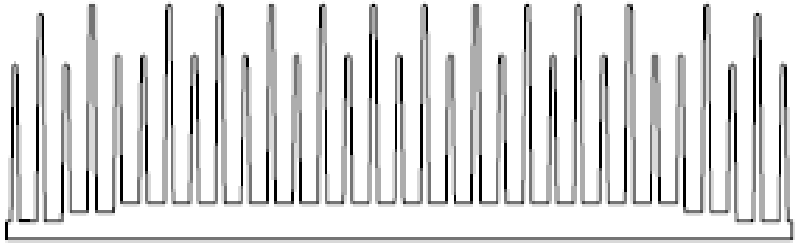


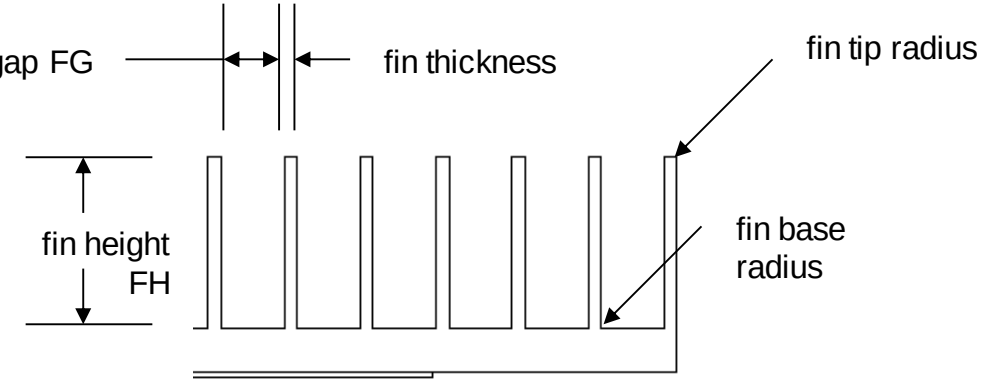
Aspect Ratio = Fin Height / Fin Gap = FH/FG

< 7:1 No problem
<10:1 Slower extrusion through put
<15:1 Selected balanced shapes only
<20:1 Consult factory
>20:1 Very Select shapes only

Fin Features

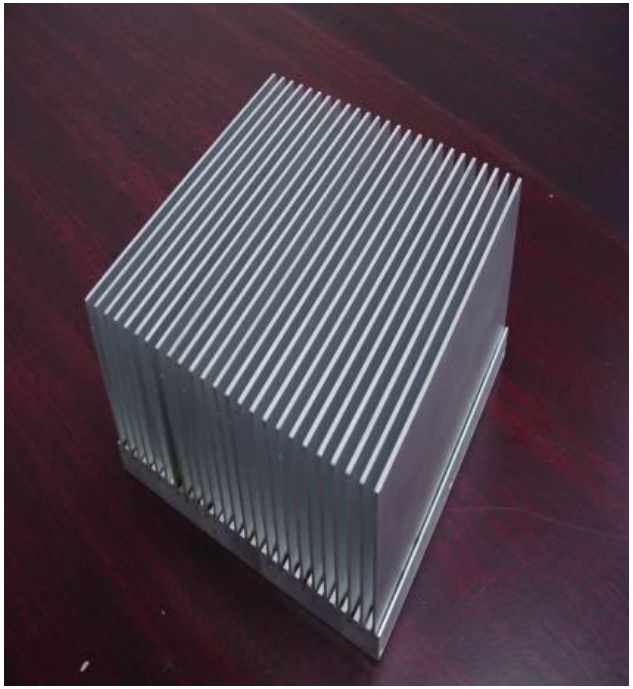
.032" min thickness preferred for machining ease and speed, under .032" is a TFE (Thin Fin Extrusion)
.020" min thickness under most circumstances.
Tapered fins, preferred for strength, especially on thin fins parts.
Radii increase tool life, reduce part and tool stress
Serrated fins greatly increase tool back pressure, not recommended.



