ASSMANN WSW components thermal management solutions for LED and UV-LED applications

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ASSMANN WSW components

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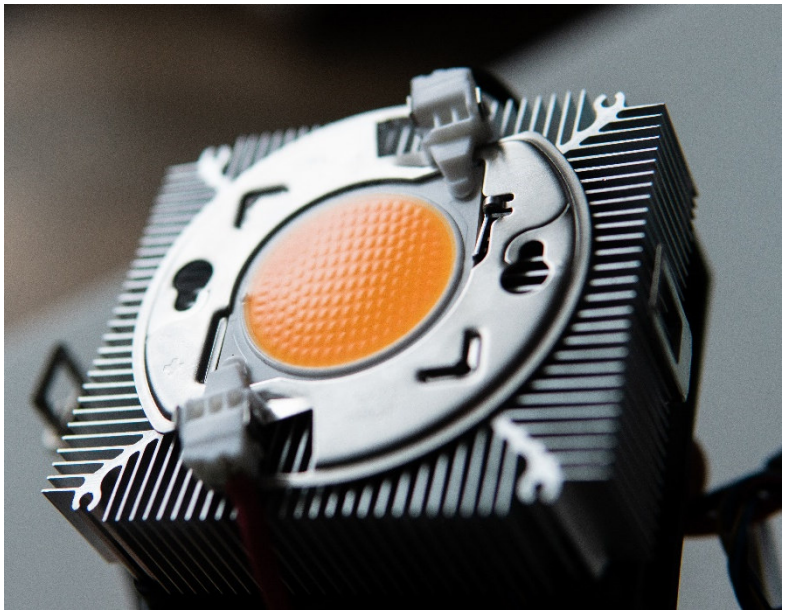
1. Basic knowledge
   1. Power dissipation of LEDs
   2. Key drivers for heat transfer
   3. Characteristics of LEDs
   4. Cooling of LEDs
2. Cooling systems
   1. Profile heat sinks
   2. Pin heat sinks
   3. Stamped heat sinks
   4. Air cooling
   5. Cold plates
3. Conclusion



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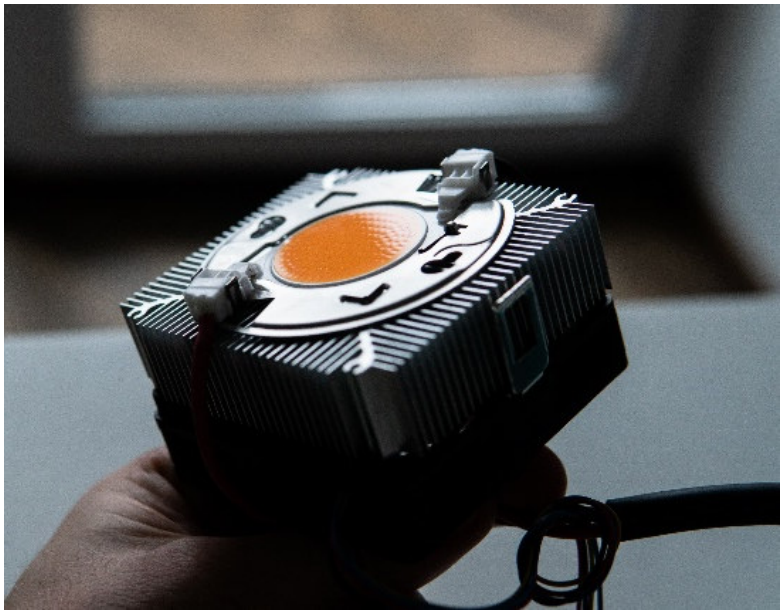

