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A Novel Design Module of RF Energy Harvesting for Powering the Low Power Electronics Circuits

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ABSTRACT

For charging the low power electronics devices RF energy harvesting system is the best approach. This paper proposed a new module of RF energy harvesting module for powering the low power devices. It is very compact in size because the receiving antenna is a coplanar monopole antenna of size $50 \times 40 \text{ mm}^2$ and the seven stage converter circuit is also of size $20 \times 30 \text{ mm}^2$. The output of this module is 289mV. The uniqueness of this system is the coplanar monopole antenna that is previously designed by the same authors for RF energy harvesting application particularly. The antenna resonates from 900MHz - 9.9 GHz with band rejection from 3.1 – 5.6 GHz. Also the area of conductor at the antenna for capturing the RF energy from ambient is more in this structure due to parasitic patch, Resonating patch and coplanar design. The measurements were taken from the set up of horn antenna having transmitting power of 10dBm. The designed antenna has shown the received voltage -26.2 dBm at the input port and the measured voltage at the output of converter circuit is 289 mV DC. This mV DC may be boosted by connecting the booster circuit or we may use the super capacitor at the output of module for charging the low power devices.

Keywords:

Coplanar monopole antenna; RF-DC convertor; RF Energy Harvesting

1. INTRODUCTION

RF Energy harvesting from the ambient will have shown active role in the present era of microelectronics devices. The researchers named it as RECTENNA.

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Two important design parts of this rectenna are an efficient receiving antenna and a good RF-DC converter circuit with better rectification efficiency.

Many antennas especially for this RF energy harvesting purpose were designed for single resonant frequency operation in GSM, ISM, C and X band [1-4]. Dual resonant frequency operated antennas were also reported [5-6] for the same purpose. To enhance the receiving power of these antenna array arrangements were also studied [7-8]. After designing the efficient receiving antenna circuit, RF-DC converters having single stage were designed [9-10]. To improve the conversion 2 to 7 stages of RF-DC converter circuits were reported. Matching circuit in between antenna and converter circuit for impedance matching is also important to deliver maximum power.

This work also proposes a novel RF Harvester module. The novelty in this work is in the design of antenna. The author previously reported the antenna [11] for RF energy harvesting purposes. The antenna is a coplanar monopole antenna with wideband operation on multiple frequencies of useful bands. This author's designed antenna is working here as receiving antenna for RF-DC converter circuit. A seven stage RF-DC converter circuit has designed for experimental purposes and results of the experimental setup are reported in this paper. The value of DC output is 289 mV with respect to input taken as $5 \mu\text{W}$.

2. DESIGN OF RF ENERGY HARVESTING CIRCUIT

The block diagram of RF energy harvesting is shown in Figure. 1. Basically, it is comprised of three sections a) antenna (As a RF Receiver) b) matching network (for impedance Matching Network) c) RF-DC converter and voltage multiplier module and load circuit. The next section describes the proposed system blocks one by one.

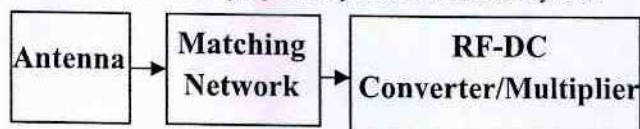


Figure 1: General block diagram for the energy harvesting system.