

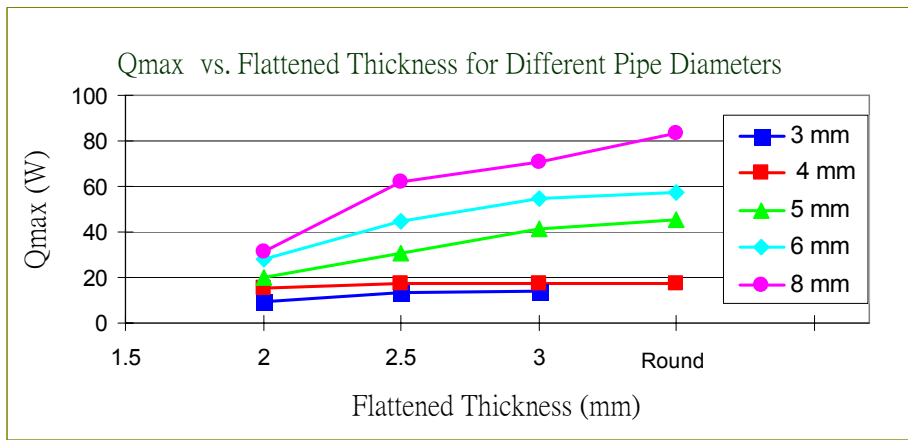


Heat Pipe Technology – Practical Applications

- Heat Carrying Capacity
- Formed Heat Pipes / Flattened and Bent
- Limitations of Bending / Min Radius
- Examples of the Technology:
 - Heat spreading
 - Increased fin efficiency
 - Press-on or solder attach fins
 - High conductivity thermal path

Heat Pipe Design - Qmax

Qmax (W) Flattened Thickness	Pipe Diameter				
	ϕ 3 mm	ϕ 4 mm	ϕ 5 mm	ϕ 6 mm	ϕ 8 mm
T = 2.0mm	10 W	15 W	21 W	N/A	N/A
T = 2.5mm	14 W	17 W	32 W	46 W	65 W
T = 3.0mm	15 W	19 W	42 W	56 W	75 W
Round	16 W	20 W	46 W	60 W	85 W



Typical Qmax Values of Heat

Pipes for the length of 150mm:

- Standard Deviation: $\pm 5\%$.
- Operating temperature at 60 ± 3 °C.
- Internal temp rise at Qmax = 3 to 5 C

Heat Pipe Design – Dimension Spec.

- **Diameter tolerance: $\pm 0.05\text{mm}$**
- **Length tolerance: ± 0.5 to $\pm 1.0\text{mm}$**
- **Thickness tolerance: $\pm 0.05\text{mm}$**
- **Width tolerance: ± 0.10 to ± 0.15 mm**

Diameter (mm)	Length (mm)	Bending Radius (mm)	Flattened Thickness (mm)
3	70 - 750	≥ 9	≥ 2
4	70 - 750	≥ 12	≥ 2
5	70 - 750	≥ 15	≥ 2.5
6	70 - 750	≥ 18	≥ 2.5
6.35(1/4")	70 - 750	≥ 19	≥ 2.5
8	70 - 750	≥ 24	≥ 2.5

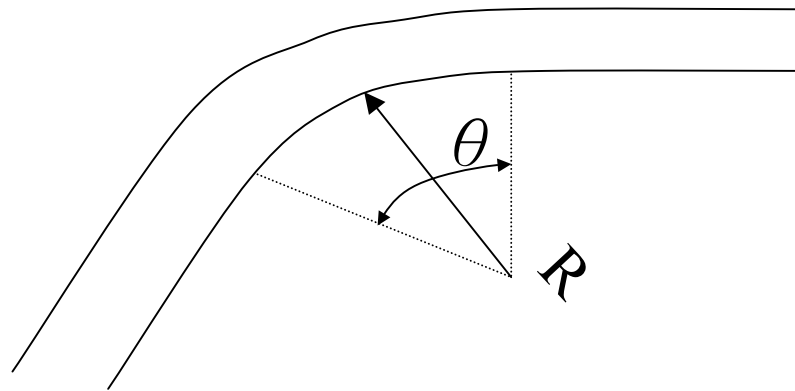
Heat Pipe Design – Dimension Spec.

