

## Antenna Test Report

**Report No.: TEOT2204000165E4**

**Test Plan: Non-compliance with ISO17025**

**Applicant Name: Microchip technology**

**Manufacturer Name: Microchip technology**

**Product Name: WBZ450 LGA**

**Model Number: WBZ450 LGA**

**Measurements performed at  
SGS Taiwan Ltd.**

**Hwaya District, Taiwan**

**Issued Date: May 06, 2022**

|              | Name                       | Date & Signature                 | Distribution |
|--------------|----------------------------|----------------------------------|--------------|
| Prepared by: | Shawn Yen<br>Supervisor    | <i>Shawn Yen</i><br>May 06, 2022 |              |
| Approved by: | Dragon Wu<br>Asst. Manager | <i>Dragon Wu</i><br>May 06, 2022 |              |

## Measurement System Information

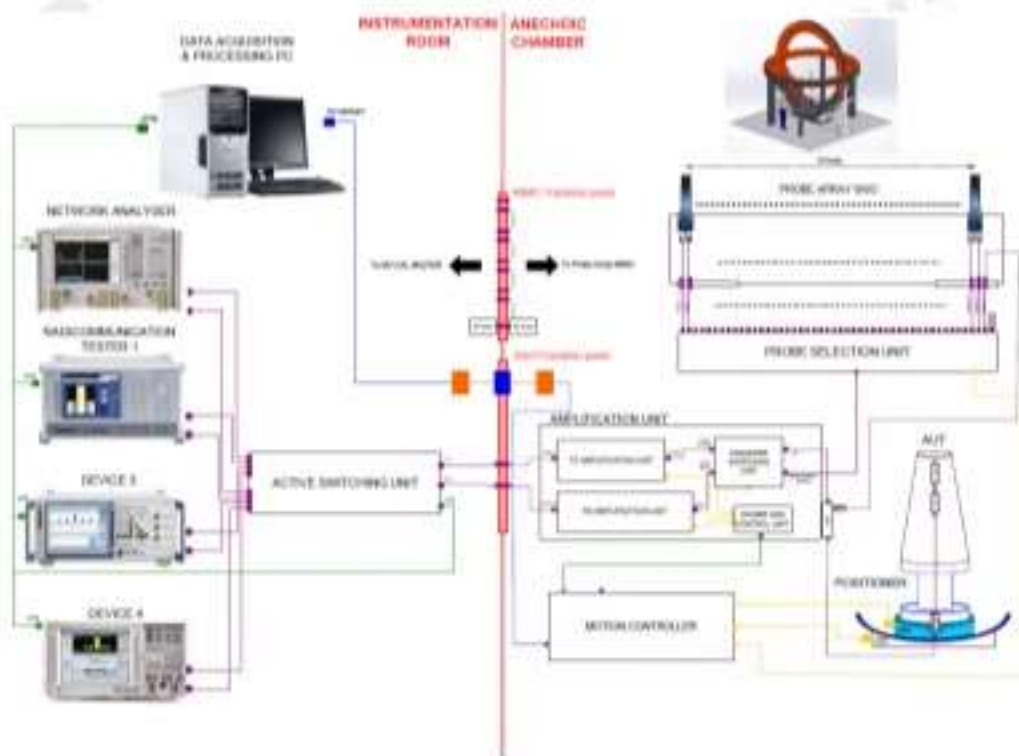
### General Information

#### Testing Condition:

- Temperature: 22±3°C
- Humidity: <80%

#### Measurement Facility:

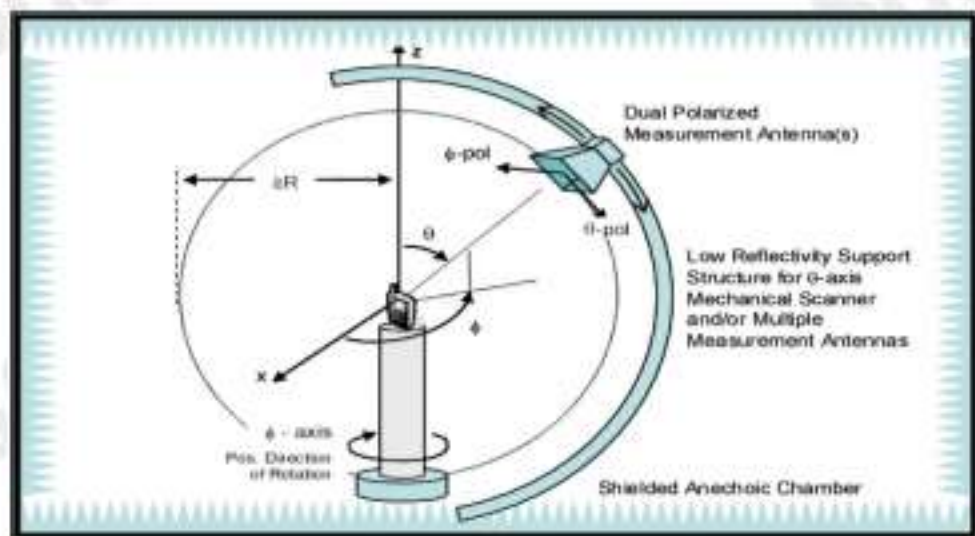
- Measurement Chamber: MVG 3D fully anechoic chamber and its measuring system (Stargate-24-L)
- Base Station Simulator: Anritsu MT8820C (or R&S CMU200)
- Network Analyzer: Agilent E5071C



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Measurements are performed in a MVG Stargate-24-L with the StarAct interface for a base station simulator. The Stargate-24-L has 23 probe antennas mounted with equal spacing on a circular arch. Electronic switching of the probe antennas provides outstanding measurement speed. The geometry of the setup, with only a Styrofoam column within 1.6 meters of the EUT, ensures minimum interference and low ripple on the measured radiation patterns. The DUT is placed on top of the pedestal, in the center of the system.

#### Typical Setup for MVG Stargate-24-L:



#### Instruments View



#### Inside View



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**Testing Laboratory: Identification of the Responsible Test Laboratory.****OTA Laboratory:****SGS Taiwan Ltd. Wireless Laboratory**

No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803.

Telephone: +886 2 2299 3279

Fax: +886 2 2298 0488

Internet: <http://www.tw.sgs.com>

**Testing Location:**

No. 2, Keji 1<sup>st</sup> Rd., Hwaya Technology Park, Guishan District, Taoyuan City, Taiwan 33383.

**Details of Applicant:**

|                             |                                                                              |
|-----------------------------|------------------------------------------------------------------------------|
| <b>Applicant's name:</b>    | Microchip technology                                                         |
| <b>Applicant's address:</b> | 6F, No.24-2, Industry E. RD. IV, HsinChu Science Park, HsinChu 30077, Taiwan |
| <b>Contact person:</b>      | Yeung Kai Hong                                                               |
| <b>Telephone:</b>           | +886-3-577-8366 ext 8764                                                     |
| <b>Fax:</b>                 | N/A                                                                          |
| <b>E-mail:</b>              | hong.yeung@microchip.com                                                     |

**Details of Manufacturer:**

|                                |                                                                              |
|--------------------------------|------------------------------------------------------------------------------|
| <b>Manufacturer's name:</b>    | Microchip technology                                                         |
| <b>Manufacturer's address:</b> | 6F, No.24-2, Industry E. RD. IV, HsinChu Science Park, HsinChu 30077, Taiwan |
| <b>Contact person:</b>         | Yeung Kai Hong                                                               |
| <b>Telephone:</b>              | +886-3-577-8366 ext 8764                                                     |
| <b>Fax:</b>                    | N/A                                                                          |
| <b>E-mail:</b>                 | hong.yeung@microchip.com                                                     |

**Details of EUT:**

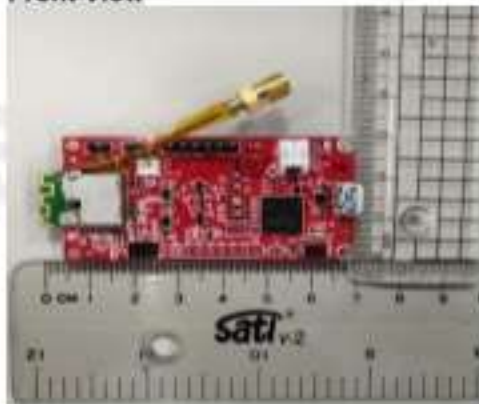
|                             |                                       |
|-----------------------------|---------------------------------------|
| <b>Device Description:</b>  | WBZ450 LGA                            |
| <b>Device Manufacturer:</b> | Microchip technology                  |
| <b>Device Model:</b>        | WBZ450 LGA                            |
| <b>Hardware Version:</b>    | N/A                                   |
| <b>Software Version:</b>    | N/A                                   |
| <b>Frequency Range:</b>     | 2400MHz ~ 2500MHz<br>Step size: 10MHz |
| <b>Antenna Type:</b>        | Internal antenna                      |

**PCB antenna Curiosity board Matching**

|                                 |       |                   |
|---------------------------------|-------|-------------------|
| C15                             | 2.5pF | GJM0335C1H2R5BB01 |
| C25                             | 2.3nH | LQP03HQ2N3B02     |
| <b>12" x 14" board Matching</b> |       |                   |
| C15                             | 2.2pF | GJM0335C1H2R2BB01 |
| C25                             | 2.3nH | LQP03HQ22N3B02    |

**Duration of Tests:**

|                             |            |
|-----------------------------|------------|
| <b>Sample Receive Date:</b> | 2022-04-27 |
| <b>Test Starting Date:</b>  | 2022-04-27 |
| <b>Test Ending Date:</b>    | 2022-04-27 |
| <b>Report Issued Date:</b>  | 2022-05-06 |

**Photographs of EUT:****Front View****Back View**

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## List of Equipment

## Equipment Summary Sheet

| Equipment Description                | Manufacturer | Identification no. | Current calibration date | Next calibration date |
|--------------------------------------|--------------|--------------------|--------------------------|-----------------------|
| Universal Radio Communication tester | Anritsu      | MT8820C            | 2021/10/12               | 2022/10/11            |
| Network Analyzer                     | Agilent      | E5071C             | 2022/01/12               | 2023/01/11            |
| Sleeve Dipole                        | MVG          | SD740              | 2022/01/07               | 2025/01/06            |
| Dual Ridge Horn                      | MVG          | SH800              | 2021/11/09               | 2022/11/08            |
| Dipole antenna                       | ETS-Lindgren | 3126-700           | 2020/10/13               | 2023/10/12            |
| Stargate-24-L probe array            | MVG          | Stargate-24-L      | 2021/11/11               | 2022/11/10            |
| Measurement software                 | MVG          | SPM V1.9           | N/A                      | N/A                   |

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## Antenna Gain and Efficiency

| WBZ450 LGA |                |            |               |
|------------|----------------|------------|---------------|
| Freq(MHz)  | Peak Gain. dBi | Efficiency | Average . dBi |
| 2400.00    | 2.82           | 40.78%     | -3.90         |
| 2410.00    | 3.31           | 45.82%     | -3.39         |
| 2420.00    | 3.69           | 49.01%     | -3.10         |
| 2430.00    | 3.91           | 50.21%     | -2.99         |
| 2440.00    | 4.14           | 52.63%     | -2.79         |
| 2450.00    | 4.08           | 52.34%     | -2.81         |
| 2460.00    | 3.86           | 50.13%     | -3.00         |
| 2470.00    | 3.79           | 48.91%     | -3.11         |
| 2480.00    | 3.48           | 45.69%     | -3.40         |
| 2490.00    | 3.14           | 43.13%     | -3.65         |
| 2500.00    | 2.60           | 40.30%     | -3.95         |

## Test Setup

Front View



Side View

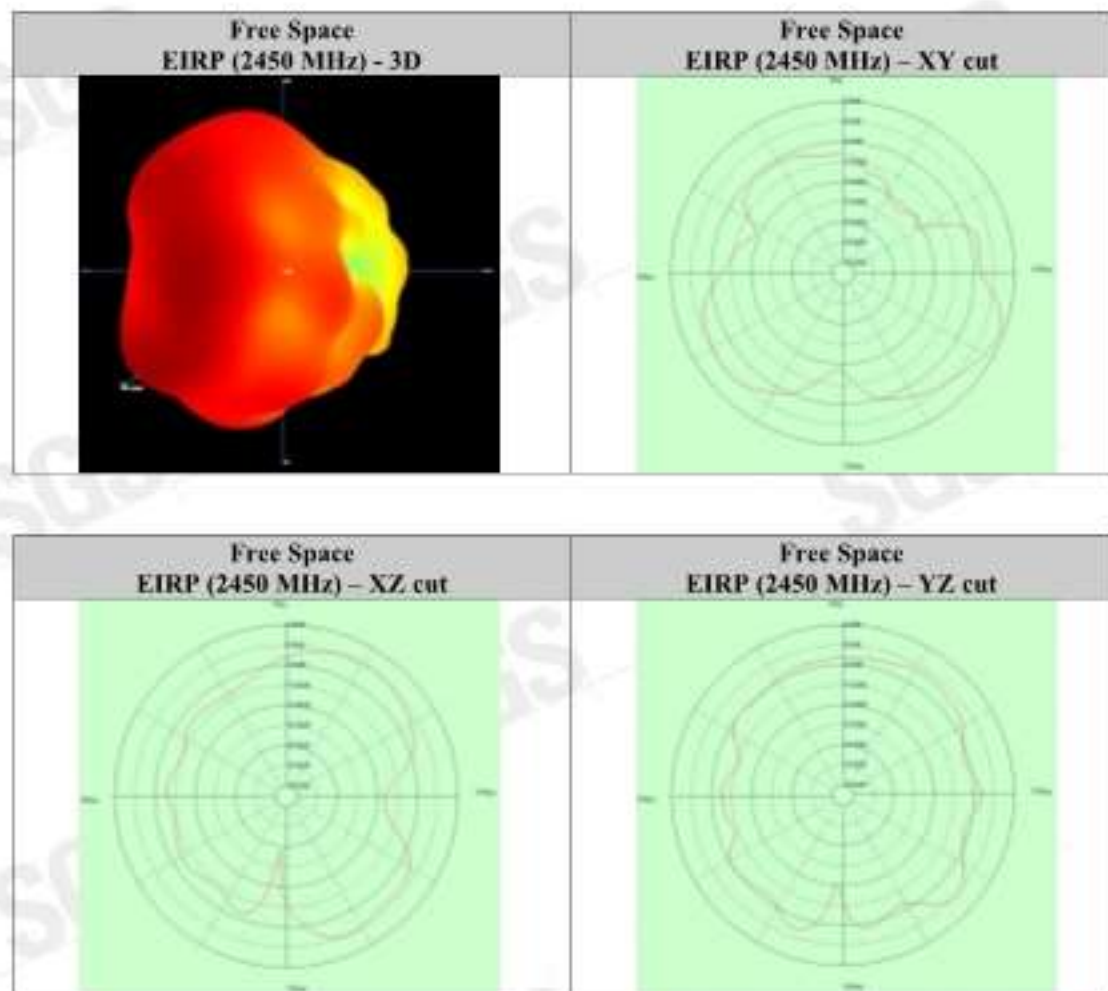


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## Antenna 3D Plot Matrix

All plots in this section show the total EIRP ( $EIRP_{\theta} + EIRP_{\phi}$ ) with the +x-axis pointing out of the page, +y-axis pointing right, and +z-axis pointing up.



## End of Report

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## 2.4 GHz – 2.5 GHz Dipole 2dBi Antenna for Reverse Polarity SMA



### ORDERING INFORMATION

| Order Number | Description                                                |
|--------------|------------------------------------------------------------|
| 001-0001     | 2.4 GHz Dipole Antenna for Reverse Polarity SMA Connector. |
| 080-0001     | U.FL to Reverse Polarity SMA Cable, 105mm                  |

Table 1 Orderable Part Numbers

### SPECIFICATIONS

| Specification  | Value             |
|----------------|-------------------|
| Peak Gain      | +2 dBi            |
| Impedance      | 50 ohms, Nominal  |
| Type           | Dipole            |
| Polarization   | Linear Vertical   |
| VSWR           | ≤2.5 : 1, Maximum |
| Frequency      | 2400-2500MHz      |
| Weight         | 13g               |
| Size           | 105×10 mm         |
| Antenna Color  | Black             |
| Operating Temp | -20°C to +65°C    |
| UL Rating      | UL 94HB           |

Table 2 Specifications

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## PHYSICAL DIMENSIONS (MM)

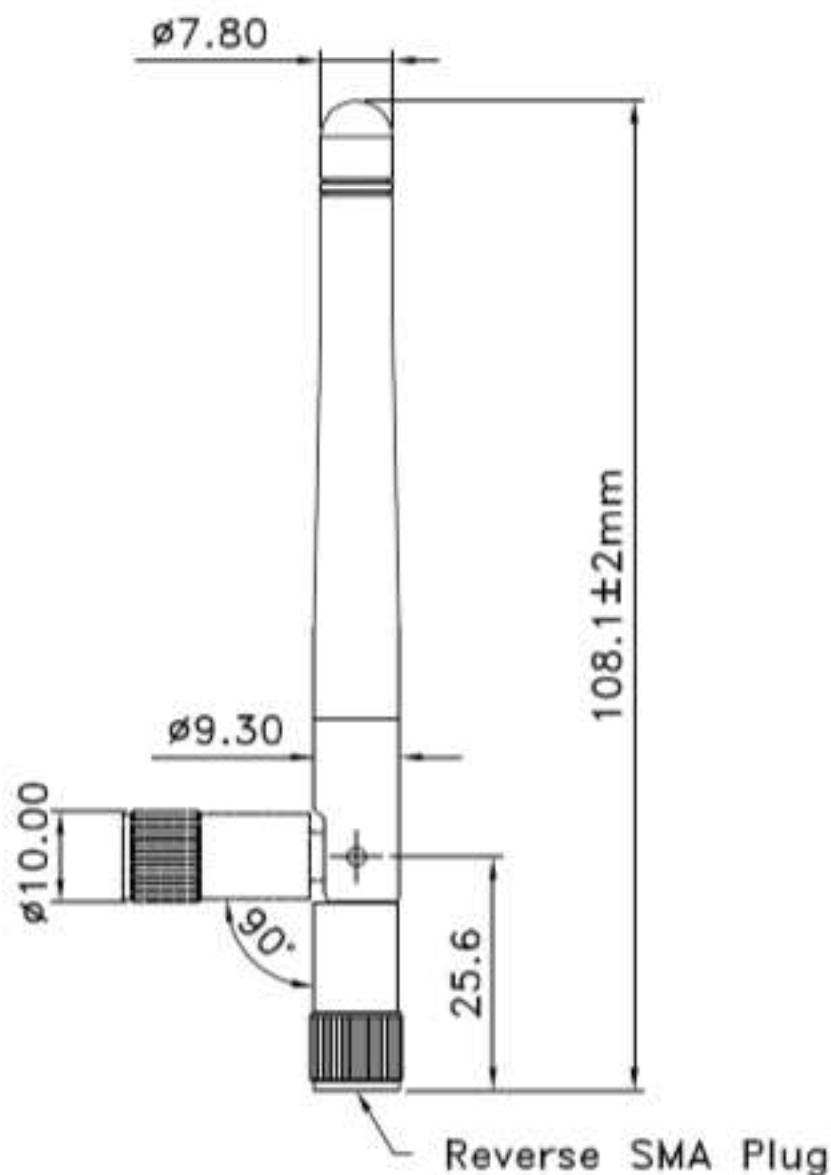


Figure 1 Physical Dimensions

## TYPICAL ANTENNA REFLECTION PERFORMANCE

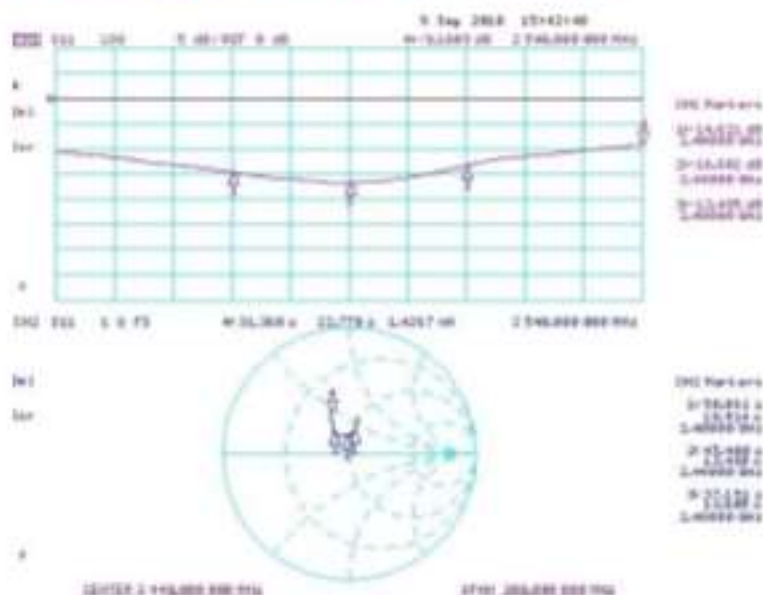


Figure 2 Reflection Parameters for Extended Configuration (S11)

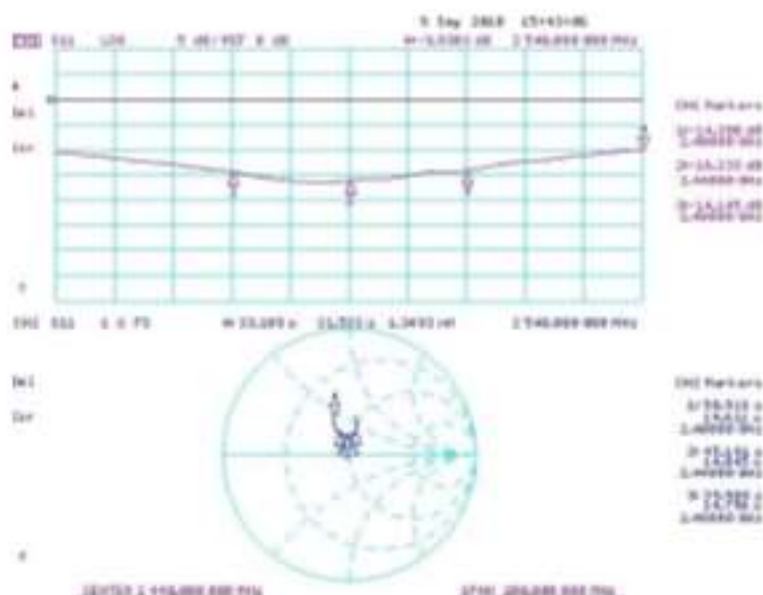
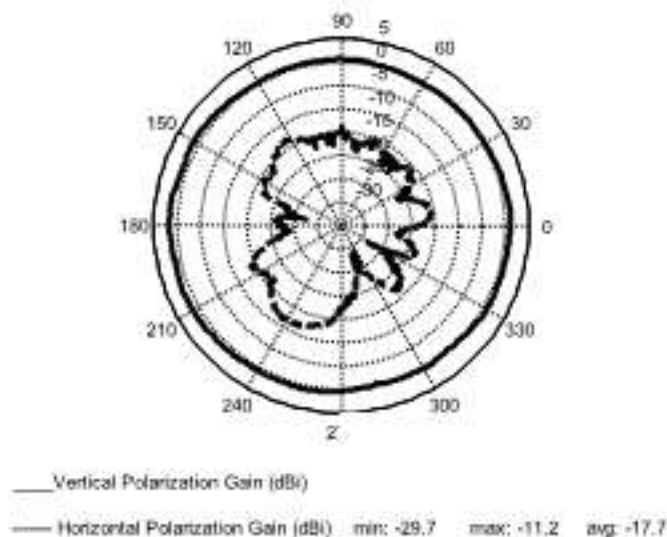


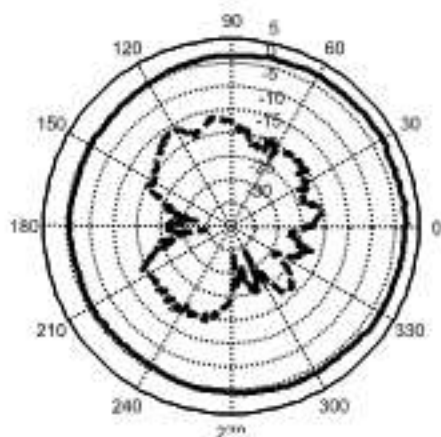
Figure 3 Reflection Parameters for Folded Configuration (S11)

## TYPICAL ANTENNA RADIATION PERFORMANCE

### LSR ANTENNA STRAIGHT 2405 MHz

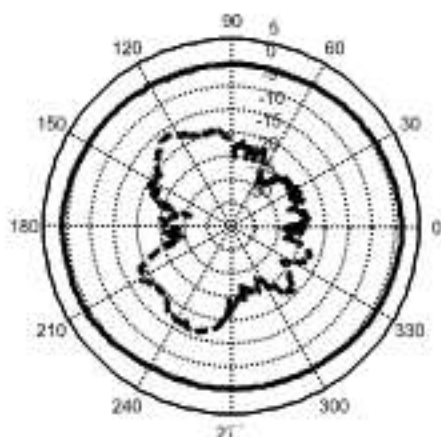


## LSR ANTENNA STRAIGHT 2440 MHz



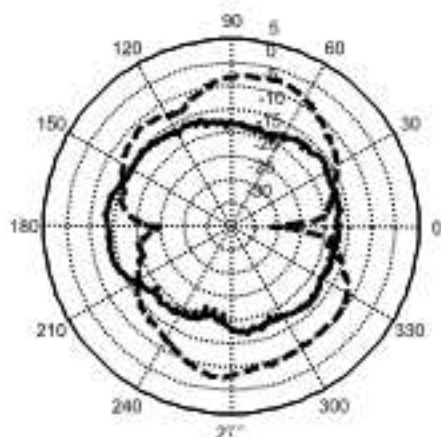
— Vertical Polarization Gain (dBi)  
 — Horizontal Polarization Gain (dBi) min: -28.0 max: -11.4 avg: -17.2

## LSR ANTENNA STRAIGHT 2480 MHz



— Vertical Polarization Gain (dBi)  
 — Horizontal Polarization Gain (dBi) min: -28.0 max: -11.1 avg: -17.7

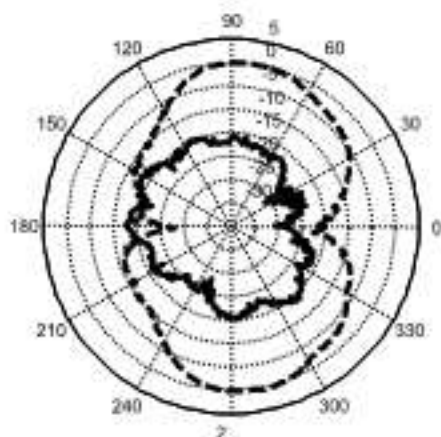
## LSR ANTENNA BENT 2405 MHz



— Vertical Polarization Gain (dBi)

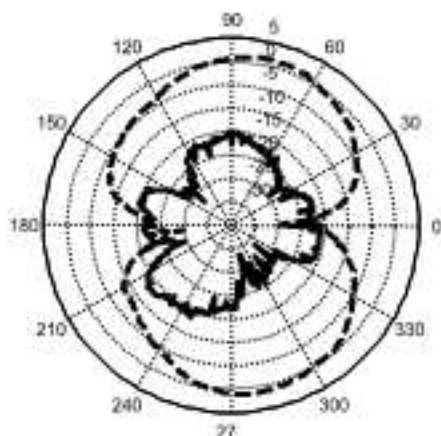
--- Horizontal Polarization Gain (dBi) min: -26.2 max: -2.1 avg: -8.9

## LSR ANTENNA BENT 2440 MHz



— Vertical Polarization Gain (dBi)  
 — Horizontal Polarization Gain (dBi) min: -22.8 max: +0.6 avg: -7.1

## LSR ANTENNA BENT 2480 MHz



— Vertical Polarization Gain (dBi)  
 — Horizontal Polarization Gain (dBi) min: -24.7 max: +1.4 avg: -5.7

---

**CONTACTING LS RESEARCH**

|                          |                                                                                                                                |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>Headquarters</b>      | LS Research, LLC<br>W66 N220 Commerce Court<br>Cedarburg, WI 53012-2636<br>USA<br>Tel: 1(262) 375-4400<br>Fax: 1(262) 375-4248 |
| <b>Website</b>           | <a href="http://www.lsr.com">www.lsr.com</a>                                                                                   |
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| <b>Sales Contact</b>     | <a href="mailto:sales@lsr.com">sales@lsr.com</a>                                                                               |

