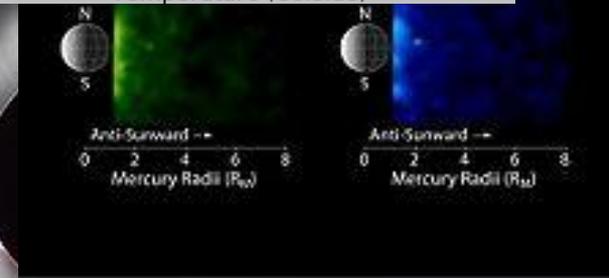
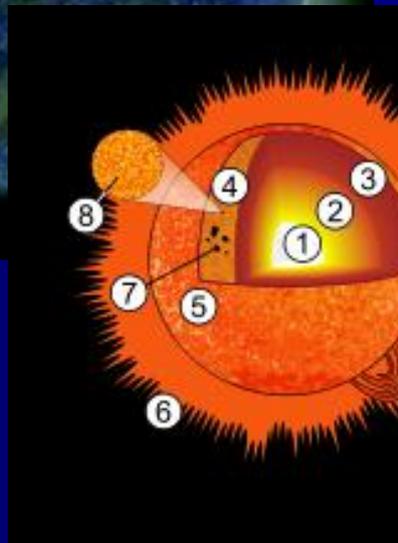
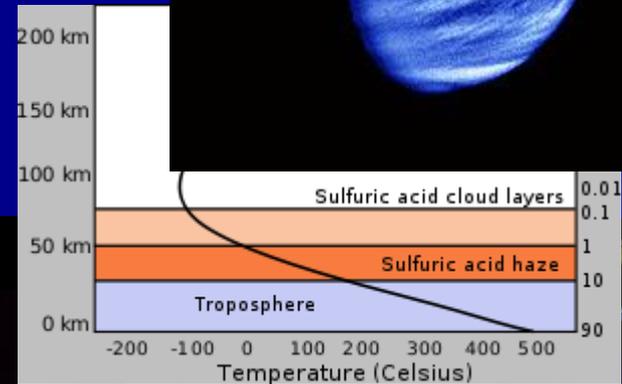
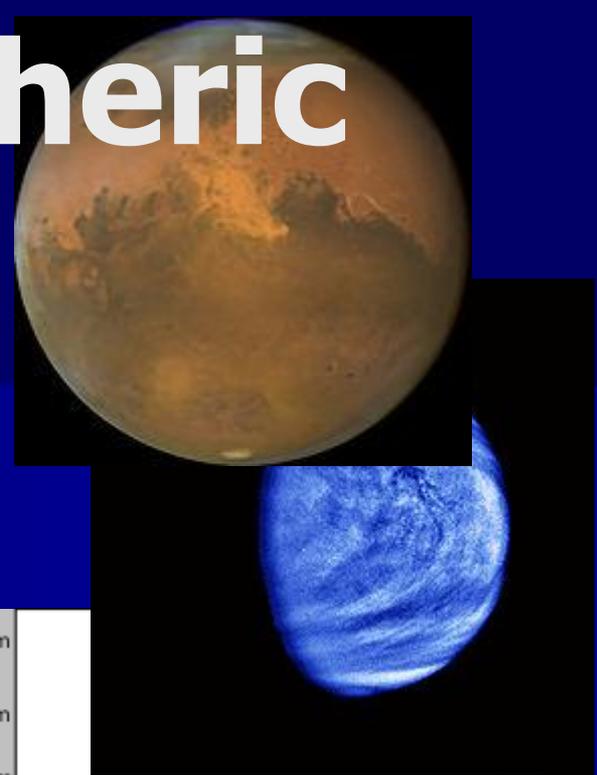
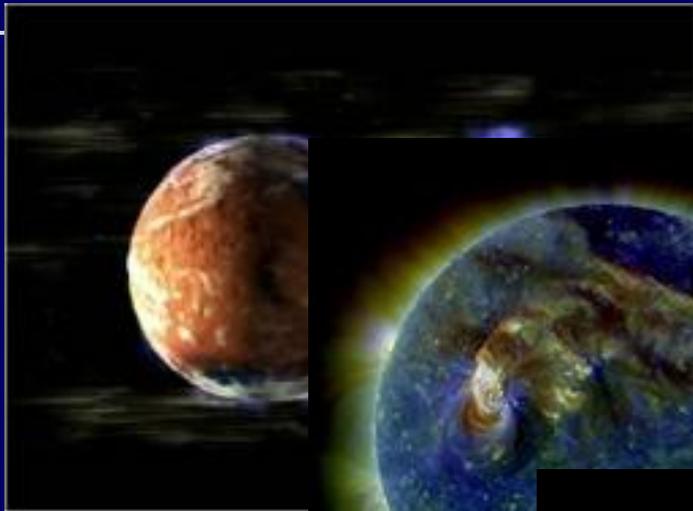


