

A Symmetric 1mm Orthomode Junction

E. Wollack (NASA/GSFC)
W. Grammer (NRAO/Tucson)

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Summary: We summarize the preliminary electrical characterization of set of prototype WR03.7 full-band orthomode transducers (OMT). The design is derived from the junction described in [1, 2]. This design is intended as a proof-of-concept for the ALMA 1mm (Band-6) OMT. To produce a manufacturable side-arm power combiner in this band, a discrete compensation approach related by symmetry to a mitre bend is employed. To mitigate the total ohmic loss in the test structure, this is done in overmoded square guide. The main-arm septum is integrated into a four step Chebyshev waveguide 2:1 impedance transformer.

Two pairs of OMT split-block housings were fabricated from leaded (360) brass, to verify reproducibility of the approach. The main arm output sections on one set were formed using EDM (electric-discharge machining), and on the other set by electroformed copper inserts. In these preliminary tests, a difference in RF loss between the two manufacturing techniques was not apparent; however, more precise measurements need to be done to verify this. In a production design, this fabrication detail may be modified to suit the details of the mixer block interface. The septum was produced by photolithographic etching on a 0.0014" thick BeCu sheet. Copper-stainless steel magnet wire with a diameter of 0.0023" was used to compensate the junction. All components were subsequently gold plated.

The measured performance indicated in Figure 1 was with the nominal septum placement and four wires to form the compensation for the junction. Measurement frequencies are normalized to the WR03.7 cutoff, $f_c = 159.6$ GHz. The potential to improve the side-arm return loss over band-6 atmospheric window will be explored.

An HP8510C vector network analyzer with Oleson millimeter-wave test sets for WR03.4 are used to measure the device's S-parameters. The overall calibration tended to drift due to the additional RF amplifiers and cabling required to interface between the HP85105-K10 on the VNA and the OLM-H01 extension modules. For this reason, the loss data presented is considered preliminary. Data was taken both in the WR03.4 (3/4" round flange) and WR03.7 (custom mini-flange) waveguides with TRL (Thru-Reflect-Line) calibration. For the WR03.4 calibration, a 2:1 transition with return loss less than 25dB was used mate to the native WR03.7 OMT guide. With in the experimental error, quantitatively consistent results were obtained with both calibration approaches. The 0.2dB ripple observed in the loss estimate results from the finite directivity of the VNA heads. The isolation data presented is for the side-to-main arm response with the common-arm open.

- Design Band: $192 < f < 303$ GHz
- Output Waveguides: WR03.7 ($0.037'' \times 0.0185''$)
- Input Waveguide: Square ($0.037'' \times 0.037''$)
- Return Loss: 17 dB

- Insertion Loss: < 0.6 dB
- Isolation: > 35 dB
- Mass: < 20 grams
- Envelope: $0.56'' \times 0.67'' \times 0.55''$

References:

[1] Bøifot, A.M., Lier, E., Schaug-Pettersen, T., “Simple and Broadband Orthomode Transducer,” 1990, *Proc. IEE*, vol. 137, no. 6, pp. 396–400; Bøifot, A.M., “Classification of Ortho-Mode Transducers,” 1991, *European Transactions on Telecommunications and Related Technologies*, vol. 2, no. 5, pp. 503–510.

[2] Wollack, E.J., Grammer, W., and Kingsley, J., The Bøifot Orthomode Junction, May 2002, NRAO, ALMA memo series #425.

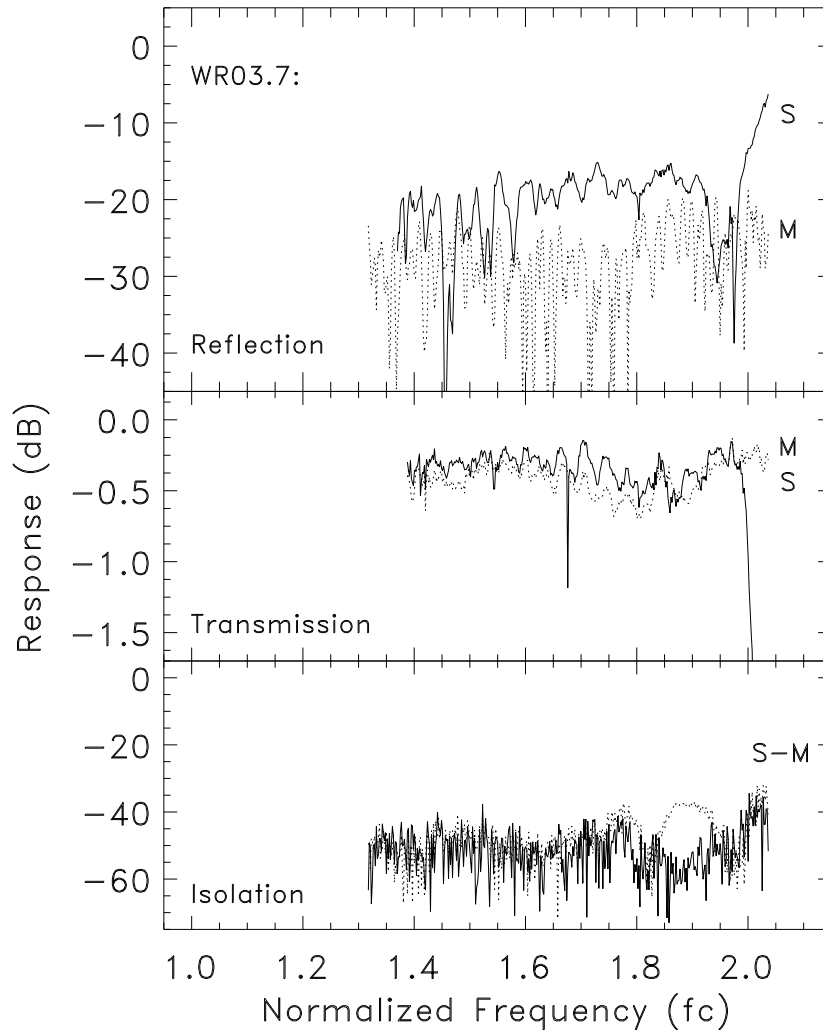


Figure 1: **Measured Alma Band-6 Orthomode Transducer Performance (WR03.7 TRL Calibration)**. The main- and side-arm return and insertion losses are indicated by solid and dashed lines respectively. The average observed loss in the main- and side-arms is consistent with the theoretical estimates, however, the accuracy of insertion loss data presented is limited by calibration stability achieved. The main- to side-arm isolation with the square common-arm terminated with an open is indicated by the dashed line. The noise floor of the calibration is indicated by the solid line.