EXACT DESIGN OF BAND-STOP MICROWAVE FILTERS

B. M. Schiffman and G. L. Matthaei

Stanford Research Institute, Menlo Park, California

Approximate techniques accurate only for filters with narrow stop-bands have previously been used for the design of band-stop filters.[1,2] In this paper, exact synthesis techniques due to Ozaki and Ishii[3] are adapted for the straightforward design of band-stop filters having stop-bands of any desired width.*[4] The first step in applying these techniques is the selection of a lumped-element, low-pass prototype filter. One then inserts the prototype element values into the basic design equations, thereby obtaining element values for the basic microwave filter structure. The basic structure consists of quarter-wavelength (at mid-stop-band), open-circuited shunt stubs, separated by quarter-wavelength sections of line. Formulas are given for converting the basic structure to either of two exactly equivalent alternative structures, both of which utilize parallel-coupled lines instead of stubs. In one such type of structure, the quarter-wavelength resonators are parallel to the main line, and are short-

---

*This work was supported by the U.S. Army Electronics Research and Development Laboratory, Fort Monmouth, New Jersey, as part of Contract DA 36-039 SC-87398.

[1] G. L. Ragan, et al., Microwave Transmission Circuits, Rad. Lab. Series, Vol. 9, Chapter 10 (McGraw-Hill Book Co., Inc., New York, New York, 1948).

[2] Leo Young, G. L. Matthaei, and E. M. T. Jones, "Microwave Band-Stop Filters with Narrow Stop Bands," IRE Trans., PGMTT-10, pp. 416-427 (November 1962).

[3] H. Ozaki and J. Ishii, "Synthesis of a Class of Strip-Line Filters," IRE Trans., PGCT-5, pp. 104-109 (June 1958).

[4] B. M. Schiffman, P. S. Carter, Jr., and G. L. Matthaei, "Microwave Filters and Coupling Structures," Quarterly Progress Report 7, Sec. II, SRI Project 3527, Contract DA 36-039 SC-87398, Stanford Research Institute, Menlo Park, California (October 1962).

circuited on one end and open-circuited on the opposite end. This type of structure allows the use of resonators having reasonable impedance values in very narrow-band filters where the basic structure would require extremely high values of stub impedance.

The other type of structure that utilizes parallel-coupled lines was found suitable for wide bandwidths. This type (herein called a spur-line filter) uses resonators which are open-circuited on one end and directly connected to the main line on the other.

Examples of each of the three types of filter were constructed. The first filter, an open-circuited shunt-stub filter, shown in Fig. 1, is based on a three-element prototype. The stop-band width is 60 percent of the stop-band center frequency, which is 1.6 Gc. The main conductor is rectangular, and the resonator stubs are cylindrical. Here the center stub is realized by two stubs in parallel, each of twice the design impedance. The measured and computed attenuation loss and VSWR are shown in Fig. 2.

A parallel-coupled resonator filter with a stop-band width of 5 percent of the center frequency is shown in Fig. 3. The coupled lines were designed with the aid of graphs of even- and odd-mode capacitance.[5] The filter response measurements shown in Fig. 4 are seen to compare well with the computed response.

A third filter, a spur-line type (Fig. 5), was constructed for 60-percent bandwidth centered at 1.6 Gc. As seen in Fig. 6, the measured response agrees with the computed response. Some distortion seen on the lower parts of the stop-band skirts might be due to the step discontinuity between the low-impedance center section and the coupled sections.

---

[5]W. J. Getsinger, "Coupled Rectuangular Bars Between Parallel Plates," IRE Trans., PGMTT-10, pp. 65-72 (January 1962).

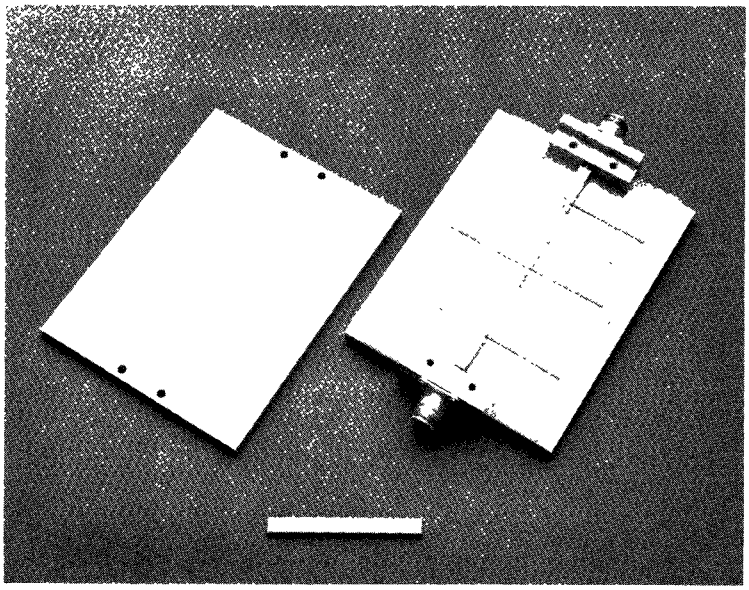

Fig. 1 A Microwave Band-Stop Filter (Basic Type)

