VSWR of Broad-Band Waveguide Series-T Junction*

The technique of using $\lambda_g/2$ transformers in a waveguide series-T junction to obtain low VSWR's over broad bandwidths has already been presented in the literature.[1] VSWR's less than 1.15 for transmission through the aligned arms, and less than 1.30 for transmission around the bend, were reported for bandwidths of 17.4 per cent.

In work performed at RCA, the analysis of Griemsmann and Kasai was extended[2] to include the discontinuity reactance of the T junction.[3] This discontinuity reactance is primarily responsible for the poorer VSWR performance realized for transmission around the bend.

Recent experimental efforts at RCA have been directed toward improving VSWR performance for transmission around the bend. A broad-band series-T junction was designed using RG-49/U waveguide, with a design-center guide wavelength of 3.400 inches. (See Fig. 1.) Efforts were primarily directed toward achieving low VSWR's over the range 4.4–5.0 Gc. For various reasons connected with the intended application, the transformer impedance selected was 0.794 the full-height waveguide impedance. Determination of transformer lengths was based on considerations of the appropriate reference planes of the T junction, as well as the capacitive discontinuities at the steps.

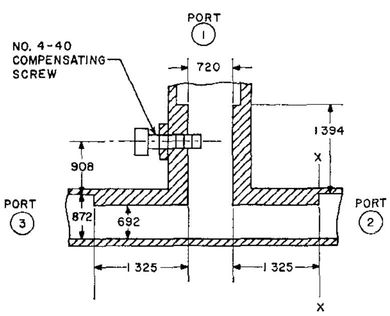

Fig. 1—Compensated E plane T cross section (RG-49/U waveguide), side view.

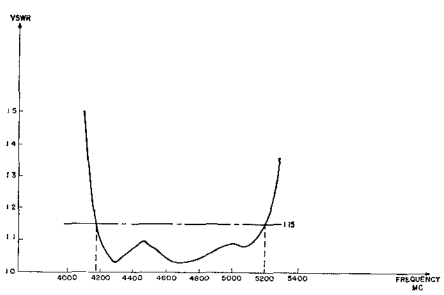

Fig. 2—Measured results: input VSWR at Port ① vs frequency with Port ② short-circuited at X-X and Port ③ terminated in matched load.

Neglecting the series discontinuity reactance, VSWR's ≦1.24 were obtained over the 4.4–5.0-Gc range for transmission around the bend. By using a 4–40 capacitive compensating screw *within* the $\lambda_g/2$ transformer, significant improvement in VSWR performance was obtained. (See Fig. 2.) A VSWR ≦1.15 for transmission around the bend was obtained over the frequency range 4.2–5.2 Gc. The proper location of this screw was determined from conventional impedance measurements and standard Smith Chart impedance-matching techniques.

The broad-band waveguide series-T junction is a useful component in duplexer applications. It should be noted, however, that the performance curve shown in Fig. 2 will not necessarily be duplicated when the physical short circuit on Port ② (Fig. 1) is replaced by the out-of-band reactance of a band-pass or band-reject filter.

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[1] J. W. E. Griemsmann and G. S. Kasai, "Broad-band waveguide series-T for switching," IRE Trans. on Microwave Theory and Techniques, vol. MTT-4, pp. 252–255; October, 1956.

[2] R. Pettai, Private communication.

[3] N. Marcuvitz, "Waveguide Handbook," in Radiation Laboratory Series, McGraw-Hill Book Co., Inc., vol. 10, p. 338; 1951.

A Wide Stop Band UHF Coaxial Band-Pass Filter*

A narrow-band coaxial filter is described which has a stop band fourteen times the fundamental frequency, and is relatively simple to design. Since the well-known multiresonator coaxial band-pass filter having quarter-wavelength resonators is probably the most commonly used coaxial filter for narrow-band frequency selection, the design to be described herein is most meaningful. Identical construction techniques used in the common quarter-wavelength filter can also be used for this design. Rather than employing the normal quarter-wavelength resonators, the filter being described here makes use of resonators which are approximately one-tenth of a wavelength long. The one-tenth wavelength coaxial sections are made to resonate by capacitively loading the open-circuit end of the cavities. The capacitors are formed by placing a disk on the end of the center conductor and inserting a low-loss dielectric between the disk and the end wall of the cavity. Fig. 1 shows a cutaway view of a four-stage filter using the above loading scheme. The dielectric section is bonded to the end of the cavity and the center conductor disk is completely captured by the dielectric in order to insure complete support of the center conductor under extreme vibration. It has been found that this type of capacitive loading does not appreciably reduce the unloaded cavity Q nor cause an increase in insertion loss of the filters.

A four-section filter was designed and built at 512 Mc using the above technique. Using Cohn's generalized design equations,[1] and a recent report by the authors[2] for practically determining interstage coupling apertures, all the significant parameters of the filter may be determined. The four-stage filter was designed to have a Chebyshev response with a 1-db ripple and a 25-Mc bandwidth. The measured response of the filter is shown plotted in Fig. 2. The measured insertion loss of 1.2 db and the skirt selectivity of 30 db compare favorably with theoretical values of 0.7 db and 34 db, respectively. The next spurious response occurs at 7000 Mc which is about fourteen times the center frequency, whereas, a normal quarter-wave filter has a spurious response at approximately three times the center frequency of the filter. Thus, it can be seen that this filter design yields an excellent frequency response characteristic together with a lightweight, compact mechanical construction. The particular filter described above was constructed almost entirely of aluminum and weighed 10 ounces. Thus, by the simple expedient of properly loading a coaxial resonator, one can easily obtain not only a physically small filter, but also one which has an extremely wide stop band.

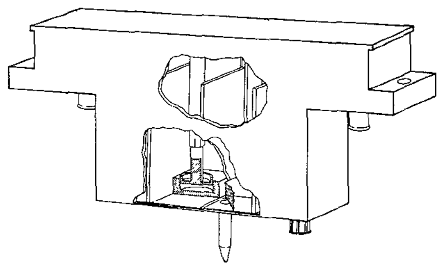

Fig. 1—Four-stage filter.

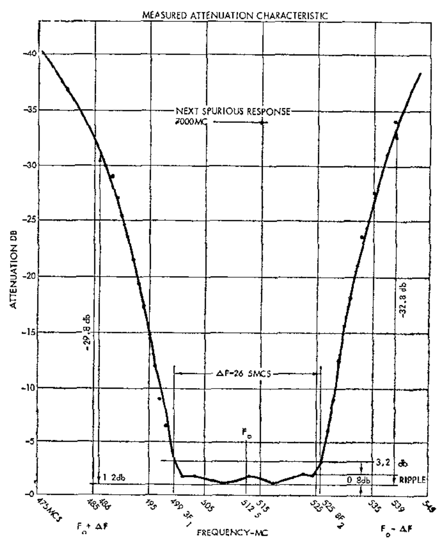

Fig. 2—Frequency vs attenuation.

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* Received April 29, 1963.

[1] S. B. Cohn, "Direct-coupled resonator filters," Proc. IRE, vol. 47, p. 187–196; February, 1957.

[2] J. F. Lally and R. R. Ciehoski, "Coaxial filters," *Electronics*, pp. 35–36; August 30, 1963.