ENERGY HARVESTING FROM RF SIGNAL

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Abstrac t— Energy harvesting or energy scavenging is simply a conversion process of the ambient energy into the electrical energy. The ambient energy exists around us in many different forms including chemical, thermal, solar, electrical and radio frequency (RF). This energy harvesting technique mainly reduces the costs of replacing batteries periodically. Electrical energy can be harvested from RF Signals those are present in our environment. By converting this RF Signals and electromagnetic signals into electrical energy, compact and lifetime batteries can be developed. In our daily life wireless sensor networks are relatively used by us, so there is wastage of RF signal is respectively increases, by converting this wastage energy signal we can get a lifelong batteries for sensors, and other low power electronics devices. In this paper we represent a simple and low cost method for energy harvesting from RF signals. First we present a review of existing research progresses in RF energy harvesting. Then we represent Block diagram of Energy Harvesting system We also explore practically tested simple circuit diagram of energy harvesting system.

***Index Terms*—Energy harvesting, RF energy harvesting circuit, Ultra low power MSP, Wireless sensor network.**

I. INTRODUCTION

In few years back, many new technologies have been applied in order to enhance our life quality. One of these technologies is the cost-saving system in a house which uses self-powered devices. Energy harvesting from different Environmental sources is important aspect in order to enhance the quality and simplicity of our daily life.

In earlier days the usage of wireless networks and applications is increasing rapidly which directly takes to increase in battery usage[2].But still the batteries used in this application has limitations, such as periodically replacement of the batteries is required in order to the application or have to charge them manually and also lifespan of this batteries is very less. Sometimes it is difficult to change or manually charge the batteries purposely. These problems can be overcome as well as remove completely by using this energy harvesting system.

As shown in the figure (1), all possibilities of RF Sources are Mobile Communication Tower, TV Transmitter Tower, and Radio Transmitter Tower, WI-Fi router, Radio and mobile phones. Almost all these RF sources are producing RF Signals continuously but are not Completely Utilizes by their Receivers. There is large amount of signals get wasted. So this wastage of the signals is to be collected by our GSM Receiver Antenna and we convert it into Electrical energy.

Fig.1. Different Sources of RF Signals.

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II. EXISTING SYSTEM

The antenna is the key element of an RF energy harvesting system to capture the radiated RF energy and extract maximum power. The aim is to design antenna which can produce large DC output voltage. Until today, various antenna topologies have been recorded [3][4][6] for RF energy harvesting; nevertheless, only a few achieves a good performance in both gain and bandwidth. Antennas can be designed in many forms, for instance patch antennas, dipole antennas, planar antennas, micro strip antennas and uniplanar antennas. Several types of patch antennas have been designed in various frequency regions focusing on bandwidth improvement [7].In previously implemented techniques they use rectenna in order to collect RF Signals but this antenna is not suitable for small range of signal and complicated to design. Important role in power and energy industry. The concept of rectenna is introduced and that rectenna can harvest wireless energy efficiently under certain conditions and have the potential to become a power supplier for some special applications[1].

Nikola Tesla's idea of wireless Transmission of electrical energy is solution for world energy crisis. he went on to speculate how one might increase the scale of this effect to transmit power and transmission, he is created tesla coil which allow wireless transfer of electricity. [4] Energy harvesting is key techniques that can be used to overcome the barriers that prevent the real world deployment of wireless sensor networks (WSNs) propose a low cost approach using RF energy harvesting from ambient RF fields; this approach mainly relies on TV broadcast signals. TV broadcast signals that are not received by the TV viewers are generally dissipated as heat resulting in a waste of energy.[5] NEC's researchers have successfully reproduced 250 mW from the electro-magnetic noise generated from a fluorescent lamp and powered an RF tag[6]. Patel et al. have focused on the noise generated during turning on and turning off home electric appliances and discussed the Feasibility of powering RFID tags with the harvested energy [7]. This wireless power transfer is assumed to transfer energy from space to ground. On the other hand, several small Wireless power transfer products that can be used in one's houses have been released, such as Power cast [8]. During the past decade, with the development in RF energy harvesting circuit, low power transfer for powering mobile terminals in wireless communication systems began to attract increasing attention [9], [10]. The authors in [9] propose a network architecture for RF charging stations, overlaying with an uplink cellular network. In [10], a harvest-then-transmit protocol is introduced for power transfer in wireless broadcast system.

