Broadband Rotman Lens Design

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Planar microwave lenses like the Rotman lens are good candidates for many millimeter wave applications including communications, automotive radar and biomedical imaging because of their ability to form multiple beams at wide angles. The Rotman lens exhibits a theoretically large bandwidth due to its true time delay (TTD) beamforming nature. They have been studied for several decades with many devices demonstrated in various technologies including the most common microstrip and rectangular waveguide-based. However, lenses built using rectangular waveguides suffer from higher order modes, which limit their bandwidth to less than an octave. Microstrip lenses can be built at these frequencies, but they often have high loss. To alleviate the above discussed issues, two separately designed double ridged waveguide Rotman lens with single modal operation over almost a 3:1 bandwidth are designed, fabricated and measured. The first lens operates over an 18 to 50 GHz bandwidth, and is constructed using traditional split block machining. The second lens operates over a 70 to 170 GHz bandwidth, and is constructed using surface micromachining. To facilitate measurements, the Ka-band lens is transitioned to the custom double-ridge waveguide, while the 100GHz instantaneous bandwidth device is terminated in a WR-10 rectangular waveguide. This work discusses the development of both lenses, starting off with custom double ridge cross section design. The transition to the parallel plate cavity of the lens will be shown, along with a discussion on the proper termination of sidewalls for broadband operation. Relevant conclusions will be supported by theory and measurements of both systems.