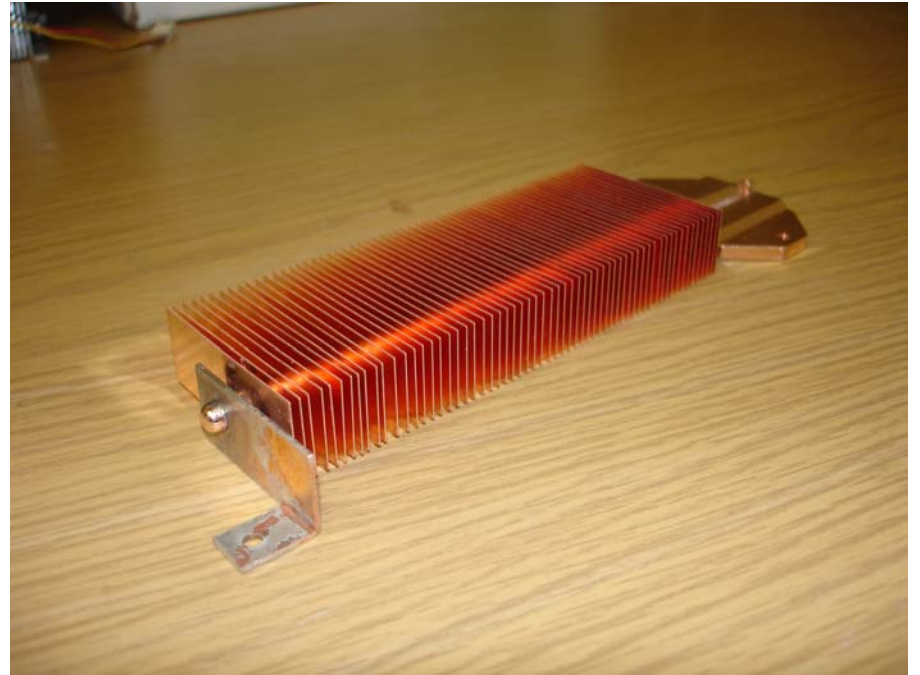
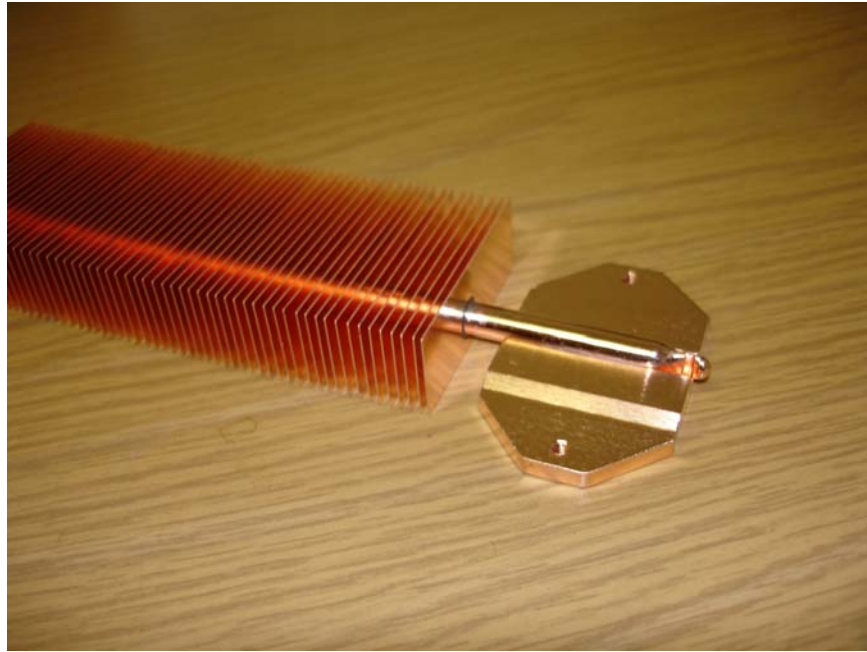
Diameter	Thickness(T)	(T)Tolerance	Width(W)	(W)Tolerance
Ø=3mm	2.0	+0.05/-0.10	3.65	+0.15/-0.15
	2.5	+0.05/-0.10	3.32	+0.15/-0.15
Ø=4mm	2.0	+0.05/-0.10	5.23	+0.15/-0.15
	2.5	+0.05/-0.10	4.96	+0.15/-0.15
	3.0	+0.05/-0.10	4.65	+0.15/-0.15
Ø=5mm	2.0	+0.05/-0.10	6.82~6.84	+0.15/-0.15
	2.5	+0.05/-0.10	6.53	+0.15/-0.15
	3.0	+0.05/-0.10	6.26	+0.15/-0.15
	3.5	+0.05/-0.10	5.95	+0.15/-0.15
	4.0	+0.05/-0.10	5.63	+0.15/-0.15
Ø=6mm	2.0	+0.05/-0.10	8.45	+0.15/-0.15
	2.5	+0.05/-0.10	8.16	+0.15/-0.15
	3.0	+0.05/-0.10	7.84	+0.15/-0.15
	3.5	+0.05/-0.10	7.57	+0.15/-0.15
	4.0	+0.05/-0.10	7.30	+0.15/-0.15
Ø=8mm	2.0	+0.05/-0.10	Undone	+0.15/-0.15
	2.5	+0.05/-0.10	11.39	+0.15/-0.15
	3.0	+0.05/-0.10	11.15	+0.15/-0.15
	3.5	+0.05/-0.10	10.83	+0.15/-0.15
	4.0	+0.05/-0.10	10.60	+0.15/-0.15
	4.5	+0.05/-0.10	10.27	+0.15/-0.15
	5.0	+0.05/-0.10	10.01	+0.15/-0.15
6.0	+0.05/-0.10	9.36	+0.15/-0.15	