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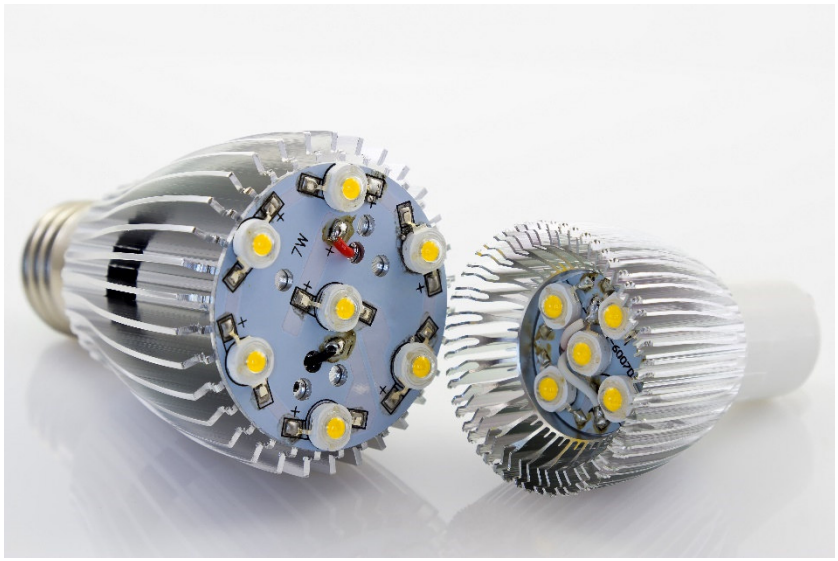
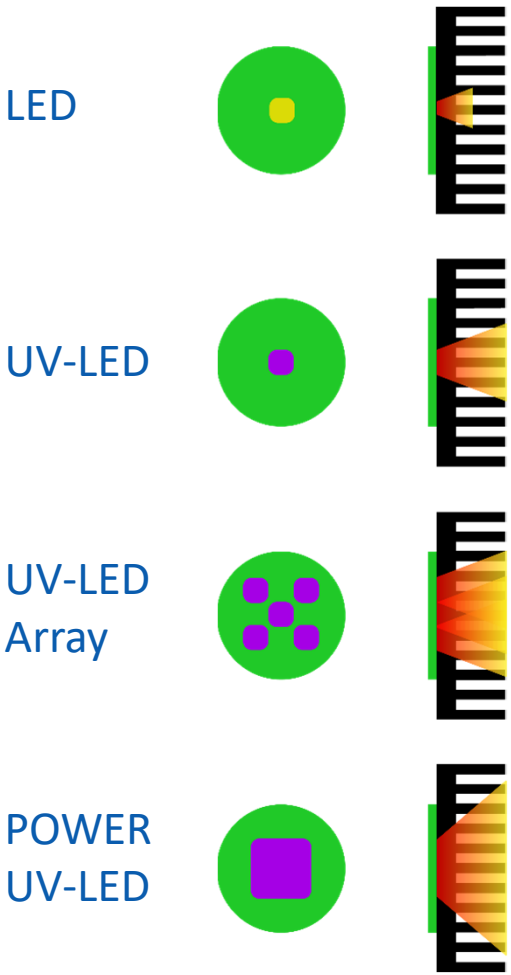


- A LED is a **semiconductor** and causes **power dissipation**.
- The **power dissipation** is converted into **thermal energy** and heats up the LED or chip / array.
- **UV-LEDs** have a **lower efficiency** as other LEDs.
- **UV-LEDs** have a higher power requirement to other LEDs.
- The increased power requirements of **UV LEDs** generate **more heat**.
- For LEDs with higher power requirements, like **UV-LEDs**, the **cooling** concept is even more **important**.

