

Cost-Effective Design of a WR-19 In-Line Waveguide-to-Coaxial Adapter Using Substrate-Integrated Waveguide (SIW) Ridge

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In prior research, we designed and fabricated an in-line waveguide-to-coaxial adapter operating in the 40–60 GHz frequency range. This adapter utilized a four-step ridge structure to gradually achieve impedance matching, with the coaxial pin positioned on top of the ridge rather than inserted into it. Simulation results demonstrated that the adapter achieved an S11 performance of less than -20 dB across the bandwidth, while back-to-back measurements showed performance of less than -15 dB, which was deemed satisfactory.

However, the production cost of the adapter was significantly higher than that of commercially available products, posing a major barrier to cost-efficient manufacturing and commercialization. The primary factor driving the high cost was the precision machining required to implement the step-ridge structure in metal. Specifically, fabricating the step-ridge for the 40–60 GHz frequency band demanded advanced techniques and equipment, significantly increasing manufacturing expenses.

To address this challenge, we propose replacing the metal step-ridge with a substrate-integrated waveguide (SIW) ridge to be incorporated into the adapter. SIW structures consist of two metallic plates sandwiching a dielectric substrate. This design necessitates stable contact between the coaxial pin and the metallic layer of the ridge. However, for this contact to be achieved, the ridge must be positioned away from the central axis. To evaluate the feasibility of this design, simulations were conducted using the existing waveguide-to-coaxial adapter to analyze how ridge positioning affects adapter performance.

The simulation results confirmed that positioning the ridge off-center does not significantly degrade the adapter's performance, provided the coaxial pin maintains stable contact with the metallic ridge. This finding validates the feasibility of integrating an SIW ridge, demonstrating that precise central alignment of the ridge is not necessary. As a result, this design offers greater flexibility in manufacturing while reducing the constraints associated with precise alignment.

Figure 1 shows the ongoing design and simulation work conducted using the electromagnetic simulation software CST. The substrate-integrated waveguide (SIW) based approach offers significant potential for reducing manufacturing costs while maintaining performance. SIW and pin connected by soldering

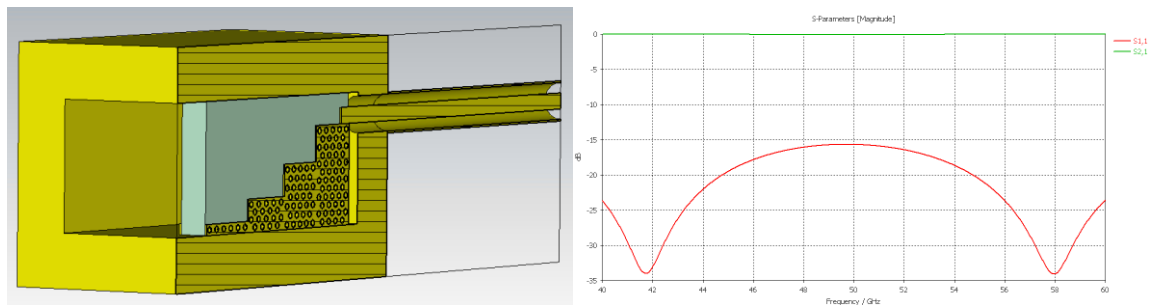


Figure 1. Adapter Design(left) and S11 Result(right).

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