COMPACT MAGNETOSTATIC WAVE CHANNELIZER

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Abstract

A compact 5 channel filter bank is described which uses the new technology of magnetostatic forward volume waves propagating in narrow epitaxial yttrium iron garnet strips. Results are presented showing S-band performance where a -55 dB out-of-band level is achieved and a 2 tone intermodulation level rejection of 50 dB at 25 MHz from the mid-band frequency.

Future EW and ESM systems require approaches to spectrum analysis which are compact, have high two tone dynamic range and cover wide microwave ranges with good frequency resolution. We report here the design and performance characteristics of a 5 channel magnetostatic wave (MSW) filter bank which displays the potential for small size (0.05 cubic inches/channel), greater than 55 dB out-of-band rejection and good two tone intermodulation rejection.

Figure 1 is a photograph showing the interior construction of the channelizer in which a central, single microstrip transducer has been photolithographically defined on a 25 mil thick alumina substrate. This transducer excites MSWs in each of the yttrium iron garnet (YIG) filter elements, and similar output transducers provide the 5 channel output signals. The bandwidth of each channel is controlled by the width of the microstrip transducers and the spacing of the YIG elements above the transducers. In this case the spacing is provided by 160 micron thick cover glass slide pieces. Bandwidth shape is also influenced by the MSWs reflected from the YIG ends. The frequency of operation is determined by the applied static bias field provided by permanent magnets and yoke as shown in Figure 2 left. A tapered magnet pole piece produces a small linear field gradient so that each YIG filter element experiences a different bias field value and thus operates at a different frequency from its neighbors. A later version of this channelizer is shown in Figure 2 right in which the size has been reduced by making the magnet yoke into the device enclosure and placing the magnets on the top and bottom plates. Using this approach channel densities of > 20 channels per cubic inch will be achieved.

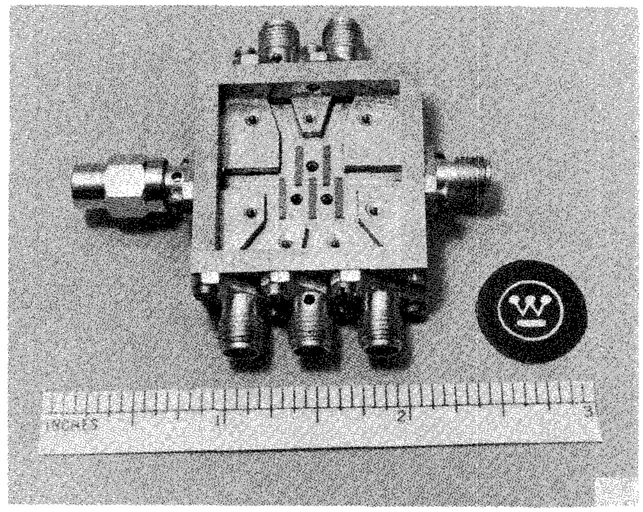

Figure 1. Photograph showing the interior of the 5-channel filter bank.

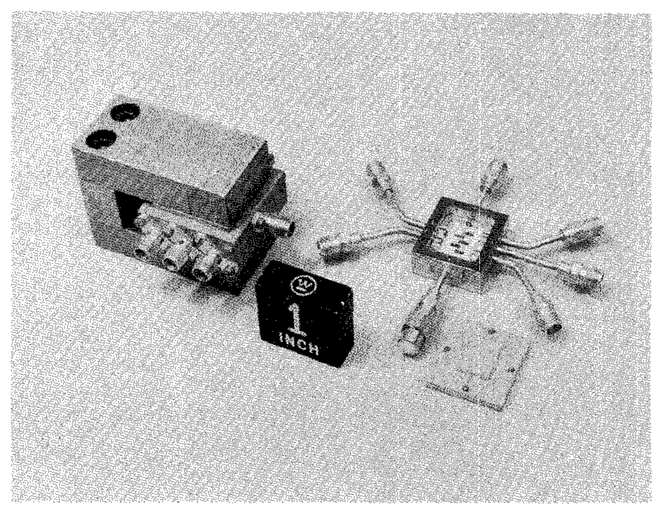

Figure 2. Photograph showing: (left) the filter bank of Fig. 1 with external magnets and magnet yoke; (right) a later version incorporating the magnet yoke as the device enclosure with magnets internal to the top and bottom plates.

Figure 3 shows the response of one of the channels in which a side lobe level of almost -50 dB is evident with respect to a mid-band insertion loss of 23 dB at S-band. The 3 dB bandwidth is approximately 16 MHz and the 50 dB bandwidth is 50 MHz. Two tone intermodulation levels are shown in Figure 4 where for a 0 dBm signal level we find a > 50 dB rejection for a signal at 25 MHz or more removed from the mid-band frequency. The passband ripple in Figure 3 is due to triple transit which also produced the periodic variation in intermodulation shown in Figure 4. These effects will be minimized by improved input and output impedance matching.

Finally, in Table 1 we summarize the expected performance of channelizers based on MSW operation with that achievable from competing technologies.

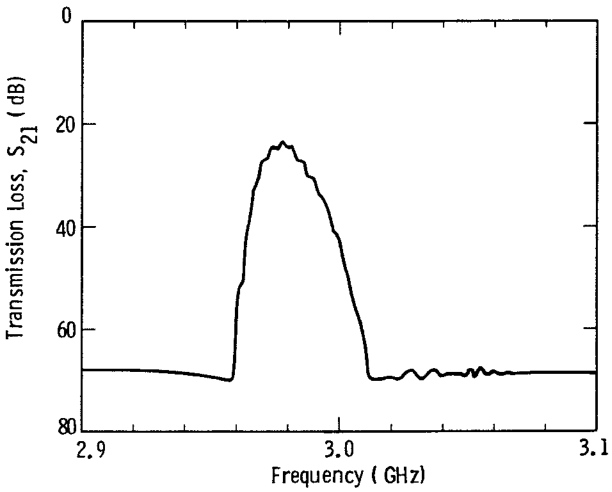

Figure 3. The transmission response, S21, versus frequency for one of the channels.

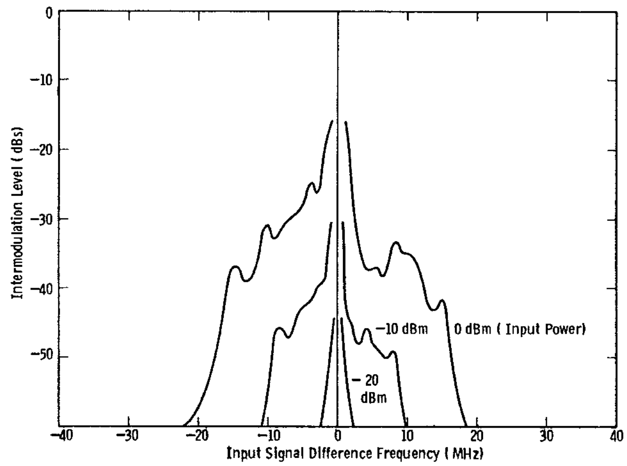

Figure 4. The intermodulation level versus frequency difference from the mid-band frequency for 2 tone injection at different power levels.

Table 1

Technology	Frequency (GHz)	Bandwidth (MHz)	2 Tone Level (dB)	Channel Density (per cu. inch)
MSW	1 - 20	5 - 100	>55	>20
SAW	0.25- 0.75	5 - 100	<40	2 - 20
Acousto/optic	0.5 - 3.5	2 - 20	<50	5 - 40
Dielectric res.	5 - 15	10 - 50	>60	1.5