**HORN ANTENNA**

An open ended waveguide can act as an antenna at microwave frequencies with the principal lobe of radiation along the axis of the guide.

The gain of an antenna is not very large but depends directly upon the area ‘ab’ of the aperture.

If the dimensions of a waveguide, determined originally from the considerations of being originally from the considerations of being able to propagate waves at frequency ‘*f* ’ are gradually increased to considerably larger dimensions at the radiating aperture, highly directive radiation patterns would result.

Horn antennas may take one of the several possible shapes are shown below.



In order to reduce the reflections of the guided wave, the dimensions of the waveguide are gradually increased to the final aperture dimensions.

The axial length of the transition from the throat to the radiating aperture is generally on the order of 5 to 15λ.

The rectangular horns with a flare in only one dimension are called SECTORAL HORNS:

For the H-plane sectoral Horn, the dimensions are flared in the xz plane of the magnetic field while, for the E-plane horn, the dimensions are gradually increased in the yz plane of the electric field.

For gradual tapers, such as are commonly used, the field variations across the aperture of the rectangular horns are similar to the field distribution of the TE10 mode across the waveguide.

The field distributions in circular waveguides and consequently across the apertures of the circular horns are the enlarged versions of the exciting TE11 mode.

“The sectoral H-plane horns are more popular than the sectoral E-plane horns because of the relative absence of secondary lobes of radiation”.

Radiation Characteristics of some commonly used Horns

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Type | Property that is optimised for a give length | Optimum properties | HP BW | | FN BW | | Gain |
| E plane | H plane | E plane | H plane |
| Pyramidal | Gain | a  b ≅ 0.81 A  Gain ≅15.3 L/λ optimum | 53o / (b/λ) | 80o / (a/λ) | 115o / (b/λ) | 172o / (a/λ) | 0.5 |
| Sectoral H-plane | Beam width in H-plane | a | 51o / (b/λ) | 80o / (a/λ) | 115o / (b/λ) | 172o / (a/λ) | 0.63 |
| Sectoral E-plane | Beam width in E-plane | b | 53o / (b/λ) | 68o / (a/λ) | 115o / (b/λ) | 172o / (a/λ) | 0.63 |
| Conical | Gain | D | 60o / (D/λ) | 70o / (D/λ) | - | - | 0.52 |

**Note:** (1) ‘a’ is the horn aperture in x direction (2) ‘b’ is to the horn aperture in y-direction (3) D is the horn diameter (4) ‘L’ is the length of the horn from the throat to the aperture.

For rectangular horns, the pattern in a given plane is dependent primarily upon the aperture in that plane and is nearly independent of the aperture in the other plane.

**Problems:**

1. A pyramidal horn antenna of aperture dimension 16″ and 19″, respectively in the E- and H-planes is used to radiate 5 watts of power at 3000 MHz. Calculate the maximum field intensity at a distance of 3 miles.
2. Calculated the gain of a pyramidal horn of dimensions a = 12 cms, b = 9 cm, L = 12 cms, at frequency of 9000 MHz and 12000 MHz.
3. Calculate the gain of the horn antenna of length L = 12 cms, a = 12 cms and ‘b’ varying from 5 cms to 10 cms in steps of 1 cms.

**PARABOLIC ANTENNAS**

A parabolic reflector can be used to concentrate the radiation from an antenna located at the focus in the same way that a search light reflector producers a sharply defined beam of light.

A parabolic reflector converts the spherical waves originating from the radiator at the focus of the parabola into a plane wave of uniform phase across the aperture (mouth) of the parabola:

Some typical forms of parabolic antennas are shown in figure.



The cut paraboloid reflector would be useful in conjunction with feed antennas having different beam widths of radiation in the horizontal and vertical planes.

In order to utilize most of the radiation from the feed antenna, the angles in the two planes subtended by the reflector at the focal point are 20-30 percent larger than the half power beam widths of the feed antenna in these planes.

The offset cut paraboloidal reflector has the advantages of no aperture blocking by the feed antenna which is placed at the focus and is consequently out of the way of the reflected energy.

The cylindrical parabolic antenna is useful in concerting a cylindrical wave radiated by an in-phase line source at the focus into a plane wave at the aperture.

The comparative characteristics of the various idealized aperture illuminations are shown:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Illumination | | Half-power  Beam width | Relative  Gain | First Null  Position |
| Rectangular Aperture of Length L | | | | |
| m = 0 (uniform) |  |  | 1.00 | 57.3 o λ/L |
| m = 1 | 68.7o λ/L | 0.81 | 85.9 o λ/L |
| m = 2 | 83.1o λ/L | 0.667 | 114.6 o λ/L |
| m = 3 | 95.1o λ/L | 0.575 | 143.2 o λ/L |
| Circular Aperture of Diameter D | | | | |
| m = 0 (uniform) |  | 58.4o λ/D | 1.00 | 69.9 o λ/D |
| m = 1 | 68.7o λ/D | 0.75 | 92.2 o λ/D |
| m = 2 | 83.1o λ/D | 0.55 | 116.3 o λ/D |
| m = 3 | 95.1o λ/D | 0.45 | * 1. o λ/D |

**Pb.** Design a parabolic antenna for an antenna gain of 6000 at a frequency of 6000 MHz. Calculate the beam width between half power points in the vertical and horizontal planes for this antenna. Assuming a 90 percent antenna efficiency, calculate the power received if the incoming signals have a power density of 1 μw/m2

**Solution:**

Assuming a circular aperture with an m = 1 tapered distribution:

* D = 142.5 cm

HP BW = 72.8o 72.8 = 2.56o

P*i* = 1 μw/m2

Power received = (effective area of the antenna). P*i*

= 0.75 P*i*.

= 1.19 μm

**Pb.** Design a parabolic antenna for an antenna gain of 4000 at a frequency of 9850 MHz. Assume M=1 tapered distribution. For this antenna calculate the HPBW in the vertical and Horizontal planes.

***Solution***:

D = 72.1 cm

HP BW = 72.8o = 72.8 = 3.13o