Akash Systems Puts GaN-on-Diamond in Orbit

By Barry Manz

GaN RF power amplifiers may be the go-to technology today, but they have one big problem: they generate a lot of heat that must be dissipated, and the prevailing approach has been to use either a copper heat spreader or a silicon carbide substrate. However, the Holy Grail solution has been to use synthetic diamond as a substrate, because it has the highest thermal conductivity (up to 1600 W/mK), of any material on Earth. But it's been fiendishly difficult to achieve. And while some defense prime contractors are very likely to have found solutions, there have been few, if any, private industry companies with a marketable product, with the notable exception of Akash Systems.

The technology and the company itself have interesting histories. The ability to bond a GaN epitaxial layer directly onto a synthetic CVD diamond substrate was first demonstrated in 2003 by Felix Ejeckam and his team at Group4 Labs. Element Six, the synthetic diamond division of De Beers, acquired Group4 in 2013. Ejeckam and co-founder Ty Mitchell then repurchased the IP in 2016 and founded **Akash Systems** the following year.

Since then, the company, headquartered in Emeryville, Calif., with fabrication facilities in nearby Oakland, has focused on satellite radios and RF power amplifier modules. For example, its GaN-on-diamond power amplifiers are used in Pixxel's Firefly hyperspectral Earth-imaging LEO observation satellites. It was the first time a GaN-on-diamond device had operated in space.

Akash's recent technical paper provides side-by-side

measurements on fully packaged parts. On multi-finger HEMTs with 10 fingers and 40-micron gate-to-gate spacing, thermal measurements showed GaN-on-diamond channel temperatures were 65° C to 70° C lower than equivalent GaN-on-SiC devices. A 5-watt GaN-on-diamond amplifier tested at 10 GHz with 100 MHz channel spacing demonstrated noise power ratios of 20 dB at 3 dB back-off from saturated power. Akash has also demonstrated power-added efficiency of up to 60% at 20 GHz.

The fielded product is an X-band transmitter operating in the 8025 to 8400 MHz Earth Exploration-Satellite Service (EESS) space-to-Earth band. It delivers 5 W CW at 8.4 GHz while transmitting data up to 643 Mb/sec in a 100-MHz bandwidth using 128-APSK modulation. The full radio measures 100 by 100 by 25 mm and weighs 0.5 kg, and the company claims that the thermal margin of the diamond substrate enables CW operation where GaN-on-SiC devices would require pulsed operation.

For an engineering community that has been waiting for 20 years for GaN-on-diamond devices and amplifiers to become commercial products, a fielded part with measurable advantages over GaN-on-SiC is a major achievement.