

Ultra-Low Loss Wideband Array Feed Tiles with High Isolation

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Isolated feed (signal distribution) networks play a crucial role in modern active electronically scanned arrays (AESAs). Although through calibration, AESAs can better tolerate distribution network imperfections than passive array systems, high feed isolation and low loss remain extremely desirable attributes. In transmit mode, isolation is critical for the stability of driver amplifiers and loss-compensation amplifiers, while feed losses directly impact effective isotropic radiated power (EIRP) and/or power consumption. In receive mode, feed isolation helps RF beamforming architectures cope with large in-band jammers and blockers, particularly when the T/R modules employ low resolution phase-shifters or variable gain amplifiers.

For two-dimensional printed circuit board (PCB) based arrays, the corporate or H-tree feed structure is by far the most popular RF signal distribution option. Corporate feeds use multiple Wilkinson power dividers/combiners, that provide 15 dB or higher isolation, connected via controlled impedance lines and sometimes are interspersed with loss-compensating amplifiers. However, as the bandwidth and array size increase, corporate feeds face significant challenges. First, each Wilkinson junction area increases proportionally to the bandwidth ratio (BWR), and the total excess insertion losses scale proportionally to $\log_2 N$ in dB, where N is the number of elements in the array. These trends make planar corporate feeds impractical for bandwidths wider than 2:1 BWR for even modest array sizes.

To address these issues, radial parallel plate waveguide (PPWG) cavity feed networks have been proposed in (L. J. Kipfer, R. W. Kindt, M. N. Vouvakis, "Wideband Isolated Dual-Polarized Array Feeds," *2022 IEEE Internat. Symp. on Antennas and Propag.* Denver, CO, USA, 2022) These structures are borrowed from power combined high power source designs, that are known for their very-low loss that is independent of the division ratio. However, in these structures it is quite challenging to isolate the divided ports. In (L. J. Kipfer, R. W. Kindt, M. N. Vouvakis, "Wideband Isolated Dual-Polarized Array Feeds," *2022 IEEE Internat. Symp. on Antennas and Propag.* Denver, CO, USA, 2022) a nearly 15dB isolated radial feed with 6:1 BWR was designed, built and measured, but it resorts to embedded resistors that pose various challenges, e.g. limited power handling.

The goal of this work is to improve the isolation of these radial feed networks to be better than 20dB over a wide bandwidth without resorting to embedded resistors and without compromising the already low losses of the feed. To get this increased isolation this work proposes to couple with wideband quadrature hybrid couplers at the input and output of two stacked PPWG radial combiners/dividers akin the approach used in balanced amplifiers.

The presentation will provide a broad overview of phased array feeds, cover the design process and present simulation and hopefully experimental results.