

A Compact Metallic Module Packaging a D-band 2D Beamforming Antenna System

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Extensive research is underway on 2D beamforming systems operating at carrier frequencies as high as the D-band. Traditional beamforming systems are typically designed for broadside radiation by linking integrated circuits with multiple RF channels to array antennas through vertical interconnect layers. In contrast, this paper presents a simpler approach, employing ICs with multiple beamforming channels connected to a linear array of end-fire antennas. The chip and linear antenna feeds are housed within a metal enclosure, offering IC protection, suppression of unwanted losses, and enhanced directive radiation patterns.

Our proposed module design, shown in Fig. 1(a), stacks horizontal linear end-fire antenna arrays vertically. Each layer of the horizontal linear array is spaced 1 mm apart, approximately half a wavelength. The passive PCB design incorporates microstrip meander lines that provide fixed phase shifts of 45 and 90 degrees at 150 GHz. To achieve a minimal vertical spacing of 1.4 mm—slightly more than half a wavelength—the linear array PCBs are mounted on thin metal blocks less than 0.2 mm thick, radiating through vertical openings of 1.2 mm, just under the standard waveguide H-plane width of 1.65 mm, as shown in Fig. 1(b). For the passive PCBs with fixed phase shifts, the RF signal is fed via a 2D power dividing network in both E and H planes at the system's input.

Measurements of the radiation patterns using different PCB configurations confirm the beam-steering capability of our 8×8 element module. The passive antenna module effectively demonstrates main beam shifts in both azimuth and elevation directions at 150 GHz, as shown in Fig. 1(c). Ongoing efforts aim to develop a module incorporating active ICs with phase-controlled RF channels.

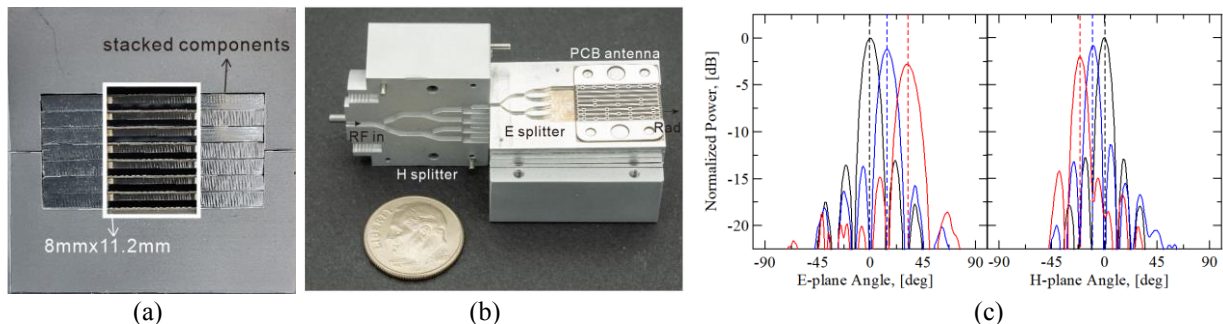


Figure 1. (a) Photograph of the beamforming module featuring stacked linear end-fire antennas: (a) front view and (b) side view, along with (c) measured patterns demonstrating beam-steering in the E and H planes.

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