HEATSINK SOLUTIONS: THERMAL MANAGEMENT IN OUR ELECTRONICS DEVICES

Maria Cuesta maria.cuesta@we-online.com
EMC Shielding & Thermal Solutions | Product Management

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

WEBINAR

AGENDA

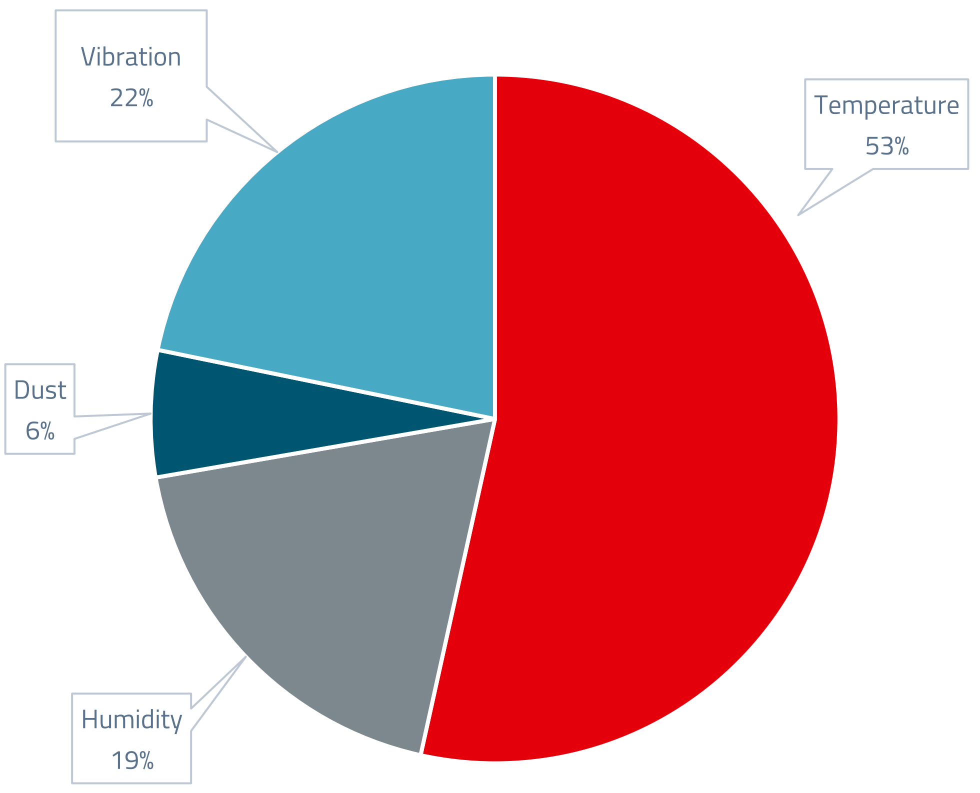
- **Why do we cool?**
- **How do we cool?**
- **Heatsink Design**
- **Our portfolio**

WHY DO WE COOL?

Thermal Management in our Electronic Devices

THERMAL MANAGEMENT IN ELECTRONIC DESIGN

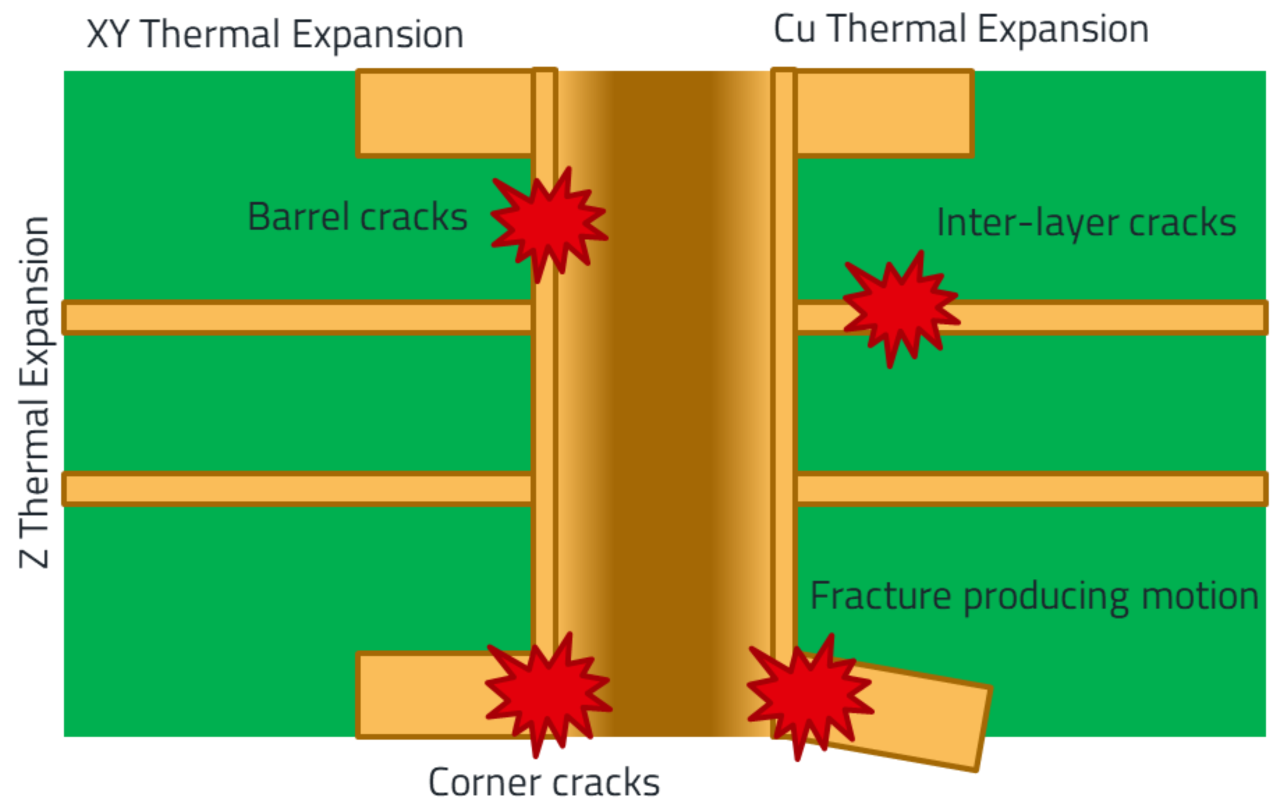
Why Do We Cool?



WHY THERMAL MANAGEMENT IN ELECTRONIC DESIGN?

Why Do We Cool?

Mechanical Stress Failure

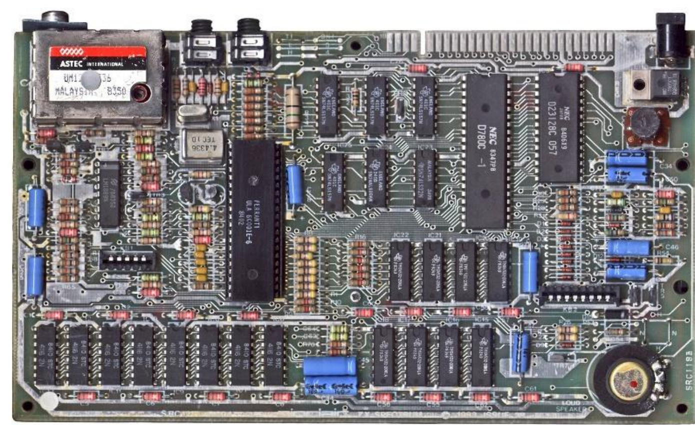


THERMAL MANAGEMENT IN ELECTRONIC DESIGN

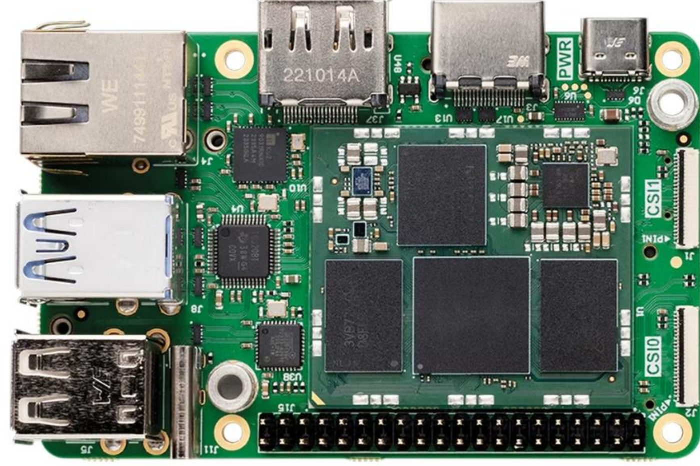
Problem Statement

- Miniaturization & Power Density

ZX Spectrum
1980s



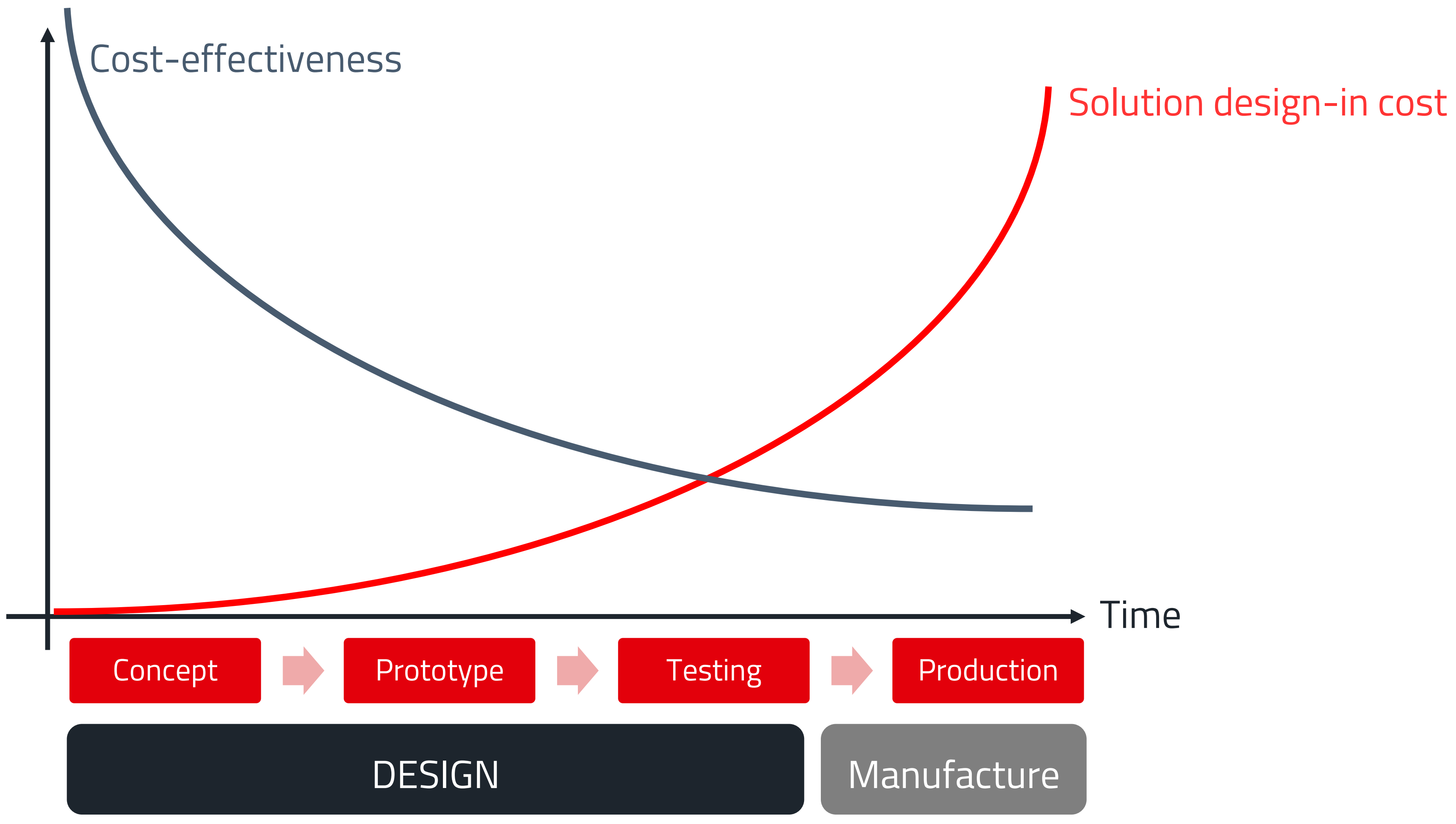
GRINN GenioBoard
2026



22 W/cm^2 ⟷ 60 W/cm^2

THERMAL MANAGEMENT IN ELECTRONIC DESIGN

Development Impact



HOW DO WE COOL?

THERMAL MANAGEMENT IN ELECTRONIC DESIGN

How Heat Behaves

- The goal of Thermal Management in Electronics is to manage **Heat Transfer**
  - Heat Transfer is energy in transit due to a **temperature difference**

- There are 3 main types of transfer:

