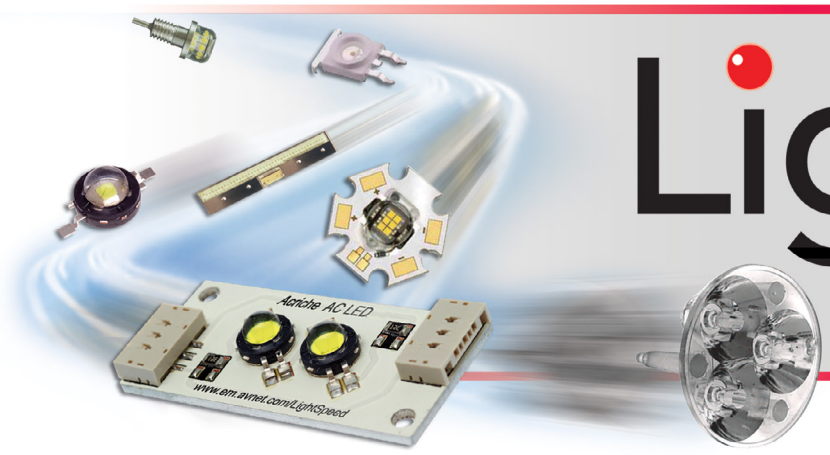


# Light Matters

## Designing illumination systems with high-brightness LEDs

**A "really cool" product for high-power LED applications** has been introduced by ebm-papst, one of the most innovative manufacturers of precision fans and blowers that I've come across. Their Active Cooling products are interesting to me because they engineered these small, specialized fan/heatsinks expressly for LEDs.

As you're probably aware if you've used high-power LEDs or read earlier Light Matters columns, thermal management is the single largest hurdle for the majority of solid state lighting applications. We need to minimize the LED's junction temperature (Tj). This is the operating temperature of the device's p-n junction, the central point of its light generation. Since "white" LEDs only convert current into visible wavelengths, negligible excess energy can escape in the form of infra-red. Heat stays trapped inside the LED die. With small LEDs this isn't an issue, but with larger devices, such as those used for lighting, it's a primary failure mechanism. The typical Tj inside a fixture exceeds 70 °C, and temperatures over 100 °C are possible. As the temperature rises, an LED's light output is reduced, and at some point its remaining lifetime drops nearly exponentially.

If you visit the Avnet LightSpeed homepage at **www.em.avnet.com/LightSpeed** you'll find a number of past columns on this "hot" topic, including a few simple methods to calculate the size of the heatsink. It boils down to this- as the light generated from a smaller area increases, the physical size, weight and cost of the necessary passive heatsink scales up dramatically.

Another option is to use "active" cooling, forcing a stream of air across the surface area of a heatsink. The most efficient way to move air is with a fan. True, there are a few novel non-motorized alternatives that generate "microjets" of air, but they are no match to the thermal requirement of today's high-performance LEDs- especially the type known as "Chip-on-Board" (CoB). CoBs are the fastest-growing package style for lighting; they are arrays of small die placed together under a single phosphor pour.

Based on the efficiency and low cost of fans, why haven't we seen more of them in LED lighting? The answer is simple. A common fan has drawbacks. Its lifetime might be in the tens of thousands of hours (less at operating temperature), which is a problem when the LED is specified to operate for 50,000 hours or longer. Many are noisy, not suitable for quiet locations. Finally, there is the concern about dust entering the bearing.

I've analyzed many LED cooling technologies; few have truly addressed the unique requirements of LED systems, or are unreasonably complicated and expensive. Now ebm-papst has stepped forward with a better solution.

To start with, their Active Coolers have a rated service life in the *hundreds of thousands of hours* (> 300K with certain models). Secondly, although the fan was designed to be nearly silent, it's enclosed in an acoustic isolation ring, bringing the net acoustic noise to less than 7dB. (The background noise in a quiet office is about 40 dB). Even the warranty is impressive- 5 years- which exceeds most CoBs.

Assembling a high-performance, long-lasting, compact, quiet and cost-effective light engine has become relatively easy. On my desk are CoBs from a half-dozen LED manufacturers; all of them fit inside their respective TE Connectivity "Lumawise" CoB holders; the holders are mounted to the ebm-papst unit; and finally a standard plastic LED reflector is snapped into the CoB holder. It's that simple. I consider the combination of an ebm-papst Active Cooler and TE CoB holder to be a "platform" for the CoB lighting systems we recommend, irrespective of the CoB manufacturer.


If you'd like more information on ebm-papst, CoBs or other LED-based systems, just send me a note at **LightSpeed@Avnet.com**. Regards, Cary

**Cary Eskow**
is Global Director of the Solid State Lighting and Advanced LED business unit of Avnet Electronics Marketing. An ardent advocate of energy efficient LED-based illumination, he has worked closely with LED manufacturers, advanced analog IC and secondary optics vendors since his first patent using LEDs was issued two decades ago. Avnet works with customers through their national team of illumination-focused sales engineers who are experienced in thermal, drive stage and optics design. Prior to his LED lighting focus, Cary was Avnet's technical director and managed Avnet's North American FAE team.

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AVNET electronics marketing

**To learn more about designing an LED-based illumination system, go to:**

**www.em.avnet.com/LightSpeed**

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