HYBRID ENERGY HARVESTING FOR LOW POWER DEVICES

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ABSTRACT

In this project we are using renewable energy as an alternate source to charge the mobile phone. Here the modules like peltier, piezoelectric sensor, solar panel and RF antenna to obtain the power. By placing cold and heat junction in the peltier current will be produced. By applying vibrations in the piezo electric sensor current will be produced. By viewing solar panel to the sunlight current will be produced. By receiving free energy from the RF antenna current will be produced. All the produced current will be transferred to the hybrid circuit that can be used to charge the mobile phone. The amount of power produced will be displayed in the LCD.

Keywords: RF, LCD, Energy harvesting, Sensor.

I. INTRODUCTION

The advancement of using renewable energy as an alternate source has enabled to charge mobile phone in an efficient way. In recent years, the use of power banks has expanded due to its size and comfortless. In addition to make it more comfortable by means of getting electricity from outside environment. However, thermoelectric cooling uses peltier effect to create a heat flux between materials, it either uses heating or cooling. Similarly, the use of piezoelectric resulting by means of pressure, the amount of current produced depends upon the pressure. RF energy harvesting holds a promise able future for generating a small amount of electrical power to drive partial circuits in wirelessly communicating device. The implementation of PV plants has expanded to provide electricity for charging mobile phone. Moreover, the amount of electricity produced by various sources is multiplexed in the Hybrid circuit.

Today, wind energy is assimilated into the grid by legislative mandates, feed-in tariffs, favorable penalty pricing, guaranteed grid access, and/or construction subsidies. The variability in production is absorbed by scheduling operating reserves. For example, in California, the Participating Intermittent Resource Program (PIRP) legislation compels the system operator to accept all produced wind power subject to certain contractual constraints (1). The DG systems are presented as a suitable form to offer highly reliable electrical power supply. The concept is particularly interesting when different kinds of energy resources are available, such as photovoltaic (PV) panels, fuel cells (FCs), or wind turbines (2).

II.RECTIFIER DESIGN

"A RF antenna is a rectifying antenna special type of antenna that is used for converting electromagnetic energy into direct current (DC) electricity. They are used in wireless power transmission systems that transmit power by radio waves. A simple antenna element consists of a dipole antenna with an RF diode connected across the dipole elements. The diode rectifies the AC current induced in the antenna by the microwaves, to produce DC power, which powers a load connected across the diode. Schottky diodes are usually used because they have the lowest voltage drop and highest speed and therefore have the lowest power losses due to conduction and switching. Large RF antennas consist of an array of many such dipole elements".

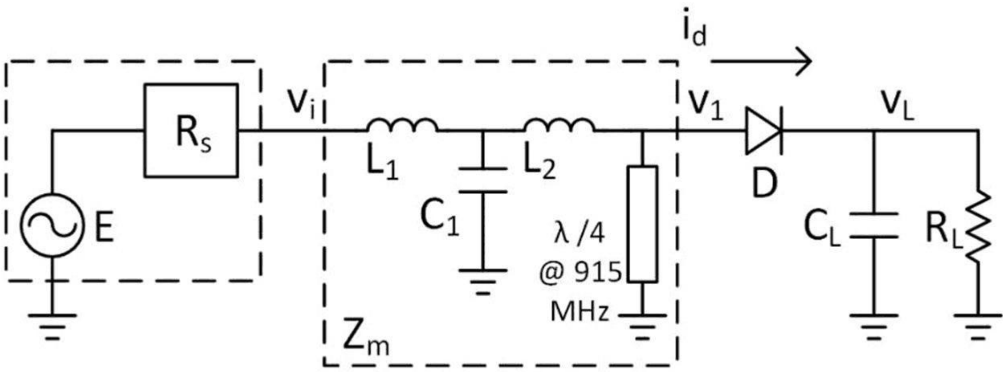

Fig:1 Rectifier conversion circuit

A T-type matching network was used consisting of two off-the-shelf series inductors and one shunt capacitor. The inductors were L1 = 3.3 nH (Coilcraft 04CS3N3) and L2 = 43 nH (Coilcraft 06CS430) and the capacitor C1 = 3 pF (Murata GMR39C0G030C050). The values of the capacitor and the two inductors were optimized simultaneously with the output load in order to maximize the efficiency for a fixed average available signal power PA = -20 dBm. The harmonic filter consisted of a shorted stub a quarter wavelength long at the fundamental frequency of 915 MHz.

