AN214895

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

Associated Part Family: CYW20732S/CYW20736S/CYW20737S/CYW20737L

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.

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1 Introduction

The CYW20732S/CYW20736S/CYW20737S/CYW20737L 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.

1.1 Cypress Part Numbering Scheme

Cypress is converting the acquired IoT part numbers from Broadcom to the Cypress part numbering scheme. Due to this conversion, there is no change in form, fit, or function as a result of offering the device with Cypress part number marking. The table provides Cypress ordering part number that matches an existing IoT part number.

Table 1. Mapping Table for Part Number between Broadcom and Cypress

Broadcom Part Number	Cypress Part Number
BCM20732S	CYW20732S
BCM20736S	CYW20736S
BCM20737S	CYW20737S
BCM20737L	CYW20737L

1.2 Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined upon first use. For a more complete list of acronyms and other terms used in Cypress documents, go to: http://www.cypress.com/glossary.

2 IoT Resources

Cypress provides a wealth of data at http://www.cypress.com/internet-things-iot to help you to select the right IoT device for your design, and quickly and effectively integrate the device into your design. Cypress provides customer access to a wide range of information, including technical documentation, schematic diagrams, product bill of materials, PCB layout information, and software updates. Customers can acquire technical documentation and software from the Cypress Support Community website (http://community.cypress.com/).

3 Antenna Description

The CYW20732S/CYW20736S/CYW20737S/CYW20737L 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.

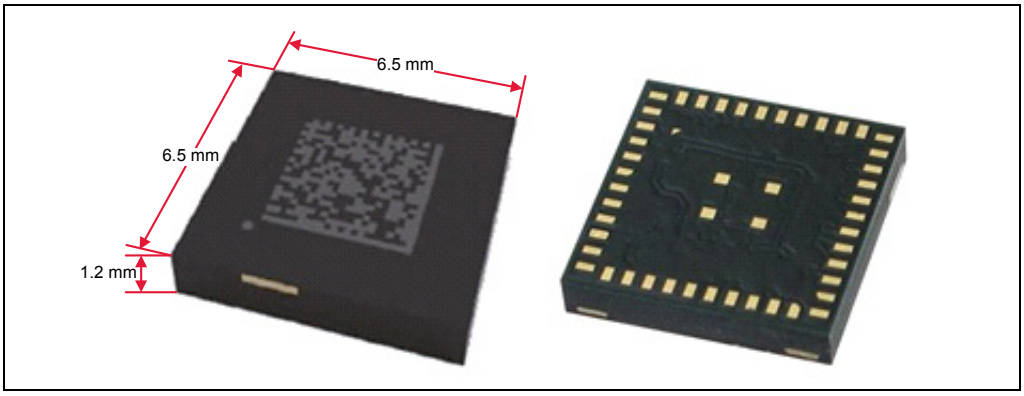
Table 2. Specifications Overview

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

4 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 3)

Figure 1. Package Dimensions



5 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.

