

## Wireless Energy Transfer

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**Abstract:** *Wireless energy transfer or wireless power is the transmission of electrical energy from a power source to an electrical load without interconnecting wires. Wireless transmission is useful in cases where interconnecting wires are inconvenient, hazardous, or impossible. The problem of wireless power transmission differs from that of wireless telecommunications, such as radio. In the latter the proportion of energy received becomes critical only if it is too low for the signal to be distinguished from the background noise. With wireless power, efficiency is the more significant parameter. A large part of the energy sent out by the generating plant must arrive at the receiver or receivers to make the system economical.*

*The traditional way of transferring wireless energy mostly depends upon electromagnetic induction. We find many difficulties in transferring energy through this process as it is less efficient and has adverse effect on human health*

*We present an idea to charge electronic gadgets through wireless medium by the use of high frequency signals, they are only affected by noise which can be removed easily by the help of a filter circuit*

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### I. History

First wireless technology was used by Alexander graham bell in 1880 for conversation. On June 3<sup>rd</sup> 1880 Alexandra bell transmitted the first wireless telephone message on his newly invented “photo phone” “Photo Phone” a device that enable sound to be transmitted on a beam of light , bell and his assistant “Charles Sumner Tainter “developed the photo phone using a sensitive selenium crystal and a mirror , that would vibrate in response to a sound.

In 1881, they successfully send a photo phone message over 200 yards from one building to another “Bell” regarded the “ Photo Phone “the greatest invention I have ever made, greater than the telephone”. Alexander graham bell reveals the principle upon which today’s laser and fiber optics communication system are founded, thought it would take the development of several modern technologies to realize it fully. Among them wireless energy transfer through high frequency signal are more compatible and economical way of transferring different forms of energy.

### II. Present scenario

From Alexander graham bell’s invention of “Photo Phone” to present mobile communication system our technology outwitted many field of success

The most significance among them is the wireless energy transfer mechanism

The various fields in which wireless technology is being used are

1. MOBILE COMMUNICATION SYSTEM
2. RADIO BROADCASTING
3. TELEVISION BROADCASTING
4. SATTELITE COMMUNICATION

#### 3.1.MOBILE COMMUNICATION

Mobile technology has already creating hype throughout the world. We are using so many features in our mobile these days which most of us have never dreamed off. What is making all these amazing features working so well? We are using SMS, deliver messages in seconds throughout the world with just a little click of button”Send”, MMS, sending pictures and video files in amazingly quick time, finding locations, accessing high speed internet in your mobiles are the features which were not possible just few years back, there are some technologies which are actually responsible for such facilities on our mobiles and we are going to talk about all these technologies in mobile communication section

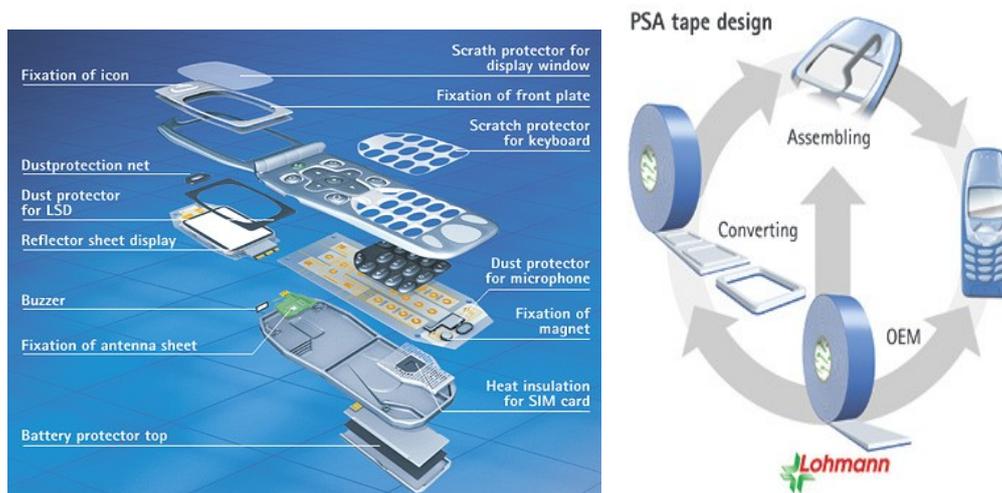
Today’s mobiles networks supports features likes SMS, GPRS, MMS, emailing facility on mobile, Bluetooth, WAP and many more depending upon how reputed and bigger mobile network company is, most of the networks worldwide provides these features as they have become the standard features in mobile communication between their customers and of course one cannot neglect how sophisticated mobiles phones are available now, these mobile phones

