Matching Network for GaN HEMT Power Amplifier

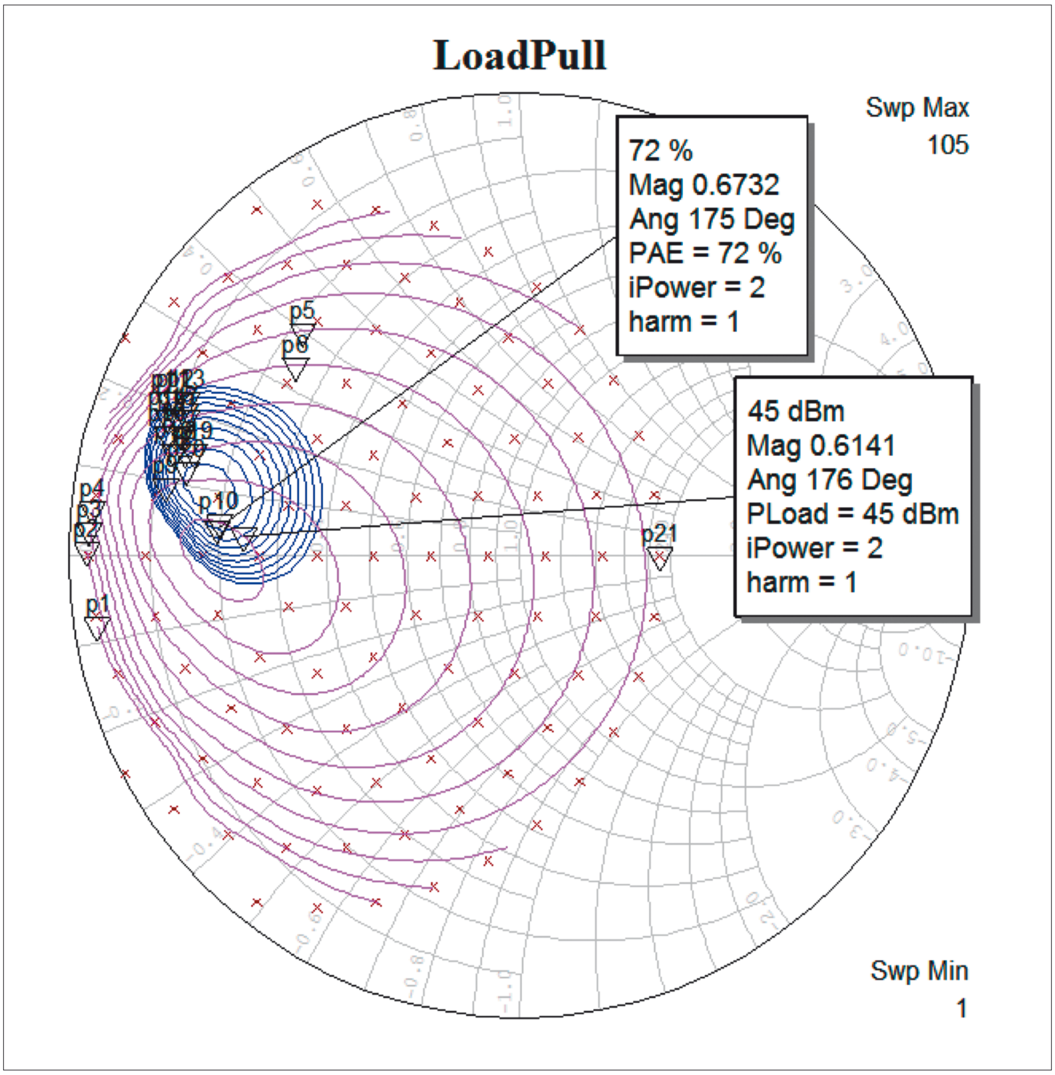

Figure 1: Load-pull contours for the PA.

The challenge was to design a power amplifier (PA) matching network for the unmatched Cree gallium nitride (GaN) high electron mobility transistor (HEMT) CGH40025F.

National Instruments
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The design goals for the PA were to 1) create an amplifier circuit that provides 25 W output power from 1.9 to 2.1 GHz for 28 V operation, 2) reach high power-added efficiency (PAE), and 3) suppress harmonics as much as possible.

High power and high efficiency are key requirements for all power amplifiers, and, in addition, harmonic suppression was required in this design in terms of second and third harmonics, which increases network efficiency. The network needed to be unconditionally stable for all passive source and load impedances. To achieve these goals, load-pull analysis was required to understand the transistor's impedances at the input and output ports. Load-pull analysis was also used to construct a set of contours on a Smith chart, which determines the maximum output power and efficiency.

Solution

Meteksan Defence designers choose the NI AWR Design Environment platform, specifically the powerful load-pull analysis capabilities within Microwave Office circuit design software. The software offers a load-pull script and the needed simulation components such as the harmonic balance tuner (HB Tuner).

Using the load-pull template in the software, the designers obtained the load-pull contours for the transistor. At the beginning of the design, it was beneficial to use the harmonic balance engine to obtain the output power and PAE information for the transistor impedance at the load port. Figure 1 shows the load-pull contours for PAE and output power.

Next, the designers explored the stability factor of the amplifier circuit. To ensure an unconditionally-stable circuit, they added a series-RC circuit using the capacitor model from the NI AWR model library.

After that, the load-pull analysis was run again to optimize the output power, harmonic suppression, and PAE (Figure 2). In this step, the second and third harmonic impedances were optimized with the HBTUNER, which provided the necessary suppression.

The final results were 25 W of output power with 50 percent PAE and 35 dB of harmo-

Company

Meteksan Defence, where the design was done, is the one of the leading defense companies in Turkey. It has prioritized university-industry cooperation, especially with Bilkent University, and aims to become a long-term advanced technology products solution partner of the Turkish Armed Forces. Meteksan Defence's mission is to develop the most creative and innovative solutions for customers in the fields of advanced design and production technologies, while taking advantage of academic infrastructure and making the company's resources available for Bilkent University.

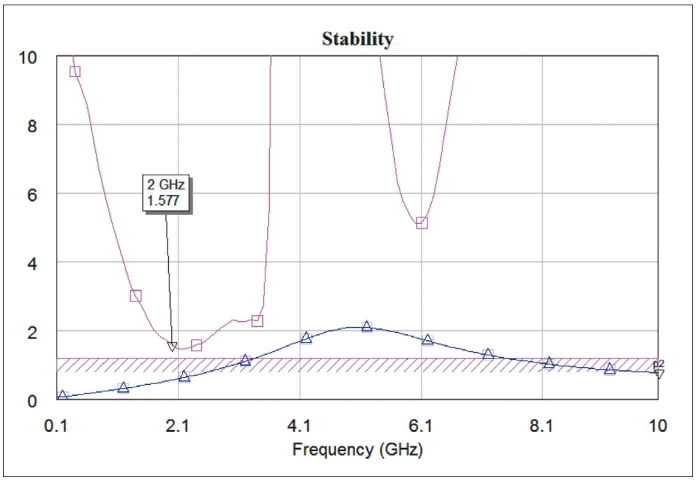

Figure 2 a: The K factor with and without the stability circuit.

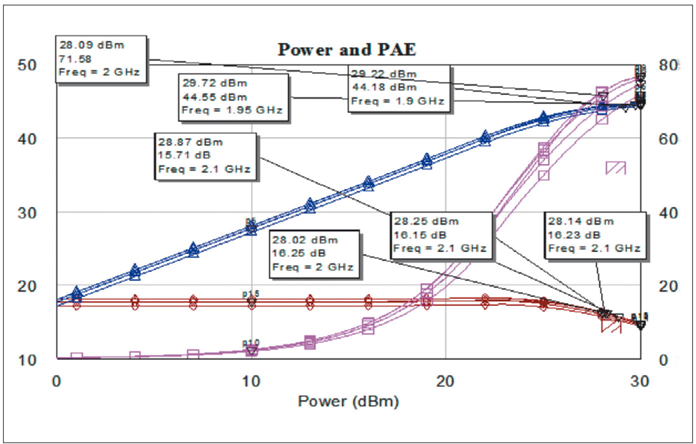

Figure 2 b: Input power vs. gain, output power, and PAE

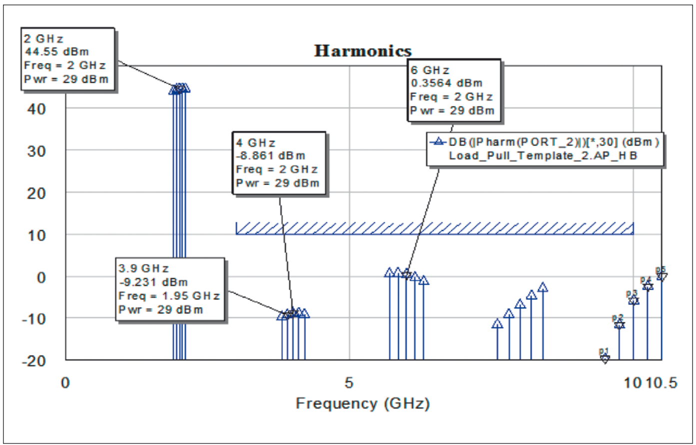

Figure 2 c: Harmonic-power levels

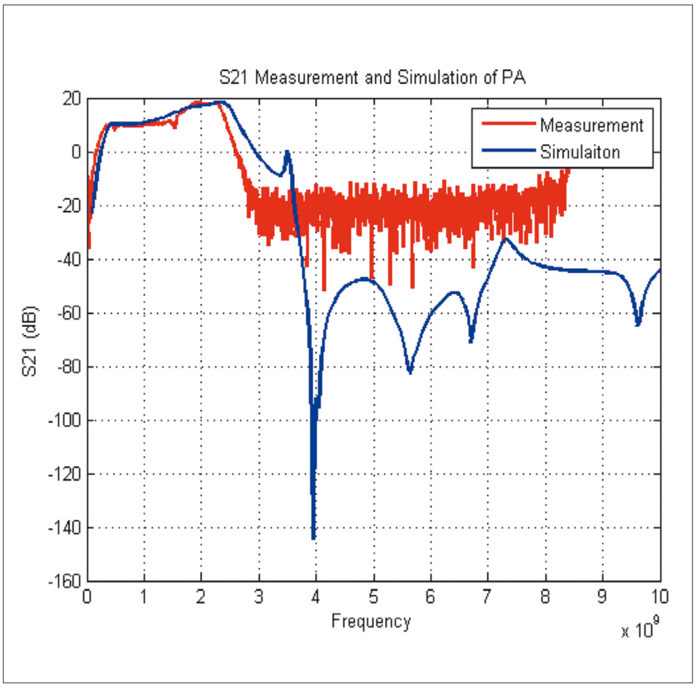

Figure 3 a: Measurement and simulation results

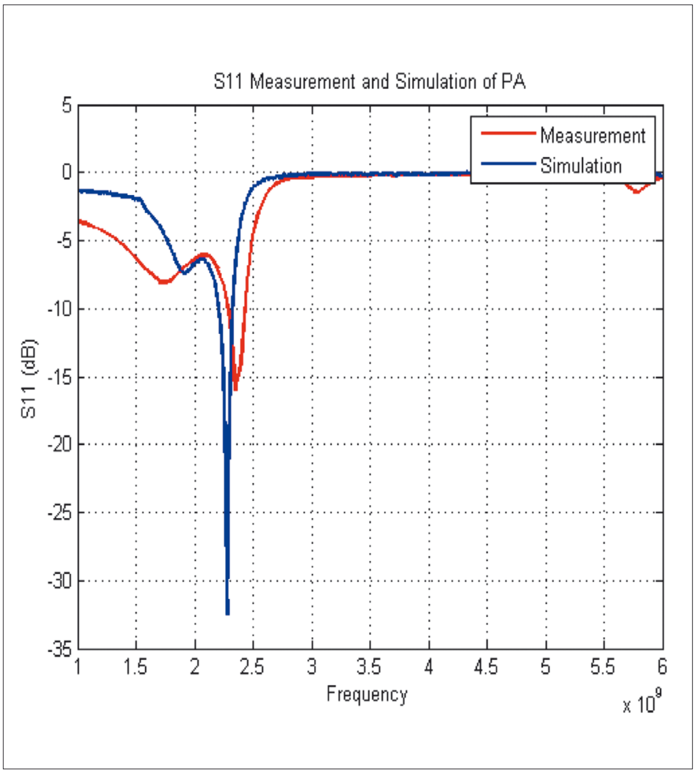

Figure 3 b: Measurement and simulation results

nic compression. Measurement results showed the amplifier circuit provided good correlation with NI AWR software simulation in terms of small-signal parameters, and 25 W was obtained from the output of the amplifier. Figure 3 shows the simulation and measurement results.

Conclusion

Meteksan Defence engineers successfully designed a PA matching network for a Cree GaN HEMT device using the powerful load-pull analysis and harmonic balance features within Microwave Office software. The designers found the software's ease of use, simulation speed, and availability of models especially useful.

Special thanks to Mister D. Eser, Electromagnetic Design Engineer, Meteksan Defence, for his contributions to this success story. ◄