Ka-band Compact 1×32 Patch Antenna Array for Cross-Shaped Parabolic Cylinder Mesh Reflector

Museong Cho
Elctronic Engineering
Soongsil university
Seoul, Korea
museong@soongsil.ac.kr

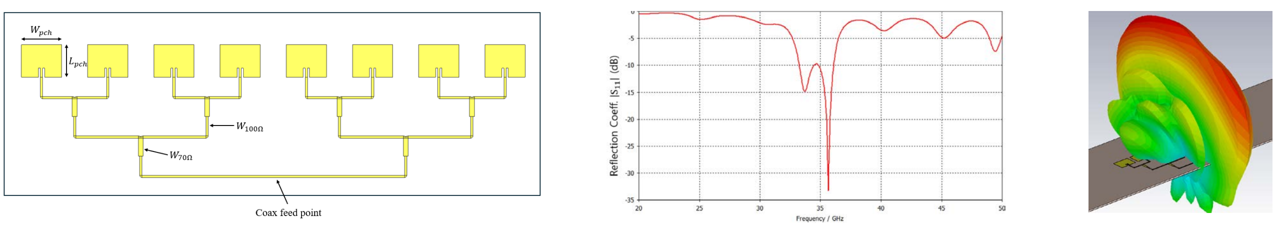
Chul Ki Kim
Electronic Engineering
Soongsil university
Seoul, Korea
chulki@ssu.ac.kr

A. *Introduction*

The increasing demand for next-generation satellite SAR missions requires lightweight and deployable reflector antennas with compact stowage and high radiation efficiency. The parabolic cylinder mesh reflector offers superior performance and mechanical reliability compared to conventional reflectors, but it suffers from spillover loss. A cross-shaped configuration can mitigate this issue. In this work, a compact 1×32 linear patch antenna array is designed at 35.75 GHz as a lightweight feed for the cross-shaped parabolic cylinder mesh reflector.

B. *Antenna Design*

The proposed 1×32 array is configured as four 1×8 subarrays, with the structure of a single subarray illustrated in Fig. 1(a). Each subarray is probe-fed using equal-length 50-Ω coaxial cables from the backside. Rogers RT/duroid 5880 was selected as the substrate owing to its low-loss characteristics and suitability for high-frequency operation. The main feed lines employ 100-Ω microstrip transmission lines, with power division achieved through a quarter-wave impedance matching network. The patch dimensions and microstrip line parameters were calculated based on the design equations provided in [2]. The simulated reflection coefficient, shown in Fig. 1(b), remains below −15 dB at the target frequency of 35.75 GHz. This performance can be further improved by adjusting the feed division scheme or optimizing the inter-element spacing. A single patch antenna yields a gain of approximately 6–7 dBi, leading to an estimated subarray gain of 15–16 dBi. The corresponding E-plane radiation pattern is presented in Fig. 1(c).



(a) (b) (b)

Fig. 1. (a) Structure of patch array. (b) Simulated reflection coefficient of the subarray. (c) Radiation pattern of E-field

C. *Conclusion*

For satellite missions where multiple payloads must be accommodated within a single launch, minimizing mass, stowage volume, and deployment complexity is essential. This work has presented the design and simulation of a 1×8 patch antenna subarray, subsequently extended into a 1×32 linear array for cross-shaped parabolic cylinder reflectors. To further reduce the feed size, future developments will include folding the transmission lines beneath the patches and employing probe connections for compact integration. Following feed optimization, reflector parameters such as focal length-to-diameter ratio and aperture length will be determined for fabrication. Ultimately, the proposed antenna array is expected to serve as a key feeder technology for mesh-based parabolic reflector antennas in next-generation satellite SAR systems.

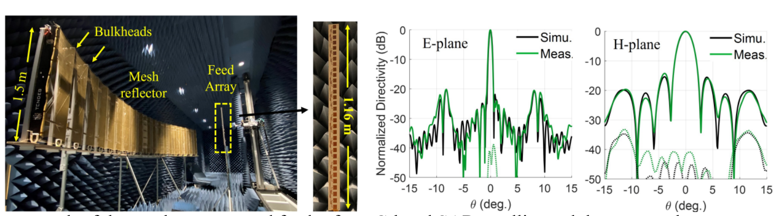


Fig. 2. Photograph of the mesh antenna and feeder for a C-band SAR satellite and the antenna beam pattern (S_{21}) [1]

References

[1] Y. Rahmat-Samii, J. Wang, J. Zamora, G. Freebury, R. E. Hodges, and S. J. Horst, "A 7 m × 1.5 m aperture parabolic cylinder deployable mesh reflector antenna for next-generation satellite synthetic aperture radar," *IEEE Transactions on Antennas and Propagation*, vol. 71, no. 8, pp. 6378–6389, Aug. 2023

[2] C. A. Balanis, “Antenna theory: A review.” Proceedings of the IEEE 80.1, 1992: 7-23.