# A Review Paper on Microwave Transmission using Reflector Antennas

Sandeep Kumar Singh [1],Sumi Kumari[2]
Sr. Lecturer, Dept. of ECE, JBIT, Dehradun [1], Asst. Professor, Dept. of ECE, VGIET, Jaipur[2]
sandy.sandeep005@gmail.com[1] sumisingh216@gmail.com[2]

**Abstract:**
The conventional optimization problem of the beamed microwave energy transmission system is considered. The criterion of maximum efficiency of power intercept is parabolic function of distribution on the transmitting antenna. It is shown that under such a condition of amplitude distribution becomes more uniform than as the unconditional optimization. In this case, we can substantially increase the power radiated by the transmitting antenna losing the power intercept no more than 2%.

**Keywords:** Parabolic Reflector Antenna, Radio Relay, Antenna Gain, Cassegrain Feed.

## I.INTRODUCTION

Microwave radiation is generally defined as that electromagnetic radiation having wavelengths between radio waves and infrared radiation. Microwave radiation can be forced to travel in specially designed waveguides. Microwave radiation can be transmitted through space or through the atmosphere in a microwave beam from a microwave antenna and the microwave energy can be collected with a microwave antenna. Microwave antennas are used for transmitting and receiving microwave radiation. Microwave antennas are usually essential parts of microwave telecommunication systems. Microwave antennas are designed either as broadband antennas or as antennas for a single frequency or band of frequencies. These devices typically comprise an open ended waveguide and a parabolic reflector or horn and they typically transmit a predetermined frequency in a predetermined direction. Microwave antennas are usually equipped with a reflector having a structure of predetermined shape on which is placed a mirror for reflecting microwaves. The structure and the mirror are supported by a frame mainly formed of tubes welded together or of welded or riveted compartments.

## II.MICROWAVE TRANSMISSION

Microwave transmission refers to the technology of transmitting information or power by the use of radio waves whose wavelengths are conveniently measured in small numbers of centimeters; 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.

## III.ANTENNA

An antenna (or aerial) is an electrical device which converts electric currents into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter applies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals, that is applied to a receiver to be amplified.

Fig 1: Folded Diopole Antenna

An antenna can be used for both transmitting and receiving. Antennas are essential components of all equipment that uses radio. They are used in systems such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, wireless microphones, bluetooth enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise.

## IV.PARABOLIC ANTENNA

The parabolic reflector or dish antenna has been used far more widely in recent years with advent of satellite television (TV). However the dish antenna finds uses in many radio and wireless applications at frequencies usually above about 1GHz where very high levels of RF antenna gain are required along with narrow beam widths.In many professional applications these parabolic reflectors or dish antennas are used for satellite as well as for radio astronomy and it is used in many microwave links, often being seen on radio relay towers and mobile phone antenna masts. In all these applications very high levels of gain are required to receive the incoming signals that are often at a very low level. For transmitting this type of RF antenna design is able to concentrate the available radiated power into a narrow beam width, ensuring all the available power is radiated in the required direction.

Fig.2: Parabolic Reflector Antenna

To direct microwaves in narrow beams for point-to-point communication links or radiolocation (radar), a parabolic antenna is usually used. This is an antenna that uses a parabolic reflector to direct the microwaves. To achieve narrow beam widths, the reflector must be much larger than the wavelength of the radio waves. The relatively short wavelength of microwaves allows reasonably sized dishes to exhibit the desired highly directional response for both receiving and transmitting.

## V.BASIC THEORY

The RF antenna consists of a radiating system that is used to illuminate a reflector that is curved in the form of a paraboloid. This shape enables a very accurate beam to be obtained. In this way, the feed system forms the actual radiating section of the antenna, and the reflecting parabolic surface is purely passive. When looking at parabolic reflector antenna systems there are a number of parameters and terms that are of importance:

- **Focus:** The focus or focal point of the parabolic reflector is the point at which any incoming signals are concentrated. When radiating from this point the signals will be reflected by the reflecting surface and travel in a parallel beam and to provide the required gain and beam width.
- **Vertex:** This is the innermost point at the centre of the parabolic reflector.
- **Focal length**: The focal length of a parabolic antenna is the distance from its focus to its vertex.
- **Aperture:** The aperture of a parabolic reflector is what may be termed its "opening" or the area which it covers. For a circular reflector, this is described by its diameter. It can be likened to the aperture of an optical lens.

