Abstract

The multipactor RF breakdown effect has been object of numerous studies for over 80 years, since the development of the first particle accelerators in the beginning of the 20th century. Around the middle of that century, with the development of high power sources for radar applications and with the emergence of the artificial satellites, a new impulse was given to the multipactor research, since it became a risk for expensive commercial projects. Traditionally, waveguides with canonical cross sections, like rectangular or coaxial ones, have been the building blocks of most microwave devices. Their main advantages are that their electromagnetic fields can be solved analytically, enabling their direct application in complex designs, as well as their manufacturing simplicity. But over the years the computation capabilities and algorithms have continuously evolved, which has broadened the spectrum of possible topologies to almost arbitrary geometries, offering the designer more room for creativity. However, most of the current microwave devices still trust on the mature canonical waveguide technologies, which do not require an additional investment in manufacturing equipment. The suppression of the multipactor effect is the motivation for considering an innovative waveguide topology, like the wedge-shaped waveguide.

It is within this context where this PhD work aims to offer a contribution. On the one hand, a numerical model for predicting the multipactor breakdown effect in wedge-shaped hollow waveguides has been developed. This tool has aided in the derivation of optimised design criteria. On the other hand, a bandpass filter synthesis method for rectangular waveguide has been adapted in order to calculate a similar design based on the new topology. As a culmination, the designed structures have been manufactured and tested, in order to verify their electromagnetic performance and their multipactor sensibility. A patent was also filed to protect these new filters. In short, this work has comprised the cycle of activities related to the whole industrial development of a passive microwave device: basic research, analysis, design, manufacturing and qualification through testing.

These measurements have verified the predicted improvement in the multipactor thresholds of microwave filters with wedge-shaped topology, and have confirmed that they can offer similar frequency responses to the equivalent rectangular waveguide ones. The implications of the results have been thoroughly evaluated and summarised in this document. As a final remark, this research document has been drafted to reflect the natural learning process, and to show the rights and wrongs experienced in the way, which all have led to the final result. Such an endeavour would not have been possible without the support and commitment

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