III. BLOCK DIAGRAM AND SPECIFICATION

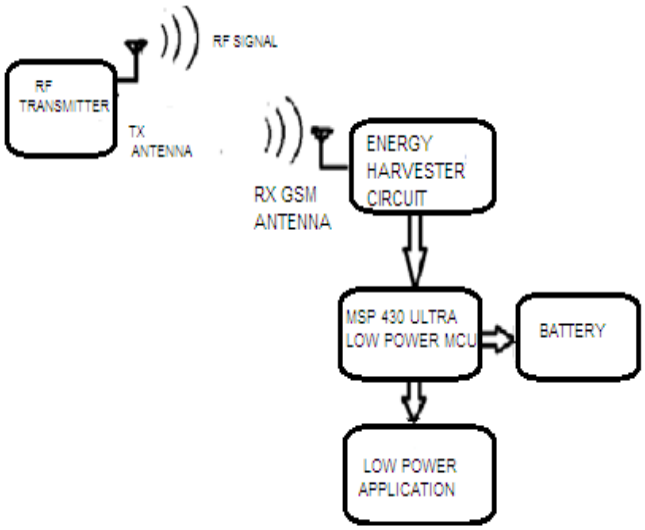

Fig.2. Block diagram of Energy Harvesting System.

The above figure is overall system of energy harvesting from RF Signal. The major blocks are RF Receiver Antenna, Energy Harvest Circuit, MSP430 Ultra Power Microcontroller, Low Power Application and Battery.

RF Signals are available easily and broadly in environment. These free signals are getting transmitted by different RF Transmitters. We have to collect these wasted RF Signals to generate electrical energy or DC voltage. Receiver Antenna will collect these RF Signals. To collect the large amount of signal in order to increase harvested power we have used number of small antennas which is a normal copper wired antenna. To get more efficient power we used GSM Antenna and Wi-Fi receiver antenna also. There are many types of GSM Antennas but for this purpose we can use antenna like a GSM Telephone Antenna as well as Wi-Fi antenna. These collected signals will be transfer to next block of system which is Energy harvesting Circuit. This circuit is heart of the overall system. This Circuit is made up of two components i.e. germanium glass diode and electrolytic capacitor. This block will convert RF Signals into DC Voltage.

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DC voltage generated by Harvesting circuit is very small and not sufficient to power normal microcontroller which operates on 5V DC .high power application so we are using a MSP430 madule.MSP430 is Ultra low power kit which operates on voltage below 3V DC. with the help of this kit we can run many low power WSN applications and we can charge 1.2V batteries.

IV. CIRCUIT DIAGRAM

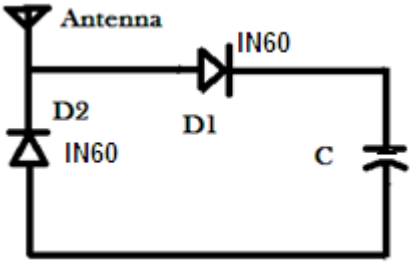

Fig .3. Basic Harvester Circuit

The circuit shown above is basic circuit to convert RF signal to DC voltage. Antenna collects the RF Signal and converts it into electrical signal which is an AC signal. Antenna is directly connected to diode D1-D2. These are the Schottky diodes. Schottky diode has high reliability, Low Reverse current and low forward voltage. is has very high switching speed. It works on small voltage signals. Diode D1 get the AC signals from Antenna and rectifies these AC Signals and convert them into Pulsating DC Signal. These Pulsating signal appeared to Capacitor which acts as a C Filter and produces pure DC Signal. Diode D2 act as open circuit and oppose to discharge Capacitor. Hence Energy will be stored in this capacitor.

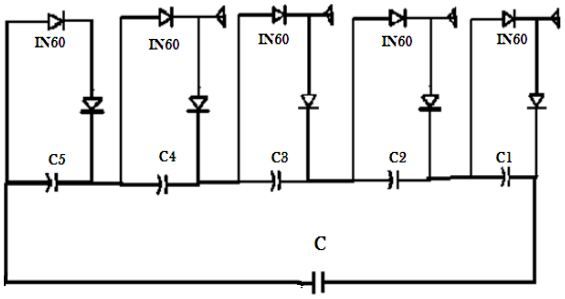

Fig.4. Multistage energy harvester circuit

This is a complete harvesting circuit which is developed by coupling multiple basic harvesting circuits. The basic circuits are connected in such a way that it harvest quite large amount of voltage. Here we connected five stages of basic circuits with copper wired antenna in series and Capacitor C is also connected to store voltage harvested by all stages. This harvested energy is used for further applications.