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## FEATURES AND BENEFITS

- Dual band antenna – 2.4 GHz and 5.5 GHz
- Quick and easy installation
- Adhesive holds to surface during humidity exposure and hot/cold cycles
- RoHS-compliant
- Can be installed in the following ways:
  - On different non-conductive surfaces and thicknesses
  - Near metals or the human body
  - On flat or curved surfaces

| SPECIFICATIONS     |                                       |             |
|--------------------|---------------------------------------|-------------|
| Frequency (MHz)    | 2400 - 2480                           | 4900 - 5900 |
| Peak Gain (dBi)    | +2.5                                  | +3.0        |
| Average Gain (dBi) | > -2.5                                | > -3.4      |
| VSWR (MHz)         | <2.5:1                                | <3.0:1      |
| Impedance (Ω)      | 50                                    |             |
| Antenna Type       | Flexible Planar Inverted F (FlexPIFA) |             |
| Polarization       | Linear                                |             |

| MECHANICAL SPECIFICATIONS          |                                        |     |
|------------------------------------|----------------------------------------|-----|
| Dimensions – mm (inches)           | 38.5 x 12.7 x 2.5 (1.52 x 0.5 x 0.098) |     |
| Weight – g (oz.)                   | 1.13 (0.040)                           |     |
| Color                              | Clear yellow                           |     |
| Adhesive                           | 3M 100MP                               |     |
| Connector Mating Height (max) – mm | MHF1 (U.FL)                            | 2.5 |
|                                    | MHF4L                                  | 1.4 |

| ENVIRONMENTAL SPECIFICATIONS    |                              |
|---------------------------------|------------------------------|
| Operating Temperature – °C (°F) | -40 to +85°C (-40 to +185°F) |
| Material Substance Compliance   | RoHS                         |

## CONFIGURATION

| PART NUMBER       | CABLE LENGTH | CONNECTOR |
|-------------------|--------------|-----------|
| 001-0016          | 100 mm       | U.FL      |
| 001-0021          | 100 mm       | MHF4L     |
| EFB2455A3S-16MHF1 | 160 mm       | MHF4L     |

# MECHANICAL DRAWING

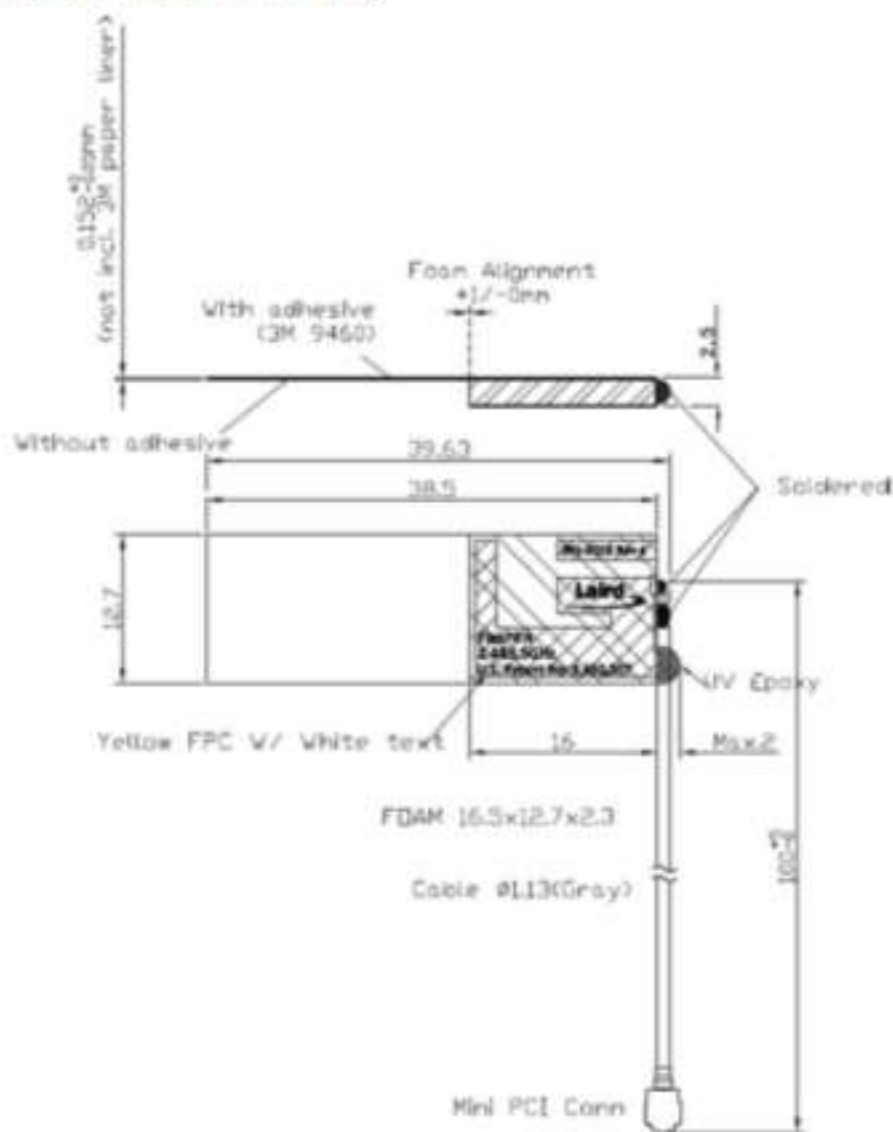


Figure 1: FlexPIFA mechanical drawing

## TEST SETUP

Antenna measurements such as VSWR were measured with an Agilent E5071C vector network analyzer. Radiation patterns were measured with a CMT Planar 804/1 vector network analyzer in a Howland Company 3100 chamber equivalent. Phase center is nine inches above the Phi positioner.

Flat surface measurements were done with the antenna centered on a 1.5 mm-thick plate of polycarbonate. Curved surface measurements were taken by placing the antenna on the inside and outside of different diameter PVC tubing.



*Figure 2: Antenna chamber*

## FI AT SURFACE ANTENNA MEASUREMENTS

### Return Loss

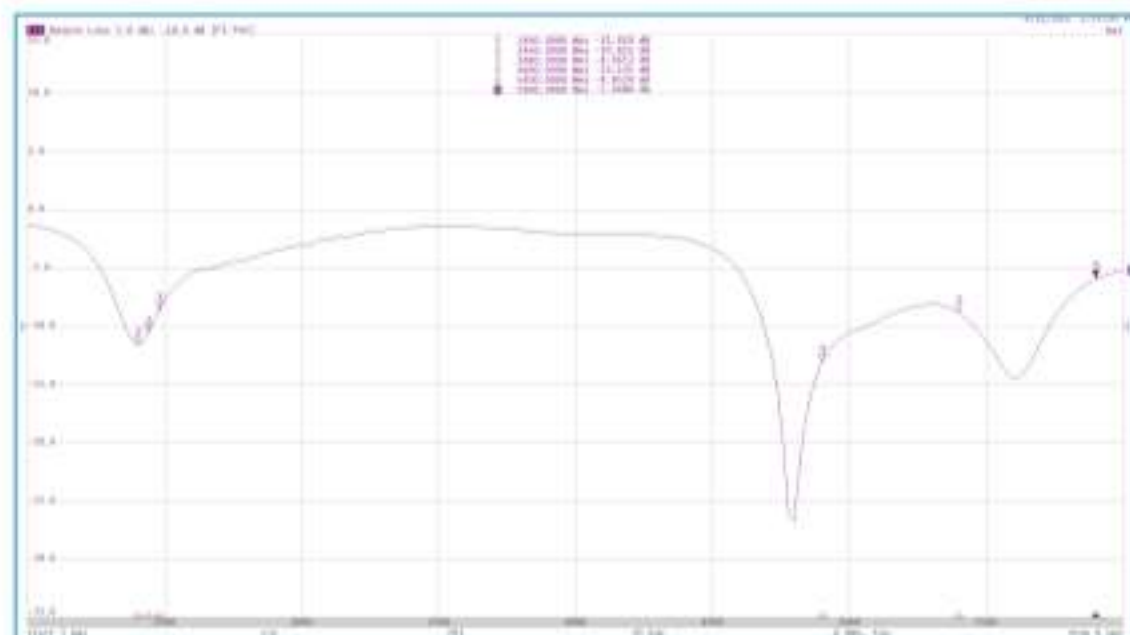


Figure 3: Antenna RL measured on a 1.5 mm-thick plate of polycarbonate

## FLAT SURFACE ANTENNA RADIATION PERFORMANCE

FlexPIFA centered on a 1.5 mm-thick plate of polycarbonate

*Antenna Measurement Set Up*

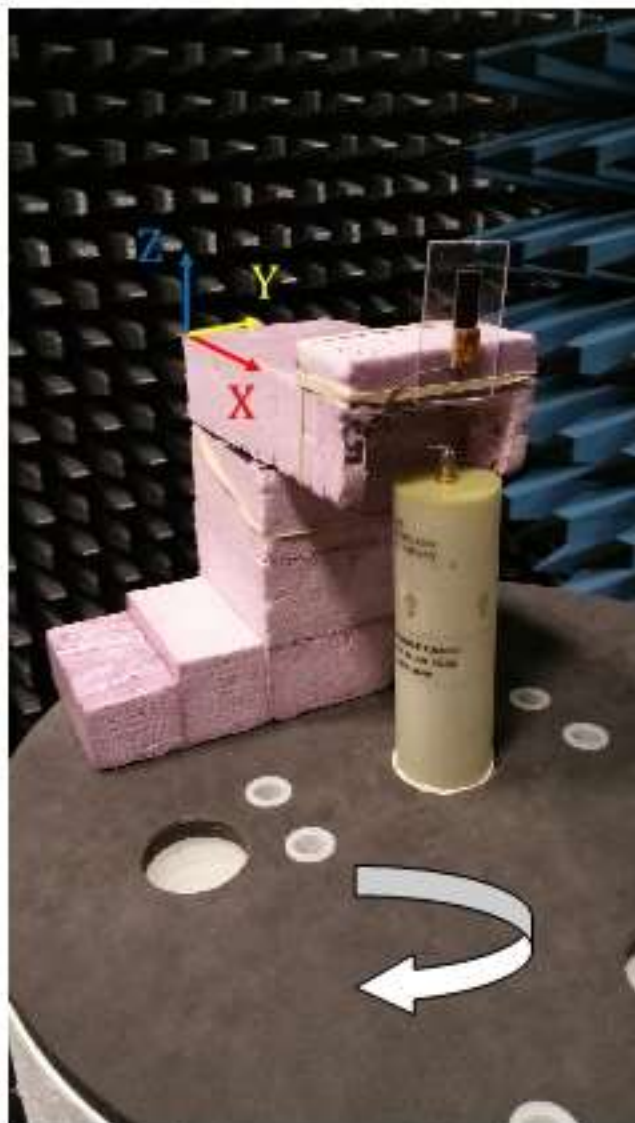
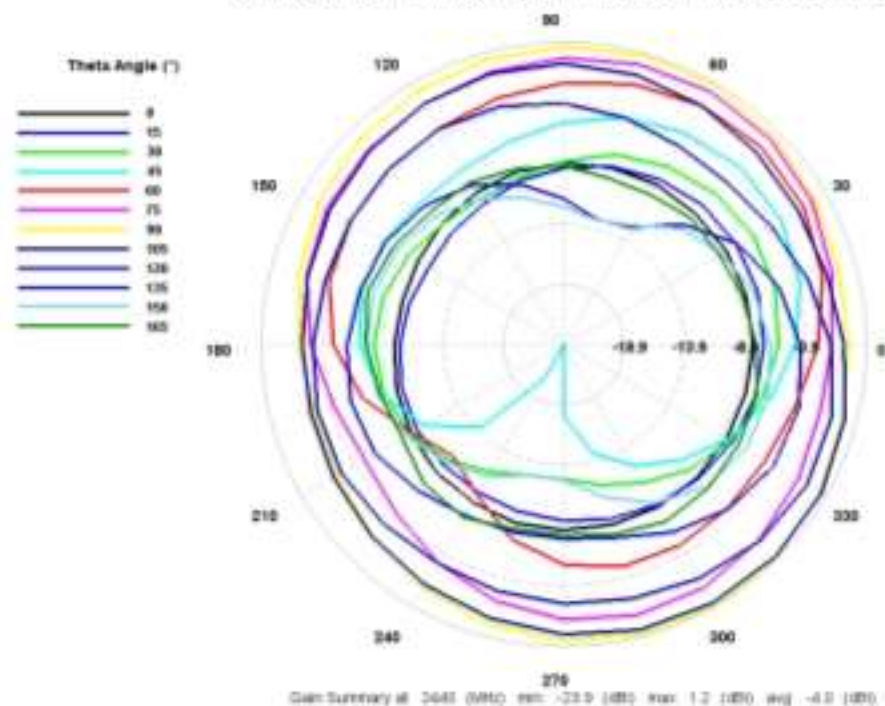


Figure 4: Flat surface setup

## 2.4 GHz Band

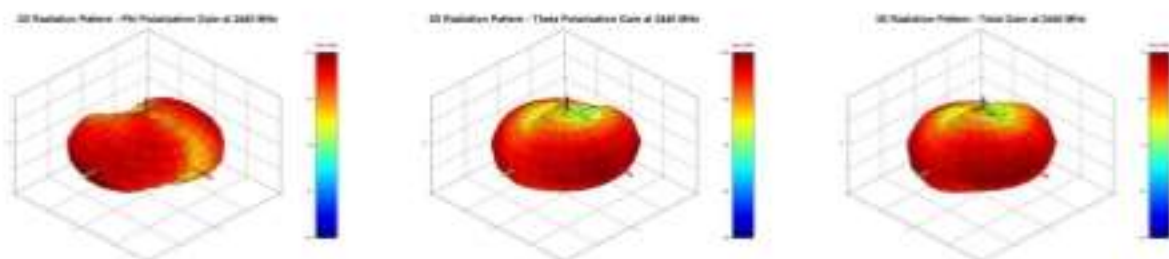
### Azimuthal Conical Cuts at 2440 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 2440 MHz**



**Figure 5: Total gain pattern**

### 3D Plots at 2440 MHz

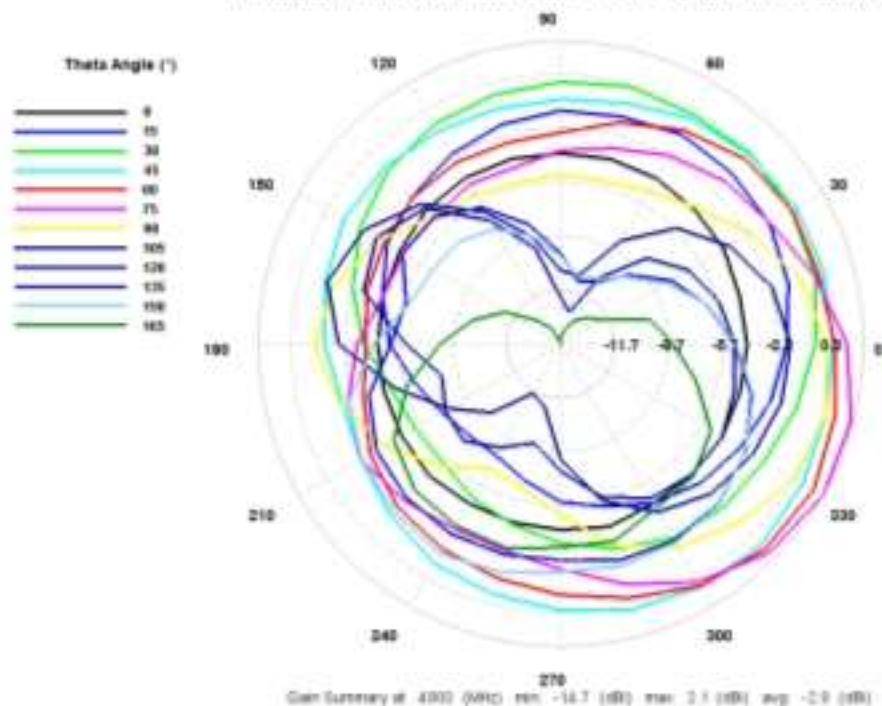


**Figure 6: Phi, Theta, and total gain plots**

## 5 GHz Band

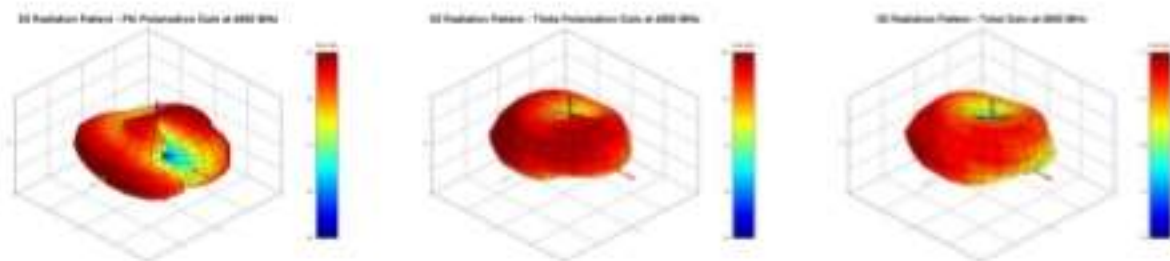
### Azimuthal Conical Cuts at 4900 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 4900 MHz**



**Figure 7: Total gain pattern**

### 3D Plots at 4900 MHz



**Figure 8: Phi, Theta, and total gain plots**

## Azimuthal Conical Cuts at 5400 MHz

### Azimuth Gain Pattern Cuts - Total Gain at 5400 MHz

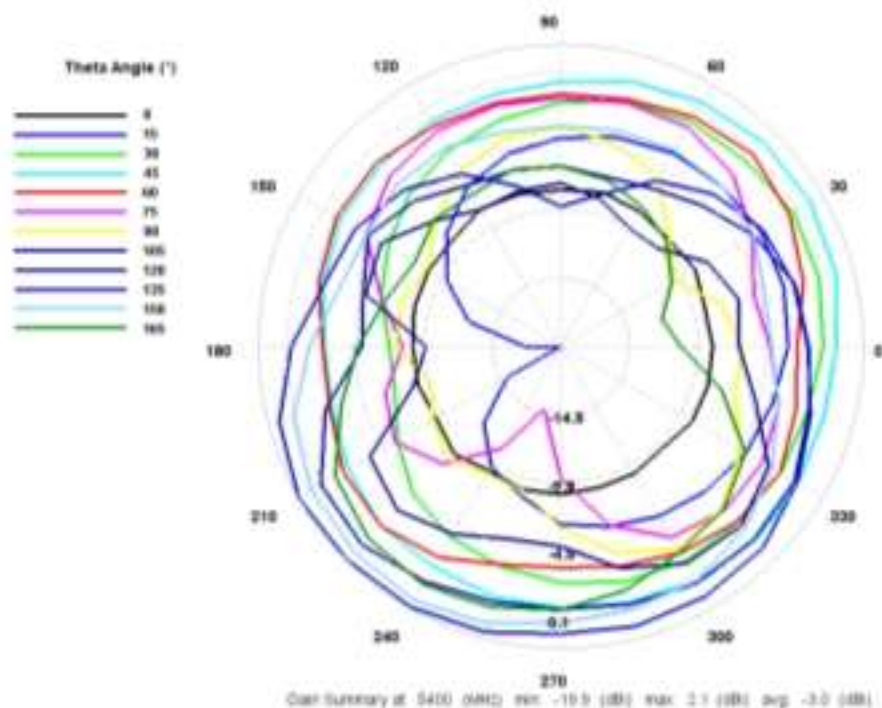


Figure 9: Total gain pattern

## 3D Plots at 5400 MHz

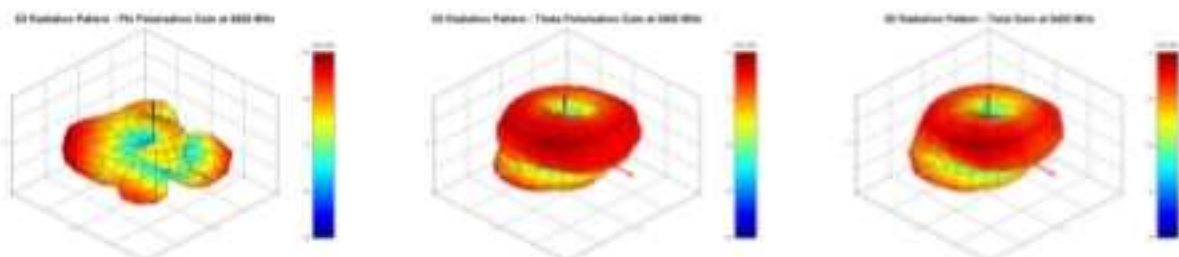
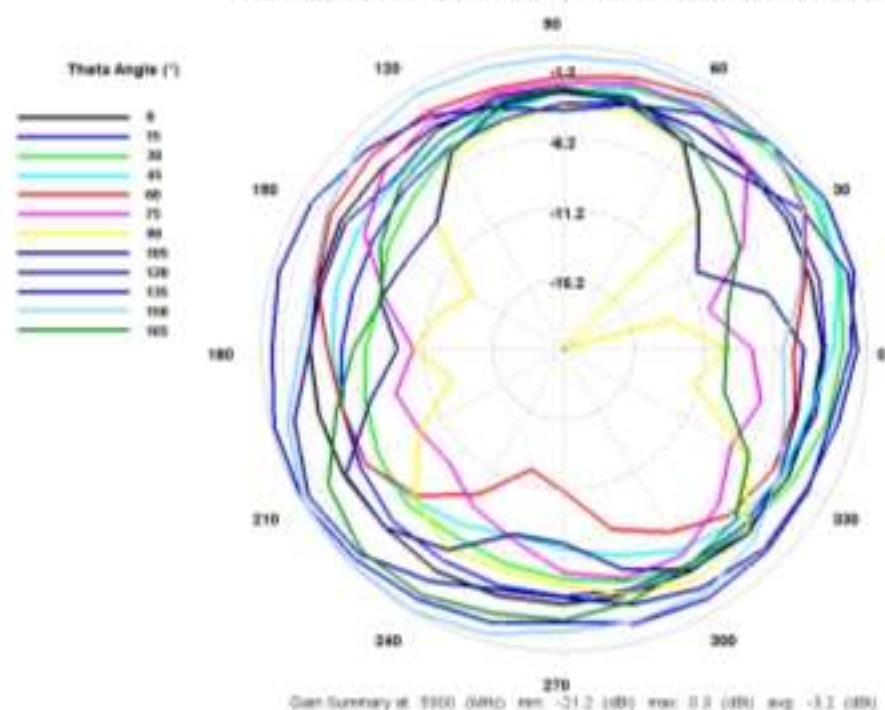


Figure 10: Phi, Theta, and total gain plots

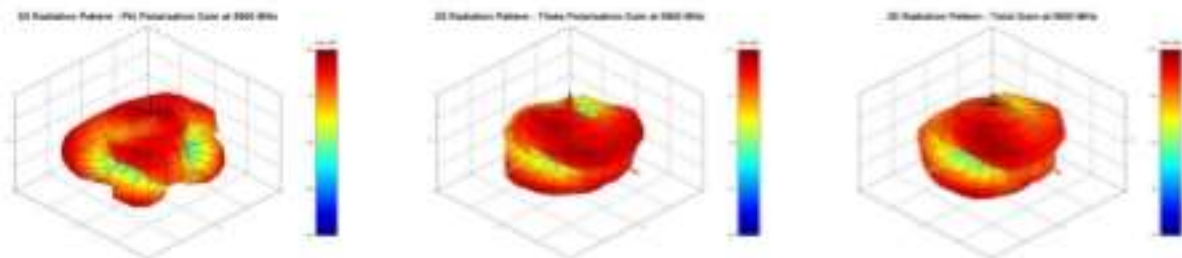
## Azimuthal Conical Cuts at 5900 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 5900 MHz**



**Figure 11: Total gain pattern**

## 3D Plots at 5900 MHz



**Figure 12: Phi, Theta, and total gain plots**

## CURVED SURFACE ANTENNA RADIATION PERFORMANCE

FlexPIFA outside 60 mm outer diameter PVC tube

Antenna Measurement Set Up

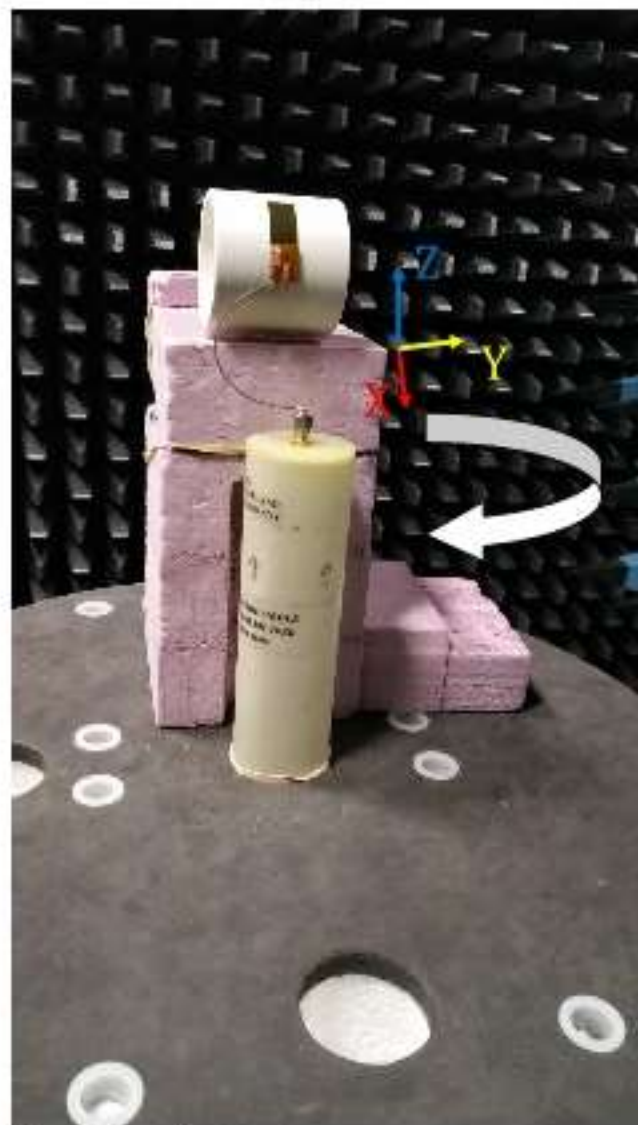
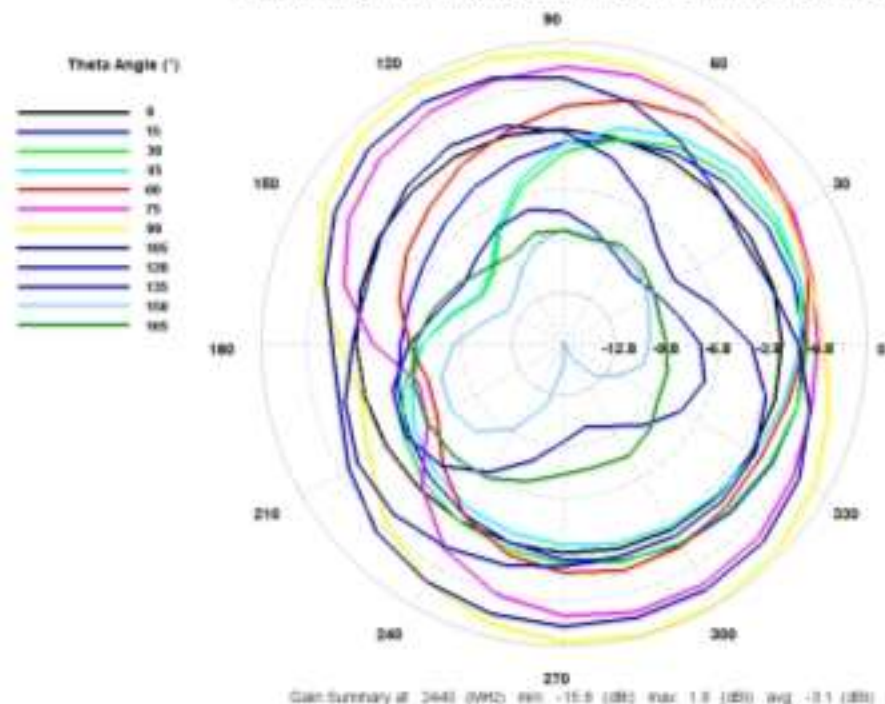


Figure 13: Outer diameter setup

## 2.4 GHz Band

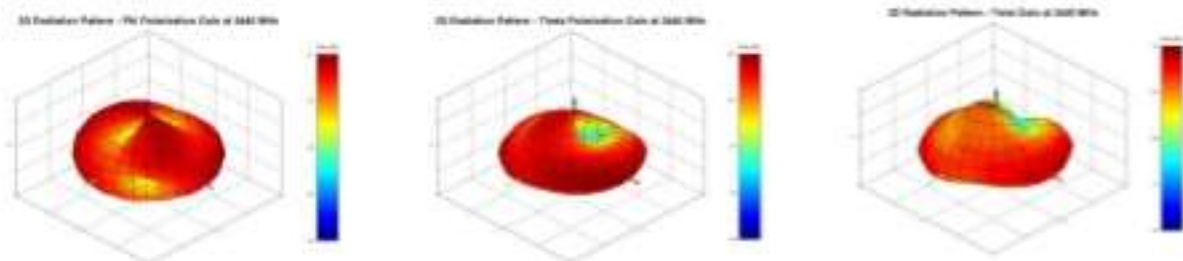
### Azimuthal Conical Cuts at 2440 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 2440 MHz**



