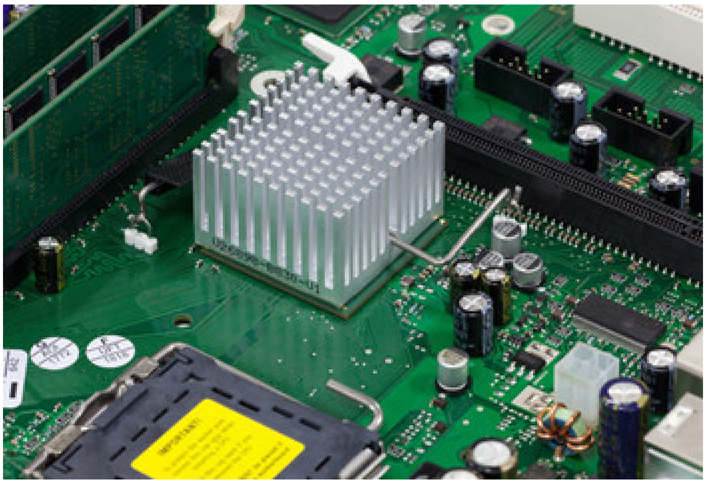
Effective Thermal Management

During use, some electronic components can generate significant amounts of heat. Failure to effectively dissipate this heat away from the component and the device can lead to reliability concerns and reduced operational lifetimes.

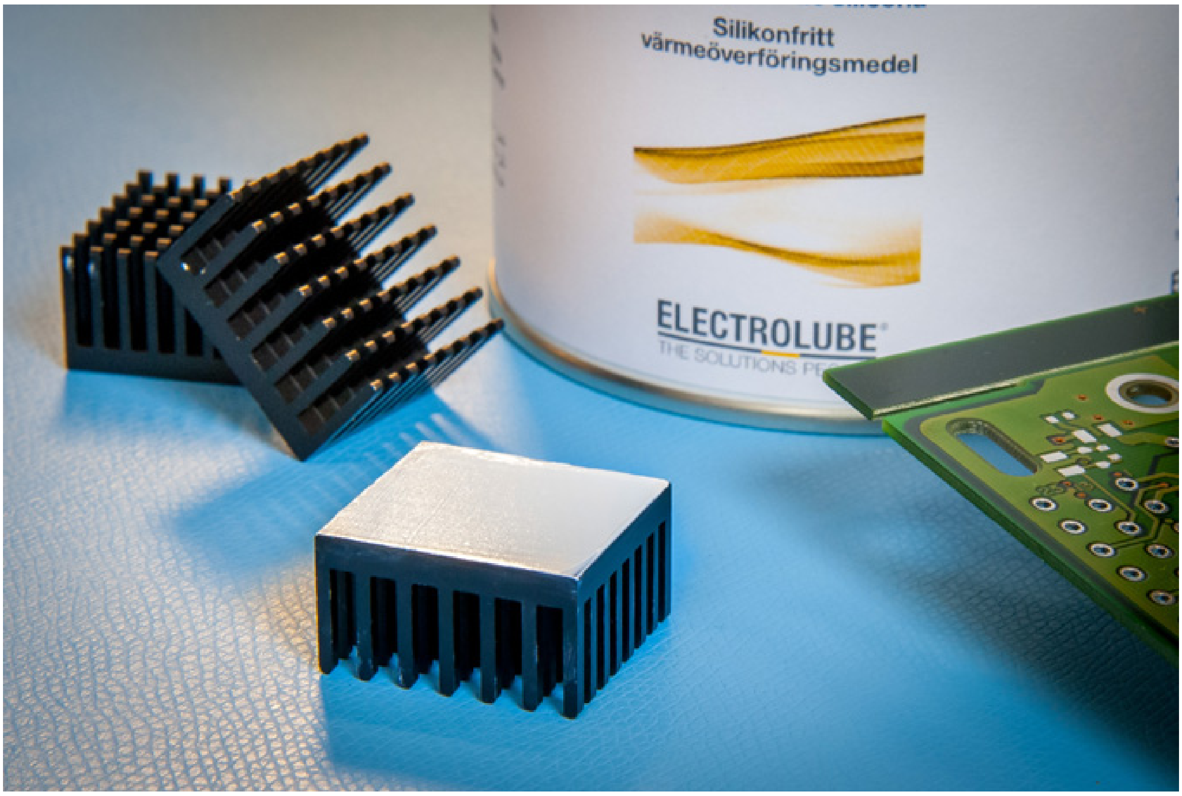


Newton's law of cooling states that the rate of loss of heat is proportional to the temperature difference between the body and its surroundings. Therefore, as the temperature of the component increases and reaches its equilibrium temperature, the rate of heat loss per second will equate to the heat produced per second within the component. This temperature may be high enough to significantly shorten the life of the component or even cause the device to fail. It is in such cases that thermal management measures need to be taken. The same considerations can be applied to a complete circuit or device which incorporates heat producing individual components.

