Ridge Waveguide Probe for Estimation of the Scattering Parameters of a Device at Millimeter- and Sub-Millimeter-Wave Frequencies

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In this study, we investigate a novel approach for on-wafer testing of active and passive circuits at Y-band and higher. This represents an alternative approach to the conventional coaxial- or CPW-based probes used at lower frequencies. The measurements based on coaxial probes at these high frequencies are unreliable and non-repeatable due to the small size of the fragile probe tips. The small dimensions of coaxial probes are needed to avoid over-moding and radiation from the fingertips of the probe. However, at high MMW and sub-MMW frequencies manufacturing tolerances limits the minimum size of such coaxial probes which inevitably leads to unreliable mode conversion and probe radiation. Another limitation in utilization of coaxial probes is that the smooth physical connection of the probes with on-wafer lines is very hard to achieve due to the small dimensions of the probes and the lines. Besides, the probe tips tend to deform after a number of measurements resulting in unreliable measurements.

Our proposed method for measuring the S-Parameters is based on non-contact coupling connection of the microstrip ports of a given device to a vertically aligned standard WR3 waveguide through a ridge waveguide transition as the non-contact probes. The configuration of the proposed method is illustrated in Figure 1 where it shows the transition from a standard WR3 waveguide that is connected to the frequency extender of a network analyzer to a ridge waveguide to concentrate the electric field near the gap close to the gap between a microstrip line and a shorted via without making any physical connection between the lines.

This method overcomes the common issues of coaxial probes discussed above. It is shown that with gaps as high as 20um the transition insertion loss is less than 0.8dB.This approach allows faster estimation of the S-Parameters of the device under test and is particularly useful in testing a large number of devices on a wafer and identifying the faulty ones.

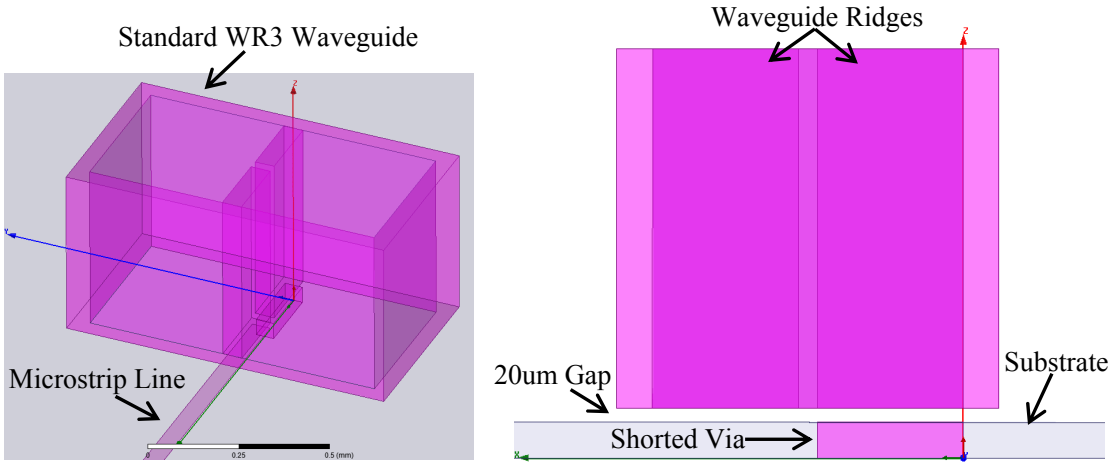

Figure 1. Transition from the standard WR3 waveguide to the microstrip ports of a given device; (a) 3D view and (b) side view.