NASA TECH BRIEF

Goddard Space Flight Center

NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

High Q Band-Pass Resonators Utilizing Composite Band-Stop Resonator Pairs

The problem:

Band-pass filters and impedance-matching networks, for components that operate in the microwave frequency range, frequently require highly-sensitive (high-loaded Q or high Q_L) band-pass resonators. The realization of such high Q_L resonators, using conventional band-pass resonant transmission-line elements, is often impractical and sometimes impossible. Typically, these transmission-line elements have excessively high or low values of characteristic impedance (or long-line lengths) for high values of Q_L. This limitation is particularly true for symmetrical stripline and microstripline transmission lines, when the range of conveniently-realizable characteristic impedances is restricted to about 15 to 100 ohms.

The solution:

High Q band-pass resonators have been developed utilizing composite band-stop resonator pairs. These band-stop resonator pairs are formed of composite series- or parallel-connected transmission-line elements, which are exclusively quarter-wavelength or half-wavelength lines.

How it's done:

The circuit representation of a parallel-connected band-pass resonator is shown in Figure 1(a). The circuit comprises two band-stop resonators, one of which is formed from L_1, C_1, and R_1, and the other is formed from L_2, C_2, and R_2 (R_1 and R_2 representing the circuit losses). Each of these resonators is centered at the specified band-stop resonant frequency, f_R, one being f_R^+ above and the other f_R^- below the desired resonator pass-band, as given by $1/(2\pi\sqrt{L_1C_1})$ and $1/(2\pi\sqrt{L_2C_2})$, respectively. In addition, the resonators are chosen so that the sum of their individual susceptances added in parallel yields a high-susceptance-slope band-pass resonance at the desired center frequency, f_o.

Figure 1(b) shows a band-pass resonator formed of a pair of quarter-wavelength, open-circuited, parallel-connected, band-stop resonators. An upper resonator element is connected to the upper transmission line and extends orthogonally across the line in opposite

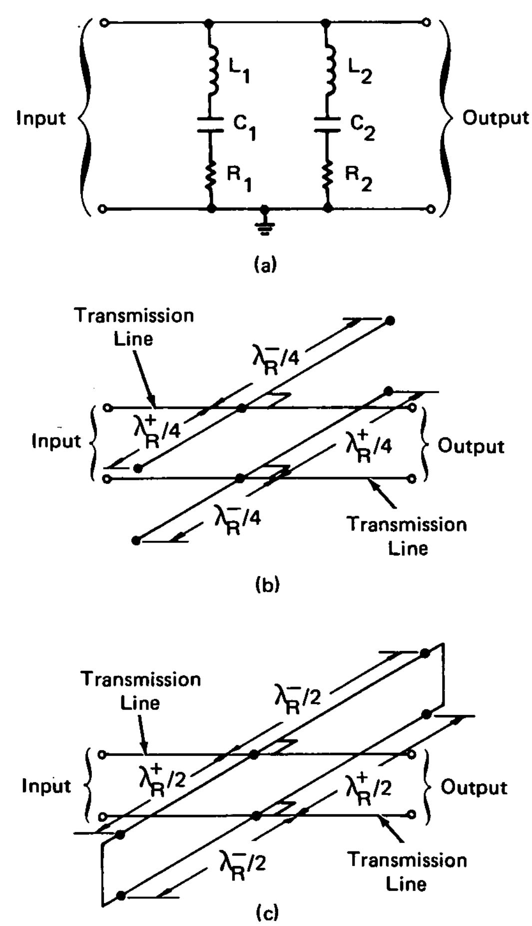

Figure 1. Parallel Band-Pass Resonators
(a) Circuit with Two Parallel Band-Stop Resonators;
(b) Open-Circuit Configuration; and
(c) Short-Circuit Configuration

(continued overleaf)

directions, defining an upper plane. Each resonator section represents the quarter wavelength, one being $\lambda_R^-/4$ and the other $\lambda_R^+/4$. The lower resonator is connected similarly to the lower transmission line. Another version of the parallel-connected band-pass resonator [Figure 1(c)] is laid out in a similar configuration as in Figure 1(b), except the resonator elements are now $\lambda_R^+/2$ and $\lambda_R^-/2$, respectively, and their adjacent ends are connected, forming a short-circuit version.

