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Statistical Analysis and Model Validation of an UWB Innovative Phased Array for M-AESA Applications

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During the past decades, phased array antennas have been widely used in several applications such as control systems, telecommunications, remote sensing, radiometry, etc. Their main advantages are related to the possibility to dynamically change the radiating properties (pointing angle, beamwidth, side lobe levels, etc.) with a high degree of flexibility, through the electronic control of the complex excitation coefficients of each radiating element constituting the array. The combination of phased array architecture with multi-functional Radio Frequency (RF) systems gives rise to the so-called Multifunctional Active Electronically Scanned Arrays (M-AESA) [1]. Such structures have two main advantages with respect to standard AESA architecture: *i)* the possibility to manage different RF functions, like radar, communications, and electronic protection, and *ii)* the simplified installation on platforms (related to volume and weight reduction). The enabling components of a M-AESA system are the Transmitting-Receiving (T/R) modules and the antenna array panel.

This work describes the statistical analysis and model validation of an innovative ultra-wideband (UWB) phased array antenna for M-AESA applications. The proposed array has been designed to work from L to C bands, providing more than a two-octave bandwidth. Specifically, we consider a M-AESA architecture consisting of 24 T/R modules and 24 radiating elements. The T/R modules provide for electronic beam-steering capabilities by means of UWB MMIC (Monolithic Microwave Integrated Circuit) phase shifters [3] and commercial-off-the-shelf GaN devices. The antenna array panel is realized with an innovative UWB radiating element, the so-called *connected* Vivaldi antenna, which is based on the *connected array theory* [2]. A connected Vivaldi element consists of a completely metallic element with extremely simplified feeding network that allows for obtaining good matching, high total efficiency, and wide scanning performances. This approach intentionally introduces coupling between neighboring elements by means of optimized metallic septa. Therefore, the array can be analyzed as a single antenna periodically fed. The measured total efficiency of the connected Vivaldi array shows an average value of 70%, that is extremely high considering its operating frequency band [3]. The array foresees a 24-elements rectangular lattice arranged by 3 rows and 8 columns. The proposed statistical analysis accounts for the quantization and uncertainty of the complex excitations, in terms of both amplitude and phase coefficients. The output data have been compared with measurements on the array prototype, providing a complete validation of the statistical model.

References

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