Rectangular Waveguide Mode and Bandwidth Enhancement Using Common and Differential Excitation

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In recent past, the typical laboratory-grade network analyzer (NWA) was designed in a two-port configuration for measuring the scattering parameters S_{11},S_{21} under forward excitation and S_{22},S_{12} under reverse excitation. The forward and reverse excitation was generally controlled via a switch, thus only a single source was necessary. Recently, new NWA designs are including multiple-controlled sources, often having a source for every port. This multisource design configuration has been greatly influenced by the demands of integrated circuit technology in which interconnects are arranged in differential-mode pairs to reduce electromagnetic interference and electromagnetic susceptibility. These multisource NWA's allow simultaneous measurement of mixed-mode (i.e., common-differential-mode) scattering parameters in order to rapidly access design performance. Although not truly relevant here, it is interesting to note that the newer-generation NWA's also provide the capability to characterize nonlinear devices, which is important for researchers working in the metamaterial/complex media community. The goal of this research effort is to show how this multisource capability can now be exploited to enhance bandwidth performance and offer mode control in rectangular waveguides.

First, mixed-mode scattering parameters are briefly reviewed. Next, a new rectangular waveguide feed/launcher design is introduced and discussed. This new feed structure is comprised of two linear probes located at "a/4" and "3a/4", with "a" being the width of the rectangular waveguide. Note, this differs from the traditional rectangular waveguide feed which contains a single linear probe located at "a/2". Next, it is revealed how both common and differential-mode excitation of this new feed can enhance both bandwidth and mode control. It will also be shown how common and differential-mode excitation can enhance measurement diversity in various waveguiding structures and thus make it a potentially powerful capability for characterizing anisotropic and bianisotropic materials. General conclusions are drawn and future work is also discussed.

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