Application Note

BCM20732S/BCM20736S/BCM20737S/BCM20737L

System-In-Package Planar Inverted-F Antenna (PIFA) Guidelines for Bluetooth Low Energy Applications

2073X-AN300-R

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Revision History

Revision	*Date*	*Change Description*
2073X-AN300-R	01/20/16	Initial release

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About This Document

Purpose and Audience

The SIP design minimizes product integration efforts and optimizes device performance. This application note provides performance data on the embedded antenna of the SIP mounted on the evaluation board.

Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined on first use.

For a comprehensive list of acronyms and other terms used in Broadcom documents, go to: http://www.broadcom.com/press/glossary.php.

References

The references in this section may be used in conjunction with this document.

Note: Broadcom provides customer access to technical documentation and software through its WICED-Smart Community website (WSC) and the Downloads and Support site (see Technical Support).

For Broadcom documents, replace the “xx” in the document number with the largest number available in the repository to ensure that you have the most current version of the document.

Document (or Item) Name	*Number*	*Source*
Broadcom Items		
[1] BCM20732S Bluetooth Low Energy SiP Module Technical Reference	DOC-1019	WSC
[2] BCM20736S Bluetooth Low Energy SiP Module Technical Reference	DOC-1455	WSC
[3] BCM20737S Bluetooth Low Energy SiP Module Technical Reference	DOC-1737	WSC

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http://community.broadcom.com/welcome.

Introduction

The BCM20732S/BCM20736S/BCM20737S/BCM20737L SIP modules minimize product integration efforts and optimize device performance. This application note provides performance data on the embedded in the antenna modules, as mounted on the evaluation board.

Antenna Description

The BCM20732S/BCM20736S/BCM20737S/BCM20737L SIPs include an embedded BLE antenna, 24 MHz crystal, and a 512 KB EEPROM: a minimal number of external components are needed to create a standalone BLE device. These devices are in small high-performance packages designed to optimize the functionality of BLE products.

The embedded antenna of the SIP operates at 2.4 GHz. The embedded antenna uses Antenna-in-Package technology to minimize size while maintaining a high radiation efficiency value. The radiation efficiency affects antenna performance by implementing a greater link range/distance and enhancing battery life.

The embedded antenna has an omni-directional radiation pattern, which is optimal for scattered environments. Internal broadband impedance matching for the 2.4 GHz ISM band allows the flexibility to easily integrate the antenna in PCB applications. The PCB layout and keep-out areas need to be respected in order to maintain antenna performance.

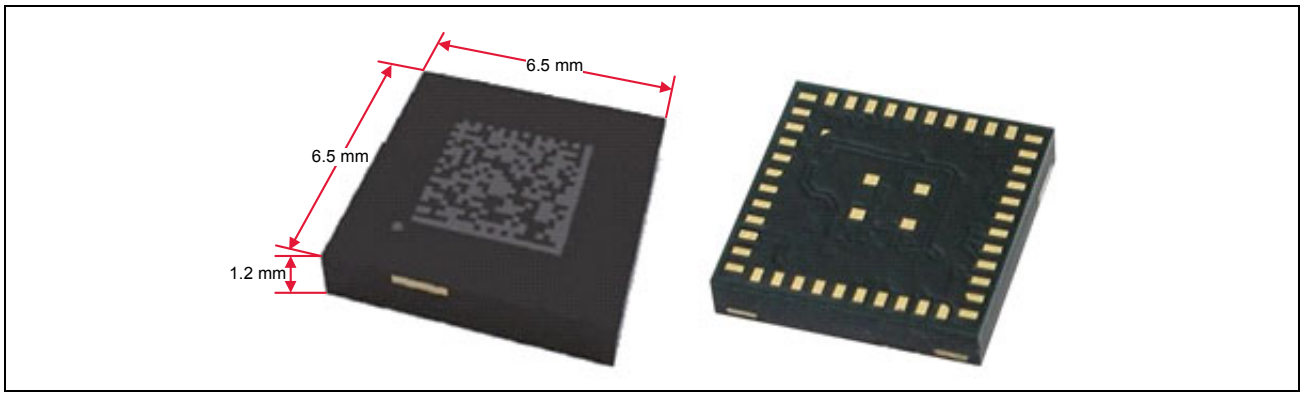
Table 1: Specifications Overview

Name	*Specification*
Frequency Range	2400-2500 MHz
Radiation Efficiency	>33%
Peak Antenna Gain	<=1.0 dBi
VSWR	<2:1
Polarization	Linear

Features

- High efficiency
- Small clearance needed
- External matching not required
- Compact physical size (6.5 x 6.5 x 1.2 mm, see Figure 1 on page 7)

Figure 1: Package Dimensions



Antenna Performance

More than 33% of the power delivered to the antenna is transmitted to free space. This value is sufficient to ensure communication reliability and prolonged battery life.

