Communication Electronics

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Unit – 2

Microwaves, Colour television and Applications

Klystron

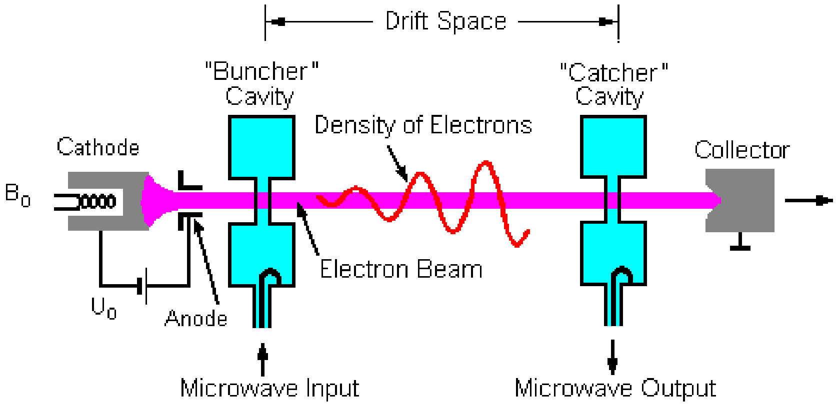
The klystron utilizes a phenomenon called electron bunching which goes as follows: Electrons in a beam leaving a source at high velocity all have a roughly equal velocity in the direction of travel. ... The grid's negative charge pushes back on the electrons as they pass through the negative left grid slowing them down.

Klystron, thermionic electron tube that generates or amplifies microwaves by controlling the speed of a stream of electrons. Amplitude modulation of the electrons in their bunched-up state induces a strong signal as the stream passes through the gap of a second resonator. Once the electrons leave the bunched cavity, they drift with a velocity along the space between two cavities. The effect of velocity modulation produces, bunching of electron beam or current modulation.

A klystron is a specialized linear-beam vacuum tube, invented in 1937 by American electrical engineers Russell and Sigurd Varian, which is used as an amplifier for high radio frequencies, from UHF up into the microwave range.

Whereas in the reflex klystron, the repeller plate used in place of collector and used to repel the electron beam. The main purpose of Two cavity klystron is to amplify the microwave signal. The main purpose of the reflex klystron is to oscillate the microwave signal.

Klystron power supply, Klystron with mount, Isolator, Frequency meter, Variable attenuator, X-band. detector, BNC-to-BNC cable and Oscilloscope. THEORY. Reflex Klystron is one of the most commonly used microwave (low power) generators.



It converts D.C. power into microwave power. An electron tube in which bunching of electrons is produced by electric fields and which is used for the generation and amplification of ultrahigh-frequency current.

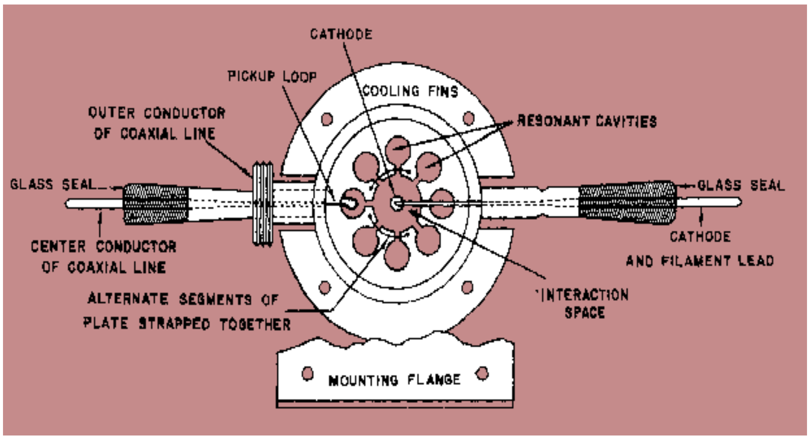
This microwave generator, is a Klystron that works on reflections and oscillations in a single cavity, which has a variable frequency. Reflex Klystron consists of an electron gun, a cathode filament, an anode cavity, and an electrode at the cathode potential. It provides low power and has low efficiency.

Magnetron

The magnetron does its stuff by resonating like a flute when you pump electrical energy into it. But, unlike a flute, it produces electromagnetic waves instead of sound waves so you can't hear the resonant energy its making. there are many reasons behind it to cause a magnetron to fail in a microwave oven.

They are Magnets Cracking, burned out terminals, Burned antenna/dome, a loose connection of magnetron, Resistance continuity etc., Some of the causes are visually seen and some are known only by testing.

The magnetron is a high-powered vacuum tube that works as a self-excited microwave oscillator. Crossed electron and magnetic fields are used in the magnetron to produce the high-power output required in radar equipment.



Crystal Detector

The crystal detector is widely used in Rf and microwave field due to their sensitivity and simple design. ... Used as video detector which produces DC output based on input signal frequency (unmodulated or modulated).
It uses only the power of the received radio signal to produce sound, needing no external power. It is named for its most important component, a crystal detector, originally made from a piece of crystalline mineral such as galena. This component is now called a diode.

The probe is connected to a crystal (diode) detector that converts the time-varying microwave voltage to a DC value with the help of a low speed modulation envelope (1 kHz) on the microwave signal. The DC voltage is measured using the SWR meter (HP 415D). crystal rectifier - a semiconductor that consists of a p-n junction. junction rectifier, semiconductor diode, diode. LED, light-emitting diode - diode such that light emitted at a p-n junction is proportional to the bias current; color depends on the material used.

A crystal detector is an obsolete electronic component used in some early 20th century radio receivers that consists of a piece of crystalline mineral which rectifies the alternating current radio signal and was employed as a detector (demodulator) to extract the audio modulation to produce the sound in the earphones.

Measurement of SWR

The amount of power reflection is measured by its standing wave ratio (SWR), which is a ratio of maximum power to minimum power in the transmission line. Too much SWR and the transmitter can burn up. As SWR increases, power out of the antenna decreases. A SWR of 1:1 is ideal. The SWR is a measure of the depth of those standing waves and is, therefore, a measure of the matching of the load to the transmission line.

A matched load would result in an SWR of 1:1 implying no reflected wave. SWR can be calculated from the formula: ... A 1.1:1 VSWR means that if there were 10,000 watts transmitted, the reflected power would be about 23 watts. A VSWR of 2:1 means that with 10,000 watts transmitted, about 1,111 watts is reflected back towards the transmitter.

The Voltage Standing Wave Ratio (VSWR) is an indication of the amount of mismatch between an antenna and the feed line connecting to it. This is also known as the Standing Wave Ratio (SWR). The range of values for VSWR is from 1 to ∞. A VSWR value under 2 is considered suitable for most antenna applications. The SWR indicator in the radio should go near flat after auto tune while the meter between the tuner and the antenna may move some but not go flat because that point in the system is not being matched. The meter at that point will prove it.

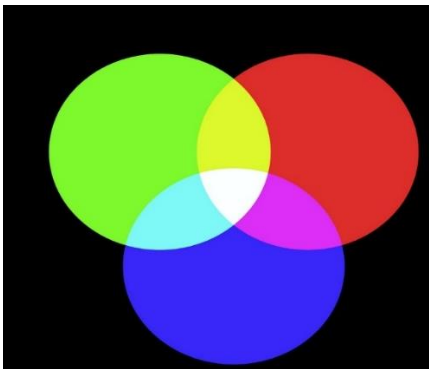
Three colour theory

Modern colour theory is based on three primary colours, projected colours red green and blue, or its printed complements, cyan, magenta, and yellow (that's yellow, hard to read on a white background, no?). A fourth "primary," black, is used for printed colour.

- Three Primary Colours (Ps): Red, Yellow, Blue.
- Three Secondary Colours (S'): Orange, Green, Violet.
- Six Tertiary Colours (Ts): Red-Orange, Yellow-Orange, Yellow-Green, Blue-Green, Blue-Violet, Red-Violet, which are formed by mixing a primary with a secondary.

Colour theory encompasses a multitude of definitions, concepts and design applications - enough to fill several encyclopaedias. However, there are three basic categories of colour theory that are logical and useful: The colour wheel, colour harmony, and the context of how colours are used.