Space Physics

Space & Atmospheric Physics

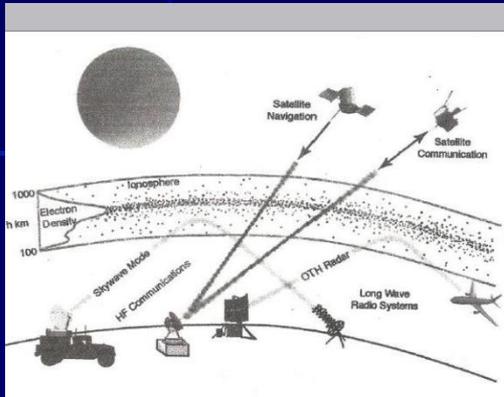


Lecture – 12

Radio Wave Communication



Radio Wave Communication



Radio waves

Radio Communication

Reflection of Radio Waves

Absorption of Radio Waves

Complex Refractive Index

Reflection Heights

Deviating Region Absorption, Non-Deviating Region Absorption

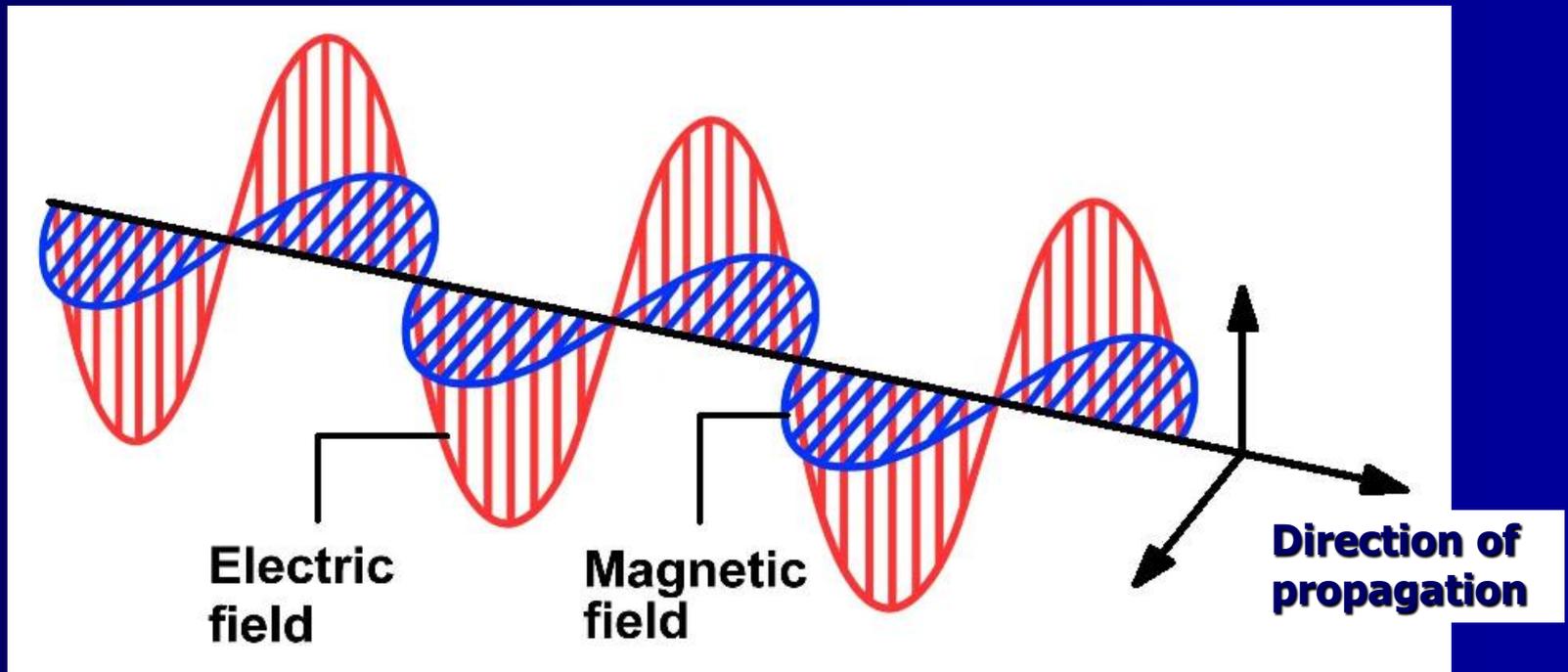
Ordinary/Extra Ordinary Waves

Ionosphere – Sounding Techniques

Pulse Reflection Methods

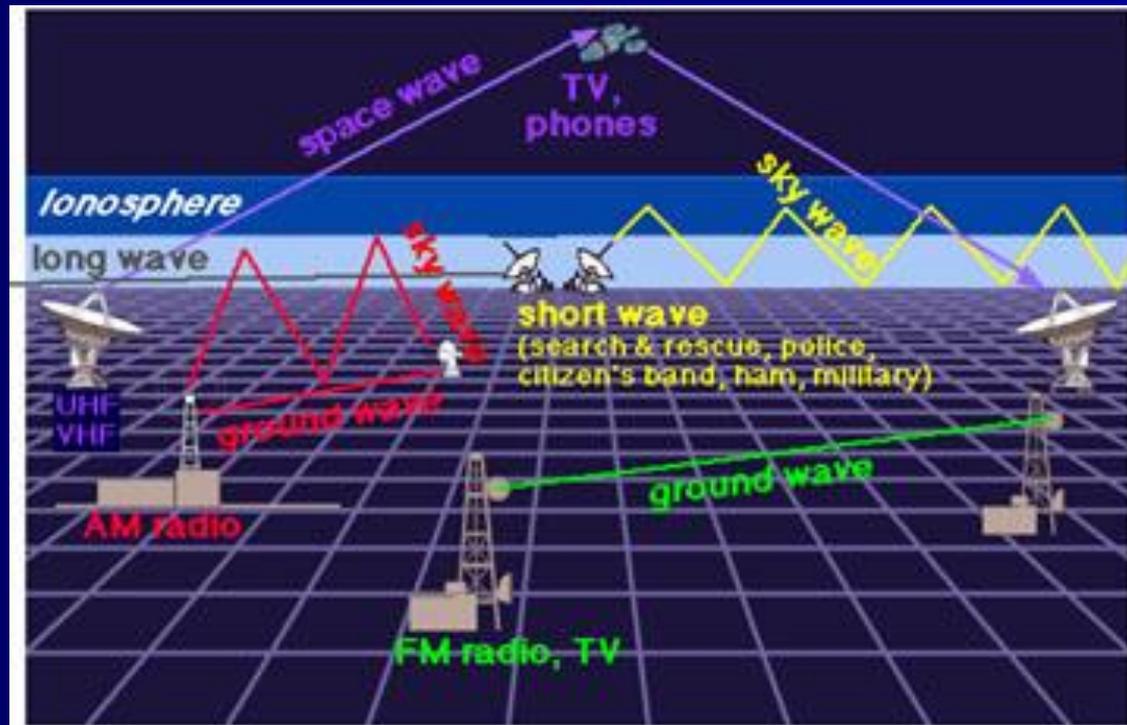
Radio waves

Radio waves are a type of **electromagnetic radiation** with wavelengths in the electromagnetic spectrum **longer than infrared light**. Like all other electromagnetic waves, **they travel at the speed of light**. Naturally-occurring radio waves are made by **lightning**, or by **astronomical objects**.



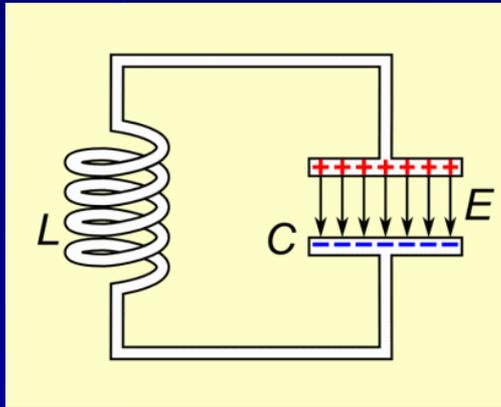
Propagation...

The study of electro magnetic phenomena such as **reflection**, **refraction**, **polarization**, **diffraction** and **absorption** is of critical importance in the study of how radio waves move in free space and over the surface of the Earth. Different frequencies experience different combination of these phenomena in the Earth's atmosphere, making certain radio bands more useful for specific purpose than others.



Radio Communication

In order to receive radio signals, for instance from **AM / FM** radio stations, a **radio antenna** must be used. However, since the antenna will pickup **thousands of radio signals** at a time, a **radio tuner** is necessary to tune in to a particular frequency (or frequency range).