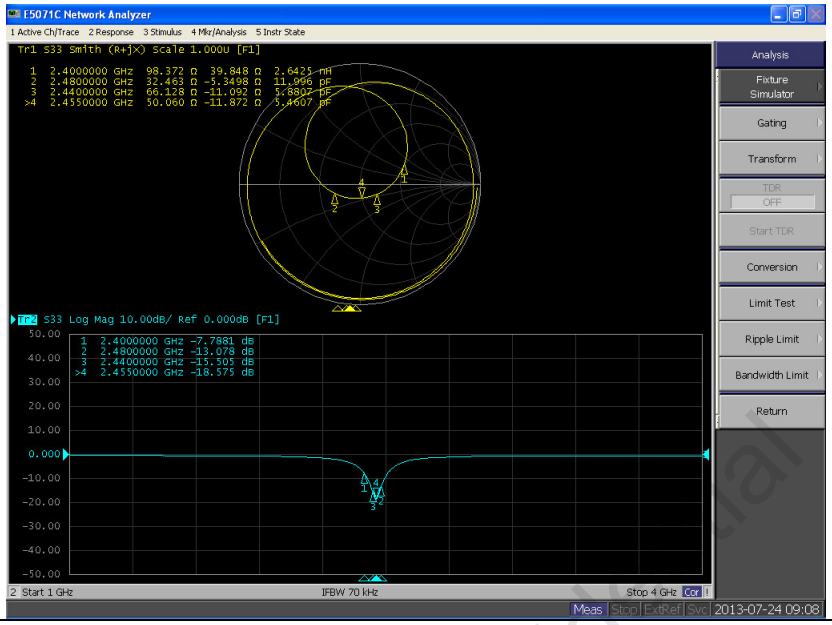
Return Loss

The embedded antenna achieves return loss <–7.5 dB within the ISM 2.4 GHZ band on the evaluation board.

This antenna efficiency helps minimize:

- Battery consumption
- Bill of materials cost

Figure 2: Embedded Antenna Return Loss



Antenna Performance Summary

Table 2: Antenna Performance Summary

Frequency (MHz)	*X-Z Plane (Phi=0) (H + V: dBi)*		*Y-Z Plane (Phi = 90) (H + V: dBi)*		*X-Y Plane (Theta = 90) (H + V: dBi)*		*Gain-3D (H + V: dBi)*	*Upper Hemisphere Avg. Gain (H + V: dBi)*	*Lower Hemisphere-Avg. Gain (H + V: dBi)*	*Efficiency (H + V/%)*
	Peak Gain	*Avg. Gain*	*Peak Gain*	*Avg. Gain*	*Peak Gain*	*Avg. Gain*				
2380	0	–6.3	–0.8	–3.8	–3.8	–6.5	0.1	–7.4	–6.9	33
2440	–0.5	–6.6	0.1	–3.5	–3.6	–6.9	0.3	–7.6	–7.1	36
2480	1	–5.9	1	–3.1	–2.5	–6.0	1.1	–7.1	–6.6	42

2D Radiation Pattern

2D patterns are measured along three orthogonal principal plane cuts: X-Z, Y-Z, and X-Y planes in spherical θ–Φ coordinate

These radiation patterns were measured with 4 x 4 mm evaluation board, shown in Figure 3.

