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Wireless Charging Of Mobile Phones Using Microwaves

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Abstract-In modern era mobile phones are basic need of every person .In this paper a new proposal has been made so as to make the recharging of the mobile phones is done automatically as you talk in your mobile phone! This is done by use of microwaves. The microwave signal is transmitted from the transmitter along with the message signal using special kind of antennas called slotted wave guide antenna at a frequency is 2.45 GHz. There are minimal additions, which have to be made in the mobile handsets, which are the addition of a sensor, a Rectenna, and a filter.

Index Terms: Rectanna, sensor, transmitter, and magnetron

I.INTRODUCTION

There are two main concepts which of this technique, first one is electromagnetic spectrum and second is microwave region.

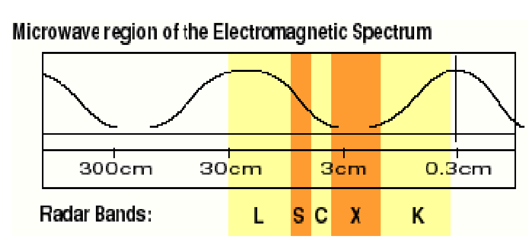
The light contains all the regions of visible spectrum which has electromagnetic waves in it. Microwaves are radio waves which has wavelength of 1mm to 1m.The term microwaves refers to alternating current signal with frequencies between 300MHz and 300GHz.Microwave components are often distributed elements, where the phase of a voltage or current are changes significantly over the physical extent of the device because the device dimensions are on the order of the microwave

Designation	Frequency range
L Band	1 to 2 GHz
S Band	2 to 4 GHz
C Band	4 to 8 GHz
X Band	8 to 12 GHz
Ku Band	12 to 18 GHz
K Band	18 to 26 GHz
Ka Band	26 to 40 GHz
Q Band	30 to 50 GHz
U Band	40 to 60 GHz

wavelength. At much lower frequency, the wavelength is large enough that there is insignificant phase variation across the dimensions of the component.

Microwave wavelengths range from approximately one millimeter (the thickness of a pencil lead) thirty centimeters (about twelve inches). In a microwave oven, the radio waves generated are tuned to frequencies that can be absorbed by the food. The food absorbs the energy and gets warmer. The dish holding the food doesn't absorb a significant amount of energy and stays much cooler. Microwaves are emitted from the Earth, from objects such as cars and planes, and from the atmosphere. These microwaves can be detected to give information, such as the temperature of the object that emitted the microwaves.

Microwaves have wavelengths that can be measured in centimeters! The longer microwaves, those closer to a foot in length, are the waves which heat our food in a microwave oven. Microwaves are good for transmitting information from one place to another because microwave energy can penetrate haze, light rain and snow, clouds, and smoke. Shorter microwaves are used in remote sensing. These microwaves are used for clouds and smoke, these waves are good for viewing the Earth from space Microwave waves are used in the communication industry and in the kitchen as a way to cook foods. Microwave radiation is still associated with energy levels that are usually considered harmless except for people with pace makers.



Here we are going to use the S band of the Microwave Spectrum.

The frequency selection is another important aspect in

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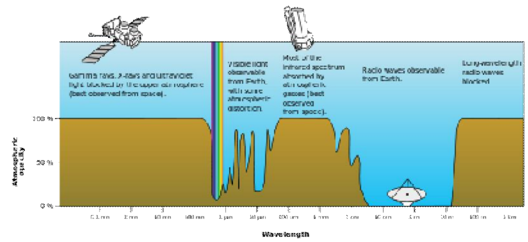
transmission. Here we have selected the license free 2.45 GHz ISM band for our purpose. The Industrial, Scientific and Medical (ISM) radio bands were originally reserved internationally for non-commercial use of RF electromagnetic fields for industrial, scientific and medical purposes. The ISM bands are defined by the ITU-T in S5.138 and S5.150 of the Radio Due to variations in national radio regulations. In recent years they have also been used for license-free error-tolerant communications applications such as wireless LANs and Bluetooth:
900 MHz band (33.3 cm) (also GSM communication in India) 2.45 GHz band (12.2 cm) IEEE 802.11b wireless Ethernet also operates on the 2.45 GHz band.

Antenna gain is proportional to the electrical size of the antenna. At higher frequency more antenna gain possible, which has important consequences for miniaturized microwave systems. More bandwidth can be realized at higher frequency bandwidth is important because available frequency bands in the electromagnetic spectrum are being rapidly depleted.

