Implementation of a System that Harvests the Energy from the Wi-Fi to Charge the Batteries

Mohankumar V[#], Dr. G V Jayaramaiah[*], R H Vijayakumar[$], Madhusudhan M[&]
[#, *, $, &]*Department of ECE/ Dr.AIT, Bengaluru-56, Karnataka, India*

***Abstract*—Energy harvesting is a process of converting waste energy into useful form. i.e., converting ambient sources like, temperature, light, sound, human body movement etc into the electrical energy, that can be used for low power applications as well as high power applications. Proposed model was implemented to address the challenges [1] for charging the batteries such as short lifetime, more power consumption and bulky. The extraction of energy from of electromagnetic radiation emitted from the wi-fi have been developed to improve the lifetime, to reduce the size and generating the energy of approximately 15V and can be used to charge the batteries.**

The proposed model uses antenna to receive the electromagnetic waves and fed to the diode-voltage doubler circuit followed by a rectifier, which generates an energy of DC 5V. 5V DC signal is applied to the boost converter to increase the voltage upto 20V, and boost converter switching action is automated using bistable multivibrator. Recharging circuit is a simple, Diode Bridge circuit.

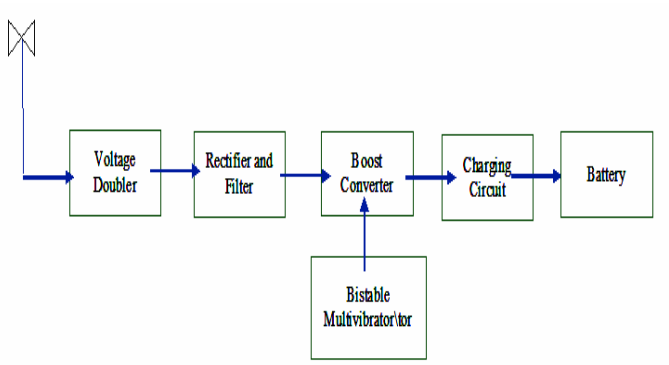
***Keywords*—Voltage doubler, Booster, Bistable multivibrator, Bridge Circuit.**

I. INTRODUCTION

Energy harvesting is a process of extracting energy from the ambient sources, one of the ambient sources is an electromagnetic signals, these signals are surrounded everywhere in the environment. especially the intensity of electromagnetic waves increases whenever using cell phones, using microwave ovens, and using laptops that are connected to wi-fi. The intensity of the Wi-Fi signal radiated by laptop is around 2-10W/cm^2, and the intensity is directly proportional to the square of the amplitude. Amplitude is directly proportional to the wave velocity and also proportional to the Voltage. The voltage range is approximately 2000mV/m-2500mV/m. The voltage doubler circuit is used to double the voltage and further boosted by using Power electronics boost converter. The charging circuit is next to the boost converter which is used to charge the dry/liquid batteries of capacity 15V.

The figure (1) shows the block diagram of proposed model, which consists of Voltage Doubler, Rectifier, Boost converter and charging Circuit.

Fig. 1 Block diagram of energy harvesting system.



II. LITERATURE SURVEY

The piezo electric transducer converts mechanical energy in into electrical energy and the size is minimized, for low power applications that can dissipate energy in a resistive load and or store energy in a capacitor [2]. A self-powered MOSFET gate drive circuit by using an averaging scheme and exhibits a pseudo resistive behaviour from the input. i.e., vibration into electrical energy [3]. Converting chemical energy into electrical energy, by using potential in the field of environmental monitoring and new energy development, microbial fuel cells are used for this application and generating energy [4].

III. PROPOSED MODEL/SOLUTION

From the literature survey, the conversion of electromagnetic radiation into electrical energy is possible and can be used to charge the batteries. The main objectives of the proposed solution are as follows:

i. Converting electromagnetic radiation into electrical energy.
ii. Boosting the energy to the higher voltage levels.
iii. Used to charge the batteries.

