Challenges and Opportunities in 5G mmWave Packaging
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5G communication will operate in both the quasi mmWave and mmWave bands. Extreme traffic density will require high-frequency mobile bands, far beyond WLAN at 6 GHz, requiring mmwave (28-39 GHz and above) communications. There are many challenges that must be addressed to achieve these goals including those associated with system-level design, materials, processes, antennas and module integration. One of the greatest challenges of 5G communication in this spectrum is the free space loss of radiated signal power. One way to overcome this loss is to use high gain antenna arrays. These arrays require many power amplifiers which dissipate large amounts of power. Because of this, the first requirement of 5G packaging is to ensure a good electrical and thermal solution. The packaging must also enable the complete integration of the antenna arrays (both radiators and reflectors) very close to the chips to achieve a small form factor and highly efficient performance.

This paper provides comprehensive case studies of a few different system integration strategies for 5G mmWave packaging. The packaging options vary widely based on the end market requirements, from performance, thermal, types and numbers of antenna arrays as well as the RF transceiver ICs. Tied closely to these performance related requirements are the competing tradeoffs of reliability, form factor and cost.

Also covered is an assessment of packaging structures for high performance mmWave network products, consumer/mobile products and automotive radar products. mmWave network products are generally not challenged by form factor and can be enhanced by the addition of more antenna arrays and RFICs. For consumer/mobile products, the primary drivers are cost and form factor. To manage antenna propagation and losses in a constrained form factor, mobile products generally require antenna in package (AiP) integration. The integration of the antenna within the same package as the RF IC greatly reduces the difficulty at the system level. This approach coupled with aggressive miniaturization of the antenna itself enables the use of the same substrate technologies as the system in package (SiP) and has led to a new class of sub-systems termed AiP. In summary, the challenges of 5G packaging will be discussed from the perspectives of design, materials, structure, manufacturability and test.