Design of an RF - DC Conversion Circuit for Energy Harvesting

K. K. A. Devi[1], Norashidah Md.Din[2], C .K. Chakrabarty[2], S. Sadasivam[1]

1. Department of Electrical and Electronic Engineering, INTI International University, Malaysia
2. Department of Electronics and Communication Engineering, Universiti Tenaga Nasional, Malaysia

Abstract- **The design of voltage multiplier module used for energy harvesting system from ambient at downlink radio frequency range (935.2 MHz-959.8 MHz) of GSM-900 is presented. The function of this voltage multiplier circuit is to convert the RF energy signal into DC voltage that can be used to energize the low power electronic devices. The design was based on the Villard voltage multiplier circuit. A 4 -stage Schottky diode voltage multiplier circuit was designed, modeled, simulated, fabricated and tested for its performance. Multisim was used for the modeling and simulation work. Simulation and practical tests were carried out for various input power levels at the specified frequency band. The RF input power levels verses the output voltages at the nodes of the Villard network were recorded. The input for the voltage multiplier module was fed through an efficient matching network from an RF energy harvesting antenna which is designed at 377 Ω impedance. For a received signal of –27dBm (1.99) µW at the antenna modules produce a DC output voltage of 2.1 V across 100 kΩ load.**

I. INTRODUCTION

RF energy harvesting requires capturing free flow of energy at the frequencies of interest and converting that energy into usable DC voltage. Ambient RF energy is captured by the use of an antenna and channeled into the input of RF-DC conversion module (a voltage multiplier circuit) through an appropriate matching network.

The energy conversion module converts the captured RF energy into DC voltage. The conceptual block diagram for energy harvesting system is shown in Fig.1. In [1], work was carried out at 900 MHz 50 Ω impedance and used resonance circuit transformation in front of the Schottky diode which yields a DC output voltage of over 0.3 V for an input power level of -26 dBm (2.5 µW). A DC voltage of 0.8 V was achieved with no load from RF input power level of -20 dBm (10 µW) at 868.3 MHz through simulation [2]. A Cockcroft-Walton multiplier circuit was used and produced 1.0 V DC voltage into a 200 MΩ load for an input power level of 1.0 µW at a fixed frequency of 2.4 GHz [3]. Using an integrated zero bias detector circuit with BiCMOS technology, [4] achieved a DC output voltage of 1 V into a 1 MΩ load for an input power level of 1.0 mW

The design of the energy conversion module in this article is based on a voltage amplifier circuit which can be able to output a DC voltage typically larger than a simple diode rectifier circuit as in [5]. This module can function as an AC to DC converter that not only rectifies the AC signal but also elevates the DC voltage level. The output voltage obtained from the energy conversion module can be used to energize the low power sensors in a sensor network.

The sensors are kept at equal spacing in the soil and play a vital role in measuring and real time monitoring of various parameters such as humidity, temperature and fertility. These soil sensors which are located at remote places are energized by the low power batteries, which needs frequent replacement and maintenance.

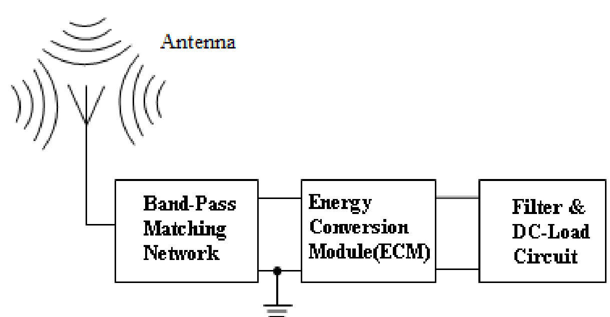

Fig.1. Conceptual block diagram for an energy harvesting system

This research work is focused to address these difficulties and the output voltage from the energy harvesting system is used to energize SHT1X series sensors for humidity and temperature from Sensirion [6].

Section 2 of this article discusses on the theoretical background of the voltage multiplier circuit. Section 3 presents the methodology which contains simulation and implementation procedures of the circuit. Section 4 provides the results and analysis. Section 5 concludes the article with the research findings.

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