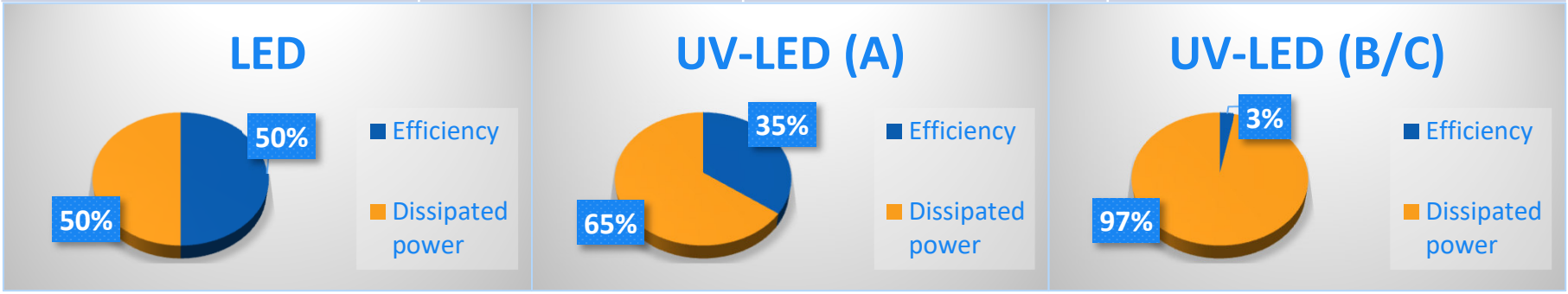
- Contact medium / material
  - Different materials have different thermal conductivities.
  - High thermal conductivity = high cooling capacity of the material
- Contact surface
  - Size
  - Concave / convex
    - ✓ As little unevenness as possible
    - ✓ Usage of thermal paste or foil
- Environment (cases or other heat sources)
  - Air flow & disability
  - Cases with poor natural air flow possibilities can impede the cooling
- Ambient
  - Ambient temperature – additional heat load

Material	Thermal conductivity λ in W/(m · K)
Silver	429
Copper	401
Gold	314
Aluminium	236
Water	0,6
Air	0,003



- LEDs (incl. UV LEDs) have important **specific technical data**:
  - Power
  - Efficiency
  - Operating temperature
- **Quantity** and **power** data of LEDs have significant **influence** on **heat generation** within the application.
- LED **quantity** → **heat densitiy** (more hotspots)
- LED **power** → **high heat load** (e.g., UV-LEDs)
- A LED emits **heat only via the rear surface** – PCB / heat sink - since no heat radiation is generated by the light emitation.

	LED	UV-LED	
Type	White	UV A	UV B / C
Wave length	~ 550 nm	315 ~ 400 nm	UV B: 280 ~ 315 nm UV C: 200 ~ 280 nm
Endurance / lifetime	> 100.000 h	Up to 50.000 h	Up to 10.000 h Up to 20.000 h (SMT)

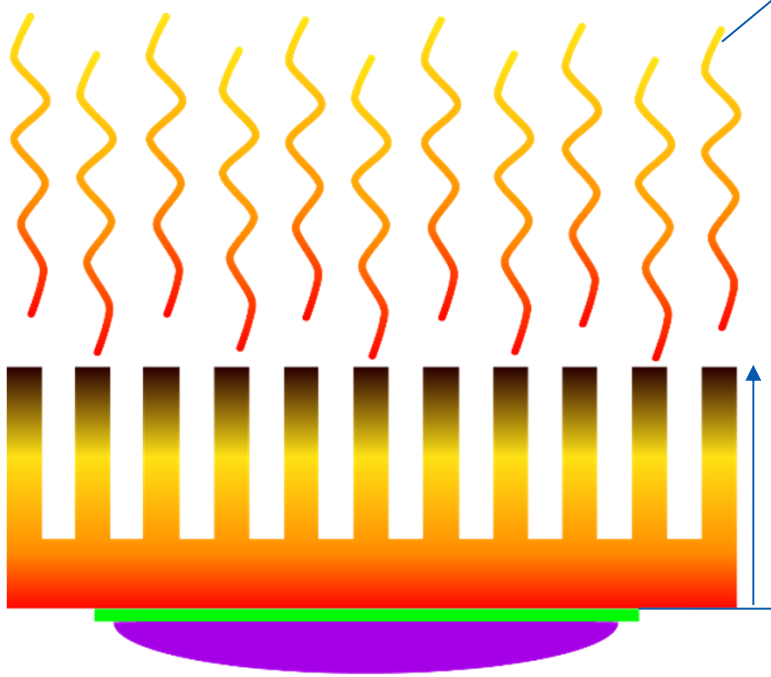


Basic comparison

UV-C radiation is very power intensive and due to the low efficiency, a very high power (P) must be supplied. Therefore, the heat load of the UVC-LEDs is also extremely high.