III.MEASUREMENTS

The rectifier RF-DC conversion efficiency obtained for different modulated signals of the same average power versus different output load RL values. "The performance of the various modulated signals is also compared to that of a continuous wave (CW) input signal. One can see that the load value corresponding to a maximum efficiency is different for each of the applied signals. There is a region corresponding to lower RL values where CW has better RF-DC conversion efficiency than modulated signals with higher HYBRID. As the load is increased, the efficiency of the CW signal eventually begins to decrease and the efficiency of modulated signals becomes better than the CW. Specifically, signals with higher HYBRID present better efficiency at higher load values. As an example, with a 1KΩ load the efficiency of a 64QAM signal is 1% worse than that of a CW signal, but if the load is increased to 15 KΩ the efficiency obtained with a 64QAM signal is 3% better than the CW signal".

The same trend was observed at different input (average) power levels of -20 dBm and 0 dBm. As the average power is increased the RF-DC efficiency values are larger for all signals considered. If the power is increased beyond 0 dBm the efficiency begins to drop due to the breakdown voltage of the diode. Furthermore, as the average input power is increased the load value RL corresponding to a maximum efficiency is reduced for all considered signals.

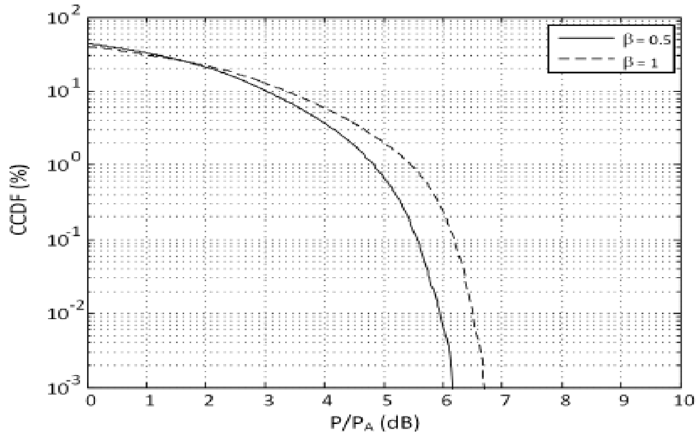

Fig 2: measurement of CCDF with 64QAM

In Fig. 3 the RF-DC conversion efficiency of 64 QAM signals with β = 0.5 and β = 1.0 is compared for varying load values RL. The CCDF of these two signals was presented in Fig. 2 where it was shown that using β = 1.0 resulted in larger CCDF values and slightly higher HYBRID. Similarly to the results of Fig. 3, the signal with lower HYBRID has a smaller optimum load than the signal with the higher HYBRID and consequently it has a larger RF-DC conversion efficiency at smaller load RL values while the signal with the higher HYBRID has better efficiency at larger RL.

