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Preliminary Measured Results of a Diagonal Quadruple-Ridged Ku-Band OMT

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Introduction

This paper briefly summarizes the measured results of two fabricated Ku-Band Diagonal Quadruple-Ridged OMT prototypes. The design is similar to the EVLA X-Band Diagonal Quadruple-Ridged OMT [1], having four ridges that are diagonal to the input square waveguide, and detecting circularly polarized signals when used in conjunction with a corrugated waveguide phase shifter [2]. Due to physical and electromagnetic constraints, however, dimensions are not directly scaled from the X-band design. Future publications will document the electromagnetic design in detail. This paper demonstrates the viability of extending the upper frequency of quadruple-ridged OMT designs to 18 GHz.

Measured Results

Measurements of reflection, amplitude match, circularly-polarized insertion loss, and isolation were taken at room temperature with an Agilent E8364B PNA Series network analyzer using techniques outlined in [1].

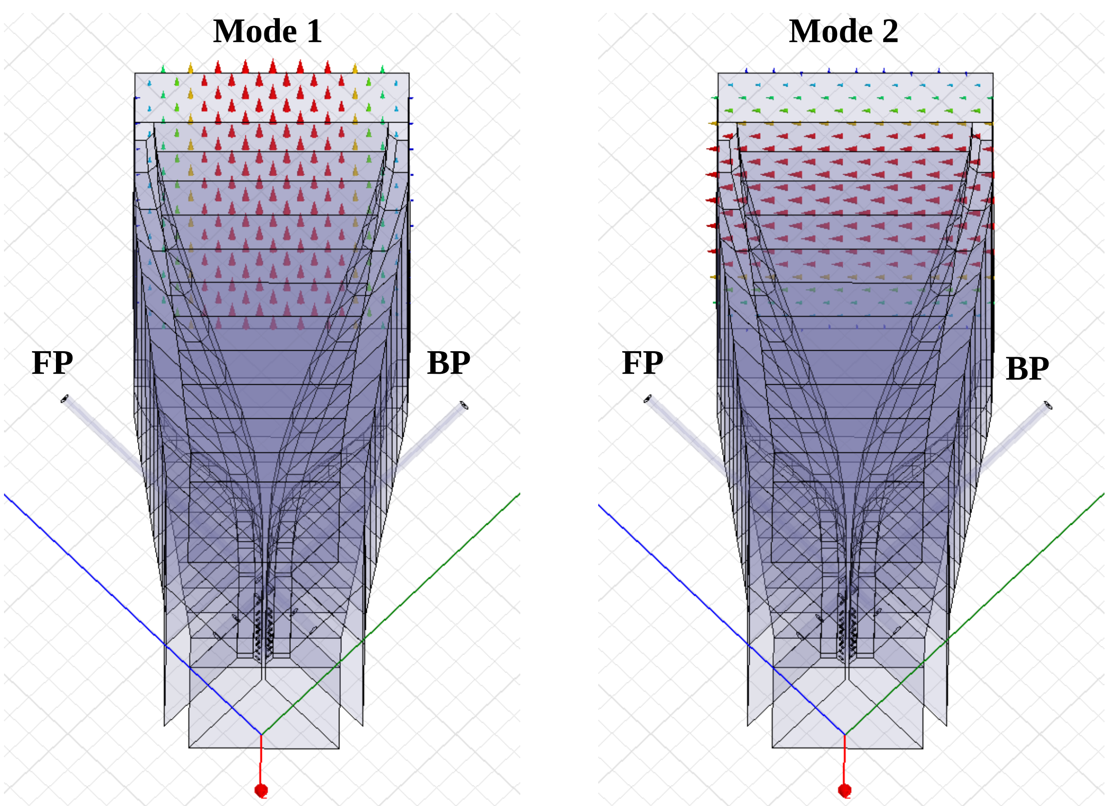

Figure 1: OMT Diagram Showing Modes and Ports

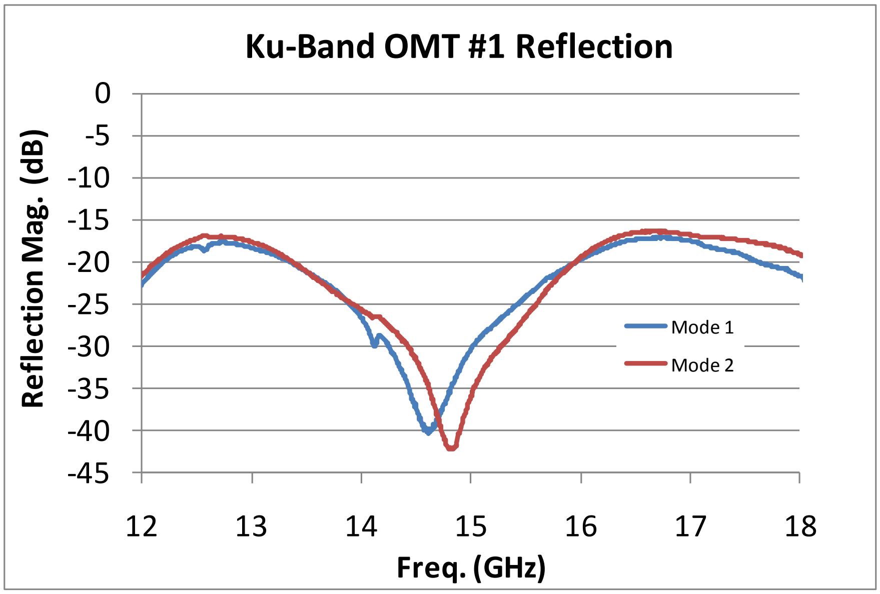

Figure 2: Ku-Band OMT#1 Reflection

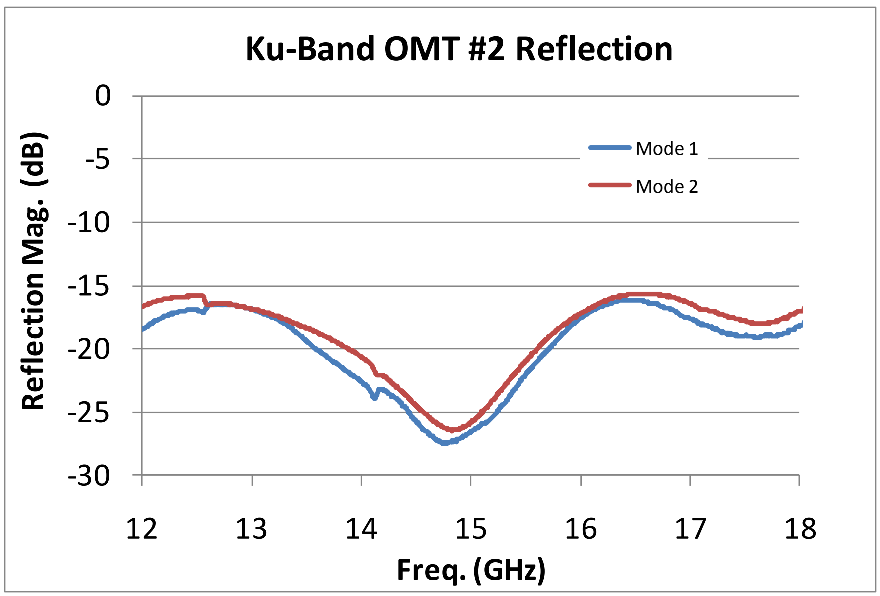

Figure 3: Ku-Band OMT#2 Reflection

Figure 2 and Figure 3 show that the measured reflection response of both OMT prototypes exceeds the 15 dB return loss specification by a comfortable margin across the 12 GHz to 18 GHz band for both input square waveguide modes (illustrated in Figure 1). The first OMT prototype has a return loss of 16.3 dB or better across the band, while the second OMT prototype has a return loss 15.6 dB or better.

