Basic Training
- Heat Sink

Christopher A. Soule
Engineering Director
Thermshield, LLC
Gilford, NH & Taipei, Taiwan

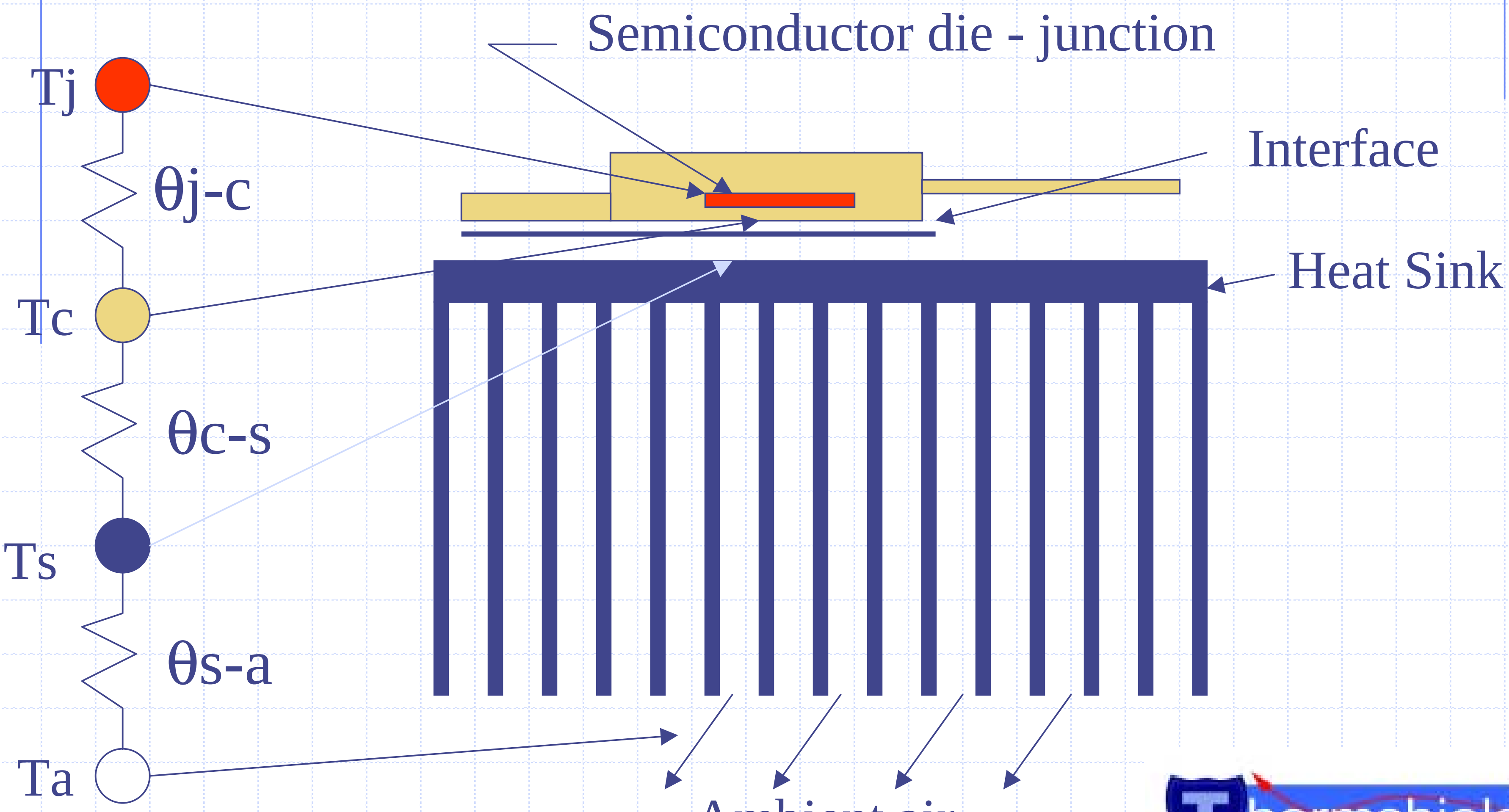
What does a Heat Sink do?

- A heat sink gives waste energy a place to go.
- A properly sized heat sink maintains the semiconductor junction temperature at or below the max. allowable temperature.
- Heat sink cooling capacity must take into account:
  - Max. power to be dissipated
  - Max. “local” ambient air temperature
  - Altitude derating
  - Customer usage
- ***Every 10 degree C increase from m***
  temperature cuts the life of the ser
  in half!

How is Heat Sink Effectiveness Measured

- θ = degrees C/ Watt = Theta = dissipation capacity
- Like an Ohm in electrical resistance Theta indicates resistance to heat flow
- Thermal resistance is temperature rise divided by power (heat).
- Theta is expressed in deg. C rise per one Watt of power output
- The smaller the θ number the greater the heat removal capability.

