A Turnstile-Based X-band 3D-Printed Orthomode Transducer

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Abstract—This paper describes a wideband 3D-printed orthomode transducer (OMT) designed for the X-band satellite communications. The OMT architecture is based on a symmetrical turnstile junction with a rectangular waveguide network of 90-degree E-plane bends and T-junctions. Notably, the symmetrical design gives a natural isolation between orthogonal polarisations, achieving a greater operational bandwidth [1] [2]. The proposed OMT is fabricated by mask stereolithography (MSLA) technology with photocurable resin materials, followed by manual in-house conductive painting. The measurements align well with simulations, proving the viability of the theory. The fabricated OMT realises complete coverage of the SATCOM X-band from 7.2 to 8.6 GHz. The input orthogonal signal has been verified to be effectively separated and output from two different ports, respectively. The return loss is larger than 20 dB at the two rectangular waveguide ports, where the isolation is greater than 35 dB. The employment of 3D printing also showcases the promising application of additive manufacturing technology, with comparable performance of traditional metal machined components.
Keywords—3D printing, additive printing, orthomode transducer (OMT), turnstile junction, satellite communications.

The fabricated OMT is shown in Fig. 1. The 90-degree bends connect the turnstile junction to the T-junction at the bottom in Fig. 1(a) and (b). The cone-shaped matching structure in Fig. 1(c) ensures a good match at the circular waveguide port. Finally, after orthogonal separation, the two pairs of signals merge at the T-junctions and output from ports 2 and 3 in Fig. 1(d), completing the conversion from CP to LP. Measurements are shown in Fig. 1(e) below:

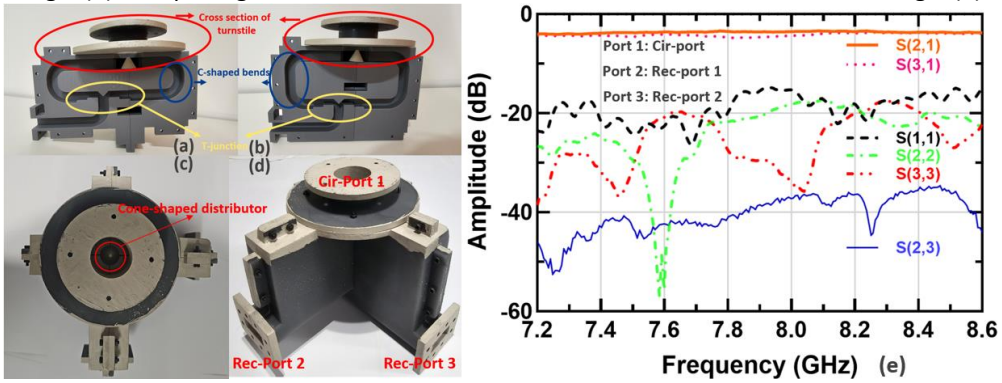

Fig. 1. Fabricated 3-port OMT and measurements: (a) Network 1, (b) Network 2, (c) Top view, (d) Overview, (e) Measurements.

By considering port 1 is a circular port supporting orthogonal TE11 modes, port 2 and port 3 are rectangular ports for linear horizontal and vertical signal output, respectively. When a vertical signal is input from port 1, since it can only transmit to port 3, port 3 has valid S-parameters, but port 2 is equivalent to being terminated, as shown in Fig. 2(a). On the contrary, if a horizontal signal is input from port 1, port 2 has valid S-parameter while port 3 is equivalent to being terminated, as shown in Fig. 2(b).

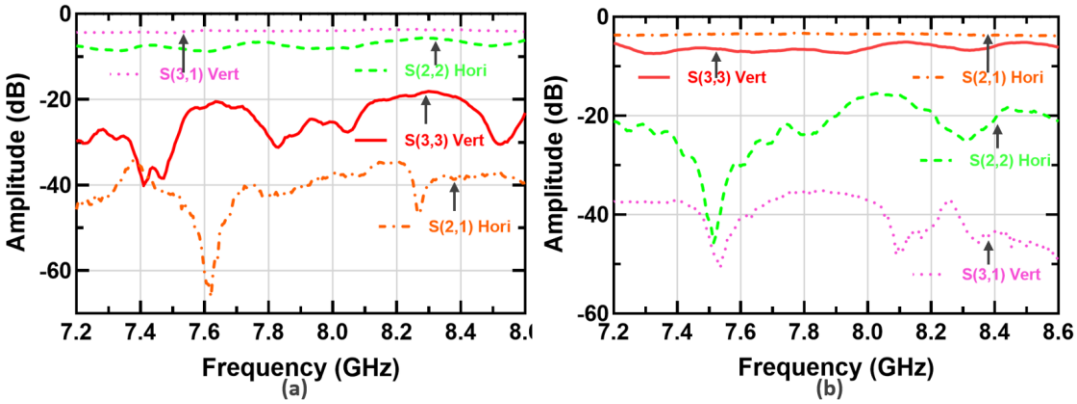

Fig. 2. Orthogonal separation measurements: (a) Vertical input, (b) Horizontal input.

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