Electronics Design and Manufacturing

EE20194: Group Design and Professional Engineering Practice II

Lecture 1/6

Dr Robert J. Watson

Summary

- Six lectures
  - Thursday 10:15-11:15
  - Friday 13:15-14:15
- Assessed coursework
  - Simple (paper) design and costing study
  - Deadline for submission: UG office 3pm, 27th April 2012
  - Feedback: informal indicative grading of assignment
- Course texts – not really one book that's worth buying…
  - "The Circuit Designer's Companion", by Williams is good!
  - "The Art of Electronics" by Horowitz & Hill, old now but classic
  - YouTube - check out http://www.EEVblog.com (I don't endorse or agree with everything he says, but some useful info!)

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Course outline

- General introduction to manufacturing methods
  - devices (semiconductors) and systems (boards, boxes)
- Component technologies
  - surface mount and through hole
- Enclosures and connector technologies
  - ingress protection, lifetime
- Thermal design
  - heat-sinks and forced-air convection

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Manufacturing

- In production, circuits are generally optimised for cost
- Consumer electronics
  - performance is often sacrificed for cost savings
- Professional: *e.g.,* precision instruments
  - performance goals are fixed
  - Longer lifetime requirements
- Discrete components (*R*s and *C*s) are more or less free
- Automated assembly is typical
- Economies of scale apply
  - *e.g.,* cost of making 10,000 is not x100 cost of making 100

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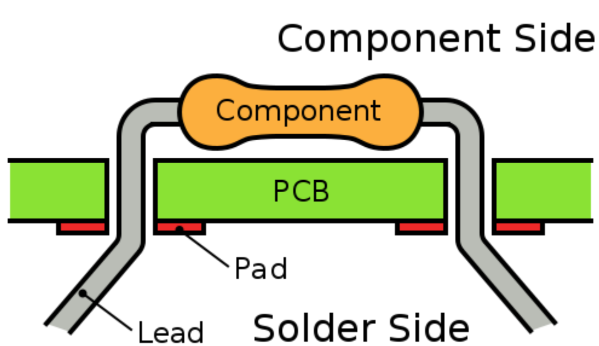
Component technology (I)

- Through-hole
  - Components have wire-leads (e.g., resistors, capacitors, transistors) or folded metal pins (e.g., integrated circuits aka “chips”).
  - Wires passed through drilled holes in printed circuit board and soldered on the copper side.



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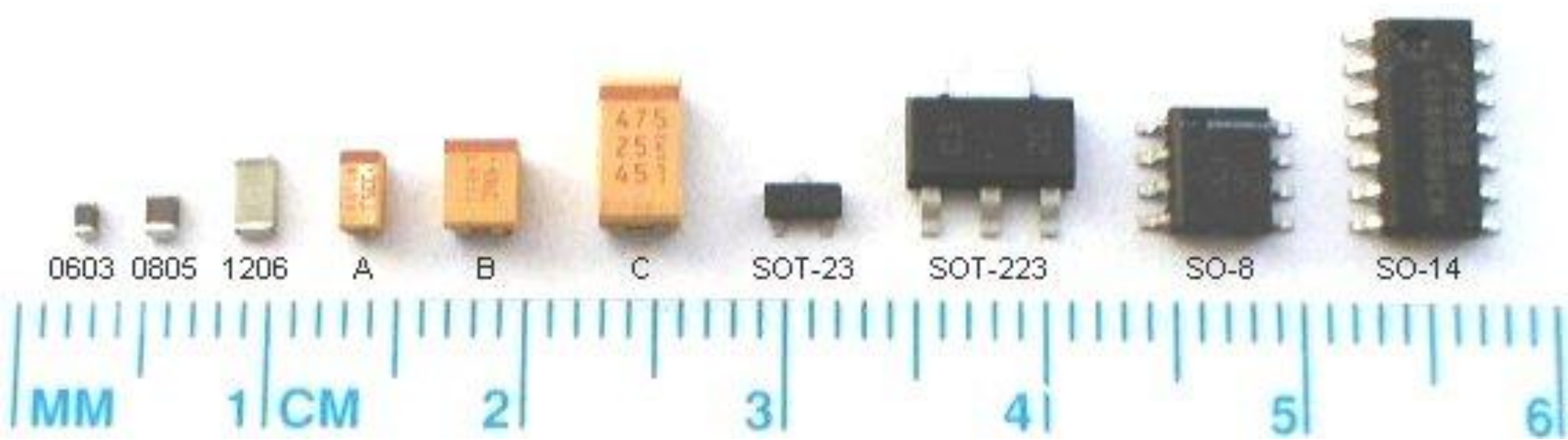
Component technology (II)

