As requirements **increase** for smaller, **high performance** power supplies and modules, **what steps** are you taking to **ensure** thermal management **needs are met** in these products?

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Over the last 30 years, converter power densities have been increasing at the pace of one order of magnitude per decade. While increased converter efficiencies have contributed to a decrease in the total heat dissipation, this decrease happened at a significantly slower pace, leading to a large net increase in heat densities.

The higher heat densities are making it more and more challenging to thermally manage high power applications, and simply increasing efficiency within existing systems and packages is not sufficient any longer. Air cooling, which has been the de-facto standard cooling method for power electronic converters from the beginning, is starting to show its limits across most applications, and it has already become obsolete for advanced technologies and cutting-edge applications like artificial intelligence (AI). For these applications, advanced packaging that maximizes thermal dissipation and is compatible with different cooling strategies is essential to ensure a successful deployment.

As such, system designers are increasingly seeking out packaging options that provide low thermal impedance from both top and bottom of the package, and preferably near-identical thermal impedances from the top and bottom of the package, to ensure even sharing of the thermal load in dual-sided cooling applications. This allows for effective dual-sided cooling for high-power and high-density applications, and the flexibility of cooling either side of the package for less heat-dense applications that only require single-side cooling. Additionally, effective packaging needs to be compatible with different cooling interfaces. Packaging characterized by planar surfaces can enable compatibility with advanced cooling methods like cold-plate liquid cooling and immersion cooling, while also retaining the ability to operate in the air-cooled environment (perhaps equipped with additional heat-sinking if necessary). These advanced power component packaging techniques that are compatible with multiple cooling methods are top of mind for system designers alike as the industry evolves to keep pace with continued, rapid gains in power converter densities for AI applications and beyond.