## VI.FEED SYSTEMS

A parabolic antenna is designed around its feed system The design of the feed system is central to the design of the overall parabolic reflector antenna system. There are two basic forms of feed system that can be used for a parabolic reflector antenna:

**Focal point feed system**: Using a focal point feed system the source of the radiation is placed at the focal point of the parabola and this is used to illuminate the reflector. The parabolic reflector or dish antenna consists of a radiating element which may be a simple dipole or a waveguide horn antenna. This is placed at the focal point of the parabolic reflecting surface. The energy from the radiating element is arranged so that it illuminates the reflecting surface. Once the energy is reflected it leaves the antenna system in a narrow beam. As a result considerable levels of gain can be achieved. Achieving this is not always easy because it is dependent upon the radiator that is used. For lower frequencies a dipole element is often employed whereas at higher frequencies a circular waveguide may be used. In fact the circular waveguide provides one of the optimum sources of illumination.

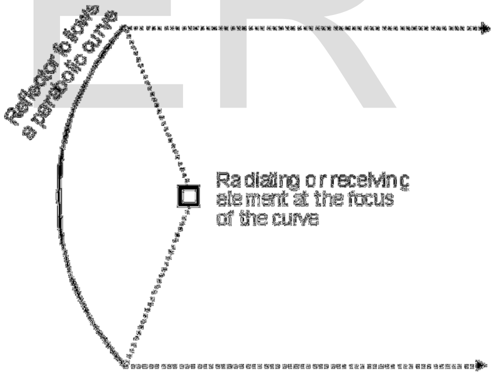

Fig. 3 Focal point Feed System

**Cassegrain reflector system:** Here the radiation is fed through the centre of the reflector towards a hyperboloidal reflector which reflects the radiation back onto the paraboloidal reflector. In this way it is possible to control the radiation more accurately. The Cassegrain feed system, although requiring a second reflecting surface has the advantage that the overall length of the dish antenna between the two reflectors is shorter than the length between the radiating element and the parabolic reflector. This is because there is a reflection in the focusing of the signal which shortens the physical length. This can be an advantage in some systems.

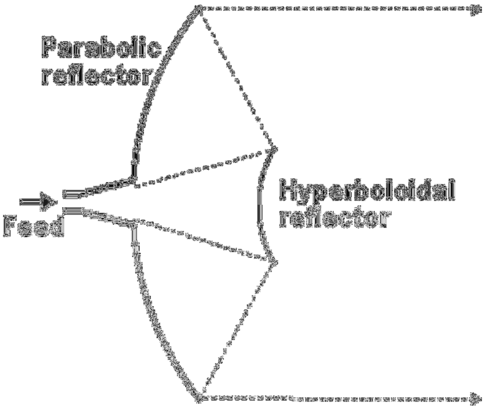

Fig. 4 Cassegrain Feed System

For most domestic systems a small reflector combined with a focal point feed are used, providing the simplest and most economical form of construction. This is the form that is most widely used for satellite television applications. These antennas may not always look exactly like the traditional full dish antenna. For mechanical and production reasons the feed is often offset from the centre and a portion of the paraboloid used, again offset from the centre. This provides mechanical advantage. Nevertheless the principles are exactly the same.

## VI.PARABOLIC ANTENNA GAIN

Parabolic reflector antennas, often called parabolic dishes are normally used in applications where gain and directivity are of paramount importance. Satellite TV reception, microwave links and other satellite links are prime examples of where parabolic reflector gain is used. The parabolic reflector antenna is ideal for high gain applications. At microwave frequencies where these antennas are normally used, they are able to produce very high levels of gain, and they offer a very convenient and robust structure that is able to withstand the rigors of external use, while still being able to perform well. Many other types of antenna design are not practicable at these frequencies. High gain parabolic reflector antennas come in a variety of sizes. The most commonly seen are those used for satellite television reception. However parabolic antennas are used in many other applications. Parabolic reflector antennas are also often seen on microwave towers for communications. Larger ones still can often be seen on TV broadcast stations where signals need to be transmitted up to a broadcast satellite and where performance is paramount. Even larger antennas may also be used for other communications or even space research applications. Some these parabolic antennas are many tens of metres across. The one common feature of all these examples is the parabolic antenna gain, or parabolic dish gain. While the larger antennas have greater levels of parabolic antenna gain, the performance of all these antennas is of prime importance. There are a number of factors that affect the parabolic antenna gain. These factors include the following:

- Diameter for the parabolic reflector antenna reflecting surface.
- Surface accuracy.
- Quality of illumination of the reflecting surface.
- Frequency or wavelength of the signal being received or transmitted.

The standard formula for the parabolic reflector antenna gain is:

$$\boxed{\text{Gain } G = \frac{10 \log_{10} k (\pi D)^2}{\lambda^2}}$$

where
G is the gain over an isotropic source in dB
k is the efficiency factor which is generally around 50% to 60%, i.e. 0.5 to 0.6
D is the diameter of the parabolic reflector in metres
lambda is the wavelength of the signal in metres

## VII.OPTIMIZING PARABOLIC ANTENNA GAIN

To provide the optimum illumination of the reflecting surface, the level of illumination should be greater in the centre than at the sides. It can be shown that the optimum situation occurs when the centre is around 10 to 11 dB greater than the illumination at the edge. Lower levels of edge illumination result in lower levels of side lobes.

