APPLICATION OF WIRELESS POWER TRANSMISSION VIA RADIO FREQUENCY (RF) SIGNAL

RAJ KUMAR PATEL, AISHWARYA RAUT, PRATIK SONAWANE

1,2,3Department of Electrical Engineering, Sandip Institute of Engineering & Management, Nasik, MH India

Abstract: This paper focuses on Application on wireless power transmission via Radio Frequency (RF) signal. Power has been the major problem in the usage of some of these devices most especially in third world countries where power is epileptically supplied. This presentation proposes a prototype system which wirelessly generates DC for charging. As the wireless technology is getting popular nowadays, the demand for power is also increasing. Batteries need to be recharged or changed eventually, hence the need for a system that is capable of supplying uninterrupted cheap power to some of these devices. The microwave source consists of a microwave oven magnetron with electronics to control the output power. The output microwave power ranges from 50 W to 200 W at 2.45 GHz. By using concept we can practically charge batteries of robots working in industry for production. By this concept we can increase productivity by continuous charging.

Keywords: RF Signal, CC2500 RF Module, A/D converter, D/A converter.

I. INTRODUCTION

Many researches had been done on how power can be generated and transmitted. The common means of generating power are through hydro, nuclear, solar, biomass etc. However, the major challenge is how can we generate and transmit uninterrupted power to power critical remote devices such as satellites in the orbits. Also, the researchers have shown that the use of cell phone and other miniatures devices has exponentially increased in developing countries, however some of these countries are experiencing interrupted power supply and most time charging these devices has become burden on the users. As the wireless technology is getting popular nowadays, the demand for power is also increasing. Batteries need to be recharged or changed eventually, hence the need for a system that is capable of supplying uninterrupted cheap power to some of these devices. This presentation proposes a prototype system which wirelessly generates DC for charging. The design captures 433.92MHz radio frequency signal which is converted into DC and stores the power in the device’s battery or use it, to power it. To overcome this difficulty, the use of wireless power transmission, in which power is generated elsewhere and transmitted to a sensor node through some form of electromagnetic wave or radio frequency (RF) radiation, is proposed.

II. INSTRUMENTS SPECIFICATION

A. Step Down ‘X’mer

a) This is a step down transformer of230/30V, 15A rating.
b) We can design this type of transformer as per the requirement.
c) After getting 30V as Output, it is given to SC circuit.
If the first coil has more turns that the second coil, the secondary voltage is smaller than the primary voltage; This is called a step-down transformer. If the second coil has half as many turns as the first coil, the secondary voltage will be half the size of the primary voltage; if the second coil has one tenth as many turns it has one tenth the voltage.

B. Signal Conditioning Circuit

The AC signal is then given to an active rectifier circuit. A rectifier converts ac signal to dc. Normally diodes are used to create a rectifier. But the voltage drop across a diode is 0.7v so we cannot rectifies signals led than 0.7v. For this purpose active rectifier is used. The active rectifier circuit consists of R2, U1 & D3. The output of the rectifier circuit is a pulsating DC signal. So this signal is then applied to a filter circuit consisting of R3, C1 & R7. The o/p of this signal is then given to ADC.

C. A/D Converter

The ADC0808, ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique.

Features
a) Easy interface to all microprocessors.
b) Operates ratio metrically or with 5V DC or analog span.
c) Adjusted voltage reference.
**D. Wireless Communication**

CC2500 RF Module is a transceiver module which provides easy to use RF communication at 2.4 GHz as shown in fig2. It can be used to transmit and receive data at multiple baud rates from any standard CMOS/TTL source. This module is a direct line in replacement for your serial communication it requires no extra hardware and no extra coding to turn your wired communication into wireless one. It works in Half Duplex mode i.e. it provides communication in both directions, but only one direction at same time (not simultaneously). This switching from receiver to transmitter mode is done automatically.

**MHZ RF TRANSMITTER (STT-433):** -
- Operating voltage: 1.5 to 12 VDC
- Operating current: 11 mA
- Current Drain: 3.5mA
- Transmitting Frequency: 433.92MHz

**MHZ RF RECEIVER (STR-433):** -
- Operating voltage: 4.5 to 5.5 VDC
- Operating current: 4.5 mA
- Current Drain: 3.5mA
- Receiver Frequency: 433.92MHz

**Features:**
- Works on ISM band (2.4 GHz) which is reserved internationally so no. Need to apply for license.
- No complex wireless connection software or intimate knowledge of RF is required to connect your serial devices.
- Works on 5-9v DC supply.

