Success Story

Wolfspeed Designs a Compact PA Solution Using Novel GaN Process and NI AWR Software

"The ability to quickly add a full Ansys HFSS package transistor model in Microwave Office along with a full AXIEM EM simulation of the PCB enabled the team to analyze the circuit in detail and achieve industry-leading performance in a short period of time."

Kasyap Patel, Wolfspeed, a Cree company

Company

Wolfspeed, a Cree company, stands alone as the premier provider of the most field-tested silicon carbide (SiC) and gallium nitride (GaN) power and RF solutions in the world. As the leader in wide bandgap semiconductor technology, Wolfspeed partners with the world's designers to build a new future of faster, smaller, lighter, and more powerful electronic systems.

Challenge

Modern electronic warfare (EW) and battlefield awareness require reliable, high-output-power, high-efficiency, and large-bandwidth power amplifier (PA) solutions. With many applications employing a single compact PA solution covering a broader frequency range, GaN on SiC has become the technology of choice due to its high-power density, high-frequency capability, and robust design ability. Designers at Wolfspeed were tasked with using a next-generation 28 V GaN process technology (G28V4, 0.25µm) to design a wideband general-purpose device capable of meeting the demands of the EW market for dismounted or man-portable applications that operate from battery power.

At-A-Glance

Application

- Amplifier

Software

- NI AWR Design Environment
- Microwave Office
- AXIEM

Benefits

- First-pass design success on the bench
- High degree of correlation between measured and simulated results
- Ability to use HFSS through AWR Connected™ solution

Wolfspeed selected the 0.25 µm process for its benefits of 6 W/mm power density, >120 V breakdown, and 28 V operation that deliver the highest power gain possible from a single-stage RF device. Design goals for the PA, shown in Figure 1, were to create a single-ended amplifier with the ability to deliver over 70 W (CW) from 0.5 – 3.0 GHz, while maintaining an efficiency high enough to operate at a case temperature of 65° C. Other critical parameters included gain flatness of +/- 1 dB for easy system integration and good input/output return losses. To achieve the large bandwidth, a packaged input-matched approach was used to reduce the burden on the input matching network (IMN), while maintaining a small form factor.

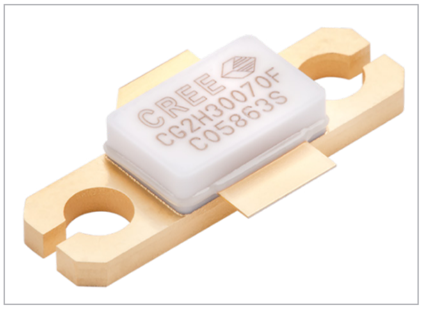


Figure 1: Compact PA solution using next-generation 28 V GaN process technology.

An input equalizer design was implemented on the printed circuit board (PCB) to shape the gain across the band to meet the required specification. A key requirement for the equalizer was to maintain the gain flatness in band and add stability margin while handling the maximum input power needed to drive the transistor into saturation without using non-surface-mount components. For this reason, careful simulations were needed to understand the dissipation in each of the components on the PCB and ensure the power ratings were not exceeded during operation.

Solution

The Wolfspeed design team chose the NI AWR Design Environment platform, specifically Microwave Office circuit design software, for the design of this device. The final product (CG2H30070) demonstrated 80 - 115 W of output power from 0.5 - 3.0 GHz with greater than 48 percent drain efficiency. The input equalizer enabled the gain flatness to be within +/- 1 dB of the nominal value. Because surface-mount components were required to reduce the complexity of the PCB, aluminum nitride (AlN) thick-film chip resistors were used on the equalizer network to handle the high-power requirement, as shown in Figure 2. Electromagnetic (EM) simulations, in conjunction with harmonic balance, were used to verify the power dissipation in each of the components and to confirm that the maximum rating was not exceeded. Using Microwave Office graphs, the dissipated power versus input drive was plotted to determine the maximum rated input power of the PA, so that a first-pass design was feasible on the bench.

For the full design, a high degree of correlation was achieved between the simulations and measured results, as demonstrated in Figure 3. The predicted drain efficiency was typically within 2 percent of the measured data and the output power was within 0.5 dB across the frequency range.

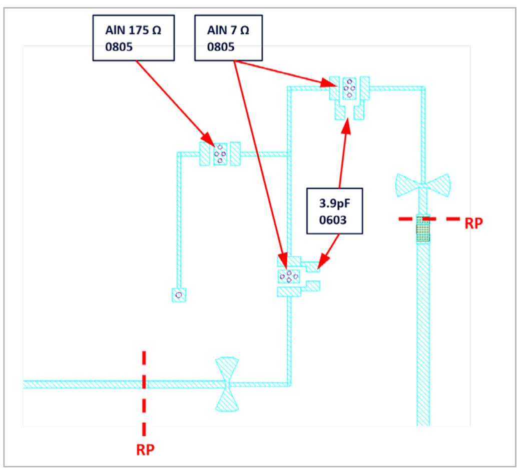


Figure 2: Equalizer network used on IMN to achieve gain flatness across required bandwidth.

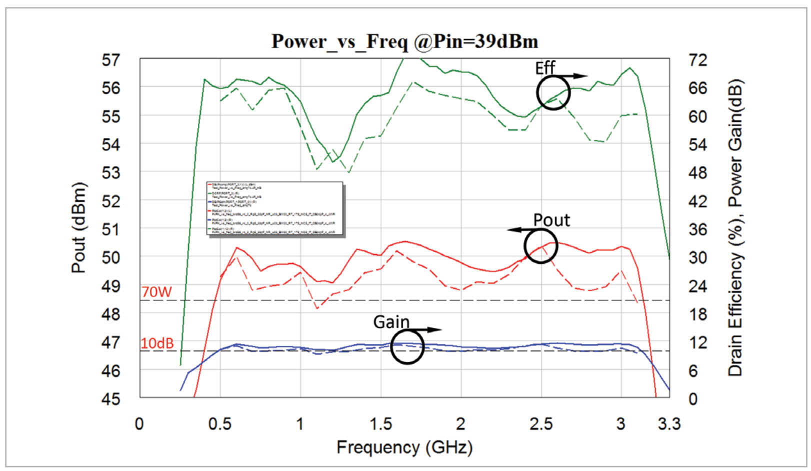
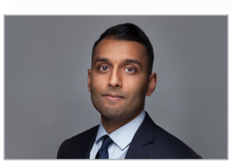


Figure 3: Measured (dashed) versus simulated (solid) data showing a high degree of correlation.

Conclusion

The Wolfspeed design team chose the NI AWR Design Environment platform for the design of the CG2H30070F 0.5-3.0 GHz GaN on SiC PA utilizing a packaged pre-match to reduce the required transformation ratio and on-board equalizer to achieve optimal gain flatness. The ability to quickly add a full Ansys HFSS package transistor model in Microwave Office software along with a full AXIEM EM simulation of the PCB enabled the team to analyze the circuit in detail and achieve industry-leading performance in a short period of time. The resulting measured-to-model correlation validated the approach and enabled quick release of a full device model.



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