Heat Pipe Design – Dimension Spec.

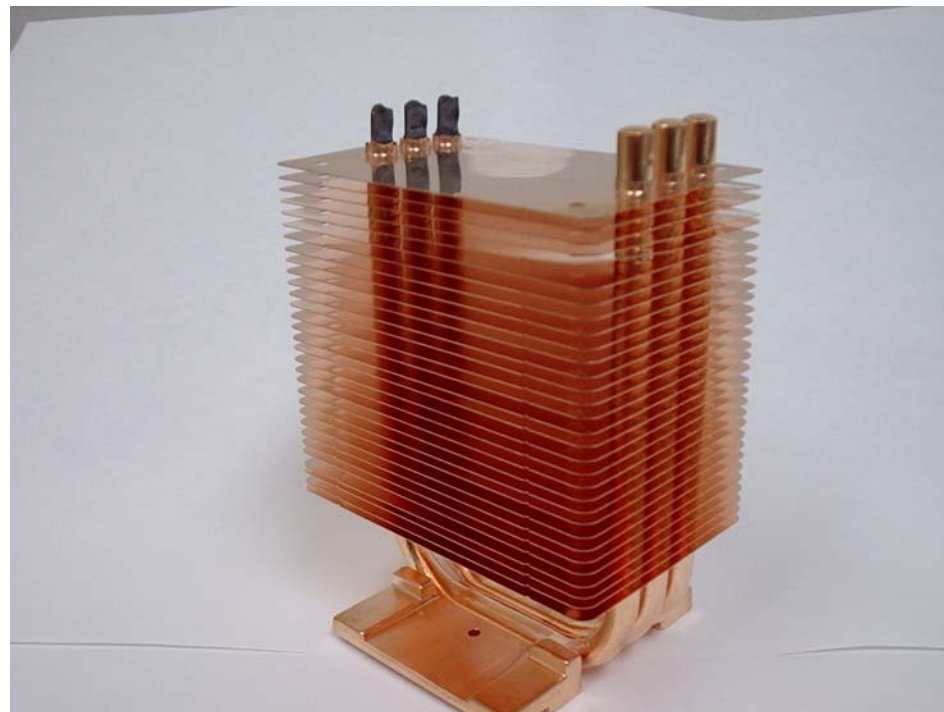
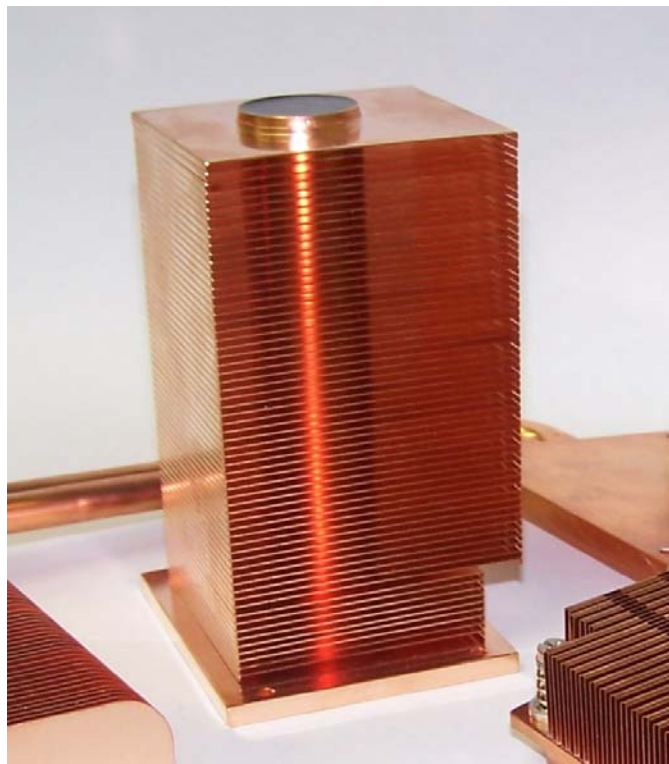
R-Angle				
	Min. R	Suggested	Min. Bending Angle	Suggested
$\phi 3$	9	12	90°	120°
$\phi 4$	12	16		
$\phi 5$	15	20		
$\phi 6$	18	24		
$\phi 8$	24	32		
$\phi 9$	27	36		
$\phi 9.35$	28	37		





Heat pipe with solder attached fins used in wafer fab control system.