The rate of loss of heat will be higher in a forced draught than still air, so one way of controlling the temperature of a device or circuit is to incorporate a fan or fans to increase the air flow. Even ensuring adequate general ventilation will result in a lower operating temperature than if the circuit is in a confined space with no ventilation slots. One point which can be overlooked is that reduced atmospheric density at high altitudes leads to less effective heat transfer to the surroundings and consequent higher device operating temperatures.

Heat is lost from a component to its surroundings at the surface of the component. The rate of loss of heat will increase with the surface area of the component; a small device producing 10 watts will reach a higher temperature than a similar powered device with a larger surface area. This is where heat sinks are used - varying in size and shape, heat sinks can be designed to offer a significantly increased surface area to maximise heat dissipation. The device and heat-sink are usually solid substrates which are mechanically bolted together. Ideally, the surfaces of these substrates should be perfectly smooth, but this is not usually possible. As a result, air gaps will be present at the interface of the device and the heat-sink, significantly reducing the efficiency of heat transfer.

To remove the air gaps from the interface between the component and the heat sink, heat transfer compounds are utilised. Such compounds are designed to fill the gap between the device and the heat sink and thus reduce the thermal resistance at the boundary between the two. This leads to faster heat loss to the heat sink and a lower operating temperature for the device. Non-curing and curing products are available. Curing products are often used as bonding materials; examples include silicone RTVs or epoxy compounds – the choice will often depend on the bond strength or operating temperature range required.



Thermal interface materials can be in the form of pastes, bonding materials/adhesives or thermally conductive pads. The non-curing pastes, ideal for applications where rework may be required, utilise different base oils to provide a range of desirable properties, such as the wide operating temperature range offered by silicone based products. Recent advancements in non-silicone technologies have seen the introduction of products with significantly reduced oil bleed and evaporation weight loss values whilst increasing the thermal conductivity properties. Such products include Electrolube's HTCX, which utilises proprietary additives to significantly improve the alignment of the thermally conductive particles, thus resulting in enhanced performance overall.

With any thermally conductive material it is very important to ensure that the interface between device and heat sink is completely filled and all air is displaced. This is usually done by a applying a quantity of the compound to the centre of the mating surface of the device or the heat sink, and bringing the two together, displacing any excess material. Ensuring all air is excluded from the interface leads to a lower thermal resistance and lower device operating temperature. The thermally conductive heat transfer compound will have a lower thermal conductivity than the heat sink material, so keeping the thickness of the film at the interface as low as possible will decrease the thermal resistance and in turn lower the operating temperature. It is important however to ensure that the lower film thickness does not result in air gaps in the film.

Another option for managing the transfer of heat away from electronic devices is to utilise a thermally conductive encapsulation resin. These products are designed to offer protection of the unit from environmental attack whilst allow heat generated within the device to be dissipated to its surroundings. Encapsulation resins also incorporate the use of thermally conductive fillers however the base resin, hardener and other additives used can be altered to provide a wide range of options:

- Epoxy-based systems provide a high level of protection in harsh environments and cure to a tough, rigid product. A thermally conductive epoxy will typically have a Shore Hardness value around D80. Look out for Electrolube's new epoxy resin ER2220; providing an enhanced thermal conductivity value of 1.54 W/mK, without increasing viscosity.
- Polyurethane-based systems also provide excellent protection in a variety of difficult conditions, however they also combine the flexibility achievable with polyurethane materials and as a result, their Shore Hardness values can be adjusted to suit the required application properties. Typically, a thermally conductive polyurethane will be around A85, within the softer Shore Hardness scale.
- Silicone-based systems combine the flexibility of a polyurethane with the high temperature properties of a silicone material, making them ideal for use in applications where operating temperatures may exceed 130˚C.

With applications requiring thermal management products on the increase, Electrolube continue to develop solutions for an array of industries, including the LED market. LEDs are replacing more traditional lighting methods in applications such as LCD TV backlights, electronic signs and displays and automotive lighting. The heat generated by the LEDs needs to be removed, just like a CPU, to ensure optimal performance.

Thermal management products are also offering solutions for greater efficiency in green energy development; photovoltaic inverters - which are known to be particularly sensitive to temperature;

connections between the heat-pipe and water storage tank for solar-heating applications; hydrogen fuel cells; wind power generators, are just a few examples. The ongoing trend for product miniaturisation - coupled with more modern, higher powered devices - has ensured that efficient thermal management is an essential part of both modern and future electronics design. Working alongside customers to develop optimum products, Electrolube offer thermal management solutions anywhere where heat dissipation is required and continue to expand the range of options available.

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