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Proposal of a Rectenna Built by Using Paper as a Dielectric Substrate for Electromagnetic Energy Harvesting

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Abstract : The recent and fast development of the internet, wireless, telecommunication technologies and low-power electronic devices has led to an expressive amount of electromagnetic energy available in the environment and the smart applications technology expansion. These applications have been used in the Internet of Things devices, 4G and 5G solutions. The main feature of this technology is the use of the wireless sensor. Although these sensors are low-power loads, their use imposes huge challenges in terms of an efficient and reliable way for power supply in order to avoid the traditional battery. The radio frequency based energy harvesting technology is especially suitable to wireless power sensors by using a rectenna since it can be completely integrated into the distributed hosting sensors structure, reducing its cost, maintenance and environmental impact. The rectenna is an equipment composed of an antenna and a rectifier circuit. The antenna function is to collect as much radio frequency radiation as possible and transfer it to the rectifier, which is a nonlinear circuit, that converts the very low input radio frequency energy into direct current voltage. In this work, a set of rectennas, mounted on a paper substrate, which can be used for the inner coating of buildings and simultaneously harvest electromagnetic energy from the environment, is proposed. Each proposed individual rectenna is composed of a 2.45 GHz patch antenna and a voltage doubler rectifier circuit, built in the same paper substrate. The antenna contains a rectangular radiator element and a microstrip transmission line that was projected and optimized by using the Computer Simulation Software (CST) in order to obtain values of S11 parameter below -10 dB in 2.45 GHz. In order to increase the amount of harvested power, eight individual rectennas, incorporating metamaterial cells, were connected in parallel forming a system, denominated Electromagnetic Wall (EW). In order to evaluate the EW performance, it was positioned at a variable distance from the internet router, and a 27 kΩ resistive load was fed. The results obtained showed that if more than one rectenna is associated in parallel, enough power level can be achieved in order to feed very low consumption sensors. The 0.12 m2 EW proposed in this work was able to harvest 0.6 mW from the environment. It also observed that the use of metamaterial structures provide an expressive growth in the amount of electromagnetic energy harvested, which was increased from 0. 2mW to 0.6 mW.

Keywords : electromagnetic energy harvesting, metamaterial, rectenna, rectifier circuit
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