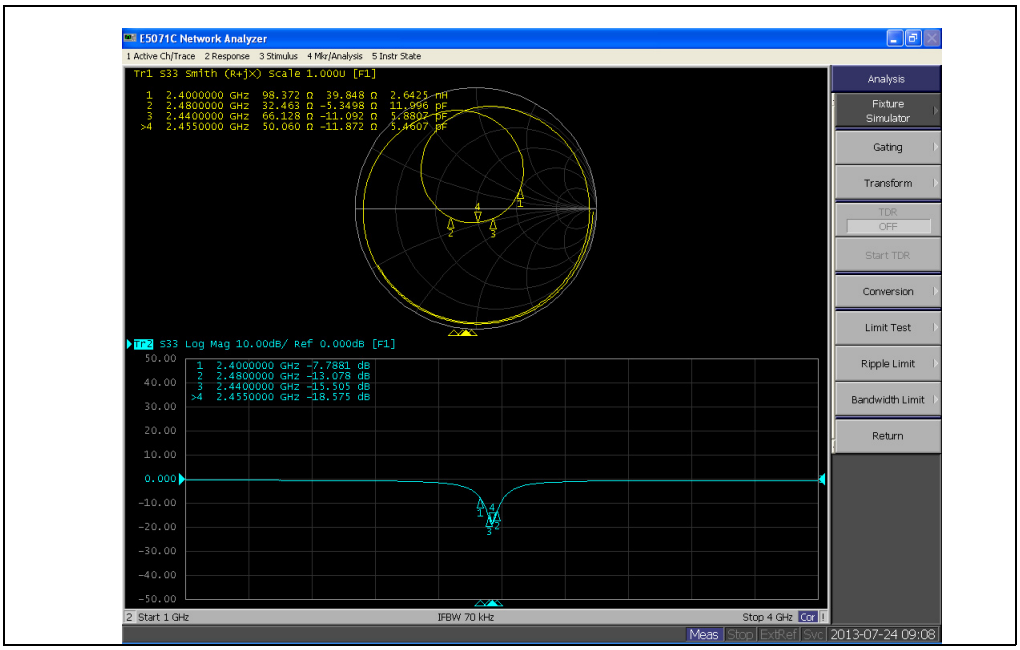
5.1 Return Loss

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



5.2 Antenna Performance Summary

Table 3. Antenna Performance Summary

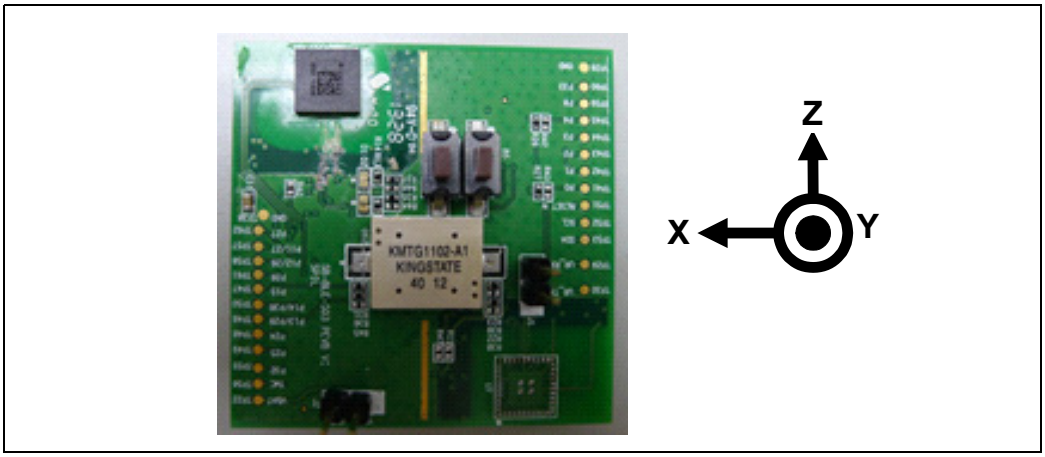
Frequency (MHz)	X-Z Plane (Phi=0) (H + V: dBi)		Y-Z Plane (Phi = 90) (H + V: dBi)		X-Y Plane (Theta = 90) (H + V: dBi)		Gain-3D (H + V: dBi)	Upper Hemisphere Avg. Gain (H + V: dBi)	Lower Hemisphere -Avg. Gain (H + V: dBi)	Efficiency (H + V/%)
	Peak Gain	Avg. Gain	Peak Gain	Avg. Gain	Peak Gain	Avg. Gain				
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

5.3 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



6 Far-Field Power Distribution

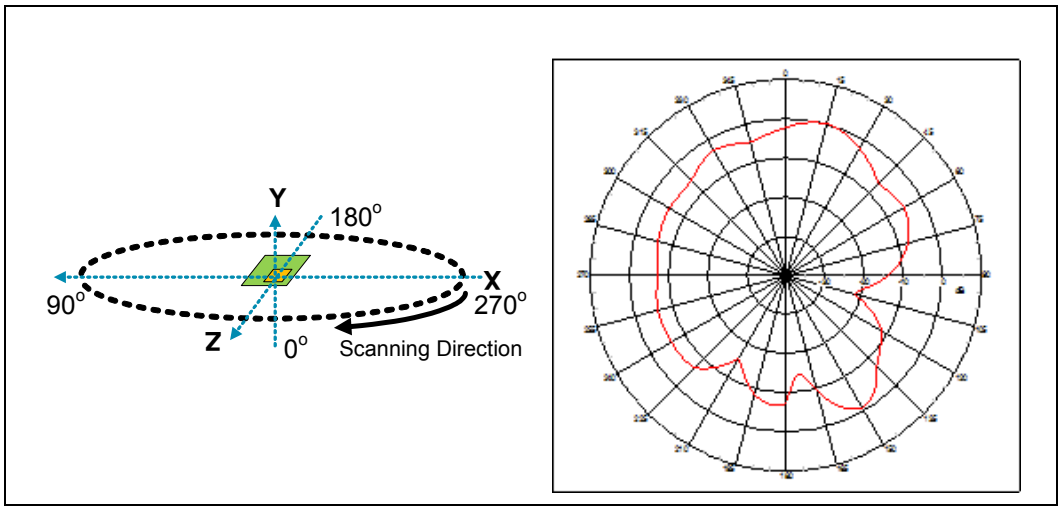
The figures in this section show the far-field power distribution (H =V) radiation patterns.