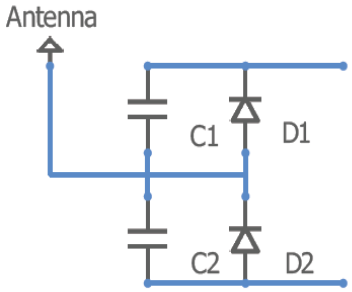
IV. IMPLEMENTATION

A. Voltage doubler circuit:

As shown in Figure 2, the electromagnetic waves received by an antenna is of low potential and can be

increased by using this circuit. The voltage doubler circuit consisting of two capacitors and two diodes.

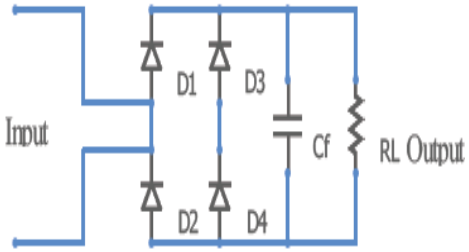
Fig. 2 Voltage Doubler Circuit.



B. Rectifier:

The electromagnetic signals are in the form of alternating, and need to convert into DC, the proposed model uses bridge connected diode circuit to convert AC to DC and the capacitor filter to remove the ripples as shown in Figure 3 , which generates a voltage of approximately 5V(DC).

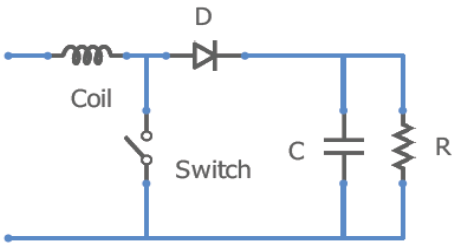
Fig. 3 Rectifier Circuit.



C. Boost Converter:

A simple boost converter, which consists of a coil, switch, diode and Capacitor. The output will be taken across the capacitor, as shown in Figure 4. This boost converter produces an output in the range of 15V(DC) to 20V(DC). The available voltage level is sufficient enough to charge the battery.

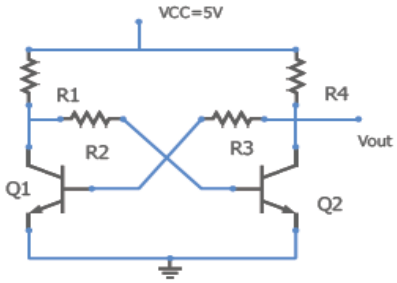
Fig. 4 Boost Converter Circuit.



D. Bistable multivibrator:

The boost converter needs a switch to turn ON and OFF continuously, then only the capacitor charged to its maximum level to generate required voltage level. Bistable multivibrator generates a clock pulse and acts as a switch. The circuit shown in Figure 5.

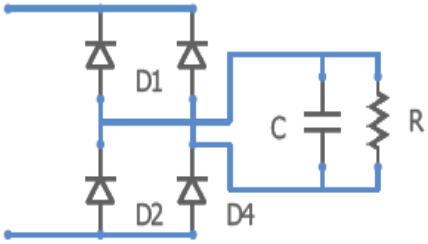
Fig. 5 Bistable multivibrator Circuit.



E. Charging circuit:

Figure 6 shows the circuit diagram of a charging circuit, and it acts as a medium between load to the boost converter.

Fig. 6 Charging Circuit.



V. RESULTS/TESTING

The proposed system was tested in three different levels, firstly unit test cases- to check the individual units, secondly Integration Test Cases- to test the combination of two or more units and finally System Test case-Testing the overall system.

TABLE I

Unit Test Case-1: antenna	
Input	Electromagnetic waves
Output	Voltage ≈2V/m
Result	Pass
Remarks: more intensity near laptop with wifi connection.	

Table1 shows the test case for unit antenna, and there is no abnormalities observed, the intensity of electromagnetic signals vary depending on the distance. The intensity is more if the antenna is near to the EMW radiation unit.

TABLE II

Unit Test Case-2: Voltage Doubler	
Input	2V elecromagnetic signals
Output	Voltage ≈5V

Result	Pass
Remarks: NIL	

Table 2 shows the test case for Voltage doubler circuit, the output is approximately twice the input.