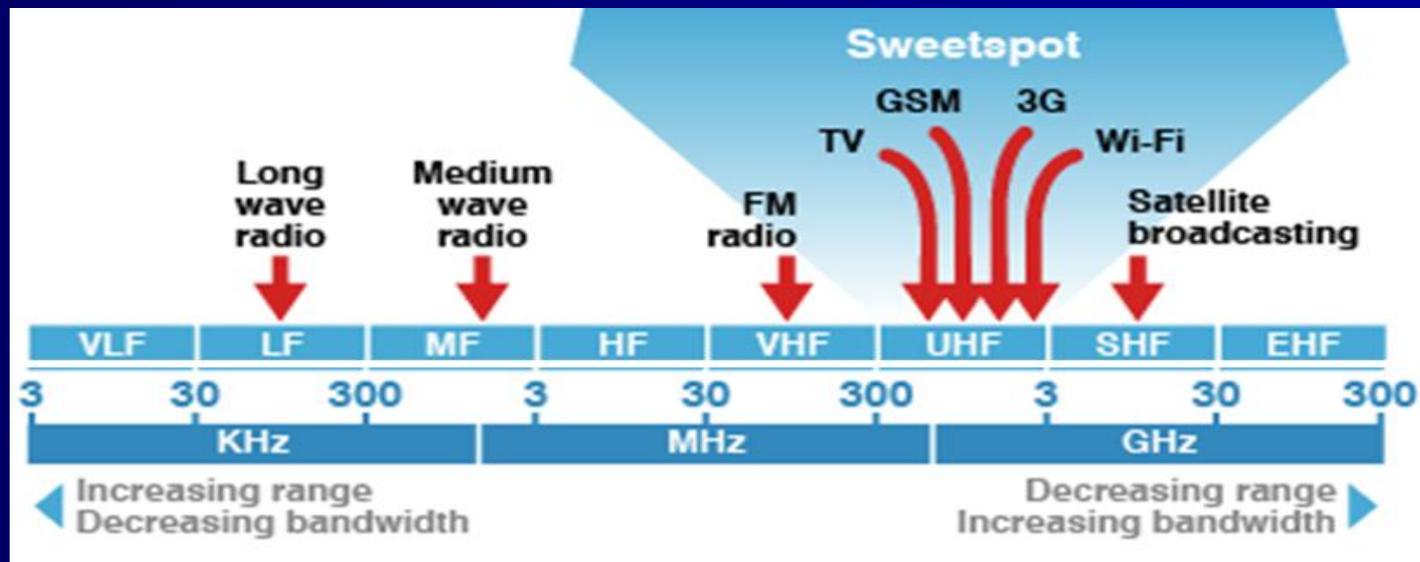


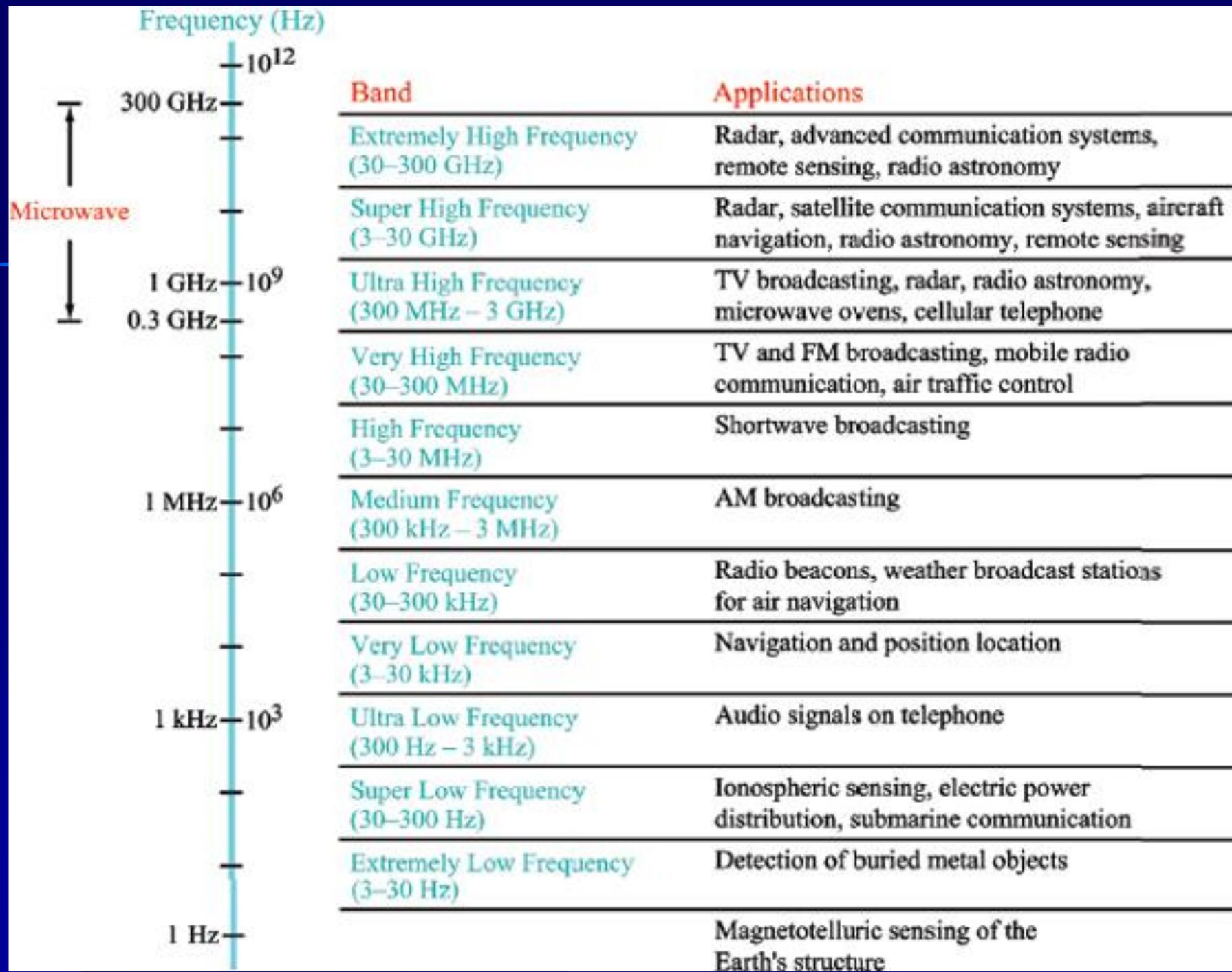
This is typically done via a **resonator** (in **the simplest form, a circuit with a capacitor and an inductor**). The resonator is configured to resonate at a particular frequency (or frequency band), thus **amplifying since waves at that radio**

frequency, while ignoring other **sine waves**. Usually, either the inductor or the capacitor of the resonator is adjustable, allowing the user to change the frequency at which it resonates.

Radio Spectrum

Band	Frequency range	Wavelength range
Extremely low frequency (ELF)	< 3 kHz	>100 km
Very low frequency (VLF)	3 - 30 Hz	10 - 100 krn
Low frequency(LF)	30 - 300 kHz	1 - 10 km
Medium frequency (MF)	300 kHz - 3 MHz	100m - 1km
High frequency (HF)	3 - 30 MHz	10 - 100m
Very high frequency (VHF)	30 - 300 MHz	1 - 10m
Ultra high frequency (UHF)	300 MHz - 3 GHz	10cm - 1m
Super high frequency (SHF)	3 - 30 GHz	1 - 10cm
Extremely high frequency (EHF)	30 - 300 GHz	1mm - 1cm





How Radio Communication Works ?

