Designation		Frequency	Wavelength
ELF	extremely low frequency	3Hz to 30Hz	100'000km to 10'000 km
SLF	superlow frequency	30Hz to 300Hz	10'000km to 1'000km
ULF	ultralow frequency	300Hz to 3000Hz	1'000km to 100km
VLF	very low frequency	3kHz to 30kHz	100km to 10km
LF	low frequency	30kHz to 300kHz	10km to 1km
MF	medium frequency	300kHz to 3000kHz	1km to 100m
HF	high frequency	3MHz to 30MHz	100m to 10m
VHF	very high frequency	30MHz to 300MHz	10m to 1m
UHF	ultrahigh frequency	300MHz to 3000MHz	1m to 10cm
SHF	superhigh frequency	3GHz to 30GHz	10cm to 1cm
EHF	extremely high frequency	30GHz to 300GHz	1cm to 1mm

HF- Communication

High frequency (HF) is the ITU-designated range of radio frequency electromagnetic waves (radio waves) between 3 and 30 MHz. It is also known as the decameter band or decameter wave as the wavelengths range from one to ten decameters (ten to one hundred metres). The HF band is a major part of the shortwave band of frequencies, so communication at these frequencies is often called shortwave radio. Radio waves in this band can be reflected back to Earth by the ionosphere layer in the atmosphere, called "skip" or skywave propagation, these frequencies can be used for long distance communication, at intercontinental distances. The band is used by international shortwave broadcasting stations (2.310 - 25.820 MHz), aviation communication, government time stations, weather stations, amateur radio and citizens band services, among other uses.

Propagation Charecteristics

The dominant means of long distance communication in this band is skywave (skip) propagation, in which radio waves directed at an angle into the sky reflect (actually refract) back to Earth from layers of ionized atoms in the ionosphere. By this method HF radio waves can travel beyond the horizon, around the curve of the Earth, and can be received at intercontinental distances. However, suitability of this portion of the spectrum for such communication varies greatly with a complex combination of factors:

Sunlight/darkness at site of transmission and reception

Transmitter/receiver proximity to solar terminator, Season, Sunspot cycle, Solar activity & Polar aurora

At any point in time, for a given "skip" communication path between two points, the frequencies at which communication is possible are specified by these parameters

Maximum usable frequency (MUF):- Maximum usable frequency (MUF) is the highest radio frequency that can be used for transmission between two points via reflection from the ionosphere (skywave or "skip" propagation) at a specified time, independent of transmitter power.

Lowest usable high frequency (LUF):- It is that frequency in the HF band at which the received field intensity is sufficient to provide the required signal-to-noise ratio for a specified time period, e.g., 0100 to 0200 UTC, on 90% of the undisturbed days of the month.

Frequency of optimum transmission (FOT):- It is the highest effective (i.e. working) frequency that is predicted to be usable for a specified path and time for 90% of the days of the month.

USAGES:-

The main users of the high frequency spectrum are:

- Military and governmental communication systems
- Aviation air-to-ground communications
- Amateur radio

Shortwave international and regional broadcasting, Maritime sea-to-shore services Over the horizon radar systems

The high frequency band is very popular with amateur radio operators, who can take advantage of direct, long-distance (often inter-continental) communications and the "thrill factor" resulting from making contacts in variable conditions. International shortwave broadcasting utilizes this set of frequenciesbut may maintain HF stations after switch-over for back-up purposes.

Antennas

Since, horizontally polarized radio waves work better for skywave propagation due to the greater ground absorption of vertically polarized waves, monopole antennas which have vertical polarization are not much used, and antennas based on horizontal dipoles are mostly used. The most common antennas in this band are wire antennas such as wire dipoles and the rhombic antenna; in the upper frequencies, multielement dipole antennas such as the Yagi, quad, and reflective array antennas. Powerful shortwave broadcasting stations often use large wire curtain arrays. For receiving, random wire antennas are often used.

Very High Frequency Communication

Very high frequency (VHF) is the ITU-designated range [1] of radio frequency electromagnetic waves from 30 MHz to 300 MHz, with corresponding wavelengths of one to ten meters.