TABLE III

Unit Test Case-3: Rectifier	
Input	AC Signal /output of voltage doubler
Output	DC signal
Result	Pass
Remarks: average voltage more in case of Bridge connected circuit compared to Halfwave Circuit.	

Table 3 shows the testing results of rectifier, and the average DC power will be maximized by using Bridge type full wave rectifier. Ripples eliminated by using capacitor filter.

TABLE IV

Unit Test Case-4: Boost Converter	
Input	DC Signal of level approximately 5V
Output	Voltage ≈20V
Result	Pass
Remarks: further voltage boosting possible by replacing coil by transformer with secondary terminals.	

Boost converter is a power electronic circuit, which increases the voltage levels, and testing of this unit shown in table 4.

TABLE V

Unit Test Case-5: Bistable Multivibrator	
Input	20V DC
Output	Charging 15V Battery
Result	Pass
Remarks: NIL	

Actually, booster circuit needs switch for its opeartion, can be done manually, but automated using bistable multivibrator. The test case of bistable multivibrator shown in table 5.

TABLE VI

Integration Test Case-1: Boost Converter with Bistable Multivibrator	
Input	Switch On and OFF
Output	Charging the Capacitor to maximize the voltage
Result	Pass
Remarks: NIL	

The integration of bistable multivibrator and booster circuit and its testing case shown in table 6.

TABLE VII

System Test Case-1: WIFI emitted EM radiation energy harvesting to charge the 15V Battery	
Input	Switch On and OFF
Output	Battery Charged
Result	Pass
Remarks: NIL	

Table 7 shows the test results of overall proposed model. Works effectively, when the distance between antenna and Wi-Fi connected laptop decreases, then intensity of electromagnetic waves increases and generates sufficient voltage level to charge the battery.

VI. CONCLUSION

The proposed model is a very needy system for our present life, and requires no power. i.e., without any external supply the proposed model generates minimum 15 V DC. This power can be utilized to charge the batteries. By further enhancement and according to the specification we can use this system for charging the laptops also.

The proposed model provides better efficiency, with simple construction and easy maintenance, the cost to build the system is also very less.

REFERENCES

[1]. Yoonmyung Lee, David Blaauw, DennisSylvester., (2016). Ultralow Power Circuit Design for Wireless Sensor Nodes for Structural Health Monitoring. Proceedings of the IEEE, Vol. 104, No. 8, pp.1529-1545.

[2]. James Dicken, Paul D. Mitcheson, Ivan Stoianov and Eric M Yeatman., (2012).Power-Extraction Circuits for Piezoelectric Energy Harvester in Miniature and Low Power Applications., IEEE Transactions on Power Electronics, Vol. 27, No. 11, pp. 4514-4529.

[3]. S Faghihi and M Moallem., (2012). Analysis and Design of Low power Electronics Circuit for Energy Harvesting Applications. IEEE Transaction, 978-1-4673-0158-9/12, pp. 183-188.

[4]. Mohd Sofwan bin Mohd Resali and Hanim Salleh., (2010). Simulation of an Energy Harvesting Circuit for Low Power Application. IEEE Transaction, 978-1-4244-7398-4/10, pp. 898-902.

[5]. Ge Shi, Yinshui Xia, Xiudeng Wang, Libo Qian, Yidie Ye and Qing Li., (2018). An Efficent Self Powered Piezoelectric Energy Harvesting CMOS Interface Circuit Based on Synchronous Charge Extraction Technique. IEEE Transactions on Circuits and Systems-I: Regular Papers, Vol. 65, No. 2, pp. 804-817.

[6]. H Sira-Ramirez and R Silva-Ortigoza., (2006). Text Book: Control Design Techniques in Power Electronics Devices, Sprnger.

[7]. Alireza Khaligh and Omer C Onar., (2010). Text Book: Energy Harvesting-Solar, Wind and Ocean Energy Conversion Systems, CRC Press.

[8]. Hrishikesh Venkataranan and Gabriel-Miro Muntear., (2012). Text Book: Green Mobile Devices and Networks CRC Press.