carries many features which sometimes are not supported by mobile networks. Mobile phones of today's age are now equal to portable PCs. These mobile phones connect to their cellular networks and these cellular networks are connected to Public switching telephone network (PSTN).

### 3.1.1. Mobile Network Technology

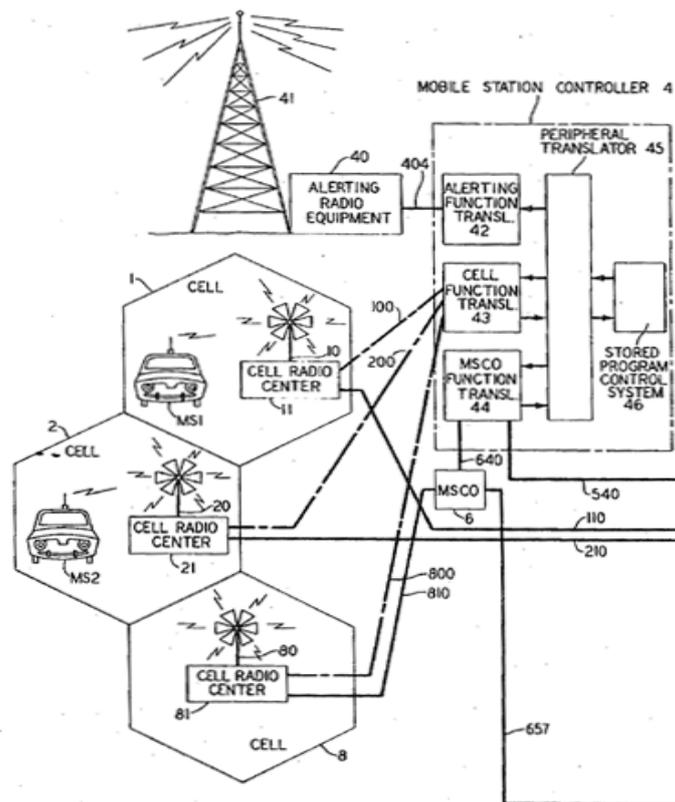
Mobile Technology has groomed a lot in past few years, major reasons for rapid advancements in mobile network technology is requirements for being mobile or connectivity on move. Latest mobile handsets offers features which one had never thought off, ultimately it forces mobile network companies to bring these features in practice use to take commercial advantages.

Cellular companies use AMPS, D-AMPS, CMMA2000, UMTS, GSM, EVDO etc. AMPS however pretty much vanished from the scene, AMPS network system was based on analog communication technology, latest features were not supported by AMPS therefore all cellular networks worldwide have adopted above mentioned digital communication methodologies to meet the need of consumers. GSM remains the highly used



Mobile communication methodology worldwide. Cellular networks and mobile phones vary from geographical locations and providers to providers, but still standard communication methods are more or less same everywhere. Basic communication takes place using electromagnetic microwaves with cellular base stations. Cellular networks have huge antennas normally located in the middle of certain area to provide optimum signal broadcasting. These antennas are known as Base Transceiver Station (BTS). Mobile handsets have low powered transceivers which transmit voice data to the closed BTS which can usually be within 5 t 8 miles radius.