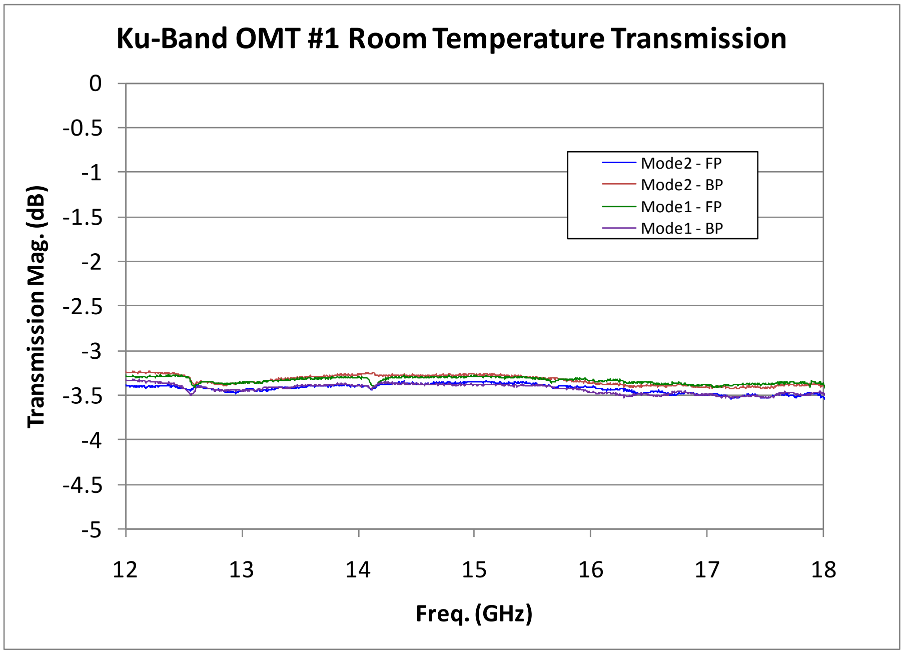

Figure 4: Amplitude Match of Prototype #1

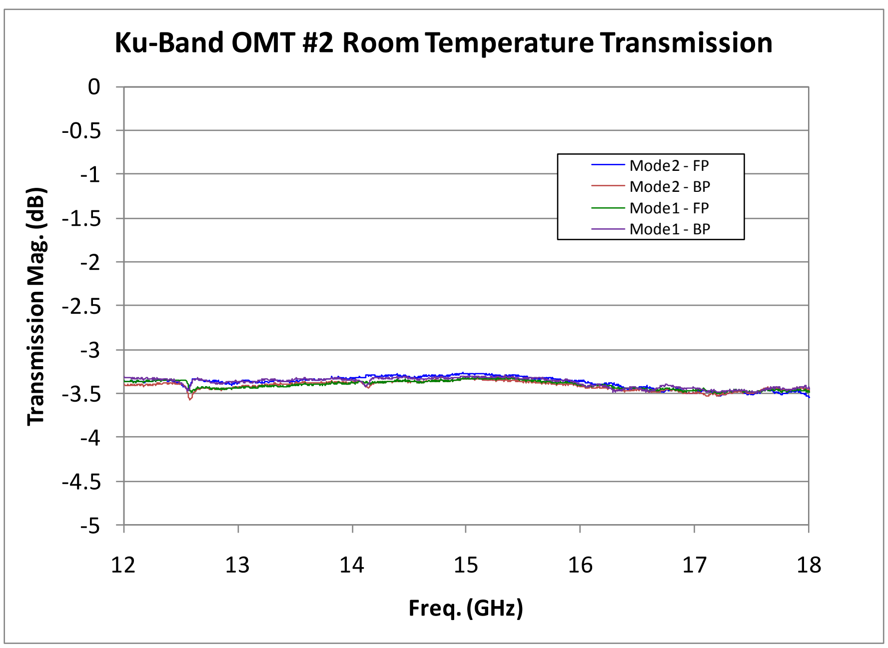

Figure 5: Amplitude Match of Prototype #2

Precise amplitude matching is essential for accurate detection of circularly polarized signals, which relies on the summation and cancellation of orthogonal components. There are four possible signal paths through the OMT, from the two orthogonal square waveguide input modes ('Mode 1' and 'Mode 2') through to the two coaxial outputs (Front Probe 'FP' and Back Probe 'BP'), as shown in Figure 1. As shown in Figure 4, the first prototype has a maximum amplitude mismatch of 0.18 dB, a minimum value of 0.048dB, and a 0.12dB average amplitude match. The second prototype, having a response shown in Figure 5, has a mismatch that varies between 0.0052 dB and 0.19 dB, averaging 0.057 dB across the band. The amplitude response for both prototypes is therefore well matched, indicating a reasonably symmetric OMT structure, and good performance in terms of circular polarization.

