SUCCESS **STORY**

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Anritsu and Cadence

Anritsu Designs G-Band Frequency Tripler for Broadband Instrumentation with AWR Software

Key Challenges

Broadband frequency sources are required to extend the frequency range of broadband microwave and mmWave test equipment for applications such as 5G new radio (NR) communications, automotive radar, and security (detection) applications.

In some broadband systems, nonlinear transmission line (NLTL)-based multipliers and receivers have been used to extend the frequency ranges. In one example, NLTL distributed harmonic generators (DHGs) can be used to extend the continuous wave (CW) source from 54GHz to 110/145GHz. However, their required input drive level must be approximately +24dBm to minimize conversion loss (and maximize output power) of the desired harmonic output tone.

For even higher frequency coverage (e.g., to 220GHz), achieving these drive levels becomes more challenging. Amplifiers that have P1dB = +24dBm in the range of 45-75GHz to drive a DHG do not exist. In addition, unwanted harmonics must be filtered at the DHG's output. Overcoming these challenges requires a multiplier with lower required input drive power, broadband operation, and a balanced structure to naturally suppress the second harmonic (Figure 1).

Application

- Test Equipment

Software

- Cadence® AWR Design Environment® Software Portfolio, including:
  - Cadence AWR® Microwave Office® software

Benefits

- Ease of use
- Reduction in design time
- Quality of results

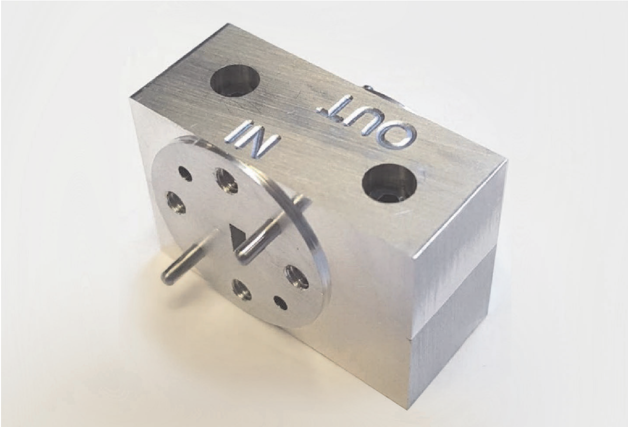

Figure 1: WR15-WR5 G-band tripler assembly

The Solution

The difficulty in meeting the input drive and unwanted harmonic suppression requirements for the DHG motivated Anritsu designers to develop an extended planar frequency tripler covering the entire G-band (140-220 GHz). Modeling the structure using a 3D simulator and extracting an accurate representation of the 6-port model was critical. The engineers chose Cadence AWR Design Environment software for this exacting design challenge. Figure 2 shows the tripler block diagram designed in the software.

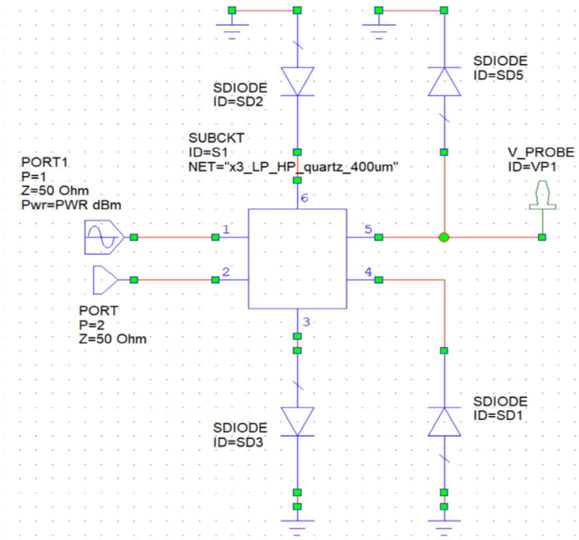

Figure 2: G-band planar frequency tripler design in the software

The design uses two commercially available discrete Schottky anti-parallel varistor diodes on either side of the main line. An 80GHz stepped-impedance resonator (SIR) low-pass filter (LPF) reflects harmonics of the input signal and prevents all generated harmonics originating from the anti-parallel diode pairs from being absorbed back into the input. A 130GHz substrate integrated waveguide (SIW) high-pass filter (HPF) passes the X3 harmonic, reflects the fundamental, and partially reflects the unbalanced X2 harmonic. It was expected that the X5 harmonic would be at least 10dBc down from the third harmonic aided by losses at the output.

When the model was brought into the AWR Microwave Office® circuit design software, the n-port representation of the 3D model allowed the Schottky diode models to be placed at their prescribed locations represented as discrete elements in the circuit model.

The EM model of the entire G-band tripler is shown in Figure 3.

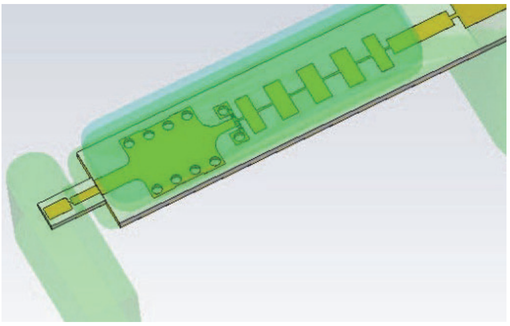

Figure 3: Complete 3DEM model of the G-band tripler

Summary

The design and development of a zero-bias, extended G-band planar frequency tripler was successfully accomplished using AWR Microwave Office software, which enabled the designers to bring in n-port models created from other EDA products.

The ability to quickly run the robust harmonic balance simulation engine and be fairly confident of solution convergence was an immense advantage in terms of cutting design time, as was the ease of plotting and displaying harmonic output power and conversion and return loss data. The ability to assign variables to model parameters was also very helpful. The quick and knowledgeable customer/technical support further helped the engineers streamline the design effort.

The time it takes to figure out how to do something with Microwave Office is far less than other circuit simulators on the market. It is the only circuit simulator Anritsu owns and uses.

Jon Martens and Tom Roberts, Anritsu

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