Microwave signals travel by line of sight and not bent by ionosphere as are low frequency signals. The effective reflection area of a radar target is proportional to targets electrical size. Molecular, atomic and nuclear reason aces occur at microwave frequency. It finds the application in the area of science remote sensing, medical diagnostics and treatment and heating methods.

The majority of applications of microwave technology to communication system, radar system, environmental remote sensing and medical system. Wireless connectivity provides voice and data access to everyone, anywhere at any time.
Microwave technology is extensively used for point to point communications (i.e., non broadcast uses). Microwaves are especially suitable for this use since they are more easily focused into narrow beams than radio waves; their comparatively higher frequencies allow broad bandwidth and high data flow, and also allowing smaller antenna size because antenna size is inversely proportional to transmitted frequency (the higher the frequency, the smaller the antenna size). Microwaves are the principal means by which data, TV, and telephone communications are transmitted between ground stations and to and from satellites. Microwaves are also employed in microwave oven in radar technology.



Rough plot of Earth's atmospheric transmittance (or opacity) to various wavelengths of electromagnetic radiation. Microwaves are strongly absorbed at wavelengths shorter than about 1.5 cm (above 20 GHz) by water and other molecules in the air.
The microwave spectrum is usually defined as electromagnetic energy ranging from approximately 1 GHz to 100 GHz in frequency, but older usage includes lower frequencies. Most common applications are within the 1 to 40 GHz range.

This is the atmospheric attenuation of microwaves in dry air with a precipitable water vapor level of 0.001 mm. The downward spikes in the graph correspond to frequencies at which microwaves are absorbed more strongly. The right half of this graph includes the lower ranges of infrared by some standards

II.TRANSMITTER DESIGN

MAGNETRON:
Magnetron is a high power microwave oscillator and it is used in microwave oven and radar transmitter. It is itself a special kind of vacuum tube that has permanent magnet in its constructions.
This magnet is setup to affect the path of travel of electrons that are in transit from cathode to the plate. Magnetron is capable to deliver more power than reflex klystron or gunn diode.
It is a high power oscillator and has high efficiency of 50% to 80%.

Magnetron is a device which produces microwave radiation of radar application and microwaves.
Magnetron functions as self-excited microwave oscillator. Crossed electron and magnetic fields are used to produce magnetron to produce the high power output required in radar equipment.
These multi cavity devices are used in transmitters as pulsed or cw oscillators to produce microwave radiation. Disadvantage of magnetron(A) is that it works only on fixed frequency .The magnetron is a self-contained microwave oscillator that operates differently from the linear-beam tubes, such as the TWT and the klystron.

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CROSSED-ELECTRON and MAGNETIC fields are used in the magnetron to produce the high-power output required in radar and communications equipment.

The magnetron is classed as a diode because it has no grid. A magnetic field located in the space between the plate (anode) and the cathode serves as a grid. The plate of a magnetron does not have the same physical appearance as the plate of an ordinary electron tube. Since conventional inductive-capacitive (LC) networks become impractical at microwave frequencies, the plate is fabricated into a cylindrical copper block containing resonant cavities that serve as tuned circuits.

The magnetron base differs considerably from the conventional tube base. The magnetron base is short in length and has large diameter leads that are carefully sealed into the tube and shielded. The cathode and filament are at the center of the tube and are supported by the filament leads. The filament leads are large and rigid enough to keep the cathode and filament structure fixed in position. The output lead is usually a probe or loops extending into one of the tuned cavities and coupled into a waveguide or coaxial line. The plate structure is a solid block of copper.

The cylindrical holes around its circumference are resonant cavities. A narrow slot runs from each cavity into the central portion of the tube dividing the inner structure into as many segments as there are cavities. Alternate segments are strapped together to put the cavities in parallel with regard to the output. The cavities control the output frequency. The straps are circular, metal bands that are placed across the top of the block at the entrance slots to the cavities.

Since the cathode must operate at high power, it must be fairly large and must also be able to withstand high operating temperatures. It must also have good emission characteristics, particularly under return bombardment by the electrons. This is because most of the output power is provided by the large number of electrons that are emitted when high-velocity electrons return to strike the cathode. The cathode is indirectly heated and is constructed of a high-emission material. The open space between the plate and the cathode is called the INTERACTION SPACE. In this space the electric and magnetic fields interact to exert force upon the electrons.