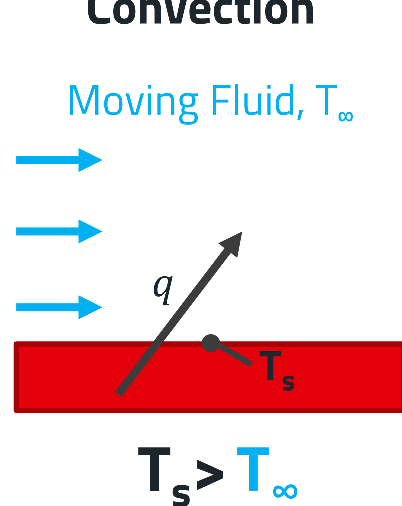
Conduction

T_1 T_2

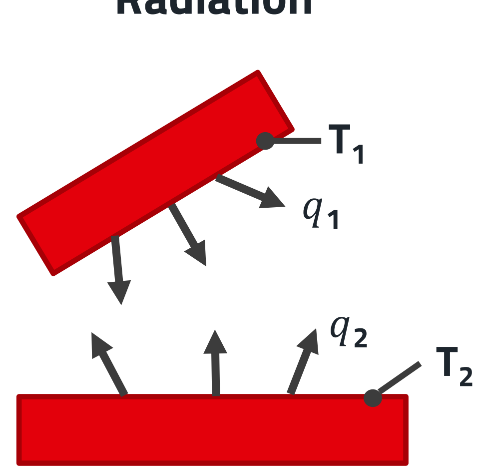
q

$T_1 > T_2$

Convection



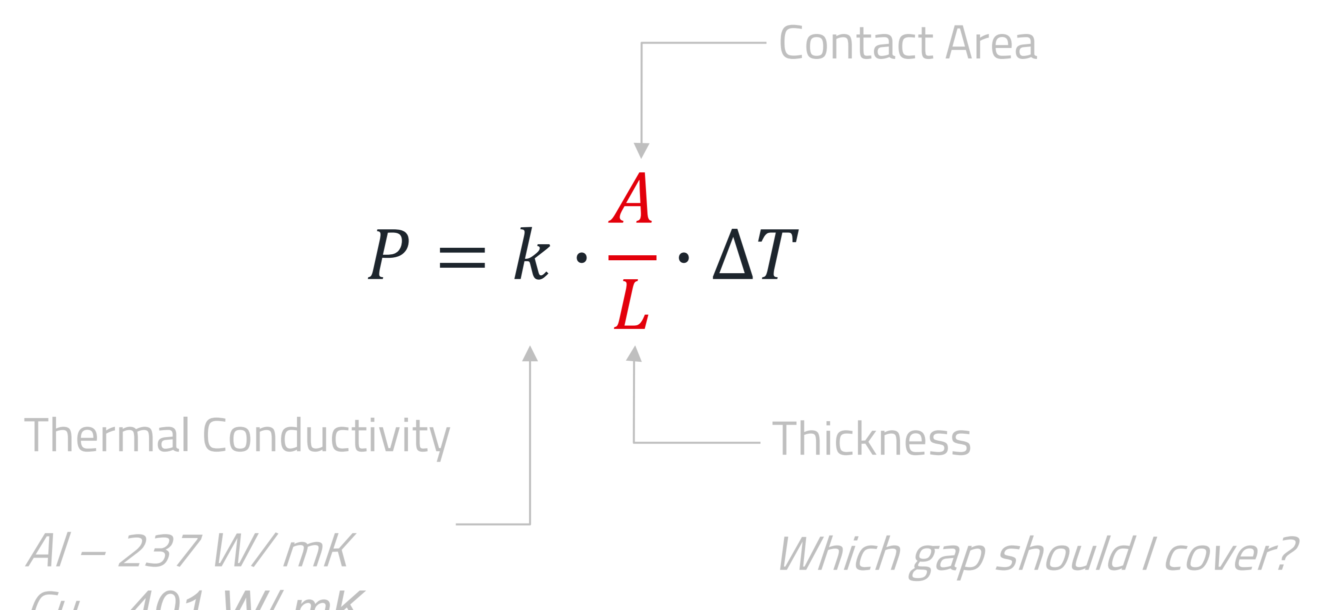
Radiation



THERMAL MANAGEMENT IN ELECTRONIC DESIGN

Conduction

- Heat flow through a solid is directly proportional to a temperature difference



Conduction

T_1 T_2 q

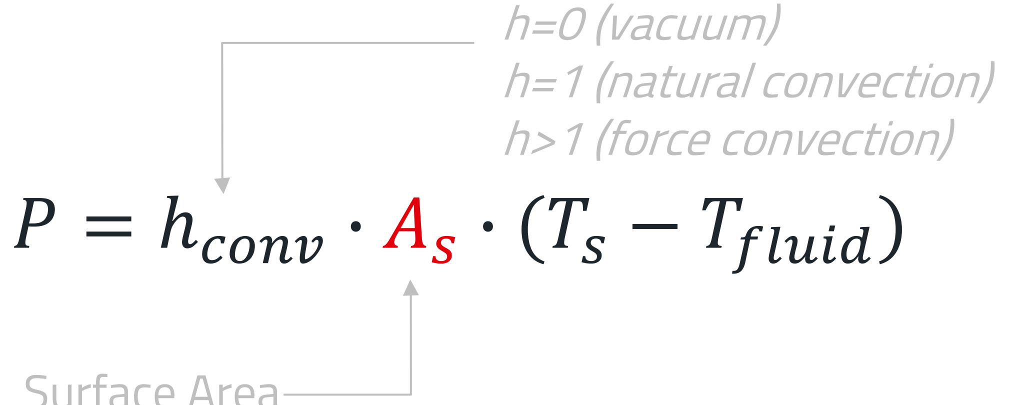
$T_1 > T_2$

Fourier's Law

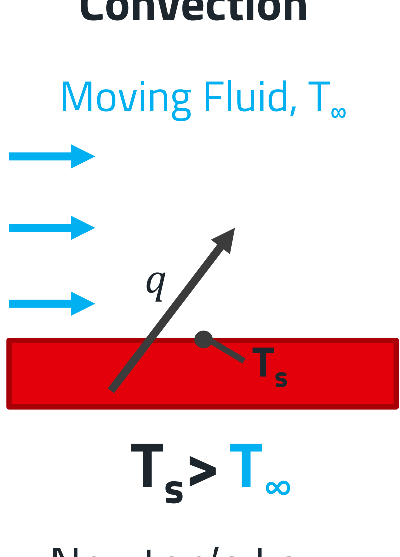
THERMAL MANAGEMENT IN ELECTRONIC DESIGN TRANSFER

Convection

- Heat flow from solid to fluid proportional to temperature difference



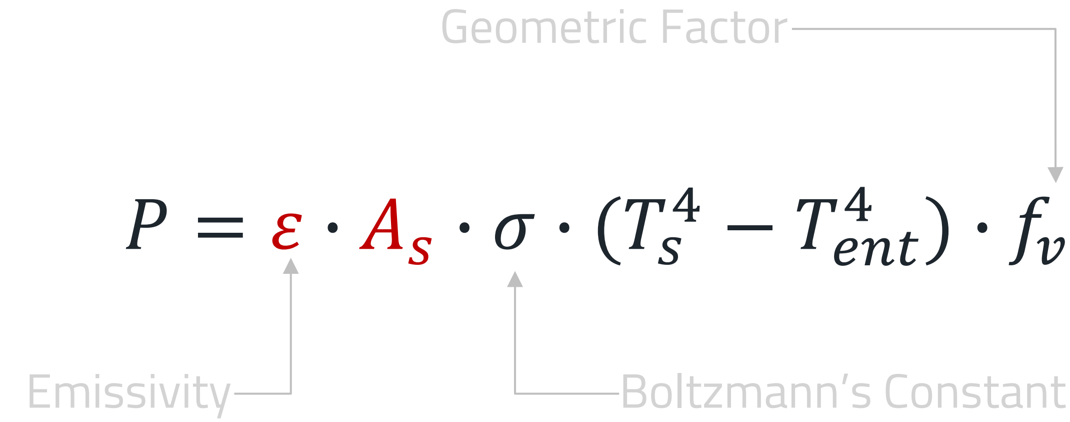
$$P = h_{conv} \cdot A_s \cdot (T_s - T_{fluid})$$



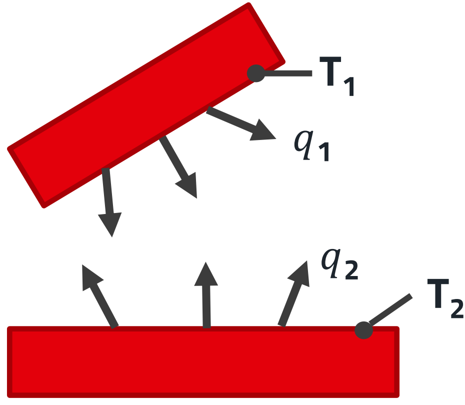
THERMAL MANAGEMENT IN ELECTRONIC DESIGN

Radiation

- When an object is surrounded by other of less temperature, a heat transfer equivalent to that of natural convection occurs



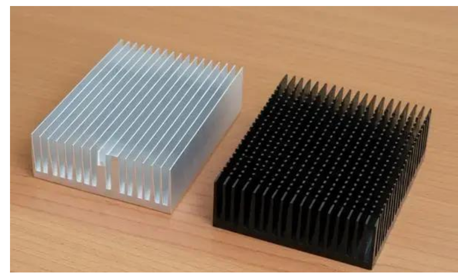
$$P = \varepsilon \cdot A_s \cdot \sigma \cdot (T_s^4 - T_{ent}^4) \cdot f_v$$



Boltzmann's Law

Material	Emissivity
Copper	0.85
PLCC	
Steel AISI 4340	
Black Anodized Aluminum Alloy 6063	0.77

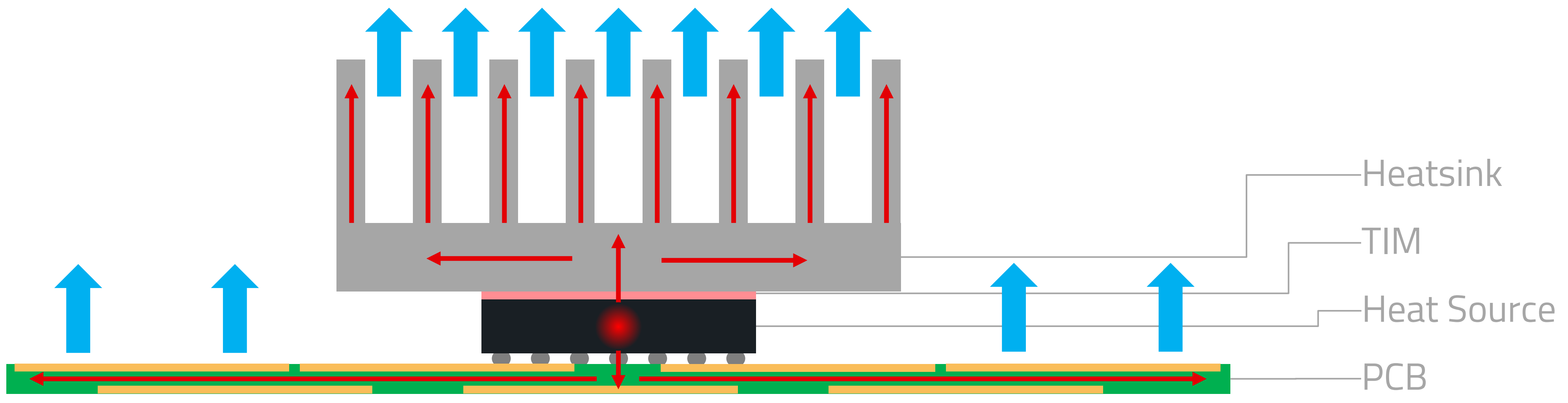
Material	εref (a)	εcal (b
polished aluminium	0.04-0.06	0.04
burnished copper	0.07	0.05



HEATSINK DESIGN

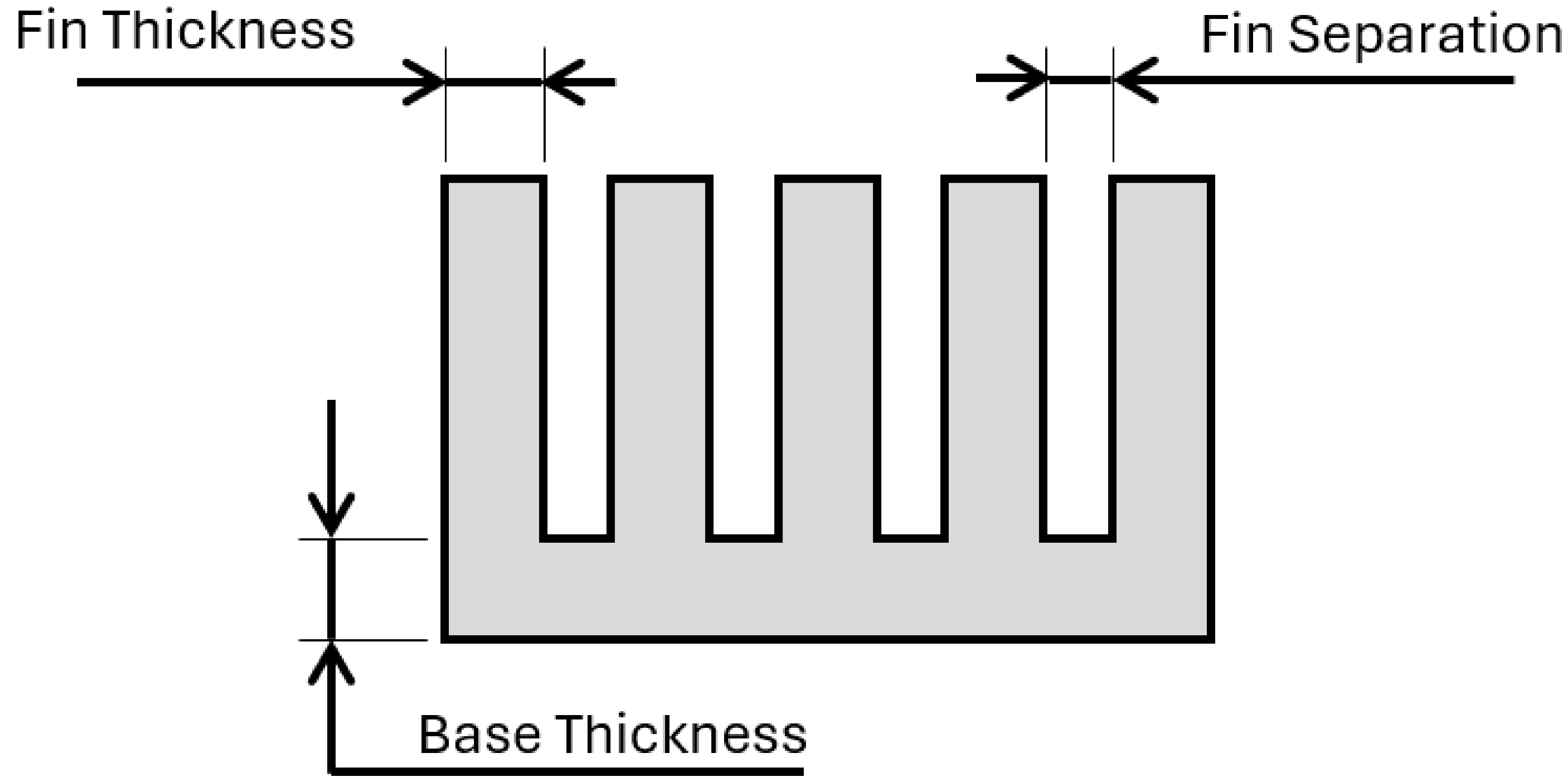
WHAT IS A HEATSINK?

