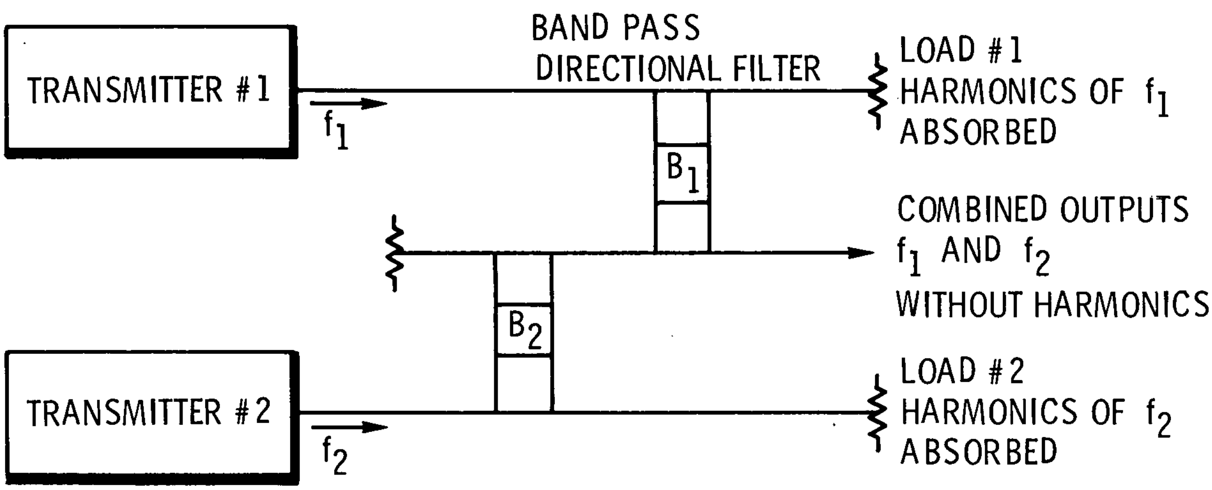
December 1973 B73-10410

NASA TECH BRIEF

Lewis Research Center

Combined Diplexer and Harmonic Filter



The Problem:

The outputs of two communications transmitters in adjacent frequency bands may be combined with a diplexer for connection to a single antenna. The diplexer provides isolation between the two transmitters which may or may not operate simultaneously.

Harmonic absorption or suppression filters are generally required in the output channel of each transmitter to reduce the harmonic output to the diplexer and antenna. The resulting waveguide system, consisting of two harmonic filters and the diplexer, is quite bulky and heavy and has considerable signal loss.

The Solution:

Combining the diplexing and harmonic filtering functions into a more compact integrated waveguide assembly by using two directional filters having circular waveguide filter cavities.

How It's Done:

The device is essentially a filter which passes power within its pass band limits, but it also has a directional characteristic so the power transmitted into the two-port output waveguide will travel in only one direction. It is a small unit which saves substantially on weight and size over more conventional waveguide filter configurations. Two directional filters having circular waveguide filter cavities are utilized. Directional filters function by propagating a circular polarization within the cavities. Only those signals with the proper field relations at the input coupling iris will propagate; other signals are strongly rejected.

As shown in the figure, the signal from transmitter #1 at frequency f_1 in passband B_1 passes through band pass directional filter #1 to the antenna. The signal from transmitter #2 at frequency f_2 in passband B_2 passes through band pass directional filter #2 and past filter #1 to the antenna, since passbands B_1 and B_2 do not overlap and have some band margin in the area between their adjacent edges.

The harmonics from transmitter #1 at multiples of f_1 will not pass through filter #1 because of the nonharmonic relationship of the filter passbands, but will pass by and be absorbed in load #1 (some form of lossy material which will absorb and dissipate the RF energy as heat). Likewise, the harmonics from transmitter #2 at multiples of f_2 will not pass through filter #2, but will be absorbed in load #2. Loads #1 and #2 must be designed to be a good match for the harmonic frequency bands and must be matched for possible higher order modes at the harmonic frequencies. The filter passbands in circular waveguide filters are not harmonically related for the

(continued overleaf)

dominant TE_{11} (the number of transverse half-wave patterns) mode because the guide wavelength does not vary inversely with frequency. The passbands for higher order modes at the higher frequencies are not harmonically related to the passband for the fundamental because of the non-periodicity of the roots of the Bessel functions. The harmonic signal levels appearing in the output to the antenna will therefore be attenuated by the amount of filter skirt attenuation to the transmitter harmonic frequencies, which fall outside the higher passbands of the filters.

Second-harmonic measurements on the diplexer were made with a sweep generator and exceptionally good suppression of the second harmonic was obtained. Over the full swept band measured, only a few transmission peaks occurred and these were all more than 35 dB down, which still exceeded the 30 dB second-harmonic attenuation requirement.

Notes:

1. The diplexer developed was a four-cavity filter type with a band width of 200 MHz.
2. Further information is available in the following report:

   NASA CR-120927 (N73-26152), High Power Microwave Components for Space Communications Satellites

   Copies may be obtained at cost from:

   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B73-10410
3. Specific technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B73-10410

Patent Status:

NASA has decided not to apply for a patent.

Source: C.C. Allen
General Electric Co.
under contract to
Lewis Research Center
(LEW-12059)