**SPECIFICATIONS:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Voltage</td>
<td>4.5</td>
<td>5</td>
<td>10</td>
<td>Volt</td>
</tr>
<tr>
<td>Frequency</td>
<td>2.4</td>
<td></td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>Range</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>Meters</td>
</tr>
</tbody>
</table>

The unit supports multiple baud rates and multiple frequency channels. The settings will take place only during power on i.e you will have to restart the module every time you change the setting.

**E. Voltage Controlled Oscillator**

The MAX2326 is monolithic self-contained voltage-controlled oscillators (VCOs) which combine an integrated oscillator and output buffer in a miniature 8-pin μMAX package. The inductor and varactor elements of the tank circuits are integrated on-chip, greatly simplifying application of the part.

**F. Preliminary Amplifier**

The preliminary amplifier, MAR-4SM, is used to boost the RF oscillation generated by the VCO by a frequency gain of 8dbm.

**G. Power Amplifier**

The power amplifier used (PF08109B) is a Dual Band MOSFET Power Amplifier Module for E-GSM and DCS1800 Handy Phone with dual frequency ranges of EGSM (880 MHz to 915 MHz) and DCS1800 (1710 MHz to 1785 MHz). It contains 2 in / 2 out dual band amplifier, Simple external circuit including output matching circuit, High efficiency: 50% type at nominal output power for E-GSM 43% type at 32.7dBm for DCS1800.

**H. Unity Amplifier-Buffer Circuit**

The unity amplifier-buffer circuit diagram
The Unity Amplifier-Buffer circuit consists of a voltage divider, unity gain operational amplifier, a buffer and a Darlington pair as illustrated in the Fig.7

I. The Receiver

The receiver section contains the receiving antenna and rectifier circuit as shown in Figure 9. The receiver’s main function is to receive the RF signal from the transmitter, convert it to DC signal which is used to charge the connected device’s battery.

J. Antenna

The antenna plays a very important role. To charge a battery, a high DC power signal is needed. The wireless battery charger circuit must keep the power loss to the minimal. Therefore, there are many considerations to choose the correct parts for the design.

K. (D/A Converter)

An analog-to-digital converter (ADC) performs the reverse function. Unlike analog signals, digital data can be transmitted, manipulated, and stored without. A DAC converts it into an analog electrical signal which drives an audio amplifier which in turn drives a loudspeaker which finally produces sound. Of course, this is a simplified and stylized description, but it does illustrate one vital role of ADCs and DACs.

L. Practical Operation

Instead of impulses, usually the sequence of numbers update the analog voltage at uniform sampling intervals which are often then interpolated via are construction filter to continuously varied levels. These numbers are written to the DAC, typically with a clock signal that causes each number to be latched in sequence, at which time the DAC output voltage changes rapidly from the previous value to the value represented by the currently latched number. The effect of this is that the output voltage is held in time at the current value until the next input number is latched, resulting in a piecewise constant or staircase-shaped output.

M. Step Up ‘X’mer

After getting output from DAC0808 it act as an input to step up transformer. The main function step up transformer is to step up given input i.e in form of voltage & current. This is done because the different batteries required different power to charge. So as per the requirement the output power is taken from the step up transformer.

N. Rectifier

A full-wave rectifier is chosen for the prototype due to its simplicity and efficiency in converting the AC signal. At the output of the rectifier, the signal is not fully DC signal yet. Thus, by adding a capacitor and a resistor can smooth out the output to become DC signal.

O. Battery Charging

After receiving a desired output from rectifier and battery can easily charge as per the requirement.

P. Microcontroller Unit

A Microcontroller unit is nothing but an control which control the input. After getting a indication signal from low level indicator the microcontroller unit gives an signal to RF sensor, which starts giving input supply. This is done when we don’t require continuous charging. So this unit acts as ON/OFF circuit also.
Features
a) Endurance: 1000 Write/Erase Cycles
b) 0V to 5.5V Operating Range
c) Fully Static Operation: 11.0592 MHz

III. ADVANTAGES
a) With the help of continuous charging the production can be done 24x7
b) Increased charging time.
c) Low cost

IV. LIMITATIONS
a) As range increased cost increases

V. APPLICATIONS
a) Inductive coupling (Electric tooth brush).
b) TV is powered by wireless electricity.
c) Wireless power matt battery charging.
d) Battery charging for floor robots.

VI. REFERENCES

★★★