Figure 3: 2D Radiation Pattern

Far-Field Power Distribution

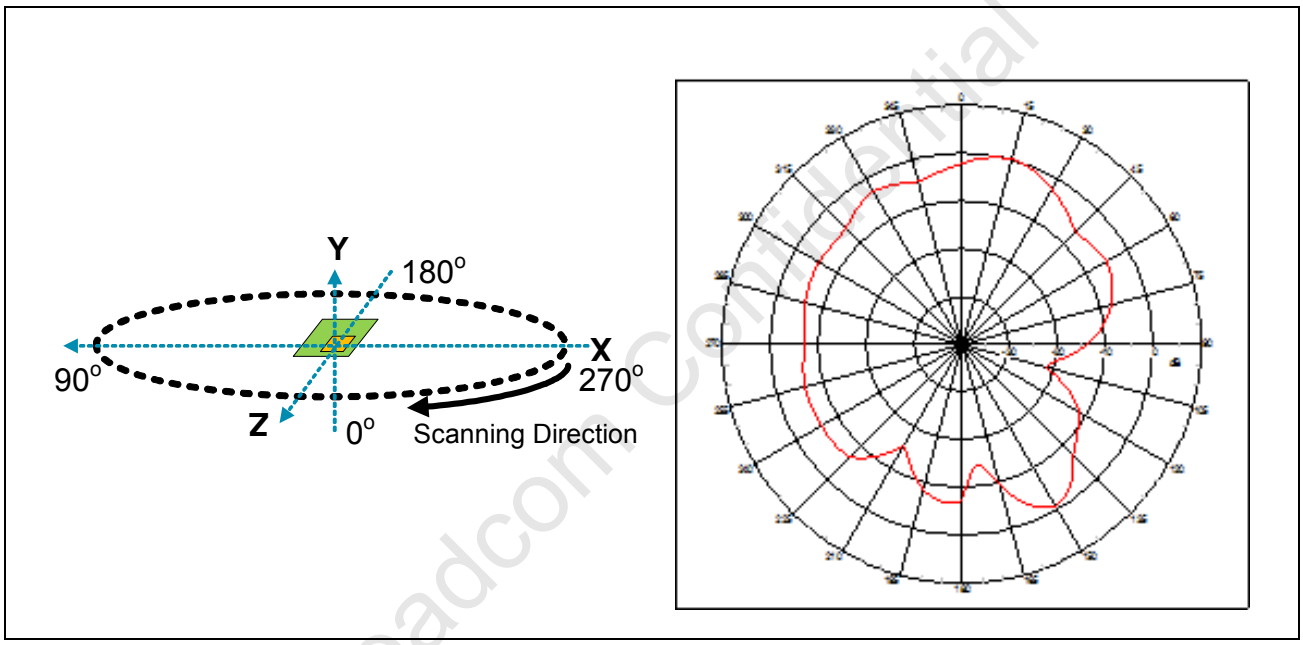
The figures in this section show the far-field power distribution (H =V) radiation patterns.

2.38 GHz

X-Z Plane

- Plot peak gain (H + V) = 0.0 dBi
- Plot average gain (H + V) = –6.3 dBi @2.38000 GHz