- Surface mount
  - No leads!
  - Connections are in form or small metal pads
  - Lots of variations: http://www.intersil.com/design/packages/



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Historical construction methods

- Breadboards – wooden boards!
- Plastic boards rows of holes spaced 0.1” (2.54mm)
  - accept dual inline package (DIP) devices
  - OK for quick prototyping, testing ideas.
  - Not useful for high speed digital or RF circuits – why?
- Wirewrap –
  - Very thin wire 30awg (American Wire Gauge) 0.255mm
  - Thin, flexible, very light plastic insulation – Kynar
  - No longer used for “real” work – why?

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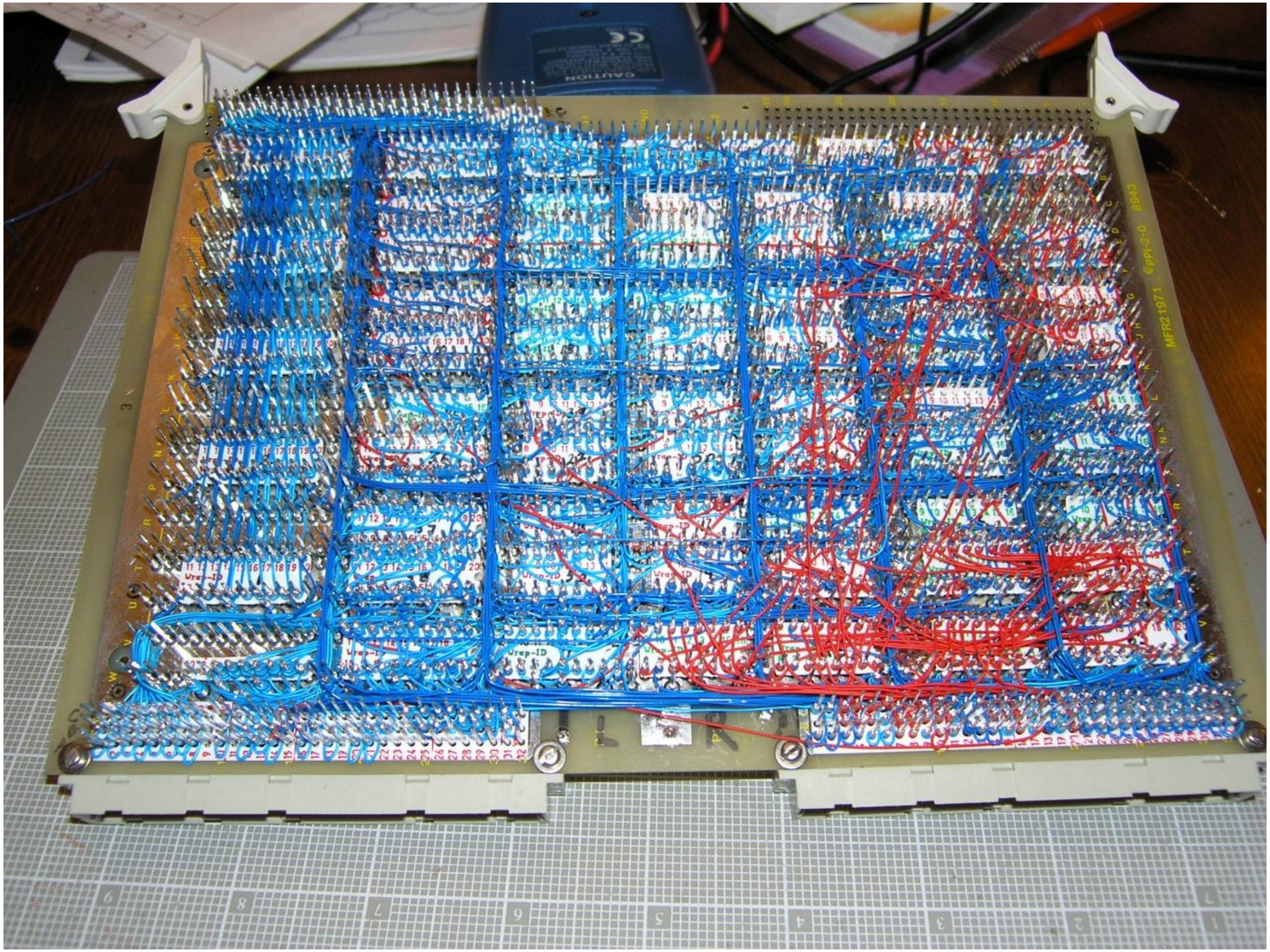
Wirewrap example (retro computer)



