W-band Low Phase Sensitivity Reflectarray Antennas with Wideband Characteristics

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Abstract—There are two critical problems in designing a wideband reflectarray antenna at millimeter-waves. The first problem is the phase sensitivity according to the variation of element length. If the unit cell is designed by only considering the target performance and not the fabrication accuracy, the desired performance may not be achieved. Therefore, the antenna must be designed so that the phase sensitivity decreases as the frequency increases. The second problem is the reduction of the gain bandwidth due to the inherent narrowband characteristics of the unit cell. In general, the bandwidth of the elements is 3%–5%, indicating that broadband characteristics cannot be obtained in the usual manner. Fortunately, low phase sensitivity is accompanied by almost parallel and linear phase slope according to different frequencies, which are general characteristics for broad gain bandwidth. However, when the angle of incidence is varied, the reflection phase distortion may occur within the target bandwidth owing to the additional resonances. Therefore, in order to achieve broad gain bandwidth, appropriate element arrangement on array surface should be implemented considering the phase distortion according to the angle of incidence.

In this study, a W-band reflectarray antenna was designed with characteristics of low phase sensitivity and wideband. Low phase sensitivity was achieved by subdividing the unit cell variation method into five steps. The phase distortion with varying angle of incidence was analyzed according to the input impedance of proposed unit cell. This study suggests the arrangement strategy of the array elements in the reflectarray surface based on the relative phase error [1]. An offset feed reflectarray with $11.47\lambda_0$ aperture diameter at 90 GHz center frequency was designed using the proposed method. The measured gain was 28.5 dBi at 90 GHz and the maximum efficiency was 60.5% at 82 GHz. The measured 1-dB gain bandwidth was approximately 28.8% in the W-band of 81-107 GHz.

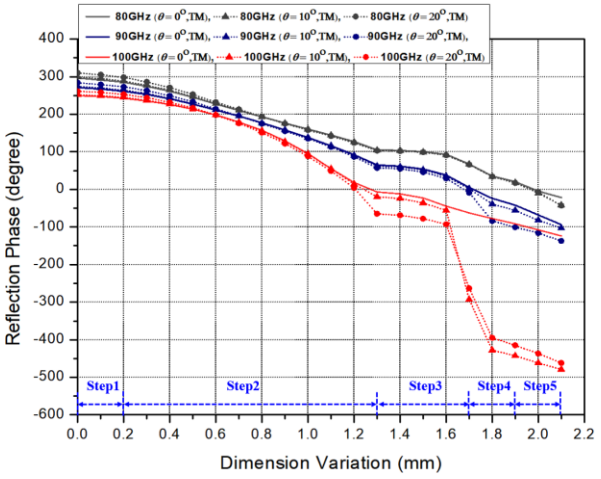

Fig. 1. Reflection phase range of the proposed unit cell according to incident angle at different frequencies.

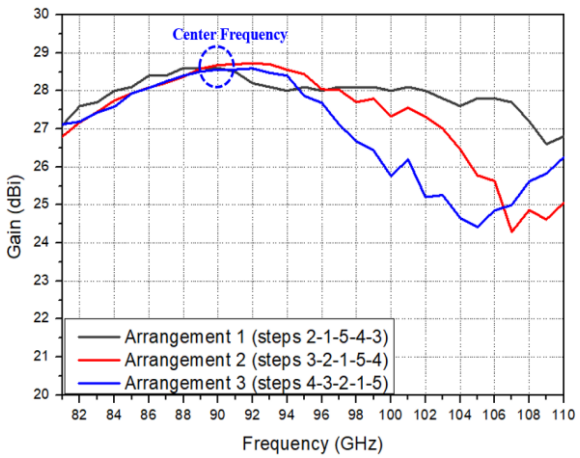

Fig. 2. Performance of reflectarray antenna at different arrangement of elements on the array surface.

REFERENCES

[1] Nayeri, Payam, Fan Yang, and Atef Z. Elsherbeni. "Broadband reflectarray antennas using double-layer subwavelength patch elements." *IEEE Antennas and Wireless Propag. Lett.*, vol. 9, pp. 1139-1142, 2010.