Common uses for VHF are FM radio broadcasting, television broadcasting, land mobile stations (emergency, business, private use and military), long range data communication up to several tens of kilometres with radio modems, amateur radio, and marine communications. Air traffic control communications and air navigation systems (e.g. VOR, DME & ILS) work at distances of 100 kilometres or more to aircraft at cruising altitude.

Propagation characteristics

VHF propagation characteristics are ideal for short-distance terrestrial communication, with a range generally somewhat farther than line-of-sight from the transmitter (see formula below). The ionosphere does not usually reflect VHF waves (called skywave propagation), so transmissions are restricted to the local radio horizon less than 100 miles. VHF is also less affected by atmospheric noise and interference from electrical equipment than lower frequencies. While it is blocked by land features such as hills and mountains, it is less affected by buildings and can be received indoors, although multipath television reception due to reflection from buildings can be a problem in urban areas

Line-of-sight calculation

For analog TV, VHF transmission range is a function of transmitter power, receiver sensitivity, and distance to the horizon, since VHF signals propagate under normal conditions as a near line-of-sight phenomenon. The distance to the radio horizon is slightly extended over the geometric line of sight to the horizon, as radio waves are weakly bent back toward the Earth by the atmosphere.

An approximation to calculate the line-of-sight horizon distance (on Earth) is:

distance in kilometres = $\sqrt{12.746 \times A_m}$ where A_m is the height of the antenna in metres

These approximations are only valid for antennas at heights that are small compared to the radius of the Earth. They may not necessarily be accurate in mountainous areas, since the landscape may not be transparent enough for radio waves.

In engineered communications systems, more complex calculations are required to assess the probable coverage area of a proposed transmitter station.

Antennas

1. VHF is the first band at which wavelengths are small enough to make efficient transmitting antennas for handheld devices, so the VHF and UHF wavelengths are used for handheld transceivers and walkie talkies.
2. Fixed station antennas are usually based on the dipole, while portable radios usually use whips or rubber ducky antennas.
3. The Yagi antenna is the most widely used as a high gain or "beam" antenna.
4. Helical and turnstile antennas are used for satellite communication since they employ circular polarization.

Universal use: Certain subparts of the VHF band have the same use around the world. Some national uses are detailed below.
108–118 MHz: Air navigation beacons VOR and Instrument Landing System localiser.
118–137 MHz: Airband for air traffic control, AM, 121.5 MHz is emergency frequency
144–146 MHz: Amateur radio. In some countries 144–148 MHz.

Ultra High Frequency Communication

Ultra-high frequency (UHF) designates the ITU radio frequency range of electromagnetic waves between 300 MHz and 3 GHz (3,000 MHz), also known as the decimetre band or decimetre wave as the wavelengths range from one to ten decimetres; that is 1 decimetre to 1 metre. UHF radio waves propagate mainly by line of sight; they are blocked by hills and large buildings although the transmission through building walls is high enough for indoor reception. They are used for television broadcasting (digital and analogue), cordless phones, walkie-talkies, satellite communication, and numerous other applications.

Charecteristics

The point to point transmission and reception of TV and radio signals is affected by many variables. Atmospheric moisture, solar wind, physical obstructions (such as mountains and buildings), and time of day all affect the signal transmission and the degradation of signal reception. All radio waves are partly absorbed by atmospheric moisture. Atmospheric absorption reduces, or attenuates, the strength of radio signals over long distances. The effects of attenuation i.e. degradation increases with frequency. UHF TV signals are generally more degraded by moisture than lower bands, such as VHF TV signals.

The ionosphere, a layer of the Earth's atmosphere, is filled with charged particles that can reflect some radio waves. Sometimes, the waves are trapped, bouncing around in the upper layers of the ionosphere until they are refracted down at another point on the Earth. This is called *skywave transmission*. UHF TV signals are not carried along the ionosphere but can be reflected off of the charged particles down at another point on Earth in order to reach farther than the typical line-of-sight transmission distances; this is the skip distance.