**Figure 14: Total gain pattern**

### 3D Plots at 2440 MHz

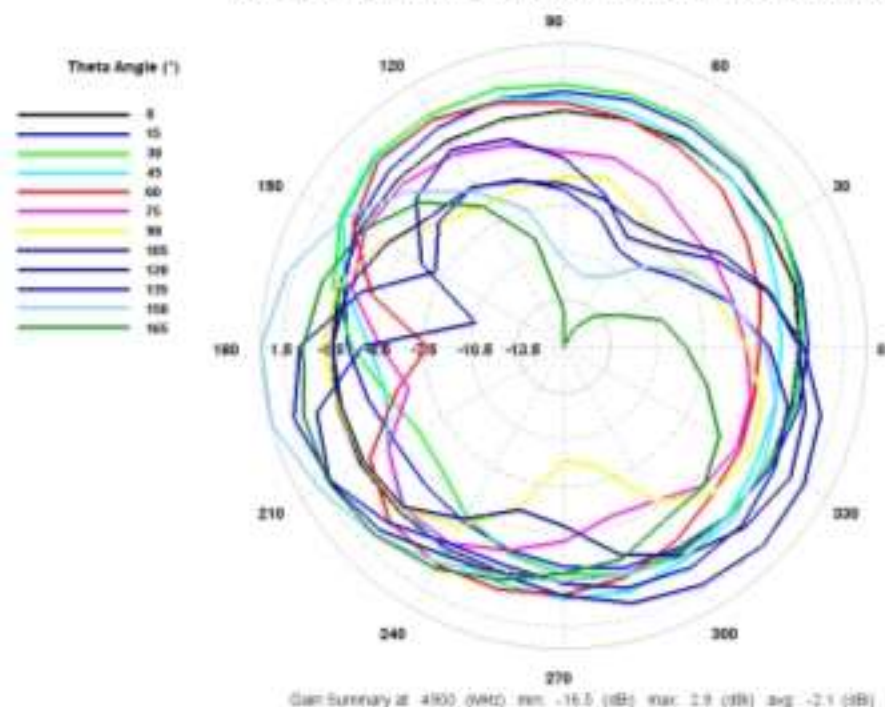


**Figure 15: Phi, Theta, and total gain plots**

## 5 GHz Band

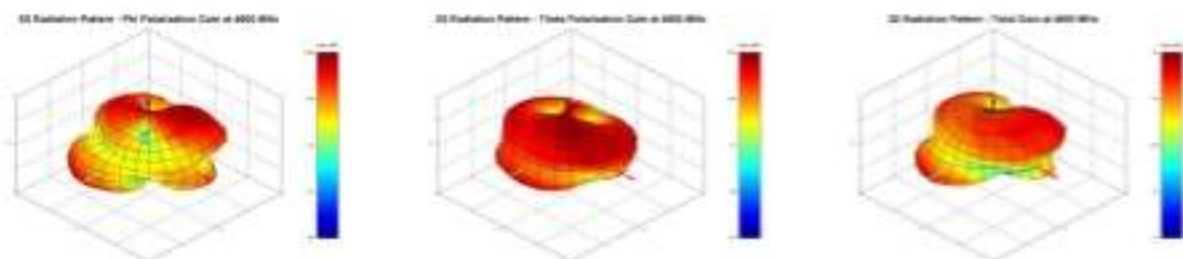
### Azimuthal Conical Cuts at 4900 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 4900 MHz**



**Figure 16: Total gain pattern**

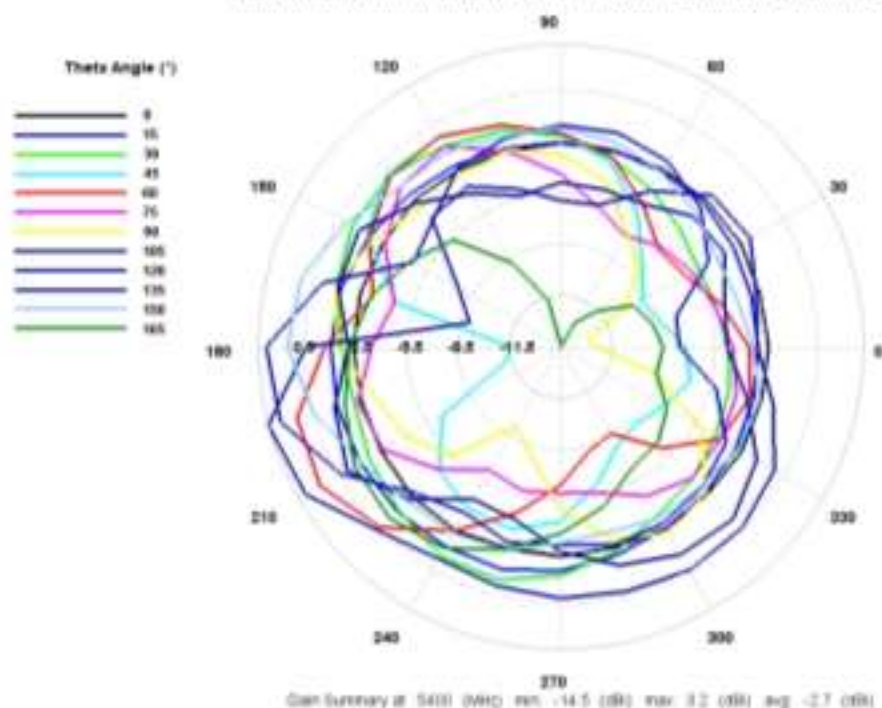
### 3D Plots at 4900 MHz



**Figure 17: Phi, Theta, and total gain plots**

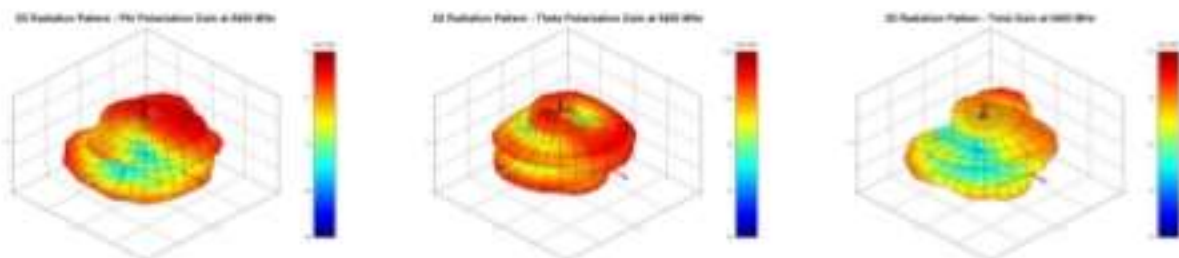
## Azimuthal Conical Cuts at 5400 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 5400 MHz**



**Figure 18: Total gain pattern**

## 3D Plots at 5400 MHz



**Figure 19: Phi, Theta, and total gain plots**

## Azimuthal Conical Cuts at 5900 MHz

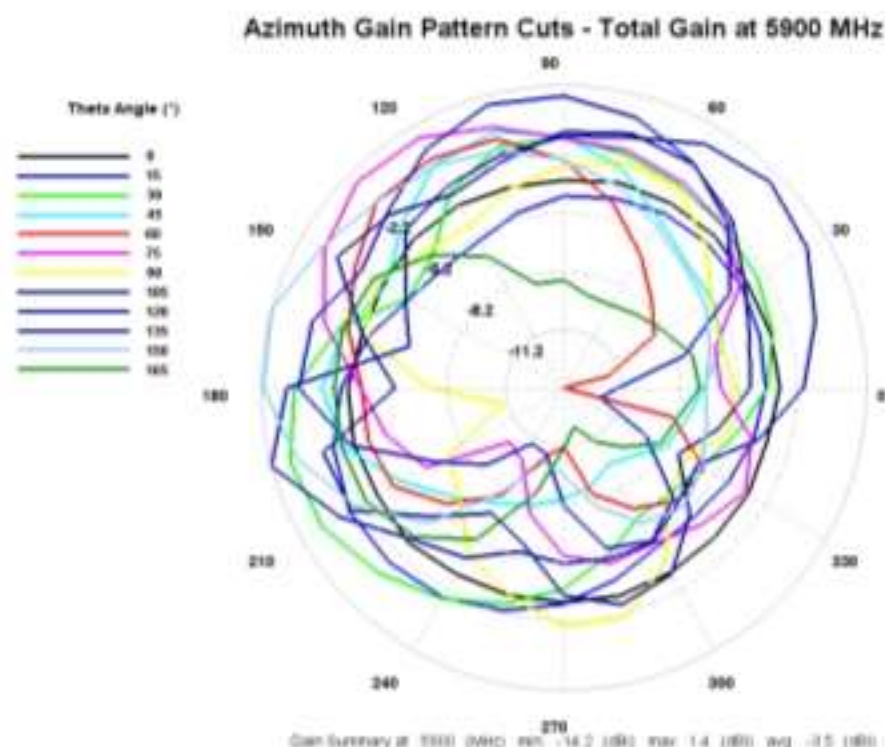


Figure 20: Total gain pattern

## 3D Plots at 5900 MHz

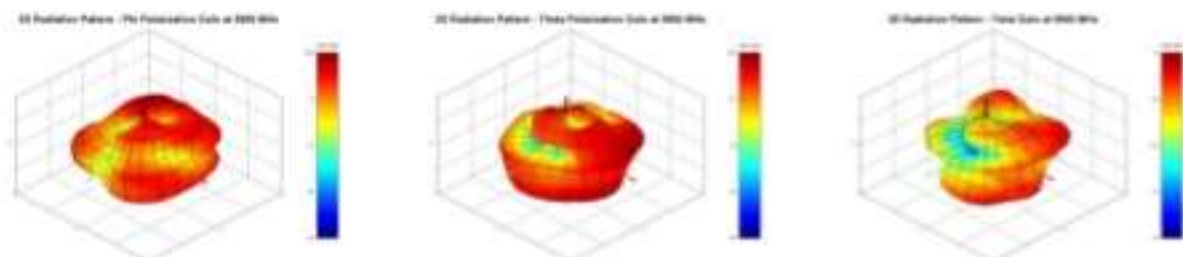


Figure 21: Phi, Theta, and total gain plots

FlexPIFA inside 52 mm inner diameter PVC tube

Antenna Measurement Setup

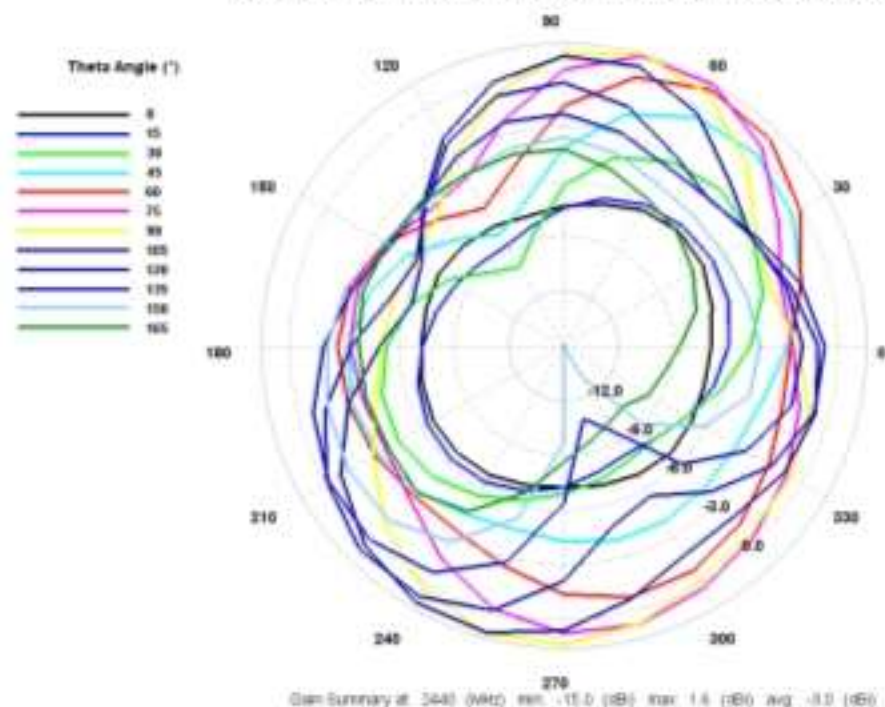


Figure 22: Inner diameter setup

## 2.4 GHz Band

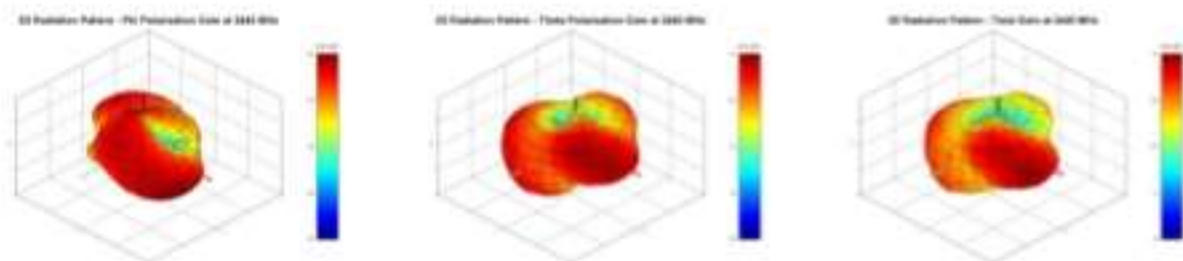
### Azimuthal Conical Cuts at 2440 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 2440 MHz**



**Figure 23: Total gain pattern**

### 3D Plots at 2440 MHz

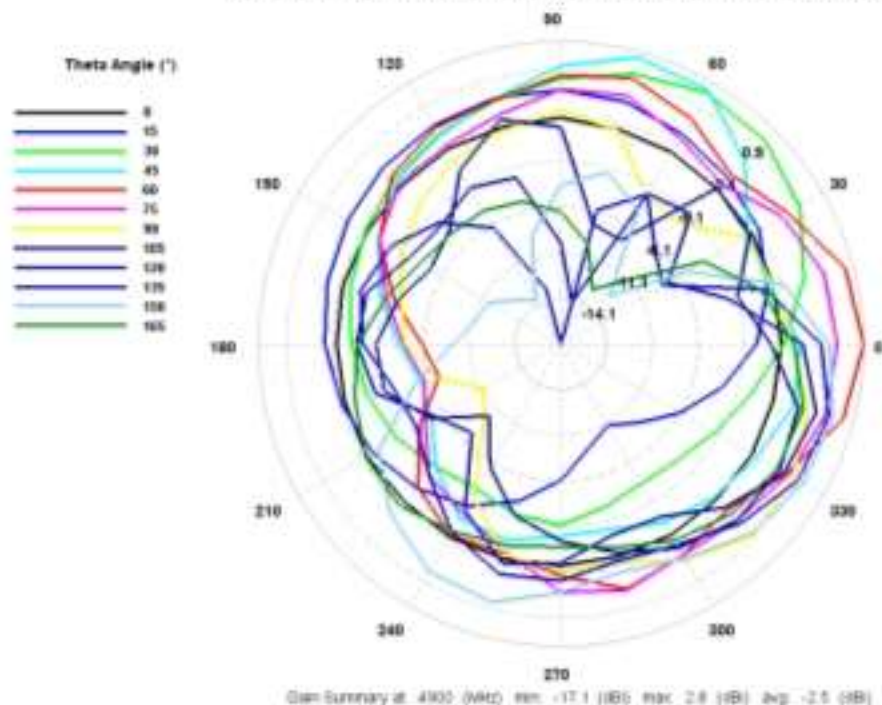


**Figure 24: Phi, Theta, and total gain plots**

## 5 GHz Band

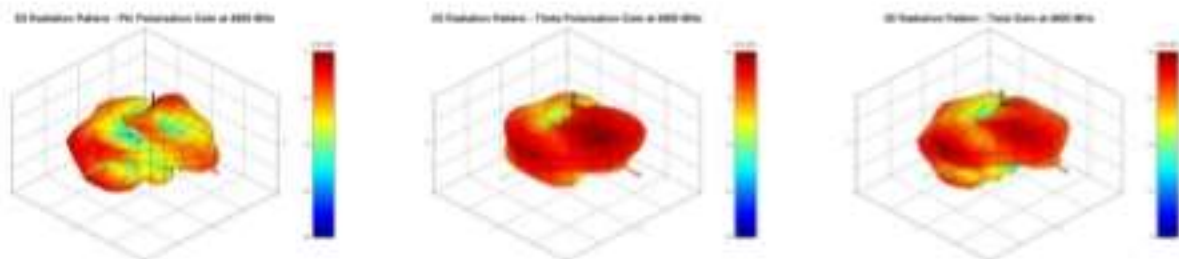
### Azimuthal Conical Cuts at 4900 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 4900 MHz**



**Figure 25: Total gain pattern**

### 3D Plots at 4900 MHz



**Figure 26: Phi, Theta, and total gain plots**

## Azimuthal Conical Cuts at 5400 MHz

### Azimuth Gain Pattern Cuts - Total Gain at 5400 MHz

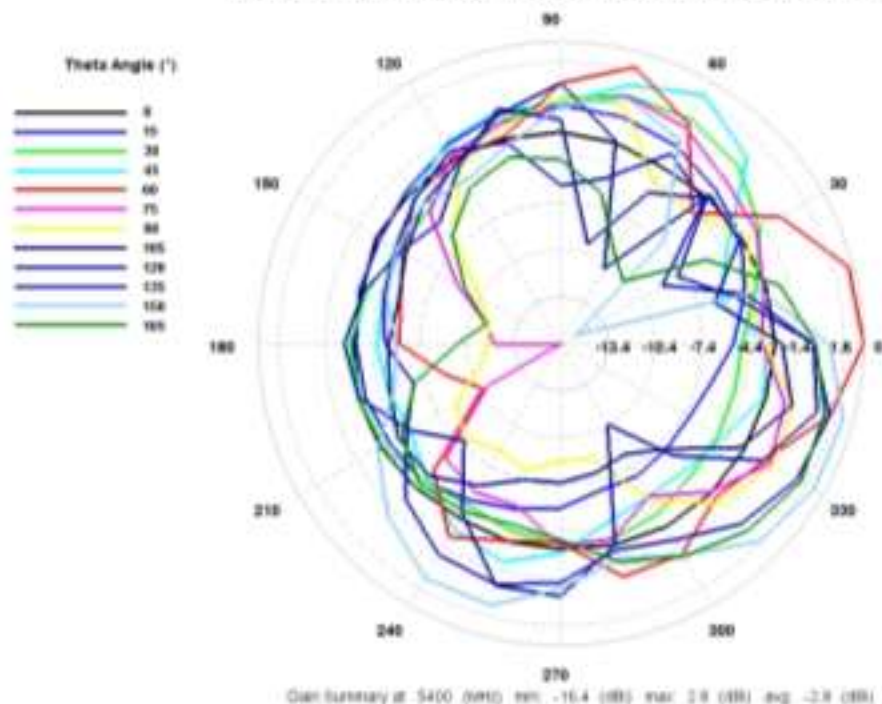


Figure 27: Total gain pattern

## 3D Plots at 5400 MHz

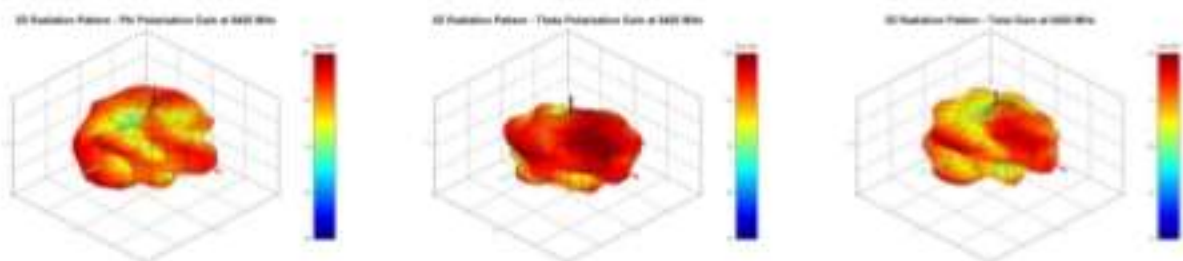
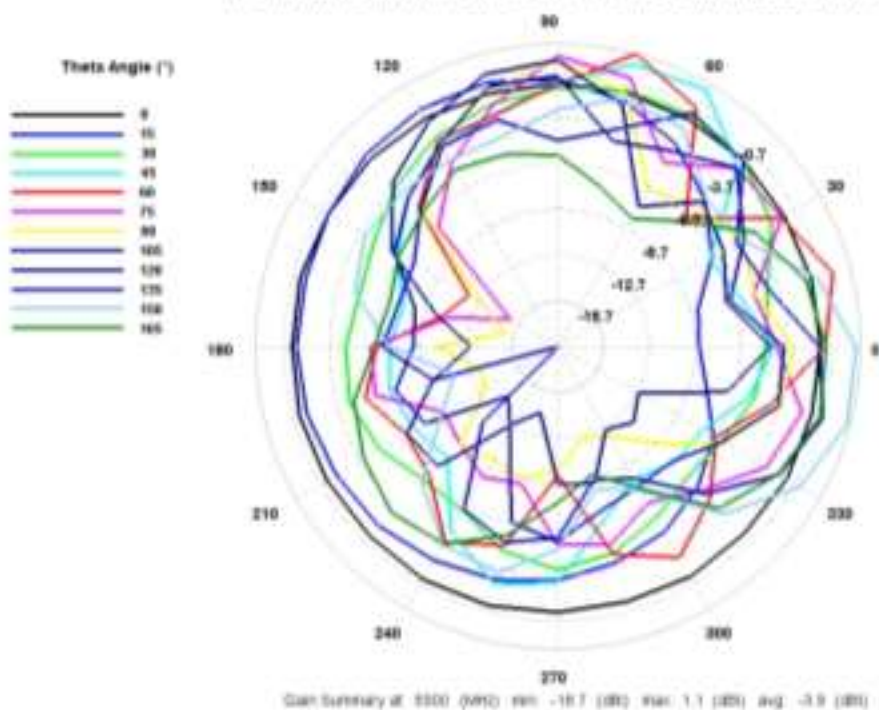


Figure 28: Phi, Theta, and total gain plots

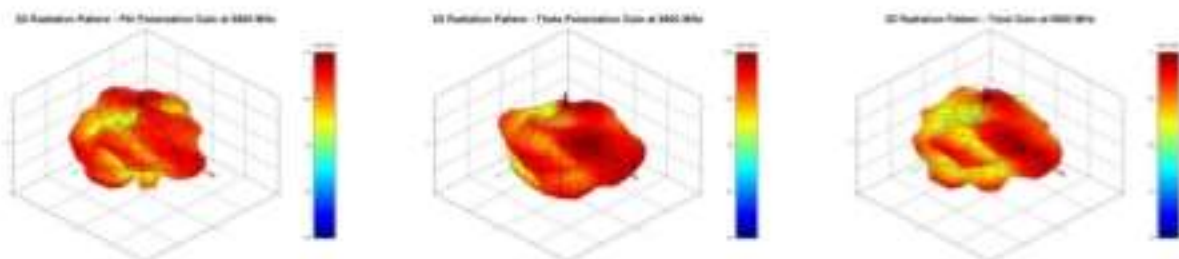
## Azimuthal Conical Cuts at 5900 MHz

**Azimuth Gain Pattern Cuts - Total Gain at 5900 MHz**



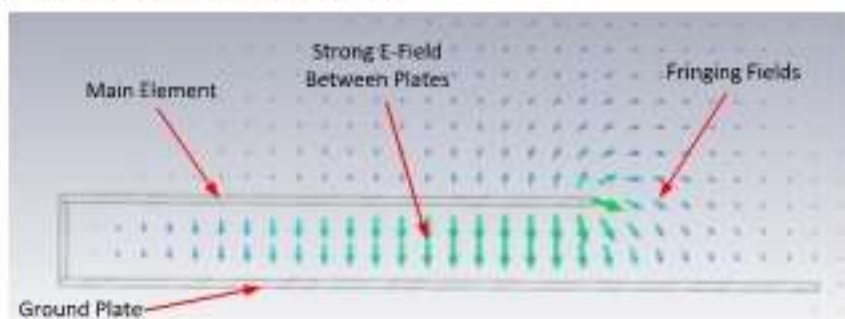
**Figure 29: Total gain pattern**

## 3D Plots at 5900 MHz



**Figure 30: Phi, Theta, and total gain plots**

## OPTIMAL INSTALLATION GUIDE



**Figure 31: E-field radiation from FlexPIFA – taken from CST simulation**

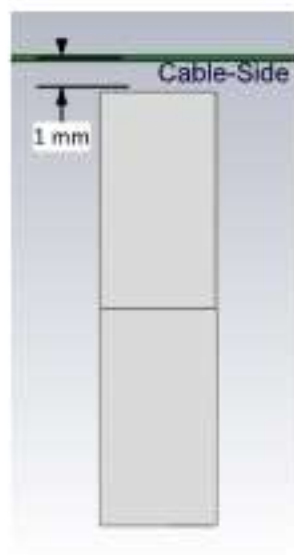
The main element should be kept clear of any non-metal objects (such as plastics) on top of it by at least three millimeters (see Figure 32). Similarly, the two long sides of the FlexPIFA should be kept clear of any non-metal object by at least two millimeters (See Figure 33). A one-millimeter clearance should be observed from the ground wall to any non-metal object. Mounting the FlexPIFA in a situation that does not allow for these clearance recommendations may change the gain characteristics stated in the datasheet, which could impact overall range of the wireless system.



**Figure 32: Top clearance**



**Side Clearance**



**Ground Wall Clearance**

**Figure 33: Side and ground wall clearance**

The ideal material on which to mount the FlexPIFA is 1.5-millimeter thick polycarbonate for maximum performance. However, as previously mentioned, the FlexPIFA can tolerate other non-metallic surfaces and thicknesses and still radiate effectively. Depending on the type of material, the FlexPIFA may be detuned.

The coaxial cable feeding the FlexPIFA should be routed away from the antenna. Do not run the coaxial cable over the top of the FlexPIFA or near the tip of the main element. The cable should be routed perpendicular to the side of the FlexPIFA (this is the way the cable comes assembled) or away from the ground wall. These options are shown in Figure 34.



Perpendicular to the side



Away from the ground wall

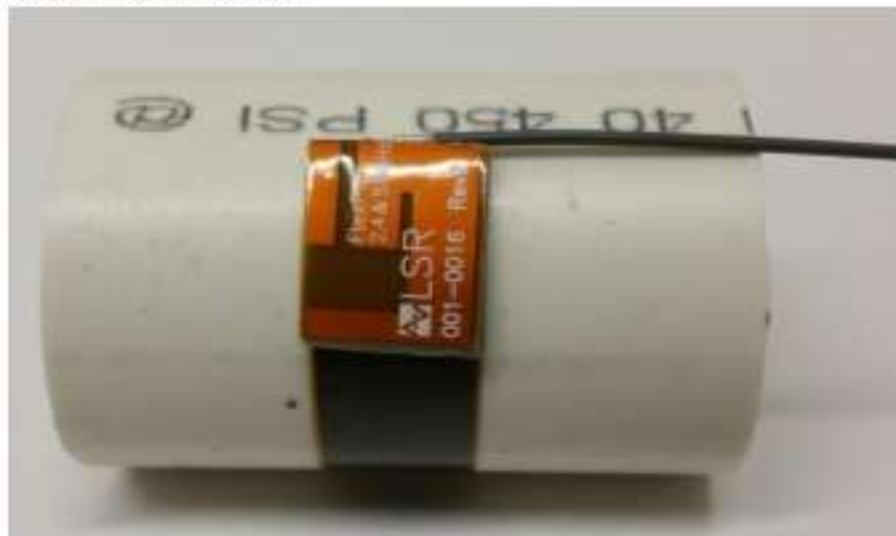
**Figure 34: Recommended cable routing**

As with any antenna, care should be taken not to place conductive materials or objects near the antenna (except as described in the next section). The radiated fields from the antenna induce currents on the surface of the metal; as a result, those currents then produce their own radiation. These re-radiating fields from the metal interfere with the fields radiating from the FlexPIFA (this is true for any antenna). Other objects, such as an LCD display, placed close to the antenna may not affect its tuning but it can distort the radiation pattern. Materials that absorb electromagnetic fields should be kept away from the antenna to maximize performance. Common things to keep in mind when placing the antenna:

- Wire routing
- Speakers – These generate magnetic fields
- Metal chassis and frames
- Battery location
- Proximity to human body
- Display screen – These absorb radiation
- Paint – Do not use metallic coating or flakes

## Flex Limits of the FlexPIFA

One of the unique features of the FlexPIFA is its ability to flex. However, due to the adhesive, there are limits as to how much the antenna can be flexed and remain secured to the device. The FlexPIFA should not be flexed in a convex position with a radius less than 16 millimeters. Going smaller than this may result in the antenna peeling off the surface over time. Should a tighter radius of curvature be required, contact Laird Connectivity for assistance.



**Figure 35: Convex-mounted**

The FlexPIFA should not be flexed in a concave position with a radius less than 25 millimeters. In this scenario, the limiting factor is performance. The ground plane of the antenna is pressed closer to the main element. As previously discussed in the introduction of this datasheet, the fringing fields developing off the end of the element are responsible for most of the radiation. In a concave position with a radius of curvature less than 25 millimeters, the fringing fields are adversely affected and gain suffers. If a tighter radius of curvature is required, contact Laird Connectivity for assistance.



**Figure 36: Concave-mounted**

The FlexPIFA is not designed to be twisted or crumpled. The adhesive back should lay flush with the surface on which it is mounted.

## Mounting on Metal and Body Loaded Applications

The FlexPIFA can tolerate being mounted on conductive surfaces. There will be some detuning of the antenna, which translates into some gain reduction. Even though the FlexPIFA is optimized to work on non-metallic surfaces, it still radiates efficiently due to the fringing fields (see Figure 31). The ground plane of the FlexPIFA carries the adhesive backing; placing the antenna onto a metal surface simply enlarges the size of the ground beneath the main element. Previously, the fringing fields only interacted with the small ground of the FlexPIFA, however they are now interacting with the much larger ground. The fringing fields still develop and radiate, but the antenna will no longer tune as well to the 2.4 GHz frequency band. Consequently, the VSWR increases and there is some loss in radiated power. If the FlexPIFA cannot meet your range requirements after being implemented on a metal surface, contact Laird Connectivity for a custom antenna build to help meet your application needs.

