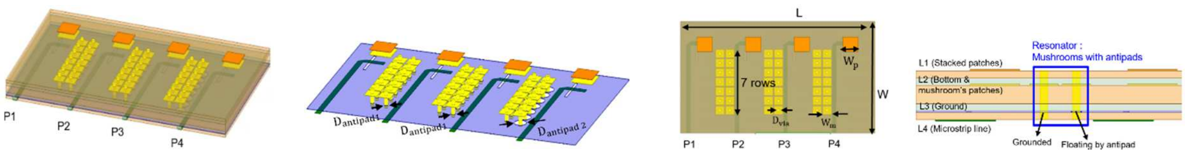
URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Wideband Mutual Coupling Reduction in mm-wave Aperture-coupled Stacked Patch Antenna Arrays using a Novel Mushroom-like Resonator

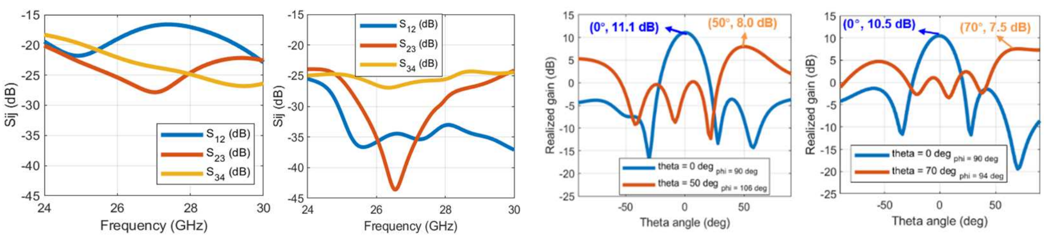
Ji-Gang Chen(1), Yi-Ting Lin(1), Chiu-Chih Chou(2) and Tzong-Lin Wu(1)
(1) National Taiwan University, Taipei, Taiwan; e-mail: r10942116@ntu.edu.tw; tlwu@ntu.edu.tw
(2) National Central University, Taoyuan, Taiwan

The millimeter wave frequency range has recently gained popularity in 5G wireless communication due to its higher data rate and capacity when compared to the sub-6 GHz band. Challenges of millimeter wave communication, especially mutual coupling and restricted coverage range, must be addressed. In this paper, different from the traditional electromagnetic bandgap (EBG) structure which has limited bandwidth, we propose a novel mushroom-like resonator with wide decoupling bandwidth for millimeter-wave aperture-coupled stacked patch antenna array [1]. Figure 1 shows a phased array composed of four 1.3-mm aperture-coupled stacked patch antennas with three sets of mushroom-like resonators, which can enhance both the isolation within array and the realized gain at high angles. From full-wave EM simulation as shown in Fig. 2 (a) and (b), 19 dB reduction of the mutual coupling is achieved by applying the proposed decoupling resonator. Moreover, mutual coupling between adjacent elements are all below −24 dB within the operating bandwidth 24.25 ~ 29.5 GHz, showing that the proposed structure has wide decoupling bandwidth. Further, the resonator can also improve the active element pattern to make it more isotropic, which is advantageous for wide scanning applications. Figure 2 (c) and (d) demonstrate that the 3 dB scanning range is enlarged from 50° to 70° at 27 GHz. At 26, 27, 28, and 29 GHz, the realized gains at 50° are also increased by 0.9 dB, 0.5 dB, 0.4 dB, and 0.8 dB, respectively. Therefore, the proposed decoupling resonator shows great potential for mutual coupling reduction in 5G millimeter-wave applications. The antenna array is fabricated and the measured S parameters show consistent results with simulation.



(a) (b) (c) (d)

Figure 1. Geometry of the aperture-coupled stacked patch antenna array with mushroom-like decoupling resonator. (a) Perspective view (b) Layer 1 ~ Layer 4 (c) Top view (d) side view of the array. W = 13.85, L = 22.80, W_p = 1.80, W_m = 1.03, D_{via} = 0.30, $D_{antipad\ 1}$ = 0.4, $D_{antipad\ 2}$ = 1 (mm)



(a) (b) (c) (d)

Figure 2. Simulation result. (a) Mutual coupling w/o decoupling resonator (b) Mutual coupling w/ decoupling resonator (c) Realized gain w/o decoupling resonator (d) Realized gain w/ decoupling resonator at 27 GHz

References

[1] S. D. Targonski, R. B. Waterhouse and D. M. Pozar, "Design of wide-band aperture-stacked patch microstrip antennas," in *IEEE Transactions on Antennas and Propagation*, vol. 46, no. 9, pp. 1245-1251, Sept. 1998