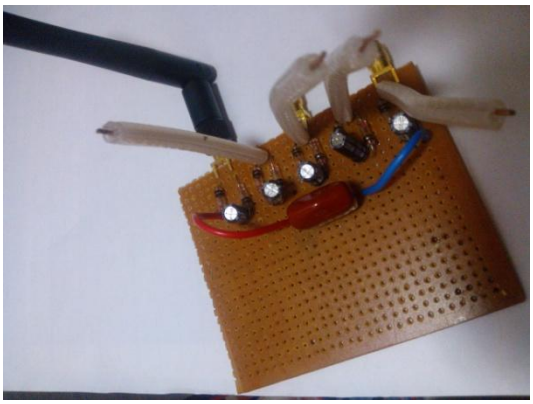

Fig.5. Circuit implemented on PCB

V. ADVANTAGES

1)The presented system could represent, on a large scale, using suitable solution to environmental sustainability: it allows reducing the use of batteries, sources of environmental pollution.

2)Wireless sensor networks (WSNs) are widely considered the technology of choice for different types of monitoring, data gathering, surveillance, appliance control applications, among others . However, one of the most important factors preventing the extensive use of WSNs is that the lifetime of the network, i.e., the duration of the services it provides, is severely limited by energy resources:

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3)The sensor nodes are powered by short-lived batteries whose replacement or recharge is expensive and environmentally unfriendly, if even possible. Therefore, human assistance for battery replacements is needed, and this severely limits the monitoring applications that can be effectively performed by WSNs

VI. RESULT

Table 2. Voltage produced by the germanium and Schottky diode.

Diode/ voltage	V1 In volts	V2 In volts	V3 In volts	V4 In volts
V_{D1} Germanium diode	0.711	0.703	0.860	0.724
V_{D2} Schotty diode	0.378	0.330	0.349	0.273

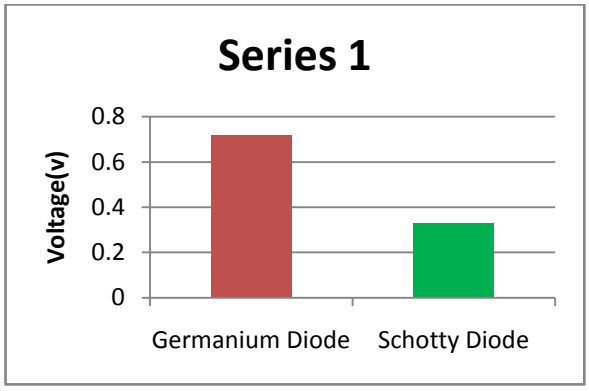

Fig.6. The effect of different diodes on voltage production

VII. CONCLUSION

Performance improvements in battery technology and the power requirements of electronics are not keeping pace with the increasing demands of many wireless sensor networking applications. For this reason, there has been considerable interest in the development of systems capable of extracting usable electrical energy from existing environmental sources. Such sources include ambient electromagnetic energy, thermal gradients, vibration and other forms of motion. In this paper, we have provided a feasibility study of harvesting electrical energy from RF signals. We conducted many experiments with various off-the-shelf diodes and current carrying conductor combinations. The results are promising in that with easily available components, up to 1-2 mw of power can be harvested. As future work, we intend to construct an inductor that is optimized for harvesting energy in this context.

In this paper we have presented a comprehensive system for RF energy Harvesting Firstly, we have provided an overview of existing systems in RF energy harvesting. Then, we have reviewed the block diagram and circuit implementations. Afterwards, we have tabulated the results of mentioned circuit using two different types of diodes.

we reviewed the study of energy harvesting based on RF Signals. We also discussed some design issues occurred in RF Signal harvesting. We try to improve the efficiency of energy harvesting via very small and simple circuit. At sufficient RF Signal this system can generate 2 to 3 DC Voltage which is sufficient to charge a batteries and used for further applications. as cost of this work is very less, we can use it in many applications such as sensors ,security systems ,indicating circuits ,drivers.

VIII. REFERENCES

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