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Efficient method of charging mobile phones utilizing radio frequency energy

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Abstract
Finite electrical battery life is encouraging the companies and researchers to come up with new ideas and technologies to drive wireless mobile devices for an infinite or enhance period of time. Common resource constrained wireless devices when they run out of battery they should be recharged. For that purpose we need main supply and charger to charge drained mobile phone batteries or any portable devices. Practically it is not possible to carry charger wherever we go and also to expect availability of power supply everywhere. To avoid such disadvantages some sort of solution should be given and that can be wireless charging of mobile phones. If the mobile can receive RF power signals from the mobile towers, why can't we extract the power from the received signals? This can be done by the method or technology called RF energy harvesting. This method will be evaluated in this proposed research paper.

Keywords: Solution should, RF power, practically

Introduction
Radio waves are present everywhere since it is used for signal transmissions of TV, Radio, Mobile phones etc. Omni directional antennas are the major components used in communication systems to broadcast RF power in KW range. In practice for mobile communication, very few milli-watts of RF power can be scavenged from the atmosphere as the receivers ensitivity of the mobile phone antennas is very high [13]. The major factor for such a tremendous reduction in the transmitted power is, absorption by the objects (i.e. obstacles) present in the path of the RF waves and also loss of power in the form of heat in materials where it gets absorbed. Most of the wireless devices like mobile phones consume only micro watts to milli watts range of power for their operation in sleep & active modes respectively. So we can readily tap the RF power available in the external environment using scavenging circuit and use it to operate our mobilephones. Now, we can see our proposed circuit for achieving such functionality. The Figure 1.1 shown represents the block diagram of various ingredients to design our proposed circuit.

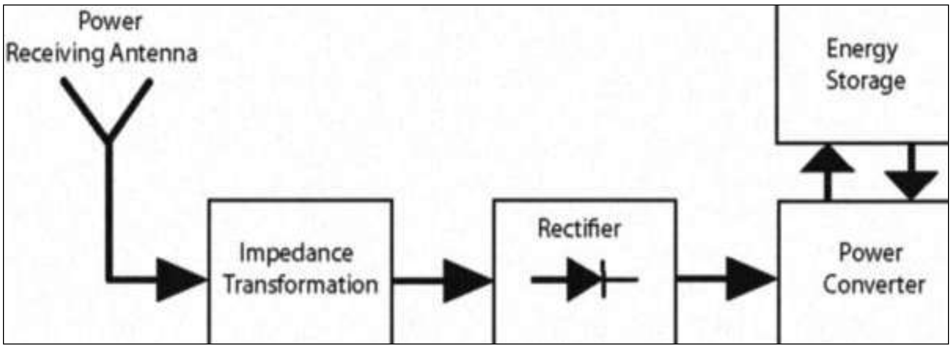


Fig 1: Block diagram

System Overview
The received RF power byan antenna is streamed through a rectifier circuit and then through a power converter circuit which increases the rectified voltage i.e. doubles/triples/quadruples. Finally the converted output DC power can be used for driving the device or it can also be used to recharge batteries.

The significance of the Impedance Matching circuit is to match the impedanc of antenna with that of rectifier circuit [14]. This achieves higher efficiency inattaining the output power. The input power received by the antenna is transferred to the rectifier circuit only at the resonant frequency. By using impedance transformation circuit, operation ofthe circuitis restricted to a specific frequency range of 0.9GHz– 1.8GHz which is the operating band for mobile communication [15].

Proposed Design

Figure 2.2 shown is our proposed circuit. In our design, in the front end of our circuit, weuse ideal power source offering impedance of 50Ω to deliver power ranging from -5 dBm to 40 dBm. This power range is chosen because the RF signalsare transmitted from the mobile towers at a power range of -5 dBm to 40 dBm. Following the source, weinclude a resonant circuitto resonate inthefrequencyrange of 0.9 GHz to 1.8 GHz. This is the frequency range at which the mobile service providers in India are allowed to communicate and hence this frequency range is chosen [16].

$$f = \frac{1}{2\pi\sqrt{LC}}$$

rcuit. In order to achieve a wide band, the quality factor of inductor is reduced by adding resistance to the inductor. This helps us to boost the output power for arrange of frequencies. The frequency range can be changed by tuning the impedance matching circuit which also acts a resonant circuit.

Following, we have voltage double r circuit in our design. During the positive half cycle, diode D1gets forward biased and charges the capacitor C1. During negative half cycle, diode D2 gets forward biased and charges the capacitor C2. The output is taken across the load resistance RL. This circuit was designed implemented and simulated in AD Stool [17]. The performances of our proposed circuit are described in the following section.