Sound and **Radio Waves** are different phenomena.

Sound consists of pressure variations in matter, such as air or water. Sound will not through a vacuum.

Radio Waves, like infrared, ultra-violet, visible light, X-rays and Gamma rays are **electro-magnetic waves** that do travel through a vacuum. When you turn-on a radio you have sounds because the transmitter at the radio station has converted the sound waves in to electro-magnetic waves, which are then encoded into an electro-magnetic wave in the radio frequency range (generally in the range of

500 kHz - 1600 kHz for AM stations

or

86 MHz - 108 MHz for FM stations

).

How Radio Communication Works ?

Radio **FM waves** are used because they can travel **very large distance** through the atmosphere **without** greatly **attenuated** due to scattering or **absorption**.

Your Radio Receives the radio waves decodes this information , and uses a speaker to change it back into a sound wave. An picture illustration of this process is given below.

Step – 01

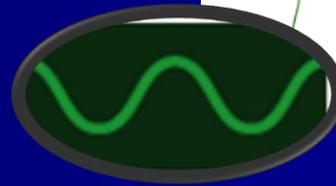
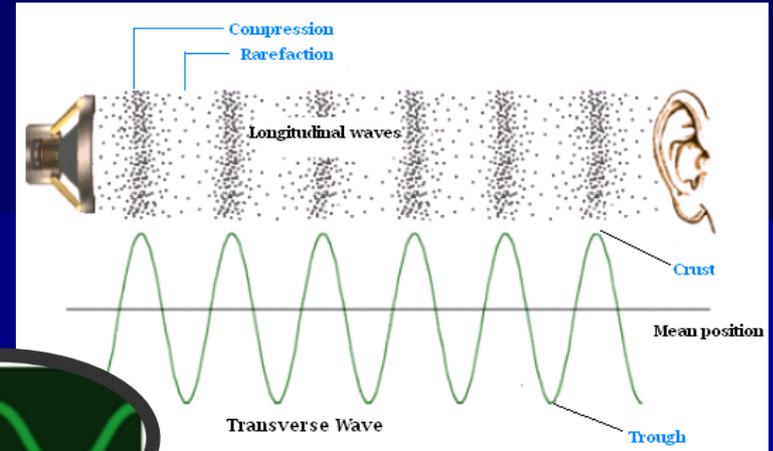
A sound wave produced with a frequency of 5 Hz – ~20 kHz



How Radio Communication Works ?

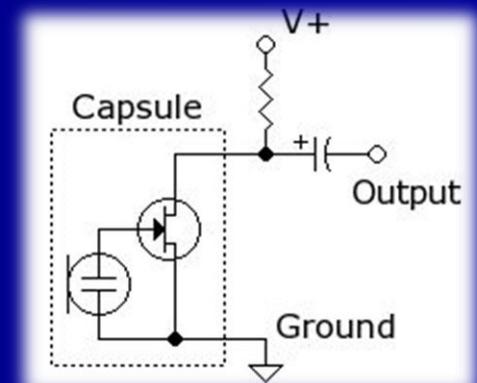
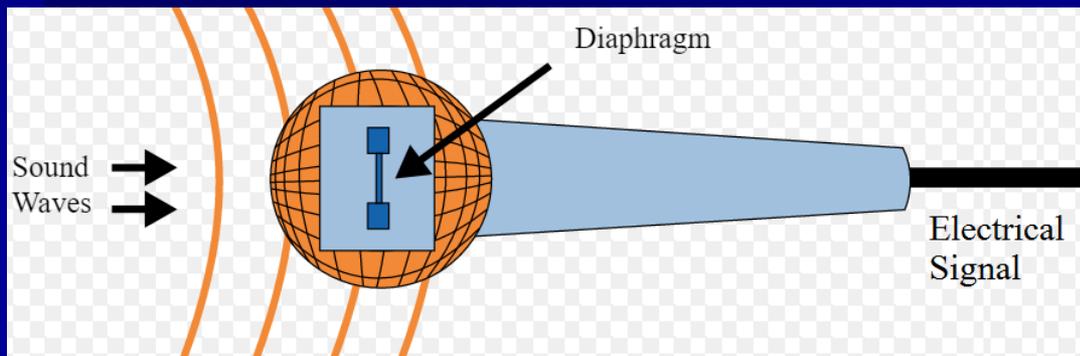
Step – 02

The sound wave is equivalent to pressure wave travelling through the air.



Step – 03

A microphone converts the sound wave into an electrical signal



How Radio Communication Works ?

Step – 04

The electrical wave travelling through the microphone wire is analogous to the original sound wave.

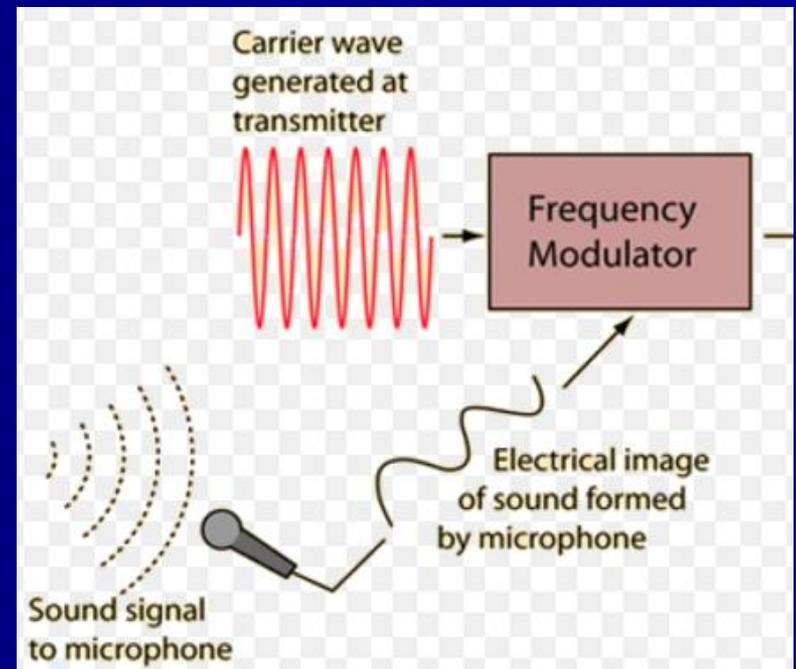
Analog Signal



How Radio Communication Works ?