Transceivers: Transceivers are devices which have capability of transmitting and receive data at the same time. Mobile handset register itself at mobile network switch or exchange as soon as it starts transmitting, usually it means when handset is turn on, it tries to registered to the network of inserted SIM card. Mobile networks uniquely identify each and every registered mobile handset on the given BTS and sends notifications to those mobile handsets which have incoming calls. Handsets will always be registered to the most nearest BTS for communication, incase if user of the network is on move, mobile phones in this case will handoff to many closest BTS during the call and keep the connection alive with nearest base stations. In case of unavailability of BTS, handset will be disconnected from the network resulting in dropping of ongoing call.

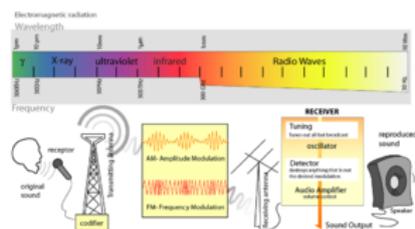


BTS also operates on less power radio frequency transmission; they make their presence feel by broadcasting signals for receivers of mobile handsets. Communication between BTS and mobile sets takes place in stream of digital data, which is digitized audio. Each mobile network operates on unique radio frequency.

### 3.2. Radio broadcasting



**Radio broadcasting** is a one-way transmission over [radio waves](#) intended to reach a wide audience. Stations can be linked in radio networks to broadcast common programming, either in syndication or simulcast or both. Audio broadcasting also can be done via [cable FM](#), local wire [networks](#), [satellite](#) and the [Internet](#).



Transmission and reception schematic

### 3.3. Television Broadcasting

While millions of people watch television each day, many of us aren't quite sure how the technology works. Television has been around for many decades and although some of the technology components have changed over the years, the way in which television broadcasts work is still pretty much the same.

### 3.3.1. Elements of Broadcast Television

There are a several major parts that are required in order to receive television broadcasts at home. They include an image source, a sound source, a transmitter, a receiver, a display device and a sound device.

#### 3.3.1.1. Image Source

The image source can be defined as the program. It can be a movie, TV show, news program, etc. The image source is just the video of the source and does not include the sound. Usually the image source has been recorded on camera or flying spot scanner.

#### 3.3.1.2. Sound Source

We already have the image source, let's say the video of a movie, now to complete the media, we also need the sound. The sound source is the audio signal of the TV programming whether coming from a movie, TV show, news program, etc. It can come in the form of mono, stereo or even digitally processed surround sound.



#### 3.3.1.3. Transmitter

A transmitter is what sends both audio and video signals over the air waves. Transmitters usually transmit more than one signal (TV channel) at a time. A transmitter modulates both picture and sound into one signal and then send this transmission over a wide range to be received by a receiver (TV set).

#### 3.3.1.4. Receiver

A receiver (TV set) is able to receive the transmitted signals (TV programs) and turn radio waves which include audio and video signals into useful signals that can be processed back into an image and sound.

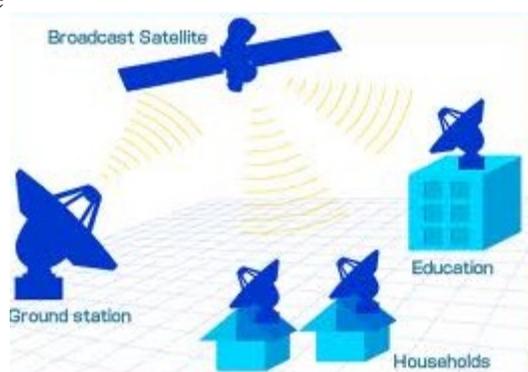
#### 3.3.1.5. Display Device

This is either a TV set or monitor. A display device has the technology to turn the electrical signals received into visible light. On a standard TV set this includes the technology CRT (Cathode Ray Tube).

#### 3.3.1.6. Sound Device

The sound device are usually speakers either built into the TV set or that accompany the TV set that turns electrical signals into sound waves to play audio along with the video images that the person is viewing.

