SOME MAGIC TEES WITH 2 TO 3 OCTAVES BANDWIDTH

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Techniques have been developed which extend the frequency range of ring magic tees to 7:1 or more. Experimental 250 to 1000 MHz ring magic tees have been built with 0.6 db insertion loss (above the 3 db power split), 0.2 db amplitude balance, 2° phase balance, and a 1.5:1 maximum VSWR over the 2-octave frequency range (Figure 4). An experimental 300 to 1800 MHz ring magic tee has been built with the performance shown in Figure 5.

Figure 1 shows schematically the basic ring magic tee, and a typical curve of VSWR versus electrical length. The four transmission lines are nominally 70.7 ohms characteristic impedance for a maximally flat design. If the line impedances are made 65 ohms, then the basic design has an equal ripple 1.18:1 VSWR bandwidth of one octave.

The bandwidth may be extended by placing a quarter-wave open stub in series with each port. By selecting transmission lines and stubs of appropriate characteristic impedances, acceptable standing wave ratios for bandwidth ratios of 4.5:1 may be obtained. Figure 2 shows a schematic of the stubbed magic tee with a typical equal ripple VSWR curve plotted against electrical length of the stubs or sides of the ring.

The bandwidth can be further extended by the addition to the extended design of a shorted stub in parallel with the ports of the magic tee. Figure 3 shows a schematic of this doubly-compensated ring magic tee and a typical curve of its VSWR performance versus its electrical line length.

NOTES

The broad-band magic tee may be conveniently built in microstrip or in coax. More than two stubs can be added with a corresponding improvement in the bandwidth, but the impedance of the lines and stubs and the theoretical performance have not yet been calculated.

A basic limitation on the bandwidth of the extended designs is inherent in the phase inverting line section of the ring. The effect of the noninfinite even mode impedance of this line section has been treated elsewhere. Use of a ferrite-loaded transmission line as the inverting section solves this problem. The function of the ferrite surrounding the transmission line is to reflect or absorb any even mode wave trying to propagate along the line. The use of ferrite has its drawbacks. First, it introduces some loss. Second, it reduces the power handling capability of the device. Despite these drawbacks, the ferrite gobbles up the even mode wave better than anything else that we have tried in broad-band applications.

For greater than one octave bandwidth up to perhaps 3 octaves bandwidth, this type of magic tee appears to be small and practical.

FIG.1a

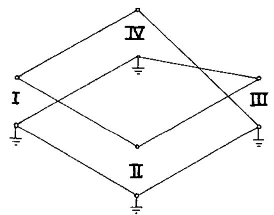


FIG.1b

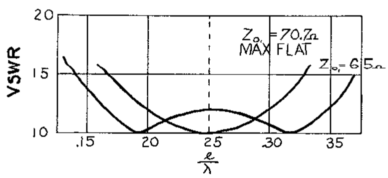


FIG.2a

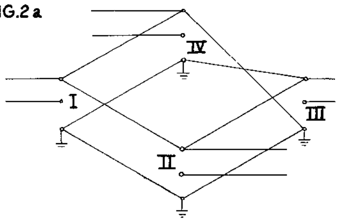


FIG.3a

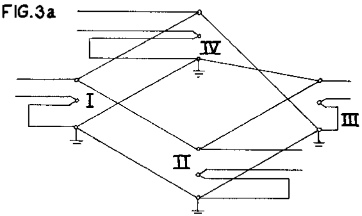


FIG.2b

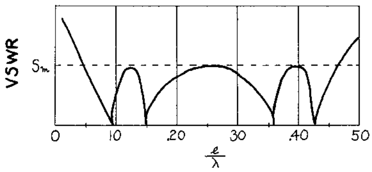
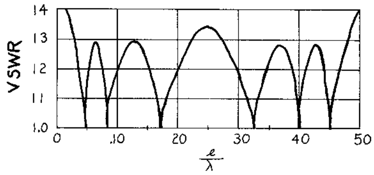


FIG.3b



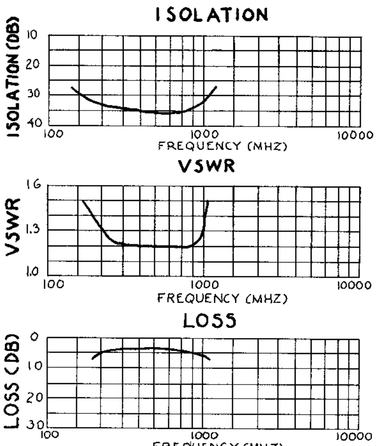


FIG. 4

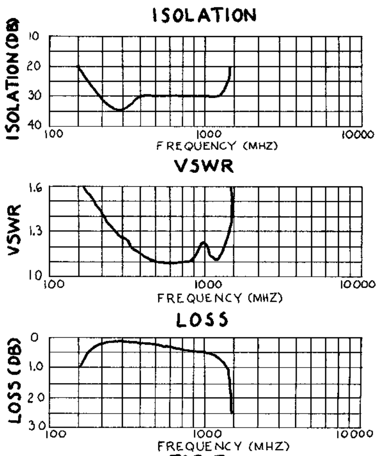


FIG. 5