DYNASTREAM®
INNOVATIONS

Interpreting RF Radiation Patterns

Application Note

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Revision History

Revision	Effective Date	Description
1.0	September 2014	First Release

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1 Introduction

RF antenna radiation patterns can be presented in several ways; manufacturer datasheets will use different scales, views, number of data points, etc. Interpreting the patterns and knowing how the data translates to performance characteristics may therefore be difficult. Understanding how these plots are generated can enable the developer to interpret the data properly.

2 RF Antenna Patterns

Figure 2-1 illustrates an antenna radiation pattern. These types of diagrams, typically referred to as polar plots, are offered on datasheets to denote antenna performance.

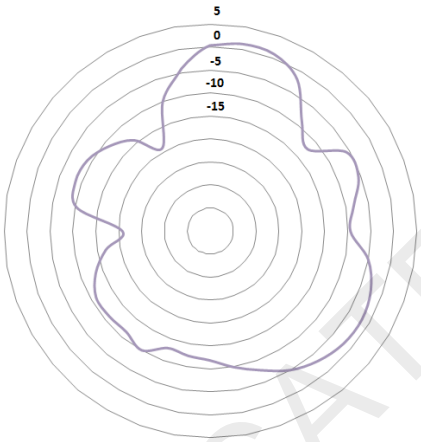

Figure 2-1 Antenna Gain (dBi)

Polar plots are derived from 3-dimensional radiation data. Figure 2-2 below is an example 3D pattern with the RF source located at the origin. Note that the power highlighted in green indicates a low power region (shown dipping towards the origin), while the higher levels are indicated in red (protruding outwards).

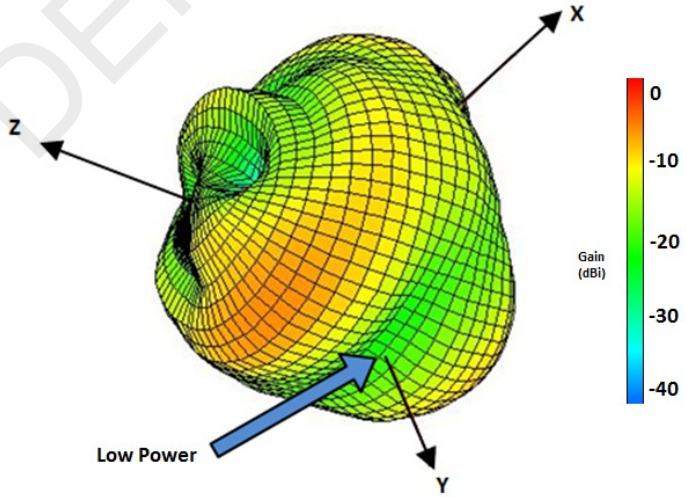

Figure 2-2 Example 3D Radiation Pattern

Taking a cross section through the origin (e.g. the XY plane as shown in Figure 2-3) and plotting the points that lay on this plane creates a polar plot of real emitted power values (Figure 2-4). Normally no additional processing is applied to these polar plots and they offer the true depiction of the antenna performance along the plane described by the cross section.

