Dual-Mode Waveguide Cavity Filters and Multiplexers

Zheng Wang
Boulder Environmental Sciences and Technology, Boulder, CO, 80303
http:// www.boulderest.com

Small, integrated, and lightweight microwave radiometers are under development at Boulder Environmental Sciences and Technology for atmospheric observation. One of the crucial components of a direct detection radiometer is a filter. The filter determines the operational frequency band where the radiometer channel is sensitive to the observed scene. For spectroscopy around oxygen and water vapor absorption lines, multiple radiometer channels are required to cover the absorption line centers, the wings, and the atmospheric windows. Therefore, the individual filter should be designed to satisfy the calculated center frequency and the bandwidth accurately. As for cost, the filters have to be inexpensive and repeatable. The size of the filters should also be considered because it affects the overall size of the radiometer system.

A filter should have low insertion loss. At the millimeter wave range, a planar filter suffers from high insertion loss due to the dielectric substrate. By contrast, a waveguide cavity filter has far lower insertion loss as long as the conductivity of the metal body is sufficient. Dual-mode resonance cavities also grant the capability of widening the bandwidth simply by combining two resonant modes adjacent with each other. In order for accurate atmospheric observation, the filter's bandwidth and center frequency have to be stable over the radiometer operational temperature range from -40°C to +80°C. However, due to the thermal expansion or contraction of the metal body, the size of the cavity varies. Therefore, a metal with low coefficient of thermal expansion should be used in manufacturing the filters. Machining tolerances also affect the accuracy of the filter design and must be carefully monitored. Due to the higher harmonics of the resonant cavities, a wide-band bandpass filter is necessary to remove unwanted resonances. A multiplexer is required for multiple simultaneous radiometer channel observations and is designed based on a waveguide manifold. Each branch is odd multiples of a quarter guided wavelength away from the back-short at the filter's center frequency. Because the calculation is based on a single frequency, the distance of the branch from the back-short needs to be further tuned.

The presentation will start with the design details of the dual-mode waveguide cavity filters, as well as the wide-band bandpass filters. The measurement data of the cavity and the bandpass filters will be compared with the initial simulation. The manifold design of the multiplexer will also be discussed and the measurement results will be shown with the individual filters connected.