Basic Semiconductor Cooling



Inputs Needed to Size a Heat Sink

- Estimated Parameters:
  - Power to be dissipated
  - Maximum ambient air temperature
  - Maximum junction temperature
  - Thermal resistance junction to case - θj-c (from semiconductor manufactures data)
  - Estimated thermal resistance between case and sink θc-s (from interface manufacturers data)
- See Thermshield – Thermal Questionnaire

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Elements of Thermal Resistance

- $\theta_{j\text{-}a} = \theta_{j\text{-}c} + \theta_{c\text{-}s} + \theta_{s\text{-}a}$
- $\theta_{j\text{-}a}$ = overall thermal resistance junction to ambient air
- $\theta_{j\text{-}c}$ = thermal resistance junction to case of semiconductor (inside semi.)
- $\theta_{c\text{-}s}$ = resistance case to sink (interface)
- $\theta_{s\text{-}a}$ = resistance sink to ambient air (heat sink)

Finding the Right Size Heat Sink

- Find the overall system thermal resistance

  θ_{j-a} = (max. junction – ambient air)/Power dissipated

- To find the max. heat sink resistance:

  θ_{s-a} = (max. junction – ambient/Power) – (θ_{j-c} + θ_{c-s})

- If the resulting thermal resistance number is negative the solution is impossible!

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Example #1

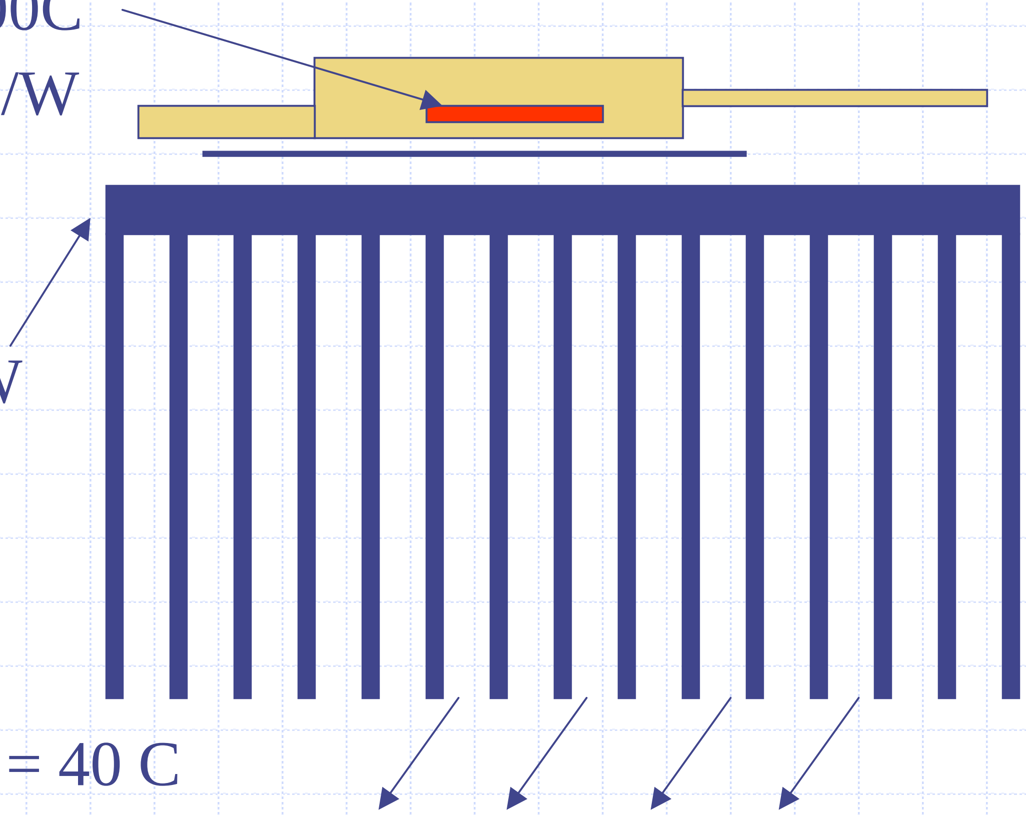
- Cooling a single power device-
  - Q = power input = 10 Watts
  - Max. Junction temp. = 100C
  - Max Ambient temp. = 40C
  - Internal thermal resistance θj-c = 1.0 C/W
  - Interface resistance θc-s = 1.5 C/W
- (100-40)/10W-(1.0+1.5) = 6.0-(2.5 C/W) = 3.5 C/W
- Max. temperature rise in heat sink must be <= 35C

Example #1 - Continued

Q = 10 Watts

T_j max = 100C

$\theta_{j\text{-}c}$ = 1.0 C/W



$\theta_{c\text{-}s}$ = 1.5 C/W

Max air temp. = 40 C

$\theta_{sa} = (100-40)/10W-(1.0+1.5) = 6.0-(2.5c/w) = 3.5\ c/w$

Review – Heat Sink Sizing

- Heat sinks help to cool semiconductors
- Most power electronics require cooling
- Thermal resistance (θ) is in degrees C/Watt
- Find the needed heat sink size by:
  - $\theta sa = (Tj - Ta)/Q - (\theta jc + \theta cs)$
- In sizing a heat sink use θsa X Watts = temperature. *Good reality check!*
- Negative thermal resistances are impossible.