Heat Transfer by Convection & Radiation
Heat Transfer by Conduction

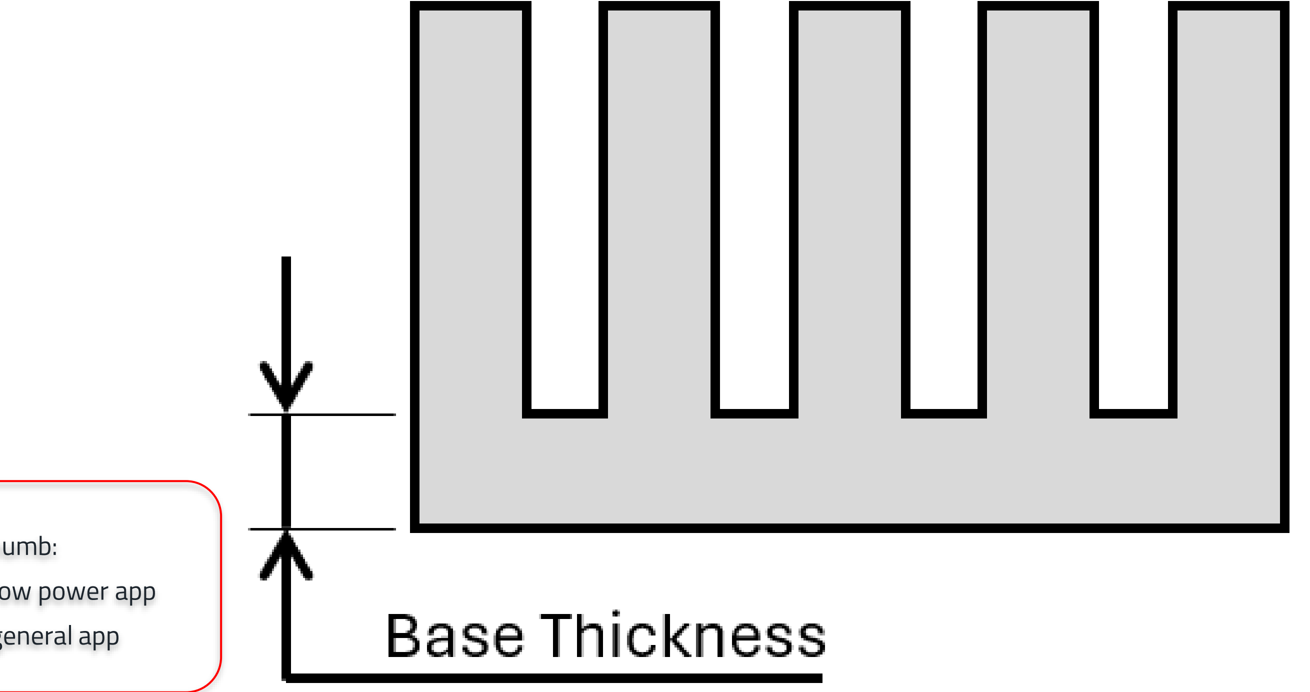


A heatsink is a passive cooling device designed to absorb and disperse heat, by **increasing the surface area available**

DESIGN CONSIDERATIONS



DESIGN CONSIDERATIONS



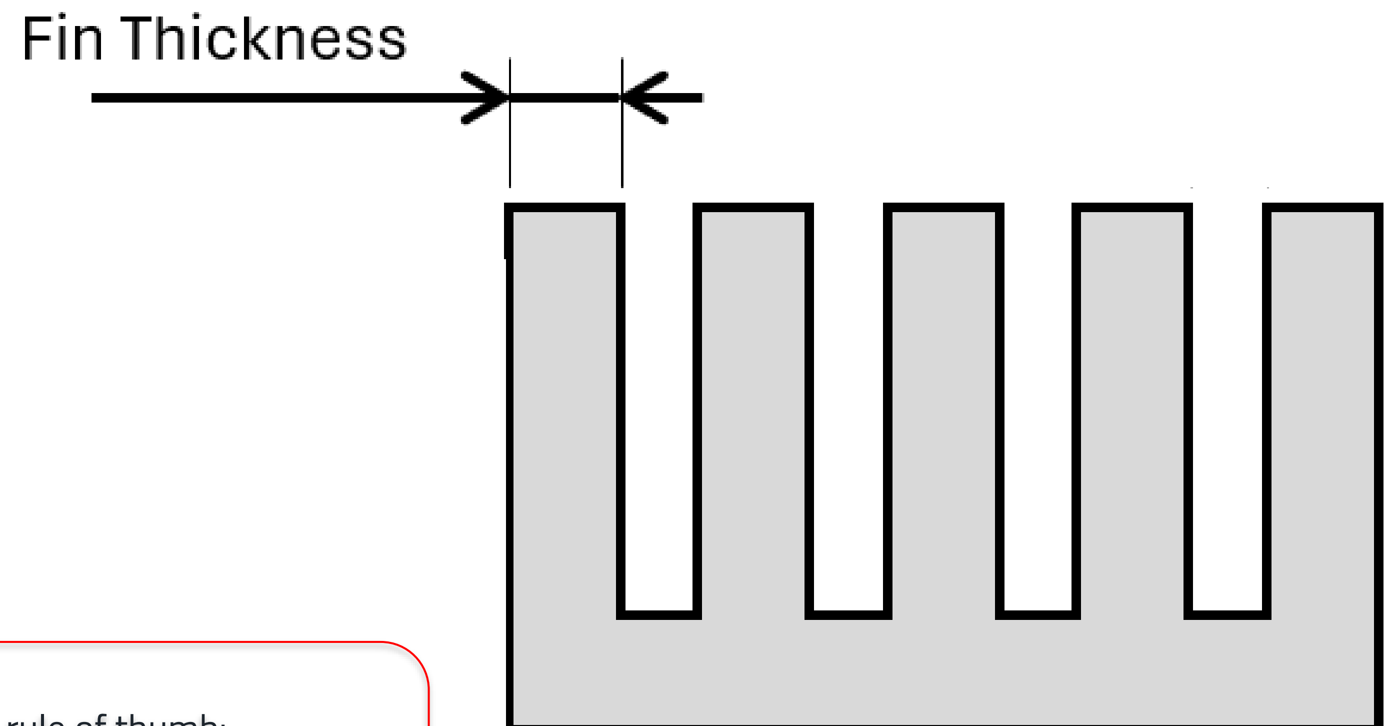
As a rule of thumb:

≈1 - 2 mm thickness: low power app

≈3 mm thickness: general app

- Thicker base provides more lateral spreading and reduce hot spots
  - Cons: the thicker, the heavier and more expensive.

DESIGN CONSIDERATIONS



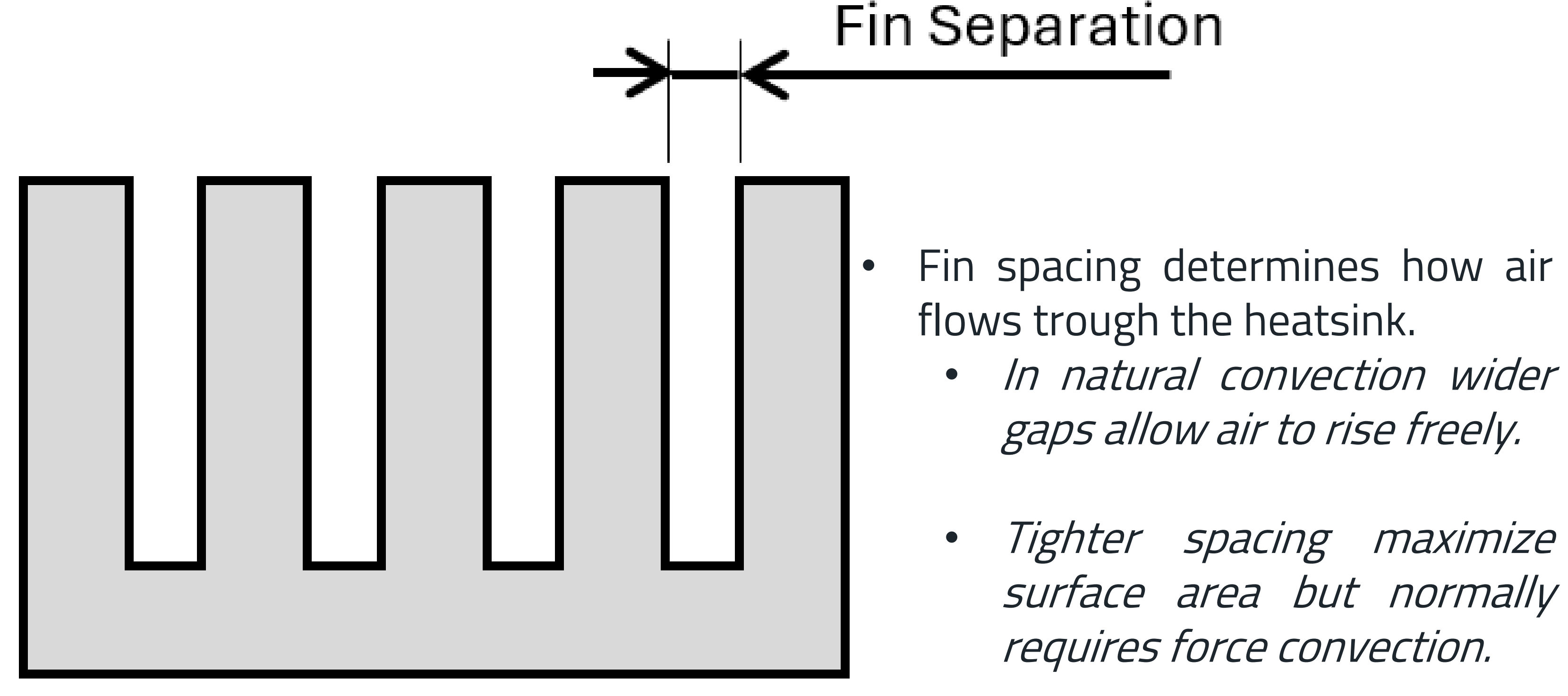
- Thicker fins help to transfer the heat easily
- Thinner fins allow to have more fins *(increasing available area)*

As a rule of thumb:

<0,5 mm thickness: force convection

>1 mm thickness: natural convection

DESIGN CONSIDERATIONS

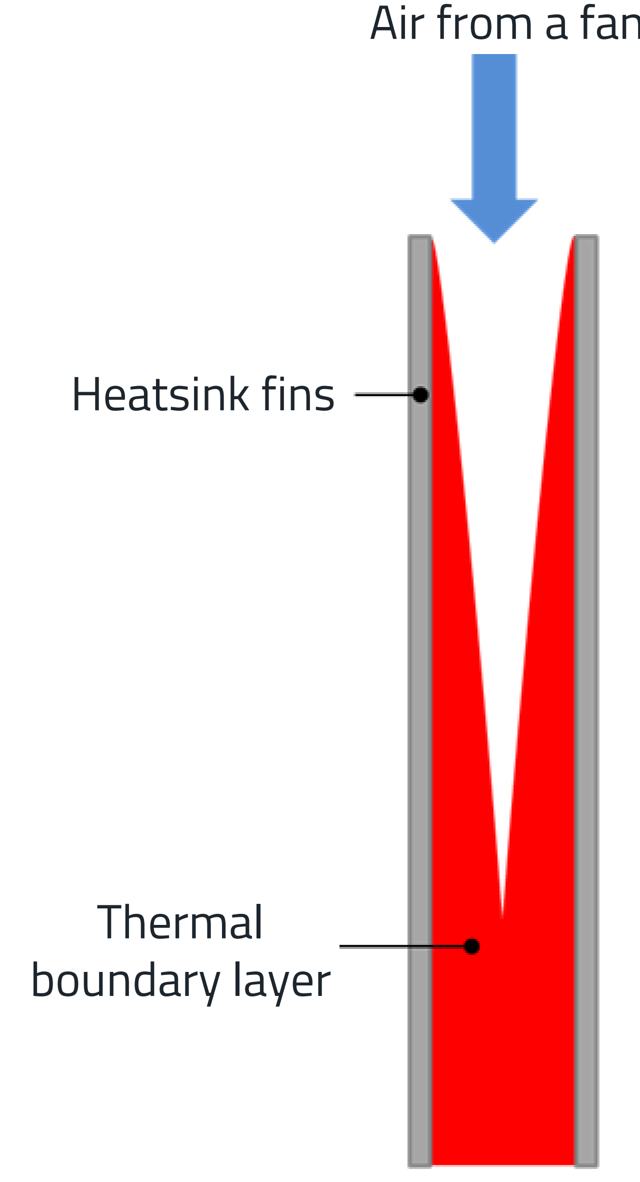


- Fin spacing determines how air flows trough the heatsink.
  - *In natural convection wider gaps allow air to rise freely.*
  - *Tighter spacing maximize surface area but normally requires force convection.*

DESIGN CONSIDERATIONS

Thermal Boundary Layer

Thermal Boundary Layer is the thin region of air adjacent to the surface of the fins where the temperature of the air changes ***from that of the fin surface to the surroundings airflow.***