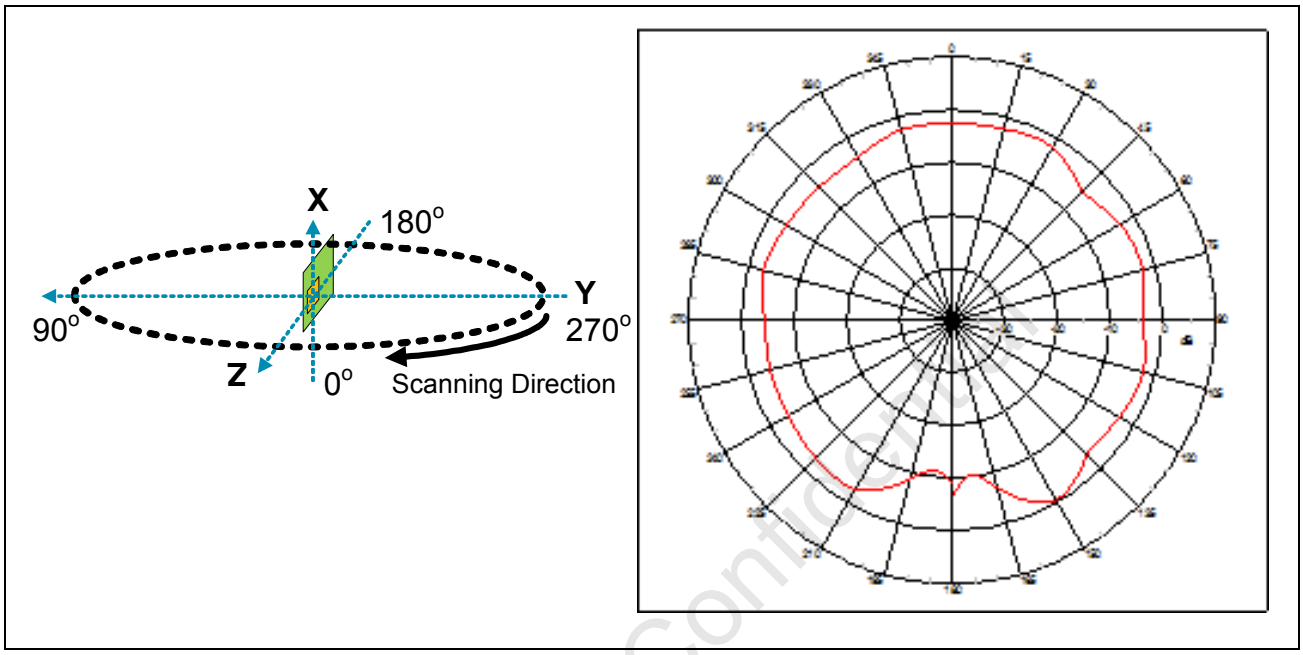
Figure 4: 2.38 GHz, X-Z Plane



Y-Z Plane

- Plot Peak Gain (H + V) = 0.8 dBi
- Plot average gain (H + V) = –3.8 dBi @2.38000 GHz

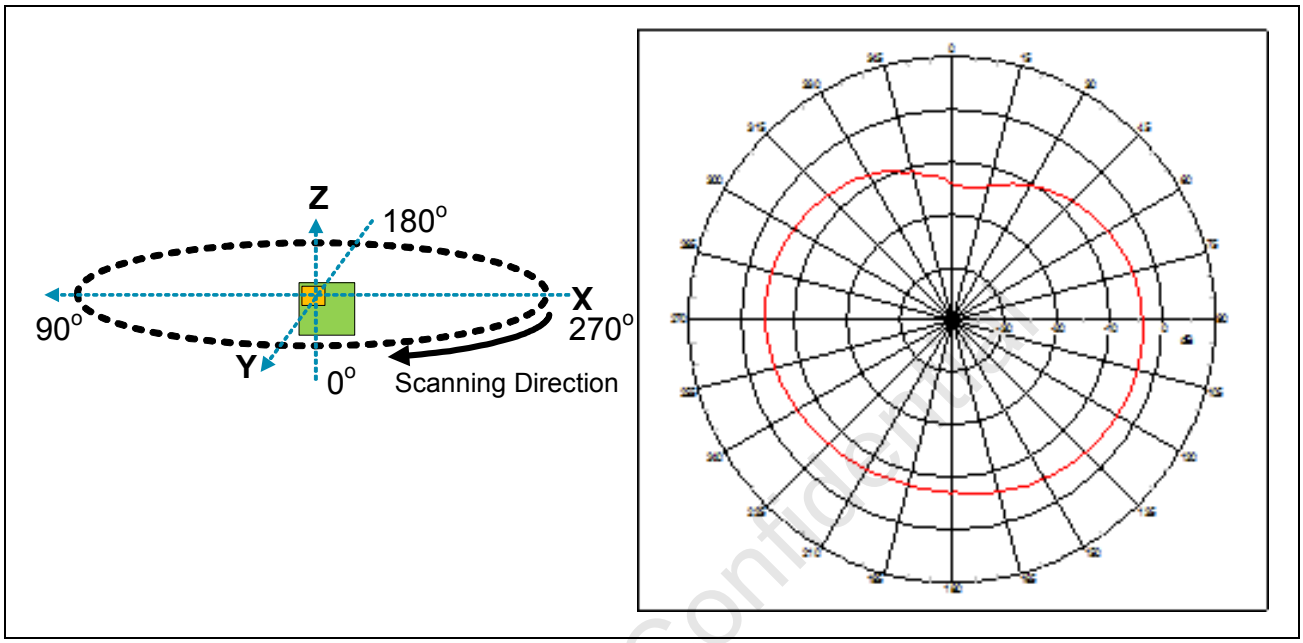
Figure 5: 2.38 GHz, Y-Z Plane



X-Y Plane

- Plot Peak Gain (H + V) = –3.8 dBi
- Plot average gain (H + V) = –6.5 dBi at 2.38000 GHz