Step – 05

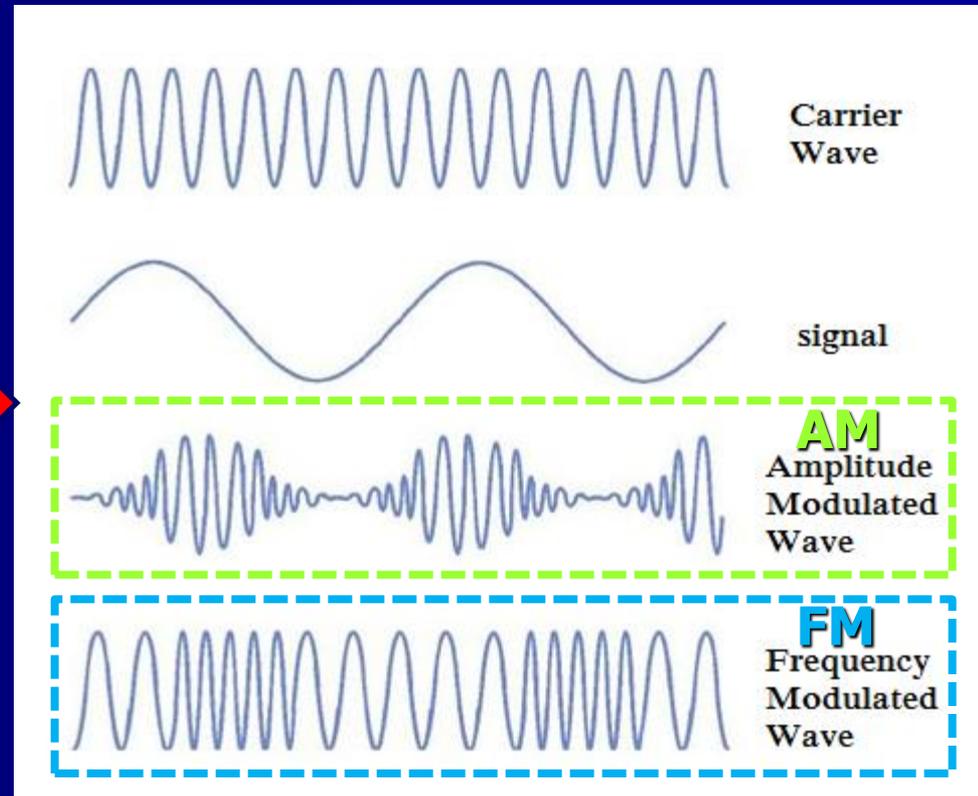
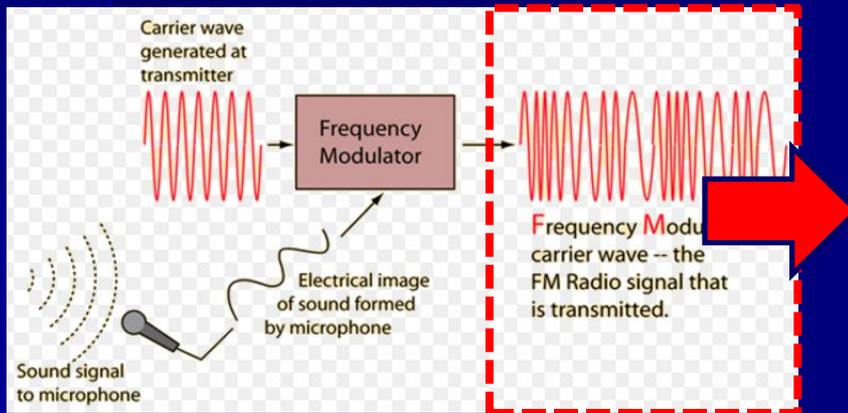
The electrical wave is used to encode or modulate a high-frequency “carrier” radio wave. The carrier wave itself does not include any of the sound information until it has been modulated.



How Radio Communication Works ?

Step – 06

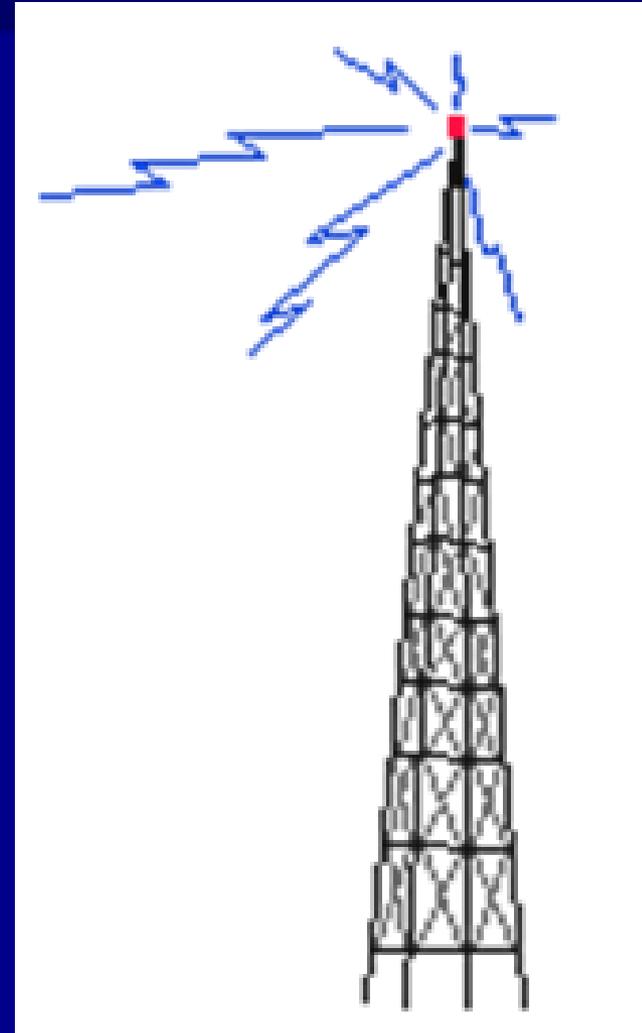
The carrier wave can either be amplitude modulated (**AM, top**) by the electrical signal, or frequency modulated (**FM, bottom**).



How Radio Communication Works ?

Step – 07

The signal is transmitted by a radio broadcast tower.



How Radio Communication Works ?