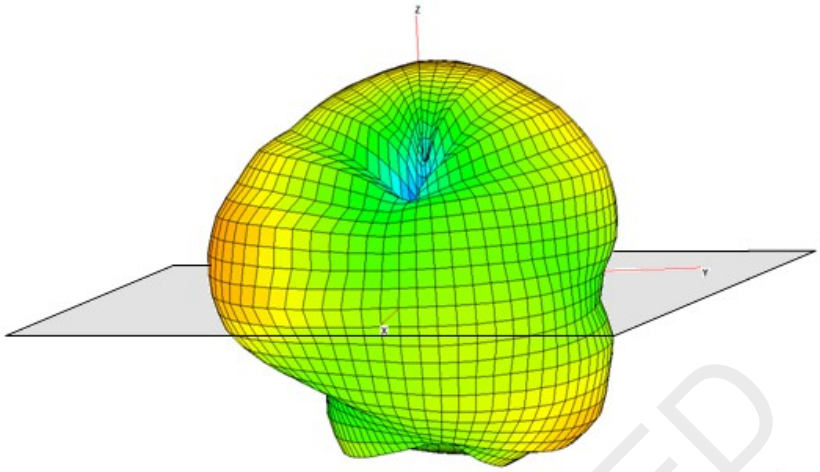

Figure 2-3 Cross Section along XY Plane

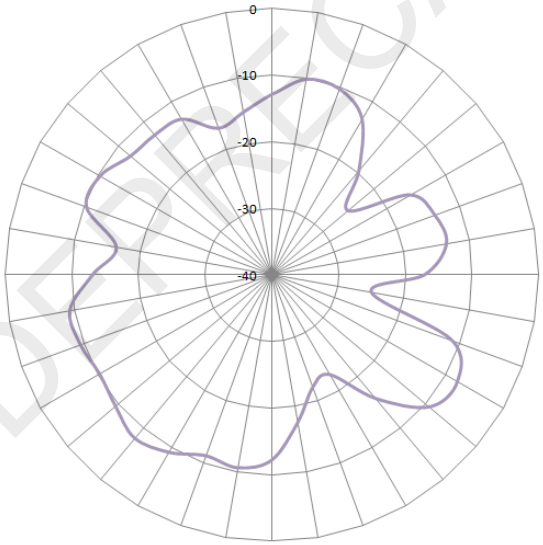

Figure 2-4 Polar Plot of XY Plane Cross Section

To provide a complete representation of the RF performance datasheets will typically provide three polar plots with planes defined as seen in Figure 2-5. The cross sections in this figure are defined as planes intersecting the origin along the XY (green), YZ (pink), and XZ (grey) planes. These planes display data points along all three axes in space which gives the developer a precise illustration of the antenna performance.

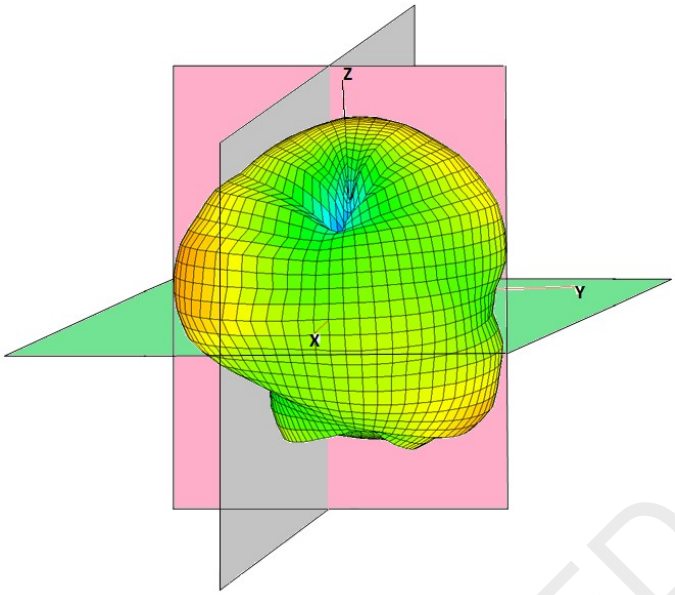

Figure 2-5 Three Perpendicular Planes

3 Variations of Polar Plots

Interpretation problems for developers can occur when a different method than the one described above is used to generate polar plots.

Consider the same example 3-D radiation pattern as above rotated so the line of sight is along the Z-axis. In this case the field of view will appear as seen in Figure 3-1.

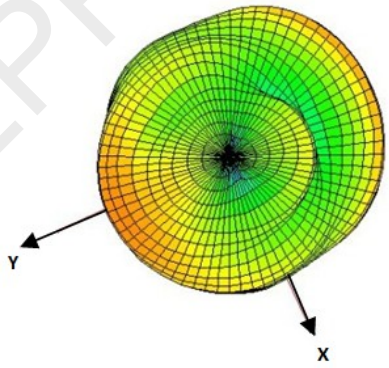

Figure 3-1 Radiation Pattern Alternate View

Note that at this angle it is impossible to see the true performance along the XY plane because the nulls can be hidden by peaks at other angles of elevation along the Z-axis (Figure below).

