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An Efficient Automated Radiation Measuring System for Plasma Monopole Antenna

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Abstract : This experimental study is aimed to examine the radiation characteristics of different plasma structures of a surface wave-driven plasma antenna by an automated measuring system. In this study, a 30 cm long plasma column of argon gas with a diameter of 3 cm is excited by surface wave discharge mechanism operating at 13.56 MHz with RF power level up to 100 Watts and gas pressure between 0.01 to 0.05 mb. The study reveals that a single structured plasma monopole can be modified into an array of plasma antenna elements by forming multiple striations or plasma blobs inside the discharge tube by altering the values of plasma properties such as working pressure, operating frequency, input RF power, discharge tube dimensions, i.e., length, radius, and thickness. It is also reported that plasma length, electron density, and conductivity are functions of operating plasma parameters and controlled by changing working pressure and input power. To investigate the antenna radiation efficiency for the far-field region, an automation-based radiation measuring system has been fabricated and presented in detail. This developed automated system involves a combined setup of controller, dc servo motors, vector network analyzer, and computing device to evaluate the radiation intensity, directivity, gain and efficiency of plasma antenna. In this system, the controller is connected to multiple motors for moving aluminum shafts in both elevation and azimuthal plane whereas radiation from plasma monopole antenna is measured by a Vector Network Analyser (VNA) which is further wired up with the computing device to display radiations in polar plot forms. Here, the radiation characteristics of both continuous and array plasma monopole antenna have been studied for various working plasma parameters. The experimental results clearly indicate that the plasma antenna is as efficient as a metallic antenna. The radiation from plasma monopole antenna is significantly influenced by plasma properties which provides a wider range in radiation pattern where desired radiation parameters like beam-width, the direction of radiation, radiation intensity, antenna efficiency, etc. can be achieved in a single monopole. Due to its wide range of selectivity in radiation pattern; this can meet the demands of wider bandwidth to get high data speed in communication systems. Moreover, this developed system provides an efficient and cost-effective solution for measuring the radiation pattern in far-field zone for any kind of antenna system.

Keywords : antenna radiation characteristics, dynamically reconfigurable, plasma antenna, plasma column, plasma striations, surface wave
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