Step – 08

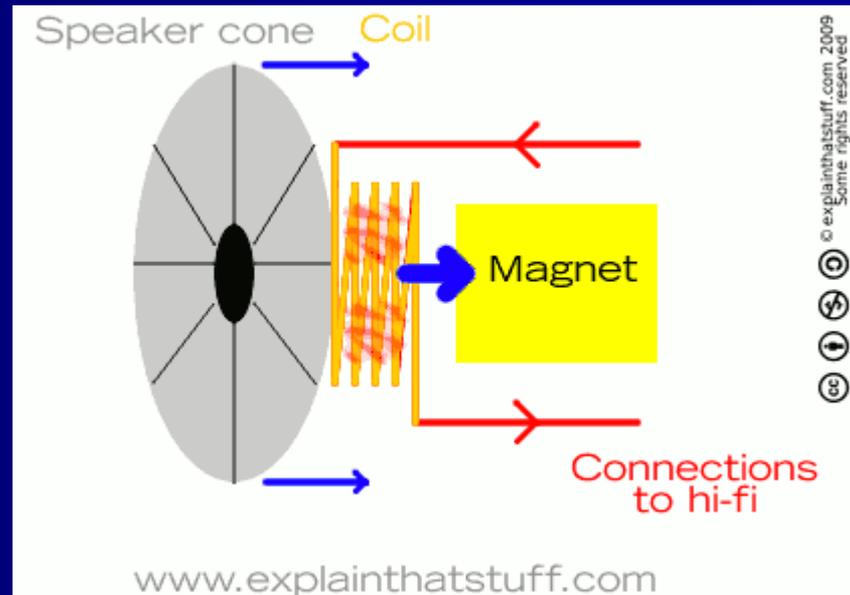
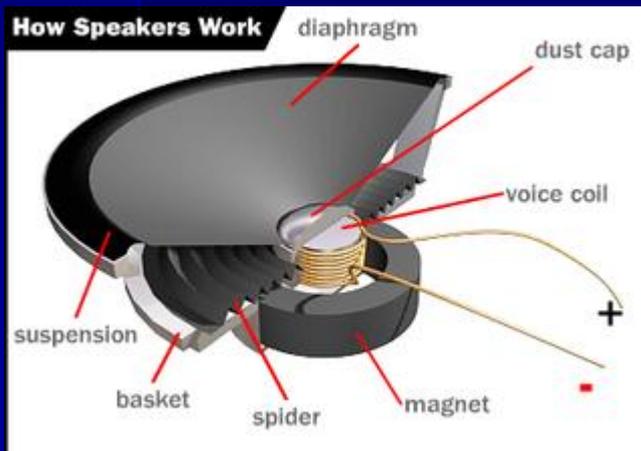
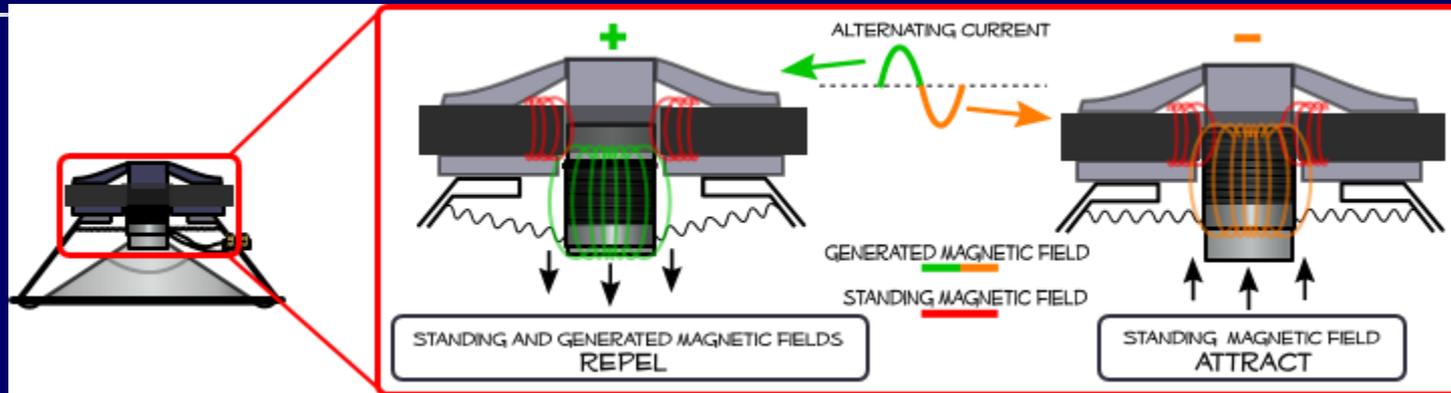
Your radio contains an antenna to detect the transmitted signal,
a tuner to pick out the desired frequency,
a demodulator to extract the original sound wave from the transmitted signal, and
an amplifier which sends the signal to the speakers.

The speakers convert the electrical signal into physical vibrations (sound).



How Radio Communication Works ?

Step – 08 : How to a speaker works ?



Amazon's Choice



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Amazon Basics Computer

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KEF R3 Standmount Speakers

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Price: \$2,973.96



KEF LSX II Wireless HiFi Speaker

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Best Seller



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Bluetooth

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Pyle Professional Dynamic Vocal Microphone - Moving Coil Dynamic Cardioid Unidirectional Handheld...

Wired, Wireless

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More Buying Choices

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Best Seller



Shinco Handheld Wired Microphone, Cardioid Dynamic Vocal Mic with 13ft Cable and ON/Off Switch, Ideally Suite...

XLR

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Microphone, Multipattern
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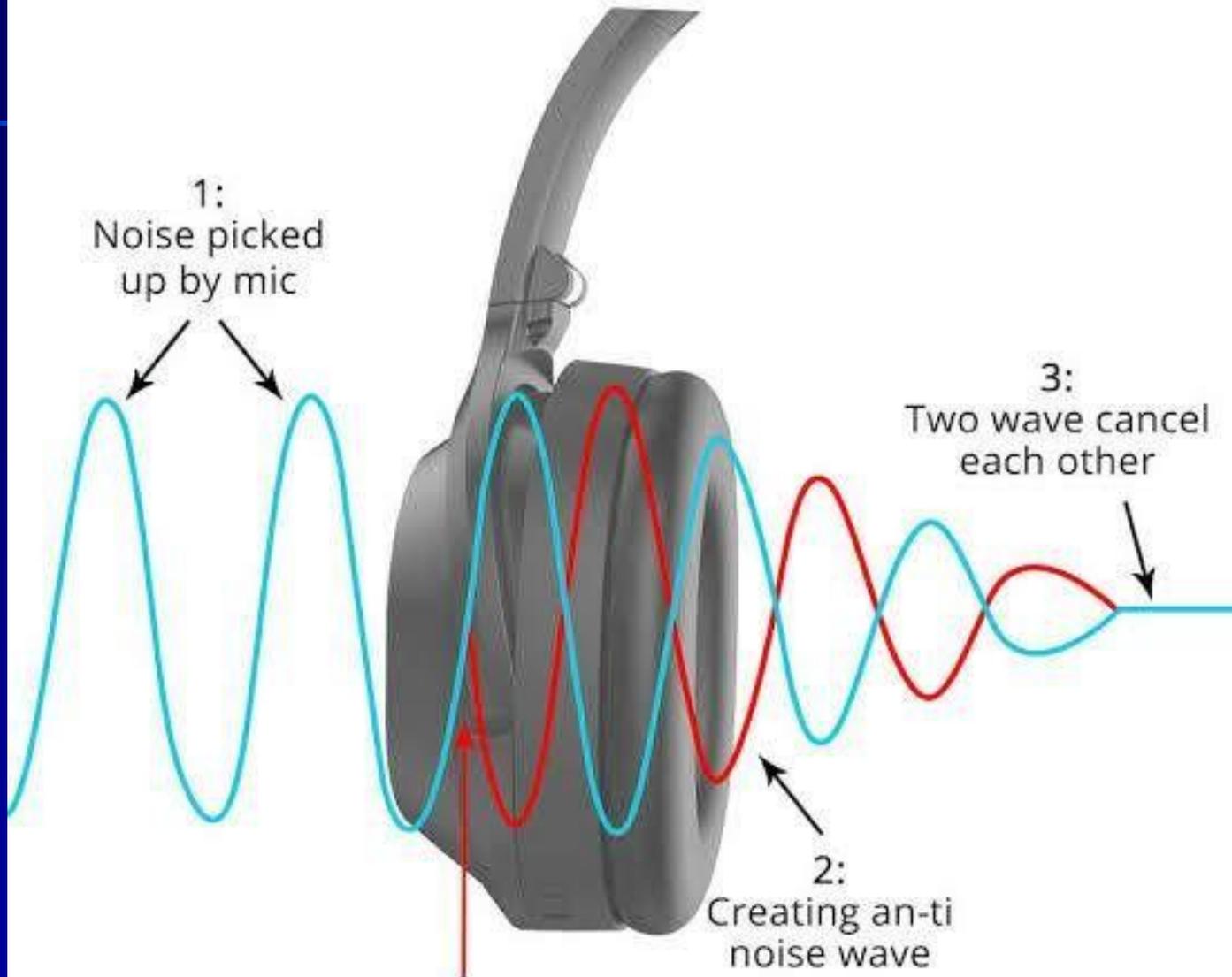
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Noise Cancelling Earphones / Headphones