The true primary colours are those that are used in printing ink, and are known as, magenta, yellow and cyan. Unfortunately, these colours are not always similarly labelled on the tubes of artists' paint.



In colour theory, a tint is a mixture of a colour with white, which increases lightness, while a shade is a mixture with black, which increases darkness. When we mix colorants, such as the pigments in paint mixtures, a colour is produced which is always darker and lower in Chroma, or saturation, than the parent colours.

Image Orthicon

When light from a scene falls on the surface of photocathode then electrons are emitted from its surface. Due to the semi-transparent nature of the cathode surface, the light penetrates in order to reach the inner surface of the material.

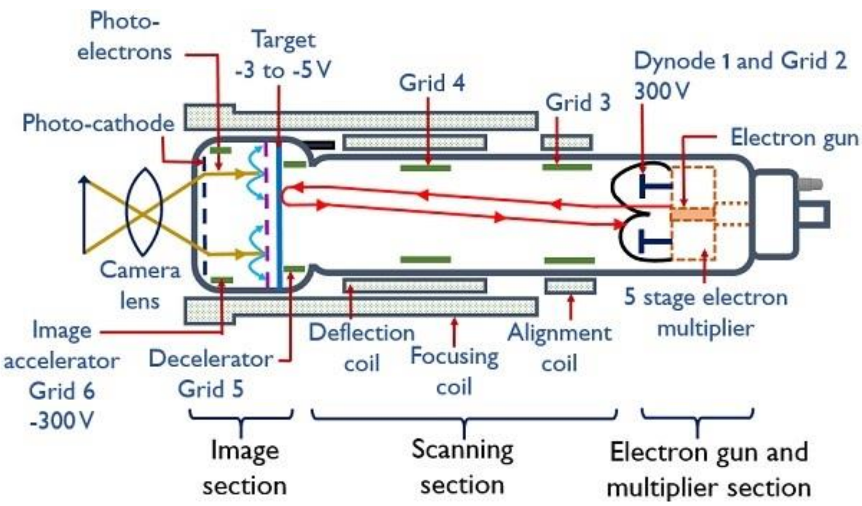
The *number of emitted electrons will be directly proportional to the intensity of the optical image* falling on the surface.

The emission of electrons from the surface of the cathode leads to the formation of an electron image on the target side of the photocathode.

Being a conductor with high conversion efficiency, the photocathode cannot hold the charge in it.

Therefore, the produced electron image moves towards the target plate present in the image section at some distance from the cathode. As we have already discussed under construction that *potential at the target plate is comparatively higher than the potential at the photocathode*. Thus the resultant electric field provides proper acceleration, thereby allowing the movement of electrons towards the target plate.

But the electrons in motion possess the tendency of repelling each other while moving, and this resultantly distorts the information present in the form of charge image. So to avoid this, an axial magnetic field is provided by the use of a focusing coil. The magnetic field focusses the emitted electrons on the surface of the target plate in the form of definite electron image of the actually provided optical image.



On the target plate towards the side of cathode, caesium is deposited that provides a high ratio of secondary emission. The high-velocity electrons emitted from the surface of the photocathode when bombards the surface of the target then secondary electrons are emitted from the surface of the target.

The wire-mesh screen present in front of the target plate collects these secondary electrons. Due to the emission of secondary electrons, a positive charge distribution is created on the surface of the target plate. This distribution of positive charge on the target surface is proportional to the intensity of indenting optical image on the surface of the photocathode.

As we have already discussed that target is made of the thin glass sheet, this is basically done to prevent the spreading of stored charge over the surface of the target. As spreading of charge will hinder the resolution of the device. A noteworthy point over here is that in order to have a continuous distribution of positive charge on the target, the light from the scene must be continuously provided to the photocathode, to allow the cumulative process.

As the presence of caesium at the target surface provides high secondary emission ratio. Therefore, this leads to higher intensity of positive charge distribution at the target than charge produced (emitted) by the photocathode.

This increase in charge density at the target wart charge at the photocathode is called image multiplication. This resultantly enhances the overall sensitivity of the image orthicon. Due to the thin structure of the target plate, the stored positive stored charge appears on the other side of the target which subjected to scanning. And the video signal is achieved from this particular side of the target plate. To facilitate the neutralization of stored charge, a scanning electron beam is used.

Vidicon

Vidicon camera is a television camera which converts the light energy into electrical energy. It functions on the principle of photo conductivity, where the resistance of target material decreases when exposed to light.

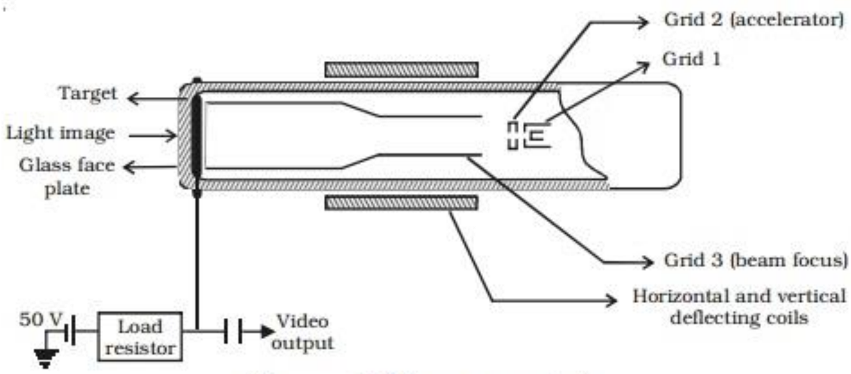


Fig *Vidicon camera tube*

Construction

The Vidicon consists of a glass envelope with an optically flat face plate . A photosensitive, target plate is available on the inner side of the face plate. The target plate has two layers. To the front, facing the face plate, is a thin layer of tin oxide. This is transparent to light but electrically conductive. The other side of the target plate is coated with a semiconductor, photosensitive antimony trisulphide. The tin oxide layer is connected to a power supply of 50V.

Grid-1 is the electron gun, consisting a cathode and a control grid. The emitted electrons are accelerated by Grid-2. The accelerated electrons are focussed on the photo conductive layer by Grid-3. Vertical and Horizontal deflecting coils, placed around the tube are used to deflect the electron beam for scanning the target.

Working

The light from a scene is focussed on the target. Light passes through the face plate and tin oxide, incident on the photo conductive layer. Due to the variations in the light intensity of the scene, the resistance of the photo conductive layer varies. The emitted electrons from antimony trisulphide reach the positive tin oxide layer. So, each point on the photo conductive layer acquires positive charge. Hence, a charge image that corresponds to the incident optical image is produced. As the electron beam from the gun is incident on the charge image, drop in voltage takes place. As a result, a varying current is produced. This current produces the video-signal output of the camera.

Scanning and synchronising

A still picture is fundamentally an arrangement of many dark and light areas. Each small area of light or shade is called a picture element. All the elements contain the visual information in the scene. If they are transmitted and reproduced in the same degree of light or shade as original and in proper position, the picture will be reproduced.

In order to produce video signal for all the elements in the picture, it is scanned by the electron beam, one element at a time, in sequential order. The scanning is done in the same way as a written page is read to cover all the words in one line and all lines on the page. Hence, scanning is the process by which an electron beam spot is made to move across a rectangular area, so as to cover it completely. This rectangular area may be the target surface in a television camera or the screen of a picture tube in a television receiver.

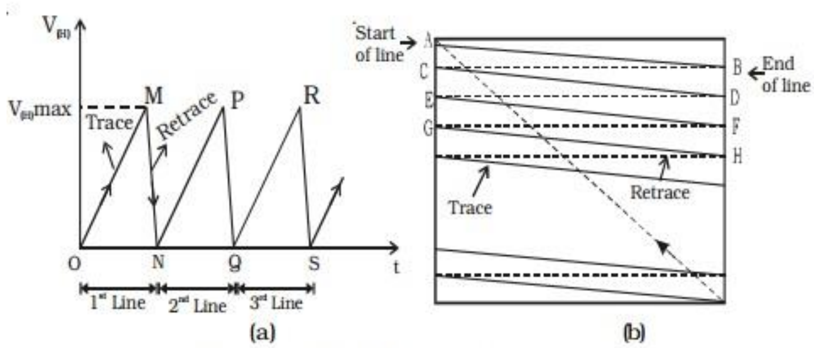


Fig *Simple scanning process*

The scene is scanned rapidly both in the horizontal and vertical directions simultaneously. This provides sufficient number of complete pictures or frames per second to give the illusion of continuous motion. In most of the television systems, the frame repetition rate (scanning frequency) is 25 per second.

