

Beam Scanning of a Dual Reflectarray with a Reconfigurable Sub-reflectarray

Jiayue He⁽¹⁾, Fan Yang⁽¹⁾, Shenheng Xu⁽¹⁾ and Maokun Li⁽¹⁾

(1) The Department of Electronic Engineering, Tsinghua University, Beijing 100084, China
(fan_yang@tsinghua.edu.cn)

Electronic beam scanning is highly anticipated in high-gain antenna systems. For a totally electronically reconfigurable reflectarray, high gain accompanies a great number of integrated active devices, resulting in high cost and large power consumption. Luckily, the dual reflector (DR) configuration paves a new way by electronically controlling a small reconfigurable sub-reflectarray (SRA) which is introduced as part of the feed system of a large reflective aperture. Generally, systems in literature follow the design of a Cassegrain or Gregorian antenna, with the SRA imitating the special hyperbolic or ellipsoidal sub-reflector which has a movable focus (C. Tienda, J. Encinar, E. Carrasco, and M. Arrebola, "Design of Dual-Reflectarray Antenna for Beam Scanning," *Journal of Wireless Networking and Communications*, vol. 2, Feb. 2012). In this way, the DR intends to mimic a single reflector with a movable feed, both of which are somehow equivalent in optics. A limited scanning range has been observed of such DRs in literature, whereas few works evaluate and analyze the performances in detail.

This research calculates and compares the scanning performances between a basic dual reflectarray (DRA) system and the equivalent single reflectarray (RA) with a movable feed as in Fig. 1. High-gain beam scanning can be achieved with both systems, whilst with gaps in performances, as shown in Fig. 2. Contrast is made in terms of the Compression Ratio of the Beam-direction (*BCR*), the scan loss with a given θ_m and the 3-dB scan range of gain loss. *BCR* is defined in Eq. (1). The *BCR* of the DRA slightly shrinks from 0.72 to 0.67 as θ_m increases from 2.5° to 7.5° , whereas that of the single-RA keeps stable at 0.80 along. Moreover, the DRA suffers a much greater gain loss given the same θ_m . Taking $\theta_m=7.5^\circ$ for example, the gain of the DRA decreases by 3.25dB relative to the focused beam, whereas that of the single-RA only decreases by 0.46dB. Consequently, the 3-dB scan range of the DRA is much narrower than that of the single-RA, with the former approximately 5° and the latter about 15° .

In summary, the calculated scanning performance of a basic DRA is demonstrated and evaluated through a comparison with a corresponding single-RA with a movable feed. Further analysis will be conducted to reveal reasons for the performance differences, and future attention will be paid to novel compensation strategies for better scanning performance.

$$BCR = |\theta_{beam}/\theta_m|. \quad (1)$$

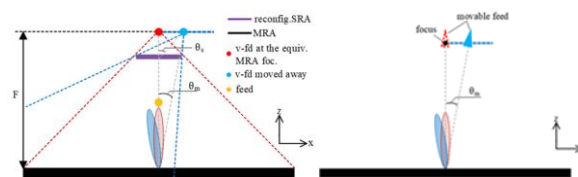


Figure 1. The system configuration of the studied DRA (left) and the equivalent single-RA (right).

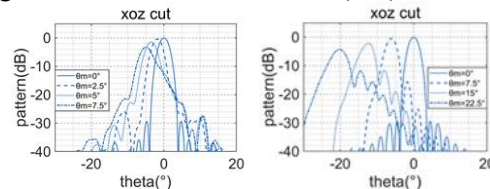


Figure 2. Calculated scanning patterns of the studied DRA (left) and the equivalent single-RA (right).