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NASA TECH BRIEF

Lewis Research Center

Extended Range Harmonic Filter

The Problem:

Recent developments in the communications satellite field have indicated a strong trend toward operation at higher frequencies, particularly in the 12 GHz region. Requirements for high power operation in this region range from a few hundred watts to possibly several kilowatts as manifested in advanced traveling wave tube and klystron developments in the 200 to 2000 watt range at 12 GHz.

A critical subsystem in a high power satellite transmitter is the waveguide assembly. One of the components of the waveguide assembly is the harmonic filter which is required to introduce high attenuation at the second through the fifth harmonics with a minimum of loss to the fundamental frequency. The conventional leaky-wall type filter has a low loss, but its attenuation is inadequate at the fourth and fifth harmonics.

The Solution:

An extended range harmonic filter combines two types of filters, leaky-wall and open-guide, into a single component.

How It's Done:

The extended range filter is based on the leaky-wall filter which uses slots cut in the walls to couple harmonics out of the main waveguide. A section of open-guide harmonic filter is inserted into the leaky-wall filter, adding only a small loss at the fundamental frequency, but increasing the attenuation of the fourth and fifth harmonics. The combined filter configuration is shown in Figure 1.

Figure 2 indicates the general appearance of the input and output sections of the filter, with slots tapering from very small at the end of the filter, to about half the broadwall dimension at the center of the filter. Slots in all four walls couple out the harmonic energy with a minimum of loss to the fundamental. A few slots at the ends are impedance matching transition slots; the center slots of each section are tuned to the second harmonic and are effective also at the third harmonic.

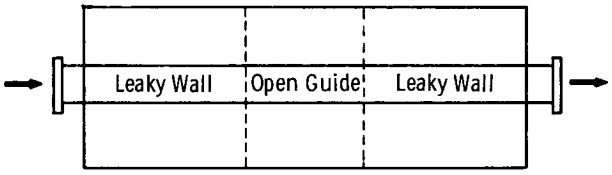

Figure 1. Combination Type Harmonic Filter

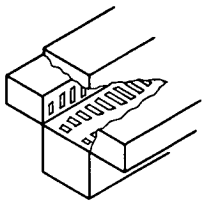

Figure 2. Leaky Wall End Sections

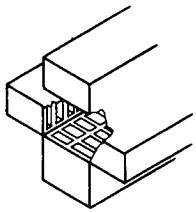

Figure 3. Open Guide Center Section

To obtain at least 20 dB attenuation above the third harmonic, an open-guide type of filter with higher attenuation of the fourth and fifth harmonics is inserted between the input and output sections of the conventional leaky-wall type. The open-guide filter type is shown in Figure 3.

The combination gives 10 dB or greater additional attenuation to the fourth and higher harmonics, at the expense of increasing the loss of the fundamental frequency by perhaps 0.05 to 0.08 dB. Thus the principal advantage is the added reduction of harmonic radiation

(continued overleaf)

from a microwave transmitter, preventing potential interferences with other devices, in return for a small power loss of 1-2%. By combining the two types of filters and keeping the open-guide section short, the overall loss was kept reasonably low and the high-harmonic attenuation was achieved.

Notes:

1. This new filter is applicable to all high power microwave transmitters, but is especially desirable for satellite transmitters.
2. A filter of this design has been built and tested for use at 8 GHz. Its performance at 12 GHz is being investigated.
3. 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: B73-10313
4. Specific technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B73-10313

Patent Status:

NASA has decided not to apply for a patent.

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