III.RECIEVER DESIGN

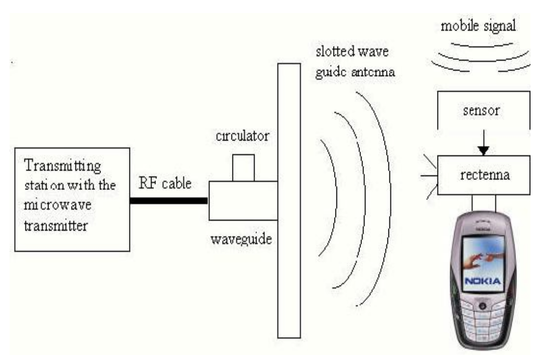
The basic addition to the mobile phone is going to be the rectenna. A rectenna is a special rectifying antenna, type of antenna that is used to directly convert microwave energy into DC electricity. Its elements are usually arranged in a mesh pattern, giving it a distinct appearance from most antennae. A simple rectenna can be constructed from a Schottky diode placed between antenna dipoles. The diode rectifies the current induced in the antenna by the microwaves. Rectennae are highly efficient at converting microwave energy to electricity.

In laboratory environments, efficiencies above 90% have been observed with regularity. Some experimentation has been done with inverse rectennae, converting electricity into microwave energy, but efficiencies are much lower--only in the area of 1%.

With the advent of nanotechnology and MEMS the size of these devices can be brought down to molecular level. It has been theorized that similar devices, scaled down to the proportions used in nanotechnology, could be used to convert light into electricity at much greater efficiencies than what is currently possible with solar cells. This type of device is called an optical rectenna. Theoretically, high efficiencies can be maintained as the device shrinks, but experiments funded by the United States National Renewable energy Laboratory have so far only obtained roughly 1% efficiency while using infrared light.

Another important part of our receiver circuitry is a simple sensor. This is simply used to identify when the mobile phone user is talking. As our main objective is to charge the mobile phone with the transmitted microwave after rectifying it by the rectenna, the sensor plays an important role.

The whole setup looks something like this.



IV RECTANNA

Rectenna is also a scanning and tracking array in the Star Wars universe.

A rectenna is a rectifying antenna, a special type of antenna that is used to convert microwave energy into direct current electricity. They are used in wireless power transmission systems that transmit power by radio waves. A simple rectenna element consists of a dipole antenna with a diode connected across the dipole elements. The diode rectifies the AC current induced in

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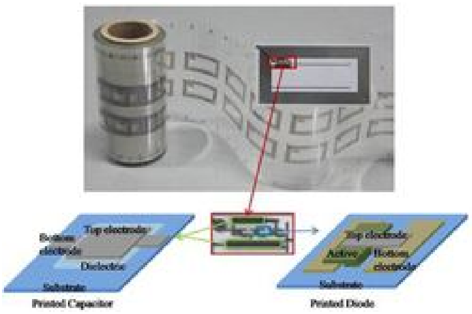
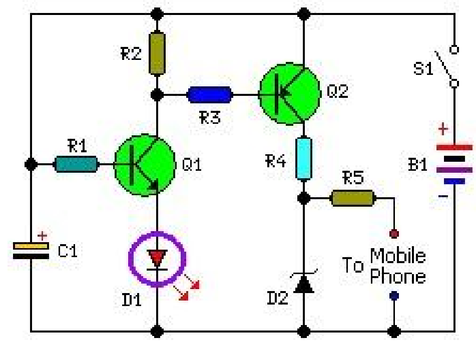
the antenna by the microwaves, to produce DC power, which powers a load connected across the diode. Schottky diodes are usually used because they have the lowest voltage drop and highest speed and therefore have the lowest power losses due to conduction and switching. Large rectennas consist of an array of many such dipole elements.



The rectenna was invented in 1964 and patented in 1969[1] by US electrical engineer William C. Brown, who demonstrated it with a model helicopter powered by microwaves transmitted from the ground, received by an attached rectenna.[2] Since the 1970s, one of the major motivations for rectenna research has been to develop a receiving antenna for proposed solar power satellites, which would harvest energy from sunlight in space with solar cells and beam it down to Earth as microwaves to huge rectenna arrays.[3] A proposed military application is to power drone reconnaissance aircraft with microwaves beamed from the ground, allowing them to stay aloft for long periods. In recent years interest has turned to using rectennas as power sources for small wireless microelectronic devices. The largest current use of rectennas is in RFID tags, proximity cards and contactless smart cards, which contain an integrated circuit (IC) which is powered by a small rectenna element. When the device is brought near an electronic reader unit, radio waves from the reader are received by the rectenna, powering up the IC, which transmits its data back to the reader.

Contents



The schematic representation of rectanna is given above.

V. PROCESS OF RECTIFICATION

A rectenna is a rectifying antenna, an antenna used to convert microwaves into DC power. Being that an antenna refers to any type of device that converts electromagnetic waves into electricity or vice versa, a rectenna is simply a microwave antenna, in contrast to the ubiquitous radio and TV antennas. You've probably seen the word rectenna pop up in discussions of solar power satellites, or other power generation schemes involving microwave power transmission or beaming.