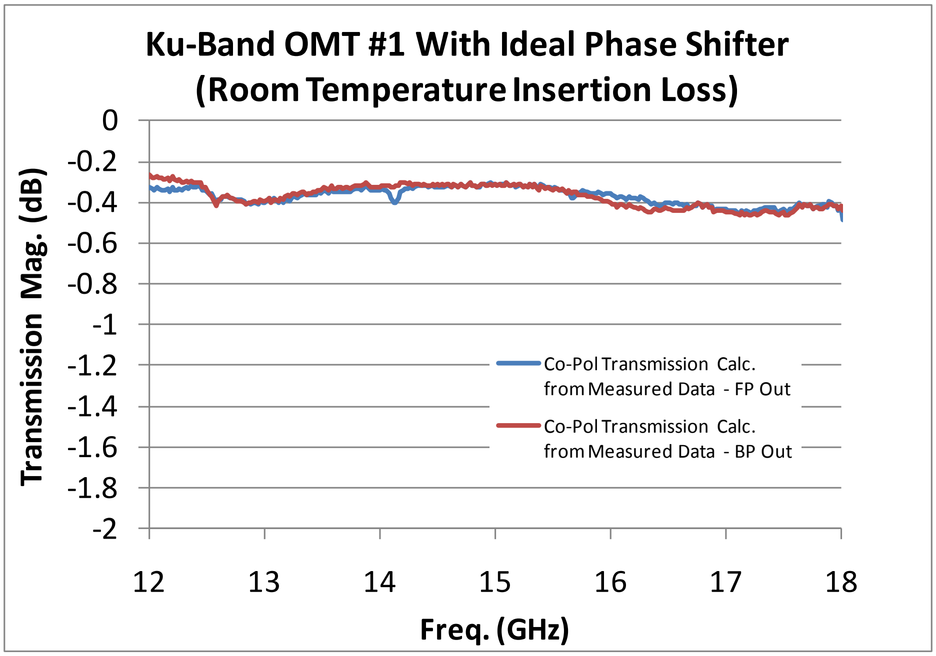

Figure 6: Circularly polarized transmission of Prototype #1

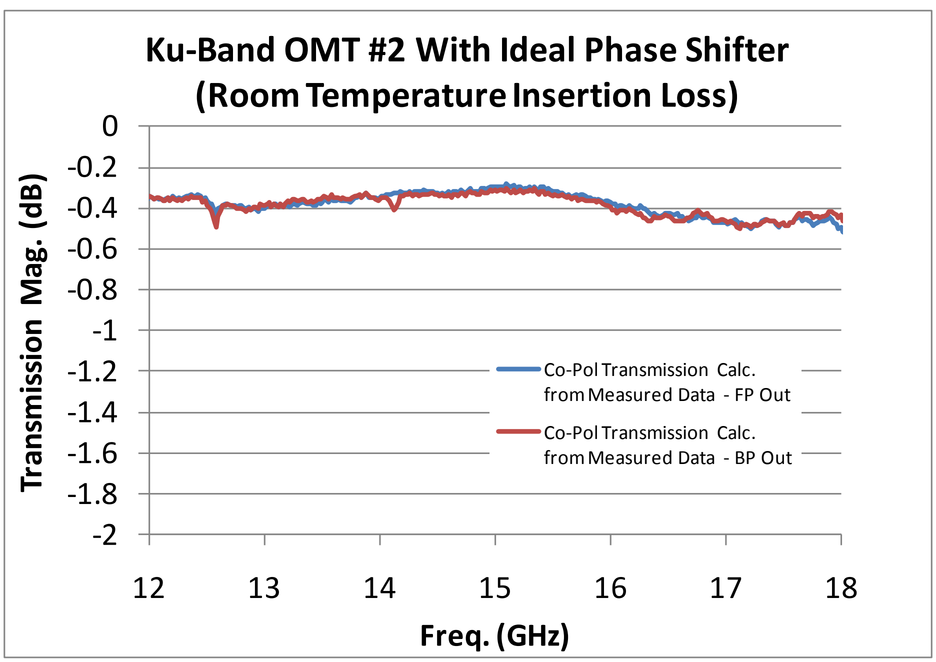

Figure 7: Circularly polarized transmission of Prototype #2

The measured transmission response of the OMT is determined by calculating the circularly polarized insertion loss from measured OMT data cascaded with an ideal, lossless 90 degree phase shifter. This represents the measured insertion loss of the OMT in a circularly polarized system. For the first prototype, the room temperature insertion loss of the Ku-Band OMT, shown in Figure 6, averages 0.37dB for both the FP and BP outputs. The insertion loss varies between 0.27dB and 0.47dB across the 12 GHz – 18 GHz band. As shown in Figure 7, the insertion loss for the second OMT prototype varies between 0.5 dB and 0.28 dB in the 12 GHz to 18 GHz band. The second OMT prototype has average insertion loss values of 0.38 dB and 0.39 dB, respectively, for the FP and BP outputs. The insertion loss will be significantly reduced in a cryogenic environment.