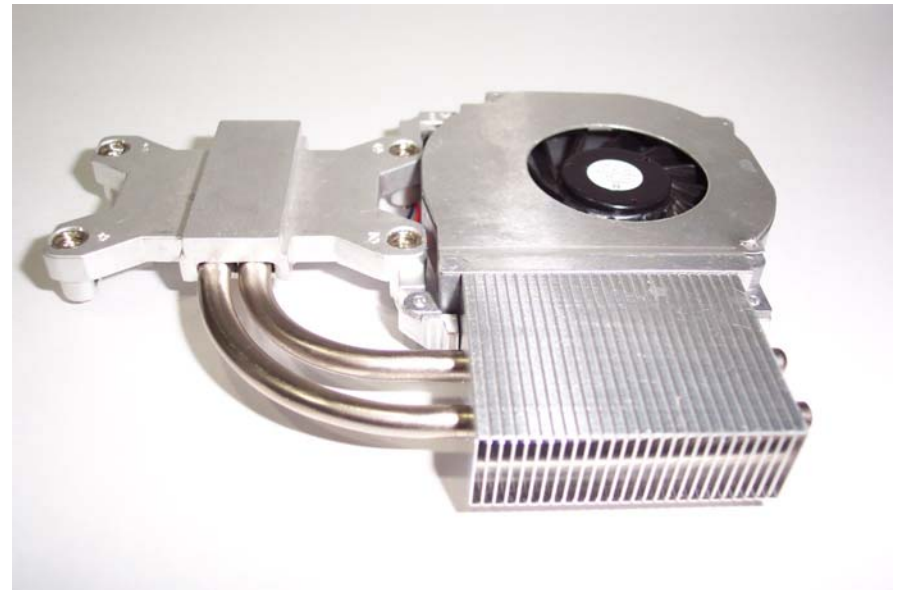




Vertically oriented heat pipe assemblies. One large dia. versus multiple smaller heat pipes. Heat pipes are isothermal body increasing fin efficiency at any distance from heat source.

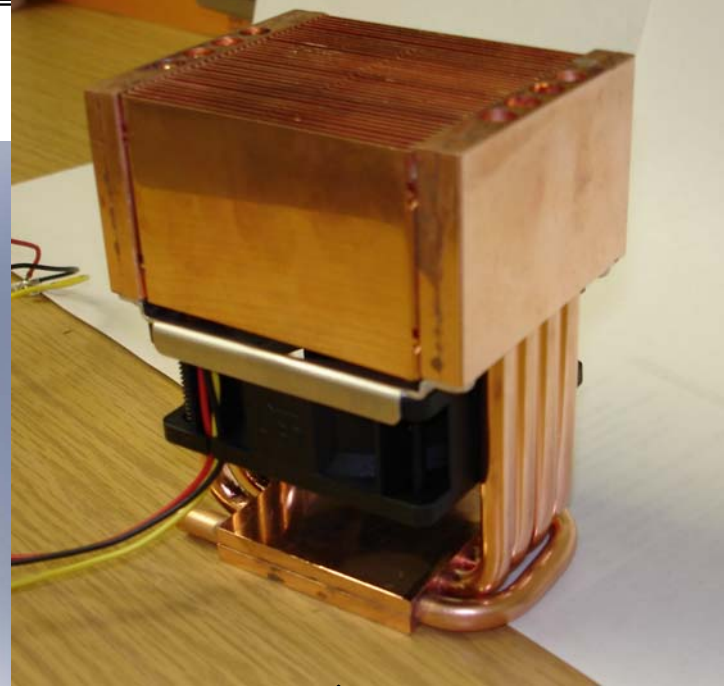
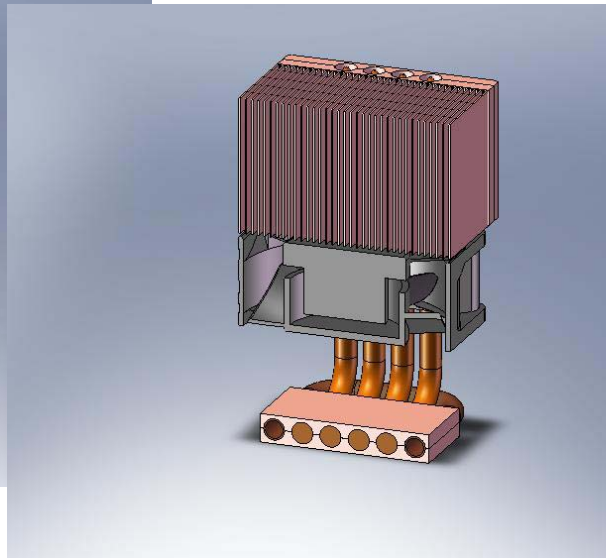
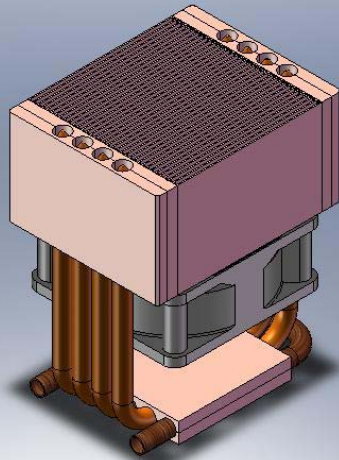


Active heat pipe assemblies
used in notebook computers
Includes blower, flattened heat pipes
and stamped fins.

