A Soft Corrugated Pyramidal Horn Antenna for Radial Power Extraction from an A6 Magnetron

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Magnetrons have been widely used over the years in a variety of high power microwave applications. Their high peak power as well as their compact configuration have made them suitable to airborne and spaceborne communication applications, radar systems as well as heating applications. One of the most common ways to extract microwave power from a magnetron is radially, by coupling the energy from at least one of its cavities to an antenna, through an aperture. Although a lot of the research has been focused on the improvement of the actual magnetron source characteristics, little work on the antenna design can be found in the literature. One antenna commonly used for radial power extraction is the pyramidal horn antenna with smooth walls due to its high power handling capability as well as its simplicity in design. A major drawback of this antenna is that it introduces relatively large side and back lobes in the radiation pattern, which are due to diffraction. These for example can lead to interference issues in communication systems, possible side lobe jamming, and interfering return limitations (clutter) in radar systems.

In this work, a corrugated pyramidal horn antenna is studied as an alternative to the smooth wall horn, to improve the radiation properties of the A6 magnetron, when radial extraction is used. This setup can significantly minimize the side and back lobes of the original one, and lead to lower ohmic loses on the walls of the antenna. In addition, the antenna can be further optimized to yield better input matching and peak gain than the smooth wall horn that is currently utilized in our laboratory, leading to more radiated power and possible reduction of the power supply unit size. CST Microwave Studio is used to optimize the proposed antenna performance. A smoother radiation pattern with low side and back lobes has been demonstrated. The peak gain has also been improved. The radiation efficiency has increased. The simulation results, the final optimized design as well as results from the measurements that will be performed will be presented. The comparison between the smooth wall horn and the corrugated horn radiation properties will be discussed. In addition to improving the radiation performance of the A6 magnetron, another important factor that should be included in the antenna design process is the possibility of breakdown. With a generated power of about 600MW, air breakdown can occur at the aperture of the antenna, or vacuum breakdown can occur inside the antenna and specifically in the vicinity of the corrugations. For this purpose, the relationship between the position, number and geometry of corrugations, antenna length, flare angles and the generated electric fields inside the antenna is studied. A method for selecting the design parameters to minimize the breakdown probability, based on the generated field values inside the structure, will be presented.