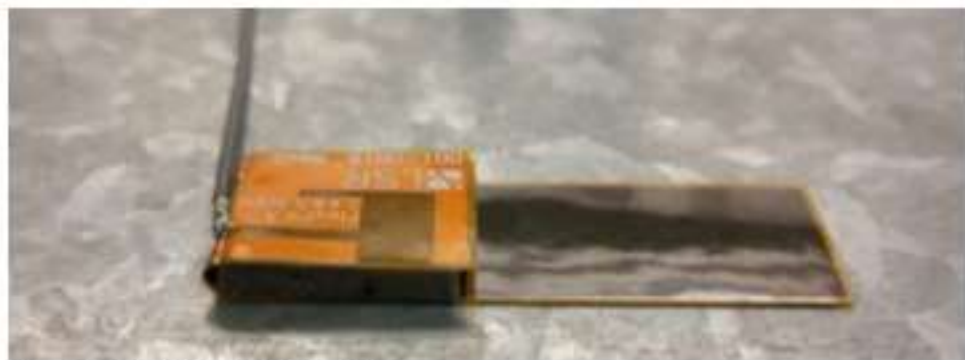


Figure 37: FlexPIFA mounted on metal

**Do not mount the FlexPIFA where metal is within ten millimeters above the main element** (see Figure 39). Not only does this severely limit the radiation pattern (mainly due to the re-radiation problem previously described) it detunes the antenna inside of this range.

Similarly, the two long sides of the FlexPIFA should be kept clear of any metal object by at least five millimeters. These keep out requirements pertain to **conductive** materials only and are different from those listed in the previous sections which apply to **non-conductive** materials. In general, it is good practice to always keep metals as far away from the antenna as possible.

For the best performance, a spacer should be placed between the FlexPIFA and the conductive surface (see Figure 38). The spacer should be 1.5 millimeters thick polycarbonate. This will significantly improve performance and tuning of the FlexPIFA on a metal surface. Other non-conductive materials such as ABS plastic can be used; however, polycarbonate provides the best results.



Figure 38: FlexPIFA mounted on metal surface with 1.5 mm thick polycarbonate spacer

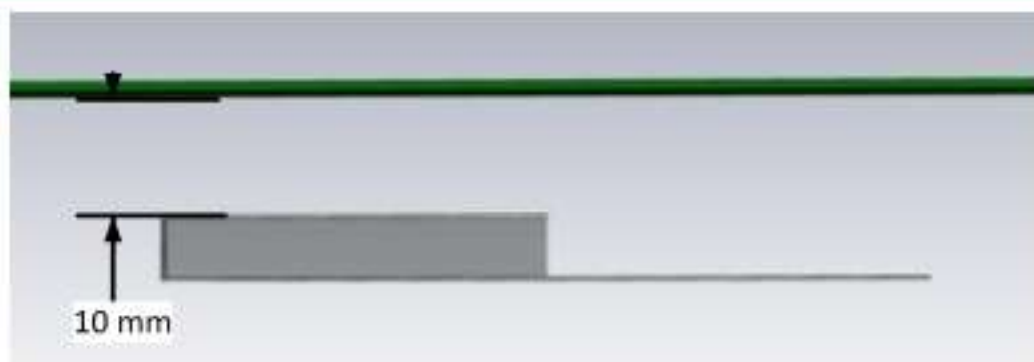


Figure 39: Metal near main element

For body-worn applications, the FlexPIFA can tolerate the presence of the human body. We do not recommend that you mount the antenna directly on body tissue to avoid detuning the FlexPIFA.

Additionally, the human body is an excellent absorber of 2.4 GHz RF signals. As a result, expect a reduction in range due to the presence of a body. In a body-worn application, the ground plate of the FlexPIFA should be closest to the body tissue. The main element should be pointed away from the body. Additionally, for handheld devices, the FlexPIFA should be mounted in a location where it is not covered by the hand. If the antenna is mounted in a location where the main element is covered or near a human body, ensure that there is at least a ten-millimeter separation distance between the main element and the body as shown in Figure 39.

Additionally, when the FlexPIFA is mounted very close to body tissue, use a spacer to create separation distance between the body tissue and ground plate. This ensures maximum performance and prevents the antenna from detuning. As previously mentioned, the ideal spacer material is 1.5 mm thick polycarbonate.

Quite often this separation distance between the body tissue and the FlexPIFA is already provided by the enclosure. Figure 40 is an example of a bracelet with the FlexPIFA integrated inside it. The enclosure provides enough spacing between the antenna and body tissue to prevent any major detuning. The enclosure is made of polycarbonate.



Figure 40: FlexPIFA integrated into bracelet

## PRODUCT REVISION HISTORY

### 001-0016

*Rev 1: Prototype Release*



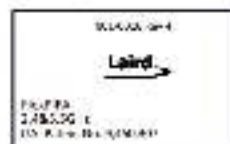
*Rev 2: Initial Production Release*



*Rev 3: Updated FPC (Improve Tuning)*



*Rev 4: Updated Silkscreen (Laird Logo and U.S. Patent)*



*Rev 5: Changed Supplier - Color Change to Antenna*



### 001-0021

*Rev 1: Initial Production Release*



*Rev 2: Updated FPC (Improve Tuning)*



*Rev 3: Updated Silkscreen (Laird Logo and U.S. Patent)*



*Rev 4: Changed Supplier - Color Change to Antenna*



## ADDITIONAL ASSISTANCE

Please contact your local Laird Connectivity sales representative or our support team for further assistance:

|                       |                                                                                                                                                           |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Support Center</b> | <a href="https://connectivity.lairdtech.com/resources/support">https://connectivity.lairdtech.com/resources/support</a>                                   |
| <b>Email</b>          | <a href="mailto:wireless.support@lairdtech.com">wireless.support@lairdtech.com</a>                                                                        |
| <b>Phone</b>          | Americas: +1-800-492-2320<br>Europe: +44-1628-858-940<br>Hong Kong: +852 2923 0610                                                                        |
| <b>Web</b>            | <a href="https://connectivity.lairdtech.com/wireless-modules/bluetooth-modules">https://connectivity.lairdtech.com/wireless-modules/bluetooth-modules</a> |



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## TITLE

### WIFI 6E FLEX CABLE BALANCE ANTENNA

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7.0 THE ANTENNA PERFORMANCE VARIATION WITH CABLE LENGTH

8.0 CHANGE HISTORY

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION:              | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>1 of 30</b>         |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |

## WIFI 6E FLEX CABLE BALANCE ANTENNA

### 1.0 SCOPE

This specification describes the antenna application and surrounding. The information in this document is for reference and benchmark purposes only. The user is responsible for validating antenna rf performance based on the user's actual implementation.

Antenna illustrations in this document are generic representations. They are not intended to be an image of any antenna listed in the scope.

### 2.0 PRODUCT DESCRIPTION

#### 2.1 PRODUCT NAME AND SERIES NUMBER (S)

Product name: WIFI 6E flex cable balance antenna

Series Number: 146153

#### 2.2 DESCRIPTION

Series 146153 is a balanced, dipole-type, high efficiency antenna for 2.4/5/6 GHz applications, including WiFi 6E, Bluetooth, Zigbee and others. This antenna is made from poly flexible material with small size 35\*9\*0.1mm and has double-sided adhesive tape for easy "peel and stick" mounting. This balanced antenna with ground plane independent design offers various cable length options for ease of integration into various devices.

#### 2.3 PRODUCT STRUCTURE INFORMATION

Please refer to PS-1461530100 for full information.



ANTENNA 3D VIEW

|                                          |                                                           |                                                                                   |                                        |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | ECR/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>2 of 30</b>            |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12               | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

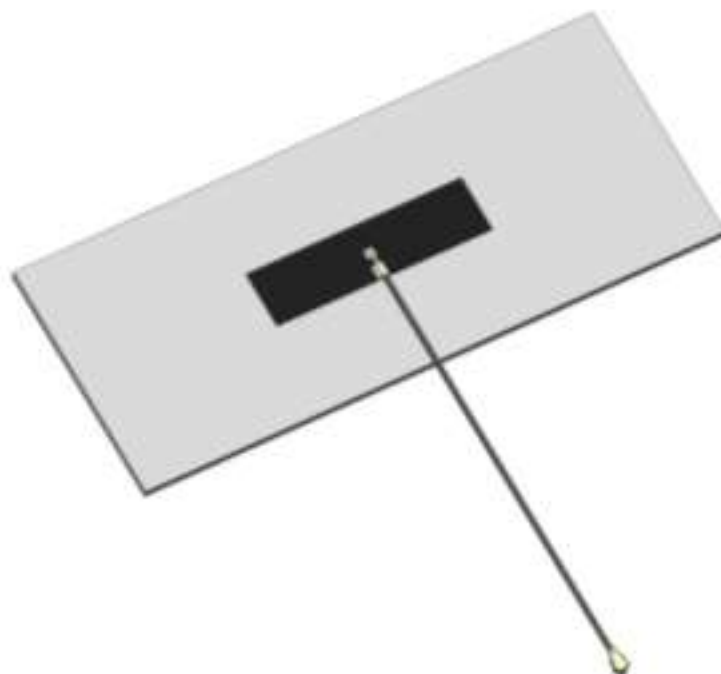
## 3.0 APPLICABLE DOCUMENTS

| DOCUMENT                   | NUMBER        | DESCRIPTION                         |
|----------------------------|---------------|-------------------------------------|
| Sale Drawing (SD)          | SD-1461530050 | Mechanical Dimension of the product |
|                            | SD-1461531050 |                                     |
| Product Specification (PS) | PS-1461530100 | Product Specification               |
| Packing Drawing (PK)       | PK-1461530100 | Product packaging specifications    |

## 4.0 ANTENNA PERFORMANCE

### 4.1 RF TEST CONDITIONS

All measurements are done of the antenna mounted on a PC/ABS material block of 1.5mm thickness with VNA Agilent E5071C and Over-The-Air (OTA) chamber. All measurements in this document are done with the part no.1461530100 with a cable length of 100mm.



**FIGURE4.1.1 ANTENNA LOADED WITH PC/ABS BLOCK OF 1.5 MM THICKNESS**

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION:              | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>3 of 30</b>         |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |

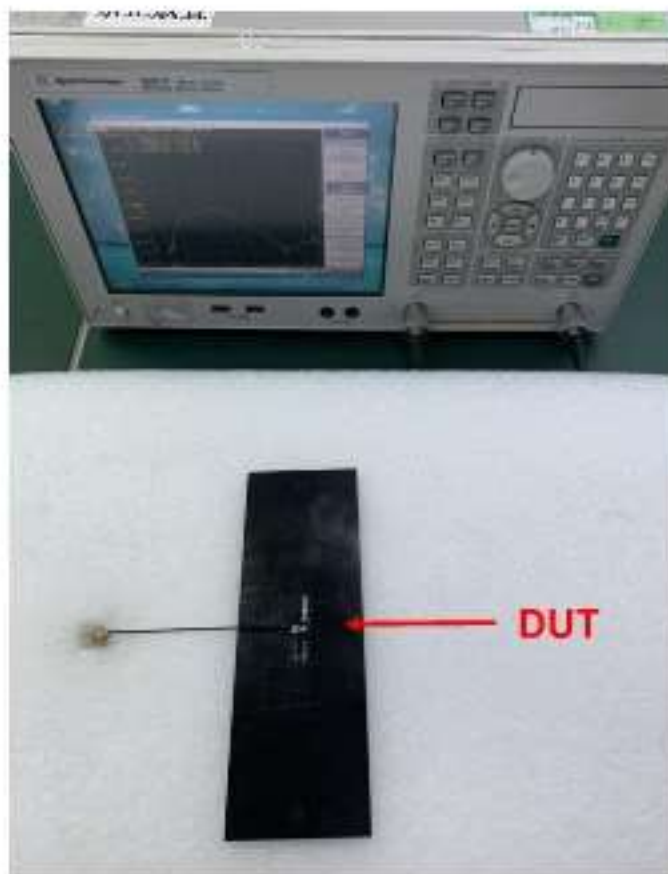
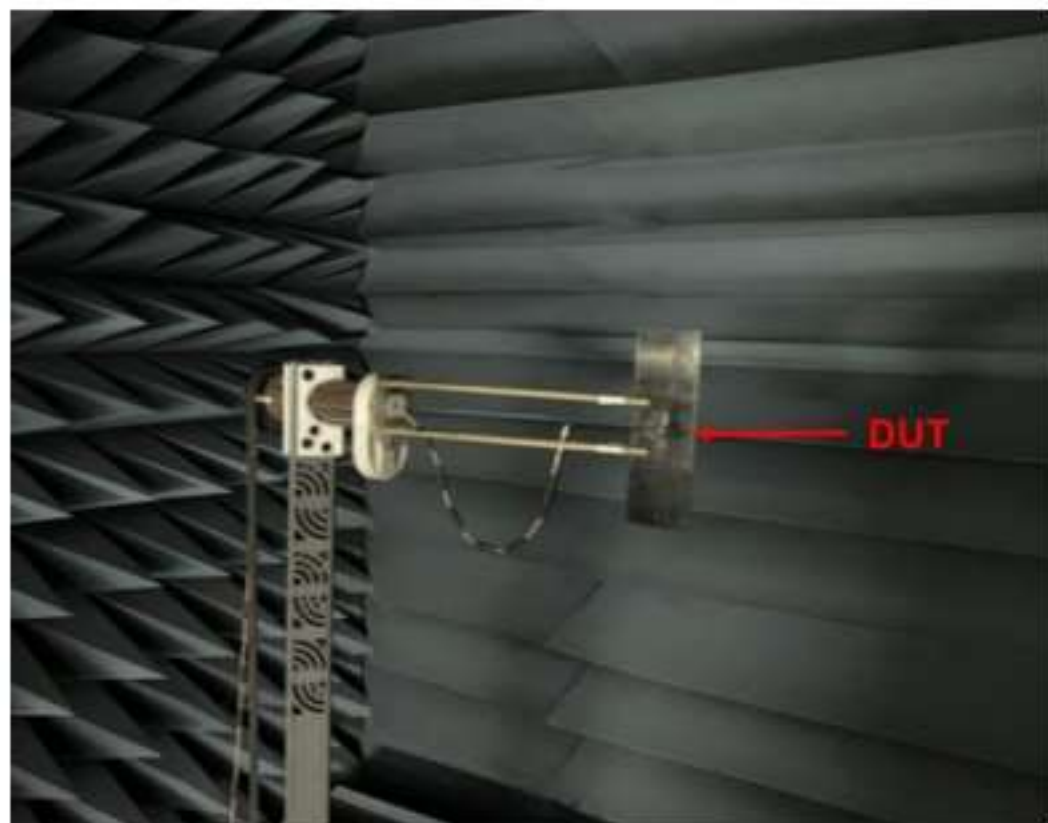


FIGURE 4.1.2 ANTENNA LOADED WITH PC/ABS BLOCK OF 1.5 MM THICKNESS WITH VNA

|                                          |                                                           |                                                                                   |                                        |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | ECR/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>4 of 30</b>            |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12               | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |



**FIGURE 4.1.3 ANTENNA LOADED WITH PC/ABS BLOCK OF 1.5 MM THICKNESS WITH OTA CHAMBER**

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION:              | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>5 of 30</b>         |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |



# APPLICATION SPECIFICATION

## 4.2 ANTENNA PERFORMANCE

All measurements in this document are done with the part no.1461530100 with a cable length of 100mm

| DESCRIPTION              | EQUIPMENT   | REQUIREMENT |              |                |
|--------------------------|-------------|-------------|--------------|----------------|
| Frequency Range          | VNA E5071C  | 2.4-2.5GHz  | 5.15-5.85GHz | 5.925-7.125GHz |
| Return Loss              | VNA E5071C  | <- 10dB     |              |                |
| Peak Gain (Max)          | OTA Chamber | 3.0dBi      | 4.0dBi       | 5.5dBi         |
| Average Total Efficiency | OTA Chamber | >75%        | >75%         | >70%           |
| Polarization             | OTA Chamber | Linear      |              |                |
| Input Impedance          | VNA E5071C  | 50 ohms     |              |                |

Note that the above antenna performance is measured with just the antenna mounted on a PC/ABS block to similar a free-space condition. When implement into the system, the frequency resonant might be off-tune due to the loading of surrounding components especially metal plane. This off-tune can be compensated through matching. Although module manufacturers specify a peak gain limit, it is based on free-space conditions. The peak gain will be degraded by 1 to 2dBi in the actual implementation as the radiation pattern will change due to the surround components. As such, during selection of antenna, you can select one with high peak gain to compensate for the loss. Molex can offer assistant to choose the best location and best tuning in-order to meet this peak gain requirement.

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION:              | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>6 of 30</b>         |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |

## 4.3 RETURN LOSS PLOT

All measurements in this document are done with a cable length of 100mm.

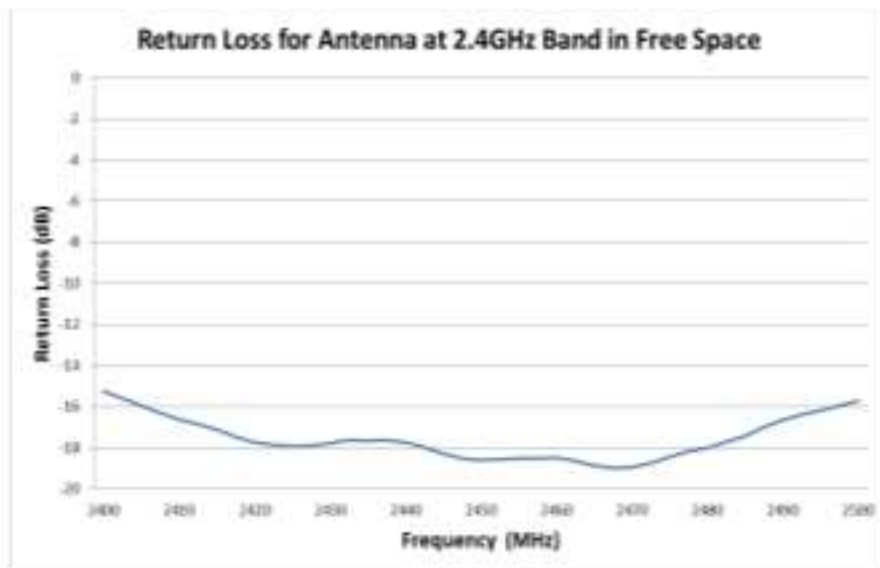


FIGURE 4.3.1 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND IN FREE SPACE

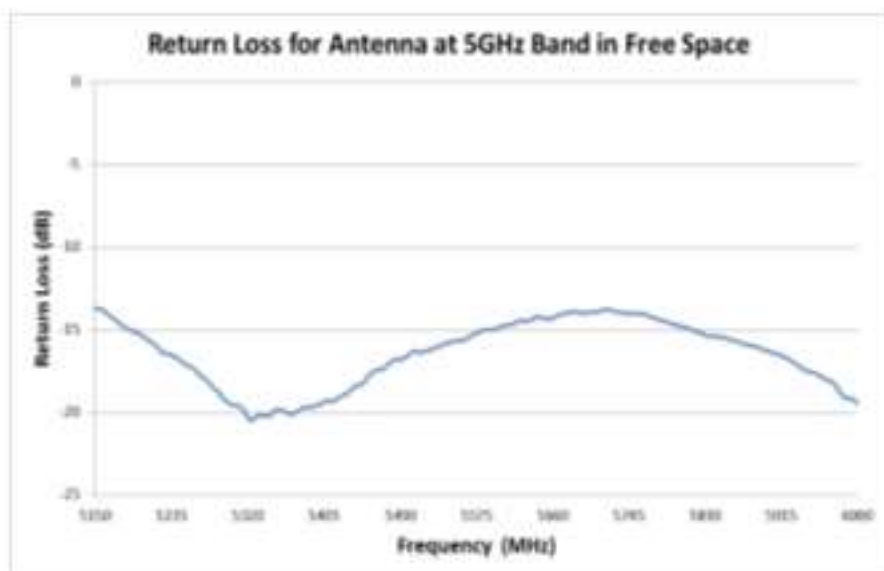
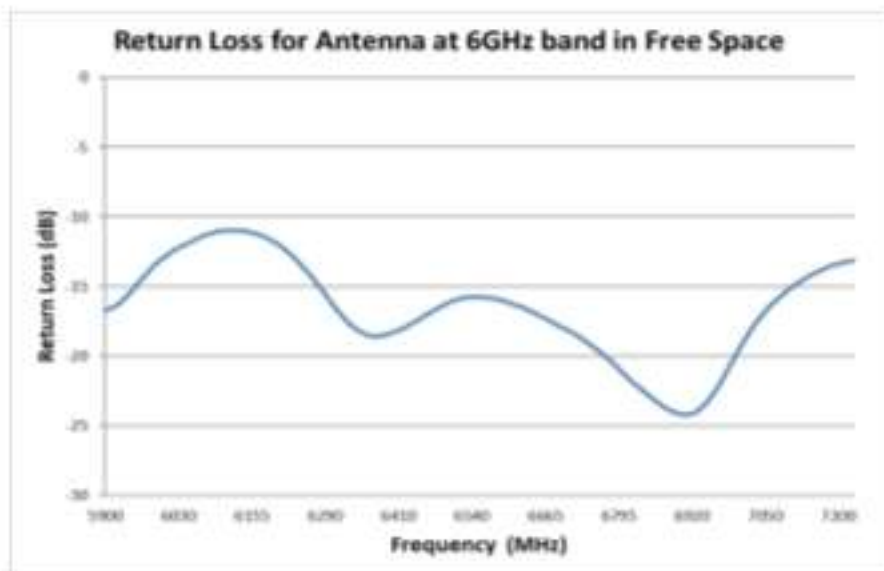


FIGURE 4.3.2 RETURN LOSS OF ANTENNA AT 5GHZ BAND IN FREE SPACE

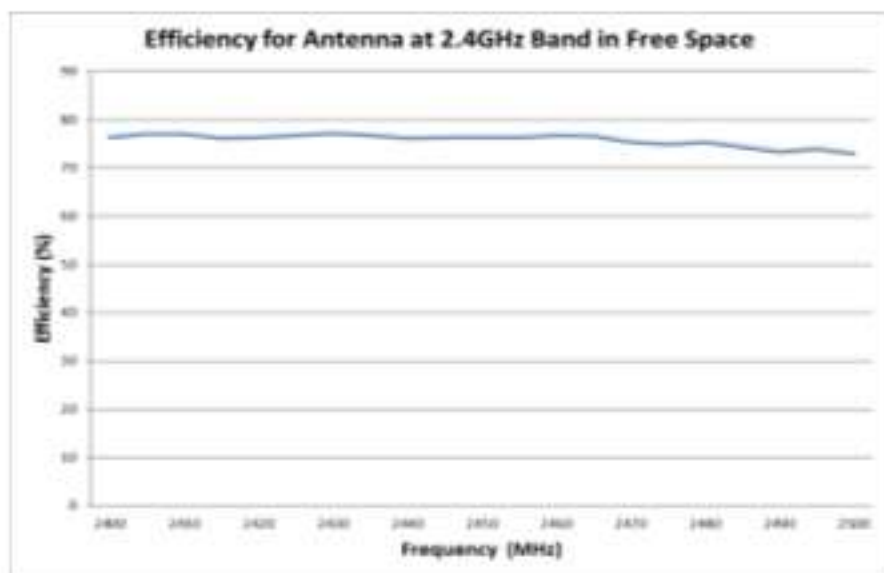
|                                          |                                                           |                                                                                   |                                        |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | ECR/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>7 of 30</b>            |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12               | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |



**FIGURE 4.3.3 RETURN LOSS OF ANTENNA AT 6GHZ BAND IN FREE SPACE**

## 4.4 EFFICIENCY PLOT

All measurements in this document are done with a cable length of 100mm.



**FIGURE 4.4.1 EFFICIENCY OF ANTENNA AT 2.4GHZ BAND IN FREE SPACE**

|                                          |                                                           |                                                                                   |                                        |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | ECR/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>8 of 30</b>            |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12               | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

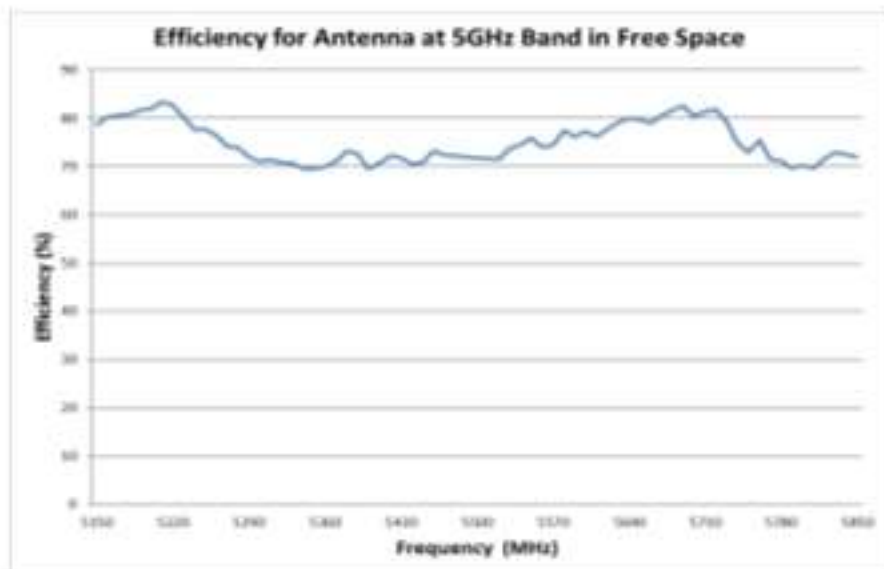


FIGURE 4.4.2 EFFICIENCY OF ANTENNA AT 5GHZ BAND IN FREE SPACE

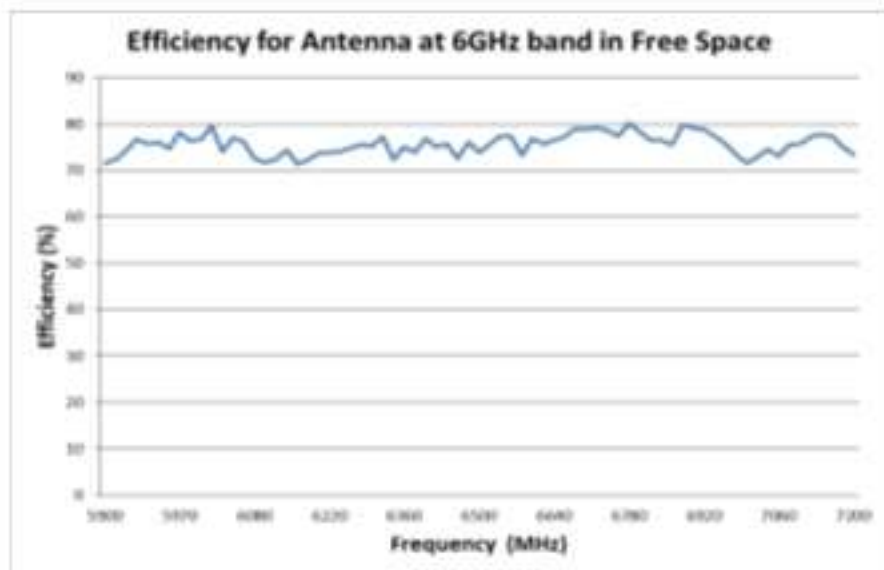


FIGURE 4.4.3 EFFICIENCY OF ANTENNA AT 6GHZ BAND IN FREE SPACE

|                                          |                                                           |                                                                                   |                                        |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | ECR/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>9 of 30</b>            |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12               | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

## 4.5 RADIATION PATTERN

All measurements in this document are done with a cable length of 100mm.