The main advantage of UHF transmission is the short wavelength that is produced by the high frequency. The size of transmission and reception antennas is related to the size of the radio wave. The UHF antenna is stubby and short. Smaller and less conspicuous antennas can be used with higher frequency bands.

The major disadvantage of UHF is its limited broadcast range, often called *line-of-sight* between the TV station's transmission antenna and customer's reception antenna, as opposed to VHF's longer broadcast range.

UHF is widely used in two-way radio systems and cordless telephones, whose transmission and reception antennas are closely spaced. Transmissions generated by two-way radios and cordless telephones do not travel far enough to interfere with local transmissions. Several public-safety and business communications are handled on UHF.

Applications

TelevisionUHF television broadcasting fulfilled the demand for additional over-the-air television channels in urban areas. Today, much of the bandwidth has been reallocated to land mobile, trunked radio and mobile telephone use. UHF channels are still used for digital television.

Radio

UHF spectrum is used world-wide for land mobile radio systems for commercial, industrial, public safety, and military purposes. Many personal radio services use frequencies allocated in the UHF band, although exact frequencies in use differ significantly between countries.

Internet

UHF/VHF signals can deliver high-speed broadband internet access.

Microwave communication:-

Microwave transmission refers to the technology of transmitting information or energy by the use of radio waves whose wavelengths are conveniently measured in small numbers of centimetre; these are called *microwaves*. This part of the radio spectrum ranges across frequencies of roughly 1.0 gigahertz (GHz) to 30 GHz. These correspond to wavelengths from 30 centimeters down to 1.0 cm.

Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Another advantage is that the high frequency of microwaves gives the microwave band a very large information-carrying capacity; the microwave band has a bandwidth 30 times that of all the rest of the radio spectrum below it. A disadvantage is that microwaves are limited to line of sight propagation; they cannot pass around hills or mountains as lower frequency radio waves can.

- Microwave radio transmission is commonly used in point-to-point communication systems on the surface of the Earth, in satellite communications, and in deep space radio communications. Other parts of the microwave radio band are used for radars, radio navigation systems, sensor systems, and radio astronomy.
- Wireless transmission of information
- One-way (e.g. television broadcasting) and two-way telecommunication using communications satellite
- Terrestrial microwave radio broadcasting relay links in telecommunications networks including e.g. backbone or backhaul carriers in cellular networks linking BTS-BSC and BSC-MSC.

How microwave radio relay links are formed

Since, the radio waves travel in narrow beams confined to a line-of-sight path from one antenna to the other, they don't interfere with other microwave equipment, and nearby microwave links can use the same frequencies. Antennas used must be highly directional (High gain); these antennas are installed in elevated locations such as large radio towers in order to be able to transmit across long distances. Typical types of antenna used in radio relay link installations are parabolic antennas, dielectric lens, and horn-reflector antennas, which have a diameter of up to 4 meters. Highly directive antennas permit an economical use of the available frequency spectrum, despite long transmission distances.

Microwave link

A microwave link is a communications system that uses a beam of radio waves in the microwave frequency range to transmit video, audio, or data between two locations, which can be from just a few feet or meters to several miles or kilometers apart. Microwave links are commonly used by television broadcasters to transmit programmes across a country, for instance, or from an outside broadcast back to a studio.

Mobile units can be camera mounted, allowing cameras the freedom to move around without trailing cables. These are often seen on the touchlines of sports fields on Steadicam systems.

Properties of microwave links

- Involve line of sight (LOS) communication technology
- Affected greatly by environmental constraints, including rain fade
- Have very limited penetration capabilities through obstacles such as hills, buildings and trees
- Sensitive to high pollen count[*citation needed*]
- Signals can be degraded[*citation needed*]during Solar proton events[5]

Uses of microwave links

- In communications between satellites and base stations
- As backbone carriers for cellular systems
- In short range indoor communications
- Telecommunications, in linking remote and regional telephone exchanges to larger (main) exchanges without the need for copper/optical fibre lines.

microwaves are used in oven.