

## Ultra Wideband Balanced Feeds for Scanning Arrays

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Differential feeding techniques are needed for exciting balanced dipoles, and therefore avoid common mode resonances when scanning in the E-plane (J. R. Bayard, et. al. "E plane Scan Performance of Infinite Arrays of Dipoles Printed on Protruding Dielectric Substrates: Coplanar Feed Line and E-Plane Metallic Wall Effects," in IEEE Transactions on Antennas and Propagation, vol. 41, no. 6, pp. 837-841, June 1993). In the case of ultra wideband arrays, these common modes arise at particular frequencies due to coupling between the ground plane or any other third conductor within the feed network.

The most common approach to suppress common modes is to employ an external balun feed. However, such baluns are bulky, expensive, and have limited bandwidth. On the other hand, integrated baluns provide wideband feeding options in a low profile setting. Among these integrated baluns, the tapered and Marchand balun have been employed more widely. More specifically, Marchand balun have also been demonstrated to be of low loss and wideband feeds (J. P. Doane, et. al. "A Wideband, Wide Scanning Tightly Coupled Dipole Array with Integrated Balun (TCDA-IB)", in IEEE Transactions on Antennas and Propagation, vol. 61, no. 9, pp. 4538-4548, Sept. 2013). Also, tapered baluns have been proposed for wideband operation with one example given by Cha et.al. (S. G. Cha, et. al. "Wideband and compact microstrip tapered balun with circular slot and double dielectric layer," IEEE International Symposium on Antennas and Propagation & USNC/URSI National Radio Science Meeting, San Diego, CA, 2017, pp. 747-748).

In this paper we provide a comparison among various balanced feeds and identify optimal low profile baluns that are wideband and concurrently of low loss. The baluns to be presented include: 1) Exponentially tapered, 2) Linear tapered, 3) Marchand, and 4) Co-planar waveguide (CPW) to co-planar stripline (CPS) baluns. Based on the understanding of the design trade space for these baluns, an optimal feed is presented with the following features: low profile, low loss, wideband matching, common mode free, low angle scanning, minimal complexity, and low cost. At the conference, measurements of a fabricated prototype will be presented showing operation across 1-18GHz with scanning down to low angles without common mode resonances.