For scanning the picture elements, saw tooth potentials can be used. Saw tooth potentials are produced by using a unijunction transistor and a R-C network. Saw tooth potentials are applied to horizontal and vertical deflector plates in a TV camera. When the saw tooth potential is applied to the horizontal plates called line synchronising pulse, the electron beam at A travels along a slanting line AB by the voltage variation of OM and reaches the point B (Fig a and b). From B, the scanning spot travels along a line BC by the voltage variation MN.

In order that no picture should be scanned during the return journey (i.e. the beam from the right horizontal end to the beginning of the next line), a blanking pulse, which is a high negative potential, is applied to the control grid of electron gun during the duration of the return journey. This prevents the emission of electrons from electron gun.

Then the electron beam starts to scan the next line and the process gets repeated till the whole picture is scanned. On reaching the right bottom corner, the scanning spot quickly moves up to the top left corner by the application of saw tooth potential to the vertical deflector plates, called frame synchronising pulse. Thus for scanning the picture, the three synchronising pulses are used.

These synchronising pulses along with the output of the TV camera are modulated on an ultra-high frequency carrier and transmitted. The accompanying sound is frequency modulated and transmitted via the same antenna.

Interlaced scanning

In India, the frame repetition rate has been standardised at 25 frames per second. This repetition rate is enough to cause an illusion of continuity. But, the brightness of one frame blends (mix) smoothly into the next, through this time when the screen is blanked between successive frames. This results in definite flicker of light, that is very annoying to the observer, when the screen becomes alternatively bright and dark. To eliminate this flicker, each frame is scanned twice.

In this scanning, the total number lines are divided into two groups called fields. During the presentation of the first field, only the odd numbered lines are scanned, while during the second field all the even numbered lines are scanned.

Half way along the bottom of the first field, the vertical retrace returns the scanning beam to the top of the image and completes the unfinished lines. The remaining even numbered lines are then scanned during second field. This method of scanning is known as interlaced scanning. In the 625-line TV system, for successful interlaced scanning, the 625 lines of each frame or picture are divided into sets of 312.5 lines and each set is scanned alternatively to cover the entire picture area. The principle of interlaced scanning is shown in Fig.

Hence, with the interlaced scanning the flicker effect is eliminated without increasing the speed of scanning, which in turn does not need any increase in channel bandwidth.

Horizontal and vertical scanning frequencies

The movement of electron beam spot from left to right and back, so as to start a new line in the same direction is termed as horizontal scanning. The horizontal scanning frequency is defined as the number of lines scanned per second. In a 625-line system, transmitting 25 frames per second, the horizontal frequency is 15,625 Hz.

Vertical scanning is the movement of the electron beam spot in the vertical direction. One frame consists of two fields, resulting into 50 fields per second with a vertical field scan time of 1/50=20ms.

LCD colour television

Liquid-crystal-display televisions (LCD TVs) are television sets that use liquid-crystal displays to produce images. They are, by far, the most widely produced and sold television display type. LCD TVs are thin and light, but have some disadvantages compared to other display types such as high power consumption, poorer contrast ratio, and inferior colour gamut.

LCD TVs rose in popularity in the early years of the 21st century, surpassing sales of cathode ray tube televisions worldwide in 2007. Sales of CRT TVs dropped rapidly after that, as did sales of competing technologies such as plasma display panels and rear-projection television.

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as pre-set words, digits, and seven-segment displays, as in a digital clock.

They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the colour of the backlight, and a character negative LCD will have a black background with the letters being of the same colour as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance.

LCDs are used in a wide range of applications, including LCD televisions, computer monitors, instrument panels, aircraft cockpit displays, and indoor and outdoor signage. Small LCD screens are common in LCD projectors and portable consumer devices such as digital cameras, watches, digital clocks, calculators, and mobile telephones, including smartphones.

LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks. LCD screens have replaced heavy, bulky cathode ray tube (CRT) displays in nearly all applications. LCD screens are available in a wider range of screen sizes than CRT and plasma displays, with LCD screens available in sizes ranging from tiny digital watches to very large television receivers. LCDs are slowly being replaced by OLEDs, which can be easily made into different shapes, and have a lower response time, wider colour gamut, virtually infinite colour contrast and viewing angles, lower weight for a given display size and a slimmer profile (because OLEDs use a single glass or plastic panel whereas LCDs use two glass panels.

The thickness of the panels increases with size but the increase is more noticeable on LCDs) and potentially lower power consumption (as the display is only "on" where needed and there is no backlight). OLEDs, however, are more expensive for a given display size due to the very expensive electroluminescent materials or phosphors that they use.

Also due to the use of phosphors, OLEDs suffer from screen burn-in and there is currently no way to recycle OLED displays, whereas LCD panels can be recycled, although the technology required to recycle LCDs is not yet widespread. performance to an OLED display, but the quantum dot layer that gives these displays their characteristics cannot yet be recycled.

Unit -4
Satellite and Communications

Satellite Communication
Satellites communicate by using radio waves to send signals to the antennas on the Earth. The antennas then capture those signals and process the information coming from those signals.

Principle of Satellites
The fundamental principle to be understood concerning satellites is that a satellite is a projectile. A satellite is an object upon which the only force is gravity. Once launched into an orbit, the only force governing the motion of a satellite is the force of gravity

Types of Satellites
There are two different types of satellites – natural and man-made. Examples of natural satellites are the Earth and Moon. The Earth rotates around the Sun and the Moon rotates around the Earth.

A man-made satellite is a machine that is launched into space and orbits around a body in space

- Communications Satellite.
- Remote Sensing Satellite.
- Navigation Satellite.
- Geocentric Orbit type satellites - LEO, MEO, HEO.
- Global Positioning System (GPS)
- Geostationary Satellites (GEOs)
- Drone Satellite.

Ground Satellite
Satellite communications play a vital role in the global telecommunications system. Approximately 2,000 artificial satellites orbiting Earth relay analog and digital signals carrying voice, video, and data to and from one or many locations worldwide.

Television. Satellites send television signals directly to homes, but they also are the backbone of cable and network TV. ...

- Telephones. ...
- Navigation. ...
- Business & finance. ...
- Weather. ...
- Climate & environmental monitoring. ...
- Safety. ...
- Land stewardship.

Advantages of Satellite Communication

There are three types of communication service
that satellites provide: telecommunications, broadcasting, and
data communications

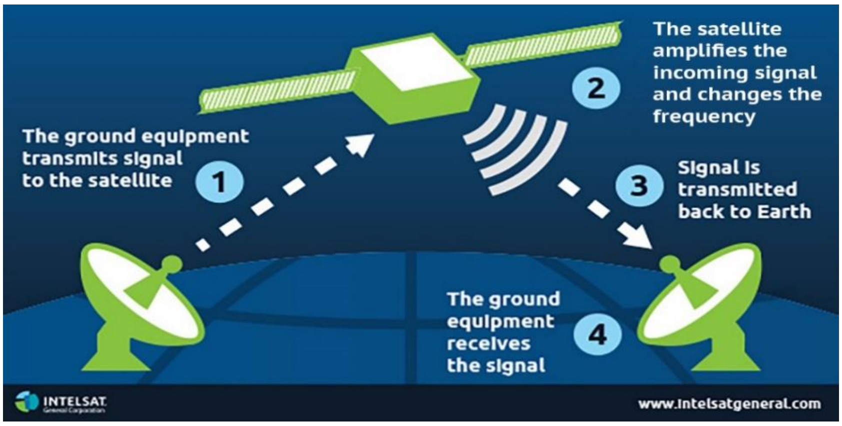
- Connecting remote assets. ...
- Driving the use of sensor networks. ...
- Transforming transportation infrastructure. ...
- Developing sustainable cities. ...
- Facilitating mobile banking and retail. ...
- Reliability. ...
- Ubiquitous coverage. ...
- Speed.