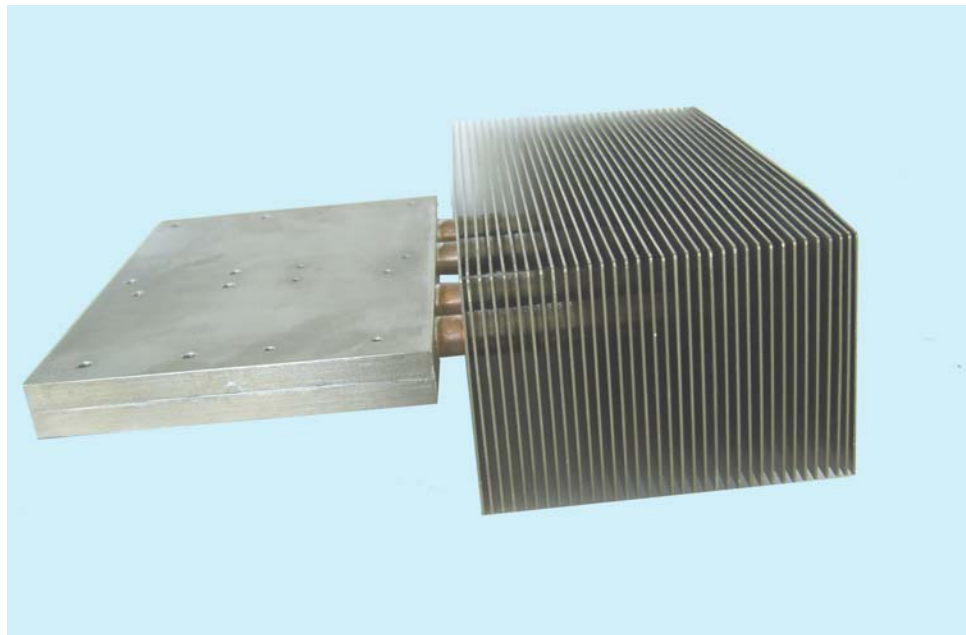
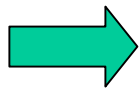


Heat pipe assembly with stacked fins pressed in place. Used in instrumentation control rack system.



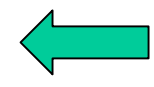
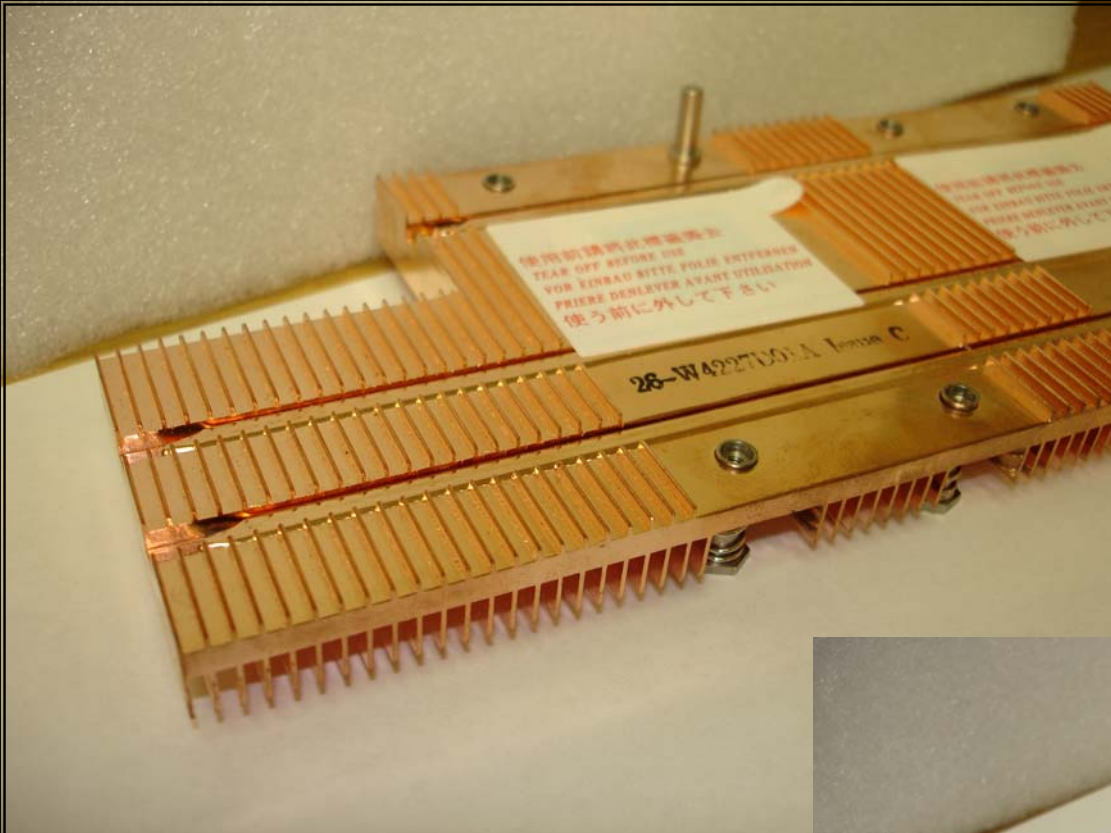