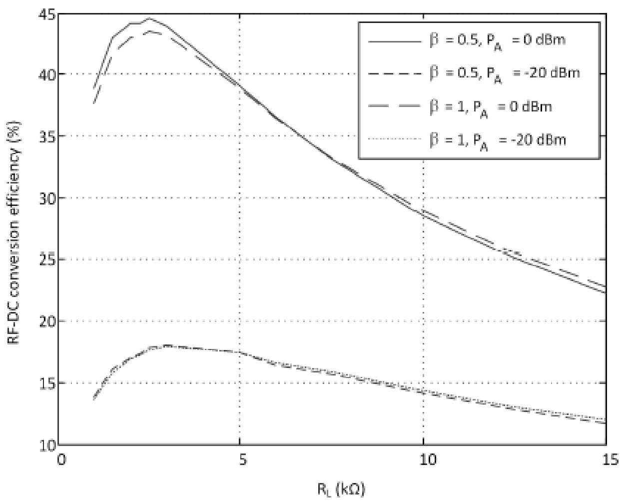

Fig 3: Measured RF-DC converted

IV.CONVERSION PROCESS

A planar low profile and light weight microstrip patch antenna is used. The application of fractal geometry to conventional antenna structures optimizes the shape of the antennas in order to increase the electrical length not physical length, thus reducing the overall size. The characteristic impedance of the feedline may be designed to be 50 ohm and the final antenna design will be optimized using efficient computational tools. The impedance matching circuit may be realized by series transmission lines and shorted stubs for good result.

The convenient way to use the energy from commercial RF broadcasting stations like radio or TV and from mobile base stations to supply energy to wireless sensor nodes. Therefore this powering method can be especially interesting for sensor nodes located in remote places, where other energy sources like solar radiation or wind energy are not feasible. This kind of energy transfer is, although small amount of energy is uninterrupted and could serve as the energy support for other energy sources. The antenna is connected to a tuner stage, since we want to use a only channel of all the possible commercial transmissions. The selected channel is the only one that is more powerful where the sensor node is located. The tuner stage is connected to a rectifier circuit which is composed by a charge pump. Generally two cell Dickson charge pump voltage doubler rectifier circuit is used because it posses the advantage of low input impedance at microwave frequencies, thus making matching to 50 ohm easier. The diodes appear in parallel to RF signals but are in series for DC circuit; as such the voltage output is doubled.

V.EXPERIMENTAL SETUP

A typical energy harvesting consists of sensors powered by small batteries that are difficult to replace if not impossible. Hence, the sensor nodes can only transmit a finite number of bits before they run out of energy. Thus, reducing the energy consumption per bit for end-to-end data transmission is an important design consideration for such networks. We assume that each information bit collected by a sensor is useful for a finite amount of time; after this time the information may become irrelevant. Hence all the bits collected by the sensors need to be communicated to a hub node before a certain deadline. Therefore, the maximum end to-end transmission delay for each bit must be controlled to meet a given deadline under the hard energy constraint. Since all layers of the protocol stack affect the energy consumption and delay for the end-to-end transmission of each bit, an efficient system requires a joint design across all these layers as well as the underlying hardware where the energy is actually expended.

After the fabrication of RF energy harvesting circuit, we compare the improvement in the wake-up performance of the combined circuit where the WISP-mote and the energy harvesting circuit work in parallel. The base case is the wake-up performance of the WISPmote acting alone. The experimental results are obtained from the study conducted in the UoR's campus, where our circuit is connected to a WISP-mote, which further triggers the Tmote Sky. The outputs of each stage are linked, as indicated in Figure 4.

The proposed energy harvester reduces the charging time of WISP's capacitor which is linked in voltage regulator input. Less charging time can enable quick wake-up. Due to this reason, the proposed circuit helps to reduce the response delay, known potential wake-up delay, by around 50%.

Fig 4: Prototype

V.CONCLUSION

The effect of randomly modulated signals on the RF-DC conversion efficiency of a UHF rectifier circuit was studied. It was observed that the optimum load corresponding to maximum RF-DC conversion efficiency increases with increasing peltier, piezoelectric sensor, solar panel and RF antenna of the input signal. As a result, signals with lower peltier, piezoelectric sensor, solar panel and RF antenna tend to lead to higher efficiency at lower load values while for large load values the efficiency obtained with signals having a high HYBRID is better. It is also observed that while hybrid is a good indicator of the RF-DC efficiency performance, the complete CCDF curve, or other statistical measures such as the instantaneous power variance is necessary for an accurate evaluation of its behavior. Finally, the RF-DC conversion efficiency depends on the modulation rate through the output filter of the rectifier formed by the output capacitor and load value.

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