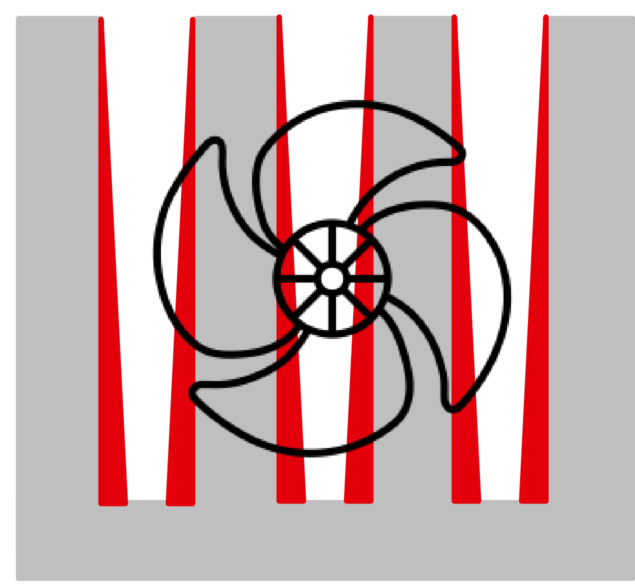


DESIGN CONSIDERATIONS

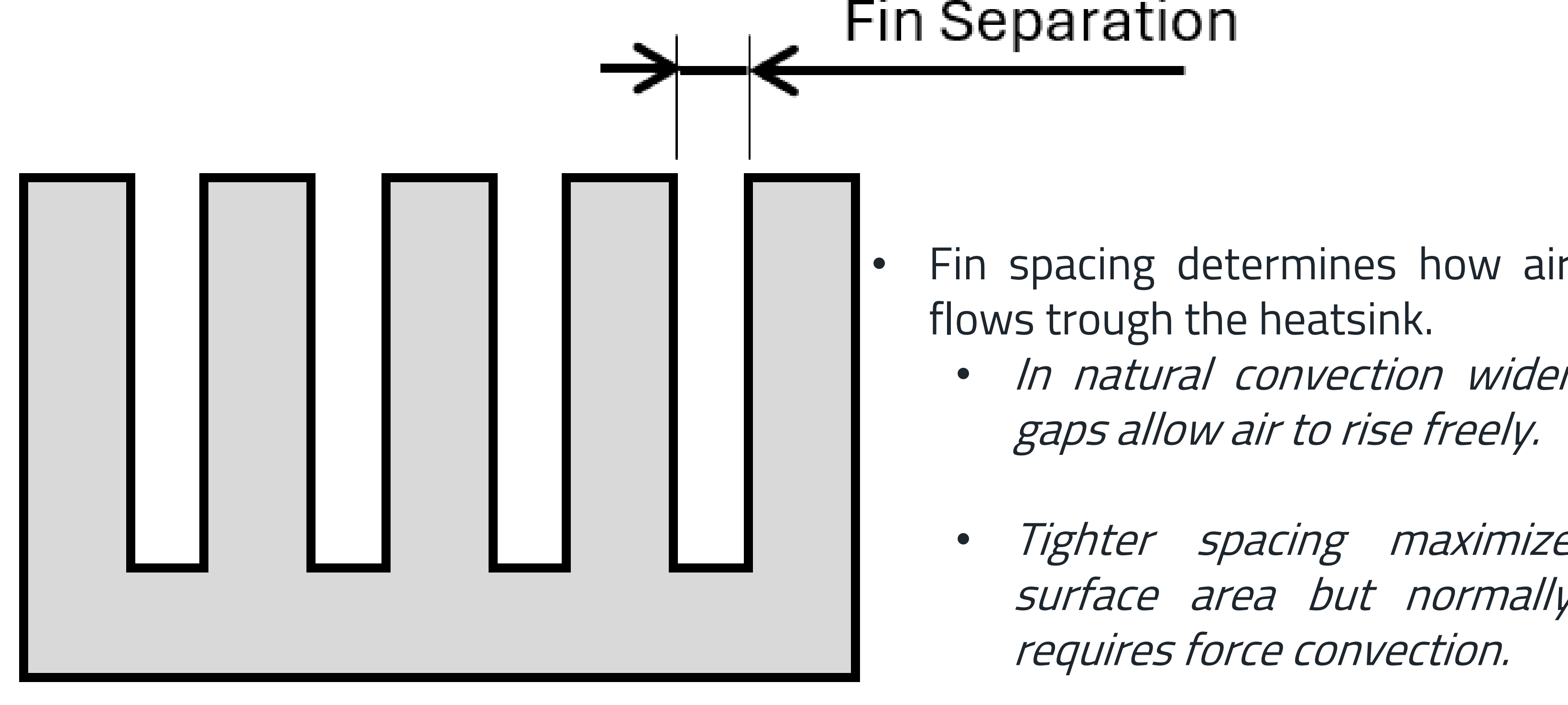
Thermal Boundary Layer

Overlap between boundary layers

No overlap between boundary layers



DESIGN CONSIDERATIONS

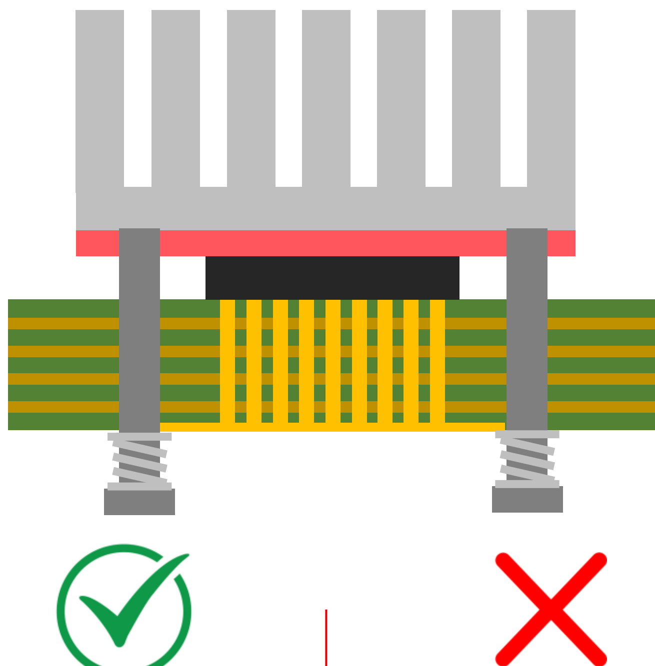


- Fin spacing determines how air flows trough the heatsink.
  - *In natural convection wider gaps allow air to rise freely.*
  - *Tighter spacing maximize surface area but normally requires force convection.*

As a rule of thumb:
2-4 mm separation: force convection
>5 mm separation: natural convection

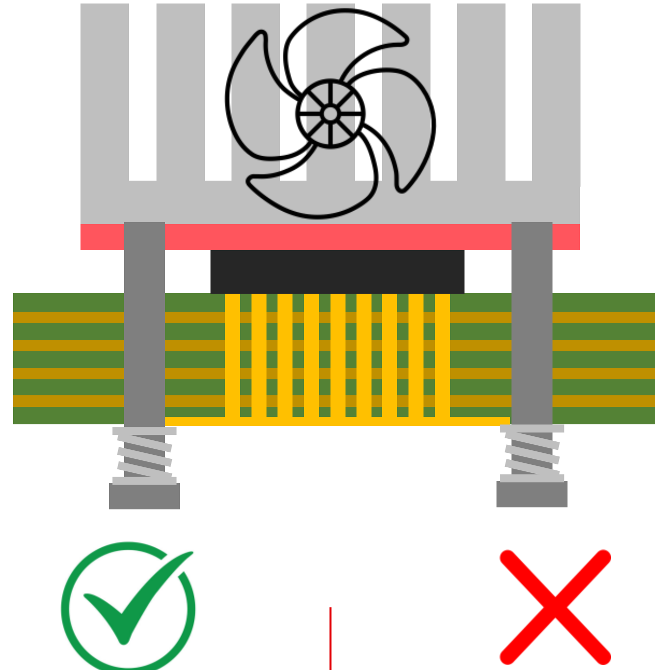
DESIGN CONSIDERATIONS

Natural vs Force Convection



- Lower cost
- Lower energy consumption
- Silent operation

- Lower cooling capacity
- Requires large heatsinks for high power app



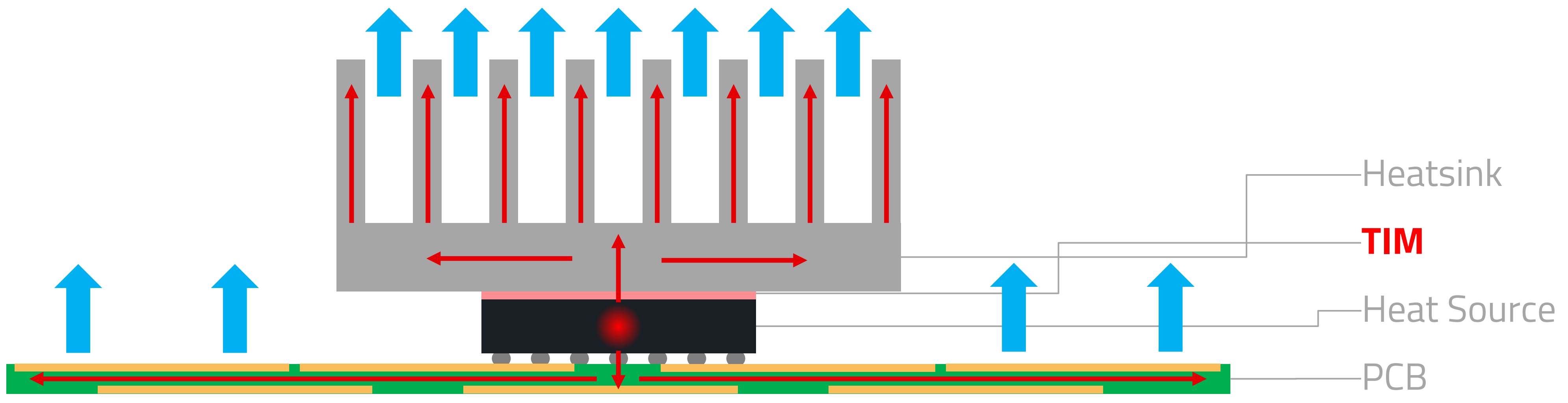
- Higher cooling capacity
- Cooling performance can be controlled dynamically
- Enables smaller heatsinks

- Noise and dust build up
- More expensive
- Extra space and power consumption

TIM IMPORTANCE

Quick reminder

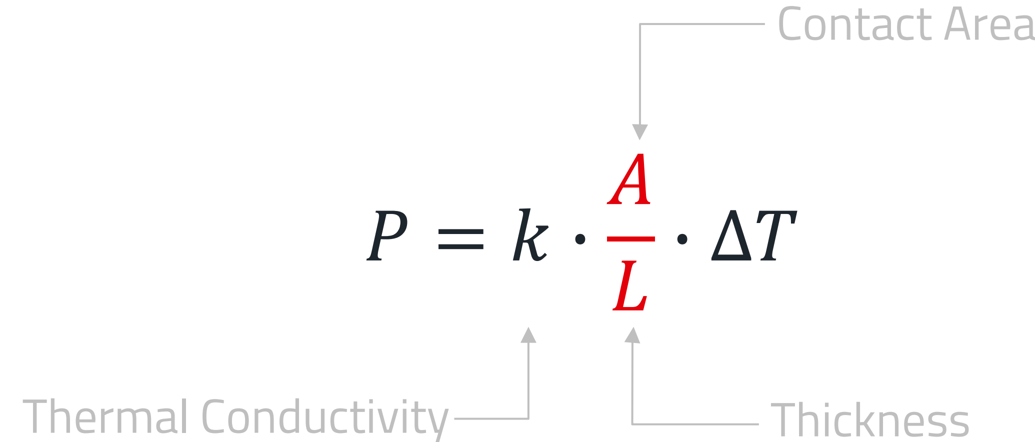
Heat Transfer by Convection & Radiation
Heat Transfer by Conduction



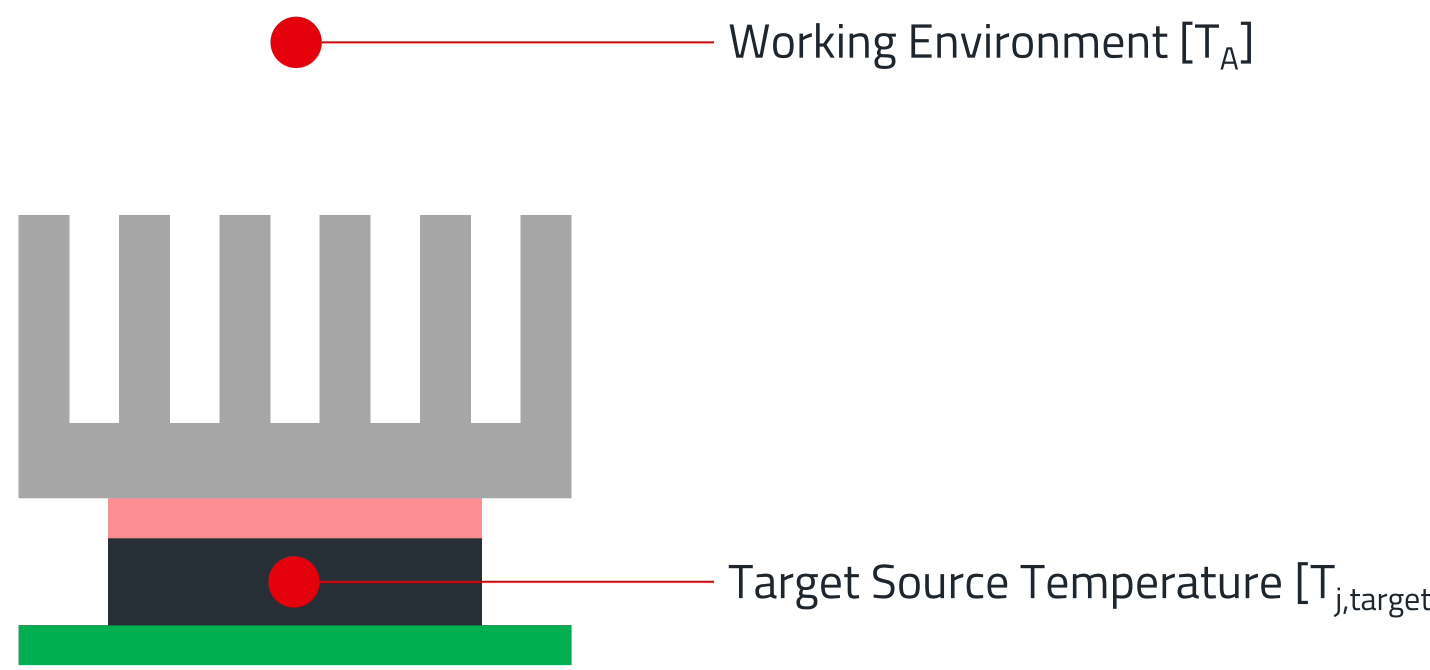
We know how to design, how to chose material…***but what about the TIM?***

TIM FOR OPTIMAL THERMAL CONDUCTION

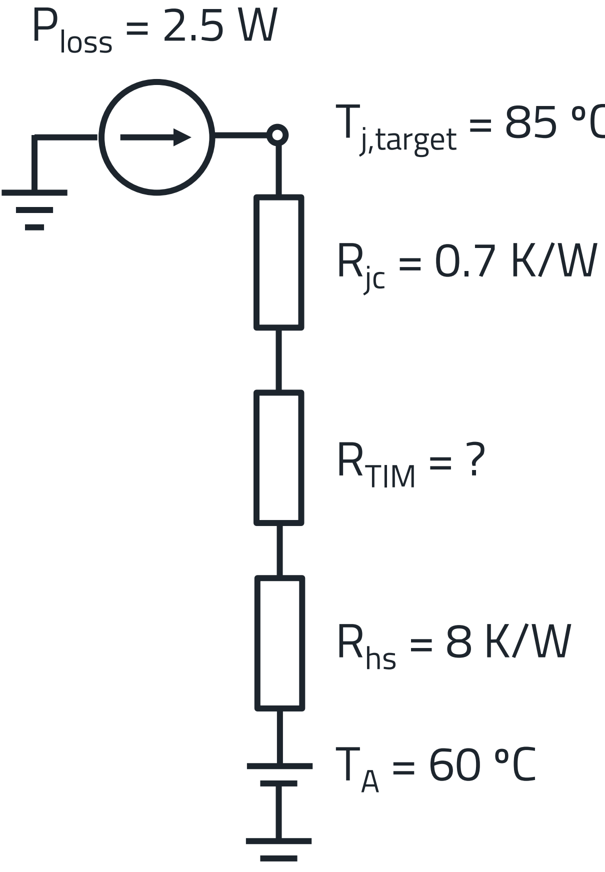
A thermal interface material (TIM) ensures good thermal transfer between heat source and cooling assembly through **conduction**.



