Company Profile

Nanjing University of Posts and Telecommunications (NUPT) has made remarkable contributions to the establishment and development of the People’s Republic of China. NUPT has developed into a university focusing on engineering, characterized by information technology integrating such disciplines as science, engineering, economics, management, literature, education, art and law, and combining the educational programs leading to bachelor’s, master’s and doctor’s degrees. The university is located in Nanjing, a historical and cultural city, and owns four campuses: Xianlin campus, Sanpailou campus, Suojincun campus, and Jiangning campus.

The Design Challenge

Bond wires are used extensively in monolithic microwave integrated circuits (MMICs) and multi-chip modules (MCMs) for signal transmission in substrates with different heights (Figure 1).

Substrate 2 with a height of H2 is stacked on substrate 1 with a height of H1, as shown in Figure 1. Bond wire interconnections are used to interconnect substrate 1 and substrate 2 (Figure 1).

Substrate-to-substrate interconnection is important for several reasons. In order to achieve a higher isolation among the transmitter, receiver, and local oscillation (LO) parts of a transceiver, each part must be designed on a separate circuit substrate to avoid signal leakage through the shared substrate, especially the high-power LO leakage to other parts. Additionally, it is not possible in every case to place all components on one circuit substrate so they must be placed on different substrates for a complex circuit.

Conventionally, substrate-to-substrate interconnection is established using bond wires, as shown in Figure 1. However, a bond wire adds a low-pass element to the microwave system and limits its operating bandwidth. Approaches using multiple bond wires or compensated microstrip stubs can broaden the bandwidth of such interconnections, but none of them exceed 20 GHz frequencies. It is more important that compensated open stubs are used to broaden the bandwidth of bond wire interconnections, but in most

Success Story

NUPT Students Design Novel Broadband Substrate Interconnection Structure Using NI AWR Design Environment

Application:
Passive Interconnect
Software:
NI AWR Design Environment
Microwave Office
AXIEM

Using Microwave Office and AXIEM to simulate and optimize this novel broadband interconnection structure gave us the insight we needed to overcome the challenges and develop a successful design.”

– Dr. Zhou
Nanjing University of Posts and Telecommunications
njupt.edu.cn/en
cases the required compensated open stubs must be narrower than 0.1 mm, which is impossible to fabricate based on current printed circuit board (PCB) substrate or low temperature co-fired ceramic (LTCC) fabrication processes.

To solve these challenges, engineers at Nanjing University of Posts and Telecommunications wanted to design a novel broadband substrate-to-substrate interconnection structure.

The Solution

The designers developed a broadband interconnection using double bond wires with square-shaped defected ground structure (DGS) under open stubs. The square-shaped DGS etched under compensated microstrip open stubs not only expanded its operating bandwidth, but also increased the characteristic impedance of the microstrip line without narrowing its width, which overcame the PCB fabrication limitation of narrow stubs (Figure 2).

The advantage of using this structure was that it enabled the designers to increase the characteristic impedance of the microstrip line without narrowing its width. A 250 ohm characteristic impedance was easily achieved using a 0.6 mm microstrip line with the DGS patterned in the ground plane. The interconnection also exhibited low-pass characteristics. The measured results agreed well with the simulations.

Electromagnetic simulation was accomplished using NI AWR Design Environment™, specifically Microwave Office circuit design software and AXIEM 3D planar EM simulator, which is a full-wave electromagnetic simulation software based on the method of moments (MoM). The optimized dimension parameters were: \(a = 3 \text{ mm}, b = 3.6 \text{ mm}, c = 0.6 \text{ mm}, g = 0.5 \text{ mm}\) and \(w = 1.2 \text{ mm}\). Equivalent circuit elements were \(C_1 = C_2 = 0.15 \text{ pf}\) and \(L = 0.26 \text{ nH}\). Figure 3 shows the simulated and measured S-parameters.

**Note that the bandwidth of the novel interconnection is 38 GHz, whereas the bandwidth of conventional interconnection is only 2.837 GHz, as shown in Figure 3(b). So the novel structure provides more than 1200 percent bandwidth increment compared to a conventional one.**

Why NI AWR Design Environment

Because NUPT is a member of the NI AWR University Program, students and professors are able to leverage the full NI AWR Design Environment suite of tools. The designers commented that Microwave Office provides an easy-to-use interface and AXIEM enabled them to easily design and optimize this novel structure.