Ground Station

Satellites communicate by using radio waves to send signals to the antennas on the Earth. The antennas then capture those signals and process the information coming from those signals. Information can include, where the satellite is currently located in space.

Repeater is a circuit which increases the strength of the received signal and then transmits it. It changes the frequency band of the transmitted signal from the received one.so the repeater is called as a transponder. The frequency with which the signal is sent into the space is called as uplink frequency.

Similarly, the frequency with which the signal is sent by the transponder is called as Downlink frequency. The process of satellite communication begins at an earth station. Here an installation is designed to transmit and receive the signals from a satellite in an orbit around the earth.



Space ground systems are made up of several primary components including Ground Stations Mission. Centres, Ground Networks, Remote Infrastructure, and Launch Facilities.

Antenna angle of elevation and transmission path

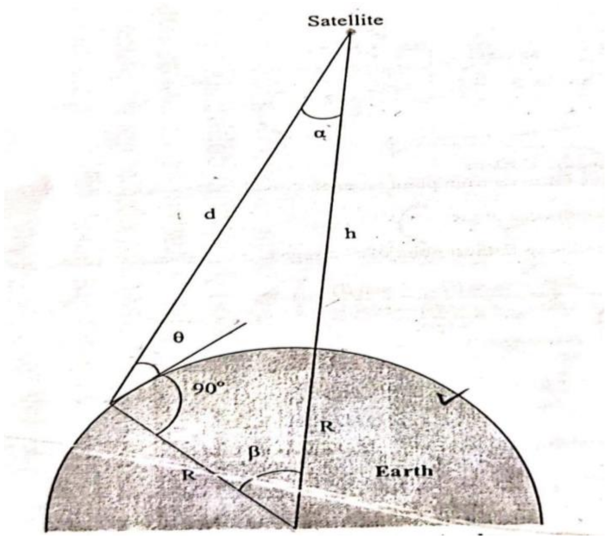
To determine the coverage area of a satellite, the elevation angle ɵ of the Earth station to be calculate. When the antenna is pointed directly at the satellite, then the angle from the horizontal line to the point on the center of the main beam of the antenna is called the angle of elevation.

Angle of elevation of 0 degree yields the maximum coverage of the earth. For downlinks, the elevation angle is about 5 to 20 degree which depends upon the frequency.

The factors that affect the choice of minimum elevation angle include the following:

- Buildings, trees, and other terrestrial objects that would block the line of sight. These may result in attenuation of the signal by absorption or in distortion due to multipath reflection

- Atmospheric attenuation is greater at low elevation angles because the signal travels the atmosphere for longer distances when the elevation angle is smaller.
- Electrical noise generated by the earth's heat near its surface adversely affects reception.



Satellite coverage area

These components work together to enable management of spacecraft, payload data, and telemetry. Satellite communication has two main components: the ground segment, which consists of fixed or mobile transmission, reception, and ancillary equipment, and the space segment, which primarily is the satellite itself.

Geometric Coverage Area

It would be possible to provide complete radio coverage of the world from just three satellites, provided that they could be precisely placed in geosynchronous orbit.

The amount of coverage is an important feature in the design of earth observation satellites. Coverage depends on altitude and look angles of the equipment, among several factors. To establish the geometric relationship of the coverage

The maximum geometric coverage can then be defined as the portion of the earth within a cone of the satellite at its apex, which is tangential to the earth's surface. Consider the angle of view from the satellite to the earth terminal as a; then the apex angle is 2a. An antenna of 18○ or 19○ beam width is used to allow for directional misalignment. Thus, for a single geostationary satellite to illuminate in excess of a third of the earth's surface, the antenna minimum beam width must be at least 2a.

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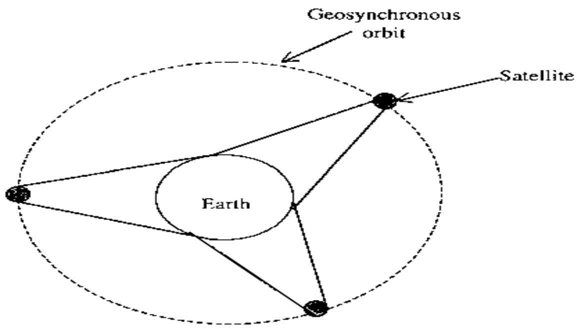
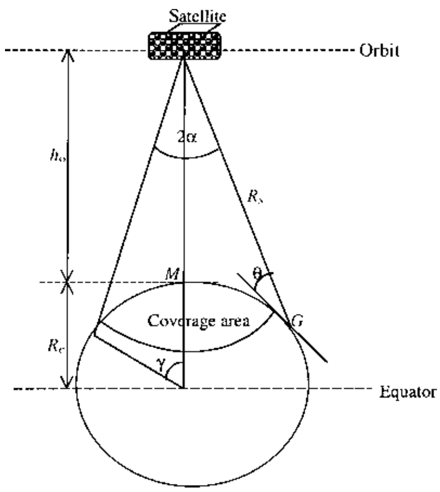




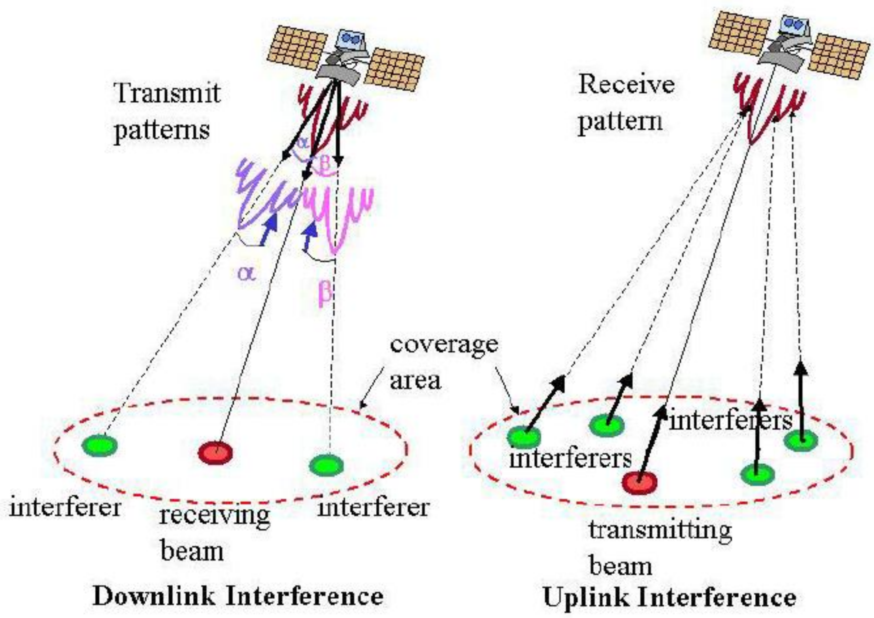
The beam width of the satellite antennas determines the area of the earth serviced or covered. The beam width required directly determines the antenna gain and, for a given operating frequency, the physical size of the antenna aperture

Using the notations in as a guide, the coverage area Ace from which the satellite is visible with an elevation angle of at least y.
where g is the central angle. It is a spherical trigonometric relation that relates to the earth and satellite coordinates.

Satellite Constellation

A constellation is a group of similar satellites working together in partnership to provide a network of useful service. The constellation (or configuration) of satellites in the LEO system is designed to function as a network primarily to get more or better coverage.

Each satellite in an orbital plane maintains its position in relation to the other satellites in the plane. Each satellite in an LEO constellation, for example, acts as a switching node and is connected to nearby satellites by anti-satellite links.



An example is the two LEOs cross-linked in These links route information received from a user terminal or a network of user terminals through the satellite network and eventually toward a gateway to an earth-based network or a mobile user.

Each satellite node implements signalling and control functions that set up and release connections. It is worth noting that the signalling protocol used when satellite systems are constellated is similar to the standard public-switched telephone network integrated services digital network and SS7 protocol for cellular mobile systems.

