Heterogeneously Integrated Phased Antenna Arrays Using Synthesized Transmission Lines – from Four Elements to Two Elements

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1 Introduction

There have been several attempts to integrate the feeding networks of the several different antenna arrays together as a single network without increasing the overall size and fabrication cost. In [1], a four-element integrated array was successfully implemented, capable of functioning as a beam-switching array, a Van Atta array, and a phase-conjugating array (PCA) in the designate operating bands. Despite of the innovative and successful implementation, in some applications with limited mounting space or payload, the feeding network of a four-element array could be still too complicated to be realized. To tackle the problem, in this presentation, a two-element dual-mode integrated array is introduced. The highlight of the idea, based on [2], is briefly discussed in the following sections.

2 Design concept

Our design goal is to fulfill a two-element array having dual operational modes in two bands. In the band #1, it is a retrodirective array while in the band #2 it becomes a beam-switching array with sum and difference patterns. As indicated in Fig. 1, the key component in the circuit realization is a dual-mode hybrid coupler. This dual-mode design should be equivalent to a 90° and a 180° hybrid coupler, respectively, in the two bands. The implementation is relied on the composite right-/left-handed (CRLH) transmission lines and purely left-handed and right-handed dual-operational synthesized transmission lines. Here, the characteristic impedance and phase delay of the CRLH lines are controlled simultaneously at both operating frequencies, which brings extra challenges and makes the new design different from those in the literature.

3 System Architecture and Results

In addition to the core component, i.e., the dual-mode hybrid coupler, the complete feeding network consists of diplexers and dual-mode delay lines, all realized using synthesized transmission lines. The radiation patterns in the band #1 (retrodirection) and band #2 (beam-switching) are shown in Fig. 2(a) and (b). Since the array is composed of only two elements, the scanning range, i.e. the beamwidth in which the RDA functions properly, is considerably extended to at least ±40°. In the meantime, the sum and difference patterns in the band #2 are completely orthogonal to each other, with the enveloped correlation coefficient (ECC) close to zero.

4 Conclusion

We briefly demonstrate the concept of a two-element heterogeneously integrated retrodirective/ beam-switching array. The design methodology will be disclosed in detail during the presentation.

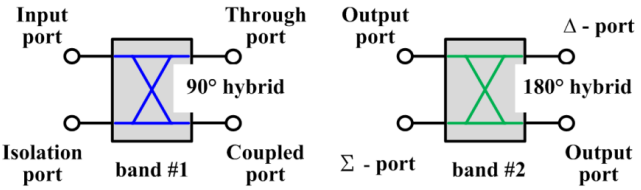

Figure 1 Key component of the two-element array.

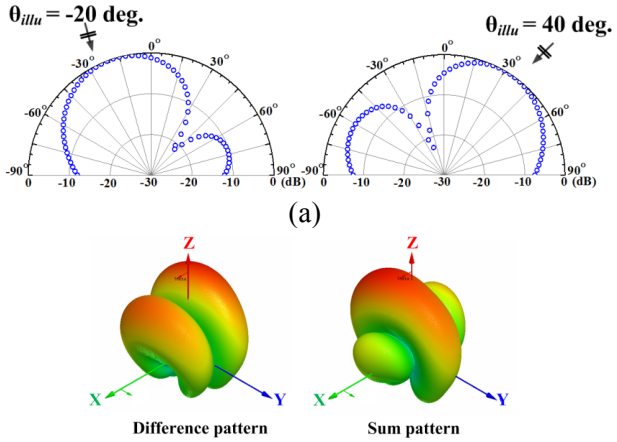

Figure 2 Radiation patterns of the two-element integrated array in (a) band #1 (retrodirection) and (b) band #2 (beam-switching).

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References

[1] C. H. Lai, C. Y. Shiau, and T. G. Ma, "Tri-Mode heterogeneous integrated beam-switching/Van Atta/phase-conjugating array using synthesized transmission lines," *IEEE Trans. Microw. Theory Techn.*, vol. 62, no. 9, pp. 2180-2192, Sept. 2014

[2] T.-G. Ma, C.-W. Wang, C.-H. Lai, Y.-C. Tseng, *Synthesized transmission lines: design, circuit implementation, and phased array applications*, John Wiley & Sons, in production.