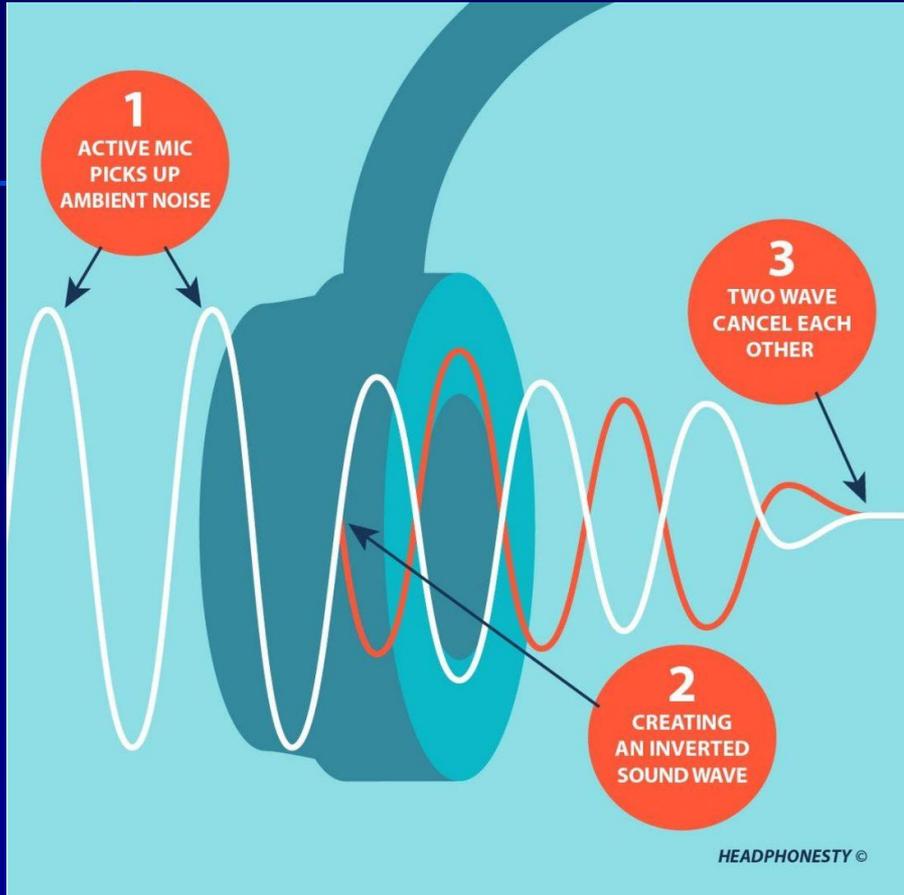
What does noise cancelling do?

Noise-cancelling audio devices use a built-in microphone to analyse the ambient sound waves around you and generate the opposite sound waves to reduce surrounding sound. Noise-cancelling devices have a built-in microphone which produces the opposite reversed sound waves to neutralise surrounding noise

ACTIVE NOISE CANCELLATION



Noise Cancelling vs. Noise Isolating



Noise Cancelling vs. Noise Isolating

What Is Noise Isolation?

Noise isolation, “Passive Noise Cancellation”, is the act of blocking noise through the use of physical barriers. Just as you hear less noise when you cover your ears with your palms, noise isolation in headphones achieves the same result by forming a secure seal using the foam pads in the ear cups.

Noise Cancelling vs. Noise Isolating

What Is Noise Cancellation?

Also known as “Active Noise Cancellation” (ANC), it’s a process for blocking off ambient sound through a system of components placed within the ear cups of the headphones.



Noise Cancelling vs. Noise Isolating

What Is Noise Isolation?

Noise isolation, “Passive Noise Cancellation”, is the act of blocking noise through the use of physical barriers. Just as you hear less noise when you cover your ears with your palms, noise isolation in headphones achieves the same result by forming a secure seal using the foam pads in the ear cups.

World's best active noise cancelling earbuds... (2025 Feb)





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Sony WF-1000XM5 Bluetooth WF XM5

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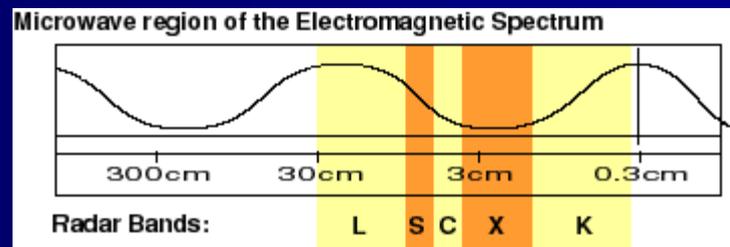
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Microwave Transmission

Microwave Transmission refers to the **technology of transmitting information** by the use of the **radio waves** whose wavelengths are conveniently measured in small numbers of centimeters, by using various electronic technologies. These are called **microwaves**.



This part of the radio spectrum **ranges across frequencies** of roughly **1 GHz – 30 GHz**. Also by using the formula $c = f \lambda$, these correspond to wavelengths from **30 cm** down to **1 cm**.

In the microwave frequency band, **antennas** are usually of **convenient sizes and shapes** and also the use of **metal waveguides** for carrying the radio power works well.