Figure 6: 2.38 GHz, X-Y Plane

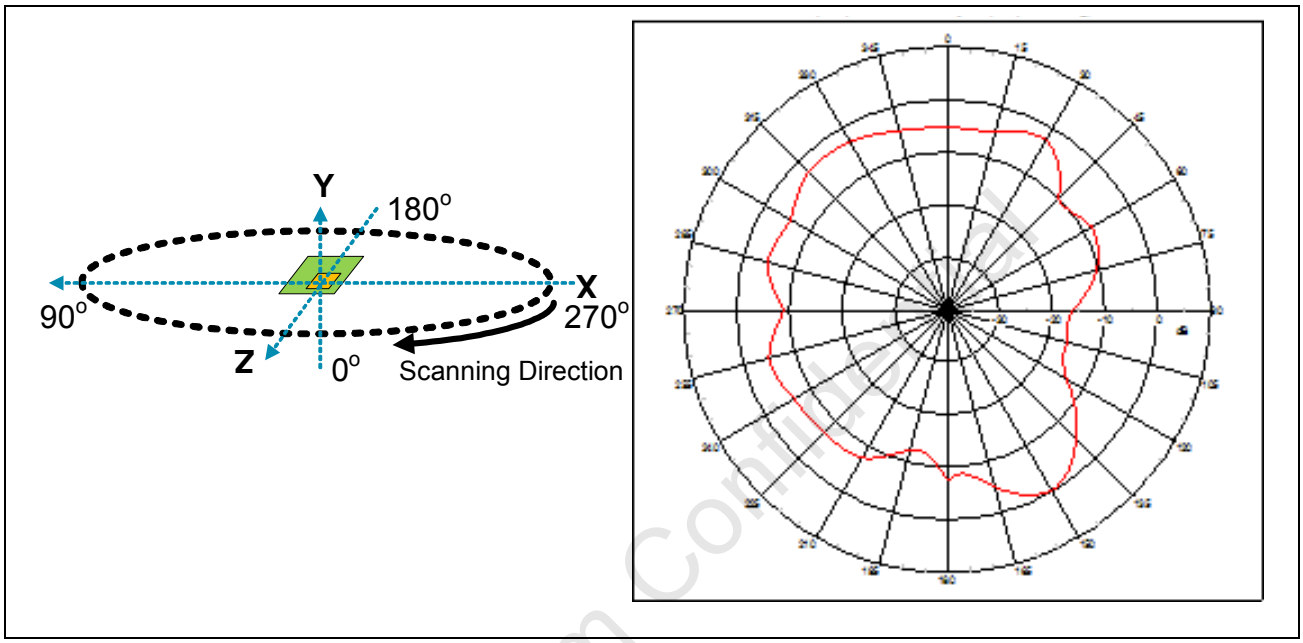


2.44 GHz

X-Z Plane

- Plot Peak Gain (H + V) = 0.5 dBi
- Plot average gain (H + V) = –6.6 dBi at 2.44000 GHz