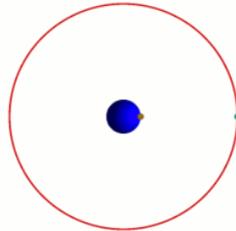
### 3.4. Communications satellite



A **communications satellite** (sometimes abbreviated to **COMSAT**) is an artificial [satellite](#) stationed in space for the purpose of [telecommunications](#). Modern communications satellites use a variety of orbits including [geostationary orbits](#), [Molniya orbits](#), other [elliptical orbits](#) and low ([polar](#) and non-polar) Earth orbits.

For fixed ([point-to-point](#)) services, communications satellites provide a [microwave radio relay](#) technology complementary to that of [submarine communication cables](#). They are also used for mobile applications such as communications to ships, vehicles, planes and hand-held terminals, and for TV and radio [broadcasting](#), for which application of other technologies, such as cable, is impractical or impossible.

### Geostationary orbits



### [Geostationary orbit](#)

A satellite in a geostationary orbit appears to be in a fixed position to an earth-based observer. A geostationary satellite revolves around the earth at a constant speed once per day over the equator.

The geostationary orbit is useful for communications applications because ground based antennas, which must be directed toward the satellite, can operate effectively without the need for expensive equipment to track the satellite's motion. Especially for applications that require a large number of ground antennas (such as direct TV distribution), the savings in ground equipment can more than justify the extra cost and onboard complexity of lifting a satellite into the relatively high geostationary orbit.

### III. Applications

Telephone, Satellite television, Mobile satellite technology, Satellite radio, Satellite Internet, Military use.

### EASE OF HUMANS

- We generally find that people usually get irritate when their electronic gadgets get discharge and it is required to connect them to a source using a wire connection
- Because of this reason people get frustrated and are not able to perform up to the mark
- It becomes a very hectic job for an individual to connect his electronic gadget through a wire as he/ she requires a switch board along with a proper length of wire.
- So the wireless energy transfer technology can be implemented to overcome the above mentioned short comings and make people feel more comfortable and work efficiently without any bondage
- Ultimately it removes the barrier of wire and allow us to work by transforming energy without wires

### IV. OUR MOTTO

We are presenting an idea to charge electronic gadgets through wireless medium by the use of-

1- ) Transmitter circuit-> oscillator (crystal oscillator), loudspeaker transducer

2- ) Receiver circuit -> microphone transducer, rectifier and amplifier

→ The concept is based on the fact similar to frequency modulation transmission in Radio.

→ This compatible technology can charge all electronic gadget provided with the receivers section.

→ Make us feel more comfortable and an efficient way to charge the gadget.

→ To remove the barriers of wire connection by providing a charging zone ranging for few meters.

→ To introduce a technology to overcome the harmful effect of EMI and carrying out wireless energy transfer through high frequency sound waves .

→ The transmitter and the receiver part are described below respectively

#### 5.1 OSCILLATOR

##### CRYSTAL OSCILLATOR

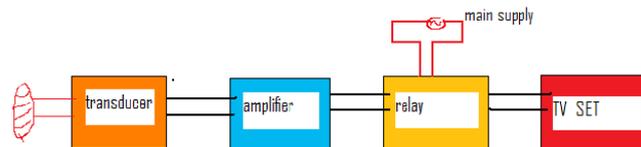
A crystal oscillator is an electronic circuit that produces electrical oscillation at a particular designed frequency determined by the physical characteristic of one or more crystal generally of quartz, positioned at in the circuit feedback loop. A piezoelectric effect causes a crystal such as quartz to vibrate and resonate at a particular frequency. The quartz crystal naturally oscillates at a particular frequency; its fundamental frequency

is hundreds of megahertz. The crystal oscillator is generally used in various forms such as frequency generator, frequency modulator, frequency converter. The oscillator utilizes crystal having excellent piezoelectric characteristic in which crystal function as a stable mechanical vibrator. Crystal oscillator using crystal has a number of advantages in actual application since crystal share high frequency oscillator and stable temperature characteristic as well as excellent processing ability. Temperature compensated crystal oscillator in which variation in oscillator frequency that arises from frequency – temperature characteristic of the quartz crystal unit is compensated, finds particularly wide use in device such as cellular phone used in a mobile environment

- The crystal oscillator mainly produces frequencies from few tens of kilohertz to tens of megahertz. They are found application in counter, signal generator and oscillator
- COMMONLY USED CRYSTAL OSCILLATOR
- 1) Crystal oscillator circuit are often designed around few standard frequencies such as 3-5 MHz, 10 MHz, 14.31MHz and 33.33MHz.