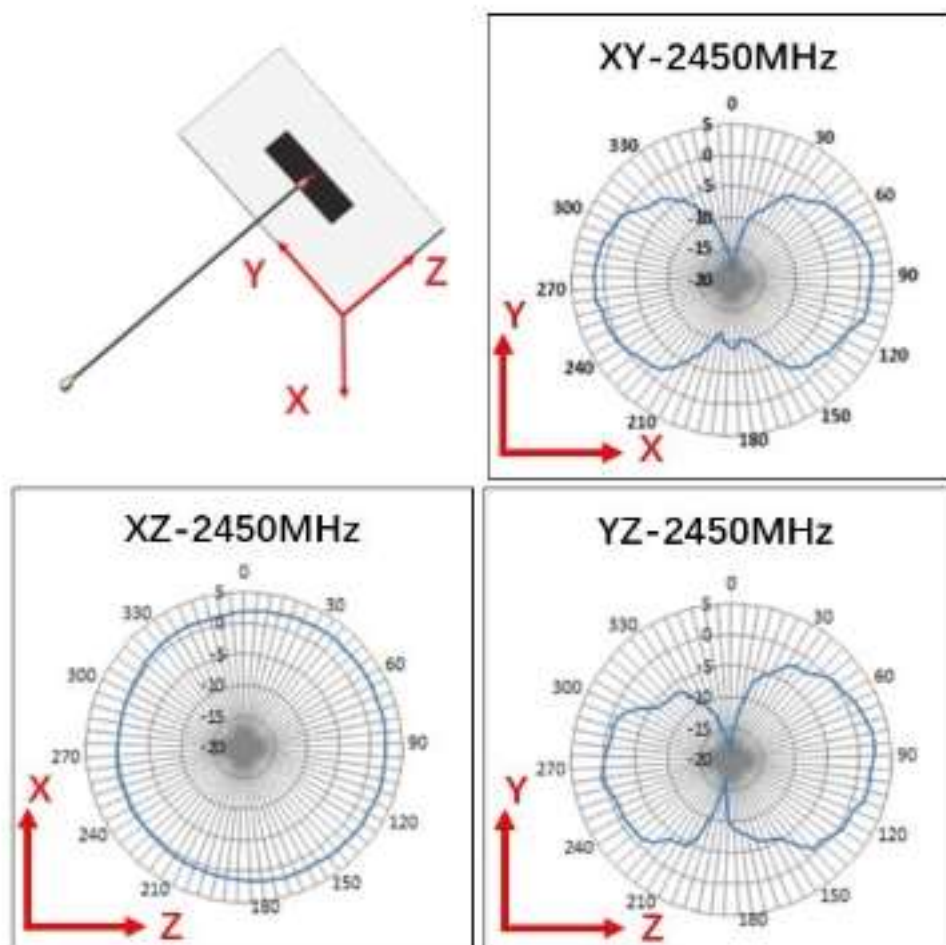


FIGURE 4.5.1 2D RADIATION PATTERN OF ANTENNA AT 2450MHZ IN FREE SPACE

|                                          |                                                          |                                                                                   |                                        |
|------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | EC/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>10 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12              | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

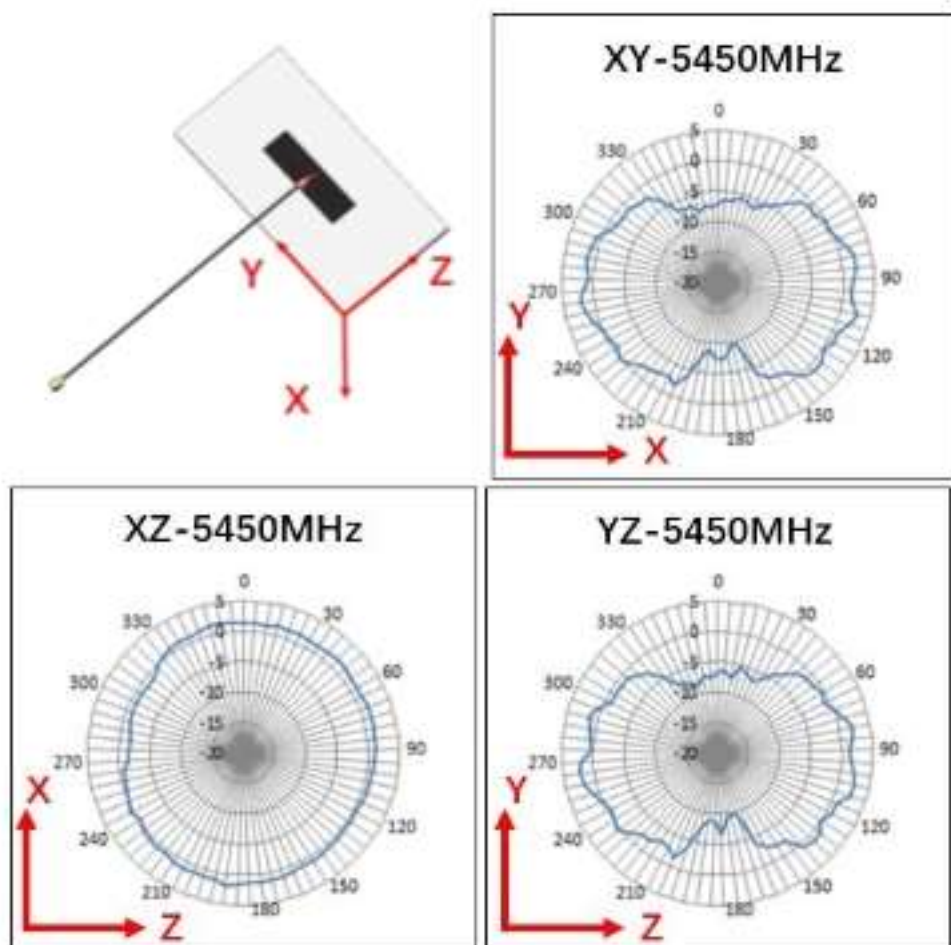


FIGURE 4.5.2 2D RADIATION PATTERN OF ANTENNA AT 5450MHZ IN FREE SPACE

|                      |                      |                                                                         |                        |
|----------------------|----------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION: | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961        | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>11 of 30</b>        |
| DOCUMENT NUMBER:     | DATE: 2021/08/17     | CREATED / REVISED BY:                                                   | APPROVED BY:           |
| <b>AS-1461530100</b> |                      | Liu Hai 2021/08/12                                                      | Chris Zhong 2021/08/12 |

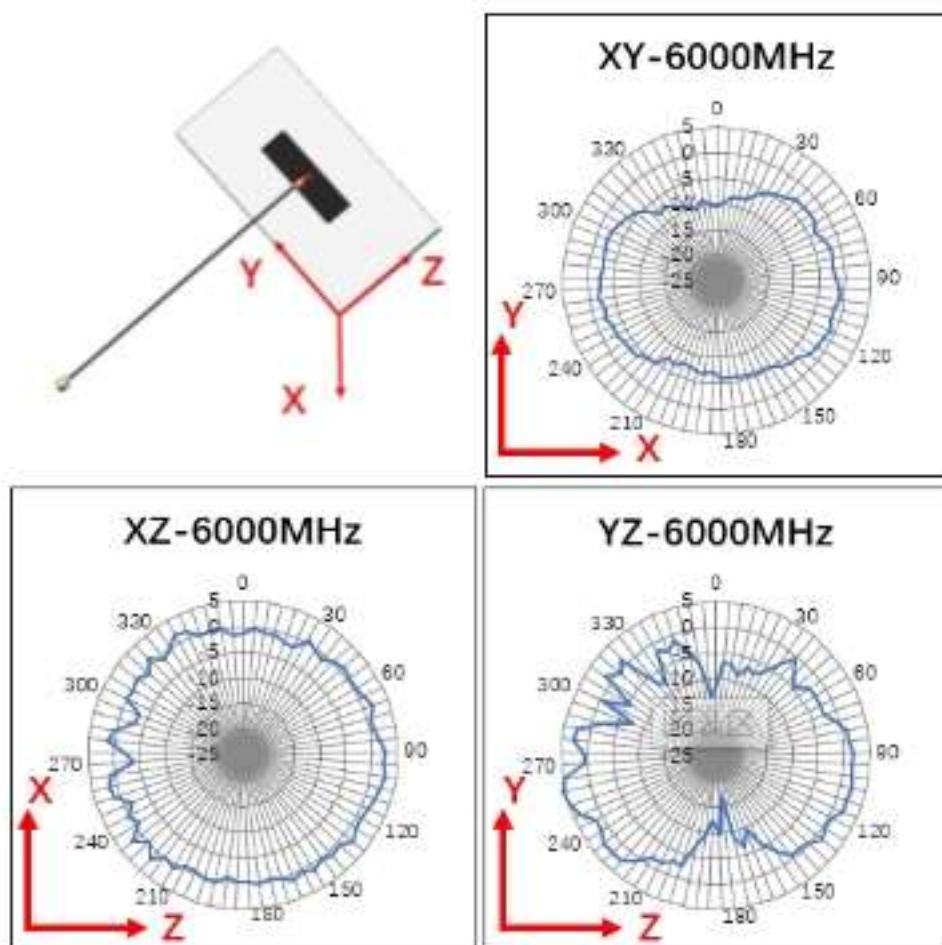


FIGURE 4.5.3 2D RADIATION PATTERN OF ANTENNA AT 6000MHZ IN FREE SPACE

|                      |                      |                                                                         |                        |
|----------------------|----------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION: | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961        | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>12 of 30</b>        |
| DOCUMENT NUMBER:     | DATE:                | CREATED / REVISED BY:                                                   | APPROVED BY:           |
| <b>AS-1461530100</b> | 2021/08/17           | Liu Hai 2021/08/12                                                      | Chris Zhong 2021/08/12 |

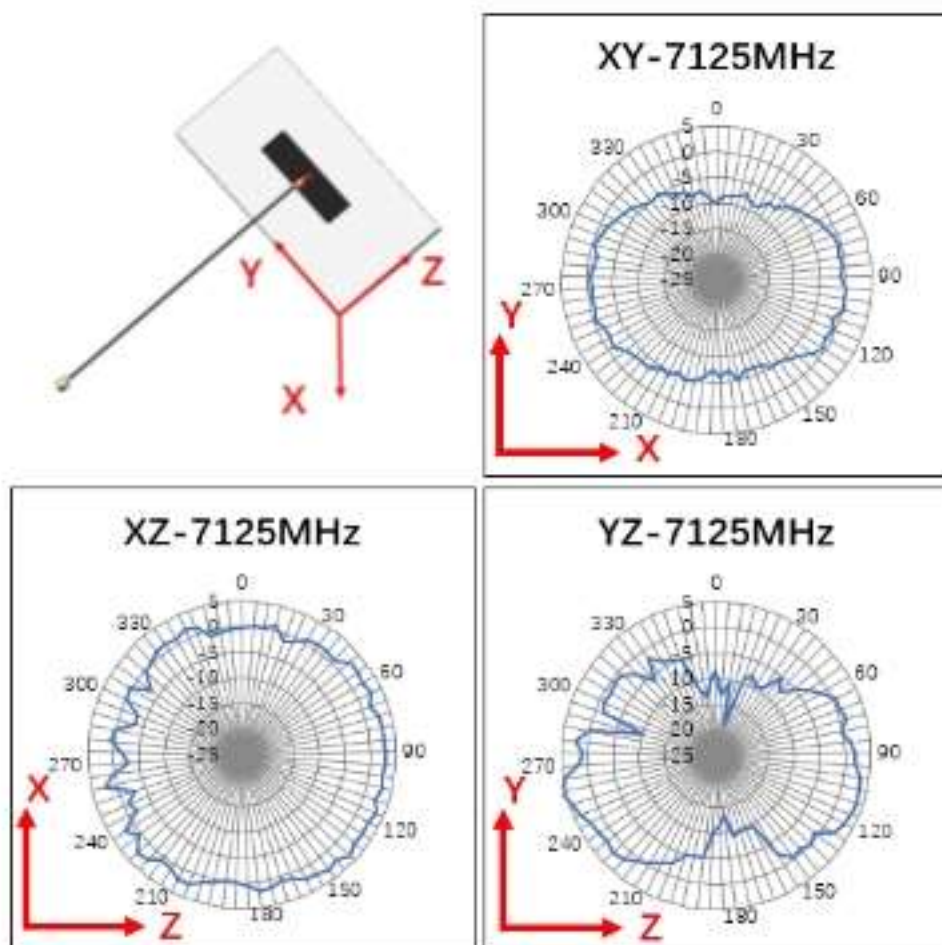


FIGURE 4.5.4 2D RADIATION PATTERN OF ANTENNA AT 7125MHZ IN FREE SPACE

|                      |                      |                                                                         |                        |
|----------------------|----------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION: | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961        | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>13 of 30</b>        |
| DOCUMENT NUMBER:     | DATE: 2021/08/17     | CREATED / REVISED BY:                                                   | APPROVED BY:           |
| <b>AS-1461530100</b> |                      | Liu Hai 2021/08/12                                                      | Chris Zhong 2021/08/12 |

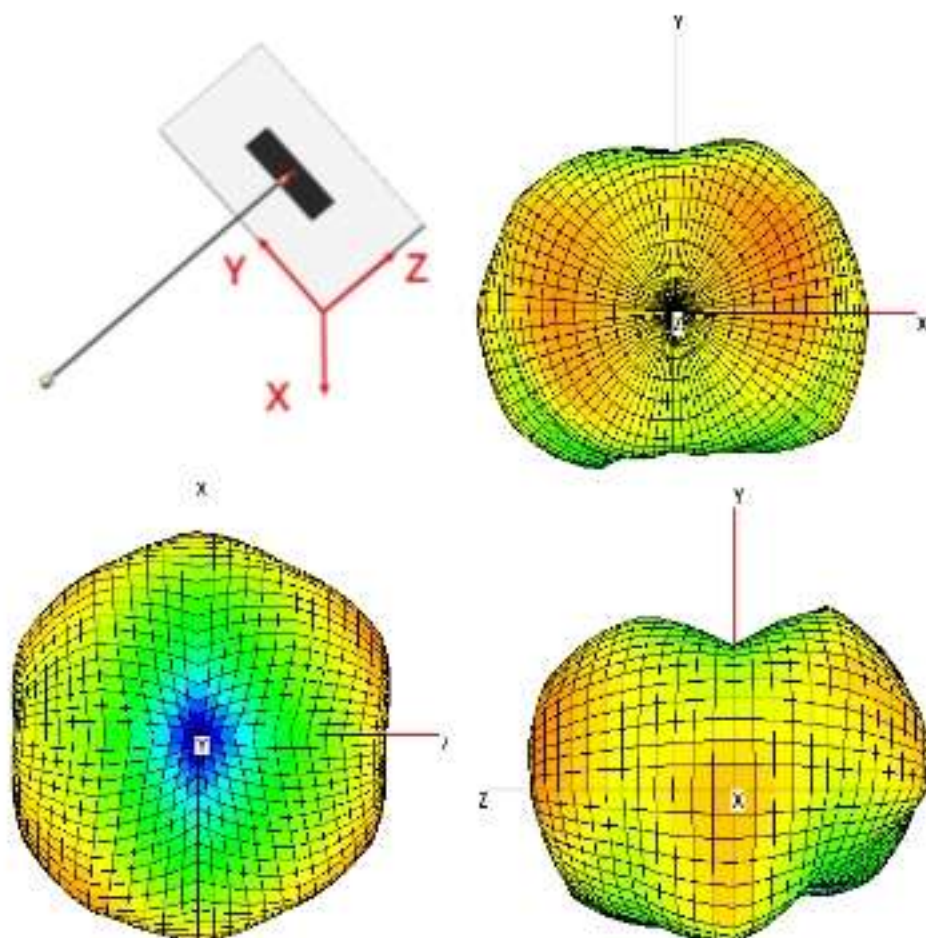


FIGURE 4.5.5 3D RADIATION PATTERN OF ANTENNA AT 2450MHZ BAND IN FREE SPACE

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION:              | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>14 of 30</b>        |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |

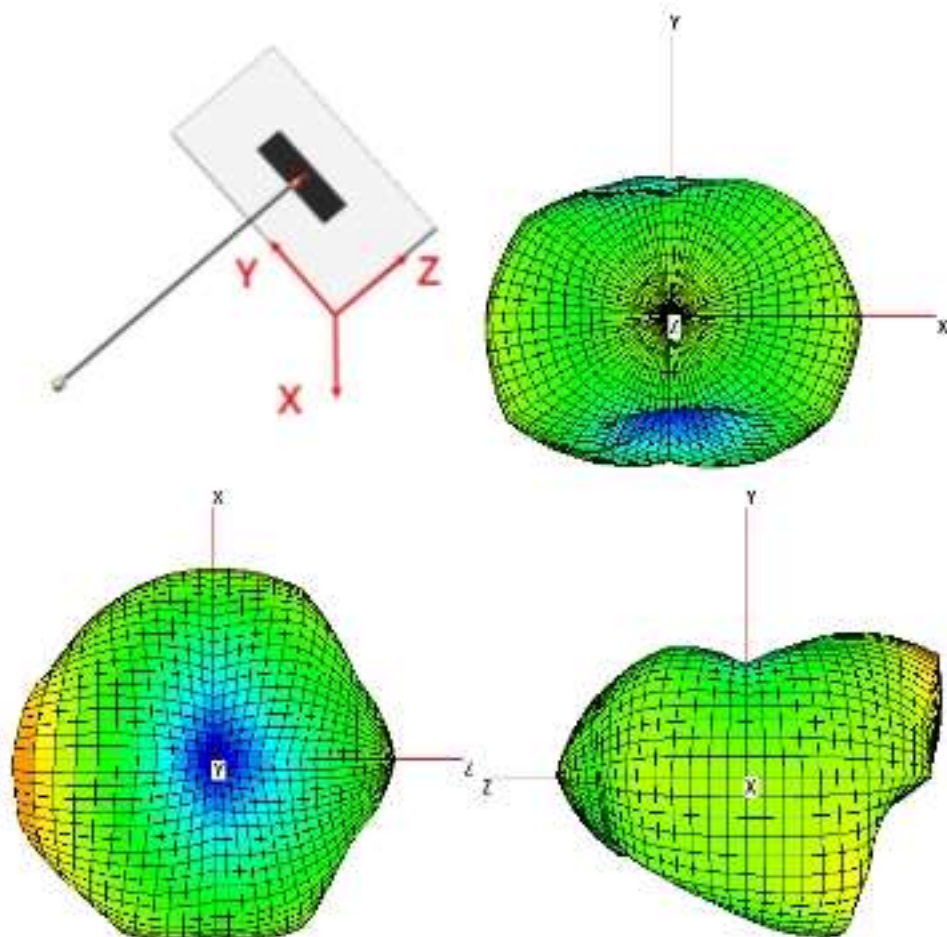


FIGURE 4.5.6 3D RADIATION PATTERN OF ANTENNA AT 5450MHZ BAND IN FREE SPACE

|                      |                      |                                                                         |                        |
|----------------------|----------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION: | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961        | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>15 of 30</b>        |
| DOCUMENT NUMBER:     | DATE: 2021/08/17     | CREATED / REVISED BY:                                                   | APPROVED BY:           |
| <b>AS-1461530100</b> |                      | Liu Hai 2021/08/12                                                      | Chris Zhong 2021/08/12 |

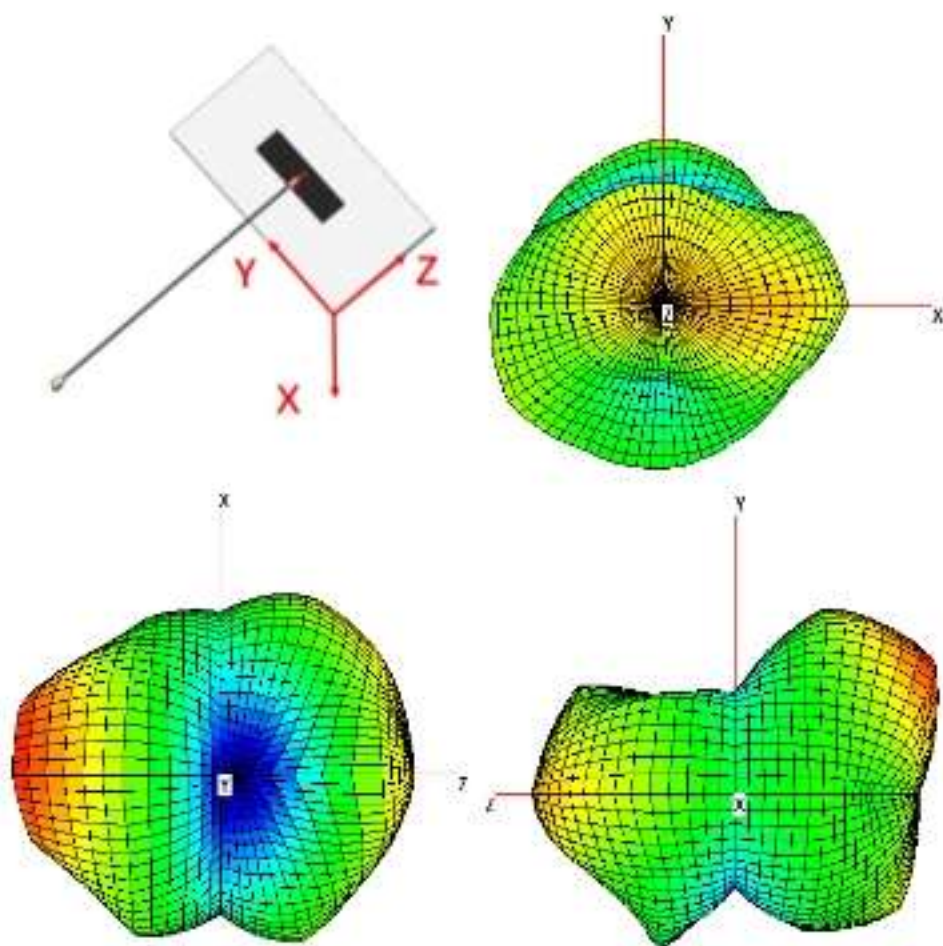


FIGURE 4.5.7 3D RADIATION PATTERN OF ANTENNA AT 6000MHZ BAND IN FREE SPACE

|                      |                      |                                                                         |                        |
|----------------------|----------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION: | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961        | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>16 of 30</b>        |
| DOCUMENT NUMBER:     | DATE: 2021/08/17     | CREATED / REVISED BY:                                                   | APPROVED BY:           |
| <b>AS-1461530100</b> |                      | Liu Hai 2021/08/12                                                      | Chris Zhong 2021/08/12 |

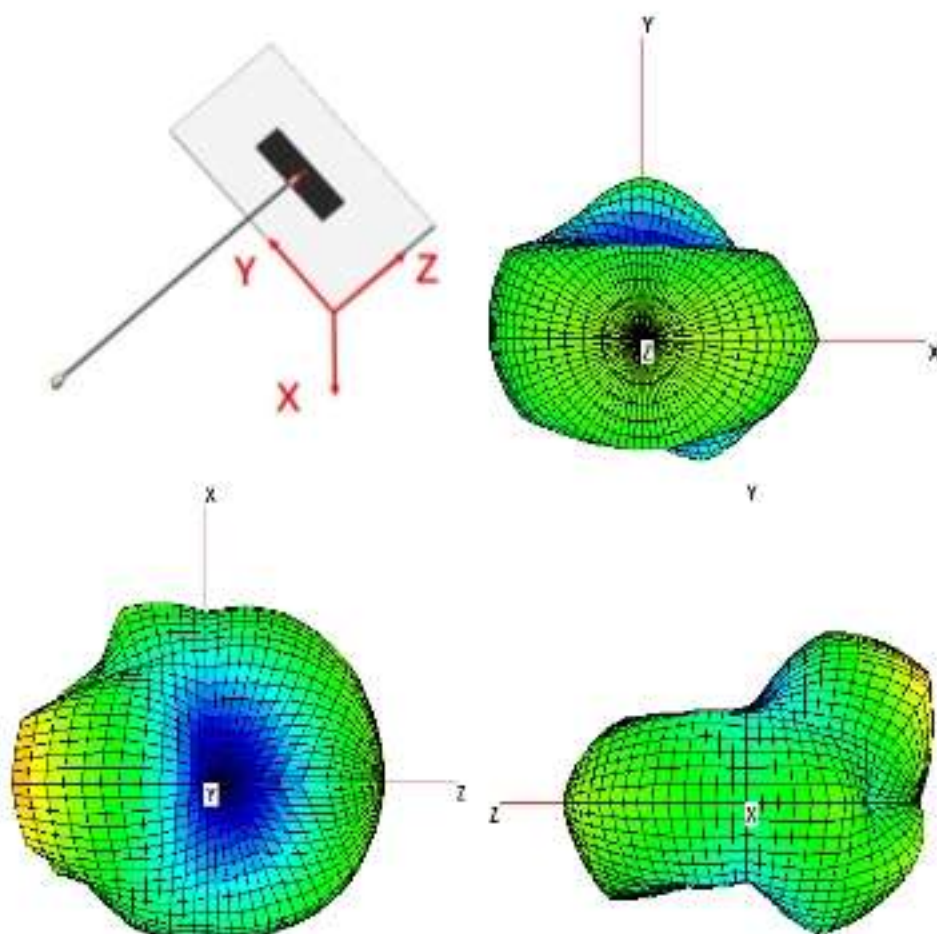


FIGURE 4.5.8 3D RADIATION PATTERN OF ANTENNA AT 7125MHZ BAND IN FREE SPACE

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION:              | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>17 of 30</b>        |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |

## 5.0 ASSEMBLY GUIDELINE

The flex antenna comes with an adhesive 3m9077 for assemble onto the plastic wall of the system. The surface should be smooth with  $ra < 1.6\mu m$  and need to clean the surface before sticking this product. The antenna cannot be placed on a metallic surface.

### 5.1 HOW TO TEAR FLEX RELEASE PAPER



1. Find cut line on flex back side



2. Bend flex slight along cut line



3. Tear release paper

|                  |                                   |                                                                 |                        |
|------------------|-----------------------------------|-----------------------------------------------------------------|------------------------|
| REVISION:        | ECR/ECN INFORMATION:              | TITLE:                                                          | SHEET No.              |
| J                | EC No: 673961<br>DATE: 2021/08/17 | WIFI 6E FLEX CABLE BALANCE ANTENNA<br>APPLICATION SPECIFICATION | 18 of 30               |
| DOCUMENT NUMBER: | CREATED / REVISED BY:             | CHECKED BY:                                                     | APPROVED BY:           |
| AS-1461530100    | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                           | Chris Zhong 2021/08/12 |

## 5.2 CABLE BENDING

During the assembly of the antenna in a device, the cable needs to be positioned away from the antenna flex to achieve best performance. The cable must be away from the Flex edge at least 5mm as shown in figure 5.2.1. If the cable bends into the antenna flex, the antenna performance will be degraded.

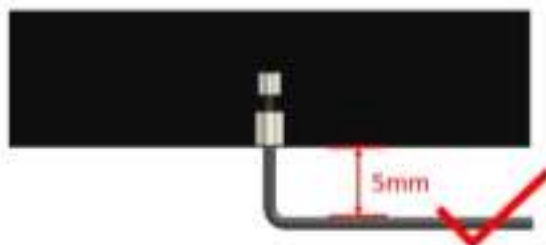


FIGURE 5.2.1 RECOMMENDED CABLE BENDING RANGE



FIGURE 5.2.2 UNRECOMMENDED CABLE BENDING RANGE

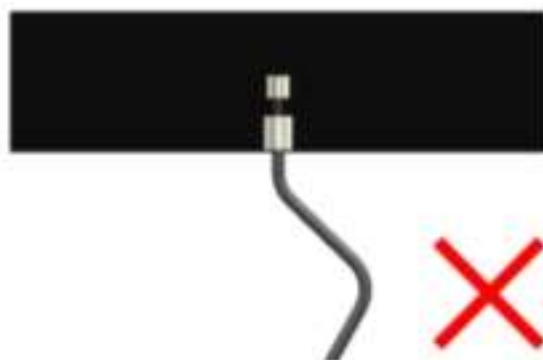


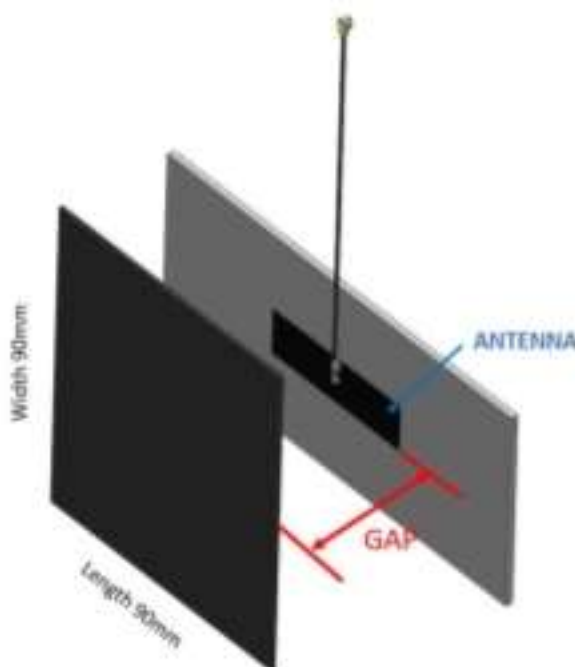
FIGURE 5.2.3 MULTIPLE BENDING OF CABLES IS NOT RECOMMENDED

|                                          |                                                          |                                                                                   |                                        |
|------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | EC/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>19 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12              | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

## 6.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

### 6.1 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH PARALLEL PLANE GROUND

Four locations with parallel plane ground have been evaluated and these locations are shown in figure 6.1.1. The plane ground size is 90mm\*90mm and we move the plane ground to four locations for each test. The antenna performance is better with larger distance between antenna and parallel plane ground. The minimum distance between antenna and plane ground is recommended to be 15mm to achieve acceptable RF performance.