TIM FOR OPTIMAL THERMAL CONDUCTION



TIM FOR OPTIMAL THERMAL CONDUCTION

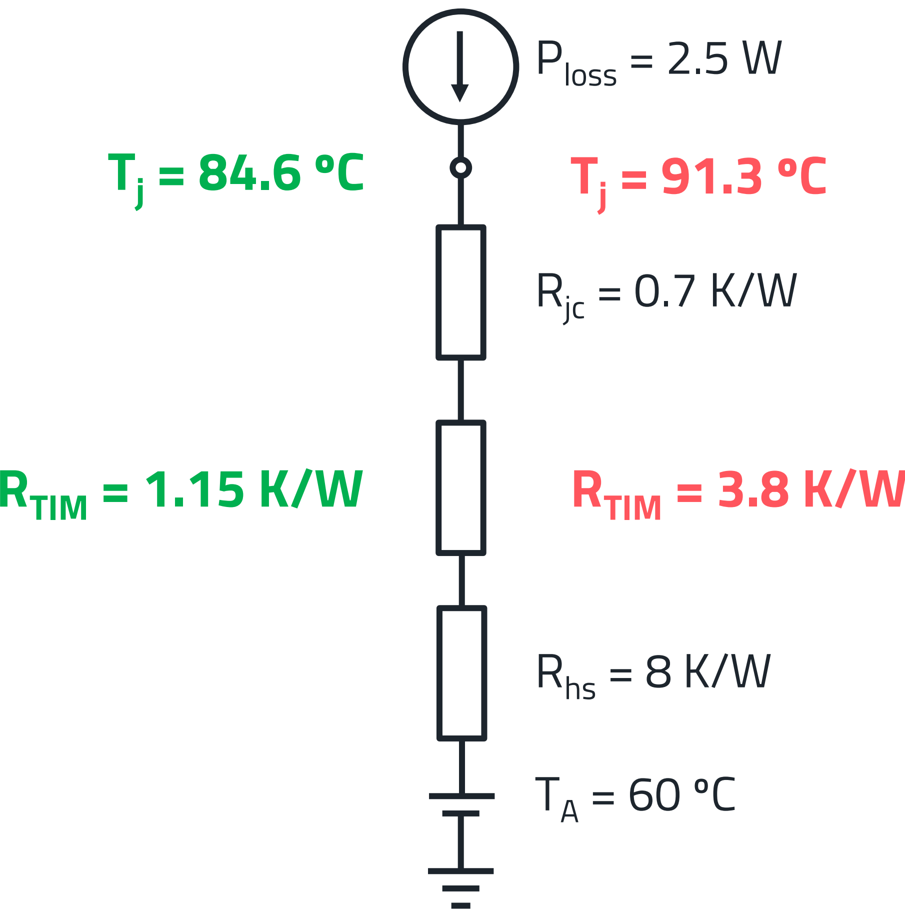


$$T_j = P_{loss} \cdot R_{jA} + T_A$$

$$85ºC = 2.5W \cdot \left(0.7\frac{K}{W} + \boldsymbol{R_{TIM}} + 8\frac{K}{W}\right) + 60ºC$$

$$\boldsymbol{R_{TIM}} \leq 1.3\frac{K}{W}$$

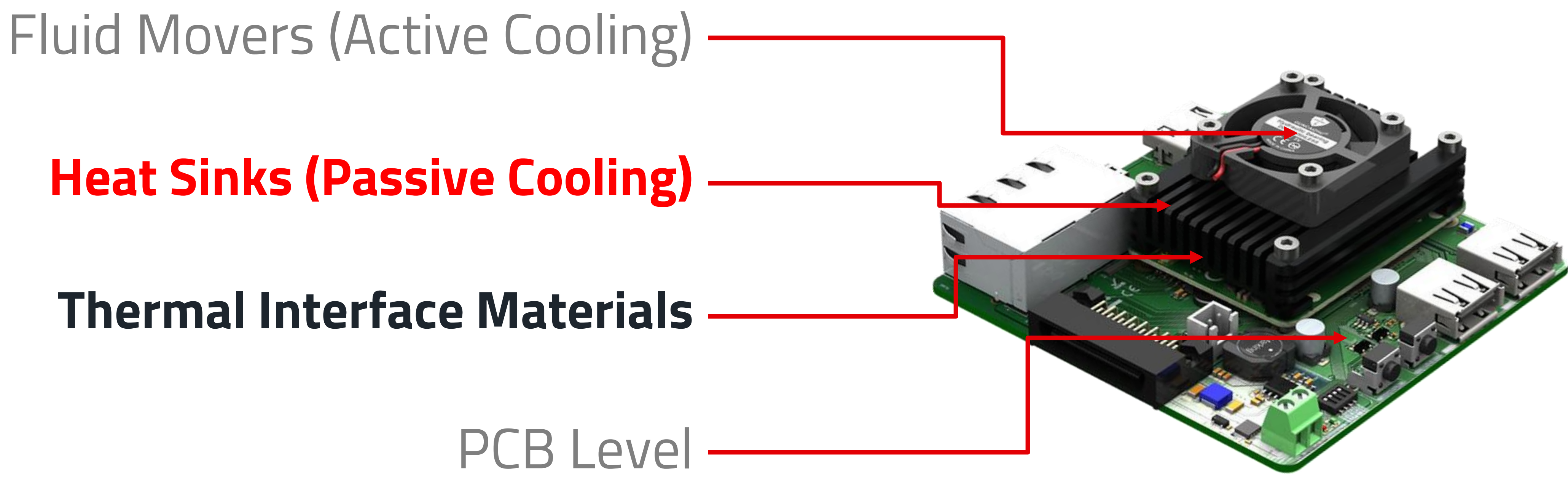
TIM FOR OPTIMAL THERMAL CONDUCTION



OUR PORTFOLIO

THERMAL MANAGEMENT IN ELECTRONIC DESIGN

Stakeholders



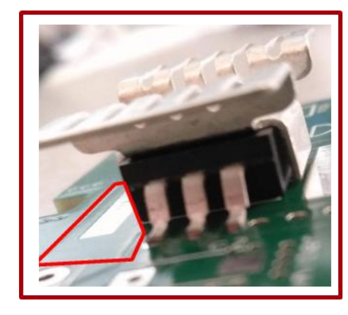
DESIGN CONSIDERATIONS

Material/Design

- Design

Screw on component

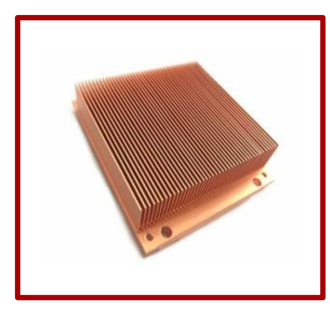
With heatpipes



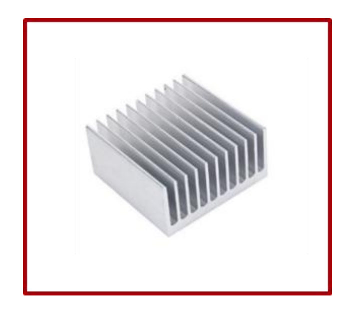
SMD

Free style

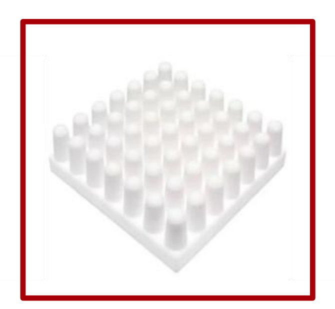
- Material



Copper



Aluminium



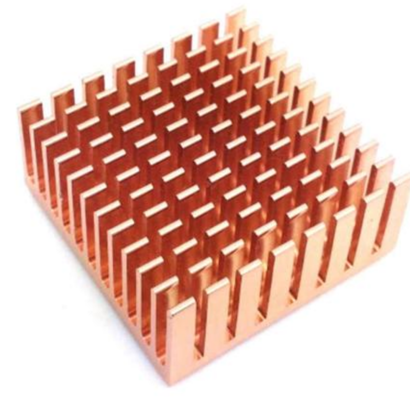
Ceramic

Plastic

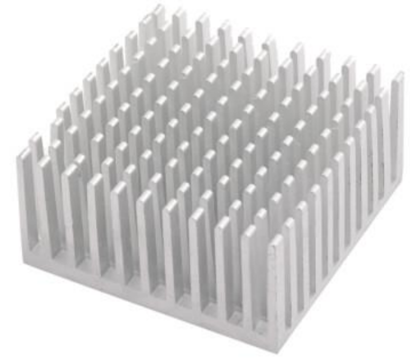
Graphite, anonized materials…

MATERIAL CHOICE

- Copper
  - Thermal conductivity: 401 W/mK
  - Density: 8,96 g/cm3
  - Price: €€€



- Aluminum
  - Thermal conductivity: 237 W/mK
  - Density: 2,7 g/cm3
  - Price: €



OUR PORTFOLIO: OVERVIEW

Thermal Management

Please select product family

OUR PORTFOLIO: OVERVIEW

Thermal Management

Please select product family

WE-HTO

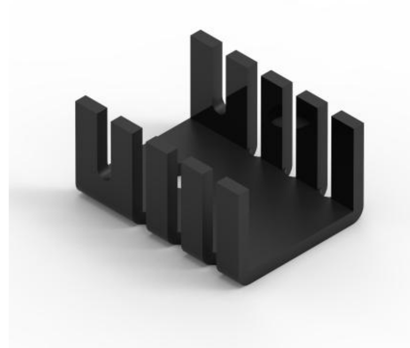
WE-HIC

WE-HTOI/WE-HICI

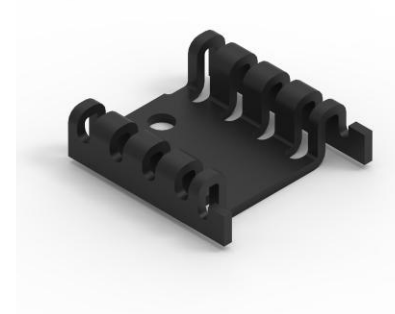
WE-HTO

TO Applications

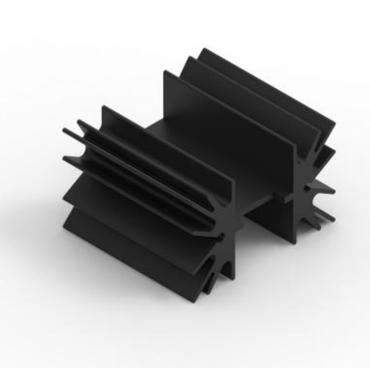
Simple topology



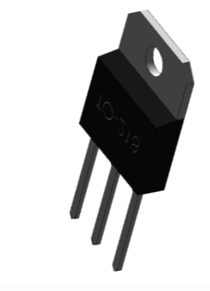
Curved topology



Extruded for TO



Clip on



WE - HTO

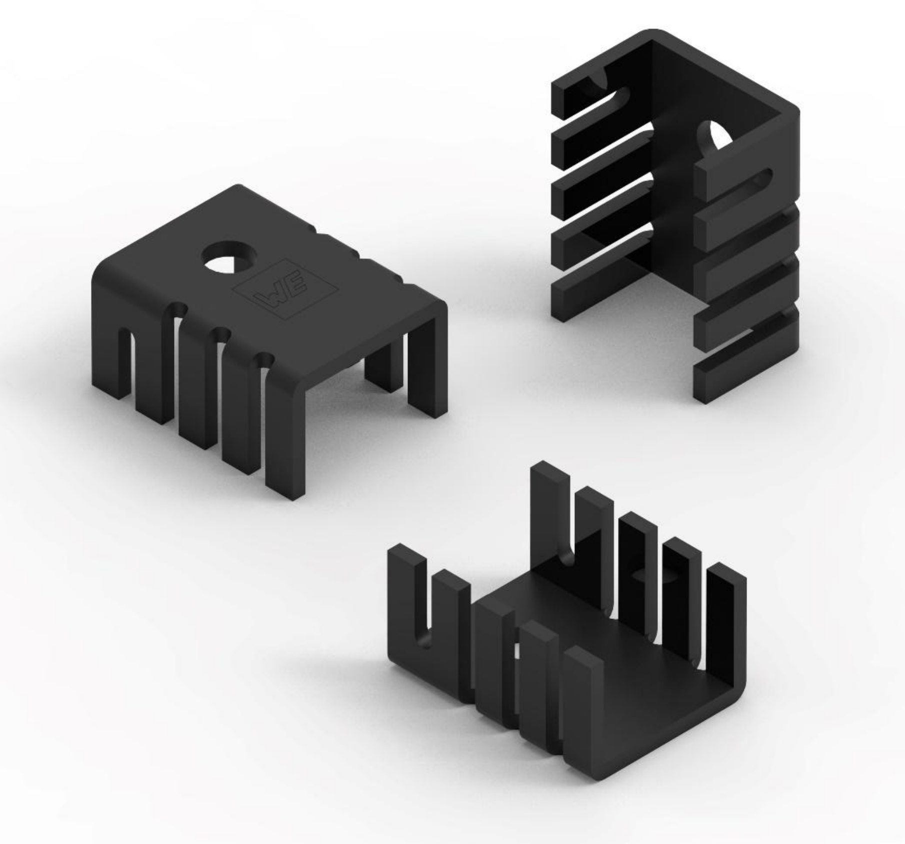
Clip on

- Clipon heatsink
  - Attachment method: Clip to the component
    - No attachment to PCB
    - No screw on the component
  - **Advantages**
    - Saving space and money
      - No screw needed
      - Easy to place
    - Can be included without taking into consideration in the layout design of PCB

WE - HTO

Simple topology

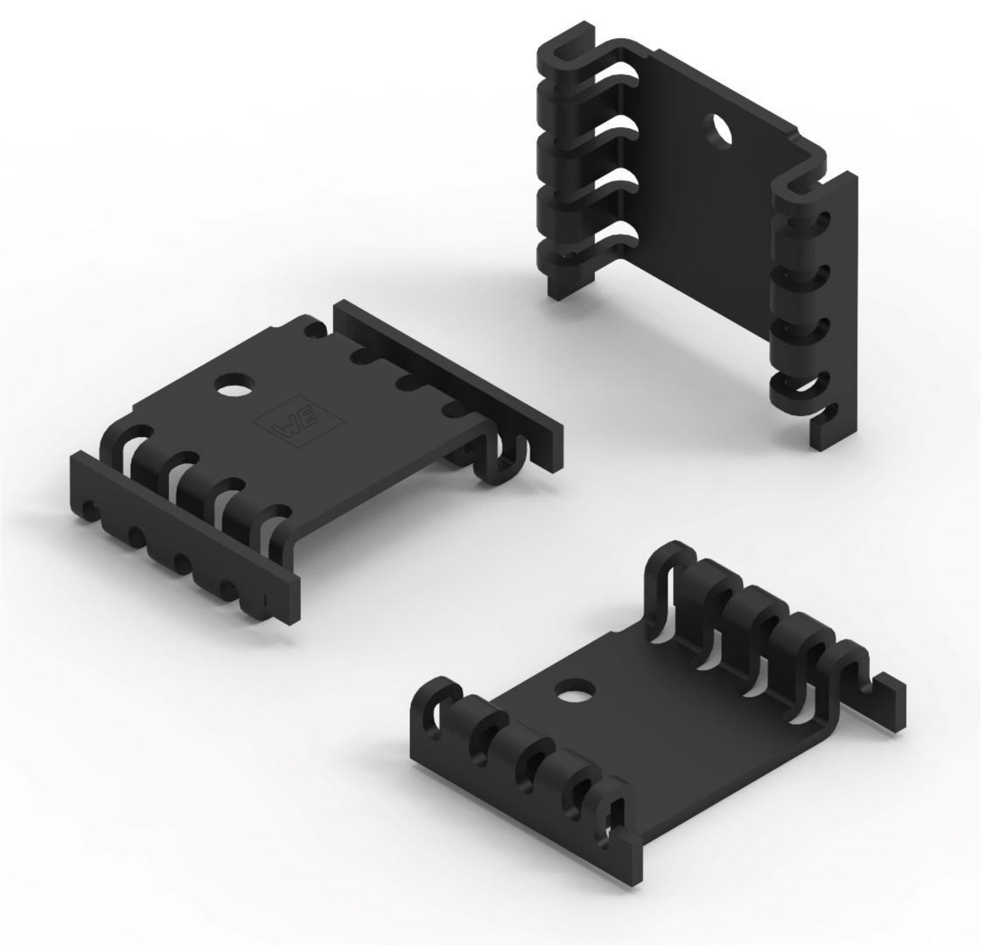
- Straight heatsink
  - Attachment method: Screw to the component
    - No attachment to PCB
  - **Advantages**
    - Light weight
    - Low volume
    - Can be included without taking into consideration in the layout design of PCB