Rectennas are quite good at what they do: efficiencies above 90% are quite common. Inverse rectennas, which convert electricity into microwave beams, are only in the early stages of development, with efficiencies of only about 1%. This poses a problem for solar power satellite proposals.

It rectifies received microwaves into DC current .A rectenna comprises of a mesh of dipoles and diodes for absorbing microwave energy from a transmitter and converting it into electric power. Its elements are usually arranged in a mesh pattern, giving it a distinct appearance from most antennae.

A simple rectenna can be constructed from a Schottky diode placed between antenna dipoles as shown in Fig.. The diode rectifies the current induced in the antenna by the microwaves. Rectenna are highly efficient at converting microwave energy to electricity. In laboratory environments, efficiencies above 90% have been observed with regularity. In future rectennas will be used to generate large-scale power from microwave beams delivered from orbiting SPS satellites.

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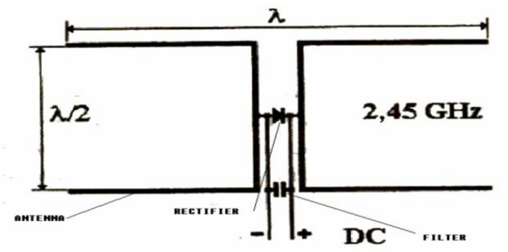
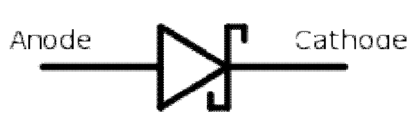


VI.BRIEF INTRODUCTION OF SCHOTTKY BARRIER DIODE

A Schottky barrier diode is different from a common P/N silicon diode. The common diode is formed by connecting a P type semiconductor with an N type semiconductor, this is connecting between a semiconductor and another semiconductor; however, a Schottky barrier diode is formed by connecting a metal with a semiconductor. When the metal contacts the semiconductor, there will be a layer of potential barrier (Schottky barrier) formed on the contact surface of them, which shows a characteristic of rectification. The material of the semiconductor usually is a semiconductor of n-type (occasionally p-type), and the material of metal generally is chosen from different metals such as molybdenum, chromium, platinum and tungsten. Sputtering technique connects the metal and the semiconductor.

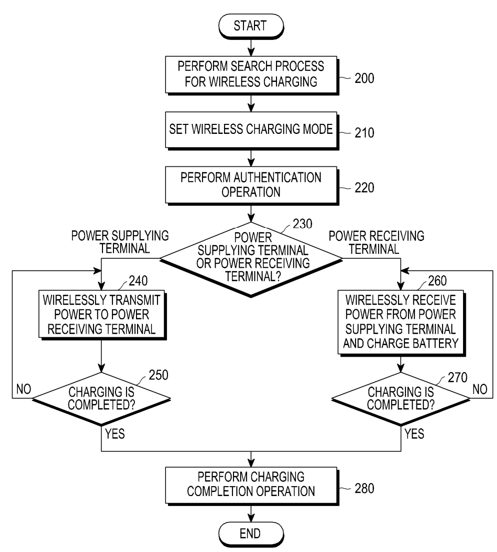


A Schottky barrier diode is a majority carrier device, while a common diode is a minority carrier device. When a common PN diode is turned from electric connecting to circuit breakage, the redundant minority carrier on the contact surface should be removed to result in time delay.

Various Schottky barrier diodes: Small signal RF devices (left), medium and high power Schottky rectifying diodes (middle and right).

When current flows through a diode there is a small voltage drop across the diode terminals. A normal silicon diode has a voltage drop between 0.6–1.7 volts, while a Schottky diode voltage drop is between approximately 0.15–0.45 volts. This lower voltage drop can provide higher switching speed and better system efficiency.

The Schottky barrier diode itself has no minority carrier, it can quickly turn from electric connecting to circuit breakage, its speed is much faster than a common P/N diode, so its reverse recovery time Trr is very short and shorter than 10 nS. And the forward voltage bias of the Schottky barrier diode is under 0.6V or so, lower than that (about 1.1V) of the common PN diode. So, The Schottky barrier diode is a comparatively ideal diode, such as for a 1 ampere limited current PN interface.
Below is the comparison of power consumption between a common diode and a Schottky barrier diode:
P=0.6*1=0.6W
P=1.1*1=1.1W
It appears that the standards of efficiency differ widely. Besides, the PIV of the Schottky barrier diode is generally far smaller than that of the PN diode; on the basis of the same unit, the PIV of the Schottky barrier diode is probably 50V while the PIV of the PN diode may be as high as 150V. Another advantage of the Schottky barrier diode is a very low noise index that is very important for a communication receiver; its working scope may reach20GHz.



