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Design Method for Minimizing RF Voltage Breakdown

Voltage breakdown in RF components produces a disruption or loss of communication and, occasionally, damage to the components. In RF voltage breakdown, there are two main electron-generation mechanisms: (1) the ionization of gas by electron collision and (2) secondary electron emission from electrodes. At gas pressures generally above 10^{-2} torr, the electron mean free path is shorter than the electrode-separation distance, and ionization by electron collision becomes the primary source of breakdown. On the other hand, at pressures below 10^{-2} torr, the electron mean free path is longer than the electrode-separation distance, and the primary generation mechanism, for RF voltage breakdown is secondary emission. The latter is known as multipacting.

To obtain further insight into RF voltage breakdown, a research study was conducted and the results were published in the "Final Report on RF Voltage Breakdown in Coaxial Transmission Lines" (JPL Technical Report 32-1500). In the report, multipacting and ionization breakdown, involving common coaxial transmission lines and the parallel-plate configuration, are discussed. The lines discussed are 50-, 74-, 91-, 132.5-, and 174-ohm impedance types. The frequency range includes the commonly-used transmission bands from approximately 1 MHz up to K-band. Data are presented for both the breakdown voltage and the breakdown power, as a function of frequency, and the inner-to-outer conductor distances.

Using the principles of similarity and a minimum of experimental data, a number of universal curves have been constructed covering a wide range of experimental parameters. Gases other than air, such as argon and carbon dioxide, also are included in the study.

Notes:

1. The data presented in the report are sufficient to determine the power-handling capability of all the common coaxial transmission lines and uniform field geometries encountered by RF design engineers.
2. Requests for further information may be directed to:

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