WE - HTO

Curved topology

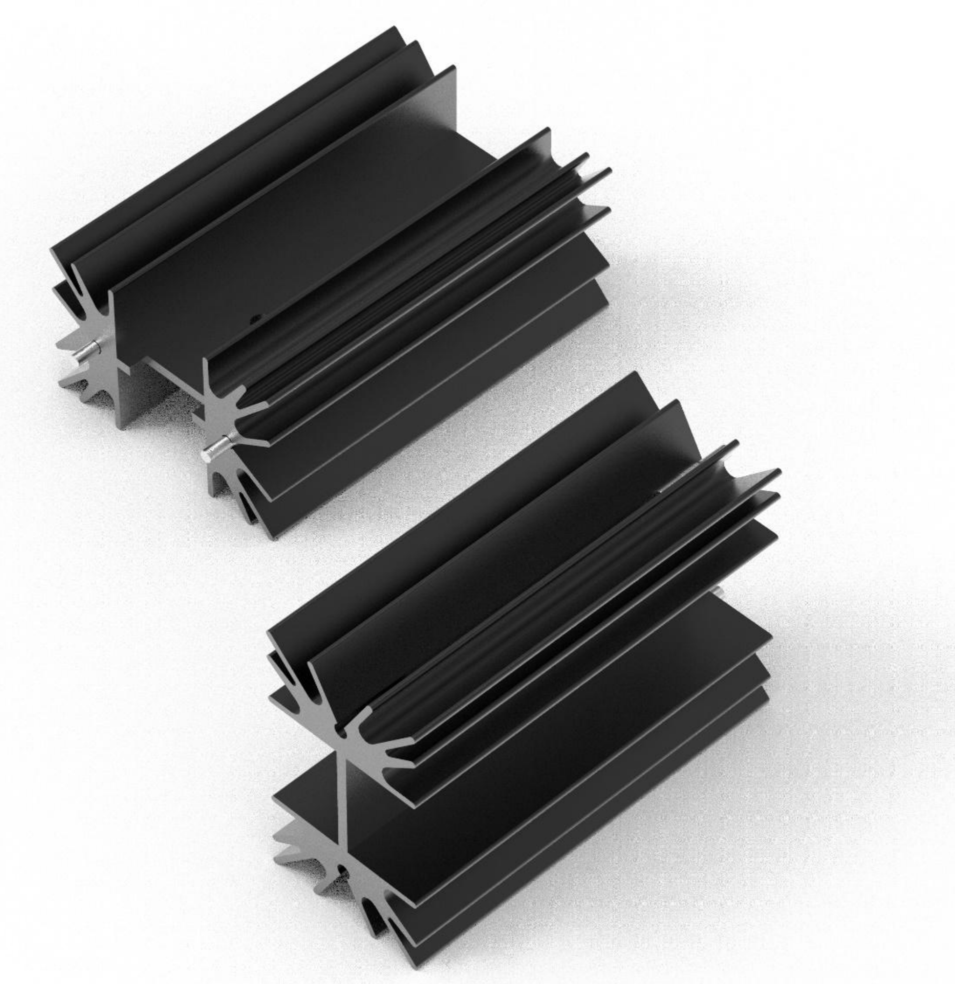
- Curved heatsink
  - Attachment method: Screw to the component
    - No attachment to PCB
  - **Advantages**
    - Optimal topology: for similar volume the performance is better that simple design
    - Can be included without taking into consideration in the layout design of PCB



WE - HTO

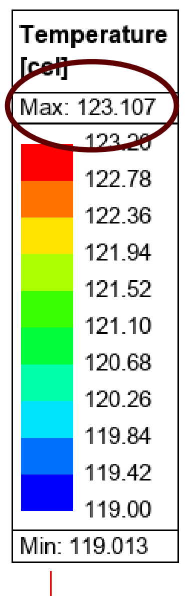
Extruded TO - XXX

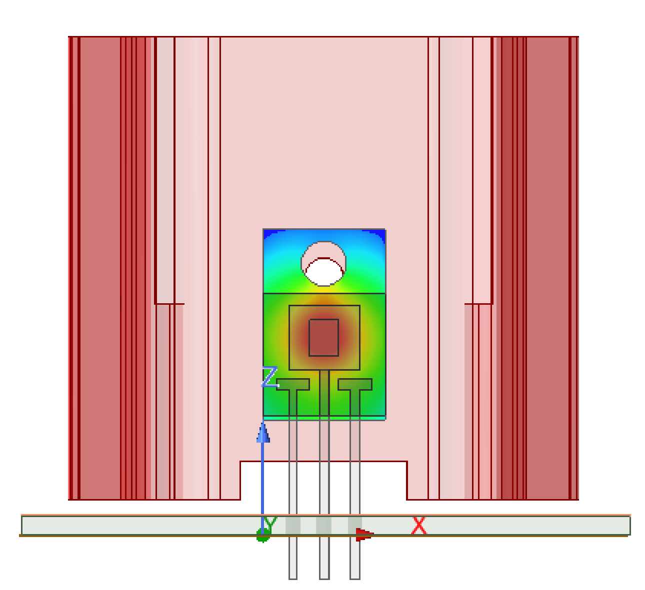
- Extruded for TO heatsink
  - Attachment method: Screw on component
    - Screw or solder to PCB
  - **Advantages**
    - Better performance than stamped heatsinks (but needs more space)
    - Focus on high power demanding applications

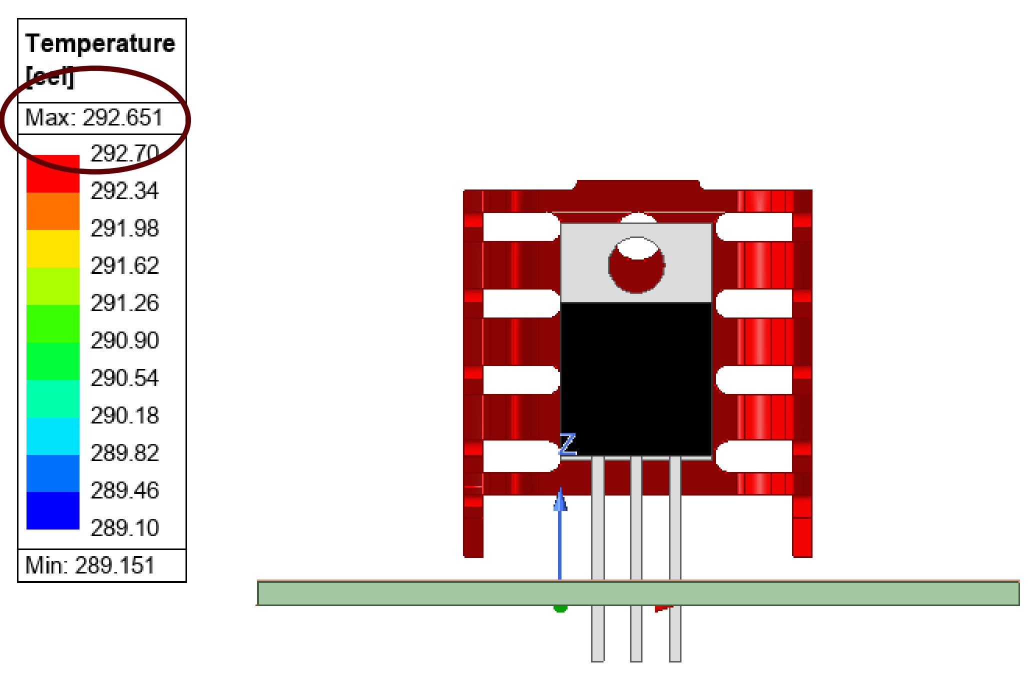


SIMULATION PERFORMANCE

Curved topology	Extruded TO-XXX
Power: 10W	Power: 10W
Max temp: 292.65 °C	Max temp: 123.11 °C







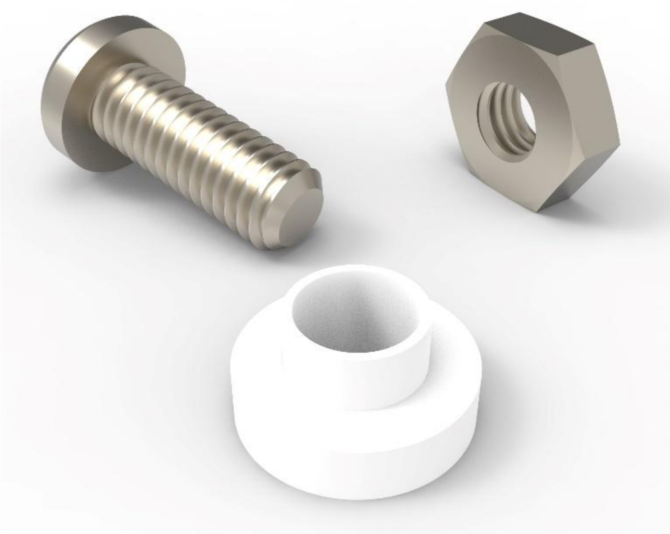
SIMULATION PERFORMANCE

Comparison table

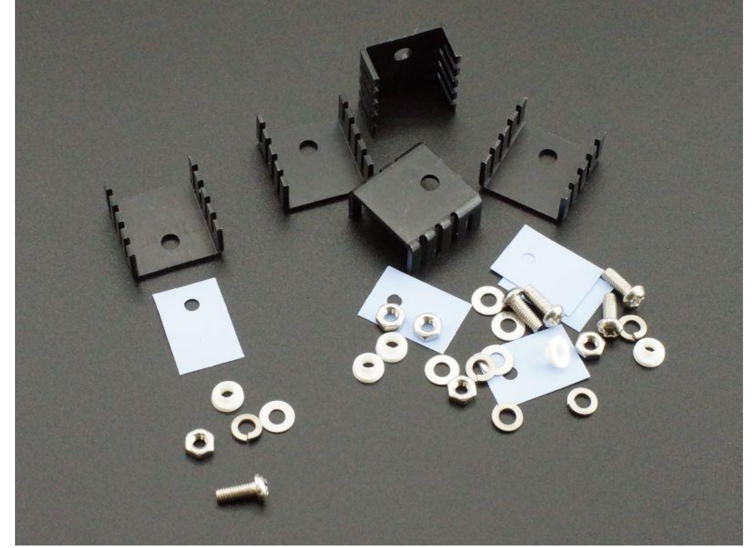
		1 W	5 W	10 W
	TO220	80,80	276,1	498,95
	Extruded ext.	57,25	68,60	76,20
	Extruded	31,35	79,80	121,9
	Curved ext.	49,58	141,19	244,45
	Curved	51,56	165,70	294,3
	Simple ext.	61,30	176	298,6
	Simple	63,95	191,7	328,2

WE-HTO MOUNTING PROCESS

Insulating Bushing + Screw + Nut + TIM



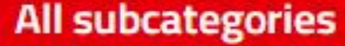
WE offer a complete solution: Insulating Washer (4103000), Screw (4101000), Nut (4102000) and TIM adapted to the shape of the heatsink (WE-HICI)