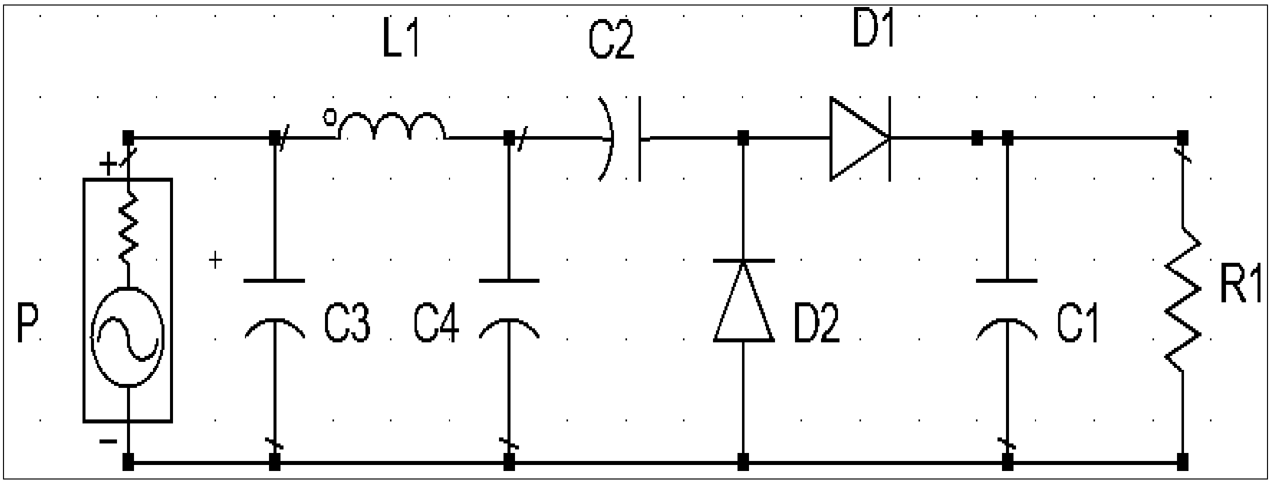


Fig 2: Circuit for RF energy harvesting

Mathematical Model

We proposed our circuit is mathematically modelled and the expressions are as follows

Let X_{L1}, X_{C1}, X_{C2}, X_{C3}, X_{C4}, D_1 & D_2 are the resistance and reactance values of the respective Inductor, Capacitors & Diodes.

If Z_1 is the output impedance of the matching network and Z_2 is the input impedance to the voltage multiplier stage, [17] then

$$Z_1 = (X_{L1}||X_{C3}) + X_{C4}$$

$$Z_2 = X_{C2} + [((X_{C4}||R_1) + D_1) || D_2]$$

Taking $X_{C1} = X_{C2} = X_{C3} = X_{C4} = X_C$ and $D_1 = D_2 = D$, the final expression of Z_1 and Z_2 are as follows-

$$Z_1 = \{1 + [\ \omega^2LC/(\omega^2LC - 1)]\}/j\omega C$$

$$Z_2 = \{([2R_1^2D^2] + [D(R_1 + D)(R_1 + 2D) / \omega^2X_C^2]) / ([4R_1^2D^2] + [((R_1 + 2D) / \omega X_C)^2])\} + j\ \{([(R_1 + 2D)(\omega^2X_C^2R_1D^2 - R_1 - 2D) / \omega^3X_C^3] - [2R_1D(R_1D - D^2) / \omega X_C]) / ([4R_1^2D^2] + [((R_1 + 2D) / \omega X_C)^2])\ \}$$