**FIGURE 6.1.1 FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

Ground Size: 90mm\*90mm;

Location 1: Distance between antenna and plane (GAP) ground is about 5mm;

Location 2: Distance between antenna and plane (GAP) ground is about 10mm;

Location 3: Distance between antenna and plane (GAP) ground is about 15mm;

Location 4: Distance between antenna and plane (GAP) ground is about 20mm.

|                                          |                                                           |                                                                                   |                                        |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | ECN/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>20 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12               | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

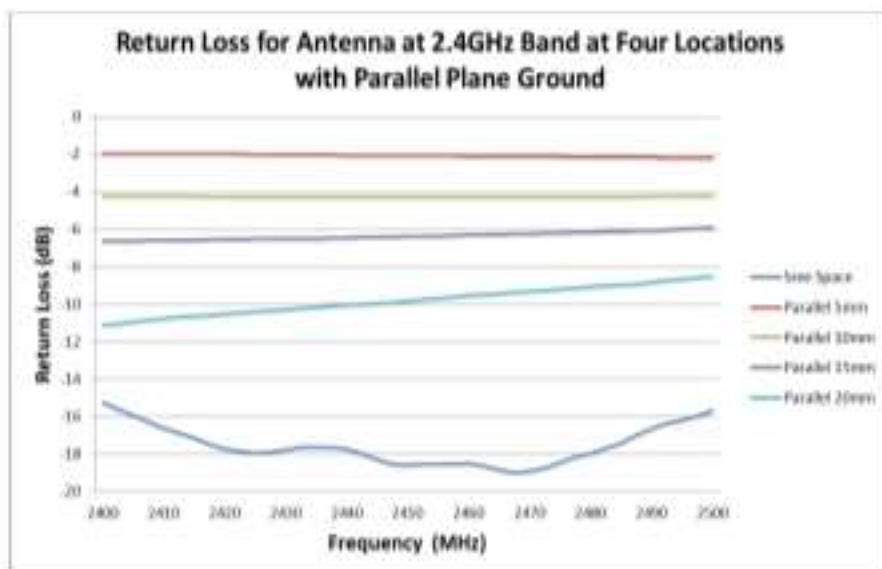


FIGURE 6.1.2 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

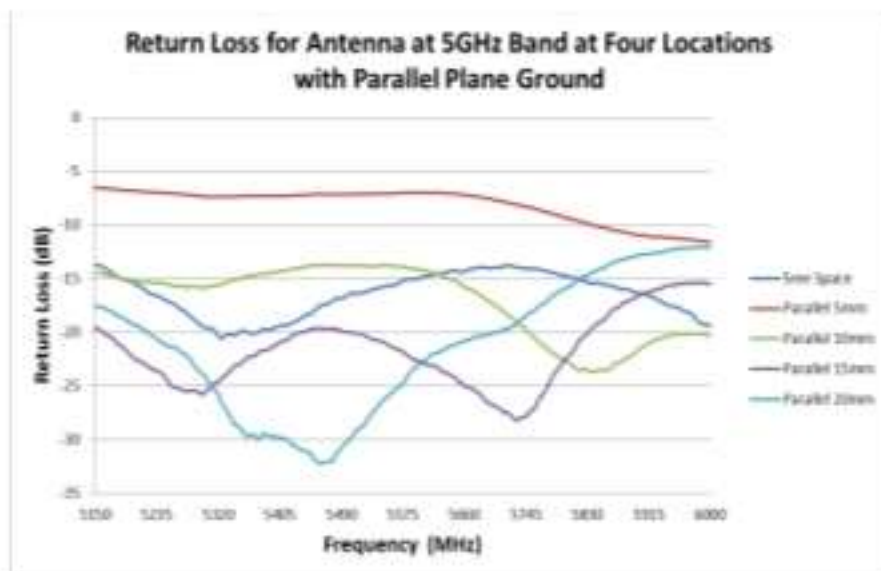


FIGURE 6.1.3 RETURN LOSS OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

|                      |                     |                                                                     |                       |
|----------------------|---------------------|---------------------------------------------------------------------|-----------------------|
| REVISION:            | EC/ECN INFORMATION: | TITLE:                                                              | SHEET No.             |
| <b>J</b>             | EC No: 673961       | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b> | <b>21 of 30</b>       |
| DOCUMENT NUMBER:     | DATE: 2021/08/17    | CREATED / REVISED BY:                                               | CHECKED BY:           |
| <b>AS-1461530100</b> |                     | Liu Hai 2021/08/12                                                  | Andy Zhang 2021/08/12 |
|                      |                     | APPROVED BY:                                                        |                       |
|                      |                     | Chris Zhong 2021/08/12                                              |                       |

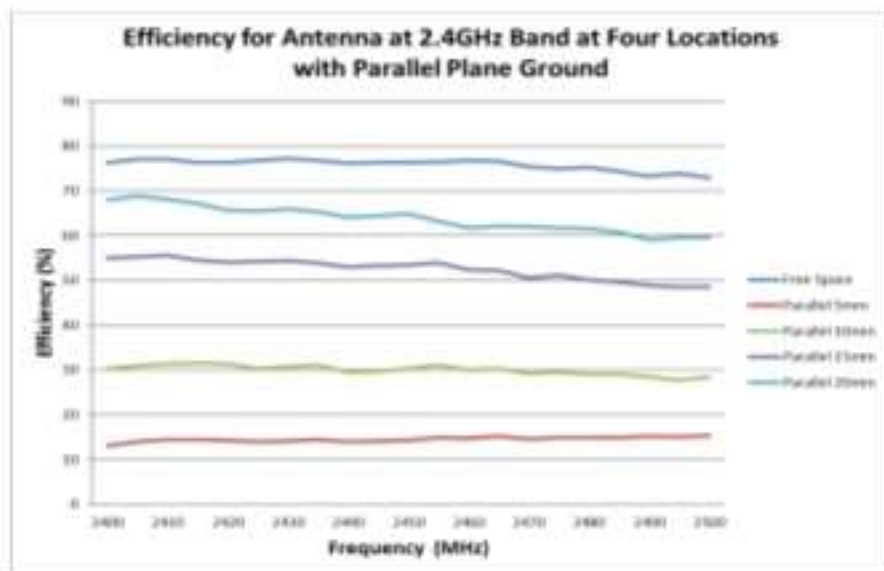


FIGURE 6.1.4 EFFICIENCY OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

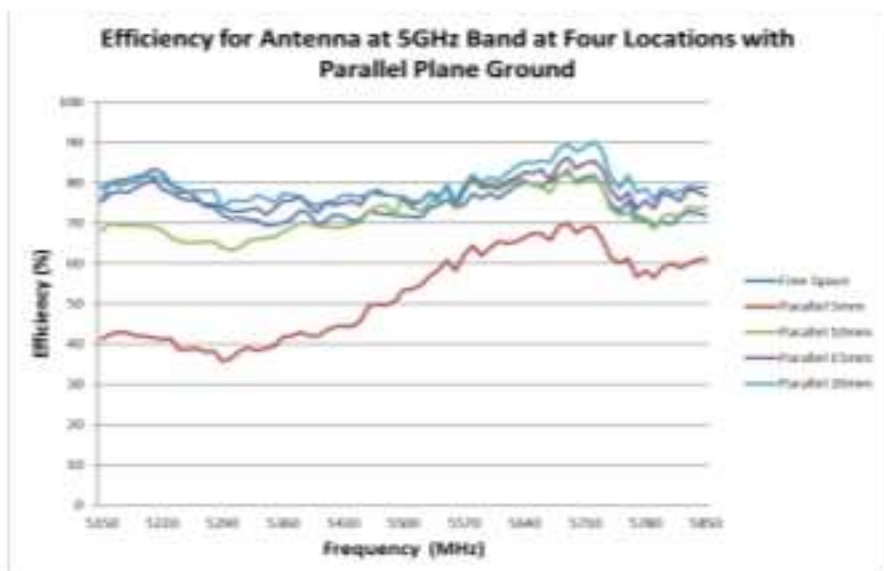
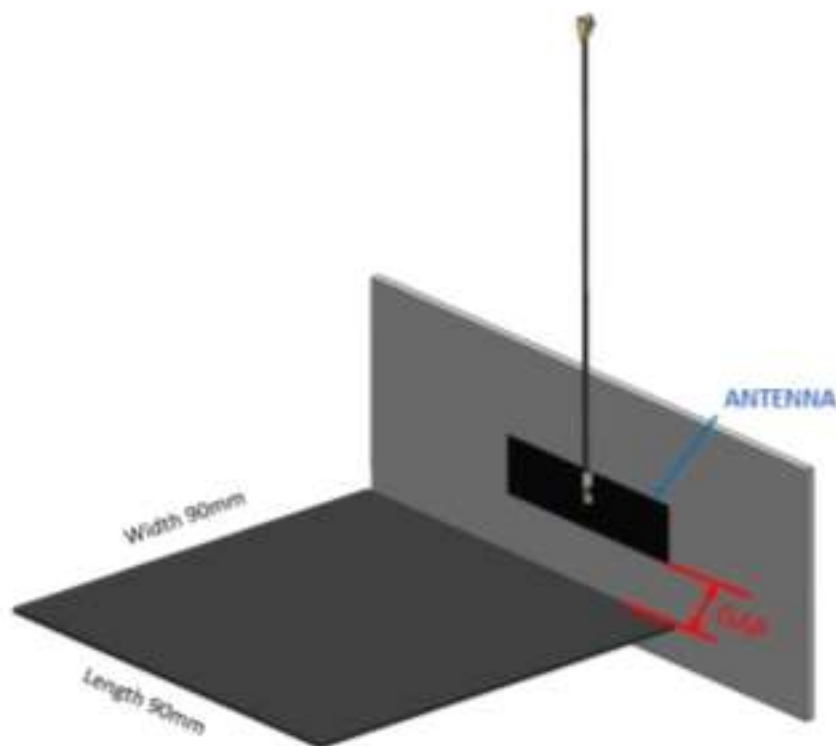


FIGURE 6.1.5 EFFICIENCY OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

|                      |                      |                                                                     |                        |
|----------------------|----------------------|---------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION: | TITLE:                                                              | SHEET No.              |
| <b>J</b>             | EC No: 673961        | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b> | <b>22 of 30</b>        |
| DOCUMENT NUMBER:     | DATE: 2021/08/17     | CREATED / REVISED BY:                                               | APPROVED BY:           |
| <b>AS-1461530100</b> |                      | Liu Hai 2021/08/12                                                  | Chris Zhong 2021/08/12 |

## 6.2 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH VERTICAL PLANE GROUND

Four locations with vertical plane ground have been evaluated and these locations are shown in figure 6.2.1. The plane ground size is 90mm\*90mm and we move the plane ground to four locations for each test. The antenna performance is better with larger distance between antenna and vertical plane ground. The minimum distance between antenna and plane ground is recommended to be 5mm to achieve acceptable RF performance.



**FIGURE 6.2.1 FOUR LOCATIONS WITH VERTICAL PLANE GROUND**

Ground Size: 90mm\*90mm;

- Location 1: Distance between antenna and plane (GAP) ground is about 5mm;
- Location 2: Distance between antenna and plane (GAP) ground is about 10mm;
- Location 3: Distance between antenna and plane (GAP) ground is about 15mm;
- Location 4: Distance between antenna and plane (GAP) ground is about 20mm;

|                                          |                                                          |                                                                                   |                                        |
|------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | EC/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>23 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12              | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

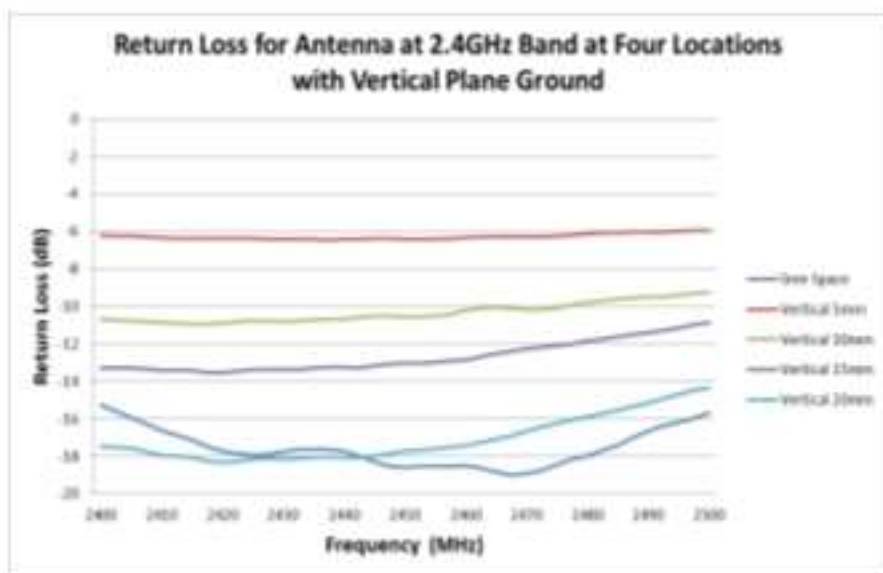


FIGURE 6.2.2 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND

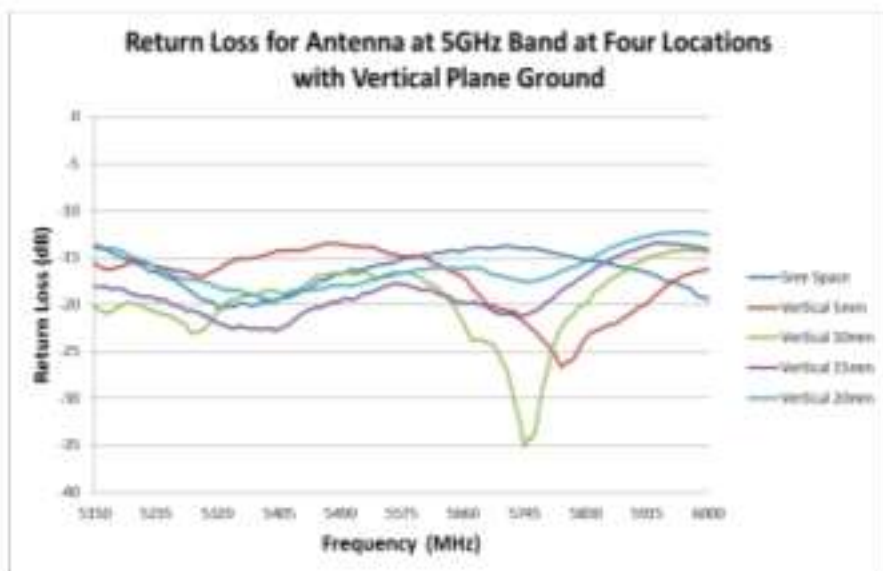


FIGURE 6.2.3 RETURN LOSS OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND

|                                          |                                                          |                                                                                   |                                        |
|------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | EC/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>24 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12              | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

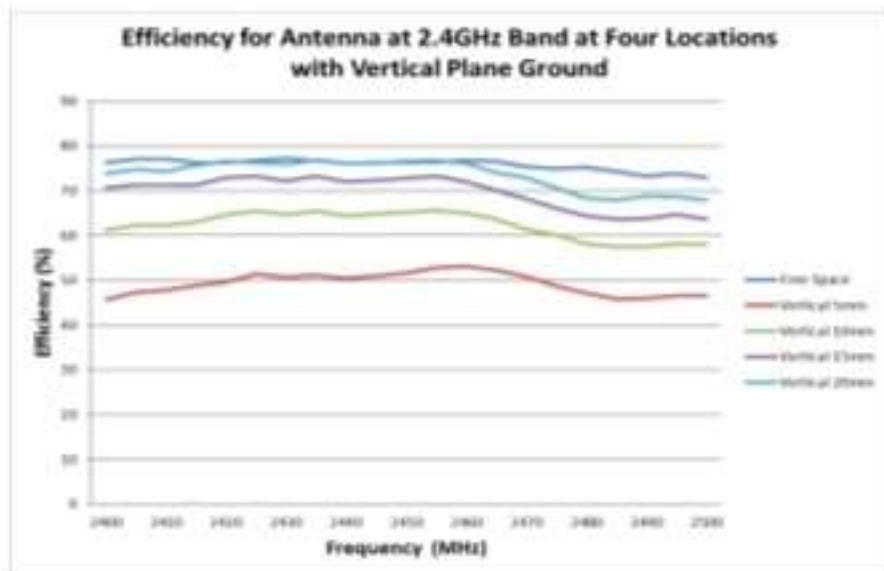


FIGURE 6.2.4 EFFICIENCY OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND

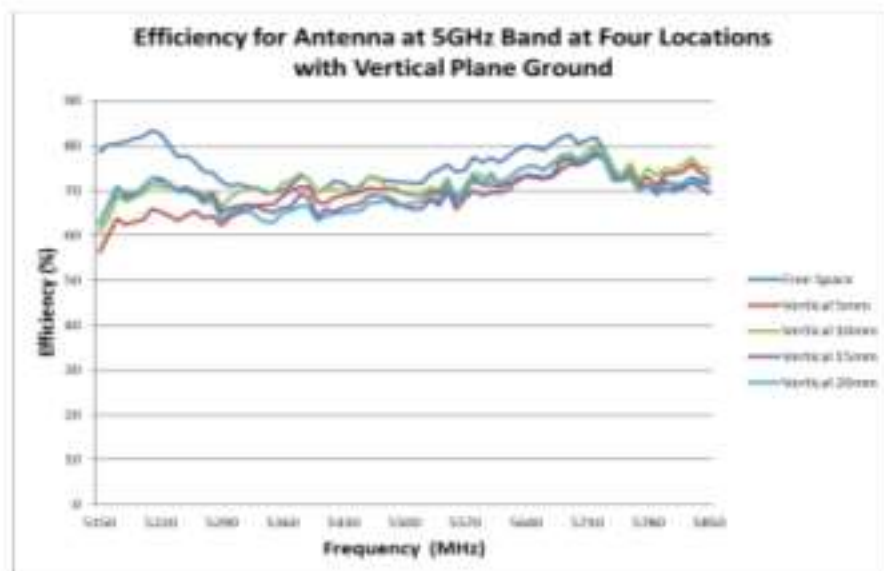
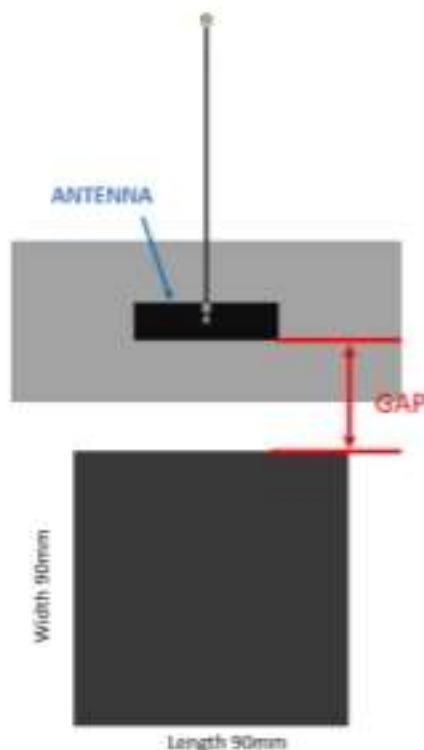


FIGURE 6.2.5 EFFICIENCY OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND

|                                          |                                                          |                                                                                   |                                        |
|------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | EC/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>25 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12              | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

### 6.3 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT DISTANCES WITH PARALLEL PLANE GROUND

Four locations with the parallel plane ground have been evaluated and these locations are shown in figure 6.3.1. The plane ground size is 90mm\*90mm and we move the plane ground to four locations for each test. The antenna performance is better with larger distance between the antenna and the parallel plane ground. The minimum distance between the antenna and the plane ground is recommended to be 5mm to achieve acceptable RF performance.



**FIGURE 6.3.1 FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

Ground Size: 90mm\*90mm;

Location 1: Distance between antenna and plane (GAP) ground is about 5mm;

Location 2: Distance between antenna and plane (GAP) ground is about 10mm;

Location 3: Distance between antenna and plane (GAP) ground is about 15mm;

Location 4: Distance between antenna and plane (GAP) ground is about 20mm.

|                                          |                                                           |                                                                                   |                                        |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | ECR/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>26 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12               | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

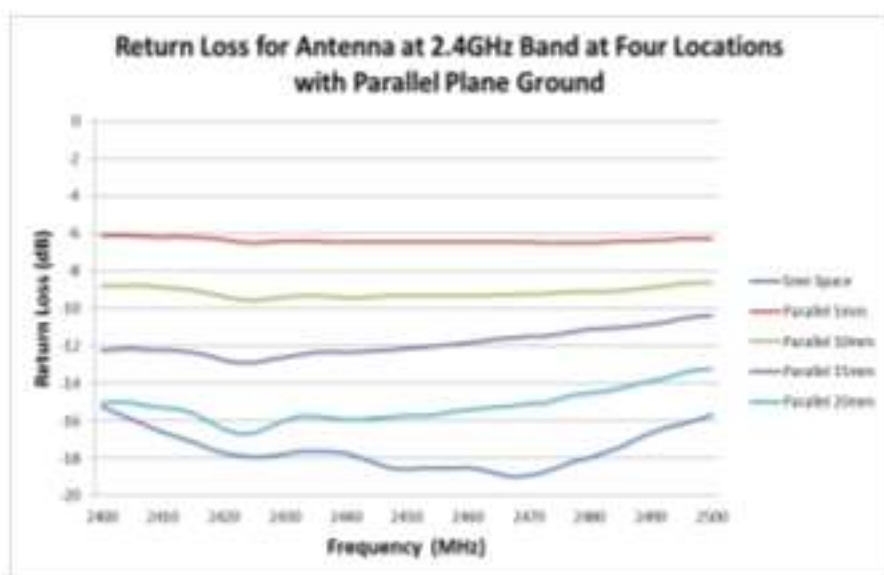


FIGURE 6.3.2 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

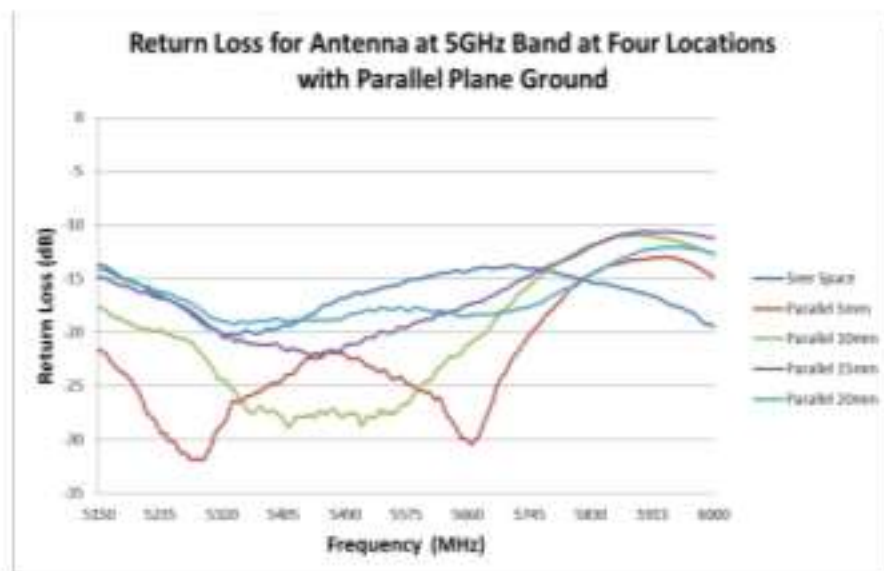


FIGURE 6.3.3 RETURN LOSS OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

|                      |                     |                                                                     |                        |
|----------------------|---------------------|---------------------------------------------------------------------|------------------------|
| REVISION:            | EC/ECN INFORMATION: | TITLE:                                                              | SHEET No.              |
| <b>J</b>             | EC No: 673961       | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b> | <b>27 of 30</b>        |
| DOCUMENT NUMBER:     | DATE: 2021/08/17    | CREATED / REVISED BY:                                               | CHECKED BY:            |
| <b>AS-1461530100</b> |                     | Liu Hai 2021/08/12                                                  | Andy Zhang 2021/08/12  |
|                      |                     | APPROVED BY:                                                        | Chris Zhong 2021/08/12 |

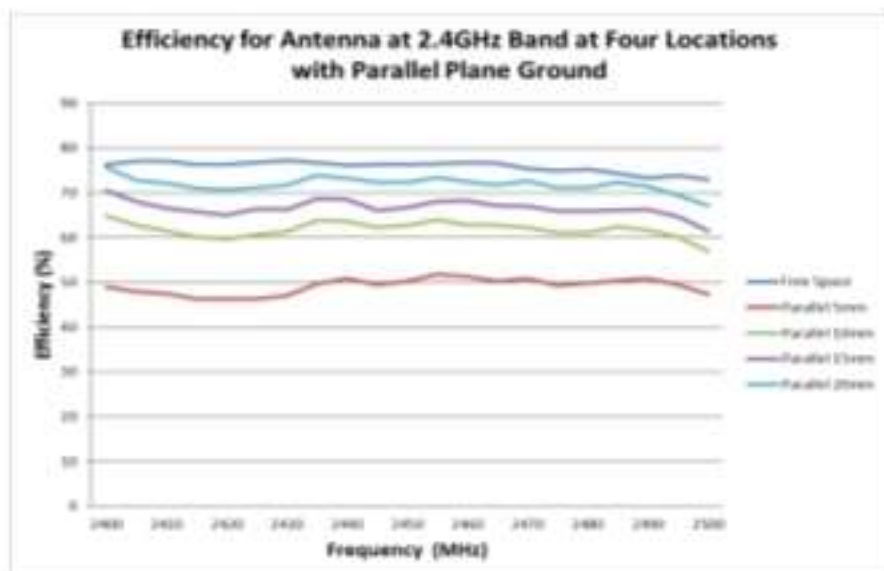


FIGURE 6.3.4 EFFICIENCY OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

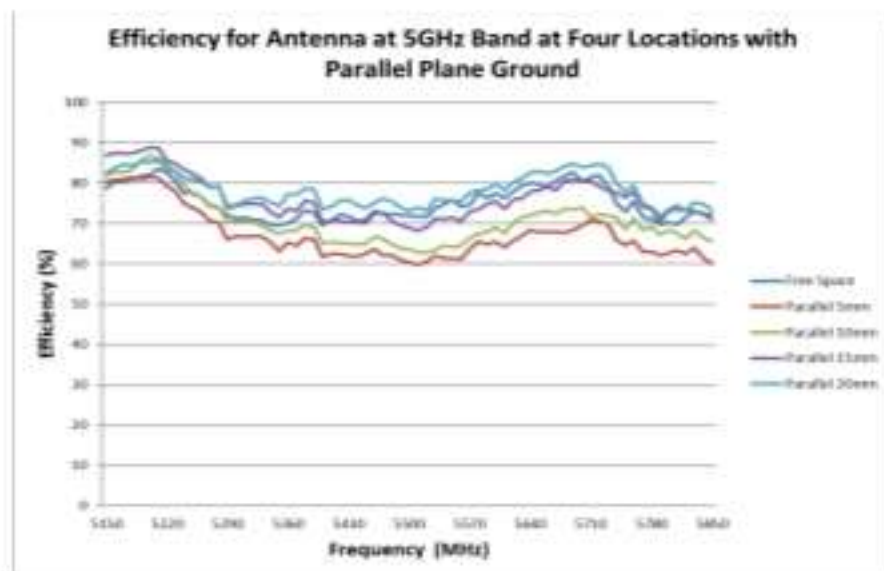


FIGURE 6.3.5 EFFICIENCY OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

|                                          |                                                          |                                                                                   |                                        |
|------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|
| REVISION:<br><b>J</b>                    | EC/ECN INFORMATION:<br>EC No: 673961<br>DATE: 2021/08/17 | TITLE:<br><b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | SHEET No.<br><b>28 of 30</b>           |
| DOCUMENT NUMBER:<br><b>AS-1461530100</b> | CREATED / REVISED BY:<br>Liu Hai 2021/08/12              | CHECKED BY:<br>Andy Zhang 2021/08/12                                              | APPROVED BY:<br>Chris Zhong 2021/08/12 |

## 7.0 THE ANTENNA PERFORMANCE VARIATION WITH CABLE LENGTH

### 7.0.1 CABLE LOSS

| ITEM    | DESCRIPTION     | TEST CONDITION                | REQUIREMENT |           |            |
|---------|-----------------|-------------------------------|-------------|-----------|------------|
| 7.0.1.1 | Frequency Range | 2 GHz~7.125GHz                | 2GHz~3GHz   | 5GHz~6GHz | 6-7.125GHz |
| 7.0.1.2 | Attenuation     | 1m cable measured by VNA5071C | ≤3.5dB/m    | ≤5.5dB/m  | ≤6.5dB/m   |

### 7.0.2 CABLE LENGTH AFFECT THE ANTENNA PERFORMANCE

Balance antenna resonance is insensitive by cable length, but the cable loss will affect the total efficiency. Refer to 7.0.1

### 7.0.3 FOR EXAMPLE

Base on the 100mm cable performance, we can mostly compute the 300mm cable's.