http://www.homebrewcpu.com/

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Printed circuit boards (I)

- Different types:
  - Single-sided (copper on one-side only)
  - Double-sided (copper on both, can have *plated-through-hole and/*or *vias*)
  - Multi-layer (copper on all planes- has internal layers, complex *vias: blind, buried*)
- Dielectric substrates
  - FR4 (standard material – glass-fibre based)
  - Radio Frequency boards – PTFE (teflon) based
  - Exotic (expensive) materials: alumina, quartz (GHz)

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Printed circuit boards (II)

- Single-sided boards
  - Cheap, simple dor low-performance and/or high production volumes
- Double-sided boards
  - Medium density, general purpose
- Multilayer
  - Several boards sandwiched together: 4-16 layers
  - High density, high speed, low signal levels
  - Dedicated power connections on “power planes”

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Connectors & Enclosures

- Many thousands to choose from!

- Standards are important in some sectors
  - Consumer: *e.g.,* USB
  - Military/Aerospace *e.g.,* MIL-C 5015 connectors

- Things that matter
  - Environmental: *e.g.,* IPXX – ingress protection
  - Safety: *e.g.,* high voltages
  - Signal integrity: *e.g.,* shielding, radio-frequency, RF
  - Legislation: *e.g.,* RoHS (some applications are exempt)

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Thermal design

- Electronic devices can consume a lot of power
  - Intel i7 3960X max dissipation: 130W
  - Microchip PIC 16F84A max dissipation: 0.8W
- Assuming energy is not transformed into another form *e.g.,* light (LED) or motion (motor) *etc* - it must be dissipated as heat – it can't just disappear!
- Quick example calculation: simple voltage regulator LM7805 to convert 12V to 5V and pass 1A of current – how much power will it dissipate?