OUR PORTFOLIO: OVERVIEW

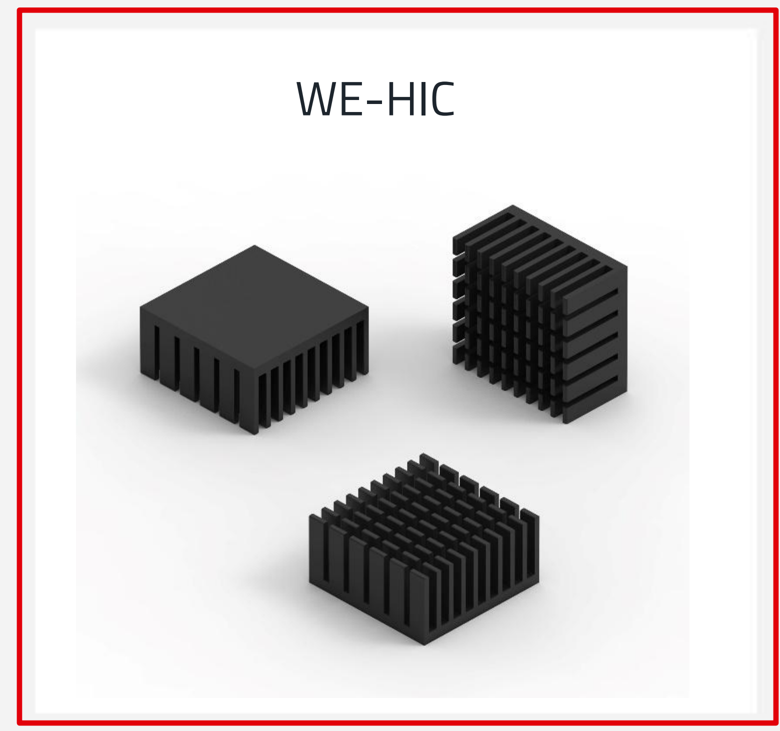
Thermal Management

Please select product family



WE-HTO

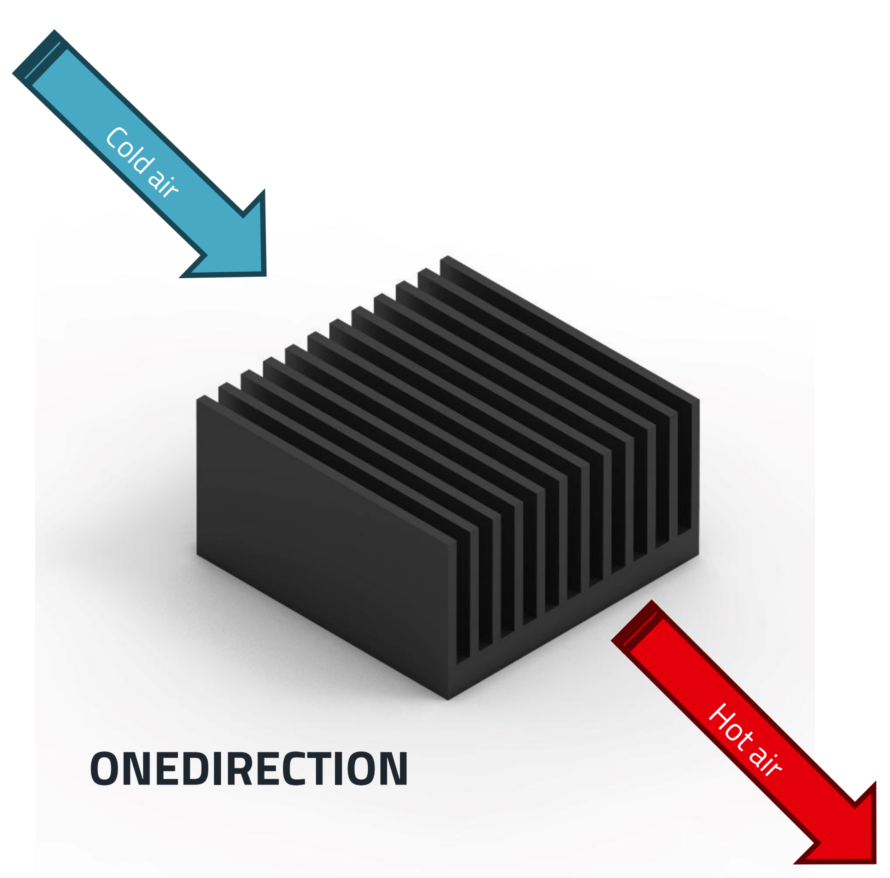
WE-HIC

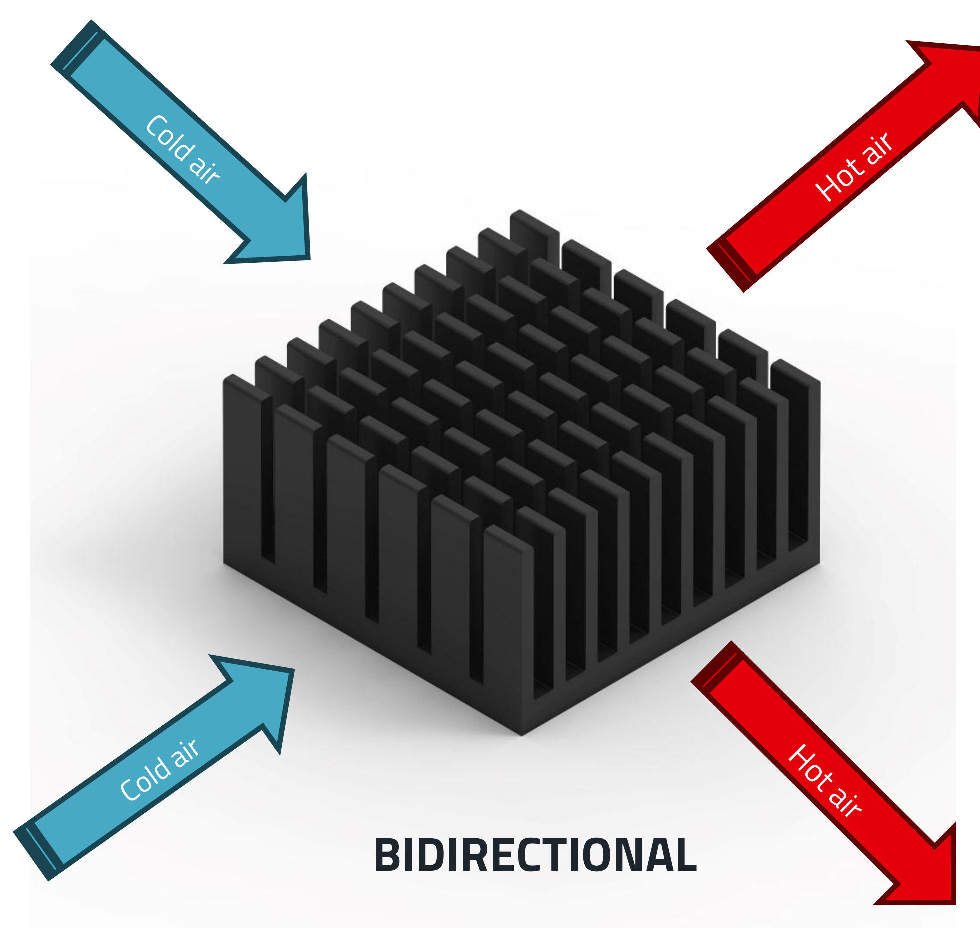


WE-HTOI/WE-HICI

WE-HIC

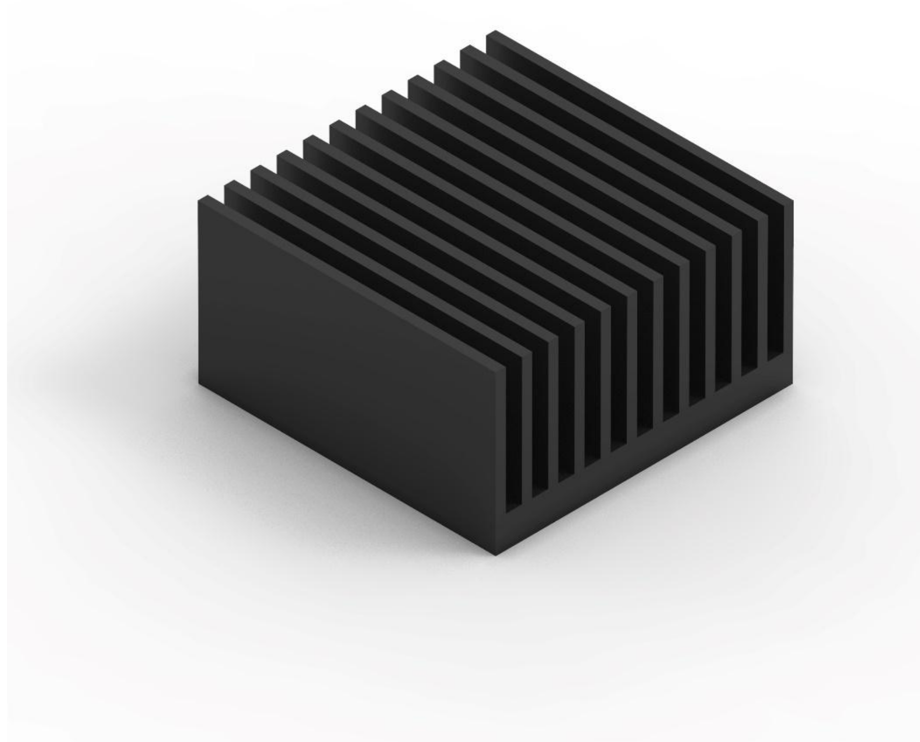
Heatsinks for IC





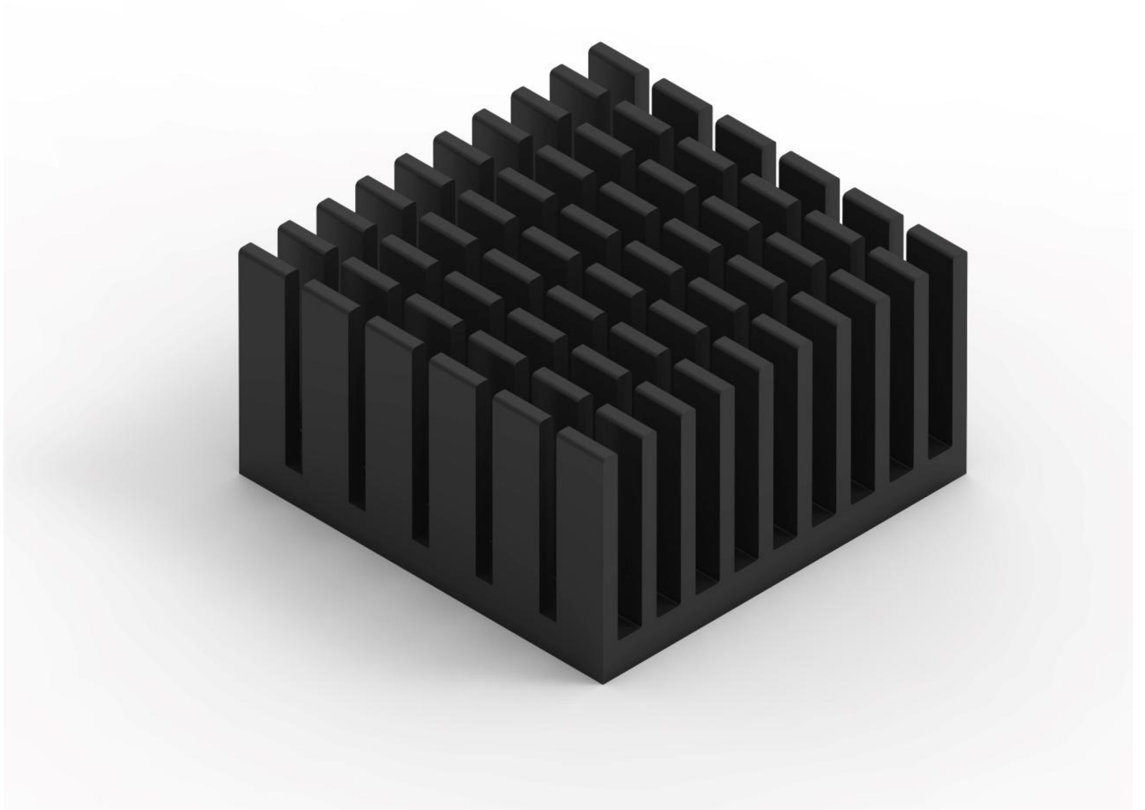
IC ONEDIRECTION HEATSINK

- Fin Heatsink
  - Attachment method: Thermal Adhesive
    - No attachment to PCB
    - No screw on the component
  - **Advantages**
    - Optimal for force convection designs
    - Size adapted to main applications

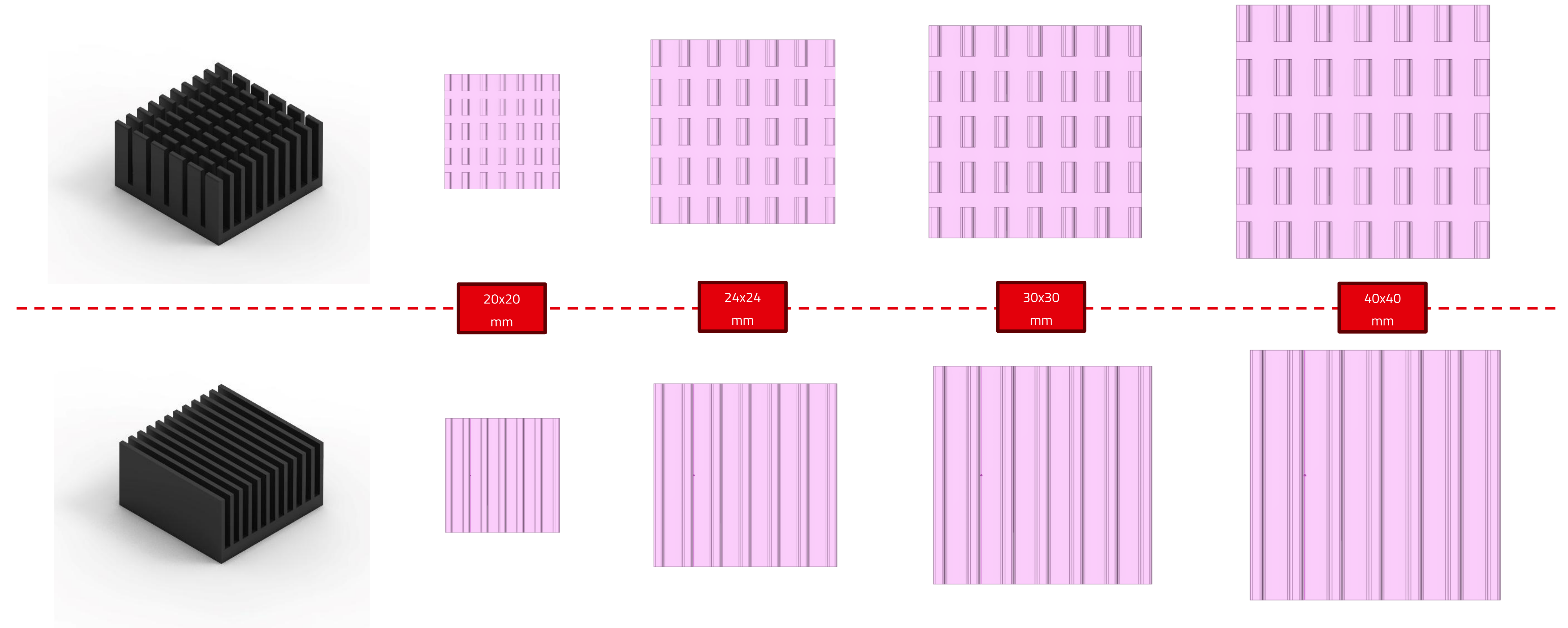


IC BIDIRECTIONAL HEATSINK

- Bidirectional Heatsink
  - Attachment method: Thermal Adhesive
    - No attachment to PCB
    - No screw on the component
  - **Advantages**
    - More versatile: No air direction needed
    - Size adapted to main applications



SUMMARY: HEATSINK SIZES



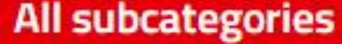
IC HEATSINKS: APPLICATIONS

- Four sizes focus on these applications:
  - DC/DC converter
  - CPU
  - BGA
  - Raspberry Pi
  - RF components

LETS TAKE A BREAK TO TALK ABOUT ANODIZATION!