| Frequency (MHz) | 100mm cable     |                | cable loss   | 300mm cable     |                |
|-----------------|-----------------|----------------|--------------|-----------------|----------------|
|                 | Efficiency (dB) | Efficiency (%) |              | Efficiency (dB) | Efficiency (%) |
|                 | X               |                | X-LOSS=Y     | Y               |                |
| 2400            | -1.09           | 77.77          | 0.2m*3.5dB/m | -1.79           | 66.19          |
| 2420            | -1.05           | 78.43          |              | -1.75           | 66.76          |
| 2440            | -1.15           | 76.82          |              | -1.85           | 65.38          |
| 2460            | -1.17           | 76.41          |              | -1.87           | 65.03          |
| 2480            | -1.19           | 76.00          |              | -1.89           | 64.68          |
| 2500            | -1.23           | 75.37          |              | -1.93           | 64.15          |
| 5150            | -1.10           | 77.71          | 0.2*5.5dB/m  | -2.20           | 60.32          |
| 5200            | -1.13           | 77.08          |              | -2.23           | 59.83          |
| 5250            | -1.13           | 77.11          |              | -2.23           | 59.85          |
| 5300            | -1.20           | 75.88          |              | -2.30           | 58.90          |
| 5350            | -1.33           | 73.54          |              | -2.43           | 57.08          |
| 5400            | -1.23           | 75.30          |              | -2.33           | 58.45          |
| 5450            | -1.16           | 76.50          |              | -2.26           | 59.38          |
| 5500            | -0.92           | 80.93          |              | -2.02           | 62.82          |
| 5550            | -0.92           | 80.95          |              | -2.02           | 62.84          |
| 5600            | -0.95           | 80.42          |              | -2.05           | 62.42          |
| 5650            | -0.97           | 79.94          |              | -2.07           | 62.05          |
| 5700            | -1.00           | 79.37          |              | -2.10           | 61.61          |
| 5750            | -1.06           | 78.38          |              | -2.16           | 60.84          |
| 5800            | -1.20           | 75.94          |              | -2.30           | 58.95          |
| 5850            | -1.11           | 77.51          |              | -2.21           | 60.17          |
| 5900            | -1.27           | 74.69          |              | -2.37           | 57.98          |
| 5925            | -1.30           | 74.20          |              | -2.40           | 57.60          |
| 5950            | -1.19           | 76.11          |              | -2.29           | 59.08          |

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | ECR/ECN INFORMATION:              | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>29 of 30</b>        |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |

| Frequency (MHz) | 100mm cable     |                | cable loss  | 300mm cable     |                |
|-----------------|-----------------|----------------|-------------|-----------------|----------------|
|                 | Efficiency (dB) | Efficiency (%) |             | Efficiency (dB) | Efficiency (%) |
|                 | X               |                | X-LOSS=Y    | Y               |                |
| 6000            | -1.00           | 79.43          | 0.2*6.5dB/m | -2.30           | 58.88          |
| 6100            | -1.44           | 71.71          |             | -2.74           | 53.16          |
| 6200            | -1.32           | 73.73          |             | -2.62           | 54.66          |
| 6300            | -1.23           | 75.26          |             | -2.53           | 55.79          |
| 6400            | -1.14           | 76.91          |             | -2.44           | 57.01          |
| 6500            | -1.32           | 73.72          |             | -2.62           | 54.65          |
| 6600            | -1.12           | 77.19          |             | -2.42           | 57.22          |
| 6700            | -1.03           | 78.87          |             | -2.33           | 58.46          |
| 6800            | -1.05           | 78.50          |             | -2.35           | 58.20          |
| 6900            | -1.01           | 79.23          |             | -2.31           | 58.73          |
| 7000            | -1.45           | 71.60          |             | -2.75           | 53.07          |
| 7100            | -1.20           | 75.84          |             | -2.50           | 56.22          |
| 7125            | -1.11           | 77.44          |             | -2.41           | 57.41          |

The data is just for your reference, all accurate performance should be according to the test results in the OTA chamber

## 8.0 CHANGE HISTORY

| CHANGE HISTORY |            |                                          |
|----------------|------------|------------------------------------------|
| REV            | DATA       | DESCRIPTION                              |
| H              | 2020/06/18 | Update 2D Figure and add 6-7.125GHz band |
| H1             | 2020/08/26 | Change 2D 2450MHz 5450MHz pattern        |
| J              | 2021/08/12 | Change 2D of 6000MHz 7125MHz pattern     |

|                      |                                   |                                                                         |                        |
|----------------------|-----------------------------------|-------------------------------------------------------------------------|------------------------|
| REVISION:            | EC/ECN INFORMATION:               | TITLE:                                                                  | SHEET No.              |
| <b>J</b>             | EC No: 673961<br>DATE: 2021/08/17 | <b>WIFI 6E FLEX CABLE BALANCE ANTENNA<br/>APPLICATION SPECIFICATION</b> | <b>30 of 30</b>        |
| DOCUMENT NUMBER:     | CREATED / REVISED BY:             | CHECKED BY:                                                             | APPROVED BY:           |
| <b>AS-1461530100</b> | Liu Hai 2021/08/12                | Andy Zhang 2021/08/12                                                   | Chris Zhong 2021/08/12 |

# Compact 2.4 GHz WiFi/BL FR4 Antenna



ABAR1504-S2450



15.0 x 4.0 x 0.8 mm  
RoHS/REACH II Compliant  
MSL = NA

## Features

- Most compact cabled 2.4GHz antenna, 15 x 4 mm
- Low Profile of 0.8 mm
- Linear Polarization
- Low VSWR
- Gain of 2.28 dBi
- Easy integration using cable and connector
- Ø1.13 mm cable and IPEX Connector

## Applications

- IoT
- Wearables
- Home automation
- WiFi/Bluetooth/ZigBee
- Appliances
- Security

## Electrical Specifications

| Parameters                | Min.      | Typ.  | Max.  | Units | Notes |
|---------------------------|-----------|-------|-------|-------|-------|
| Operating Frequency Range | 2400-2484 |       |       | MHz   |       |
| Frequency                 | 2400      | 2450  | 2500  |       |       |
| VSWR                      | 2.70      | 1.63  | 1.66  | dBi   |       |
| Peak Gain                 | 1.52      | 2.28  | 1.89  |       |       |
| Average Gain              | -5.92     | -5.16 | -5.54 | %     |       |
| Polarization              | Linear    |       |       |       |       |
| Impedance                 | 50        |       |       | Ω     |       |

## Mechanical Specification

| Parameters   | Description |
|--------------|-------------|
| Cable Type   | Ø1.13 mm    |
| Cable Length | 250 mm      |
| Connector    | IPEX        |

## Environmental Specification

| Parameters            | Description    |
|-----------------------|----------------|
| Operating Temperature | -40°C to +85°C |
| Storage Temperature   | -40°C to +85°C |
| Relative Humidity     | 0 ~ 95 %       |



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# Compact 2.4 GHz WiFi/BL FR4 Antenna

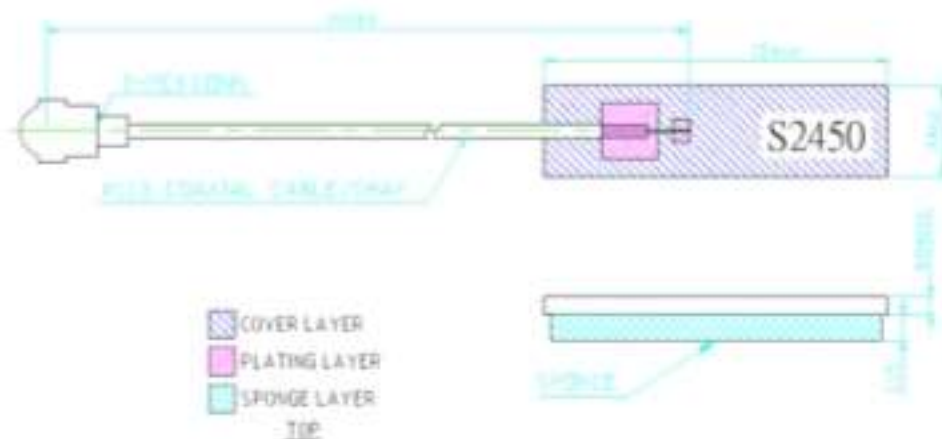


ABAR1504-S2450



15.0 x 4.0 x 0.8 mm  
RoHS/RoHS II Compliant  
MSL = NA

## Product Dimensions



Dimensions: mm

# Compact 2.4 GHz WiFi/BL FR4 Antenna

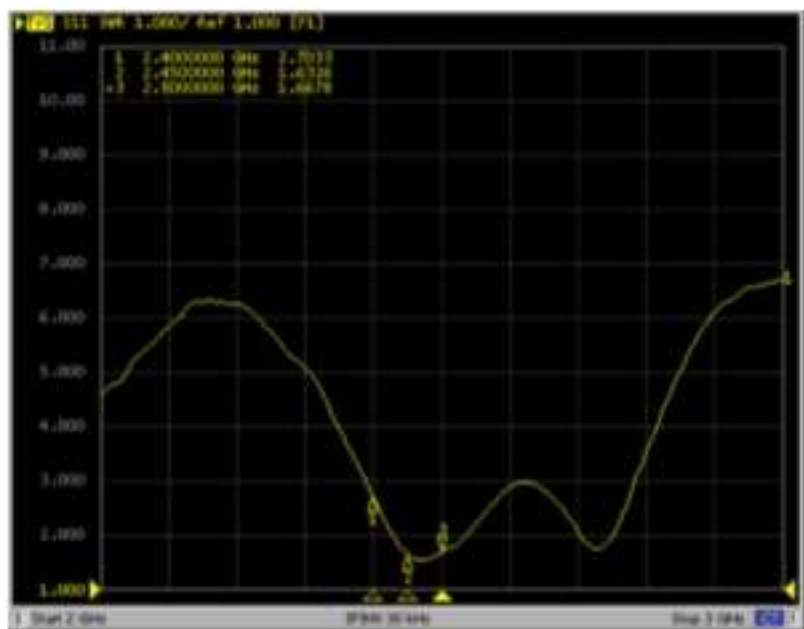


ABAR1504-S2450



15.0 x 4.0 x 0.8 mm  
RoHS/REACH II Compliant  
MSL = NA

VSWR



# Compact 2.4 GHz WiFi/BL FR4 Antenna

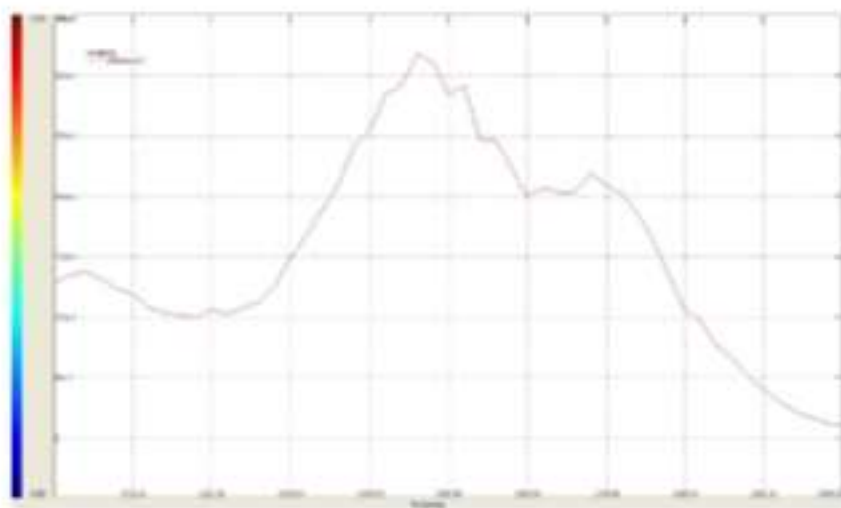


ABAR1504-S2450

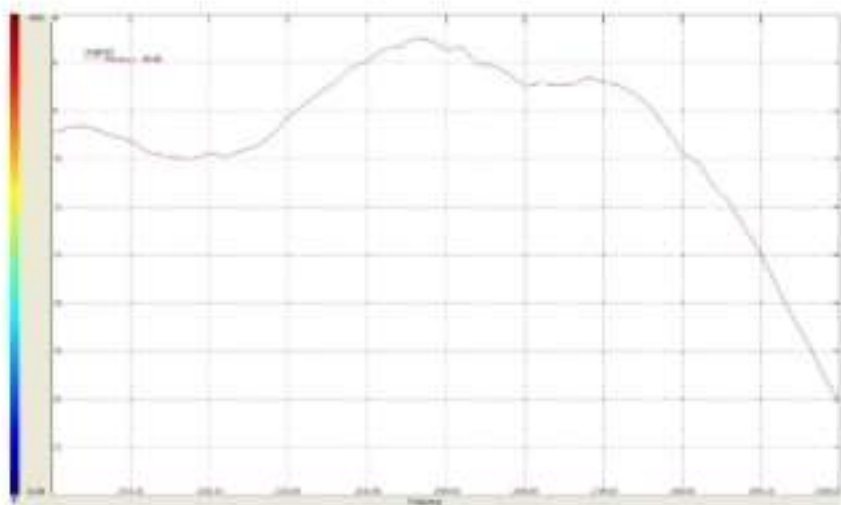


15.0 x 4.0 x 0.8 mm  
RoHS/REACH II Compliant  
MSL = NA

## Efficiency



## Average Gain



# Compact 2.4 GHz WiFi/BL FR4 Antenna

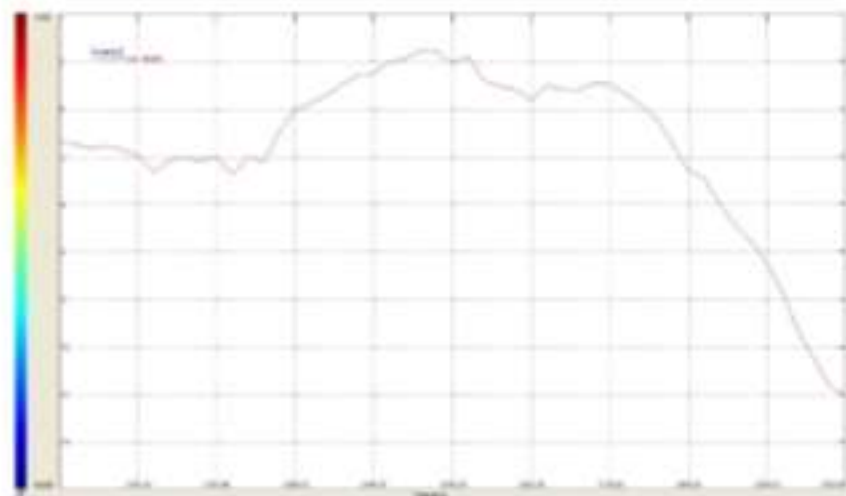


ABAR1504-S2450



15.0 x 4.0 x 0.8 mm  
RoHS/RoHS II Compliant  
MSL = NA

## Peak Gain



| BT                 | 2400 MHz | 2450 MHz | 2500 MHz |
|--------------------|----------|----------|----------|
| Efficiency (%)     | 25.56    | 30.50    | 28.50    |
| Average Gain (dBi) | -5.92    | -5.16    | -5.54    |
| Peak Gain (dBi)    | 1.52     | 2.28     | 1.89     |

# Compact 2.4 GHz WiFi/BL FR4 Antenna



ABAR1504-S2450

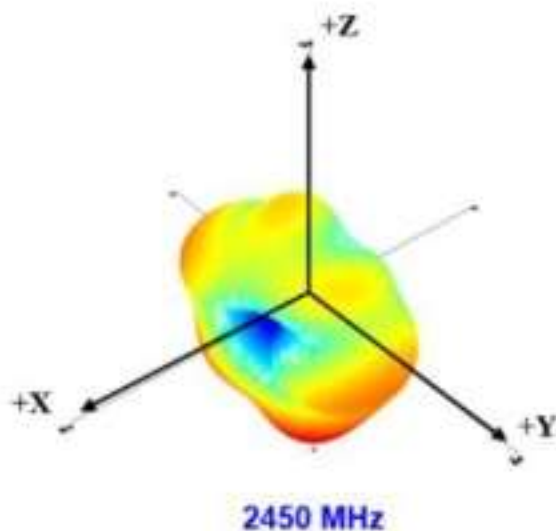


15.0 x 4.0 x 0.8 mm  
RoHS/REACH II Compliant  
MSL = NA

Radiation Pattern @ 2450MHz



3D Pattern



# Compact 2.4 GHz WiFi/BL FR4 Antenna



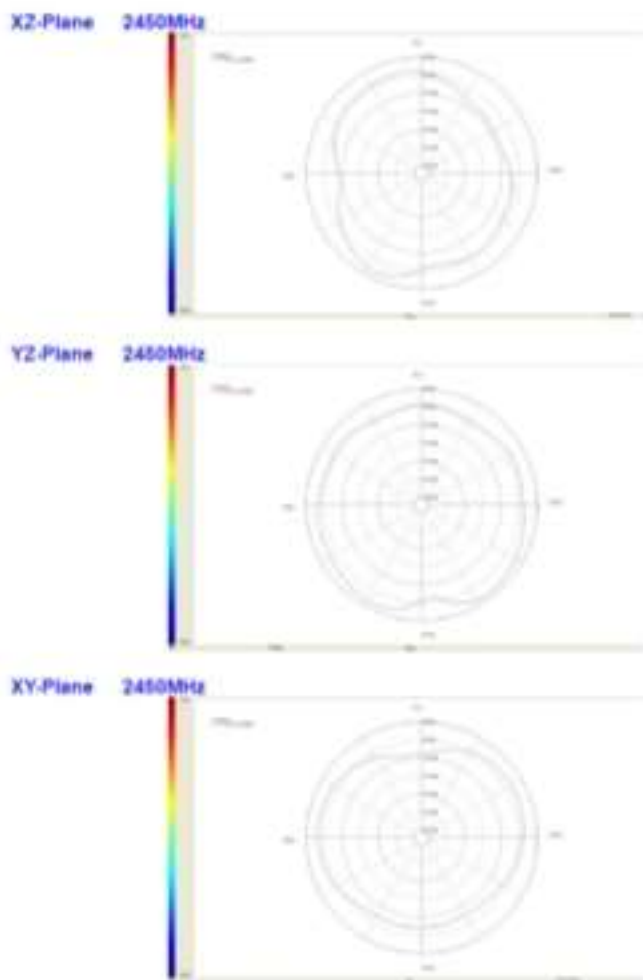
ABAR1504-S2450



15.0 x 4.0 x 0.8 mm  
RoHS/REACH II Compliant  
MSL = NA

## 2D Pattern

| Measurement Plane | XZ        | YZ        | XY        |
|-------------------|-----------|-----------|-----------|
| 2450 MHz          | -1.91 dBi | -1.24 dBi | -3.25 dBi |



## Compact 2.4 GHz WiFi/BL FR4 Antenna



ABAR1504-S2450



15.0 x 4.0 x 0.8 mm  
RoHS/REACH II Compliant  
MSL = NA

### Packaging

Each carton is 330 x 280 x 254 mm and has 3600 pcs of antenna.

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## ANT-2.4-LPW-125 2.4 GHz Panel-Mount Dipole Antenna

The ANT-2.4-LPW-125 (LPW) is a panel-mount dipole antenna for Bluetooth®, ZigBee® and other 2.4 GHz ISM applications including WiFi/WLAN.

The snap-in panel mount provides for easy and secure installation and the hinged whip with 3-position detent allows for optimal antenna positioning.

Connection is made to the radio via a 125 mm long, 1.13 mm coaxial cable terminated in an MHF1/U.FL-compatible plug connector.



### Features

- Performance
  - VSWR:  $\leq 1.5$
  - Peak Gain: 2.8 dBi
  - Efficiency: 83%
- Snap-in panel mount
  - 9.5 mm (0.37 in) diameter hole
- 93.7 mm (3.69 in) long
- Hinged with detents for straight, 45 degree and 90-degree positioning
- MHF1/U.FL-compatible plug (female socket) connector attached to 125 mm of 1.13 mm coax cable
- Omnidirectional radiation pattern

### Applications

- 2.4 GHz applications
  - Bluetooth® and ZigBee®
- Single-band WiFi / WLAN
  - WiFi 4
  - 802.11b/g/n
- Smart Home networking
- Sensing and remote monitoring
- Internet of Things (IoT) devices
- Gateways

### Ordering Information

| Part Number     | Description                                                                        |
|-----------------|------------------------------------------------------------------------------------|
| ANT-2.4-LPW-125 | Antenna with MHF1/U.FL-compatible connector on 125 mm (4.92 in) 1.13 mm coax cable |

Available from Linx Technologies and select distributors and representatives.

## Electrical Specifications

| ANT-2.4-LPW-125             | 2.4 GHz                                   |
|-----------------------------|-------------------------------------------|
| Frequency Range             | 2.4 GHz to 2.485 GHz                      |
| VSWR (max.)                 | 1.5                                       |
| Return Loss (max.)          | -14.6                                     |
| Peak Gain (dBi)             | 2.8                                       |
| Average Gain (dBi)          | -1.0                                      |
| Efficiency (%)              | 83                                        |
| Polarization                | Linear                                    |
| Radiation                   | Omnidirectional                           |
| Max Power                   | 10 W                                      |
| Wavelength                  | 1/2-wave                                  |
| Electrical Type             | Dipole                                    |
| Impedance                   | 50 $\Omega$                               |
| Connection                  | NHF1/U, FL-compatible plug, female socket |
| Coaxial Cable               | Type: 1.13 mm / Length: 125 mm (4.92 in)  |
| Weight                      | 6.1 g (0.22 oz)                           |
| Height                      | 93.7 mm (3.69 in)                         |
| Operating Temperature Range | -20 °C to +85 °C                          |

Electrical specifications and plots measured in Bent-90 configuration.

## Packaging Information

The ANT-2.4-LPW-125 antennas are individually sealed in a clear plastic bag. Individual packages are packed in a bag of 50, seven bags of 50 to a box and twenty boxes to a carton. Distribution channels may offer alternative packaging options.

## Product Dimensions

Figure 1 shows the overall dimensions and mounting information for the LPW antenna. The antenna's hinged whip can be tilted 90 degrees and has detents at 0, 45 and 90 degrees.

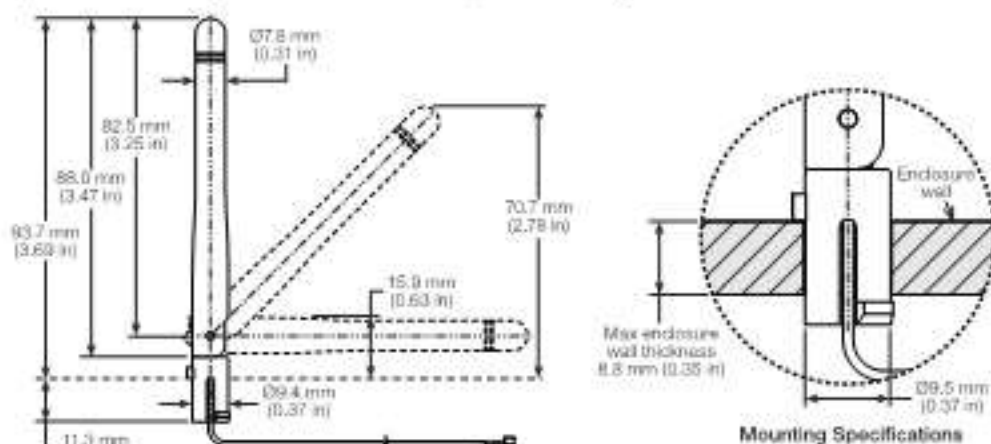


Figure 1. ANT-2.4-LPW-125 Dimensions and Mounting Data

# Antenna Orientation - Bent 90 Degrees

The charts on the following pages represent data taken with the antenna Bent-90 degrees, as shown in Figure 2.



Figure 2. LPW Antenna, Bent 90 Degrees (Bent-90)

## VSWR

Figure 3 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR describes the power reflected from the antenna back to the radio. A lower VSWR value indicates better antenna performance at a given frequency. Reflected power is also shown on the right-side vertical axis as a gauge of the percentage of transmitter power reflected back from the antenna.

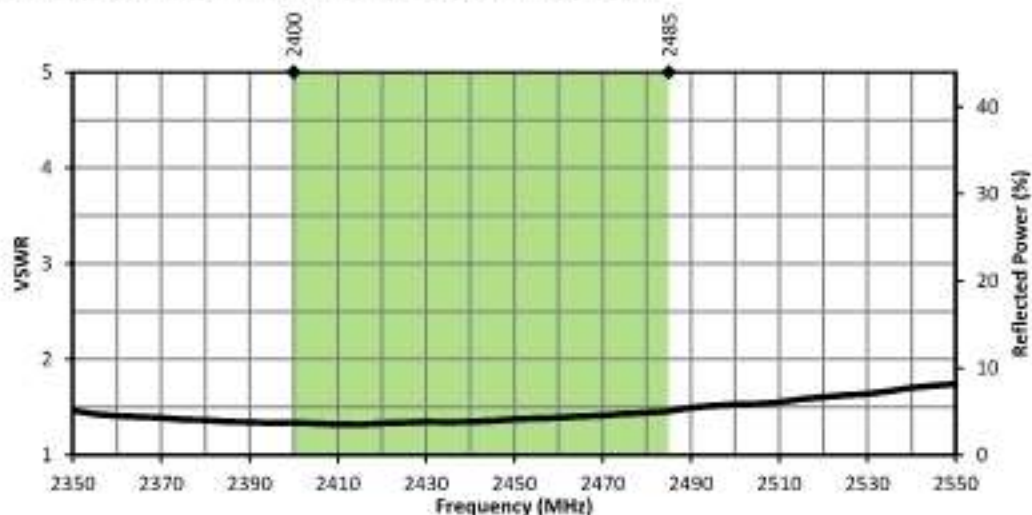


Figure 3. LPW VSWR, Bent-90

### Return Loss

Return loss (Figure 4), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

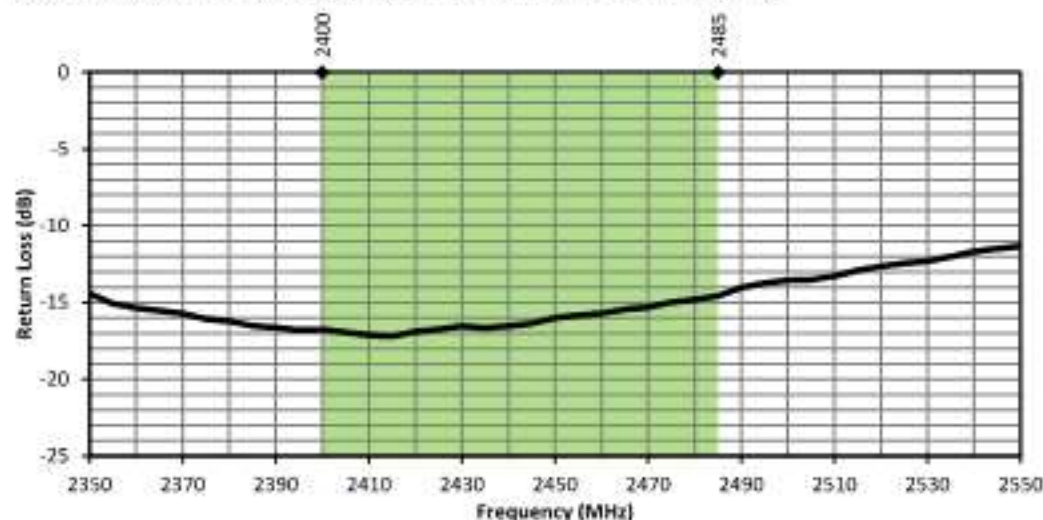


Figure 4. LPW Return Loss, Bent-90

### Peak Gain

The peak gain across the antenna bandwidth is shown in Figure 5. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance at a given frequency, but does not consider any directionality in the gain pattern.

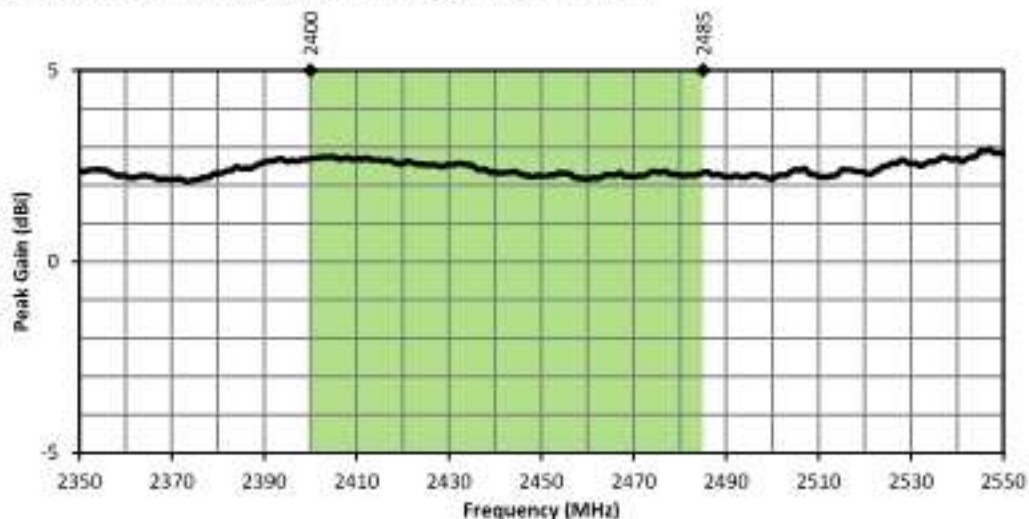


Figure 5. LPW Peak Gain, Bent-90

### Average Gain

Average gain (Figure 6), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

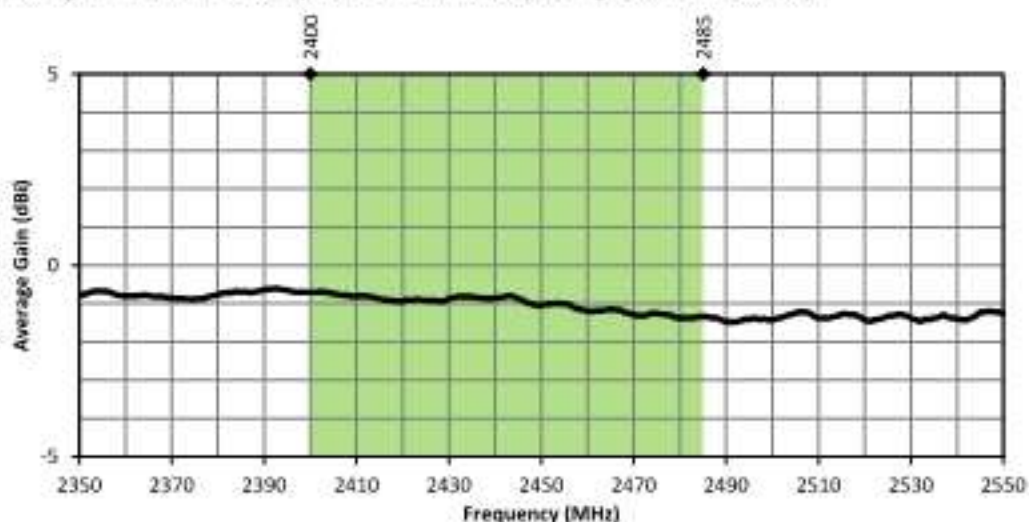


Figure 6. LPW Average Gain, Bent-90

### Radiation Efficiency

Radiation efficiency (Figure 7), shows the ratio of power delivered to the antenna relative to the power radiated at the antenna, expressed as a percentage, where a higher percentage indicates better performance at a given frequency.