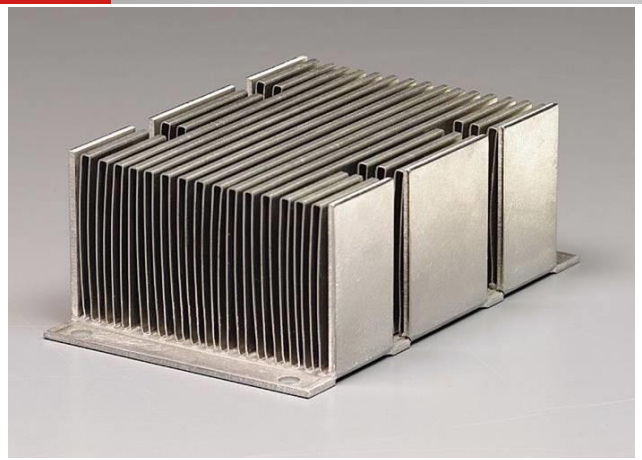


Bonded Fin

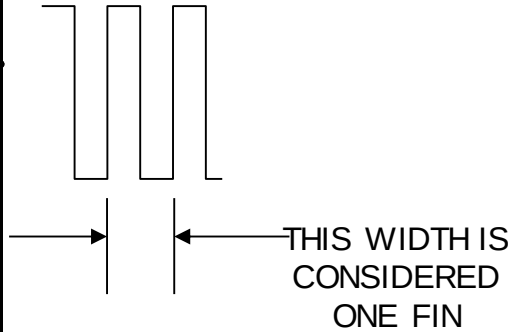
- Fins are individually glued into slots in the base using thermal epoxy
- Aluminum assemblies can be braze construction, but the fins must be of 606X alloy (temper issues)
- Copper assemblies can be solder construction
- Fin heights are unlimited
- Fins can be copper/aluminum or combination
- Base can be copper/aluminum or combination
- Fins can be of different thickness in different areas
- Can make as a “sandwich” style (base-fins-base) for better space optimization



Folded Fin



Fin Thickness	Max Fin Density
.032"	11.5 fpi
.040"	10 fpi
.050"	9 fpi
.062"	8 fpi



- Used when thin fins are required for back pressure
- Used to achieve higher fin density then extrusion
- Cutouts have to be manually cut, so try to avoid
- Fins available in straight, lanced or ruffled configurations

Standard Folded Fin

Thickness: 0.002” -- .080”

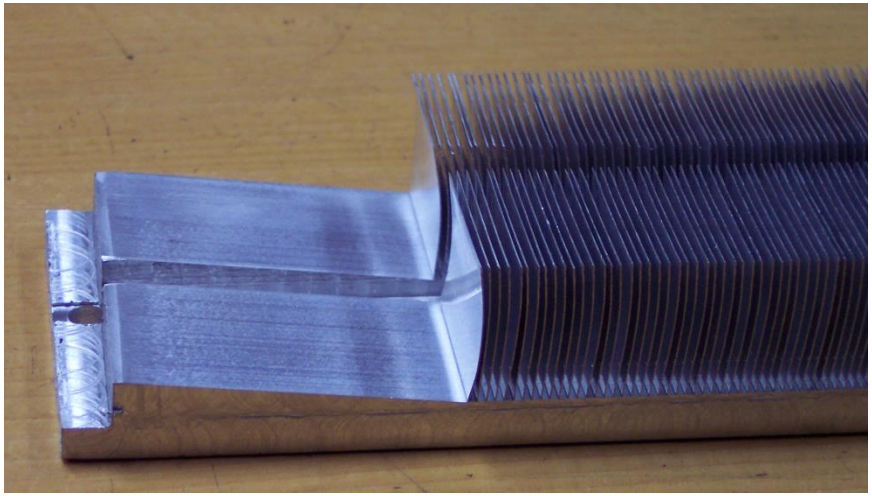
Fin Height: 0.020” – 4.00”

Flow Length: 0.125”-- 24.0”