## TRANSDUCER

When we talked about instrumentation science it begins with transducer because instrument needs input in the form of electrical, similarly the quantity to be measured may not be available in electrical form. For instance, a temperature indicator or a controller the quantity is physical. It became an important part of the instrument to convert non-electrical quantity into the electrical one by means of transducer. Transducer plays a very important role of input quantity like light, pressure into proportional electrical signal. Basically, it is very difficult to define and classify this transducer because technology has invented very small device to sense one quantity convert it into required form hence transducer may be called as a "sensor". Transducer is defined as the device used to convert a non-electrical quantity into an electrical signal. For example, a clap circuit, where it senses sound by simply using a microphone transducer and get electrical output to make the required thing ON or OFF. This idea of clap switch is used to make TV ON or OFF.



A Transducer is a device used to convert position displacement, thermal and optical signal into electrical quantities that may be amplified, recorded and otherwise processed in the instrumentation system.

Transducer is of two types: **Active transducer** and **Passive transducer**

### Active transducer:

A transducer that is capable of producing electrical variation when stimulated by some physical form of energy, and we do not require external supply to perform their function, hence known as a self-generating or active transducer because it is capable of generating signal directly and without any external supply. For example thermocouple it generates emf across its junction of two dissimilar metal or semiconductor, when the junction is heated. A piezo electric crystal generate an electric potential difference across its opposite surface when mechanical pressure is applied across its other surface e.g. Thermocouple, Piezoelectric pick up, Photovoltaic cells.

### Passive transducer:

These Transducer requires external power to produce change in the electrical quantity like resistance, capacitance. For example, a thermistor it changes its resistance with temperature but electrical supply is essential to produce the current variation in the circuit. Similarly, a capacitive transducer like capacitive microphone, LVDT they need electric supply to perform their function so these transducer are called as externally powered or passive transducer. They produce variation in some electrical parameter such as resistance, capacitance etc. which can be measured as a voltage or current variation. One of its examples: Displacement (sound) transducer.

## LOUDSPEAKER TRANSDUCER

The loudspeaker transducer is mainly an active transducer that changes the electrical impulses into a mechanical movement of the speaker cone to produce a sound output. The term "loudspeaker" may refer to individual transducers (known as "drivers") or to complete speaker systems consisting of an [enclosure](#) including one or more drivers. To adequately reproduce a wide range of frequencies, most loudspeaker systems employ more than one driver, particularly for higher [sound pressure level](#) or maximum accuracy. Individual drivers are used to reproduce different frequency ranges. The drivers are named [subwoofers](#) (for very low frequencies); [woofers](#) (low frequencies); [mid-range speakers](#) (middle frequencies); [tweeters](#) (high frequencies); and sometimes [supertweeters](#), optimized for the highest audible frequencies. The terms for different speaker drivers differ, depending on the application. In two-way systems there is no mid-range driver, so the task of reproducing the mid-range sounds falls upon the woofer and tweeter. Home stereos use the designation "tweeter" for the high frequency driver, while professional concert systems may designate them as "HF" or "highs". When multiple drivers are used in a system, a "filter network", called a [crossover](#), separates the incoming signal into different frequency ranges and routes them to the appropriate driver. A loudspeaker system with  $n$  separate frequency bands is described as " $n$ -way speakers": a two-way system will have a woofer and a tweeter; a three-way system employs a woofer, a mid-range, and a tweeter.

### CONSTRUCTION-

The construction of moving coil type (dynamic) loudspeaker is shown in the figure. The dynamic loudspeaker consists of the voice coil, the voice coil former, the centring spider, magnet, magnetic circuit, the cone (diaphragm), apex radiator and dust cap.

