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Importance of Microwave Antenna in Communication System

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ABSTRACT: This paper provide various types of information about microwave antenna in communication system. Antenna plays a crucial role in this communication system, which is used to transmit and receive the data. The classification of the antenna is based on the specifications like frequency, polarization, radiation, etc. In this we will observe some important point about microwave antenna in communication network, relay stations, transmission system, interconnection cable and inter-operations performing as an integrated whole.

KEYWORDS: Microwave Antenna, Types of Antenna, Properties of Antenna, Applications of Antenna.

I. INTRODUCTION

The main purpose of this research to help people know many things about microwave antenna use in communication system. 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.

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.

The next higher part of the radio electromagnetic spectrum, where the frequencies are above 30 ghz and below 100 ghz, are called "millimeter waves" because their wavelengths are conveniently measured in millimeters, and their wavelengths range from 10 mm down to 3.0 mm (Higher frequency waves are smaller in wavelength). Radio waves in this band are usually strongly attenuated by the Earthly atmosphere and particles contained in it, especially during wet weather. Also, in wide band of frequencies around 60 ghz, the radio waves 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.

The effects of atmospheric stratification cause the radio path to bend downward in a typical situation so a major distance is possible as the earth equivalent curvature increases from 6370 km to about 8500 km (a 4/3 equivalent radius effect). Rare events of temperature, humidity and pressure profile versus height, may produce large deviations and distortion of the propagation and affect transmission quality. High intensity rain and snow making rain fade must also be considered as an impairment factor, especially at frequencies above 10 ghz. All previous factors, collectively known as path loss, make it necessary to compute suitable power margins, in order to maintain the link operative for a high percentage of time, like the standard 99.99% or 99.999% used in 'carrier class' services of most telecommunication operators.

II. TYPES OF MICROWAVE ANTENNA

1. Micro Strip Patch Antenna

Micro strip patch antenna
These antennas are also known as patch antennas. A micro strip patch antenna consists of a radiating patch that is bonded to a dielectric substrate on one side and has a ground plane on the other side.

The patch is generally composed of conducting materials like copper or gold. The operational frequency of these antennas range between 100 MHz and 100 GHz. Due to the advantages like less weight, low volume and low fabrication cost, these antennas can be manufactured in large quantities.

The micro strip patch antennas are well-known for their performance and extent of usage. The usage of micro strip antennas in the wide range could take over the usage of conventional antennas in applications.
There are several applications that use the micro-strip patch antennas, such as global positing satellites, cellular phones, personal communication system and paging devices.

2. Horn Antenna

The Horn antenna or Microwave Horn is an antenna consisting of a waveguide whose end walls are flared outside to form a megaphone like structure, as shown in the below figure. These horns are widely used as antennas at ultra-high frequencies and microwave frequencies that are well above 300 MHz.

These are used to measure the gain of other antennas as calibrating antennas and directive antennas for devices like automatic door openers and microwave-radio meters.

The advantages of the horn antenna include moderate directivity, low-standing wave ratio and broad bandwidth. The gain of horn antenna ranges upto 25 db.These are extensively used at microwave frequency when the power gain needed is moderate.

3. Parabolic antenna

A parabola antenna is an antenna that uses a parabolic reflector, a curved surface with cross sectional shape of a parabola to direct the radio waves. The shape of the antenna is in the form of a dish; therefore, it is popularly known as dish antenna or parabolic dish. High directivity is the main advantage of the parabolic antenna.

Parabolic antenna
These antennas find their applications as high gain antennas for point-to-point communication and also as radio telescopes. In addition to this, the parabolic antennas are also used as radar antennas because in radars there is a need for transmitting a narrow beam of radio waves to local objects like ships, airplanes, etc.

4. MIMO antenna

In radio, multiple inputs and multiple outputs or MIMO are used, and therefore, the multiple antennas are used at both the transmitter and receiver ends to improve communication’s performance. It is one of the smart antenna technologies.
MIMO antenna

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The multiple antennas in MIMO can be exploited in two ways: one is for the creation of highly effective antenna directivity, and the other is for transmitting the parallel data streams to increase the capacity of the system. The applications of the MIMO antennas are mesh networks and RFID systems.

III. MICROWAVE ANTENNA SYSTEMS

Over the past decade microwave links have proven a popular solution for the telecommunication industry. The relative ease and economy of installation has been them deployed in an increasing number of point-to-point applications – from communications backbones (blue), to branch links (white) and distribution networks (light blue), not to mention applications in the broadcast industry and private enterprises. With the rise of new cellular operators and technologies, overall microwave network density is undeniably escalating. Backbone systems are built country wide in a majority of case using a ring structure. In the very seldom case that a link is down the service will remain full operational. The frequencies in use are below 10 GHz allowing link distances up to 50 km with antennas up to 4.5m diameter. Branch links are connected to the backbone towers providing the signal to main areas and towns. The frequencies in use are up to 20 GHz providing links up to 20 km with medium size antennas. Distribution links using frequencies above 22 GHz with small antennas are completing the network. Yet this intensification of microwave communications brings added challenge. The greater the number of point-to-point links in a given area, the greater the potential for these to interact with one another and cause interference. Since any distortion of the signal reduces the quality of service, controlling interferences is now the mandate of any radio network operator and national authority. The key issue for consideration is the design and location of the source of the signal – the antenna.