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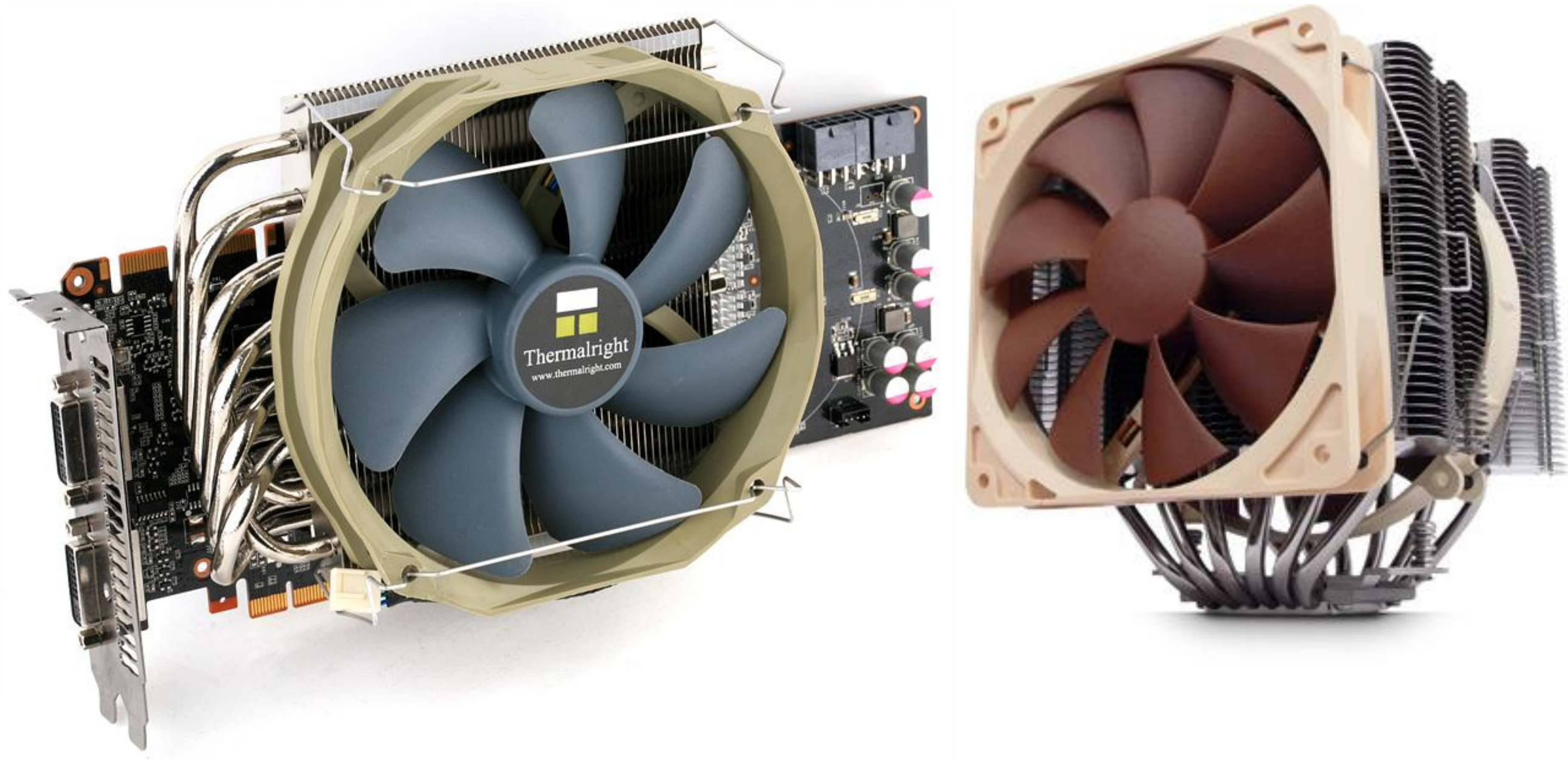
Examples you know of…



Wouldn't be as efficient at high altitude or even in space – why?