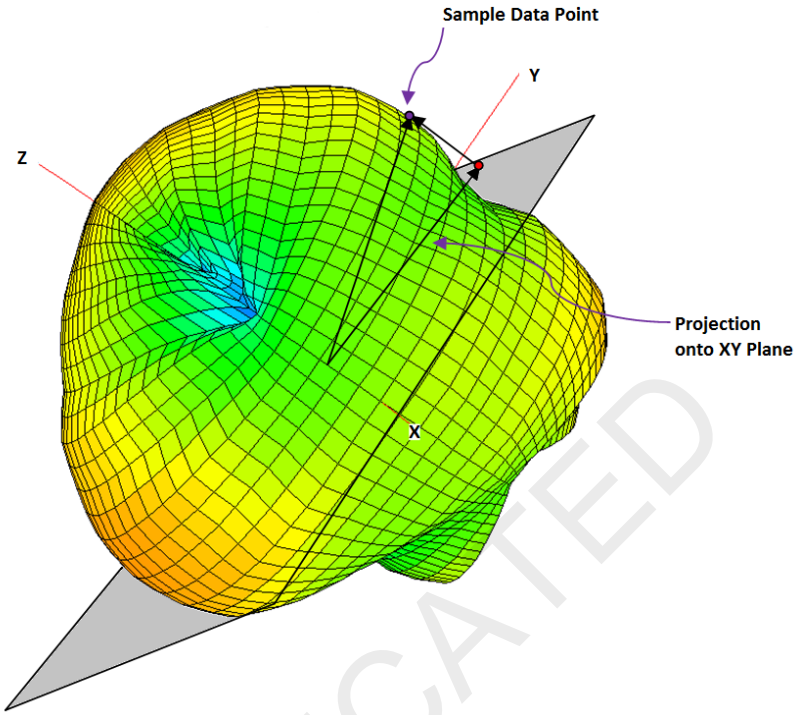

Figure 3-2 Projection of RF Data

The sample RF data point effectively becomes projected onto the XY plane. The magnitude of the point projected is larger than the actual value of the RF data point that exists on that plane.

The resultant polar plot representation of that plane is shown in the figure below.

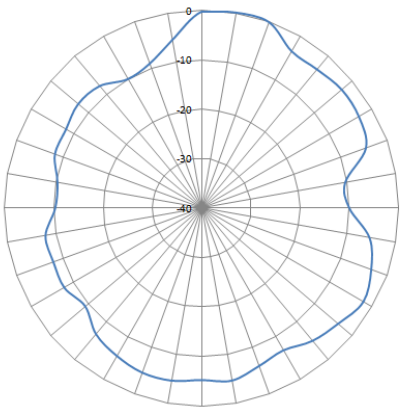

Figure 3-3 Projected Polar Plot

Figure 3-4 is a comparison between the true polar plot and the plot above.

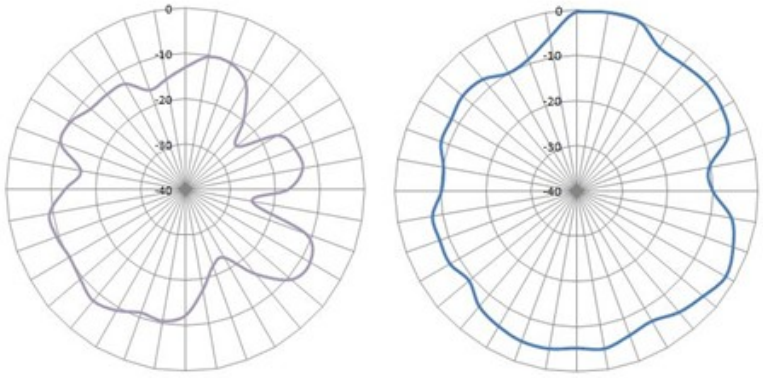

Figure 3-4 True Cross Section Vs Projection

If a manufacturer generates a plot by projecting the data onto a plane as opposed to taking a true cross section of the 3-D pattern the resultant polar plot can present a far too ideal depiction of what is actually radiated by the source.

4 Summary

Datasheets provide radiation patterns to denote the RF performance of a module. Displaying the radiation data using methods that do not show actual values from each of the cross sections is not conducive for developers attempting to optimize RF performance. This application note can be used to assist in proper interpretation of RF radiation patterns.