Two connections are made to the voice coil. When there is current through the coil, a magnetic field is setup inside the coil. This magnetic field either helps or opposes the permanent magnetic field,

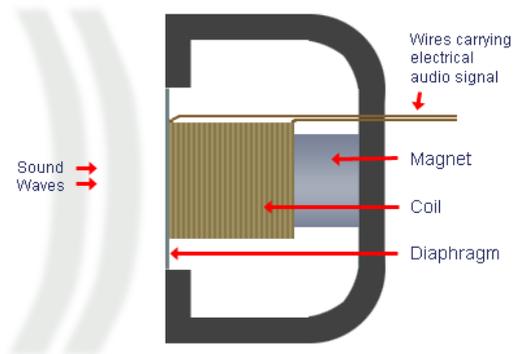
Through the coil, a magnetic field is setup inside the coil. This magnetic field either helps or opposes the permanent magnetic field, causing the voice coil and speaker to move either in or out. If we apply an alternating current to the coil, the cone reproduces sound as it moves the surrounding air back and forth. The spider allows motion in forward and backward direction only.

The loud speaker doesn't require external source of power other than the signal power to make it to operate. Magnet is the power house of the loudspeaker.

### MICROPHONE TRANSDUCER

It is a sound transducer that converts sound energy into electrical energy. The condenser microphone invented at Bell Labs in 1916 by E.C.Wenteis called a capacitor microphone. Here it mainly consist of two parts i.e. two parts- 1. Static plate 2.Dynamic plate. The dynamic plate is called as a diaphragm plate and this part is flexible part and usually when pressure is applied to it the distance between the plate decreases. Now the staticplate is the constant metal plate .

## Cross-Section of Dynamic Microphone



Here the Diaphragm acts as one plate of capacitor and the vibration produces changes in the distance between the plates. Mainly the voltage maintained across the capacitor plate changes with the vibration in the air, according to the capacitance equation ( $c=q/v$ ) where  $q$  = charge in coulombs,  $c$  = capacitance in farad,  $v$  = potential difference in volt. So as per the formula  $c = AEo/d$  as the distance 'd' decreases the capacitance increases and more and more charge get in calculated on the plate of transducer. The output is passed through the Load connected at the output of the transducer.

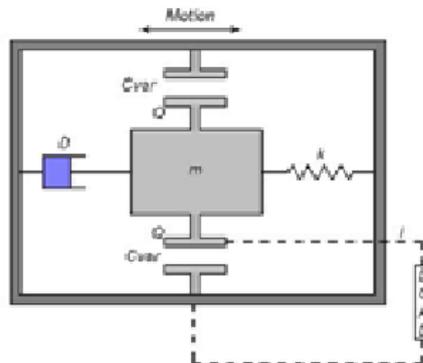


Fig.1: Micro Capacitive Transducer Model

**Advantage:**

1. Easy construction and low price.
2. It can be used to measured static and dynamic quantities.

**Operational amplifier:**

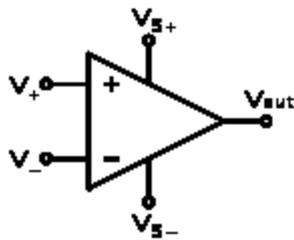
An **operational amplifier** ("op-amp") is a [DC-coupled](#) high-[gain](#) electronic voltage [amplifier](#) with a differential input and, usually, a single-ended output. An op-amp produces an output voltage that is typically hundreds of thousands times larger than the voltage *difference* between its input terminals.

Operational amplifiers are important building blocks for a wide range of electronic circuits. They had their origins in [analog computers](#) where they were used in many linear, non-linear and frequency-dependent circuits. Their popularity in circuit design largely stems from the fact the characteristics of the final elements (such as their [gain](#)) are set by external components with little dependence on temperature changes and manufacturing variations in the op-amp itself.

Op-amps are among the most widely used electronic devices today, being used in a vast array of consumer, industrial, and scientific devices. Many standard IC op-amps cost only a few cents in moderate production volume; however some integrated or hybrid operational amplifiers with special performance specifications may cost over \$100 US in small quantities. Op-amps may be packaged as components, or used as elements of more complex integrated circuits.