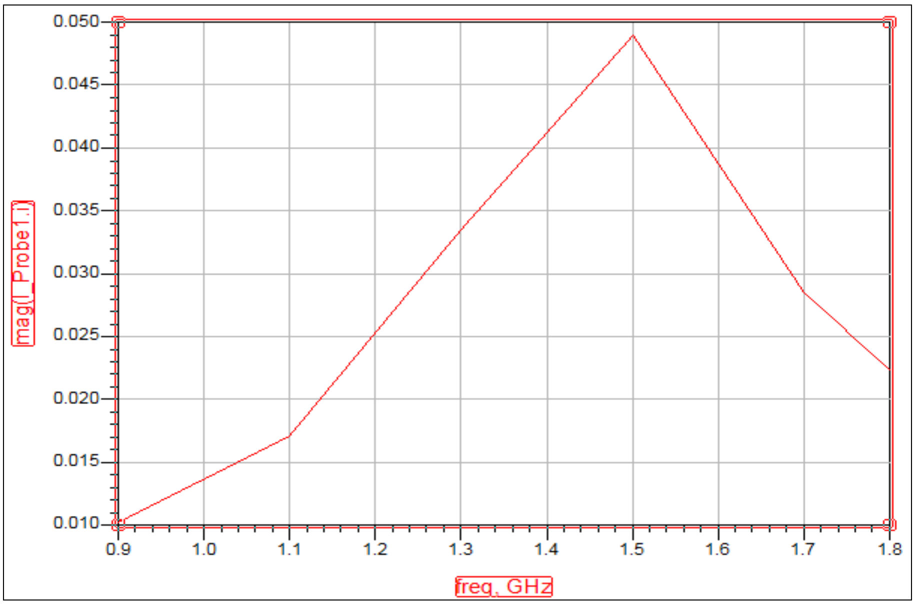
Where $\omega = 2\pi f$ is the frequency of the input RF power signal.

On substituting the values for the above expressions, we find them to be equal, thus satisfying the property of the matching network in the circuit [18].

Simulation Results

Usually mobile phone receives a power ranging from -5dBm to 40dBm. If the device is close to the transmitter, maximum power can be received. Assuming the device can receive an average power of about 20dBm, performance of the circuitis measured. Figure 2.3] and Figure 2.4 are graphs plotted for the input signal of 20dBm.

If the graphs are plotted with 40db m as input, then the output will bemore, which is more than sufficient for the mobile phone tooperate. From Figure 2.3 and 2.4 it is obvious that we may get a more efficient and rectified output voltage as well as current for the mobile to work at active state or while talking over phone for the desired operating frequency range of 0.9 GHz to 1.9 GHz.



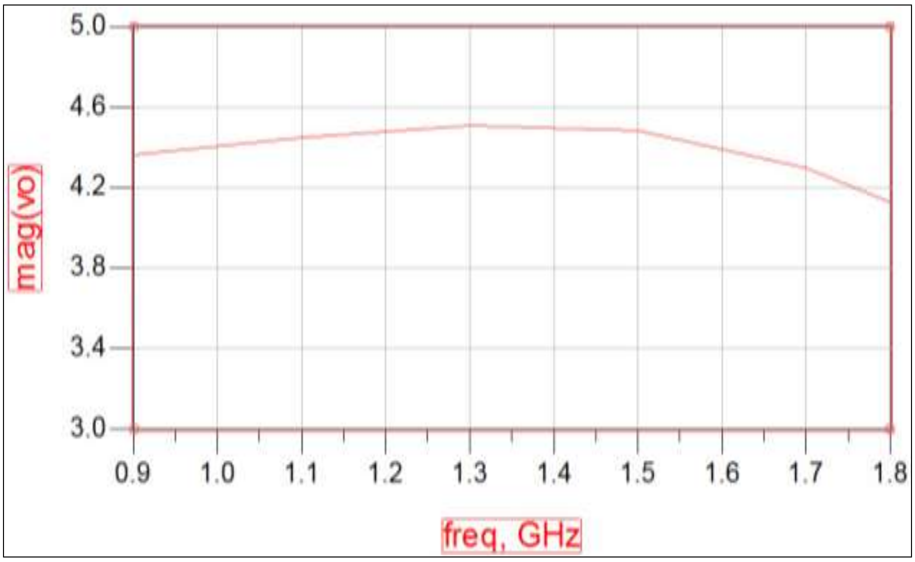


Fig 3: Graph plotted Current I Vs Frequency

Conclusion

Our proposed circuit for harvesting energy from the received RF signal generates a minimum rectified output voltage and current. This output can still be increased by reducing the capacitance values to the range of very low values and increasing the voltage multiplier stages. However this proposed circuit can conveniently capture the RF energy from the transmitted by the mobile phone to were soreven the Blue tooth device of some paired portable device and convert it to a useful power which can be used to run the mobile phones or to charge the drained batteries of the mobile phones. Because of the minimum size of the above circuit, it can easily be implemented inside the mobile phones without any space constraints. As on whole this system can conveniently charge adrained battery of the mobile phones without the need for main supply or charger and the application of this circuit i.e. charging the mobile phones using Blue tooth can help charging the devices during a situation of emergency.

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