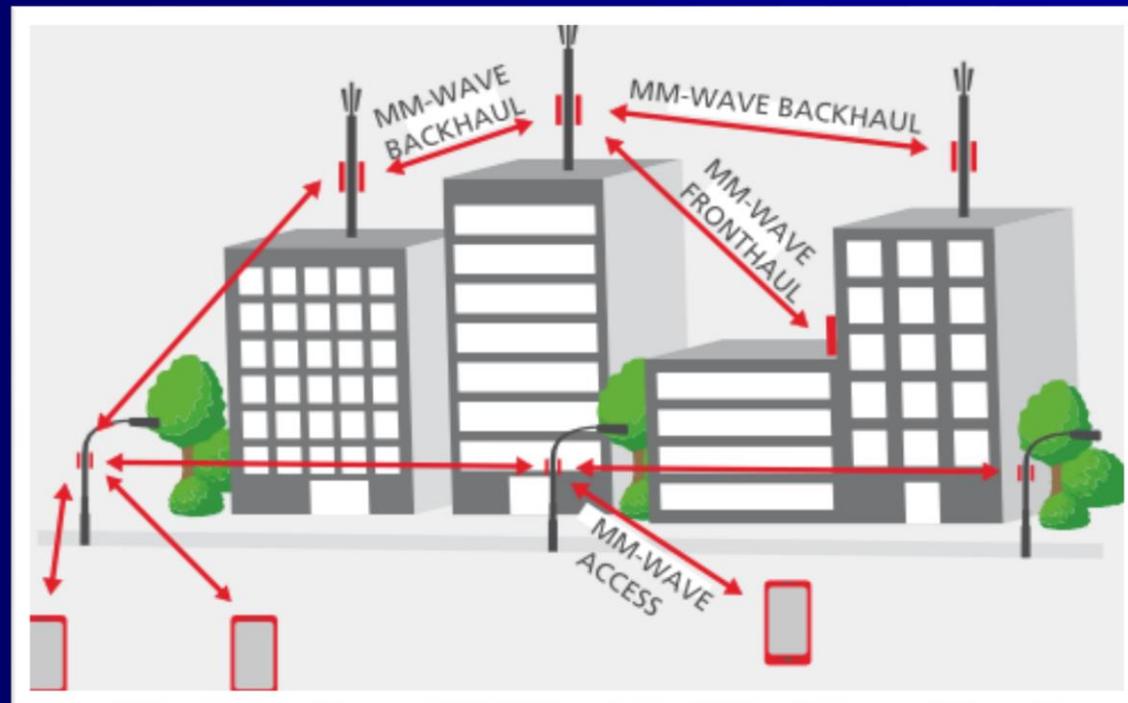
Microwave Transmission



Microwave radio transmission is commonly used by **communication systems on the surface of the Earth**, in **satellite communications**, and in **deep space radio communication**. Other parts of the microwave radio band are used for **radars**, **radio navigation systems**, **sensor systems** and **radio astronomy**.

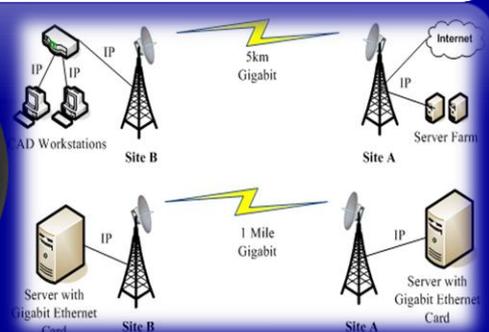
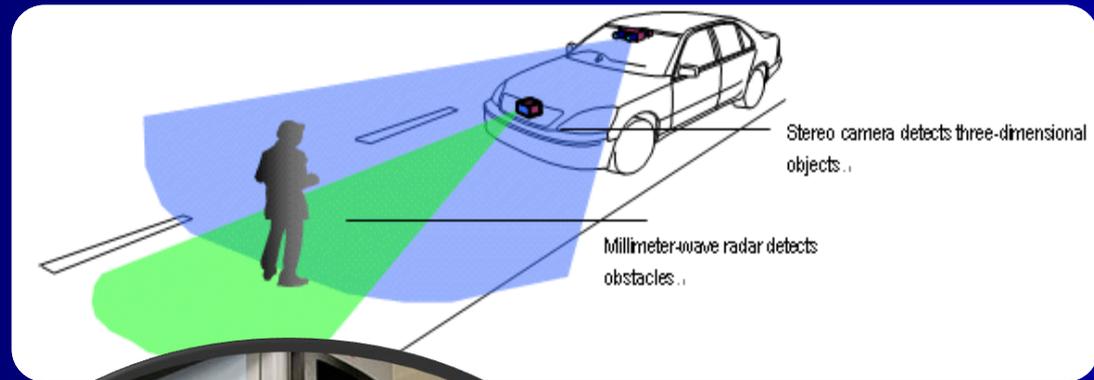
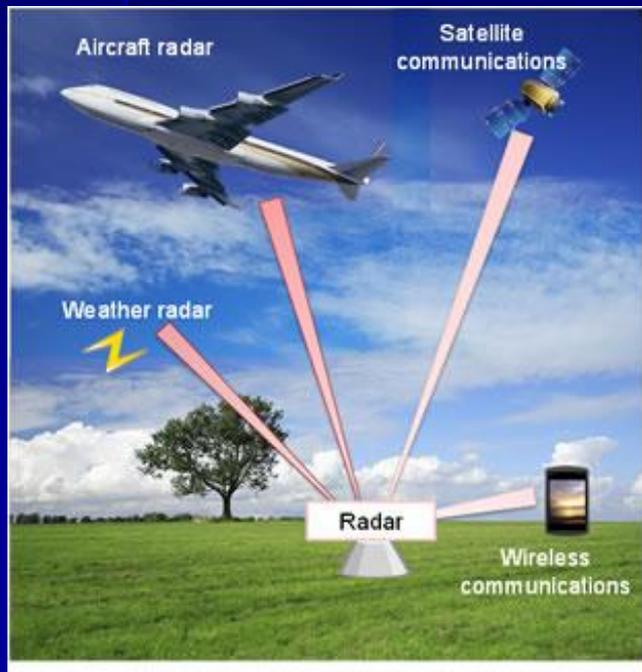
Radio Transmission – (MM Waves)

The next higher part of the radio electro magnetic spectrum, where the frequencies are **above 30 GHz** and **below 100 GHz** are called “**Milimeter Waves**” because their wavelengths are conveniently measured in millimeters, and their **wavelengths** range from **10 mm** down to **3 mm**.



Radio Transmission – (MM Waves)

Radio waves in this band are usually **strongly attenuated** by the **Earth atmosphere** and particles contained in it, especially during **wet weather**. Also in wide band of frequencies around **60 GHz**, the radio wave are strongly **attenuated** by **molecular oxygen** in the atmosphere. The electronic technologies needed in the millimeter wave band are also much more difficult to utilize than those of the microwave band.



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Consumption	≤ 1.9 ltr/100 km* + 14.0 kWh/100 km*
Emissions	42 g CO ₂ /km*

* All figures are preliminary.

The values of fuel consumptions, CO₂ emissions and energy consumptions shown were determined according to the European Regulation (EC) 715/2007 in the version applicable at the time of type approval. The figures refer to a vehicle with basic configuration in Germany and the range shown considers optional equipment and the different size of wheels and tires available on the selected model.

All values are already based on the new WLTP regulation and are translated back into NEDC-equivalent values in order to ensure the comparison between the vehicles. [With respect to these vehicles, for vehicle related taxes or other duties based (at least inter alia) on CO₂-emissions the CO₂ values may differ to the values stated here.]

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Radio Wave Communication

Radio waves

Radio Communication

Reflection of Radio Waves

Absorption of Radio Waves

Complex Refractive Index

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Deviating Region Absorption, Non-

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Pulse Reflection Methods

Thank You !