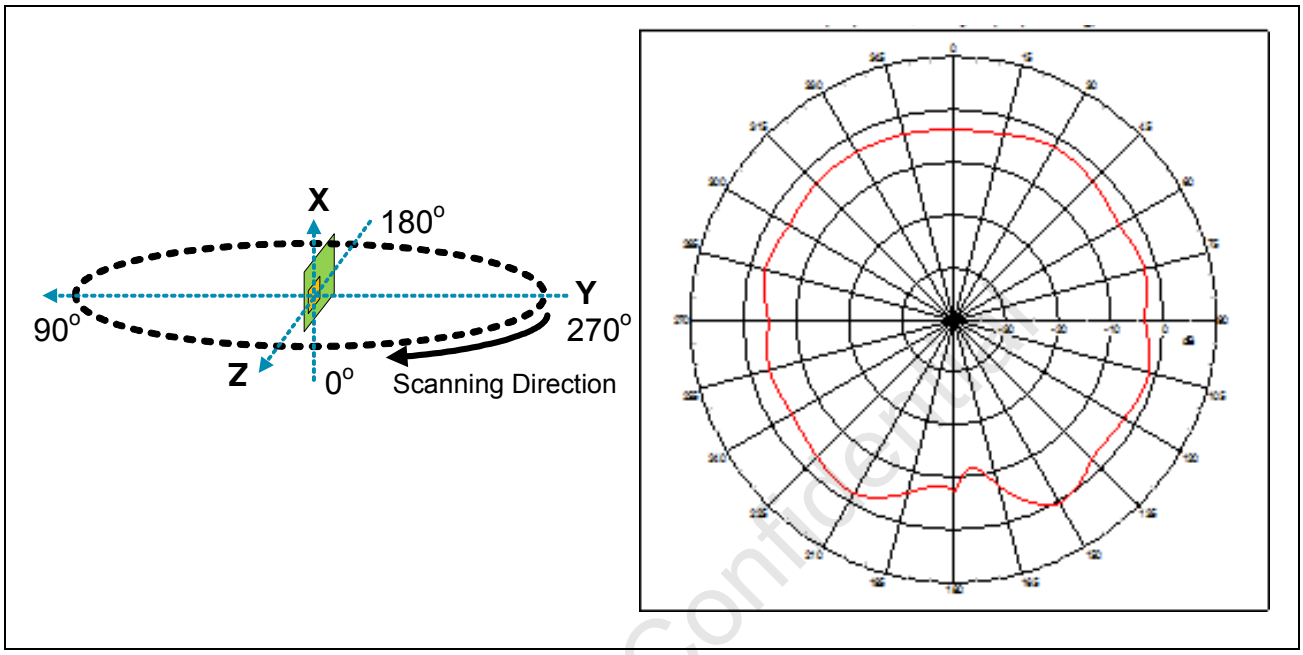
Figure 7: 2.44 GHz, X-Z Plane



Y-Z Plane

- Plot Peak Gain (H + V) = 0.1 dBi
- Plot average gain (H + V) = –3.5 dBi @2.44000 GHz

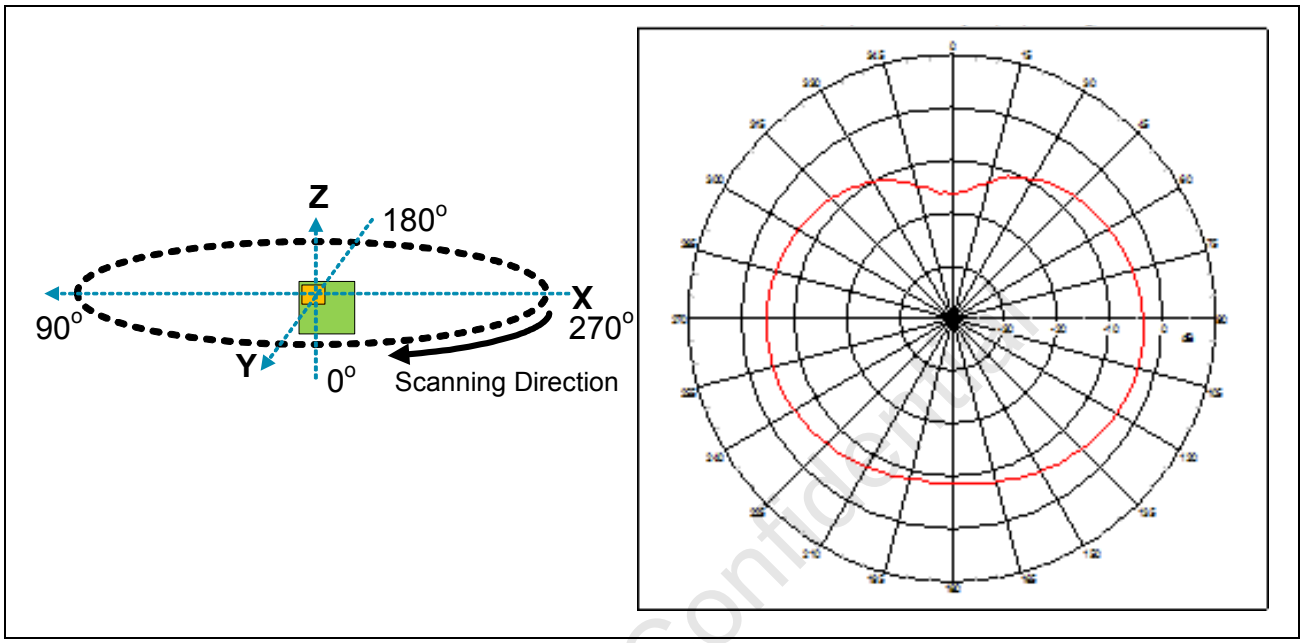
Figure 8: 2.44 GHz, Y-Z Plane



X-Y Plane

- Plot Peak Gain (H + V) = –3.6 dBi
- Plot average gain (H + V) = –6.9 dBi at 2.44000 GHz