Fig. 5: Microwave Radio Relay using Parabolic Reflectors

The reflecting surface antenna forms a major part of the whole system. In many respects it is not as critical as may be thought at first. Often a wire mesh may be used. Provided that the pitch of the mesh is small compared to a wavelength it will be seen as a continuous surface by the radio signals. If a mesh is used then the wind resistance will be reduced, and this provides significant advantages.

Microwave radio relay is a technology for transmitting digital and analog signals, such as long-distance telephone calls, television programs, and computer data, between two locations on a line of sight radio path. In microwave radio relay, radio waves are transmitted between the two locations with directional antennas, forming a fixed radio connection between the two points. Long daisy-chained series of such links form transcontinental telephone and/or television communication systems. Because 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, shell antennas and horn radiators, 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.

## CONCLUSION

A microwave link frequently is used to transmit signals in instances in which it would be impractical to run cables. If you need to connect two networks separated by a public road, for example, you might find that regulations restrict you from running cables above or below the road. In such a case, a microwave link is an ideal solution. Microwave systems are highly susceptible to atmospheric interference and also can be vulnerable to electronic eavesdropping. For this reason, signals transmitted through microwave are frequently encrypted.<br. An advantage of parabolic antennas is that most of the structure of the antenna (all of it except the feed antenna) is nonresonant, so it can function over a wide range of frequencies, that is a wide bandwidth. All that is necessary to change the frequency of operation is to replace the feed antenna with one that works at the new frequency. Some parabolic antennas transmit or receive at multiple frequencies by having several feed antennas mounted at the focal point, close together. Parabolic antennas are used as high-gain antennas for point-to-point communication, in applications such as microwave relay links that carry telephone and television signals between nearby cities, wireless WAN/LAN links for data communications, satellite and spacecraft communication antennas, and radio telescopes. Their other large use is in radar antennas, which need to emit a narrow beam of radio waves to locate objects like ships and airplanes. With the advent of home satellite television dishes, parabolic antennas have become a ubiquitous feature of the modern landscape. Parabolic antennas have some of the highest gains, that is they can produce the narrowest beam width angles, of any antenna type.[1] In order to achieve narrow beam widths, the parabolic reflector must be much larger than the wavelength of the radio waves used, so parabolic antennas are used in the high frequency part of the radio spectrum, at UHF and microwave (SHF) frequencies, at which wavelengths are small enough that conveniently sized dishes can be used.

## ACKNOWLEDGEMENTS

Our sincere thanks to our respective departments where we have serve and serving for their valuable suggestion and encouragement ie. Department of ECE JBIT,Department of ECE VGIET,Department of Digital Communication, GyanVihar University, Department of Digital Communication, Poornima College of Engineering and Department of Electronics & Communication, Rajasthan College of Engineering for Women. We are especially grateful to our Colleagues Mr. Giriraj Methi & Mr. Sanjeev Yadav for their valuable suggestions. We are also indebted to thanks Mr. Madan Pal singh HOD(ECE), JBIT & Mr. Nitin Gupta, HOD(ECE), RCEW, who has given us much advice & patience towards our work.

## REFERENCES

1. Antenna Theory (3rd edition), by C. Balanis, Wiley, 2005.
2. Antenna Theory and Design (2nd edition), by W. Stutzman and G. Thiele, Wiley, 1997.
3. Antennas (3rd edition), by J. Kraus and R. Marhefka, McGraw-Hill, 2001.
4. Antennenbuch, by Karl Rothammel, publ. Franck'sche Verlagshandlung Stuttgart, 1991.
5. Antennas for portable Devices, Zhi Ning Chen (edited), John Wiley & Sons in March 2007
6. Broadband Planar Antennas: Design and Applications, Zhi Ning Chen and M. Y. W. Chia, John Wiley & Sons
7. James Bamford, The Shadow Factory, Doubleday, 2008.
8. Wireless Power Transmission for Solar Power Satellite (SPS) (Second Draft by N. Shinohara), Space Solar Power Workshop, Georgia Institute of Technology
9. Brown., W. C. (September 1984). "The History of Power Transmission by Radio Waves". Microwave Theory and Techniques, IEEE Transactions .
10. POINT-TO-POINT WIRELESS POWER TRANSPORTATION IN REUNION ISLAND 48th International Astronautical Congress, Turin, Italy, 6–10 October 1997 - IAF-97-R.4.08 J. D. Lan Sun Luk, A. Celeste, P. Romanacce, L. Chane Kuang Sang, J. C. Gatina - University of La Réunion - Faculty of Science and Technology.