Kilowatt IGBT
power module
cooler

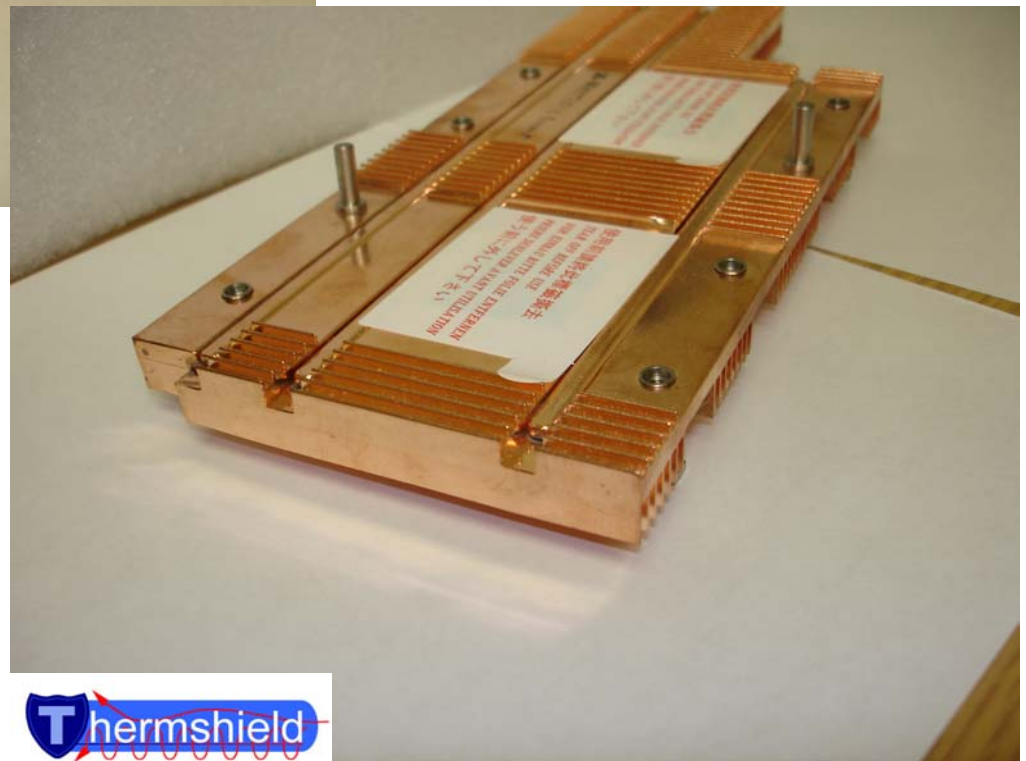
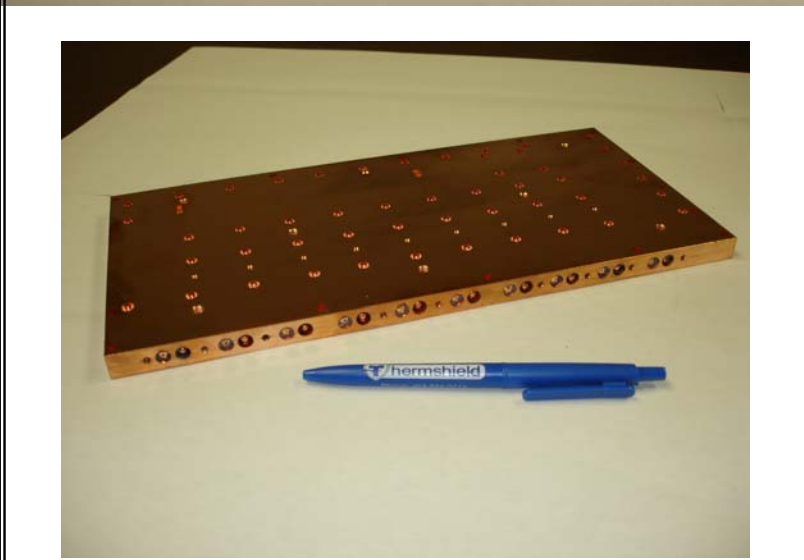