Typical examples of satellite constellation are the U.S Defence satellite operational network called FLTSATCOM (Fleet satellite communications system) and SBIRS (Space-based infrared system) and the Iridium and Telegenic networks, which provide global mobile
telephone and paging services.

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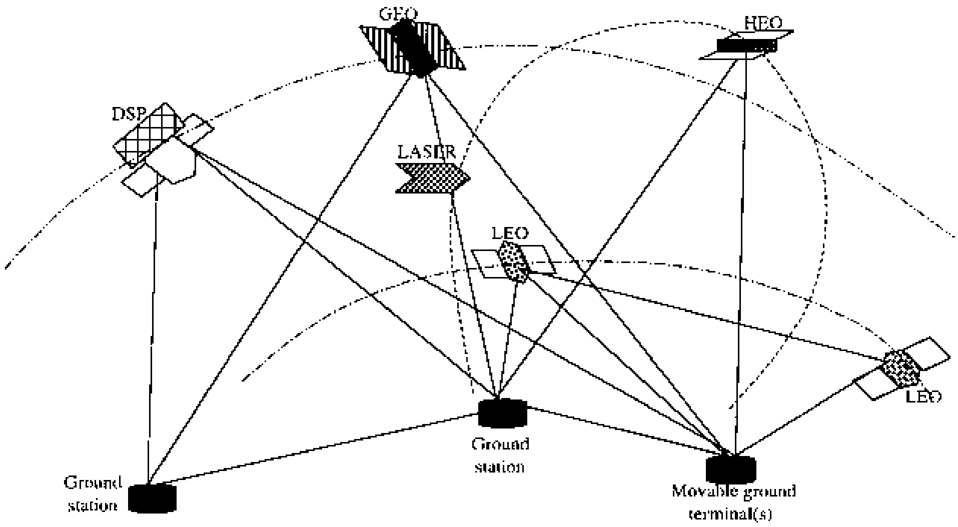

FLTSATCOM provides worldwide communications for the U.S. Navy and Air Force units, except for the polar regions. FLTSATCOM comprises four satellites. Each satellite is injected into a near-geosynchronous equatorial orbit.

Each satellite overlaps in coverage with the adjacent satellite, thereby avoiding any gap in space-segment continuity. The coverage is between the latitudes of 70○N and 70○S. The fleet constitutes the primary Navy's broadcast and ship interchange communications system. It also provides vital communications to the Allied Forces worldwide.

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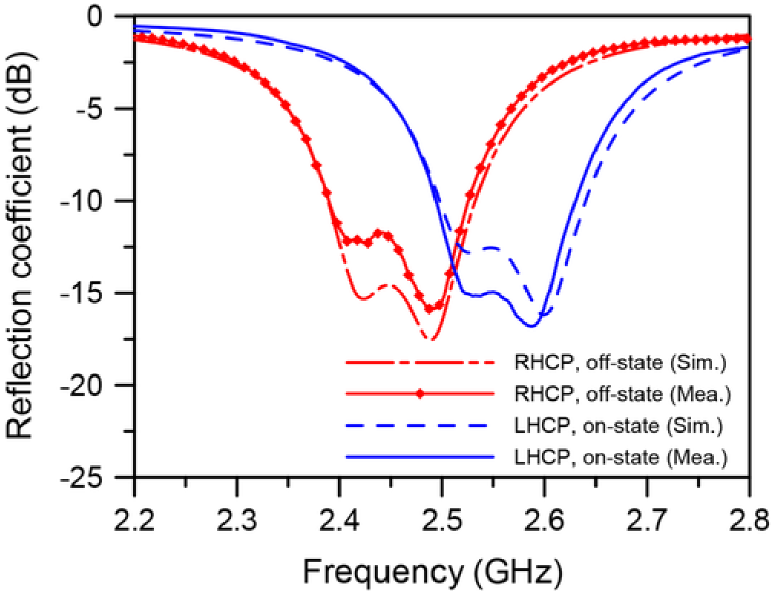


Height of the Geocentric orbit

A satellite placed at a definite height directly above the Earth's equator and revolves in the same direction as the Earth rotates; so that its orbital time period is same as the Earth's rotation period (24 hours), is called a Geo-stationary satellite.

The observer at the equator views the satellite as stationary, hence such types of satellites are also called geosynchronous satellites. These are used for communication, radio broadcasting, universe related studies & researches and gathering weather information. Communication satellite is also a Geo-stationary satellite.

We know the time period of a satellite,

$$T = GM2\pi r3/2$$

$$\therefore r = [4\pi 2GMT2]1/3 \qquad \ldots(1)$$

Putting $G=6.67\times 10-11Nm2/kg2$, mass of Earth $M=6\times 1024kg$, time period $T=24$ hours in above equation.

Orbital radius of the satellite from the equation (1) by putting all values;

$r = 4.2\times 104=42000km$

but $r = R+h$

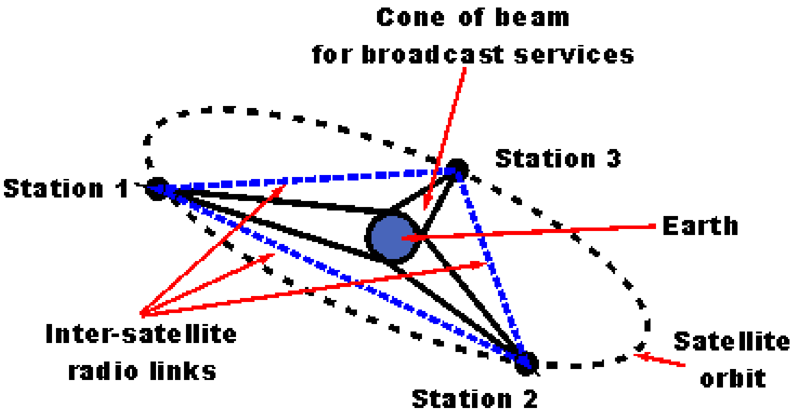
Hence, height of the satellite from the surface of the Earth;

$h = r - R$

$h = 42000km - 6400km$

or $h \approx 36000km$

Hence, the height of a geo-stationary from the Earth's surface is approximately 36000km



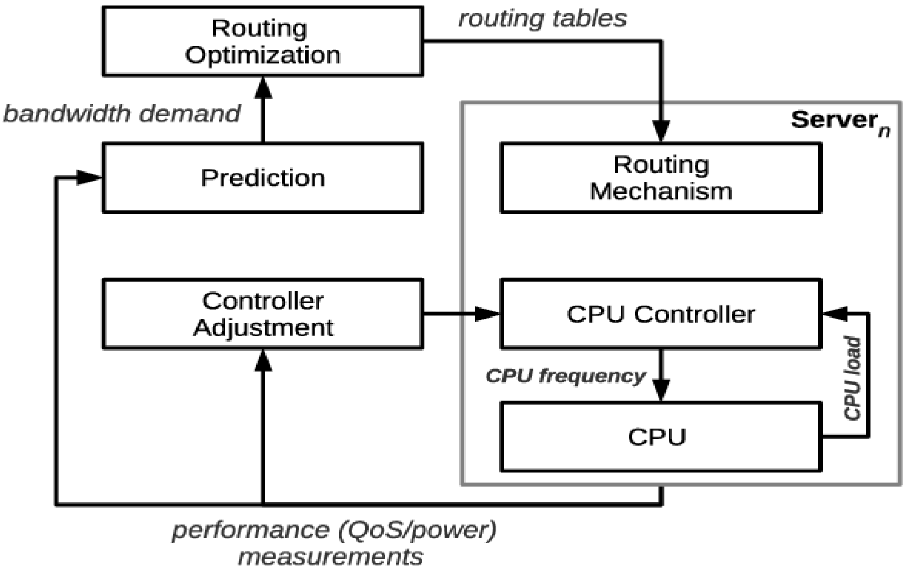
only 31 part of the Earth. Hence, to broadcast information throughout the Earth minimum three satellites are necessary. Any communication satellite (geostationary) cannot be placed over India's capital New Delhi because it will not be in equatorial line.