The op-amp is one type of [differential amplifier](#). Other types of differential amplifier include the [fully differential amplifier](#) (similar to the op-amp, but with two outputs), the [instrumentation amplifier](#) (usually built from three op-amps), the [isolation amplifier](#) (similar to the instrumentation amplifier, but with tolerance to common-mode voltages that would destroy an a resistive feedback network).

#### Circuit notation



Circuit diagram symbol for an op-amp

The circuit symbol for an op-amp is shown to the right, where:

- $V_+$ : non-inverting input
- $V_-$ : inverting input
- $V_{out}$ : output
- $V_{S+}$ : positive power supply
- $V_{S-}$ : negative power supply

The power supply pins ( $V_{S+}$  and  $V_{S-}$ ) can be labeled in different way. Despite different labeling, the function remains the same — to provide additional power for amplification of the signal. Often these pins are left out of the diagram for clarity, and the power configuration is described or assumed from the circuit.

#### Rectifier

A **rectifier** is an electrical device that converts [alternating current](#) (AC), which periodically reverses direction, to [direct current](#) (DC), which is in only one direction, a process known as **rectification**. Rectifiers have many uses including as components of [power supplies](#) and as [detectors](#) of [radio](#) signals. Rectifiers may be made of [solid state diodes](#), [vacuum tube](#) diodes, [mercury arc valves](#), and other components.

A device which performs the opposite function (converting DC to AC) is known as an [inverter](#).

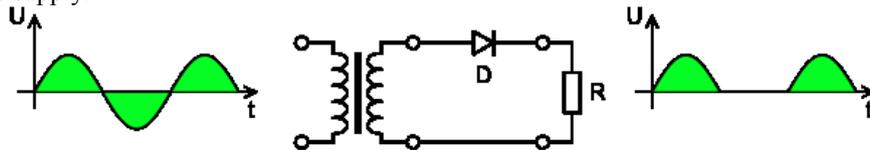
When only one diode is used to rectify AC (by blocking the negative or positive portion of the [waveform](#)), the difference between the term *diode* and the term *rectifier* is merely one of usage, i.e., the term *rectifier* describes a *diode* that is being used to convert AC to DC. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than is possible with only one diode. Before the development of silicon semiconductor rectifiers, vacuum tube diodes and [copper\(I\) oxide](#) or [selenium](#) rectifier stacks were used.

Early radio receivers, called [crystal radios](#), used a "cat's whisker" of fine wire pressing on a crystal of [galena](#) (lead sulfide) to serve as a point-contact rectifier or "[crystal detector](#)". Rectification may occasionally serve in roles other than to generate direct current per se. For example, in gas heating systems *flame rectification* is used to detect presence of flame. Two metal electrodes in the outer layer of the flame provide a current path, and rectification of an applied alternating voltage will happen in the plasma, but only while the flame is present to generate it.

#### Half-wave rectification

In half wave rectification, either the positive or negative half of the AC wave is passed, while the other half is blocked. Because only one half of the input waveform reaches the output, it is very inefficient if used for power

transfer. Half-wave rectification can be achieved with a single diode in a one-phase supply, or with three diodes in a three-phase supply.

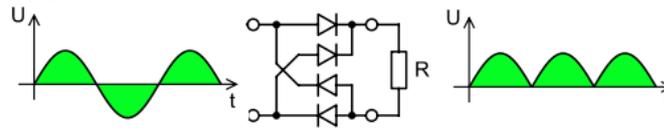


The output DC voltage of a half wave rectifier can be calculated with the following two ideal equations: [\[1\]](#)

$$V_{rms} = \frac{V_{peak}}{2} V_{dc} = \frac{V_{peak}}{\pi}$$

#### FULL WAVE RECTIFIER

A full-wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output. Full-wave rectification converts both polarities of the input waveform to DC (direct current), and is more efficient. However, in a circuit with a non-center tapped transformer, four diodes are required instead of the one needed for half-wave rectification. (See [semiconductors](#), [diode](#)). Four diodes arranged this way are called a [diode bridge](#) or bridge rectifier.



