



Multipactors

Introduction

The multipactor is a rather unique receiver protector form. The technology originated many years ago at General Electric. It was then acquired by Hughes Aircraft who developed it into a realizable technology for production systems.

The multipactor is a pre-limiting device, which serves the same function in a radar system as a Pre-TR, TR tube, or Ferrite Limiter. It provides significant protection against high power signals, but not enough to adequately protect a receiver. Therefore, a multipactor must be followed by a diode limiter for complete receiver protection.

Theory of Operation

Multipacting is a phenomenon by which secondary emission of electrons is caused when high-energy electrons strike a surface under the right conditions. The basic multipactor structure is formed by two opposing comb lines in a waveguide. The tips of the comb line structure are coated with a material which is highly conducive to secondary emission generation. The waveguide is evacuated. An electron gun provides a source of free electrons which “prime” the unit and ensure that multipaction occurs on every pulse.

In the low power state, this structure is a basic band pass filter structure which will allow the radar’s low power “echo” signal to pass through to the receiver with little attenuation.

In the presence of a high power signal, free electrons (either those provided by the electron gun or directly from the secondary emission material) are driven into the secondary emission material on the cone tips. This will cause a chain reaction by which electrons are driven off the cone tips. These, in turn, strike other cone tips, driving off

more electrons, etc. This activity is powered by the high RF field present in the waveguide. The effect is to draw energy from the RF field. Thus, unlike most other receiver protector forms, which are reflective, the multipactor performs its limiting function by absorbing RF energy. This RF energy is converted to heat energy which flows to the waveguide walls. The heat is carried away by a liquid cooling channel.

Also incorporated into the unit are a vac-ion pump and an oxygen generator. The oxygen generator is needed to help keep the secondary emission material active; the vac-ion pump is needed to help maintain a vacuum inside the waveguide.

Performance Characteristics

To be sure, as a design approach, the multipactor is somewhat inelegant. However, this is more than compensated for by its fine performance as a receiver protector device. The multipactor can handle high RF power levels with very wide pulsewidths and very high duty cycles. Its insertion loss is low (on the order of 0.4dB). Its leakage power levels are also low enough (typical values for spike and flat are 20 Watts and 7 Watts, respectively) that a standard medium power diode limiter may be used for clean up protection.

However, the multipactor's real claim to fame is its super-fast recovery time. Although normally specified at 50 nanoseconds, a multipactor will typically recover in less than 10 nanoseconds. No other receiver protector technology comes close to this. The multipactor is orders of magnitude faster than any other receiver protector form, depending on the actual power, pulsewidth, and frequency conditions.

(February, 1999)