Band Pass Filter Limiting Front-Door Coupling of HPEM Threats to Protect K_u-band Satellite Communication System

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***Abstract*— In this paper, an energy sensitive bandpass filter (ESBPF) is introduced to protect K_u-band satellite communication systems from a front door coupling of high power electromagnetic (HPEM) threats. The ESBPF operates as a BPF at a power level below the maximum permissible power level (MPPL) of the system. However, the circuit works like a variable attenuator at the power level equal to or higher than the MPPL of the system. To increase attenuation and selectivity functions, two cascaded ESBPFs are loaded transversely in a WR-75 waveguide. The development of the circuit model has been started with lumped elements under the condition of 0dBm MPPL of LNA used in the system. Then the model has been simulated, optimized with HFSS, and fabricated. Measurement results show that the ESBPF has insertion loss less than -1.27dB at the power level lower than -2dBm for the frequency range from 11.8 to 12.3GHz. At the power level higher than -2 dBm, the circuit provides different levels of attenuation depending on the input power within the identical frequency band. The insertion loss, which provides isolation characteristics, is larger than -30 dB at the power level of 30 dBm.**

Keywords-Energy sensitive bandpass filter; K_u-band; satellite communication system.

I. Introduction

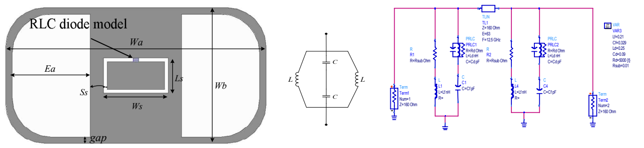
An energy sensitive band pass filter (ESBPF) has been developed to protect K_u-band satellite systems. After the frequency selective surface (FSS) technique has been reviewed for the structure of the filter circuit [1], [2], where the array of square structure had been used, a single element structure has been selected rather than array, and we modified the structure to mount in a WR-75. A new filter circuit has been mounted on a transverse plane of a WR-75 waveguide. Anti-parallel configuration of the diodes has been applied to operate the circuit without bias. The final circuit has a 63° transmission line section between two adjacent layers.

II. ESBPF Circuit Model and Realization

We have first considered a BPF structure for the frequency range from 11.8-12.3GHz and the equivalent circuit model shown in Figures 1(a) and (b), respectively. The ADS and HFSS simulations for both of the equivalent circuit (Figure 1(b)) and the structure (Figure 1(a)) models without diodes have been tried at the center frequency of 12.5GHz.

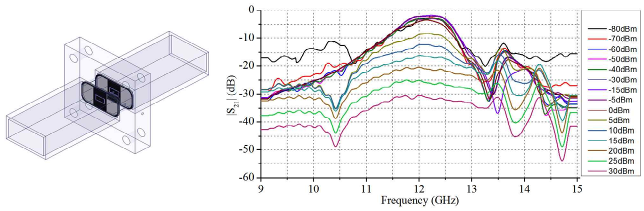
To have better selectivity, two layered configuration has been used with a 63° line section between the two, since the 63° section provides two transmission poles, and an anti-parallel Schottky Barrier diode model has been inserted as shown in Figure 1(c) since the diodes provides attenuation control. The two layered ESBPF shown in Figure 2(a), has been simulated with the circuit and structure models shown in Figures 1(c) and 2(a), respectively, by ADS and HFSS simulators based on the dimensions of Wa=20.05mm, Wb=10.525 mm, Ws=5 mm, Ls=2.75 mm, Ss=0.3 mm, Ea=6 mm, gap=0.5 mm on a substrate with ε_r =4.5 and thickness 0.508mm, and distance 7.4mm between two layers for the 63° section as shown in Figures 1(a) and 2(a). After the BPF have been fabricated on the TMM4 substrate, anti-parallel Schottky Barrier diodes, MADS-101318-1197HP, has been mounted across the upper gap of the structure.

At the power level lower than -2dBm, insertion loss less than -1.27dB has been measured when the circuit works like a BPF. Measurement results for different input power levels are shown in Figure 2(b), where the BPF makes the signal attenuate gradually as higher incident power is coupled.



(a) (b) (c)

Figure 1. (a) ESBPF structure. (b) Lumped element equivalent model for the circuit shown in (a). (C) ADS model for two layered ESBPF with anti-parallel Schottky Barrier diodes.



(a) (b)

Figure 2. (a) HFSS simulation structure for the ESBPF using two layers. (b) Measurement results for $|S_{21}|$ of the ESBPF at different input power levels.

References

[1] G. I. Kiani, K. L. Ford, L. G. Olsson, K. P. Esselle, and C. J. Panagamuwa, "Switchable Frequency Selective Surface for Reconfigurable Electromagnetic Architecture of Buildings", IEEE Transactions on Antennas and Propagation, Vol. 58, No. 2, February 2010.

[2] S. M. Amjadi, and M. Soleimani, "Narrow Band-Pass Waveguide Filter Using Frequency Selective Surfaces Loaded with Surface Mount Capacitors", Int. Conf. on Electromagnetics in Advanced Applications 2007. Pp. 173-176,2007