A Turnstile Quad-Ridge OMT for Full Octave-Bandwidth Receivers

Doug Henke*[1], Neal Kelly[1], Kyle Marshall[1], Ivan Wevers[1], and Lewis B. G. Knee[1]

***Abstract*—We report on measured results of a turnstile quad-ridge OMT suitable for millimeter-wavelength receivers. The quad-ridge OMT is directly compatible with a quad-ridge feed horn to facilitate dual-polarization low-noise receivers that exceed the single-mode bandwidth of rectangular waveguide. We have chosen a bandwidth of 24–51 GHz to demonstrate machinability and implementation.**

***Keywords*—octave-bandwidth receivers, OMT, orthomode transducer, quad-ridge OMT, ridge waveguide**

I. The Turnstile Quad-Ridge OMT

In order to exceed the usable single-mode bandwidth of a standard waveguide (i.e., ~1.7:1), the waveguide cross-section must be modified; most often ridges or fins are used to modify the circular and rectangular waveguide sections. There are existing quad-ridge OMTs that exceed an octave bandwidth and make use of coaxial probes/pins, in combination with a backshort, to couple out the polarized signals (see [1] as an excellent recent example). As frequencies exceed 10 GHz, however, the tight clearances required for the ridges and probes become increasingly difficult to manufacture and assemble. Planar OMTs may also be paired with quad-ridge feed horns for wide bandwidth operation [2], [3].

In [4] and [5], a quad-ridge turnstile OMT was demonstrated with performance exceeding an octave bandwidth across impressive frequency ranges of 6–19 GHz and 18–45 GHz. The OMT was also paired with a separate quad-ridge feed horn. In order to manufacture the OMT, the base and upper blocks were each sectioned into 4 quarters, and each ridge section was clamped within the joins. The turnstile tuning stub was replaceable to allow for experimentation with various stub geometries.

In [6], a conceptual design of the turnstile quad ridge OMT was shown following a layer approach where the ridges were directly machined into the adjoining layer, instead of as separate assemblies. Here, we present measured results with details on implementation and machinability. A frequency range spanning 24–51 GHz was used to demonstrate the design.

As shown in Fig. 1 (a), the turnstile quad-ridge OMT is a network of ridge waveguide components: a quad-ridge circular input, a turnstile with single-ridge rectangular outputs, E-bends with double-ridge waveguide, and a T-junction single-ridge combiner.

The six-layered design is compatible with a 3-axis milling machining center and Fig. 1 (c) illustrates how the ridges are milled into the adjacent layer.

To provide compatibility with standard rectangular waveguide for measurement, custom adapters spanning WR-34 and WR-22 were used, as shown in Fig. 2. Tellurium copper was used throughout.