A slightly higher orbit might take 100 minutes instead of 90. For a geosynchronous orbit, the orbit has to take 24 hours instead of 90 minutes, because the earth takes 24 hours to spin. This happens when the circle is expanded to an altitude of about 35000 km.

While geosynchronous satellites can have any inclination, the key difference to geostationary orbit is the fact that they lie on the same plane as the equator. Geostationary orbits fall in the same category as geosynchronous orbits, but it's parked over the equator.

Geostationary communication satellites are useful because they are visible from a large area of the earth's surface, extending 81° away in both latitude and longitude. They appear stationary in the sky, which eliminates the need for ground stations to have movable antennas.

Block diagram of network control station



Network Control Station which provides services such as management of satellite terminals' channel requirement and network access, remote management of satellite terminals for land, sea and air satellite communication system, offers a switching infrastructure for the communication configurations of satellite terminals. A Networked Control System (NCS) is a control system wherein the control loops are closed through a communication network.

The defining feature of an NCS is that control and feedback signals are exchanged among the system's components in the form of information packages through a network.

A network is a collection of computers servers, mainframes, network devices, peripherals, or other devices connected to one another to allow the sharing of data. An example of a network is the Internet, which connects millions of people all over the world.

At its core, network maintenance constitutes all the tasks and systems in place to monitor, update and run your organization's computer network before problems strike.

Some of the more common network maintenance tasks include, but are not limited to, the following general activities: Installing, replacing or upgrading both hardware and software. Monitoring, tuning and optimizing the network.

Documenting the network and maintaining network documentation.
There are two approaches to network maintenance: Interrupt Driven and Structured. Interrupt Driven is the most basic method of performing network maintenance and is more prevalent in smaller networks while a structured approach more involved and is more prevalent in larger networks.

Maintaining your computer network is important because there are many factors that can go wrong on a daily basis. Regular maintenance can keep the big problems away, while helping to maintain your networks optimal performance.

The main functions of network management include configuration (of equipment and connections in the network), performance monitoring, and fault management. In addition, security and accounting are also management functions.

Common tasks that you will perform to ensure these goals include installing and maintaining networking hardware and software. assigning names and addresses to each computer and device on the network. assigning names and identification numbers (IDs) to network users and groups.

These operational areas are fault management, configuration management, accounting management, performance management and security management, also known as FCAPS. Each network management sub discipline incorporates several operational elements. Here is a rundown of the different types of network management.

A radio net is three or more radio stations communicating with each other on a common. A net is essentially a moderated conference call conducted over two-way radio, typically in half-duplex operating conditions.

The use of half-duplex operation requires a very particular set of operating procedures to be followed in order to avoid inefficiencies and chaos.

Nets operate either on schedule or continuously (continuous watch). Nets operating on schedule handle traffic only at definite, prearranged times and in accordance with a prearranged schedule of intercommunication.

Nets operating continuously are prepared to handle traffic at any time; they maintain operators on duty at all stations in the net at all times. When practicable, messages relating to schedules will be transmitted by a means of signal communication other than radio.

Unit – 5

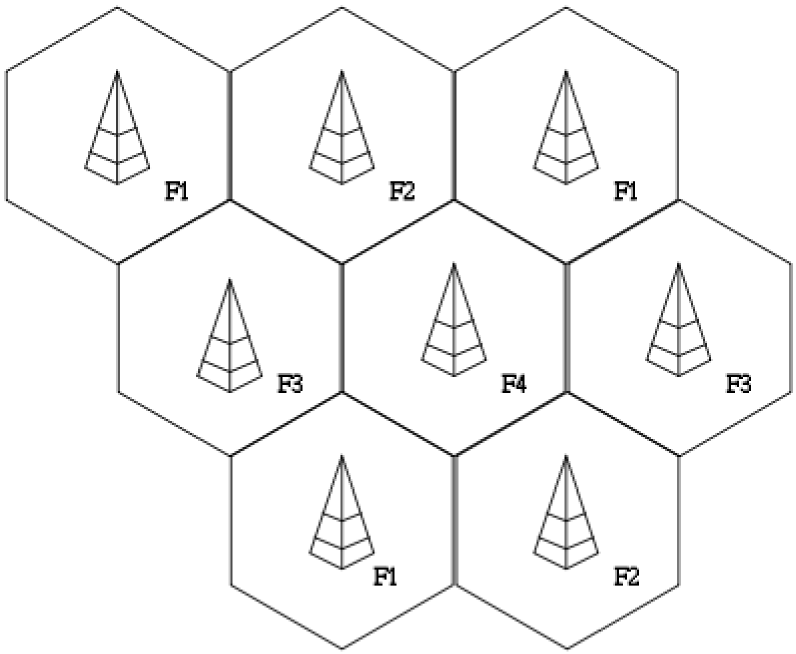
Cellular Communication

Basic idea of Cellular network

A cellular network or mobile network is a communication network where the last link is wireless. The network is distributed over land areas called "cells", each served by at least one fixed-location transceiver, but more normally, three cell sites or base transceiver stations.

Cellular communication is a form of communication technology that enables the use of mobile phones. A mobile phone is a bidirectional radio that enables simultaneous transmission and reception.

Cellular communication is based on the geographic division of the communication coverage area into cells, and within cells. In multicellular organisms, cells send and receive chemical messages constantly to coordinate the actions of distant organs, tissues, and cells. The ability to send messages quickly and efficiently enables cells to coordinate and fine-tune their functions.



Operational principle of WDM

Wave Division Multiplexing (WDM) is an optical transport technology that divides existing dark fibre into multiple channels of traffic to simultaneously transport several streams of data, increasing the number of lanes on a highway to make the flow of traffic more efficient.

Wavelength division multiplexing (WDM) is a technology or technique modulating numerous data streams, i.e. optical carrier signals of varying wavelengths of laser light, onto a single optical fibre. WDM enables bi-directional communication as well as multiplication of signal capacity.

Since the spectral width of a high-quality source occupies only a narrow slice of optical bandwidth, there are many independent operating regions across the spectrum, ranging from the a-band through the L-band, that can be used simultaneously. The original use of WDM was to upgrade the capacity of installed point-to-point transmission links.

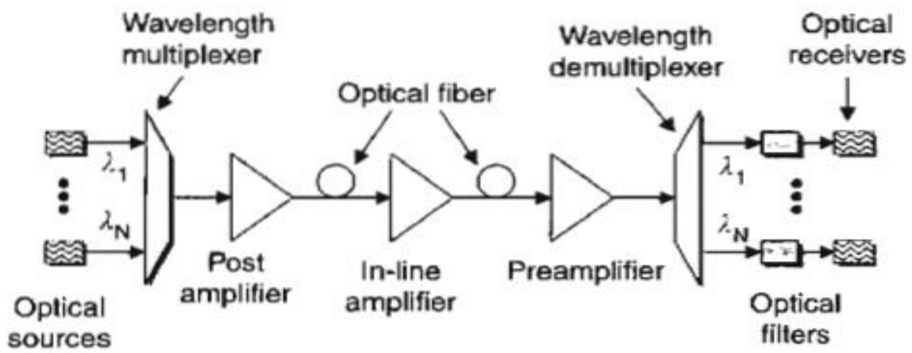
This was achieved with wavelengths that were separated from several tens up to 200 nm in order not to impose strict wavelength-tolerance requirements on the different laser sources and the receiving wavelength splitters. Subsequently, the development of lasers that have extremely narrow spectra emission widths allowed wavelengths to be spaced less than a nanometre apart.

This is the basis of wavelength-division multiplexing, which simultaneously uses a number of light sources, each emitting at a slightly different peak wavelength. Each wavelength carries an independent signal, so that the link capacity is increased greatly.

The main trick is to ensure that the peak wavelength of a source is spaced sufficiently far from its neighbour so as not to create interference between their spectral extents. Equally important is the requirement that during the operation of a system these peak wavelengths do not drift into the spectral territory occupied by adjacent channels.