VII.SENSOR CIRCUITRY

A sensor is desired to sense the activities such as texting, callings, sms and mms being carried out in a cell phone within a specified range
It is an easy to use handy mobile device sometimes also called as sniffers or pocket size mobile transmission

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detector.

A cell phone sensor can sense the presence of an activated cell phone within the range of around one and a half meters.

The cell phone sensor circuit has been designed to perfection so that it may be able to track the appearance of mobile phone and all its activities including video, transmissions, incoming calls as well as outgoing calls.

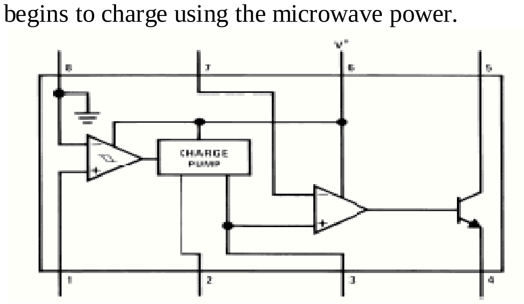
The device is capable to function properly even if the cell phone is under surveillance is on silent mode.

As soon as the sensor senses the RF transmission signal from a phone located somewhere in its vicinity, it starts raising a beep alarm which continues till the signal transmission is not ceased sensor circuitry is a simple circuit which detects if the mobile phone receives any message signal. This is required as the phone has to be charged as long as the user is talking. Thus, a simple F to V converters would serve our purpose. The operating frequency of mobile phone operators is 900 MHZ or 1800 MHZ for the GSM system for mobile communication.

Thus, the usage of simple F to V converters would act as switches to trigger the rectenna circuit to on.

The sensor circuitry is a simple circuit, which detects if the mobile phone receives any message signal. This is required, as the phone has to be charged as long as the user is talking. Thus a simple F to V converter would serve our purpose. In India the operating frequency of the mobile phone operators is generally 900MHz or 1800MHz for the GSM system for mobile communication. Thus the usage of simple F to V converters would act as switches to trigger the rectenna circuit to on.

A simple yet powerful F to V converter is LM2907. Using LM2907 would greatly serve our purpose. It acts as a switch for triggering the rectenna circuitry. The general block diagram for the LM2907 is given below. Thus on the reception of the signal the sensor circuitry directs the rectenna circuit to ON and the mobile phone begins to charge using the microwave power.



A sensor is devised to sense the activities such as texting, calling, SMS and MMS, being carried out in a cell phone within a specified range.

It is an easy to use handy mobile device, sometimes also called as sniffer or pocket-size mobile transmission detector.

A number of phone sensor manufacturing companies have sprouted in the industry, each offering some or the other exceptional features in their products.

You can choose the one as per your own requirements.

A cell phone sensor can sense the presence of an activated cell phone within the range of around one and a half metres.

The cell phone sensor circuit has been designed to perfection so that it may be able to track the appearance of a mobile phone and all its activities, including SMS, video transmissions, incoming calls as well as outgoing calls.

The device is quiet capable to function properly even if the cell phone under surveillance is on silent mode.

As soon as the sensor senses the RF transmission signals from a phone located somewhere in its vicinity, it starts raising a beep alarm which continues till the signal transmission is not ceased.

VIII.ADVANTAGES

Use of separate chargers is eliminated.
Electricity is saved.
The phone can be charged anywhere anytime.

Lower risk of electrical shock because there are no exposed conductors

- Easier than plugging into a power cable
- Corrosion does not occur when exposed to atmosphere
- Safe for medical implants for embedded medical devices allows recharging through skin rather than having wires penetrate through skin
- It does not require wire for charging

IX.CONCLUSION

Thus this paper successfully demonstrates a novel method of using the power of the microwave to charge the mobile phones without the use of wired chargers. Thus this method provides great advantage to the mobile phone users to carry their phones anywhere even if the place is devoid of facilities for charging.

A novel use of the rectenna and a sensor in a mobile phone could provide a new dimension in the revelation of mobile phone. In this modern generation where we prefer the most efficient gadgets to serve our purposes,

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not even a slightly deviated device is acceptable. The highly accomplished cell phone sensor created by the exactly topnotch manufacturers in the industry befit your needs the best way and proves to be highly effective tools to combat security breach. Depending on the features they offer, these are available in different price ranges, you can buy the one that suits you the best.

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