Graetz bridge rectifier: a full-wave rectifier using 4 diodes.

#### WORKING PRINCIPLE:

Here we consider an oscillator circuit to be implemented inside the charger.

Now as we know that the crystal oscillator is been used, so it emit high frequency electrical signals to the loudspeaker transducer present inside the charger.

The purpose of using loudspeaker transducer is to transmit high frequency sound waves through air medium.

Now the transmitted sound signal is being received by the microphone transducer that is present inside the electronic gadgets.

Here the same technique is used as implementation of clap circuit in television set.

When this high frequency signal bombard with the diaphragm of the transducer the distance between the two plates decreases (static and dynamic plate).

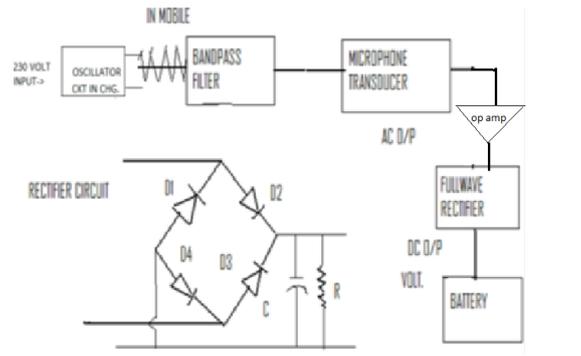
Due to which charge get accumulated across the capacitor in the transducer.

Now, this charge is been passed through the load across the transducer.

The output of the microphone transducer is then provided to an amplifier circuit to increase the strength of the signal and now we can apply this sinusoidal signal to the rectifier which converts this AC signal into DC signal. Now this DC signal can be given to the any charge accumulator to get charged up.

#### TOTAL REVIEW:

1. OSCILLATOR CIRCUIT IN CHARGER
2. LOUDSPEAKER TRANSDUCER CONNECTED TO THE OUTPUT OF THE OSCILLATOR CIRCUIT IN THE CHARGER.
3. THE SOUND WAVES IS BEING RECEIVED BY MICROPHONE TRANSDUCER.
4. OUTPUT IS THEN PROVIDED TO AMPLIFIER
5. AMPLIFIED SIGNAL IS THEN PROVIDED TO THE RECTIFIER.
6. CONVERTING AC SIGNAL TO DC
7. SIGNAL GIVEN TO BATTERY TO GET CHARGE.



**APPLICATIONS:**

1. WIDE SCALE APPLICATION IN CHARGING ELECTRONIC GADGETS WIRELESSLY LIKE CELLULAR PHONES,LAPTOPS, ELECTRONIC BRUSHES AND TRIMMERS,DIGITAL CAMERAS ETC.
2. USEFUL AND COMPATIBLE WAY OF CHARGING ESPECIALLY WHILE WE ARE TRAVELLING.
3. ALLOW US TO HAVE A CHARGEABLE ZONE OF FEW METERS MAY BE A LOBBY.
4. SCOPE FOR SETTING UP MOBILE CHARGING ZONES IN PUBLIC PLACES.
5. EVEN UNWANTED NOISE CAN ACT AS A SOURCE FOR CHARGING MEDIA.

**V. Conclusion:**

1. WE PRESENTED AN IDEA TO CHARGE ELECTRONIC GADGETS THROUGH WIRELESS MEDIUM.
2. CONCEPT IS SIMILAR TO FM TRANSMISSION IN RADIO.
3. MAKING USE OF HIGH FREQUENCY SIGNALS INSPITE of EMI(ELECTRO MAGNETIC INDUCTION).
4. USE OF SIMPLE AND LESS COMPLICATED CIRCUIT.
5. LESS POWER LOSS AND MORE EFFICIENCY AS COMPARED TO EMI.

**References:**

- [1]. En.wikipedia.org
- [2]. www.mit.edu
- [3]. Snajay Sharma, Wireless Technology.