Material: Copper, Aluminum, SS

The taller the Fin Height, the lower the fin density

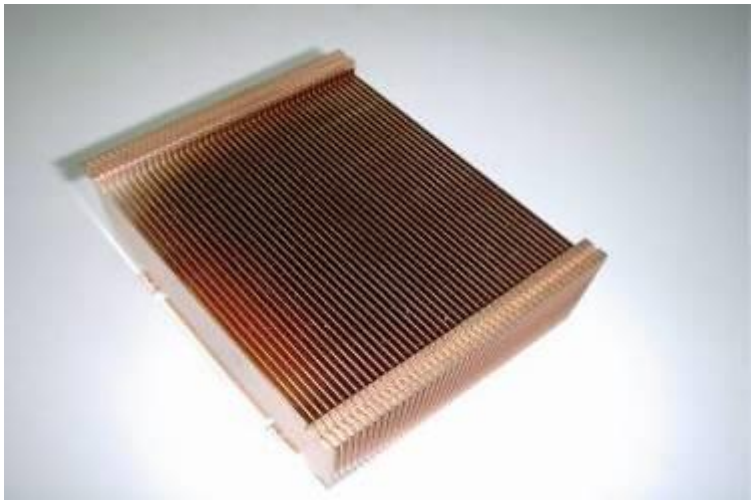
Skived Fin

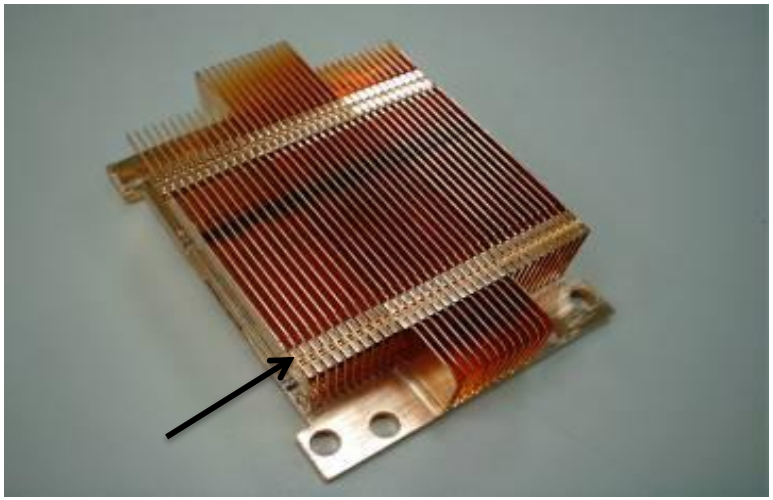


- Used as an alternative to Folded Fin
- Good choice if high fin density/ thin fin required
- Can be made from aluminum (6063-T5) or copper (C101/C110)
- Starter bar follows commercial extrusion tolerances
- Tooling Cost more then extrusion, less then Zipper Fin
- No secondary material between base and fins
- Fins are 0.5 to 0.76mm thick
- Flow lengths of >80mm require break in fins. Fin breaks are between 5 to 6mm in length
- Maximum height is 51mm
- Minimum base thickness is 4mm. Base can be cut down afterwards
- Different surface finish on both sides of the fin. Front side is smooth, back is very rough. This extra roughness can cause issues with back pressure
- Fins are easily damaged during handling and secondary operation, use of a shroud is recommended.

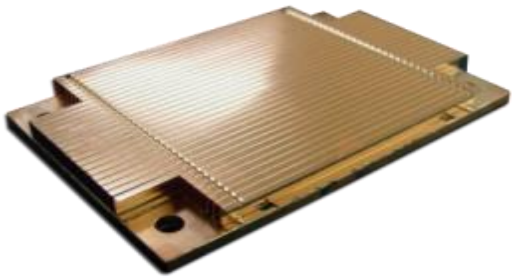
Zipper Fin

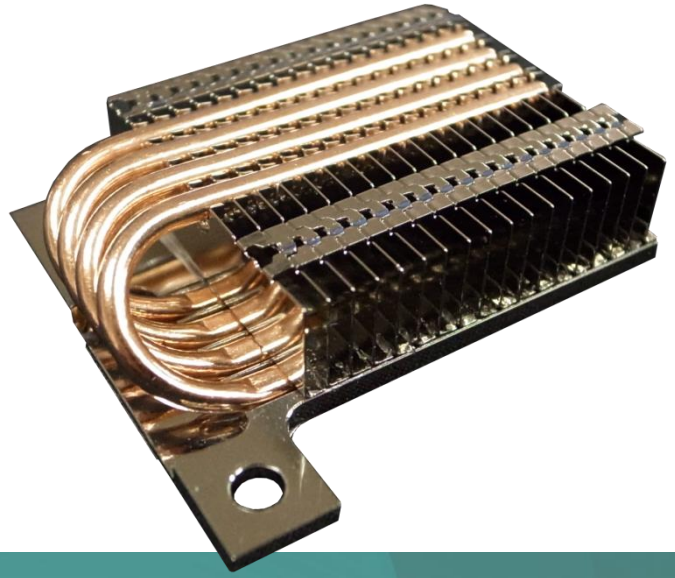
- Alternative to folded fin
- Made by stamping a single fin on a progressive tool, then interlocking together
- Length/height limited by press size
- Fins can be aluminum or copper
- Fins vary from 0.25mm to 2.0mm in thickness
- Generally solder to base plate, but epoxy can also be used
- Fins can be stamped in strange shapes or designed to accept heatpipes
- Fins are automatically joined together in the tool, different lengths or different materials are manually joined together