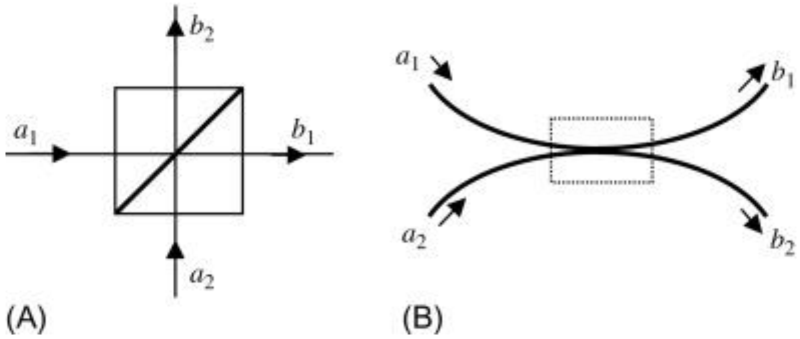
In addition to maintaining strict control of the wavelength, system designers include an empty guard band between the channels as an operations safety factor. Thereby the fidelities of the independent messages from each source are maintained for subsequent conversion to electrical signals at the receiving end.

Below fig. shows the implementation of a simple WDM link. The transmitting side has a series of independently modulated fixed-wavelength light sources, each of which emits signals at a unique wavelength. Here a multiplexer (popularly called a mux) is needed to combine these optical outputs into a continuous spectrum of signals and couple them onto a single fibre. Within a standard telecommunication link there may be various types of optical amplifiers, a variety of specialized active



2 × 2 optical couplers

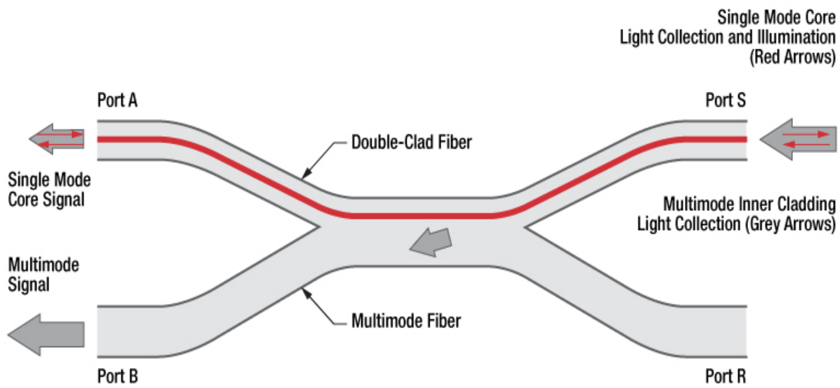
2 × 2 optical couplers as an example for the discussion of design principles and basic parameters. This section will present the general optical field transfer function of a 2 × 2 optical couplers. To be general, a 2 × 2 optical couplers is a 4-terminal device which can be either free space or made by all-fibre, both having two input ports and two output ports as illustrated in Fig.



In the FBT process the cores of two identical parallel fibres are so close to one another that the evanescent wave can "leak" from one fibre core into the other core. This allows an exchange of energy, analogous to the energy exchange that takes place with two coupled pendulums.

A fibre optic coupler is a device used in optical fibre systems with one or more input fibres and one or several output fibres. Light entering an input fibre can appear at one or more outputs and its power distribution potentially depending on the wavelength and polarization.

Coupling ratio is calculated from the measured insertion loss. Coupling ratio (in %) is the ratio of the optical power from each output port (A and B) to the sum of the total power of both output ports as a function of wavelength.



the most common method for manufacturing couplers is the fused conical taper (FBT) technique. In this method the fibres are generally twisted together and then spot fused under tension such that the fused section is elongated to form a biotical taper structure. A fibre optic coupler is a device used in optical fibre systems with one or more input fibres and one or several output fibres. Light entering an input fibre can appear at one or more outputs and its power distribution potentially depending on the wavelength and polarization.

Fibre grating filters

A fibre Bragg grating (FBG) is a type of distributed Bragg reflector constructed in a short segment of optical fibre that reflects particular wavelengths of light and transmits all others. Fibre Bragg Gratings are made by laterally exposing the core of a single-mode fibre to a periodic pattern of intense laser light.

All the reflected light signals combine coherently to one large reflection at a particular wavelength when the grating period is approximately half the input light's wavelength. A fibre Bragg grating (FBG) is a microstructure typically a few millimetres in length that can be photo inscribed in the core of a single mode fibre.

This is done by transversely illuminating the fibre with a UV laser beam and using a phase mask to generate an interference pattern in its core. A grating is called an SPG when the period of the grating is less than the optical wavelength, which is on the order of 1.3–1.6 μm. For typical SPG, the period of the grating is $\Lambda = 0.5$ μm. In this grating structure, the interaction of light takes place with a periodic structure, as shown in Fig. Using a diffraction grating provides more slits, which increases the interference between the beams. By using more slits, you get more destructive interference. The maxima on the other hand become much brighter because of increased constructive interference.

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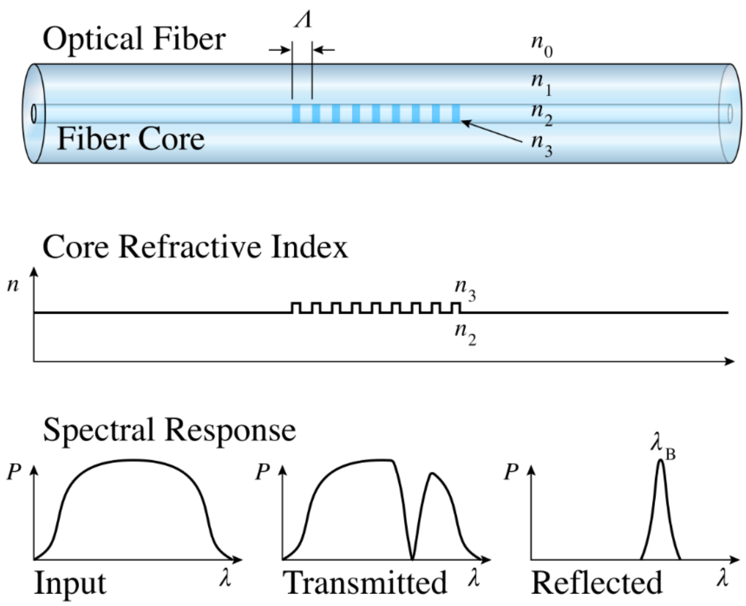
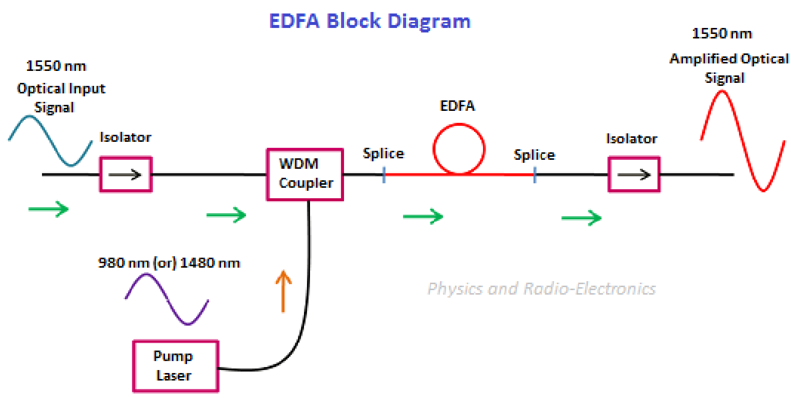


Erbium-Doped Fibre Amplifier (EDFA)

Erbium-Doped Fibre Amplifier (EDFA) is an optical amplifier used in the C-band and L-band, where loss of telecom optical fibres becomes lowest in the entire optical telecommunication wavelength bands. A typical distance between each of the EDFAs is several tens of kilometres.

Erbium-doped fibre amplifier (EDFA) is an optical repeater device that is used to boost the intensity of optical signals being carried through a fibre optic communications system.