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Thermal Products from Thermshield

- PC board level stampings & extrusions
  - Finished parts
  - Commonly stocked
  - Commodity items
- Aluminum extrusions
  - Higher fin densities than most competitors
  - Raw stock or machined and finished
  - Sizes up to 13 inches wide
  - Conventional, semi-hollow and full hollow

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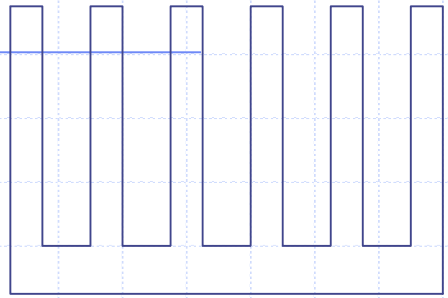
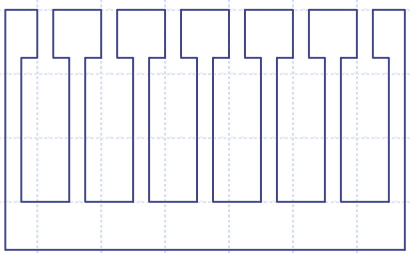
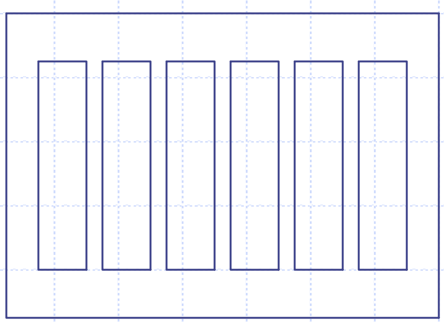
Aluminum Extrusion Styles



Conventional Extrusion



Semi-Hollow Extrusion



Full Hollow Extrusion

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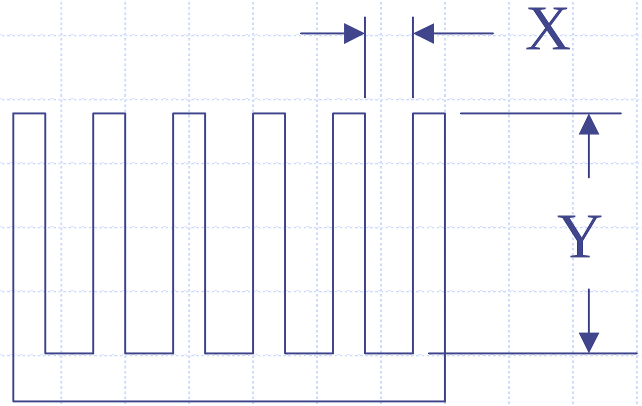
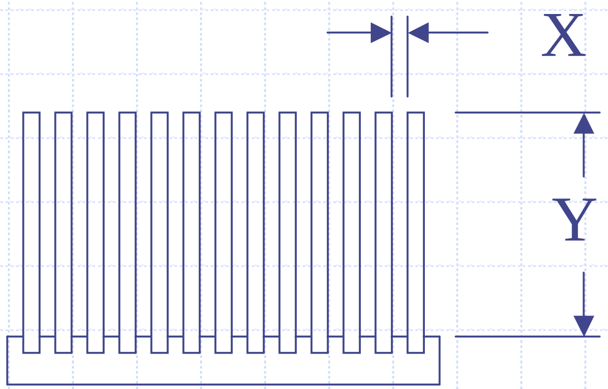
Extrusion Ratios

Y/X = height vs. thickness
of ext. die tool steel



Conventional Extrusion
Up to 20:1 depending
on overall side



Bonded Fin Extrusion
Up to 40:1 size is not
a restriction.

Thermal Products from Thermshield

- Fans / Blowers and Air Movers
  - DC and AC
  - Sizes from 25 mm to 192 mm
- BGA coolers
  - Extrusions or microforged
  - Plastic clip or double sided interface attachment
  - Sizes from 21mm to 45 mm
- Interface Pads and Materials

Thermal Products from Thermshield

- Skived Fin Heat Sinks
  - Thinner fins, tighter fin spacing than extrusion
  - Low cost than folded fin
- Heat Pipe Assemblies
  - Round from 3 mm to 15 mm
  - Flat from 14 mm to 49 mm
  - Typically sold as an assembled system not standalone
- Bonded Fin Heat Sinks
  - Ultra high extrusion ratios / 2X surface area
  - Higher in cost that other solutions

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Thermal Products from Thermshield

- Liquid Cooled Cold Plates
  - Standard and custom styles
  - Typically Alum. plate and copper tube
- Microprocessor Coolers
  - P3, P4 and AMD coolers
  - New patented laminated fin design
  - Aluminum, copper and combinations

And In the End...

- Early involvement = production quantity buys
- New Technologies get attention
- Aggressive pricing and quick samples
- Technical support at no added cost
- Excellent customer support

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