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Design and Implementation of an Ultra-wideband Multipactor Test Cell

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Multipactor is cascade avalanche growth of free electrons in RF components under vacuum. In two-surface multipactor, a free electron gets accelerated by electric field and impacts a facing surface with enough energy to liberate secondary electrons. Cascade evolution of these electrons under certain conditions can load and short circuit the RF power.

We will discuss the design and implementation of a test cell to study multipactor susceptibility and suppression in two-surface RF components. The cell was designed with a gradual transition from a coaxial line to a planar microstrip line. This allows for multipactor research over a wideband frequency range from DC to 1.5 GHz. A centered transmission line was designed, minimizing the disturbance of the fields and resulting in a low reflection of less than -30 dB over the entire frequency range. While the ending coaxial lines are fixed, a planar multipactor center section is replaceable and can stand above the ground plane with an adjustable gap distance. This platform facilitates the multipactor test with a wide range of gap dimensions, frequencies, surface treatments, and geometrical modifications.

The above-mentioned transmission line is situated in an ultra-high-vacuum chamber that simulates the low-pressure environment in space-based applications. A chain of vacuum pumps including scroll pump, turbo, and ion pumps bring the chamber pressure down to 10×e-8 Torr. The vacuum chamber has multiple arms which makes it possible to seed and collect electrons concurrently. Electron seeding is carried out using the photoelectric process. An ultraviolet LED creates UV light with a wavelength of 265 nm whose photon has enough energy to free electrons out of copper. The LED's light is transferred into the vacuum chamber through fiber patch cords and focused onto the multipactor section.

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