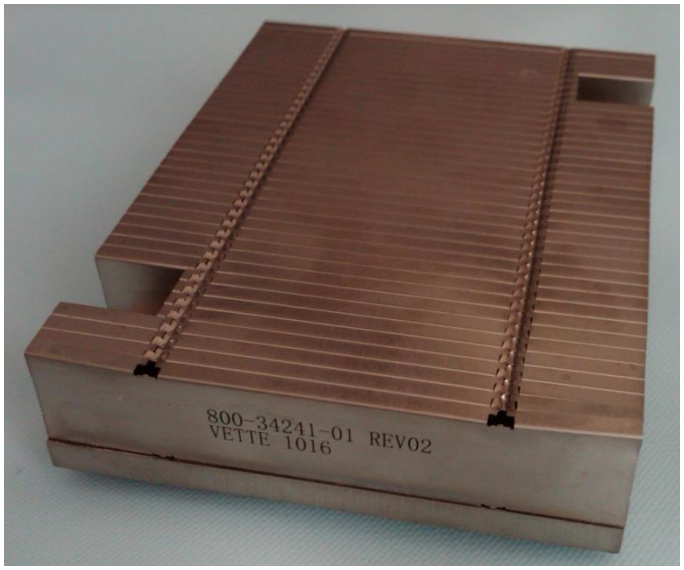




Zipper Fin







Die Casting

- Alternative to extruded/machined heatsink
- Casting process allows for near-net shape with only minor secondary processes
- Can produce complex geometry that would be impractical to machine
- Various casting processes (investment, sand, permanent mold, high-pressure). Each process has pros and cons like min feature size, overall part size, volume of parts per tool, etc.
- Aluminum cast material is less conductive then extruded aluminum which may impact or limit thermal performance

What is Liquid Cooling?

- Liquid cooling is a natural evolution beyond air cooling where either due to thermal requirements or footprint requirements, the desired performance can no longer be economically met by air cooling.
- Liquid technology is typically selected based on two requirements;
  - Normalized Thermal Resistance (°C/W)
    - Average Plate temperature minus incoming fluid temperature/total thermal power.
  - Pressure Drop (PSI)

Liquid Cooling Summary

	Material			Characteristic & Rating			
Style	**Base Material**	**Tube Material**	**Bonding Material**	**Cost**	**Performance**	**Design Flexibility**	**Key Attribute**
Rolled Tube	Al	Cu/SS	Epoxy	1	1	1	Cost effective single sided cooling
Full Buried	Al or Cu	Cu	Epoxy	1	2	3	Liquid flow contained in a continuous tube
Exposed Tube	Al or Cu	Cu	Epoxy	2	3	3	Continuous tube with direct device mounting
Half Buried	Cu	Cu	Soldering Paste	2	4	2	Efficient but inexpensive construction
Two Piece Brazed	Al or Cu	None	Solder	5	5	5	Allows for unlimited and divided flow paths
Two Piece Gasket	Al or Cu	None	Gasket	3	4	5	Unlimited flow path without braze cost
Two Piece Welded	AL	None	Weld Alloy	3	5	4	Allows for unlimited and divided flow paths
Sandwich Design	Al or Cu	Cu	Epoxy	3	2	2	Allows for double sided equal cooling
Deep Drilled	Al or Cu	None	None	3	3	3	Reliably balanced construction

Thanks for attending!

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