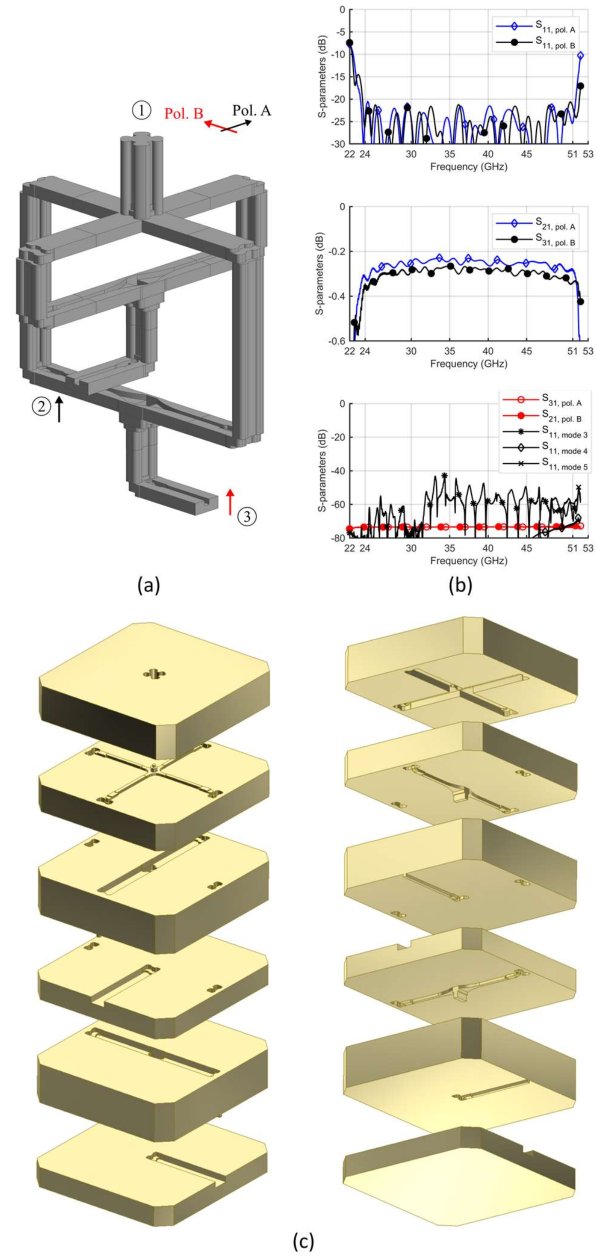

Fig. 1. (a) CAD model of the quad-ridge turnstile OMT showing the waveguide channels and corresponding polarization outputs. Encircled numbers represent the ports for simulation. (b) Simulated results of the OMT. (c) Iso views showing the waveguide channel and ridge details.

The measured OMT demonstrated 15 dB return loss across 24–51 GHz, as shown in Fig. 3 (a) and (b). Cross-polarization leakage [Fig. 3 (c)] and port isolation were both measured < -40 dB, with mean values of ~-50 dB. Insertion loss was found to be 0.25–0.4 dB across the band. Full details can be found in [7].

[1]NRC Herzberg Astronomy and Astrophysics, Victoria, B.C., Canada.

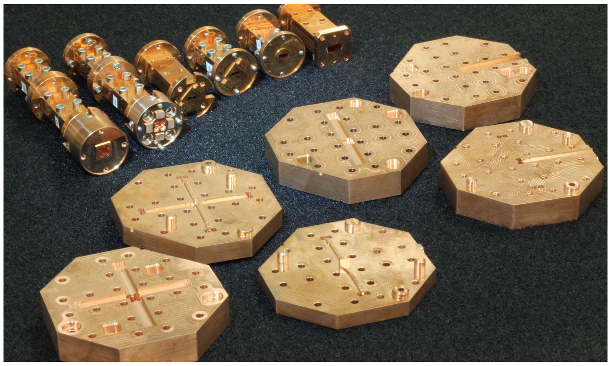

Fig. 2. Machined adapters and quad-ridge OMT. Since the operating bandwidth spans two standard waveguide bands (WR-34 and WR-22), custom adapters were used to transform to single-ridge waveguide. A cloverleaf shaped transition was used to excite the OMT quad-ridge input. 6 layers were used to complete the OMT assembly.

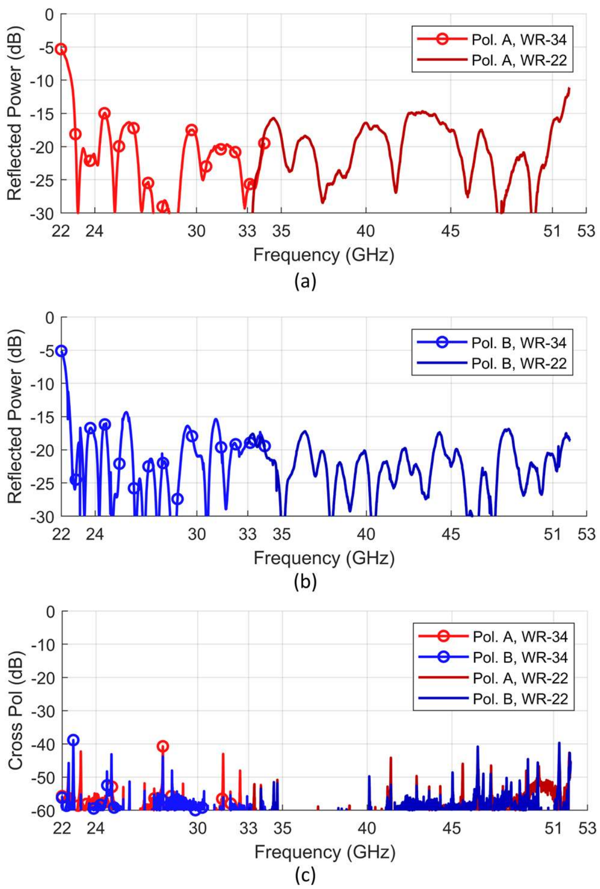

Fig. 3. Measure response of the fabricated quad-ridge turnstile OMT. The reflected power response, i.e., S_{11}, is shows in (a) and (b) for polarization A and B, respectively. Cross-polarization leakage is shown in (c).

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