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BANDSTOP FILTER IN NONRADIATIVE DIELECTRIC WAVEGUIDE USING RECTANGULAR RESONATORS.

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Abstract.

A bandstop filter realized by means of rectangular resonators coupled to the centre dielectric strip of a Nonradiative Dielectric (NRD) waveguide is described. This filter has the advantage that it is simple to manufacture, making use of a centre dielectric of standard cross section. The design procedure is similar to the conventional stripline design procedure, with the stubs replaced by "stubs" of dielectric, or resonators. The properties of the stubs are obtained through measurement.

I INTRODUCTION

A new bandstop filter realized by means of rectangular resonators coupled to the centre dielectric strip of a Nonradiative Dielectric (NRD) waveguide is described in this paper. Other bandstop filters in this medium have made use of coupled lines [1], or circular cylindrical resonators [2]. This filter has the advantage that it is simple to manufacture, as the dielectric resonators used are of the same cross section as the main dielectric line. The resonators are spaced only $3\lambda_g/4$ apart, on alternating sides of the main line.

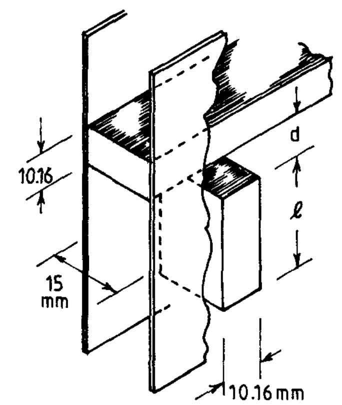

Fig. 1. Dimensions of dielectric stubs.

The design procedure is based on conventional synthesis, [3] and because of the extreme analytical complexity, the stub coupling properties are determined through measurement. A fabricated filter gave excellent performance, and is very easy to tune.

II STUB CHARACTERIZATION

The resonant frequencies and bandwidths of a number of dielectric resonators of the same cross section as the centre dielectric strip of an NRD guide were measured, with dimensions defined as shown in Fig. 1. It was found that the resonant frequency of the stubs is almost entirely determined by the length of the stub, with only a secondary dependance on the tightness of coupling to the centre strip. At the same

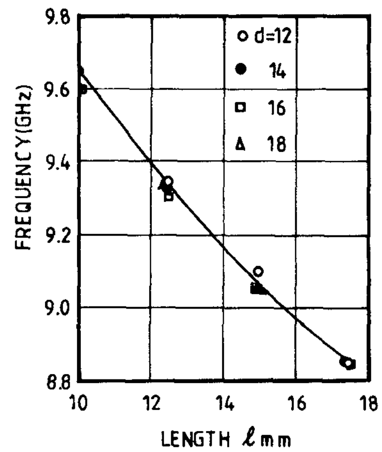

Fig. 2. Measured resonant frequency versus stub length for various coupling values.

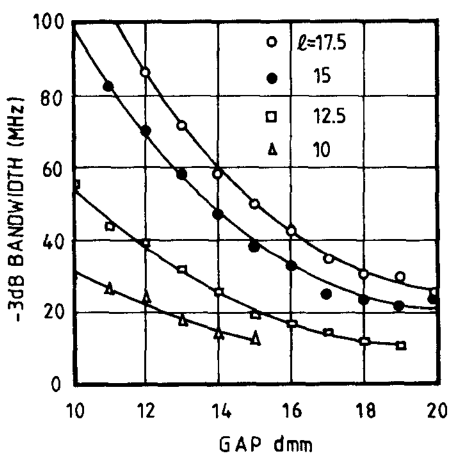

Fig. 3. Bandwidth of stubs for different coupling values.

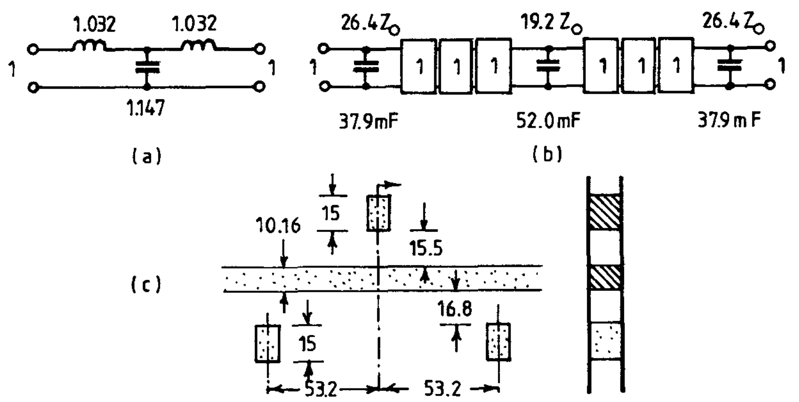

Fig. 4. Development of a microwave filter prototype; (a), lumped element filter and (b) the microwave realization. Physical construction is shown in (c).

time, the relative stub bandwidth is only a function of the coupling to the guide for a given stub length. Fig. 2 shows the measured resonant frequency versus stub length for different coupling values. The 3 dB bandwidth of a stub versus gap for a number of stub lengths is shown in Fig. 3.

III FILTER DESIGN.

The design of a bandstop filter using rectangular stubs is illustrated by means of an example. Fig. 4 (a) shows a third order Chebyshev lowpass filter prototype with 0.1 dB passband ripple. No impedance scaling is performed, because the design is normalized to the waveguide impedance. The stub impedances are determined from the desired bandwidth while the guide wave number is used in the real frequency variable [3]. Application of a Kuroda transform to a stub and unit element at each end, gives the network shown in Fig. 4(b).

The unit elements are realized directly, and are approximated as lines with unit impedance. The stub lengths and coupling gaps are obtained from Figs. 2 and 3, and are fitted to alternating sides of the main dielectric strip.

IV MEASUREMENTS.

The filter constructed in this way did not perform satisfactorily, because of coupling between the resonators. Consequently, first two and then four additional unit elements were transformed into the circuit from each end, in order to reduce this coupling. Fig. 5 compares the theoretical frequency response to the measured values, for the case where two additional unit elements are introduced at each end. It was found that the stubs were sufficiently decoupled in this case.

V CONCLUSION

The design procedure described in this paper is fast and simple, and gives filters with properties that agree well with the design values. It is extremely easy to tune the filter or make adjustments in the design, as this can be achieved by shifting the resonators. The filter has only three unit elements between each pair of stubs.

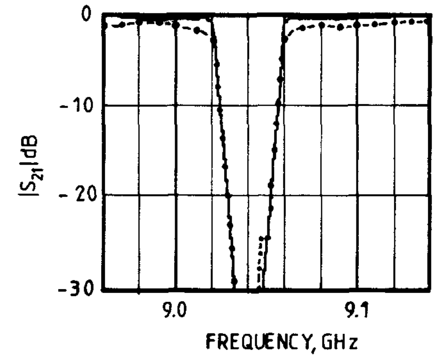

Fig. 5. Frequency response of the realized filter. Measured values are shown dashed.

References.

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[2] T. Yoneyama, F. Kuroki and S. Nishida, "Experimental Design of Millimeter-Wave Nonradiative Dielectric Waveguide Filters", **Trans. Elec. & Comm. Eng.** Japan, vol. 68B, nov. 2, pp. 213-219, Feb. 1985 (In Japanese).

[3] J.A.G. Malherbe, **Microwave Transmission Line Filters,** Artech House, Dedham, Mass., 1979.