6.1 2.38 GHz

6.1.1 X-Z Plane

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

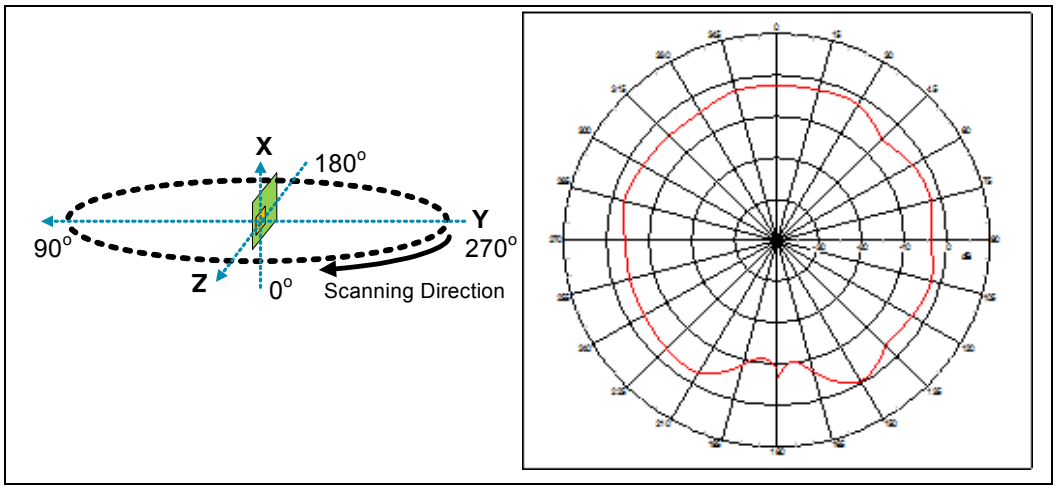
Figure 4. 2.38 GHz, X-Z Plane



6.1.2 Y-Z Plane

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

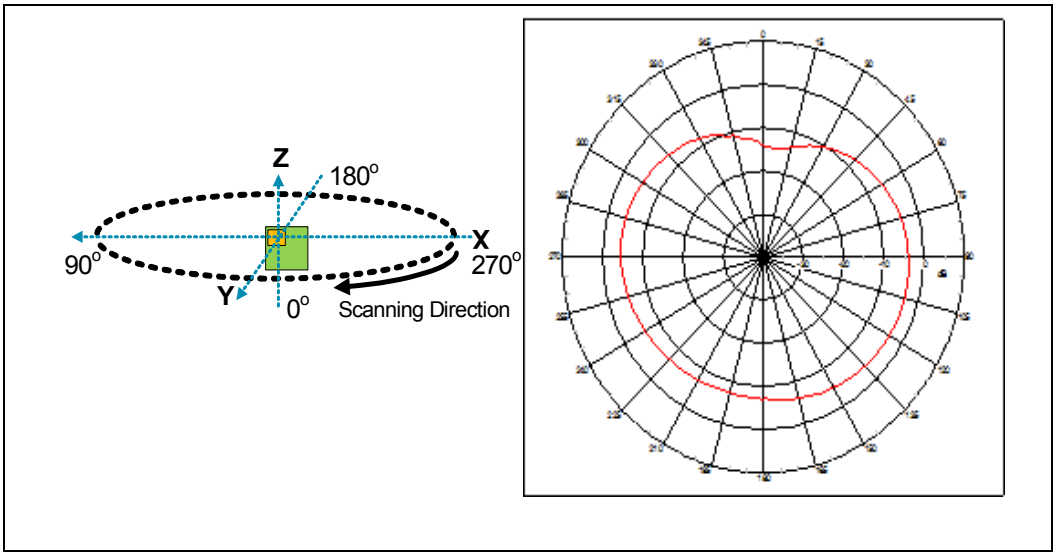
Figure 5. 2.38 GHz, Y-Z Plane



6.1.3 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

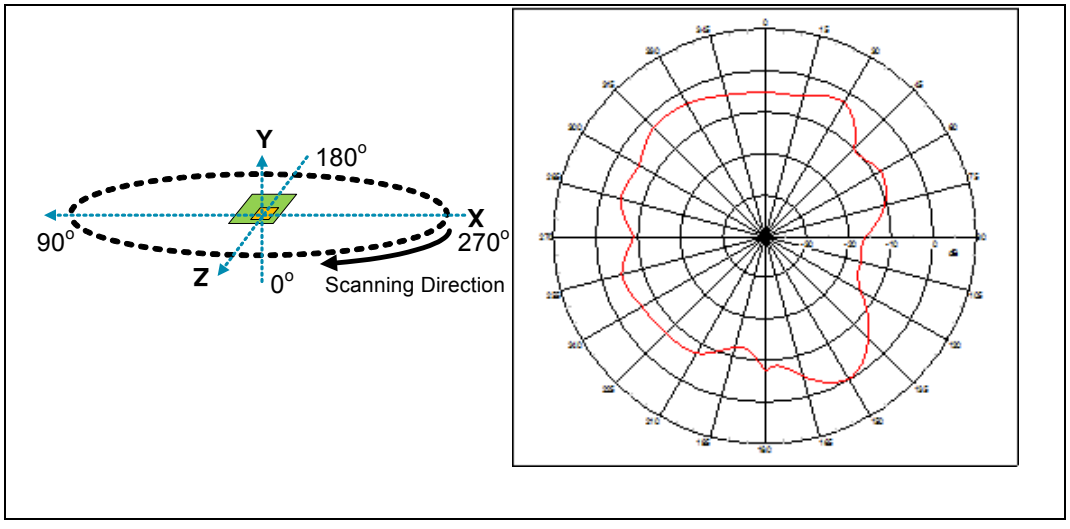


6.2 2.44 GHz

6.2.1 X-Z Plane

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

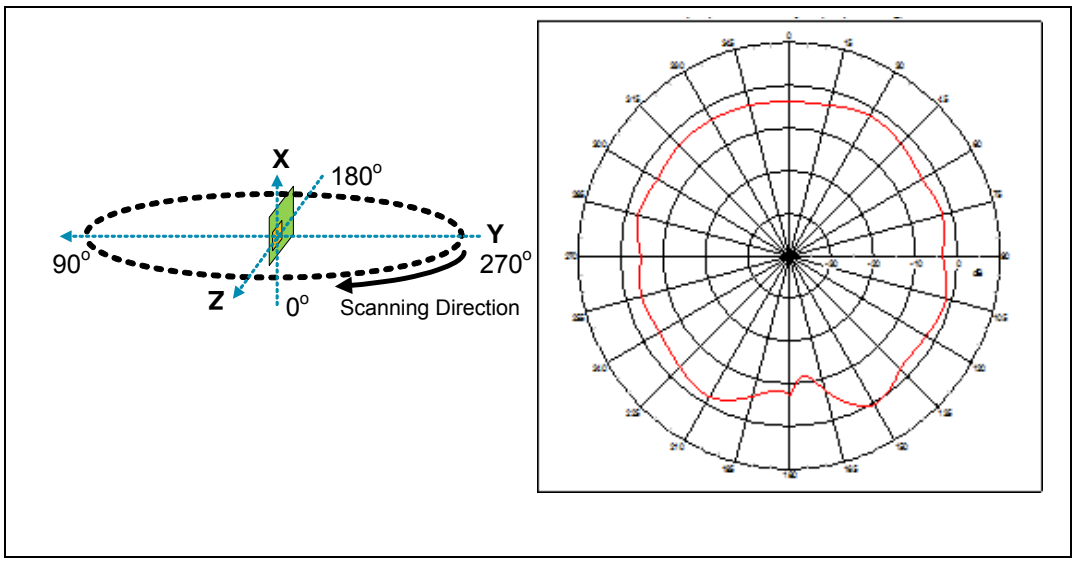
Figure 7. 2.44 GHz, X-Z Plane



6.2.2 Y-Z Plane

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

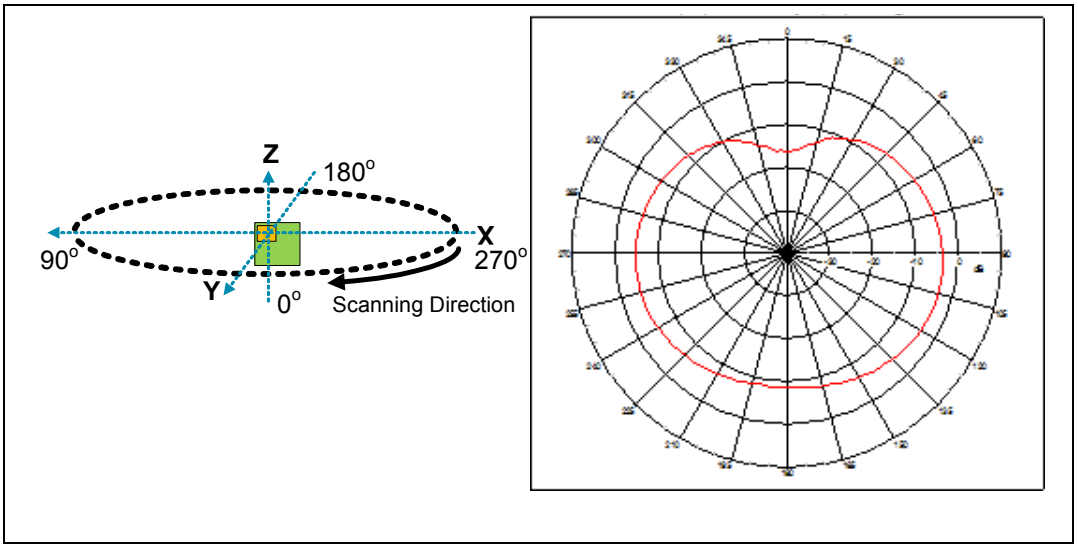
Figure 8. 2.44 GHz, Y-Z Plane



6.2.3 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

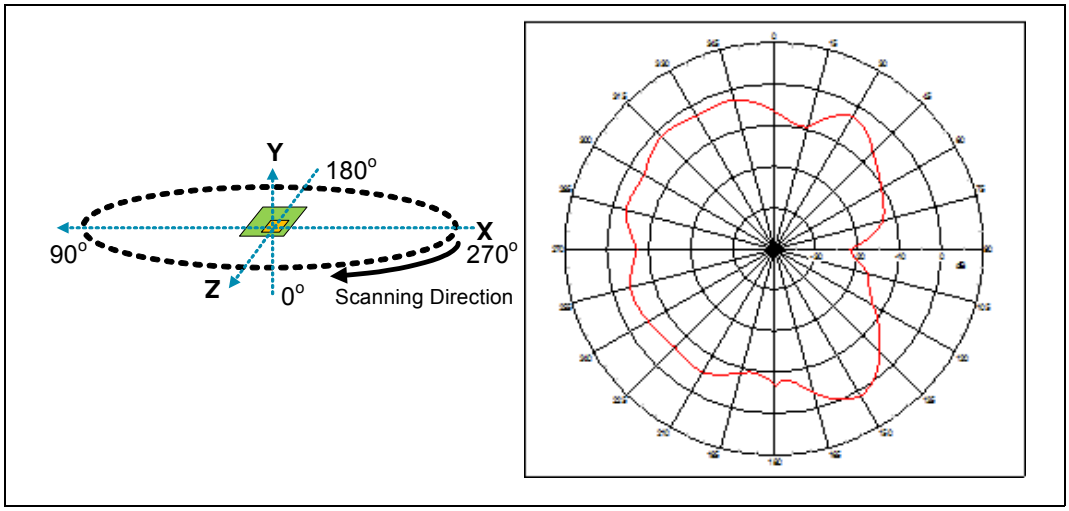


6.3 2.48 GHz

6.3.1 X-Z Plane

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

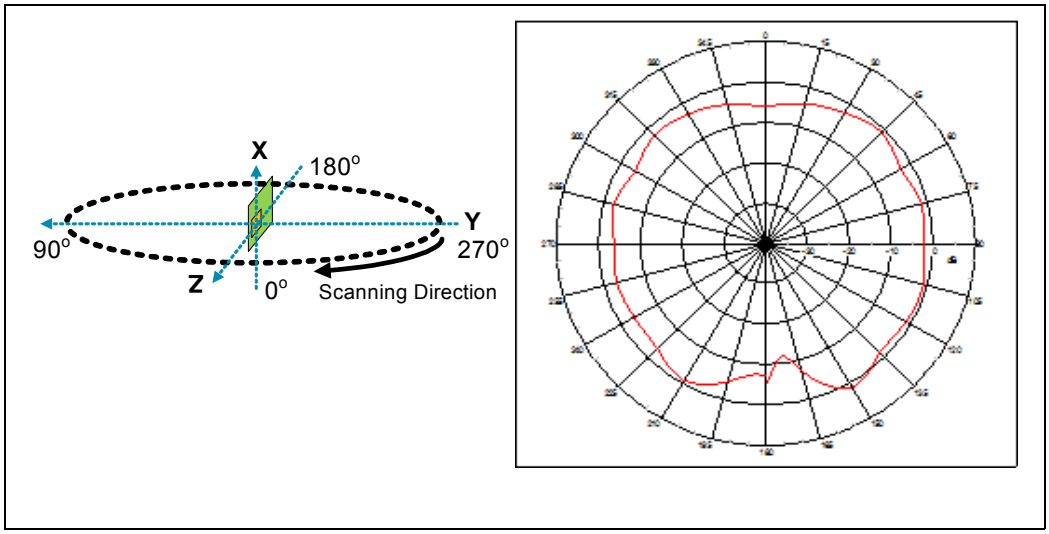
Figure 10. 2.48 GHz, X-Z Plane



6.3.2 Y-Z Plane

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

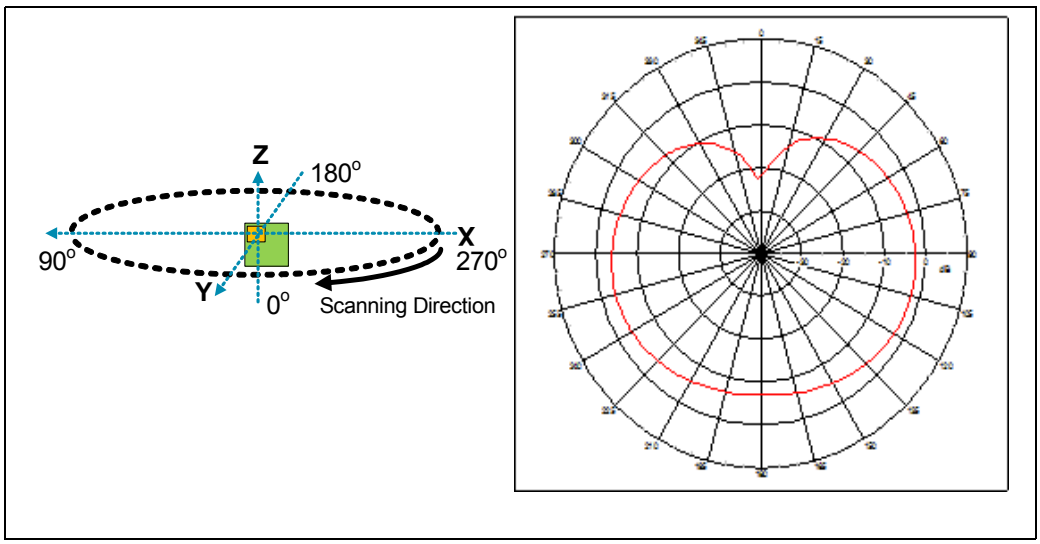
Figure 11. 2.48 GHz, Y-Z Plane



6.3.3 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



7 References

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

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

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

Document History Page

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Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	-	-	01/20/2016	Initial release
*A	5452851	UTSV	09/28/2016	Added Cypress Part Numbering Scheme and Mapping Table. Updated in Cypress template
*B	5787216	AESATMP9	06/27/2017	Updated logo and copyright.

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