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Thermal management

- Quite often it's easier to efficiently move the heat away from the device and then dump it.
  - Heat pipes (sealed tubes – transition liquid/vapour)
  - Heat pumps (Peltier effect)
- Cooling in harsh environments
  - "Thin" low density air *e.g.,* high altitudes
  - "No" density air *e.g.,* space!
- Problems caused by temperature
  - Every components has a temperature coefficient

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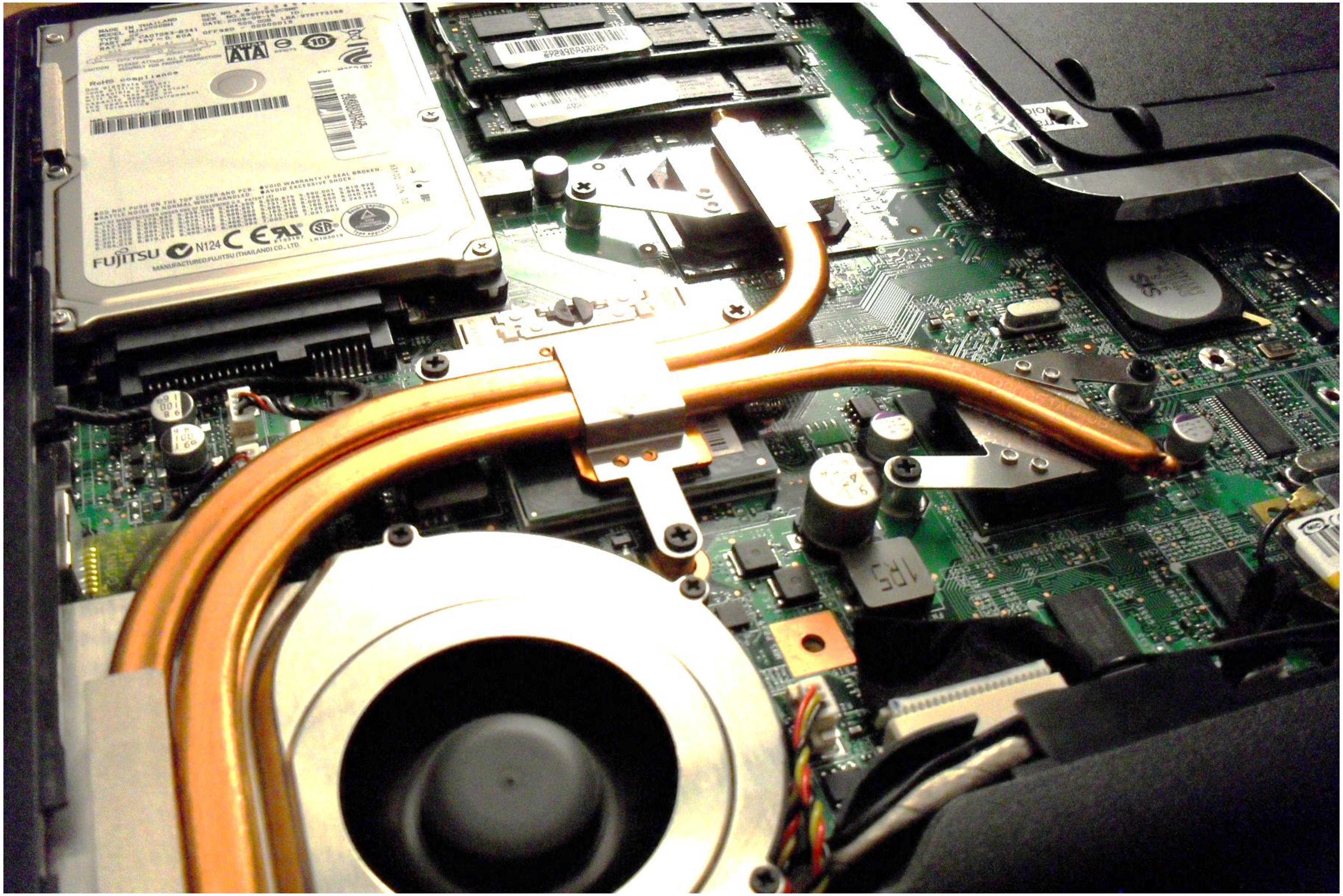
Laptop heatpipes for CPU and GPU



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