Figure 9: 2.44 GHz, X-Y Plane

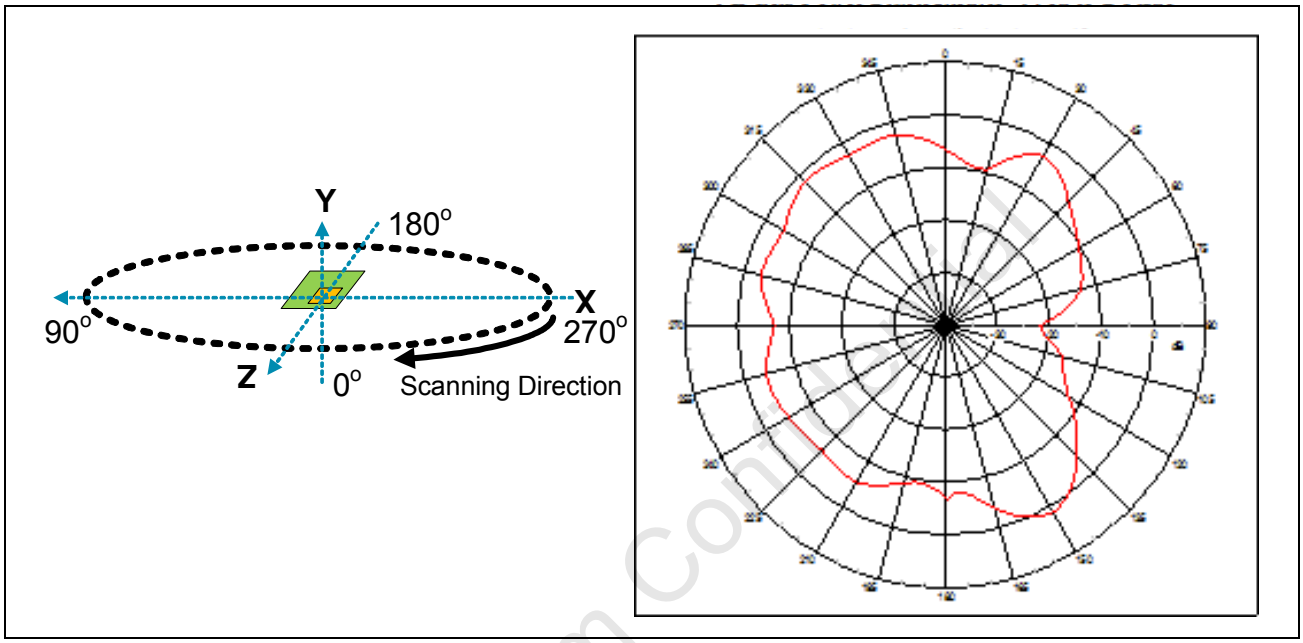


2.48 GHz

X-Z Plane

- Plot Peak Gain (H + V) = 1.0 dBi
- Plot average gain (H + V) = –5.9 dBi at 2.48000 GHz