The generated heat of the UVC-LEDs, based on the power dissipation, is often similar to the power input.

For the heat transfer of LEDs two different ways need to be considered:

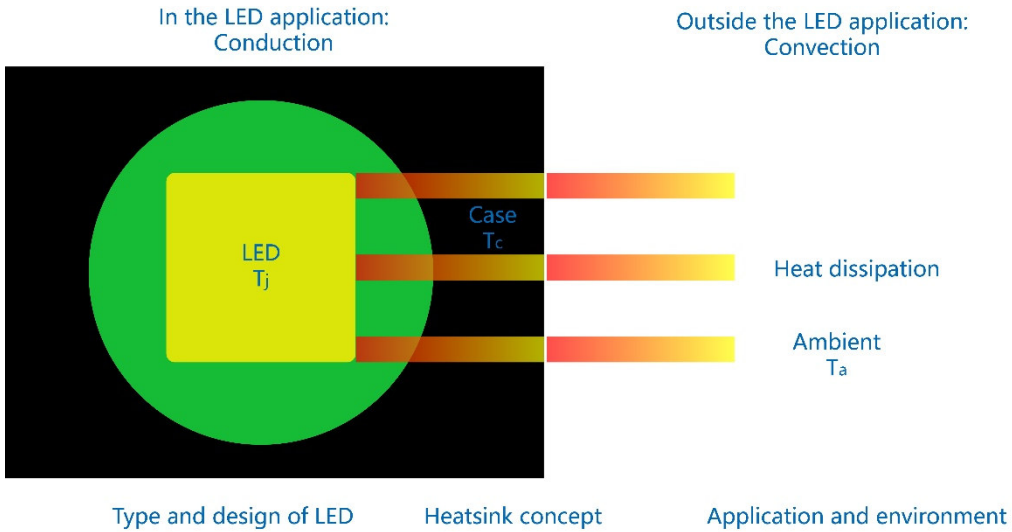


Convection
Transfer of heat through the air

- Passive - natural
- Active - fans or cold plates

Conduction
Transfer of heat trough solid materials (LED / heat sink)

The power of heat sinks are defined in terms of **thermal resistance (Rth).**



Tj = Temperature junction

Tc = Temperature case

Ta = Temperature ambient

Cooling concept

The heat transfer will be influenced by three key criterias:

- Type and design of LED
- Heat sink concept
- Application and environment

Good heat transfer (**conduction**) **through** the **heat sink** is therefore **essential** for LED cooling. Otherwise, the cooling concept would not be sufficient.

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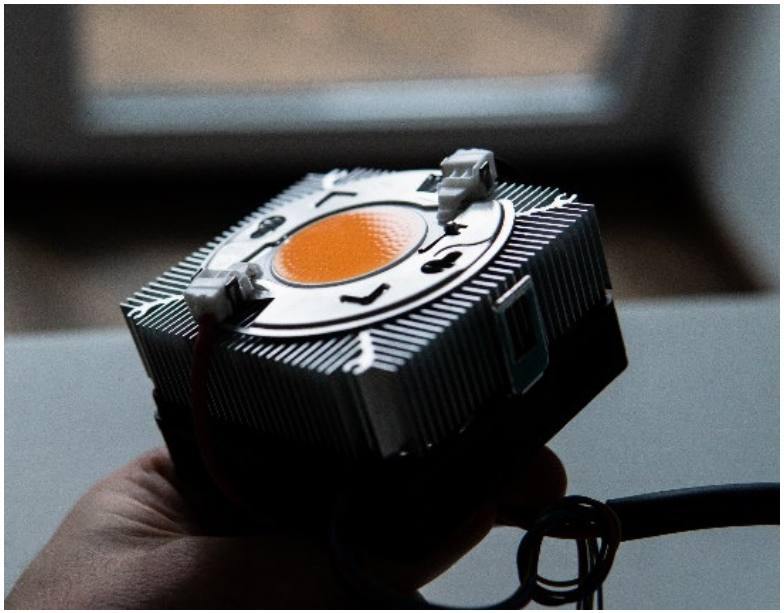

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Most important factors for a suitable cooling concept

LED

- Size
- Quantity
  - ➢ Single / Array
- Power
- Type
- Thermal conditions
  - ➢ Operating temperature

Application

- Case / housing
- Temperature requirements
- Air flow within application
- Space requirements
- Special requirements

➡ The cooling solution can only be selected on the base of the final application.

