RF Energy Harvesting Using Impedance Matching Circuit

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Abstract- *The paper describes the design of high efficiency RF Energy Harvesting circuit combined with antenna. The circuit consist of low noise amplifier, impedance matching circuit and booster rectifier circuit to converting the RF energy into the boosted DC voltage. Matching network and booster rectifier stages also played a crucial role in the output voltage and efficiency of the circuit.*

Keywords- Rf Energy Harvesting, Matching network, Low noise amplifier

Software Used: Multisim version 7.

I. INTRODUCTION

Radio frequency energy harvesting is basically known as an energy conversion technique which convert energy from the electromagnetic field into the electrical domain (i.e. into voltages and currents). RF is one of the best renewable sources of energy. Recently, it is useful for battery free or low power device such as wireless sensor nodes, remote control etc. The frequency range between 1800-1950 MHz is most important for the cellular network.

Electromagnetic wave received by the antenna which have very low power efficiency and highly noisy. These problems mainly improved by the low noise amplifier. Input impedance 50 Ω in order to connect the transmitter and receiver circuit without reflection. It is necessary to optimize the input impedance of the antenna by matching circuit. It is difficult to realize the high-efficient RF energy harvesting circuit by using basic booster circuit composed of single diode and capacitor. In order to boost the low input voltage, seven stage Cockcroft-Walton circuit is used.

II. BLOCK DIAGRAM

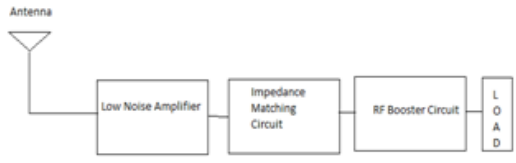

Figure 1: Block diagram of Rf energy harvesting

Figure1 shows the basic block diagram of Rf energy harvesting circuit with receiving antenna. The first stage of circuit contain the low noise amplifier, which main function is to provide enough gain to overcome the noise of subsequent stages. LNA should assemble large signal without distortion and frequently must also present a specific impedance.

III. WORKING

IV. IMPEDANCE MATCHING CIRCUIT

The main part of RF design circuit is matching network (circuit). To provide maximum power transfer from one part to another part matching network is used. The main function of matching circuit is transfer power without transmission losses. The signal from LNA circuit completely transmitted to the booster circuit without loss these done by the impedance matching circuit. Maximum power transfer can be realized when the impedance at LNA output and impedance of load is conjugate of each other. Figure 2 is the impedance circuit which we used as matching circuit.

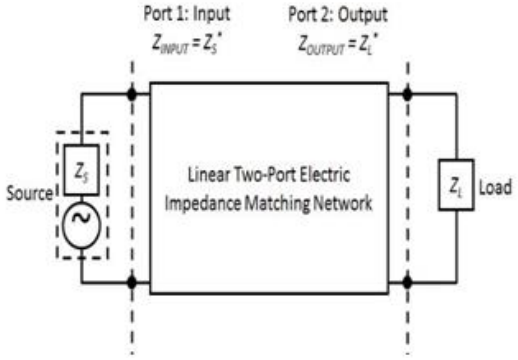

Figure2: Basic impedance matching network

FORMULAS

$$Zo = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{R+j\omega L}{G+j\omega C}} \quad (1)$$

If the resistive terms are neglected then result will be;

$$Zo = \sqrt{\frac{L}{C}} \quad (2)$$

Reflection coefficient:

$$\Gamma_L = \frac{ZL - Zo}{ZL + Zo}$$

$$VSWR = \frac{1 - \Gamma L}{1 + \Gamma L}$$

V. BOOSTER CIRCUIT

The output of impedance matching circuit is the input for the rectifier circuit. The basic of rectifier circuit is to convert the AC signal into the DC signal. Here rectifier circuit convert RF signal to the DC one. Figure 3 shows the Cockcroft–Walton booster circuit. CW circuit convert low level AC or DC signal to high level. It consists of a voltage multiplier ladder network of capacitors and diodes to generate high voltages. In the working of two stage CW booster circuit, capacitor c1 charges to V_p and all other capacitors in circuit charges $2V_p$. This circuit can increase to any number of stages. The no-load output voltage is twice the peak input voltage multiplied by the number of stages ***N*** or equivalently the peak to peak input voltage swing times the number of stages.

$$V_o = 2NV_p$$

$$\%\eta = \frac{Pout(CW\ circuit\ output)}{Pin(impedance\ matching\ circuit\ output)}$$

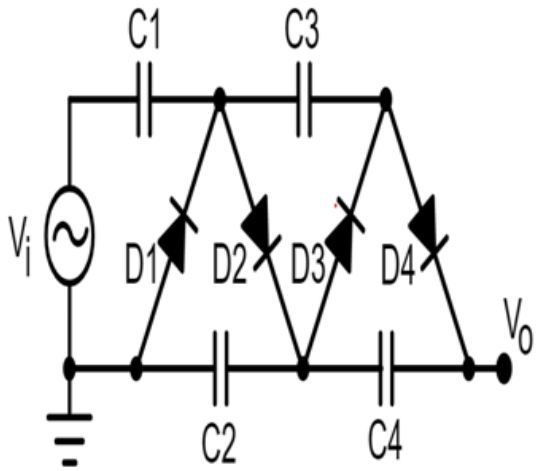

Figure 3: 2 stage Cockcroft -Walton booster circuit

VI. APPLICATION

- Can us for the body area networks
- Can useful for wireless sensors
- Can useful for the battery less power supply
- Can useful for internet on thing (IOT)

VII. ADVANTAGES

- Conventional power should be replaced of rf energy harvesting.
- Unlimited spectrums of sources are available
- There is no wastage of energy occur.
- No use of the periodic battery
- Efficient amount of energy available.

VIII. DISAVDAVTAGES

- Due to atmospheric changes,
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- physical obstacle receive power is too low or vary with time.
- Efficiency should be change due component used in the circuit designing.

IX. RESULT

Achieves the maximum output voltage for the minimum input voltage i.e. 4.5v from 9mv. Also reduces the insertion loss in the impedance matching circuit by -0.085dB.

X. CONCLUSIONS

In these paper we design the rf energy harvesting circuit by using the impedance matching circuit and Cockcroft-Walton booster circuit.

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