Octave-Band Orthomode Transducers for the Expanded Very Large Array

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The Expanded Very Large Array (EVLA) project is currently under way to upgrade the Very Large Array (VLA) to improve the sensitivity, bandwidth, spectral resolution and frequency coverage of the existing array of 27 radio telescopes. Three of the EVLA receivers will provide octave band coverage for the L-band (1 GHz to 2 GHz), S-Band (2 GHz to 4 GHz) and C-band (4 GHz to 8 GHz). For the L, S and C bands, the polarizer consists of a quad-ridge orthomode transducer (OMT) that separates the orthogonal linearly polarized components of the signal. The OMT is followed by a quadrature hybrid which adds the linear outputs together with the appropriate phase shift to detect the circularly polarized components of the astronomical signal.

The quad-ridge OMT was designed with a strong emphasis on manufacturability and ease of tuning since the EVLA project requires 30 units (one for each of the 27 antennas and 3 spares) for each of the L, S and C bands, or a total of 90 units, to be manufactured by 2012. The OMT designs were extensively analyzed and optimized using theoretical models and finite-element electromagnetic simulation tools (Ansoft's High-Frequency Structure Simulator, HFSS). Extensive parametric analyses were carried out using HFSS to determine the most critical dimensions and set fabrication tolerances accordingly.

A novel scheme is implemented to eliminate trapped-mode resonances that tend to occur in quad-ridge orthomode transducers, enabling the OMT to meet stringent specifications over an entire octave bandwidth. Prototype OMT structures have been fabricated and measured at the L, S and C bands. The prototypes could be tuned in less than one hour for both polarizations.

The measured performance of the prototype OMT structures correlates well with simulated results, and meets the -15dB return loss specification by very wide margins for all bands. Additionally, the measured results show excellent performance in terms of transmission and isolation between orthogonally polarized signals over the entire octave bandwidth, with no evidence of trapped mode resonances.