Split-Block Waveguide Polarization Twist for 220 to 325 GHz

This device is superior to conventional twisted rectangular waveguides for submillimeter wavelengths.

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A split-block waveguide circuit that rotates polarization by 90° has been designed with WR-3 input and output waveguides, which are rectangular waveguides used for a nominal frequency range of 220 to 325 GHz. Heretofore, twisted rectangular waveguides equipped with flanges at the input and output have been the standard means of rotating the polarizations of guided microwave signals. However, the fabrication and assembly of such components become difficult at high frequency due to decreasing wavelength, such that twisted rectangular waveguides become impractical at frequencies above a few hundred gigahertz. Conventional twisted rectangular waveguides are also not amenable to integration into highly miniaturized subassemblies of advanced millimeter- and submillimeter-wave detector arrays now undergoing development. In contrast, the present polarization-rotating waveguide can readily be incorporated into complex integrated waveguide circuits such as miniaturized detector arrays fabricated by either conventional end milling of metal blocks or by deep reactive ion etching of silicon blocks. Moreover, the present split-block design can be scaled up in frequency to at least 5 THz.

The main step in fabricating a split-block polarization-rotating waveguide of the present design is to cut channels having special asymmetrically shaped steps into mating upper and lower blocks (see Figure 1). The dimensions of the steps are chosen to be consistent with the WR-3 waveguide cross section, which is 0.864 by 0.432 mm. The channels are characterized by varying widths with constant depths of 0.432, 0.324, and 0.216 mm and by relatively large corner radii to facilitate fabrication. The steps effect both a geometric transition and the corresponding impedance-matched electromagnetic-polarization transition between (1) a WR-3 rectangular waveguide oriented with the electric field vector normal to the block mating surfaces and (2) a corresponding WR-3 waveguide oriented with its electric field vector parallel to the mating surfaces of the blocks.

A prototype has been built and tested. Figure 2 presents test results indicative of good performance over nearly the entire WR-3 waveguide frequency band.

This work was done by John Ward and Goutam Chattopadhyay of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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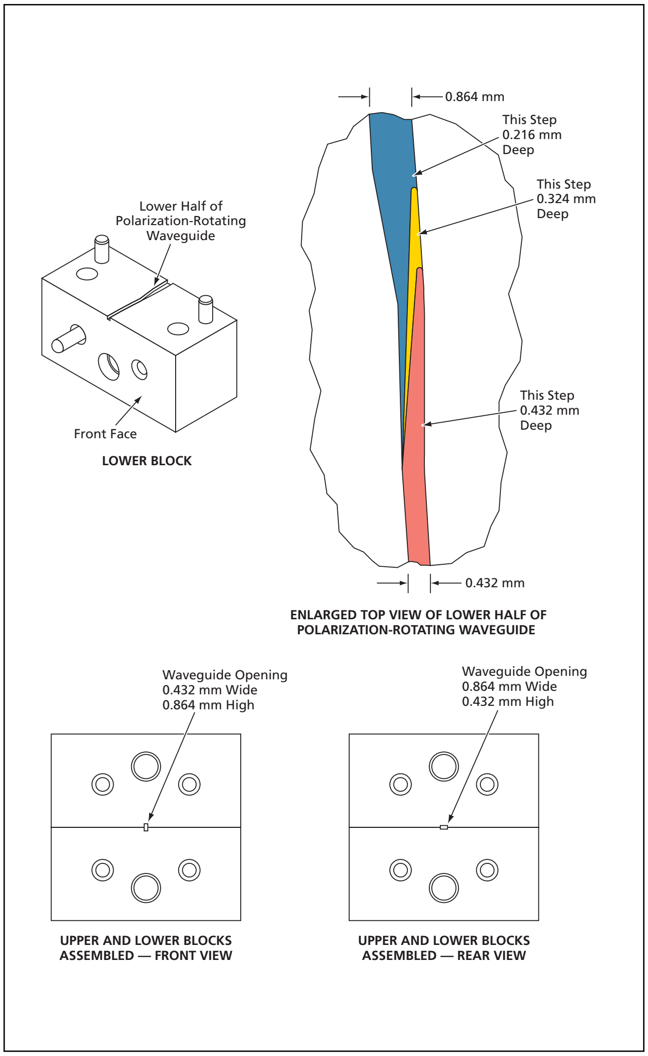

Figure 1. A **Channel Having Asymmetric Steps** is cut into the lower block. An identical channel is cut into the upper block. Then with the help of alignment pins, the blocks are assembled so that the two channels merge into one channel that makes a transition between two orthogonal orientations of a WR-3 waveguide.

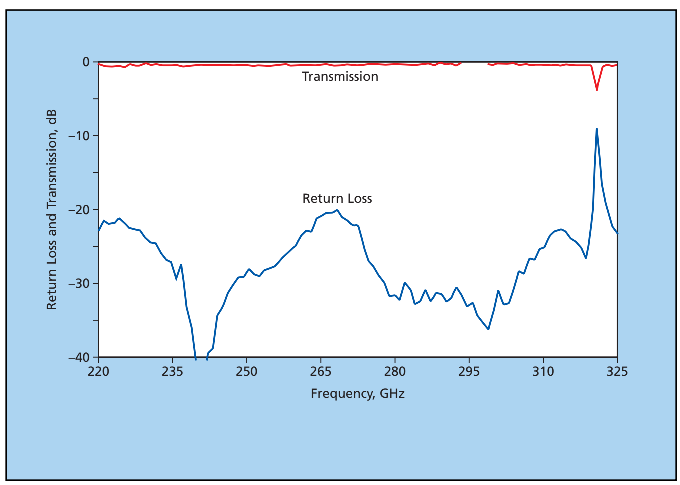

Figure 2. The **Return Loss and Transmission** of a prototype of a polarization-rotating waveguide like that of Figure 1 was measured over the nominal frequency band of WR-3 waveguide.