A series band-pass resonator is formed from a band-stop resonator pair connected in series. Figure 2(a) shows the circuit for this combination. The series configuration is formed from two parallel-connected L_1, R_1, C_1 and L_2, R_2, C_2 circuits (R_1 and R_2 representing the circuit losses). Resonator frequencies for each band-stop resonator are determined by $1/(2\pi\sqrt{L_1C_1})$, for f_R^+, and by $1/(2\pi\sqrt{L_2C_2})$, for f_R^-. These resonator circuits are chosen so that their individual reactances added in series yield a high-reactance-slope band-pass resonance at the desired center frequency, f_0.

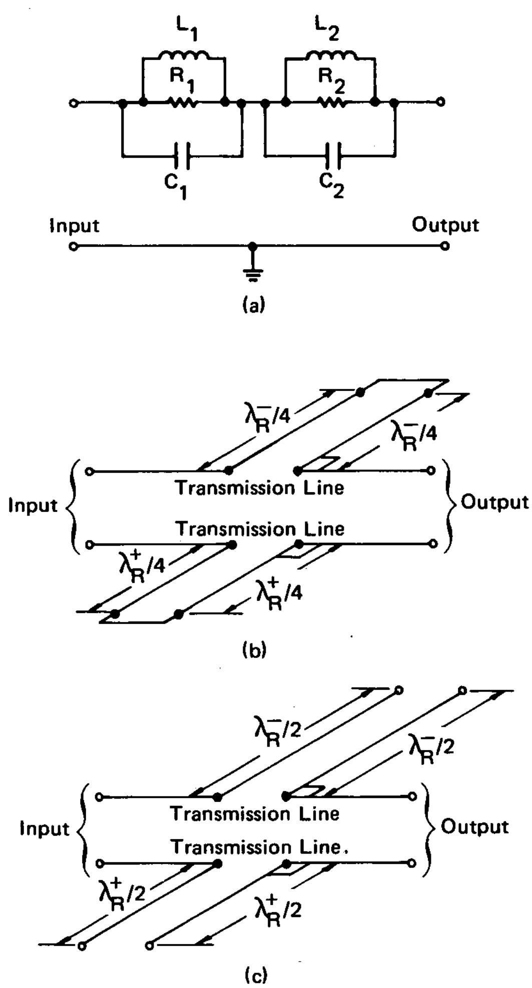

Figure 2. Series Band-Pass Resonators
(a) Two Band-Stop Resonators in Series;
(b) Short-Circuit Configuration; and
(c) Open-Circuit Configuration

A short-circuited, series-connected resonator configuration is shown in Figure 2(b). This particular band-pass resonator is formed from a pair of series-connected, quarter-wavelength, short-circuited band-stop resonators. Each resonator comprises two resonator elements and a short-circuit element connecting the two resonator elements. Each pair of resonator elements is constructed of $\lambda_R^+/4$- or $\lambda_R^-/4$-long transmission lines. Both resonators extend orthogonally from their respective transmission lines.

Figure 2(c) shows another series-connected resonator, which is open circuited and comprises two half-wavelength band-stop resonators. The configuration is similar to the one in Figure 2(b), except that resonator elements in one resonator are $\lambda_R^-/2$ long and the others are $\lambda_R^+/2$ long. In addition, the resonator element pairs are open.

Resonator elements in all of these configurations are constructed with microstriplines in parallel planes separated by a dielectric. Striplines and coaxial transmission lines can be used in construction also.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
Code 207.1
Greenbelt, Maryland 20771
Reference: TSP74-10035

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,737,815). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

Patent Counsel
Goddard Space Flight Center
Code 204
Greenbelt, Maryland 20771

Source: H. C. Okean
AIL Division, Cutler-Hammer Corp.
under contract to
Goddard Space Flight Center
(GSC-10990)