Thermal Management

Please select product family



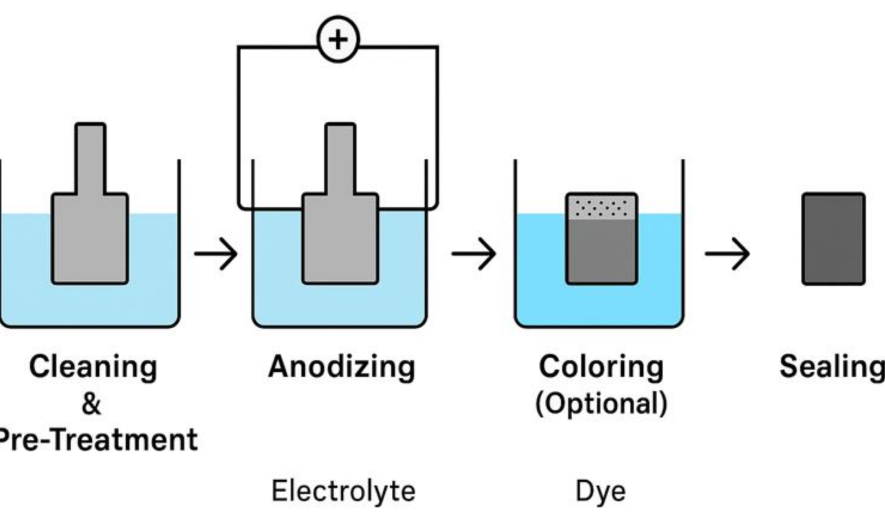
WE-HTO

WE-HIC

WE-HTOI/WE-HICI

ANODIZING TECHNIQUE

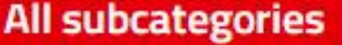
Anodizing is an **electrochemical process** that transforms the outer surface of aluminum into a durable, corrosion-resistant, porous layer of **aluminum oxide (Al_2O_3)**. Unlike paint or plating, this oxide layer is not just on top — it's grown *from the metal itself* and is integral to the part.



OUR PORTFOLIO: OVERVIEW

Thermal Management

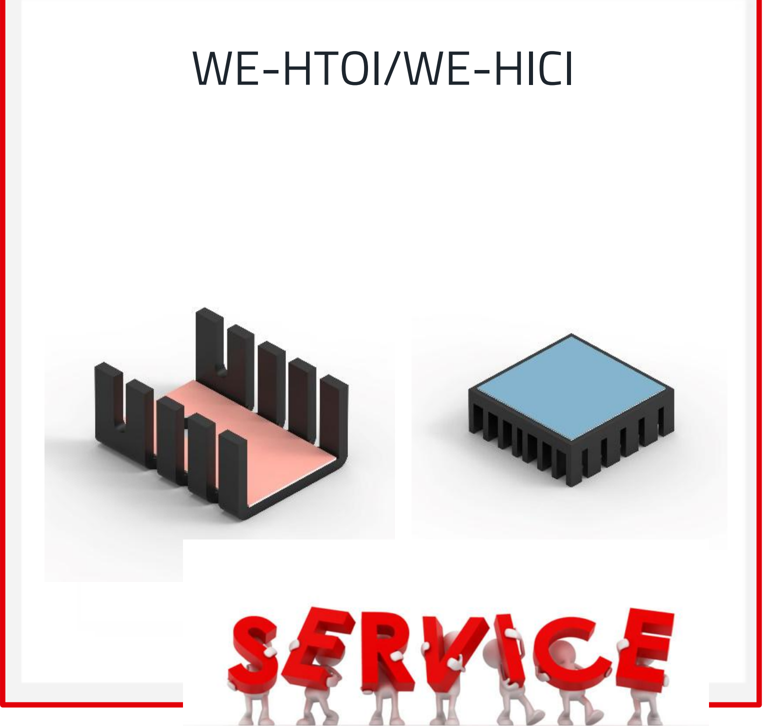
Please select product family



WE-HTO

WE-HIC

WE-HTOI/WE-HICI

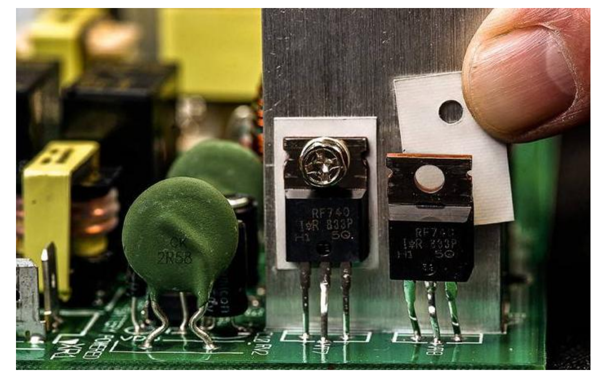


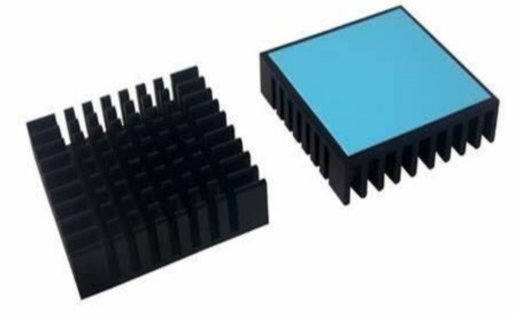
WE – HICI/WE - HTOI

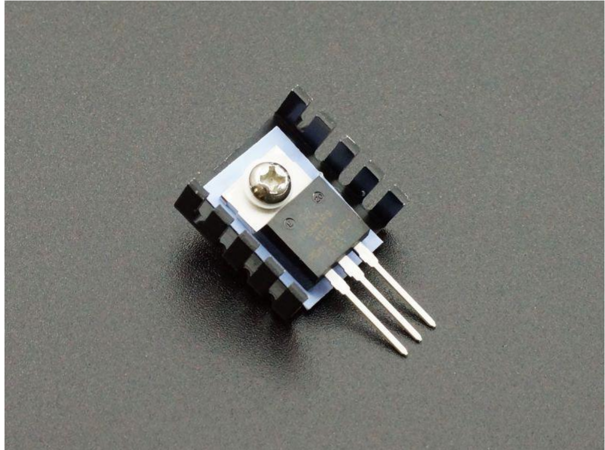
It's about the service

To guarantee **an optimal performance**, we should enhance the best contact between the component and heatsink.

This we achieve it with our thermal interface materials.





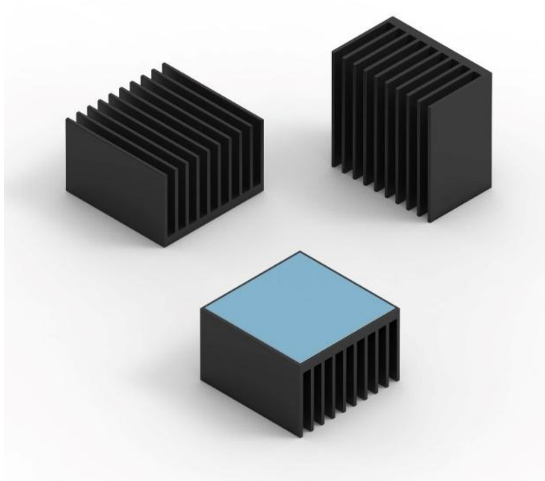


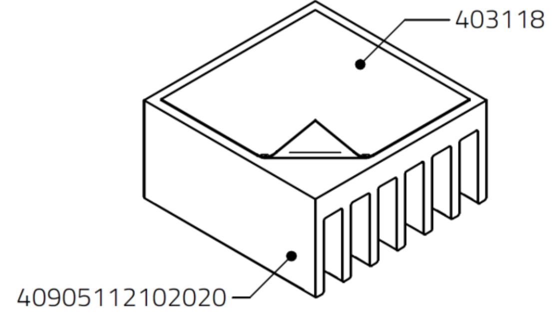
WE-HICI

TIM + Heatsink

- WE-TTT will be pre applied on the heatsink helping with:
  - Lowering thermal resistance between component and heatsink
  - Helping with mechanical adhesion

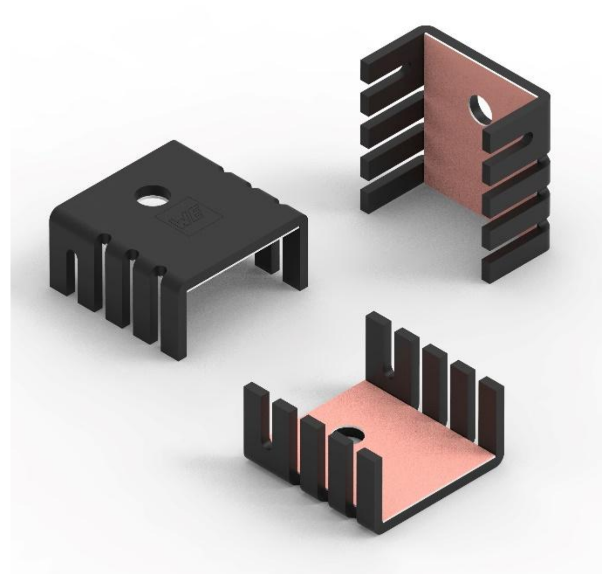
- TIM will be offered:
  - Pre-applied on the heatsink
  - As a standard PN separated from heatsink



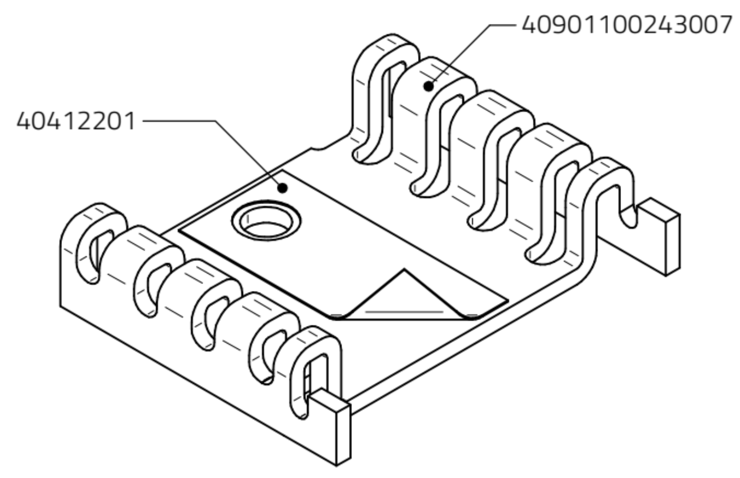


WE-HTOI

TIM + Heatsink



- WE-TINS will be pre applied on the heatsink helping with:
  - Lowering thermal resistance between component and heatsink
  - Insulating heatsink from component



- TIM will be offered:
  - Pre-applied on the heatsink
  - As a standard PN separated from heatsink

OUR PORTFOLIO: OVERVIEW

Thermal Management

Please select product family

WE-HTO

WE-HIC

WE-HTOI/WE-HICI

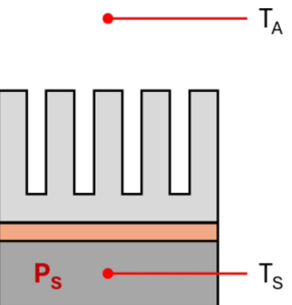
MORE THAN YOU EXPECT

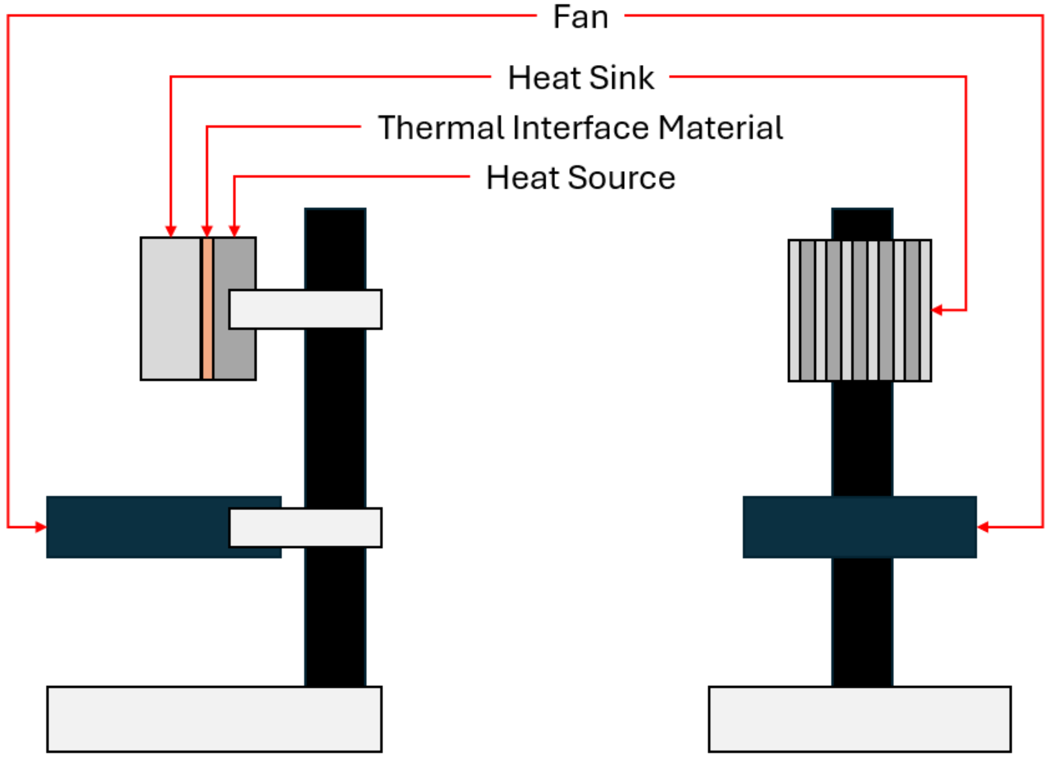
Some extra information

THERMAL CHARACTERIZATION

More than you Expect

- We measure:
  - Power output heat source
  - Source temperature
  - Ambient temperature
- We calculate:
  - Thermal resistance





HEATSINK GUIDELINE

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

SUPPORT NOTE

SN035 | Information on Heatsinks
WE-HTO & WE-HIC

Maria Cuesta-Martin, Sebastian Mirasol

1. INTRODUCTION AND THEORETICAL BACKGROUND

Thermal management is a critical aspect of electronic design, directly impacting performance, reliability, and longevity. This guideline serves as a practical resource for engineers and designers who need to select and design-in the WE-HTO, WE-HTOI, WE-HIC and WE-HICI series heatsinks in different use-case scenarios.

Electronic components such as processors, power transistors, and LEDs generate heat during operation. If not properly dissipated, excessive heat can lead to:

3. Radiation: Plays a minor role, contributing <10% of heat dissipation in most scenarios, though surface treatments (e.g., anodization) can enhance radiative cooling.

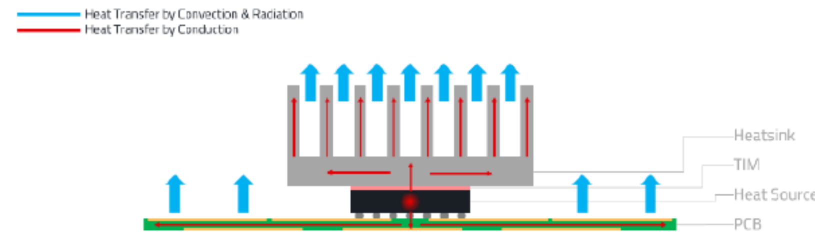


Figure 1: Heat transfer inside a heatsink.

2. CHARACTERISTICS & SPECIFICATIONS

HEATSINK SOLUTIONS: THERMAL MANAGEMENT IN OUR ELECTRONICS DEVICES

Maria Cuesta maria.cuesta@we-online.com
EMC Shielding & Thermal Solutions | Product Management

WEBINAR

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT