

Success Story

Marki Microwave Designs Industry's Highest Performing MMIC T3 Mixer With NI AWR Software

Company Profile

Marki Microwave provides an extensive line of industry-leading, high-performance mixers that cover frequencies to 65 GHz, all built on a legacy of providing the best mixer performance in the world for over 20 years. Marki's goal is to invent technologies to empower the RF and microwave industry to design faster, simplify production, eliminate complexity, and shatter performance barriers. This goal is achieved through intensive research, product development, and advanced and carefully controlled production. The company has a multi-decade legacy designing high performance microwave components, demonstrating technical leadership through collaboration with thousands of customers.

The Design Challenge

The company's initial monolithic microwave integrated circuit (MMIC) mixers were nearly perfectly predicted using NI AWR Design Environment, specifically Microwave Office for circuit design, and the AWR Connected™ ANSYS HFSS partner solution for EM simulation. After successfully bringing to market its line of simple double-balanced mixers, Christopher Marki and his design team began focusing on improving the design process for its high-performance devices, which could only be made by hand and therefore could not effectively compete in the mass/high-volume market. The main T3 mixer line (Figure 1), Marki Microwave's flagship IP, is the most sophisticated mixer circuit available. These mixers are designed for applications where intermodulation distortion (IP3 or two tone) and input power compression (1-dB compression) are system limitations. When provided with a square wave LO drive (generated by the integrated LO amplifier in T3A units) they provide the highest possible IP3, 1-dB compression, and spurious product prevention, particularly at frequencies below 10 GHz. The challenge was to make MMIC T3s in volume to compete in the mass volume market.



Figure 1: Marki's T3 Mixer.



Application:

Mixer

MMIC

Software:

NI AWR Design Environment

Microwave Office



“Every designer faces a choice during the design cycle: do I believe the simulation results displayed by the software, or not? I trusted the predictions, and thanks to Microwave Office the new design worked perfectly. The performance we have achieved is unlike any other MMIC ever produced.”

– Christopher Marki
CEO

Marki Microwave
markimicrowave.com

The Solution

There were many challenges to this undertaking, but thanks to Microwave Office, designers succeeded in proving the concept in Q2 2016 on their first try. "The parts looked great, very similar to simulation, and they were ready to go to market that summer," commented Christopher Marki. Then, one morning, the design team had an idea and decided to make some tweaks to the design in Microwave Office. With a "flip of the wrist" simulation in the software, the nonlinear performance improved by 2-4 dB across the band. The extra performance was a huge deal because it meant the designers could essentially double the linearity for free, in other words, without making any other specification tradeoffs. Specifically, Marki went from mixers that were nominally about +28 dBm IP3 across the band to ones that achieved about +31 dBm across the band.

Every designer faces a choice during the design cycle: do I believe the software or not? Alternatively, the boss asks: "is it time to shoot the engineer and go to market?" Although he could not prove it, Christopher inherently believed in the harmonic balance solver within Microwave Office. The design team trusted their simulations and made a new mask set at significant expense. The new design worked perfectly. The screenshots in Figure 2 and 3 show the original generation 1 versus the revised generation 2. The higher IP3 is the key spec the designers were looking for.

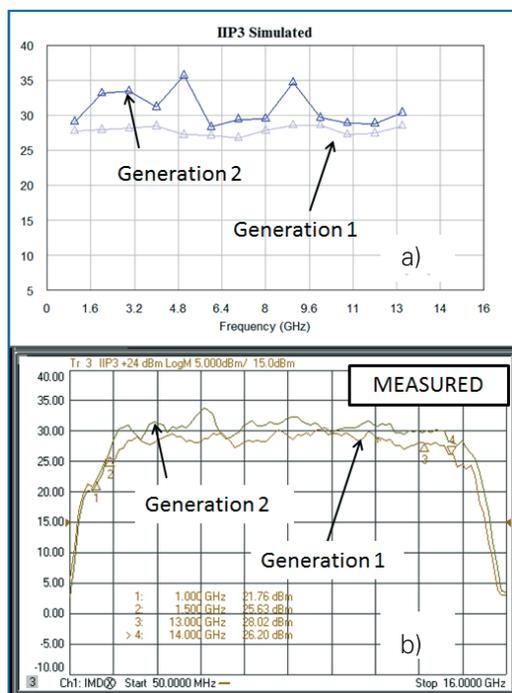


Figure 2: IIP3 for the MT3-0113H mixer with a +20 dBm LO drive. a) Simulated. b) Measured. NOTE: Measurements include additional fixturing not included in simulation.

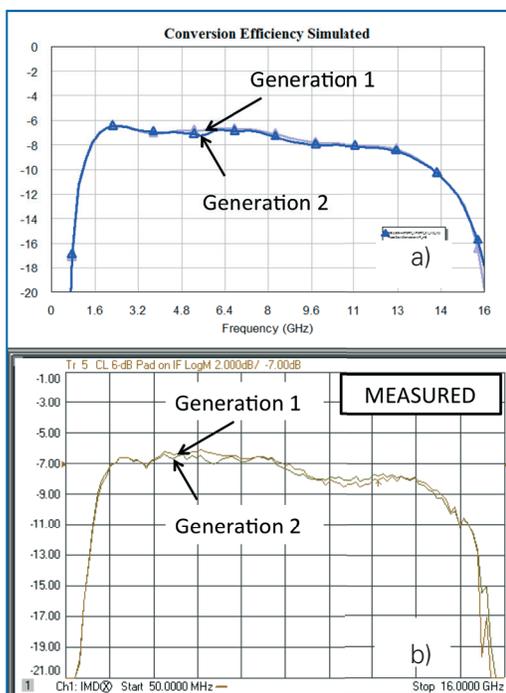


Figure 3: Conversion efficiency for a fixed IF (100 MHz) downconversion. a) Simulated. b) Measured. NOTE: Measurements include additional fixturing not included in simulation.

Why NI AWR Design Environment

Christopher has been using Microwave Office for many years to design the highest quality mixers for customers who demand the best performance possible, and his confidence in the software paid off in a big way. Converting over to the new design delayed the overall production schedule slightly, however, in the end, the performance delta was clearly worth the wait and customers cannot believe how well the devices are made. In fact, the new ones are superior to the old parts by a noticeable margin in almost every spec. Better yet, Marki can attack high volume markets now because the devices are not built by hand like the traditional T3s. With the help of Microwave Office, Marki has unleashed the best mixer technology onto an IC platform, and this will revolutionize what customers will come to expect out of high performance mixers for years to come.