Advanced 3D Radiation Pattern Analysis of Omni-Directional Antenna

1. Introduction

This report presents a detailed 3D radiation pattern analysis of an ideal omni-directional antenna and compares it with a half-wave dipole antenna. The radiation pattern is simulated using MATLAB and analyzed in both linear scale and decibel (dB) scale.

2. Theoretical Background

Omni-directional antenna field pattern: $E(\theta) = \sin(\theta)$. Power pattern: $P(\theta) = \sin^2(\theta)$. Maximum radiation occurs at $\theta = 90°$, and nulls occur at $\theta = 0°$ and $180°$.

Dipole antenna normalized field pattern: $E(\theta) = (\cos((\pi/2)\cos\theta) / \sin\theta)$. The dipole pattern also exhibits nulls along the axis and maximum radiation at broadside.

3. Gain Representation in dB

Radiation gain in decibels is computed as: $G(dB) = 10 \log10(P)$. The dB scale provides better visualization of dynamic range and attenuation regions.

4. Comparison Table

Parameter	Omni-Directional	Half-Wave Dipole
Max Radiation	$\theta = 90°$	$\theta = 90°$
Null Direction	0° and 180°	0° and 180°
3D Shape	Toroidal (Doughnut)	Toroidal (Narrower)
Azimuth Coverage	360° Uniform	360° Uniform

5. Conclusion

The omni-directional antenna produces a toroidal radiation pattern with uniform azimuth coverage. When compared to a dipole antenna, both exhibit similar broadside radiation characteristics; however, the dipole shows slightly more concentrated radiation intensity. The dB representation enhances visualization of null regions and side attenuation.