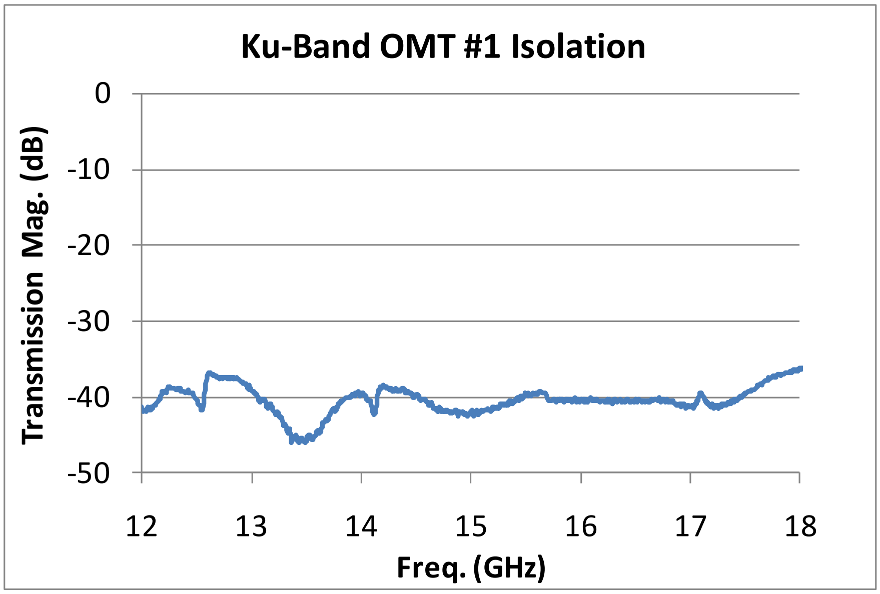

Figure 8: Isolation between coaxial ports of Prototype #1

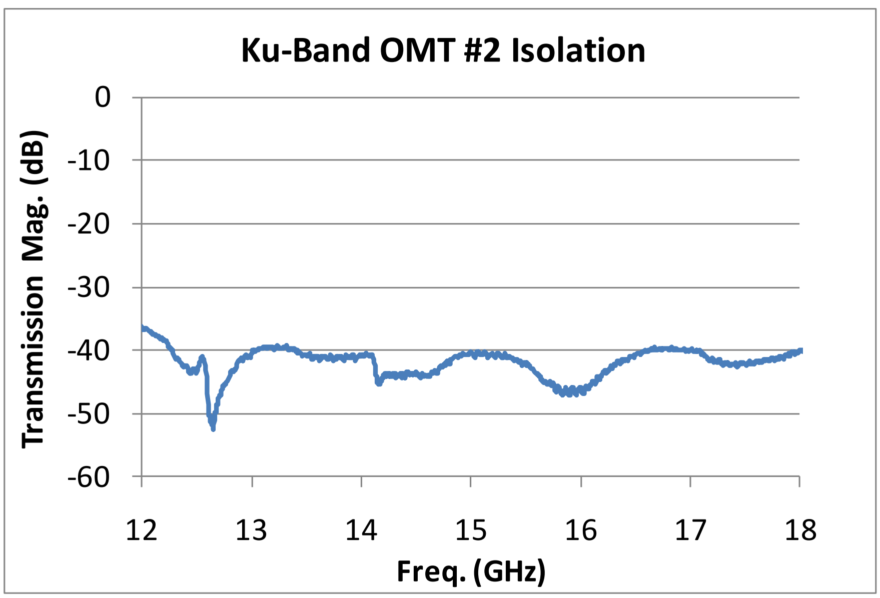

Figure 9: Isolation between coaxial ports of Prototype #2

For the first prototype, the isolation is 36.3 dB or better, averaging 40.4 dB across the 12 GHz- 18 GHz band as shown in Figure 8. Isolation for the second prototype, shown in Figure 9, is 36.5 dB or better, averaging 41.9 dB across the Ku-Band. The isolation of both prototype OMTs is very good across the band, indicating a reasonably symmetric fabricated structure.

Conclusions

Two Ku-Band Diagonal Quadruple-Ridge OMT prototypes were fabricated, and tested at room temperature. Measured results indicate that both units perform well in the context of a circularly polarized system. Future work could further extend the OMT bandwidth, and possibly push the maximum operating frequency to over 20 GHz.

Refrerences

[1] Coutts, G. M., "Wideband Diagonal Quadruple-Ridge Orthomode Transducer for Circular Polarization Detection," *Accepted for Publication in the IEEE Transactions on Antennas and Propagation*.

[2] S. Srikanth, "Wide-Band Corrugated Rectangular Waveguide Phase Shifter for Cryogenically Cooled Receivers," *IEEE Microwave and Guided Wave Letters*, vol. 7, no. 6 , pp. 150-152, June 1997.