Cooling solutions

Passive

- Profile heat sinks
- Pin heat sinks
- Stamped heat sinks

Active

- Fans
- Liquid cold plates

Advantages

Passive

- High cooling capacity
- Noiseless
- No vibrations / shocks
- No additional maintenance
- Good for customization

Active

- Very high cooling capacity
- High efficency
- Small space requirements
- Integration into existing cooling solutions

Disadvantages

Passive

- More space needed within application

Active

- Additional maintenance
- Noise & dust possible
- Vibrations or shocks possible

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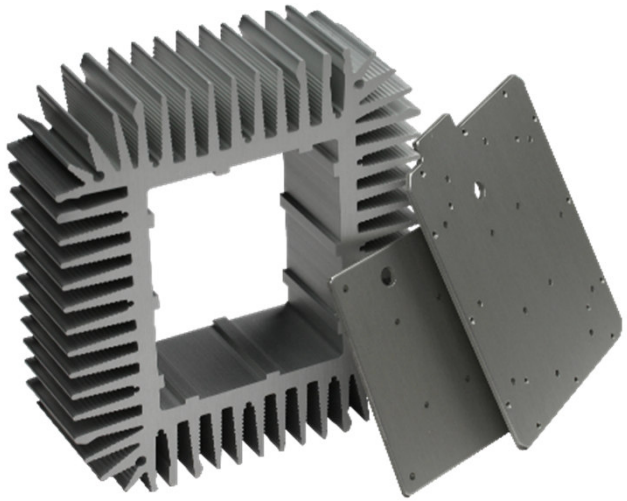
Heat sink characteristics

- Low to high power (dissipation)
- LED & UV-LEDs (A/B/C)
- Cooling capacity depends on profile design



LED street light with IP67

Product capabilities

- Customization
  - According to LED & application
  - Contact area
  - Fluted fins
  - Cross cut
- Design aspects / visible parts
- IP67

Design

- Alignment
  - In airflow
  - Vertical fins ~ 30% better convection (natural)
- Fin design

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Heat sink characteristics

- Low to medium power (dissipation)
- LED & UV-LEDs (A/B)
- Cooling capacity depends on size

Product capabilities

- Customization
  - According to LED & application
  - Contact area
  - Pin number
  - Pin size / length
- Design aspects / visible parts
- Cost-effective

Design

- Alignment
  - Vertical
- Pins
  - Long
  - Narrow

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Heat sink characteristics

- Low to single medium power (dissipation)
- LED & UV-LEDs (A/B-single)
- Cooling capacity depends on design and size

Product capabilities

- Customization
  - According to LED & application
  - Size / design
  - Perforation
  - Contact area
- Less re-radiation
- Cost-effective

Design

- Customized for LED / application
- Fins
  - Separated
  - Narrow

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Heat sink characteristics

- Low to high power (dissipation)
- LED & UV-LEDs (A/B/C)
- Cooling capacity depends on heatsink & fan combination

Product capabilities

- Combination with passive heat sinks
  - Higher cooling capacity
  - Small space
  - Replace big passive heat sinks
- Customization
- Higher convection

Design

- Customized for LED / application
- Airflow
  - Volume / CFM
  - Integration into system