IV. PROPERTIES OF MICROWAVE ANTENNA

- **Half Power Beam Width (HPBW)**

The angle, relative to the main beam axis, between the two directions at which the co-polar pattern is 3 dB below the value on the main beam axis. The values are nominal and stated as the minimum for the frequency band.

- **Gain**

The ratio of the radiation intensity, in the main beam axis to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically. Value measured in dBi. The values are stated for the three frequencies at mid-band as well as at bottom and top of the frequency band. The tolerance for antenna gain is ± 0.2 dB for single polarized antennas. In the case of dual polarized antennas, tolerance is also ± 0.2 dB for the average value of both ports and ± 0.3 dB for each port alone.

- **Front-to-back-ratio (F/B)**

Denotes the highest level of radiation relative to the main beam in an angular zone of 180° ± 40° for all antennas. Tolerance on stated values is 2 dB

- **Cross-polar discrimination (XPD)**

The difference in dB between the co-polarized main beam gain and the cross-polarized signal measured within an angular zone in azimuth of twice the maximum half power beam width of the frequency band. The value is 30 dB minimum for all antennas except where noted.

- **Antenna inter-port isolation (IPI)**

Denotes the ratio in dB of the power level applied to one port of a dual polarized antenna to the power level received in the other input port of the same antenna. The value is 35 dB minimum for all antennas (40 dB respectively 45 dB for UXA antennas).

- **Radiation pattern envelopes (RPE's)**

The envelope represent the worst values of measurements taken on the pattern test range at the three frequencies mid-band, bottom and top of the band, in both copolar and cross polar condition, horizontal and vertical polarized, over the

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full 360° of azimuth. Since the envelope is drawn over the highest peaks out of all measurements actual interference radiation in an operation system will be generally smaller than calculated from the RPE. Tolerance on given values is 3 dB in an angular region of ±100° and 2 dB from 100° to 180°.

- **Survival windspeed**

The antenna sub-system will survive the specified survival windspeed without any permanent deformation or changes of shape. The value is 250 km/h (70 m/sec) for the 1 ft and 2 ft antennas and 200 km/h (56 m/sec) for all other antennas. An additional load of an ice layer of 30 mm radial ice is taken into account. Special 'Windload kits' are available to improve the survival windspeed of all antennas up to 250 km/h.

V. APPLICATIONS OF MICROWAVE ANTENNA

Over the past decade microwave links have proven a popular solution for the telecommunication industry. The relative ease and economy of installation has been them deployed in an increasing number of point-to-point applications – from communications backbones (blue), to branch links (white) and distribution networks (light blue), not to mention applications in the broadcast industry and private enterprises. With the rise of new cellular operators and technologies, overall microwave network density is undeniably escalating. Backbone systems are built country wide in a majority of case using a ring structure. In the very seldom case that a link is down the service will remain full operational. The frequencies in use are below 10 GHz allowing link distances up to 50 km with antennas up to 4.5m diameter. Branch links are connected to the backbone towers providing the signal to main areas and towns. The frequencies in use are up to 20 GHz providing links up to 20 km with medium size antennas. Distribution links using frequencies above 22 GHz with small antennas are completing the network. Yet this intensification of microwave communications brings added challenge. The greater the number of point-to-point links in a given area, the greater the potential for these to interact with one another and cause interference. Since any distortion of the signal reduces the quality of service, controlling interferences is now the mandate of any radio network operator and national authority. The key issue for consideration is the design and location of the source of the signal – the antenna.

- **Radio Link Applications**

In the field of telecommunications, recent years have been marked by the rapid construction of radio link networks for different applications.

- **Radio Link Backbone Systems**

Backbone or back haul systems have been built for mobile operators who want to be independent from Telcos and fixed wire operators. It saves cost for leasing a fixed line and allows a simple upgrade of the network if higher capacity is required. In addition traditional and new telcom's, utilities as well as broadcast organizations are upgrading their networks to offer higher capacities to clients or to upgrade their system from analogue to digital service. Backbone systems usually use large size antennas in frequency bands below 10 GHz.

- **Radio link systems for base station connectivity**

Mobile operators use microwave in about 70% of cases for the connection of base station to base station and base station to switching centers. A very quick and cost effective deployment is mandatory to be successful in a rapidly growing market. This construction process is still a long way from completion. The central issues are higher and more secure network coverage as well as expansion of capacity. Radio link stations can be erected in a large variety of locations, and these all have specific structural and electrical requirements which must be fulfilled by the antenna/waveguide system.

- **Antennas with waveguide installation**

Small antennas (1 and 2 ft) operating in the frequency range above 10 GHz are, as a rule, connected directly to the transmission equipment. Special mechanical and electrical matching ensures that the RF signal passes directly into the radio equipment with the minimum loss. It is not always possible to integrate the antenna and radio equipment due to structural restrictions at the installation site. In this case, as with larger antennas, use is made of flexible waveguide.

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Long connections lead to increased losses. These losses can only be offset in the overall link calculations by using larger antennas or additional amplifier stages in the transmission equipment.

VI. CONCLUSION

We have studied a lot about microwave antenna and how the microwave antenna work and we have also studied about various properties of antenna and application about the microwave antenna. Where we are using in real life and how it is very useful.

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