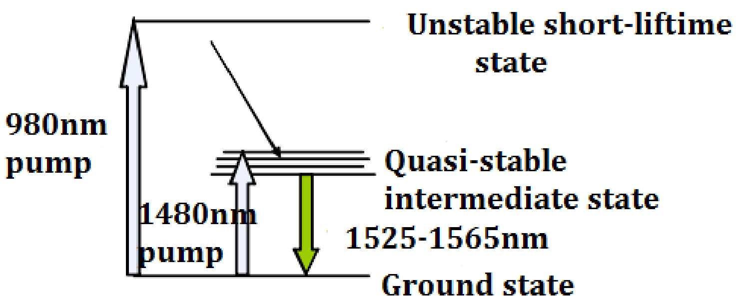
A higher power efficiency can be achieved by in-band pumping around 1450 nm. However, stimulated emission by pump light then limits the achievable excitation level, hence also the gain per unit length, and the maximum gain occurs at longer wavelengths. The noise figure will also be higher. In general, EDFA works on the principle of stimulating the emission of photons. With EDFA, an erbium-doped optical fibre at the core is pumped with light from laser diodes. ... Pump lasers, known as pumping bands, insert dopants into the silica fibre, resulting in a gain, or amplification



In general, EDFA works on the principle of stimulating the emission of photons. With EDFA, an erbium-doped optical fibre at the core is pumped with light from laser diodes.

This type of setup in telecom systems can help with fibre communications, for example, boosting the power of a data transmitter. The erbium-doped fibre (EDF) is at the core of EDFA technology, which is a conventional silica fibre doped with Erbium. When the Erbium is illuminated with light energy at a suitable wavelength (either 980 nm or 1480 nm), it is motivated to a long-lifetime intermediate state, then it decays back to the ground state by emitting light within the 1525-1565 nm band.

The Erbium can be either pumped by 980 nm light, in which case it passes through an unstable short lifetime state before rapidly decaying to a quasi-stable state, or by 1480 nm light in which case it is directly excited to the quasi-stable state. Once in the quasi-stable state, it decays to the ground state by emitting light in the 1525-1565 nm band. This decay process can be stimulated by pre-existing light, thus resulting in amplification. EDFA working principle is shown in the fig.



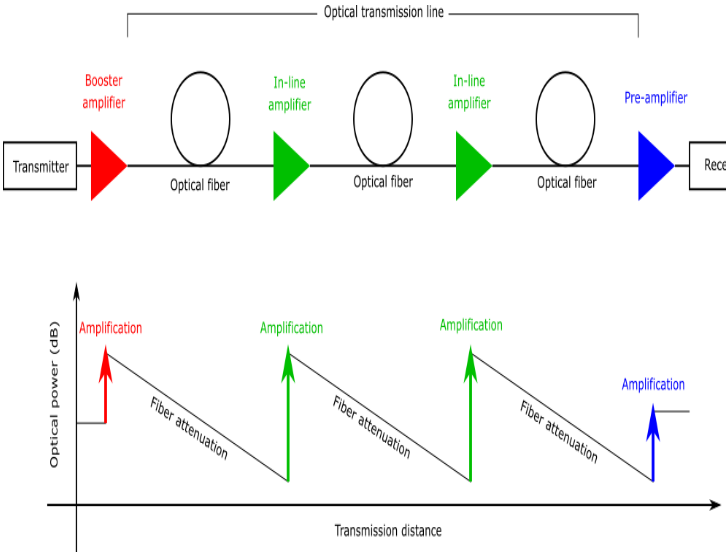
EDFA Architecture

EDFA consists of an erbium-doped fibre, one or more pump lasers, a wavelength division multiplexer, and optical isolators, as shown in Fig. 1 Multiplexer handles either 980/1550-nm or1480/1550-nm wavelength combinations to couple both the pump and signal optical power efficiently into the fibre amplifier.

Erbium-Doped Fibre Amplifier (EDFA) is an optical amplifier used in the C-band and L-band, where loss of telecom optical fibres becomes lowest in the entire optical telecommunication wavelength bands.

EDFA is now most commonly used to compensate the loss of an optical fibre in long-distance optical communication. Another important characteristic is that EDFA can amplify multiple optical signals simultaneously, and thus can be easily combined with WDM technology. EDFAs are used as a booster, inline, and pre-amplifier in an optical transmission line. The booster amplifier is placed just after the transmitter to increase the optical power launched to the transmission line.

The inline amplifiers are placed in the transmission line, compensating the attenuation induced by the optical fibre. The pre-amplifier is placed just before the receiver; such that sufficient optical power is launched to the receiver. A typical distance between each of the EDFAs is several tens of kilometres.



When an EDFA is pumped at 1480 nm, err ion doped in the fibre absorbs the pump light and is excited to an excited state (Excited state 1 in Figure 3). When sufficient pump power is launched to the fibre and population inversion is created between the ground state and Excited state 1, amplification by stimulated emission takes place at around 1550 nm. When an EDFA is pumped at 980 nm, err ion absorbs the pump light and is excited to another excited state.

The lifetime of the Excited state 2 is relatively short, and as a result, the Err ion is immediately relaxed to the Excited state 1 by radiating heat (i.e. no photon emission). This relaxation process creates a population inversion between the ground level and Excited state 1, and amplification takes place at around 1550 nm.

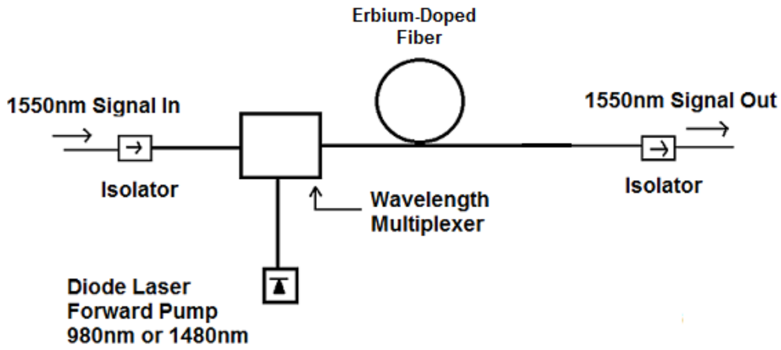
Since the first demonstration of a diode-pumped EDFA intensive effort has been made to make the pump LD highly reliable. Now high-power pump laser diodes at 980 nm or 1480 nm are both commercially available, and most EDFAs are pumped by laser diodes due to the compactness and robustness.

Performance of WDM+EDFA system

A key mechanism for Wavelength Division Multiplexing (WDM) implementation in optical network systems is gain flatness of Erbium-Doped fibre Amplifier (EDFA). The main intention of this paper is to correct the non-uniformity in the gain for every single channel so that the amplitude gain of the Wavelength Division Multiplexing (WDM) arrangement can be equalized.

The software used in this paper is Opt system 13 so as to accomplish gain flatness of EDFA. The gains are flattened inside 27dB from 1546nm to 1568nm group of wavelength with noise figure < 14dB and we have also seen the effect of various pumping techniques on gain and noise figure. A

WDM system arrangement that includes an EDFA is modelled and obtained maximum uniformed gains.



As shown in the Fig, two pump wavelengths can be utilized for EDFA i.e. 980nm and 1480nm. With 980nm pumping wavelength the Er3+ ions in the ground state (E1) are excited to the excited state (E3). The rate of transition from ground state to the excited state depends upon the pump power. The ions in the excited state are not going to stay there for a long period and decays back to the meta-stable state and then plummet back to the ground state after 14 approximately 10ms and emits photon. This is called spontaneous emission.

But photons generated in this spontaneous process are treated as noise as the photons are non-polarized and incoherent across time and space. But after the ions or photons that are in the metastable state event alongside light photons of suitable wavelength, they plummet back to the ground state emitting photons having same phase, frequency and polarization and travel in the same direction as the photons of the incident wave. This is called stimulated emission.

In this procedure one photon gives two photons at the output. Hence multiplication of photons occurs and several number of photons subjected at the input generates huge number of photons at the output that increases the light intensity that we call gain and it amplifies the input signal. With 1480nm the ions in the ground state excited undeviating

References

1. M.Schwaiirts, W.R Bannet 1996 Communication systems and techniques, Hill- New Delhi
2. S.D. Personick 2007 Fiber optics technology and applications, Khanna publishers, New Delhi.
3. J.Milliman & C.Halkias Tata 2001 Electronic devices and circuits, McGraw Hill- New Delhi.
4. D.Roddy and Coolen 2005 Electronics communication, Prentice, Hall Ltd

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1. https://scihub.wikicn.top/