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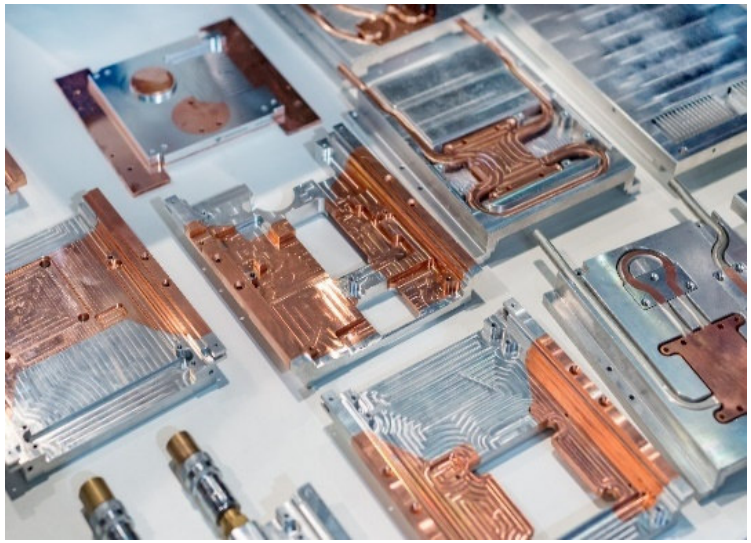
Heat sink characteristics

- Very high power (dissipation)
- LED & UV-LEDs (A/B/C)
- Cooling capacity depends on design



Product capabilities

- Very high cooling capacity
  - ➢ Small space
  - ➢ Replace big passive heat sinks
- Inserted tubes
- Drilled & milled channels
- Milled channels & friction welding

Design

- Always customized for the application
- Coolant depends on application and power dissipation
- Other components can be integrated through cutouts.

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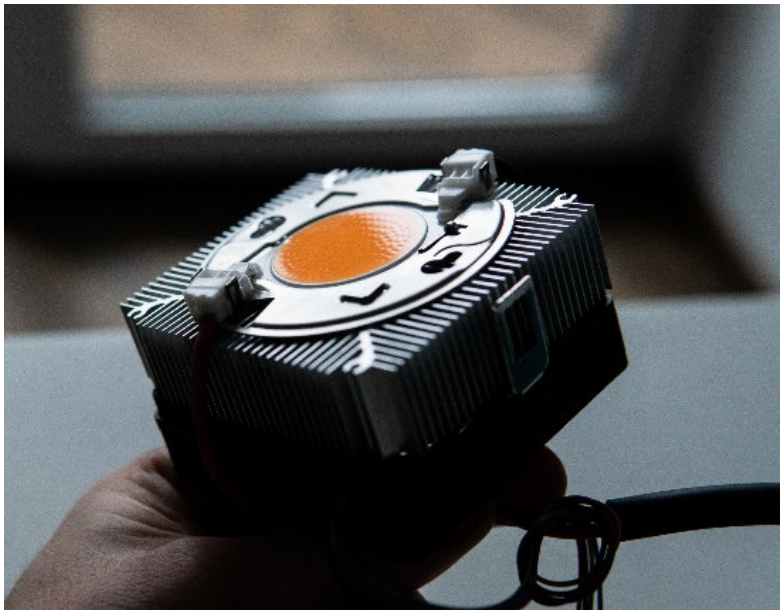

- Every application has specific requirements
  - LED – Power
  - Contact surface
  - Ambient / space
  - Cases & convection possibilities

- The choice of the **cooling solution depends** on the **heat** to be dissipated, the **size** and **number** of **LEDs** used and the **application** itself.

- The **power** and power **density of** the **LEDs** are a **main factor** for the cooling concept.

Successful cooling solutions for UV-LEDs always will be customized according to the specific application.

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Profile heat sinks - UV A / B / C
- High power dissipation
- Convection possibility must be available
- Complex applications

Pin heat sinks - UV A / B
- Medium power dissipation
- Convection possibility must be available
- Simple applications

Stamped heat sinks - UV A / (B)
- Low power dissipation
- Limited space for heat sinks

Air cooling - UV A / B / C
- High power dissipation
- For poor free natural convection
- Limited space for heat sinks

Cold plates - UV A / B / C
- Very high-power dissipation
- Specific applications (e.g., industrial requirements or disinfection)