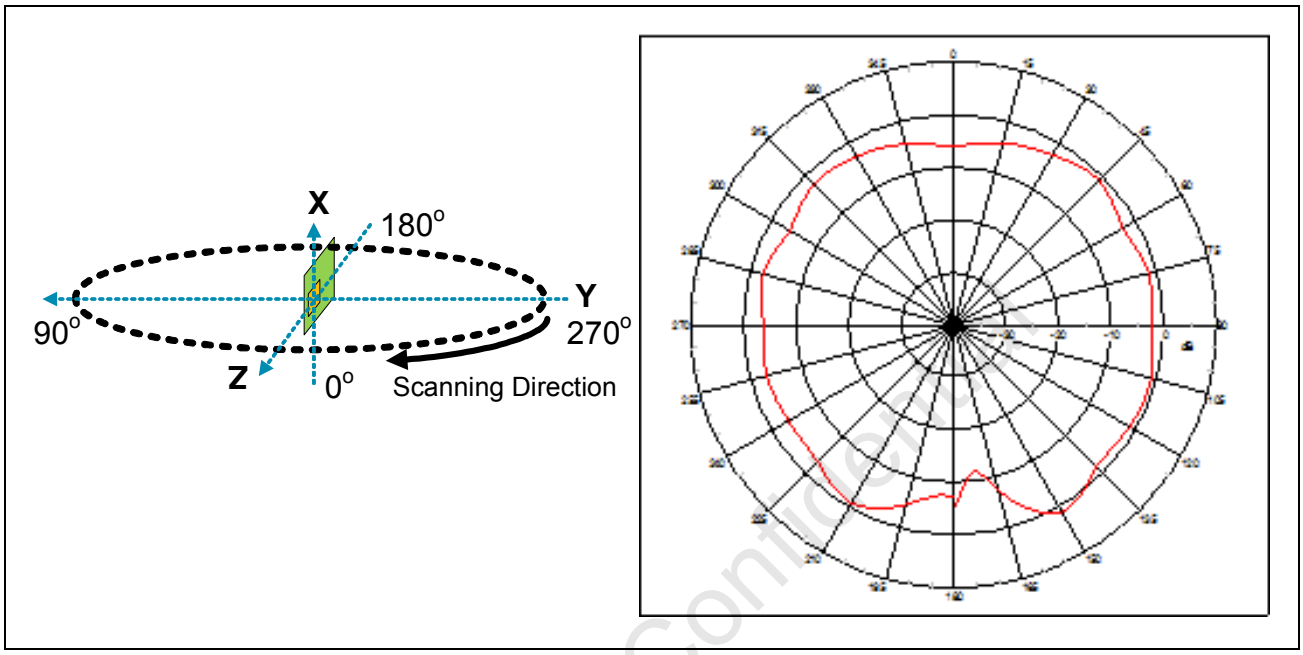
Figure 10: 2.48 GHz, X-Z Plane



Y-Z Plane

- Plot Peak Gain (H + V) = 1.0 dBi
- Plot average gain (H + V) = –3.1 dBi @2.48000 GHz

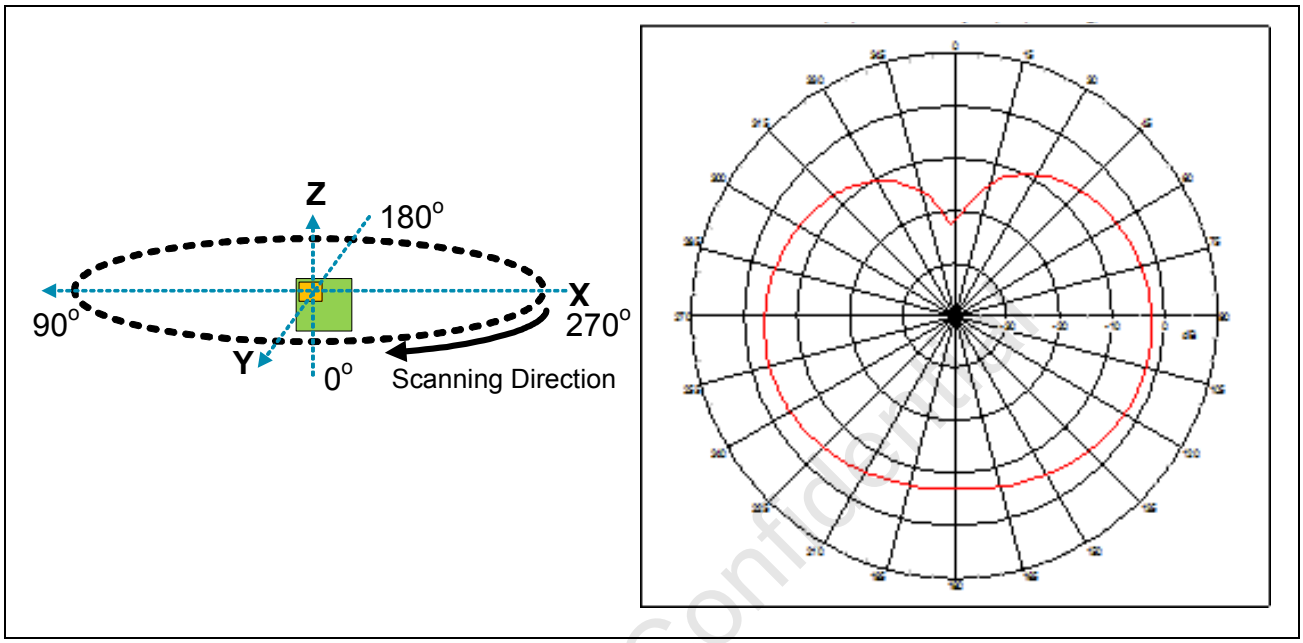
Figure 11: 2.48 GHz, Y-Z Plane



X-Y Plane

- Plot Peak Gain (H + V) = –2.5 dBi
- Plot average gain (H + V) = –6.0 dBi at 2.48000 GHz

Figure 12: 2.48 GHz, X-Y Plane



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