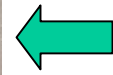
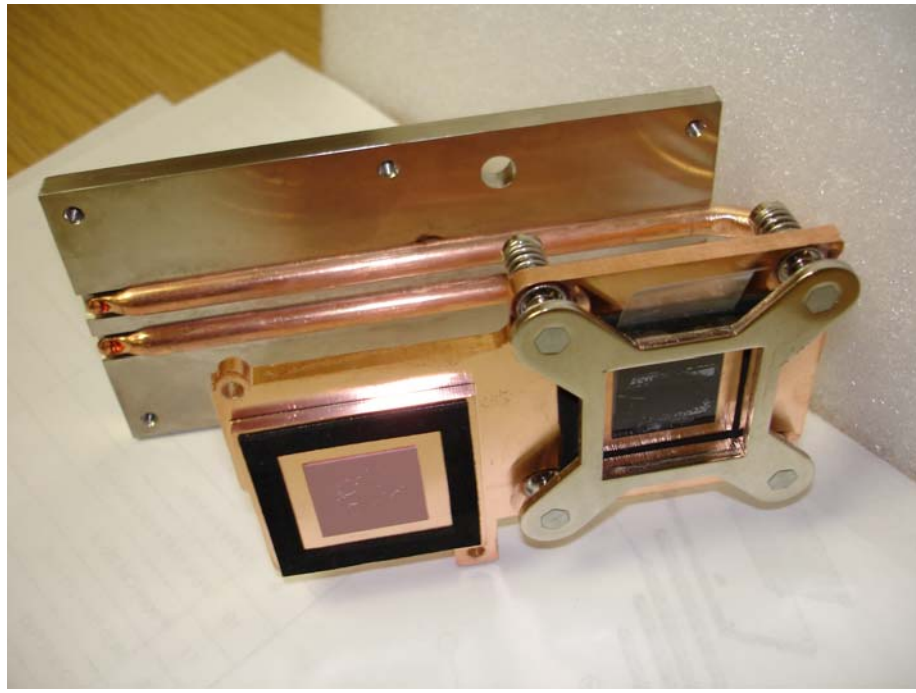
Combined
Heat pipe /
water cooling
Jacket for
hi-def CCD
camera.





Heat pipes used in heat spreading to increase effective effective thermal conductivity.





Dual heat pipe assy used in sealed, hardened computer. Transfers heat from processor and graphics chip to lid.