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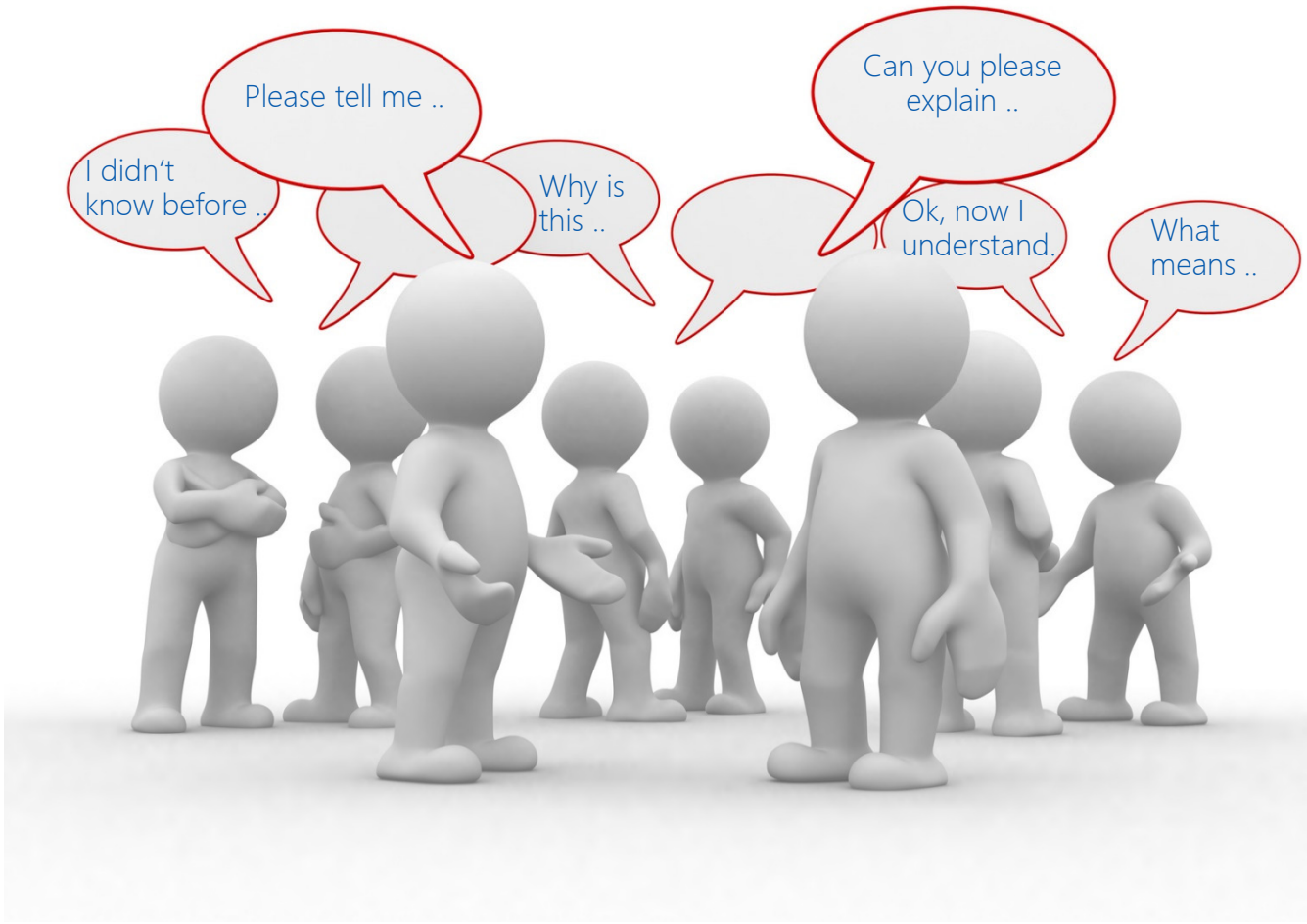

RUTRONIK – TECH TALK

THERMAL MANAGEMENT UV-LEDS

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OPEN QUESTIONS

Patrick Larsen

2021-06-09

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INSPIRE WITH PERFORMANCE

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