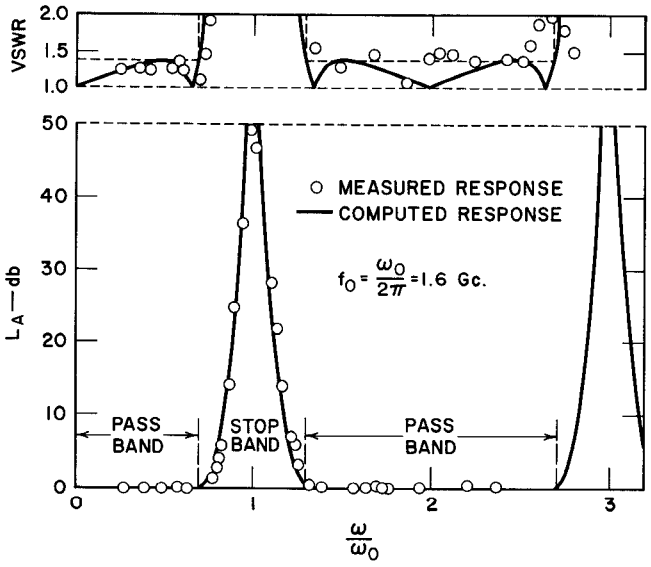

Fig. 2 Theoretical and Measured Performance of Filter of Fig. 1

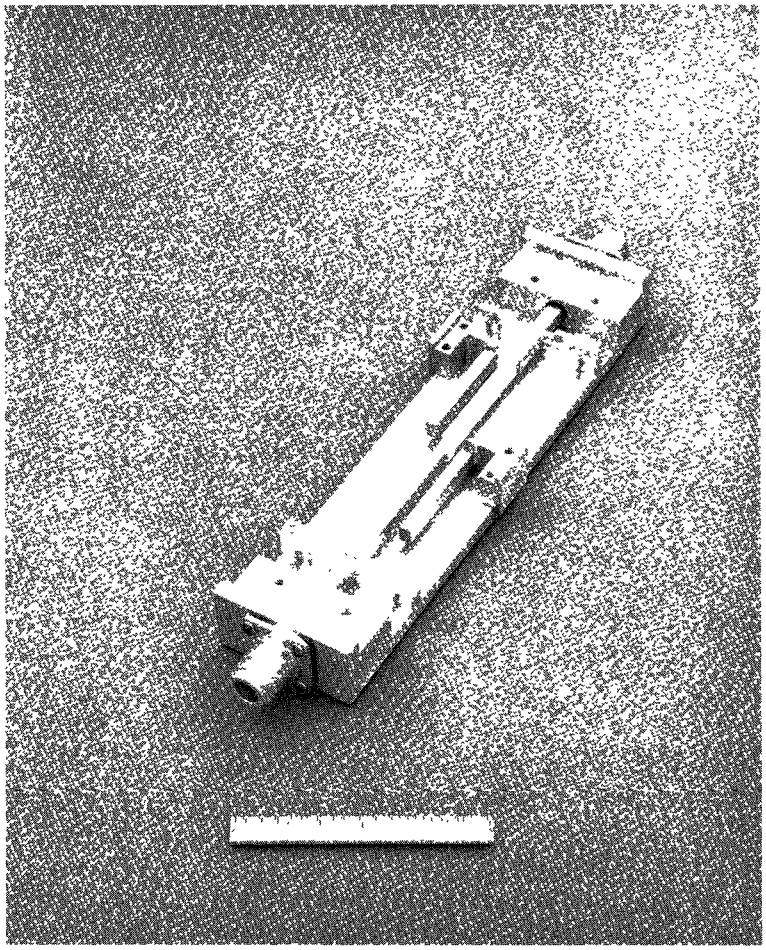

Fig. 3 A Parallel-Coupled-Resonator Type of Band-Stop Filter

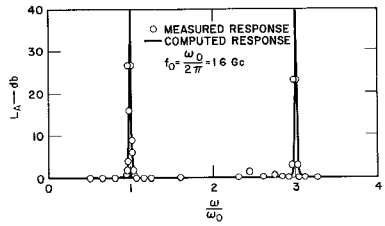

Fig. 4 Theoretical and Measured Performance of Filter of Fig. 3

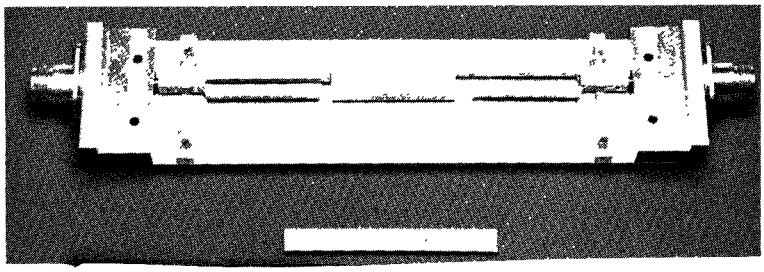

Fig. 5 A Spur-Line Type of Band-Stop Filter

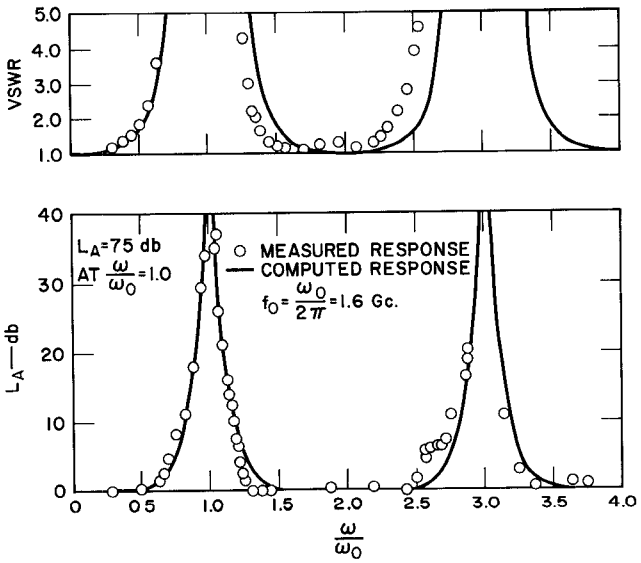

Fig. 6 Theoretical and Measured Performance of Filter of Fig. 5

NOTES