Exp-3:- Beam Pattern

Aim

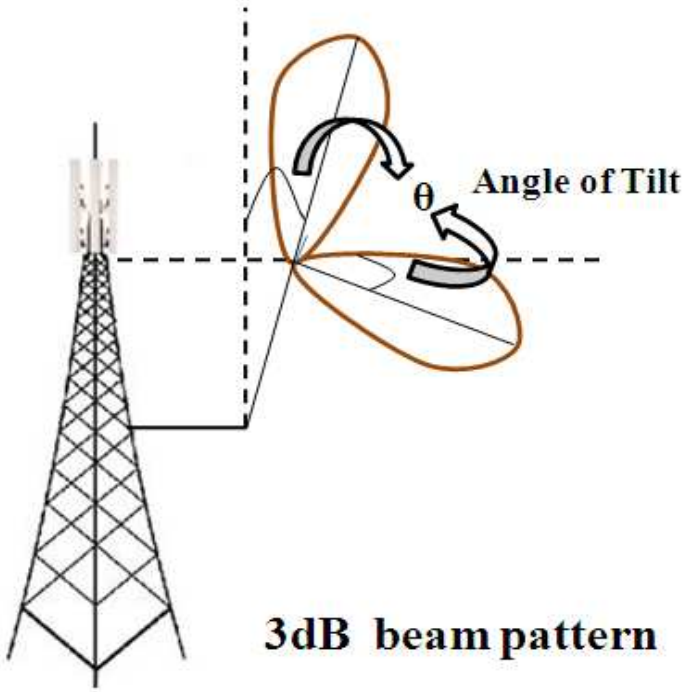
To find the 3dB beam width of a base station antenna.

Objectives

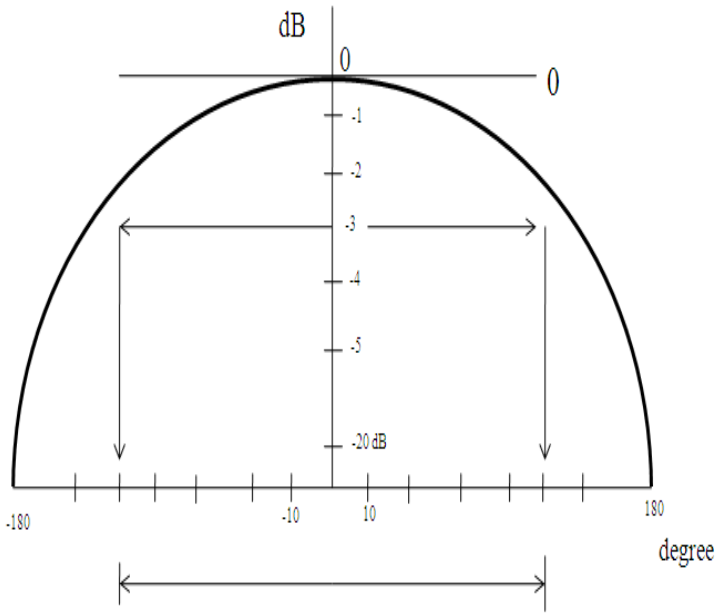
1. To study horizontal beam pattern and calculate the 3 dB beamwidth,
2. To study the vertical beam pattern of the Base Station antenna,
3. To calculate the beam width for horizontal beam pattern,
4. To calculate the beam width and tilt angle for vertical beam pattern.

1 Theory for Experiment 3:-Beam Pattern

The antennas used at the base station of a cellular system play an important role in determing the coverage area; the interference and hence the quality of service (signal strength) experienced by the user equipment in downlink it plays a similar role in the uplink .An omnidirectional antenna in simple to use compared to a directive antenna. Directive antennas limit the radiated signal power to a specific direction. This helps in reducing spatial interference and increasing capacity through sectoring.A horizontal antenna pattern is used to obtain sectoring details of which are given below. Similar to the horizontal beam pattern a vertical beam pattern is also used alongwith a vertical beam tilt higher the tilt the smaller is the coverage.



usually the 3dB(half power) width(as usal)is used as a measure of the beam width.



3dB beam width

The horizontal antenna pattern used is specified as:

$$A(\theta) = -min\Big[12\Big(\frac{\theta}{\theta_{3dB}}\Big)^2, A_m\Big]$$

Where ,
$A(\theta)$ is the relative antenna gain (dB) in the direction θ, -$180^0 \leq \theta \leq 180^0$,and min[.] denotes the minimum function,
θ_{3dB} is the 3 dB beam width corresponding to $\theta_{3dB} = 70^0$, and $A_m = 20$ dB is the maximum attenuation.
A similar antenna pattern will be used for elevation with a slight change. The formula is given by:-

$$A_e(\phi) = -min\Big[12\Big(\phi - \frac{\phi_{tilt}}{\phi_{3dB}}\Big)^2, A_m\Big]$$

Where,

- $A_e(\phi)$ is the relative antenna gain (dB) in the elevation direction,$-180^0 \leq \phi \leq 180^0$.
- ϕ_{3dB} is the elevation 3 dB beamwidth value, and it may be assumed to be 15^0. ϕ_{tilt} is the tilt angle.

1.1 Example of beam width calculation for Expt 3A:-

Calculation of beam width :- suppose at 0^0 received power is -75.47 dBm at 10^0 received power is -78.47dBm

There is a 3 dBm fall in received power in at -10^0 and 10^0 so beam width=$(10^0 - (-10^0)) = 20^0$

1.2 Example of beamwidth calculation for Expt 3B:-

calculation of tilt angle:-

find the maximum value of angle where received power is maximum.thuis value angle where 3dbm fall in received power .suppose at$1.15^0$and -1.15^0 received power is -43.08db. so beam width will be = $(1.15^0 - (-1.15^0)) = 2.3^0$