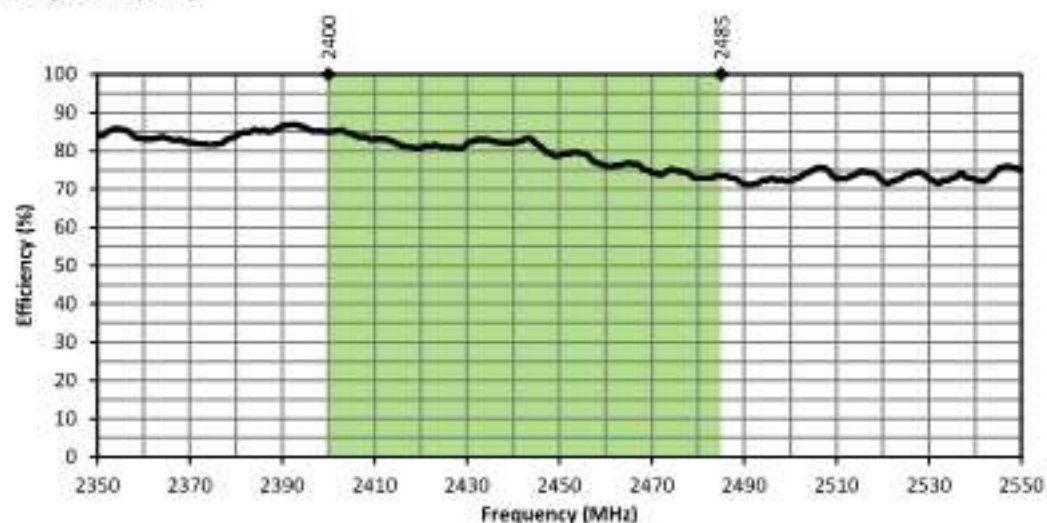


Figure 7. LPW Radiation Efficiency, Bent-90

### Radiation Patterns

Radiation patterns provide information about the directionality and 3-dimensional gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns for a Bent-90 orientation are shown in Figure 8 using polar plots covering 360 degrees. The antenna graphic provides reference to the plane of the column of plots below it. Note: when viewed with typical PDF viewing software, zooming into radiation patterns is possible to reveal fine detail.

### Radiation Patterns - Bent-90 Degrees



### 2400 MHz to 2485 MHz (2450 MHz)

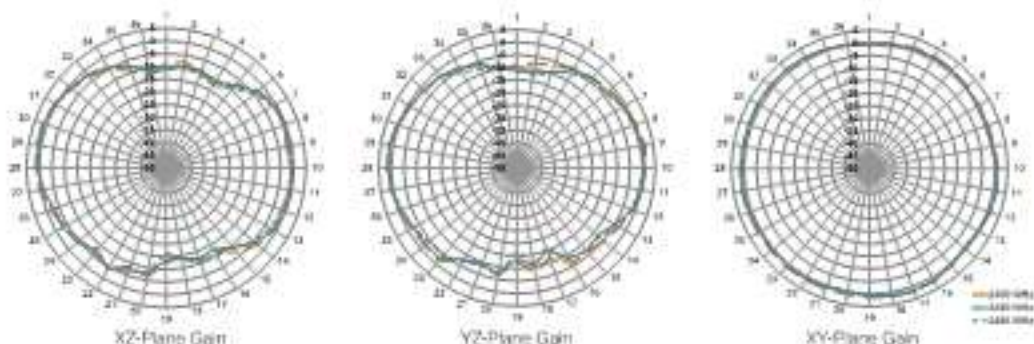


Figure 8. Radiation Patterns for LPW, Bent-90

### Antenna Orientation - Straight

The charts on the following pages represent data taken with the antenna oriented straight, as shown in Figure 9.



Figure 9. LPD Antenna Shown Straight

### VSWR

Figure 10 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR describes the power reflected from the antenna back to the radio. A lower VSWR value indicates better antenna performance at a given frequency. Reflected power is also shown on the right-side vertical axis as a gauge of the percentage of transmitter power reflected back from the antenna.

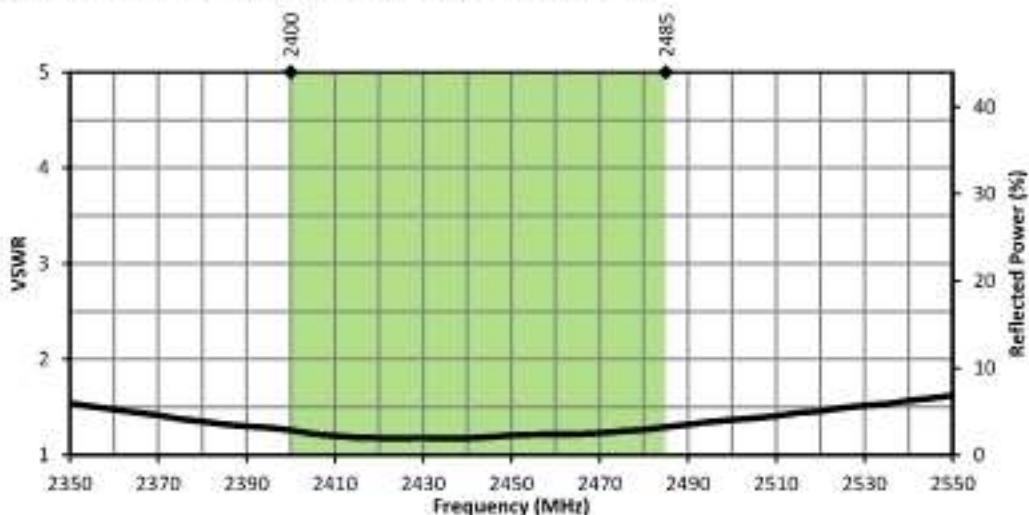


Figure 10. LPW VSWR, Straight

### Return Loss

Return loss (Figure 11), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

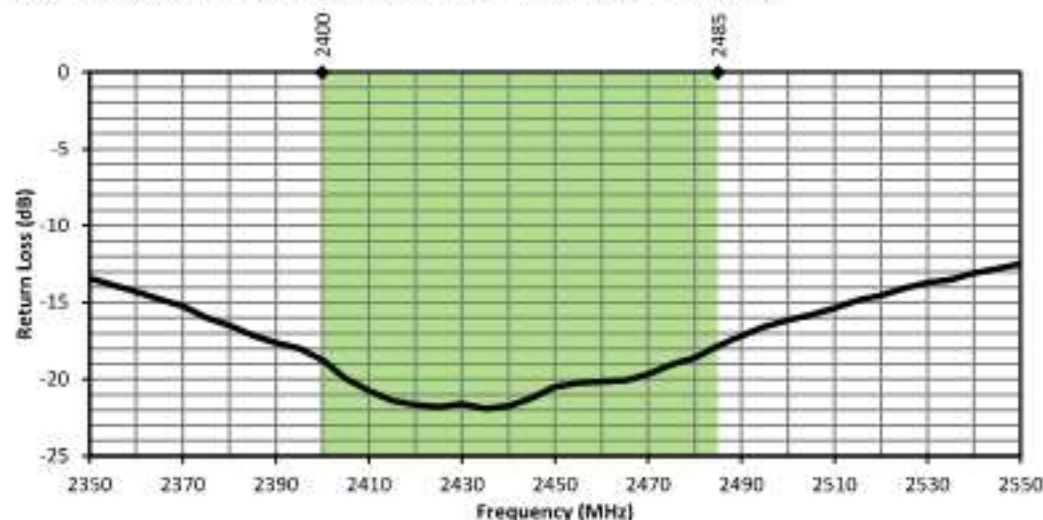


Figure 11. LPW Return Loss, Straight

### Peak Gain

The peak gain across the antenna bandwidth is shown in Figure 12. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance at a given frequency, but does not consider any directionality in the gain pattern.

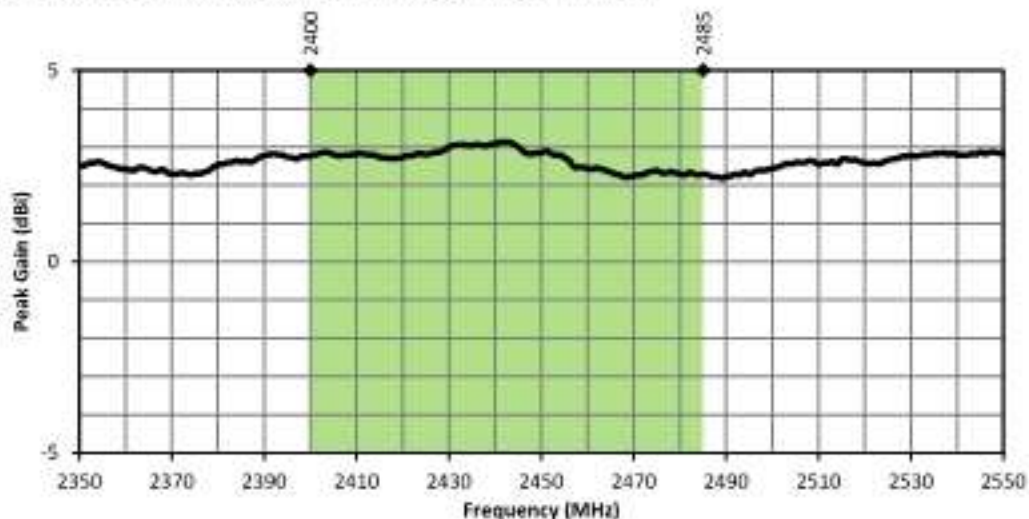


Figure 12. LPW Peak Gain, Straight

### Average Gain

Average gain (Figure 13), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

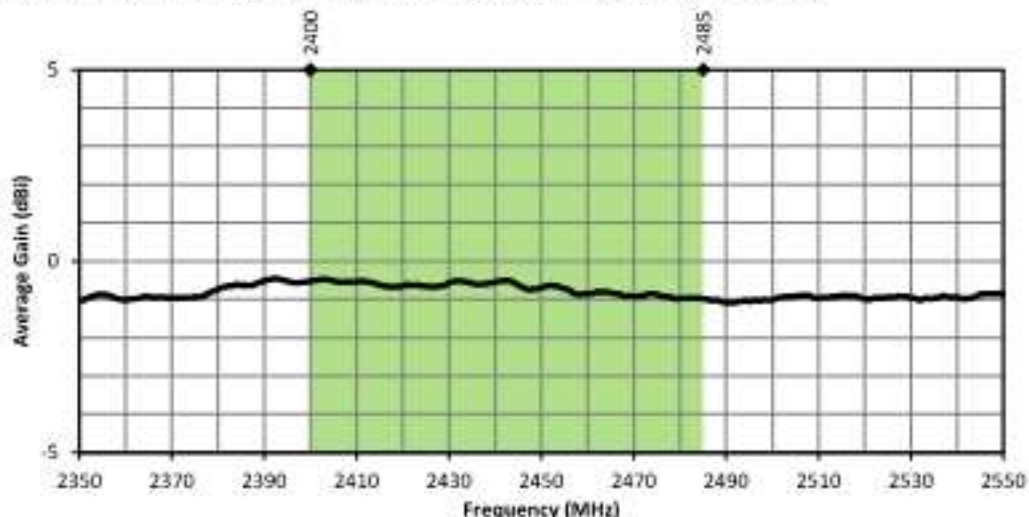


Figure 13. LPW Average Gain, Straight

### Radiation Efficiency

Radiation efficiency (Figure 14), shows the ratio of power delivered to the antenna relative to the power radiated at the antenna, expressed as a percentage, where a higher percentage indicates better performance at a given frequency.

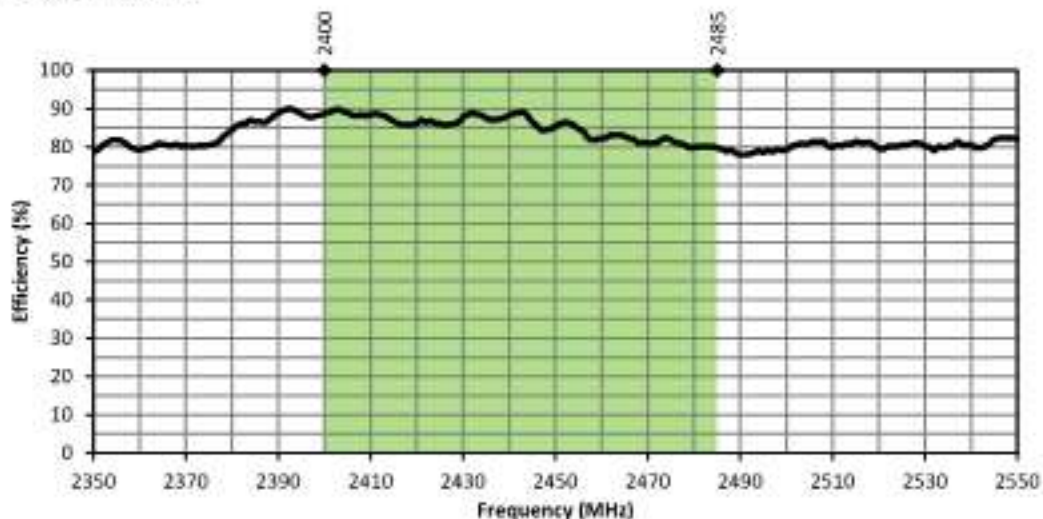


Figure 14. LPW Radiation Efficiency, Straight

### Radiation Patterns

Radiation patterns provide information about the directionality and 3-dimensional gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns for a Straight orientation are shown in Figure 15 using polar plots covering 360 degrees. The antenna graphic provides reference to the plane of the column of plots below it. Note: when viewed with typical PDF viewing software, zooming into radiation patterns is possible to reveal fine detail.

#### Radiation Patterns - Straight



#### 2400 MHz to 2485 MHz (2450 MHz)

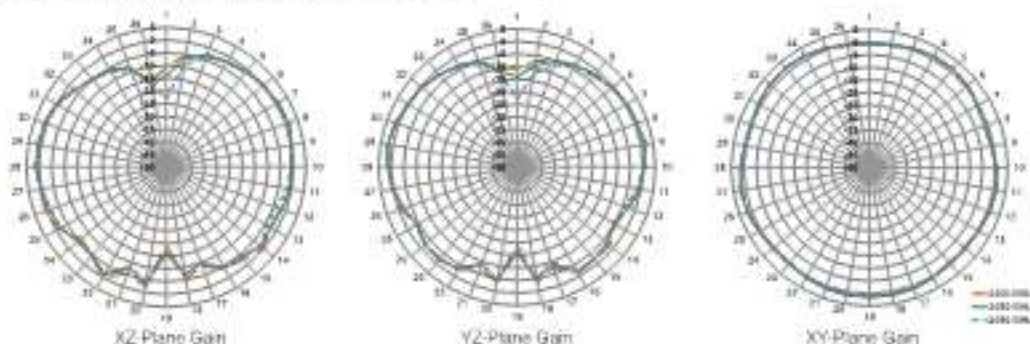


Figure 15. Radiation Patterns for LPW, Straight

## Antenna Definitions and Useful Formulas

**VSWR** - Voltage Standing Wave Ratio. VSWR is a unitless ratio that describes the power reflected from the antenna back to the radio. A lower VSWR value indicates better antenna performance at a given frequency. VSWR is easily derived from Return Loss.

$$VSWR = \frac{10^{\left[\frac{\text{Return Loss}}{20}\right]} + 1}{10^{\left[\frac{\text{Return Loss}}{20}\right]} - 1}$$

**Return Loss** - Return loss represents the loss in power at the antenna due to reflected signals, measured in decibels. A lower return loss value indicates better antenna performance at a given frequency. Return Loss is easily derived from VSWR.

$$\text{Return Loss} = -20 \log_{10} \left[ \frac{VSWR - 1}{VSWR + 1} \right]$$

**Efficiency ( $\eta$ )** - The total power radiated from an antenna divided by the input power at the feed point of the antenna as a percentage.

**Total Radiated Efficiency - (TRE)** The total efficiency of an antenna solution comprising the radiation efficiency of the antenna and the transmitted (forward) efficiency from the transmitter.

$$TRE = \eta \cdot \left( 1 - \left( \frac{VSWR - 1}{VSWR + 1} \right)^2 \right)$$

**Gain** - The ratio of an antenna's efficiency in a given direction (G) to the power produced by a theoretical lossless (100% efficient) isotropic antenna. The gain of an antenna is almost always expressed in decibels.

$$G_{dB} = 10 \log_{10}(G)$$

$$G_{dBi} = G_{dB} - 2.51 \text{ dB}$$

**Peak Gain** - The highest antenna gain across all directions for a given frequency range. A directional antenna will have a very high peak gain compared to average gain.

**Average Gain** - The average gain across all directions for a given frequency range.

**Maximum Power** - The maximum signal power which may be applied to an antenna feed point, typically measured in watts (W).

**Reflected Power** - A portion of the forward power reflected back toward the amplifier due to a mismatch at the antenna port.

$$\left( \frac{VSWR - 1}{VSWR + 1} \right)^2$$

**decibel (dB)** - A logarithmic unit of measure of the power of an electrical signal.

**decibel isotropic (dBi)** - A comparative measure in decibels between an antenna under test and an isotropic radiator.

**decibel relative to a dipole (dBd)** - A comparative measure in decibels between an antenna under test and an ideal half-wave dipole.

**Dipole** - An ideal dipole comprises a straight electrical conductor measuring 1/2 wavelength from end to end connected at the center to a feed point for the radio.

**Isotropic Radiator** - A theoretical antenna which radiates energy equally in all directions as a perfect sphere.

**Omnidirectional** - Term describing an antenna radiation pattern that is uniform in all directions. An isotropic antenna is the theoretical perfect omnidirectional antenna. An ideal dipole antenna has a donut-shaped radiation pattern and other practical antenna implementations will have less perfect but generally omnidirectional radiation patterns which are typically plotted on three axes.

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## RFA-02-P05-D034

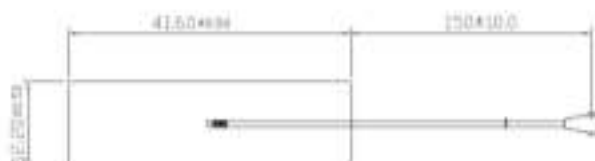
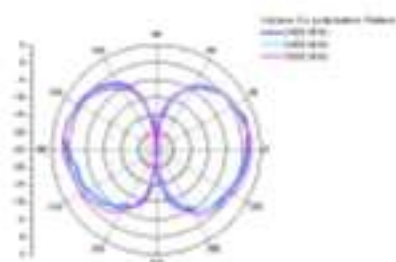
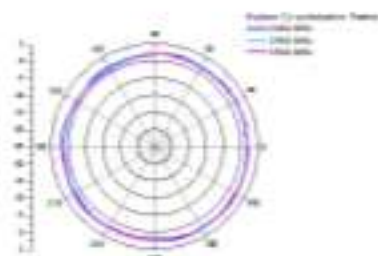
### Electrical Specifications

|                 |                             |
|-----------------|-----------------------------|
| Frequency range | 2400 MHz ~ 2500 MHz         |
| Peak Gain       | 2 dBi                       |
| Average gain    | 1 dBi                       |
| VSWR            | 2.0 : 1 Max.                |
| Polarization    | Linear, vertical            |
| Power handling  | 1W (cw)                     |
| Impedance       | 50 $\Omega$                 |
| Connector       | I-PEX                       |
| Cable           | $\varnothing 1.13\text{mm}$ |



### Environmental & Mechanical Characteristics

|             |                                                  |
|-------------|--------------------------------------------------|
| Temperature | -10 $^{\circ}\text{C}$ to +55 $^{\circ}\text{C}$ |
| Humidity    | 95% @ 25 $^{\circ}\text{C}$                      |



## RFA-02-P33-D034

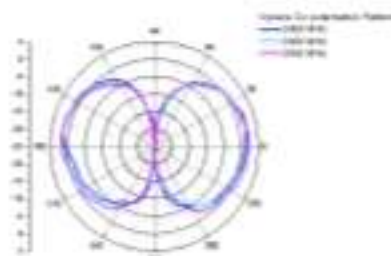
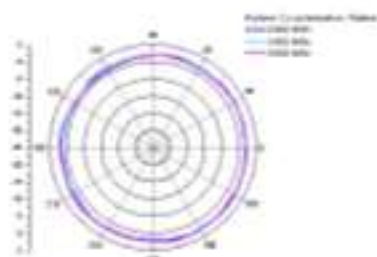
### Electrical Specifications

|                 |                      |
|-----------------|----------------------|
| Frequency range | 2400 MHz ~ 2500 MHz  |
| Peak gain       | 2dBi                 |
| VSWR            | 2.0 : 1 Max.         |
| Polarization    | Linear, vertical     |
| Power handling  | 1W (cw)              |
| Impedance       | 50 $\Omega$          |
| Connector       | I-PEX                |
| Cable           | $\phi 1.13\text{mm}$ |

### Environmental & Mechanical Characteristics

|             |                                                  |
|-------------|--------------------------------------------------|
| Temperature | -10 $^{\circ}\text{C}$ to +55 $^{\circ}\text{C}$ |
| Humidity    | 95% @ 25 $^{\circ}\text{C}$                      |

## Specifications



**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB



### Features:

- 2400-2500 MHz
- Size: 10.7 x 47.7 x 0.8 mm
- Gain 1.5dBi
- Radiation pattern Omni
- Cable length, see page 2
- Connector U.FL compatible
- RoHS Compliant

### Applications:

- 2.4GHz ISM band radios
- WiFi, Bluetooth, BLE, ZigBee
- Devices requiring internal antenna
- Security, IoT, Monitoring, Industrial applications

All dimensions are in mm / inches

#### Issue: 2105

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Tel: 86 512 8207 9398



**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**Series:** Internal PCB

**PART NUMBER:** W3525BXXX

**This document covers all product variants of the following product family**

| Part Number | Cable Length    | Adhesive Tape     | Cable type                        | Connector type                                   | Frequency | Max Gain |
|-------------|-----------------|-------------------|-----------------------------------|--------------------------------------------------|-----------|----------|
| W3525B039   | 3.9" / 100 mm   | N.A.              | Ø1.13mm Coax Cable,<br>Gray color | I-PEX MHF or equivalent,<br>Compatible with U.FL | 2.4 GHz   | 2 dBi    |
| W3525B052   | 5.2" / 132.1 mm | N.A.              |                                   |                                                  |           |          |
| W3525B100   | 10" / 254 mm    | N.A.              |                                   |                                                  |           |          |
| W3525B039T  | 3.9" / 100 mm   | 3M 467 (T=0.05mm) |                                   |                                                  |           |          |
| W3525B0150T | 150 mm          | 3M 467 (T=0.05mm) |                                   |                                                  |           |          |
| W3525B0250  | 250 mm          | N.A.              |                                   |                                                  |           |          |
| W3525B0250T | 250 mm          | 3M 467 (T=0.05mm) |                                   |                                                  |           |          |
| W3525B254T  | 254 mm          | 3M 467 (T=0.05mm) |                                   |                                                  |           |          |

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 Tel: 86 512 8207 9398


**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

### ELECTRICAL SPECIFICATIONS

|                    |                  |
|--------------------|------------------|
| Antenna Type       | Dipole PCB+Cable |
| Frequency          | 2400-2500MHz     |
| Nominal Impedance  | 50 $\Omega$      |
| VSWR               | 2.5:1            |
| Radiation Pattern  | Omni             |
| Gain               | 1.5dBi           |
| Efficiency         | 55%              |
| Polarization       | Vertical         |
| Power Withstanding | 1W               |

### MECHANICAL SPECIFICATIONS

|                  |                     |
|------------------|---------------------|
| Overall Length   | 10.7x47.7x0.8mm     |
| Antenna Material | PCB                 |
| Connector type   | I-PEX or equivalent |
| Cable type       | MI-113 Gray         |

### ENVIRONMENTAL SPECIFICATIONS

|                       |                |
|-----------------------|----------------|
| Operating Temperature | -40° C~+85 ° C |
| Storage Temperature   | -40° C~+85 °C  |
| RoHS Compliant        | Yes            |

### OTHER SPECIFICATIONS

Issue: 2105

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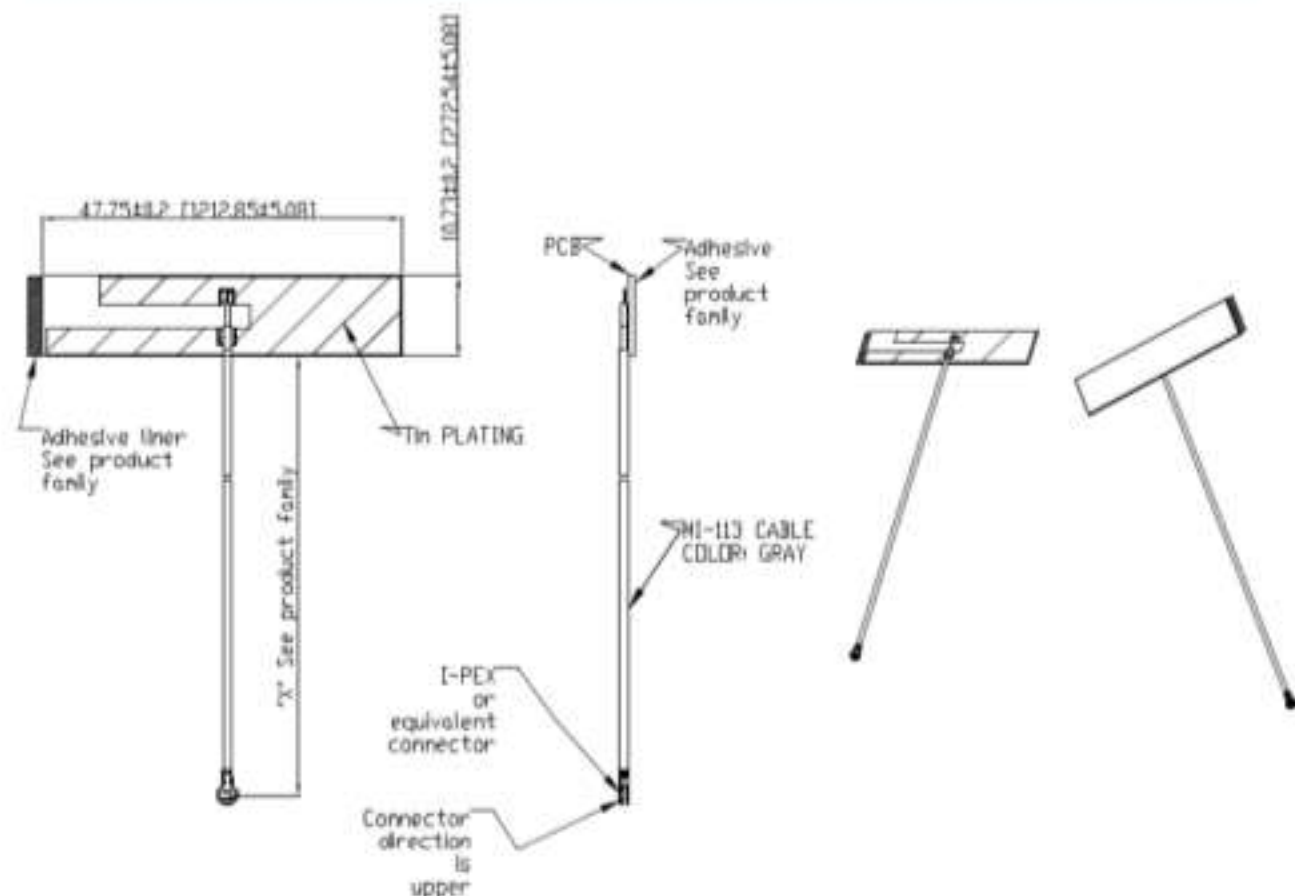
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**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

**MECHANICAL DRAWING**


| Part Number | Frequency(GHz) | Max Gain(dBi) | Impedance(ohm) | PWB Length(in/mm) | Cable Length(in/mm) | Adhesive Tape |
|-------------|----------------|---------------|----------------|-------------------|---------------------|---------------|
| W3525B039   | 2.4            | 2             | 50             | 1.87/47.7         | 3.9/100             | N/A           |
| W3525B052   | 2.4            | 2             | 50             | 1.87/47.7         | 5.2/132.1           | N/A           |
| W3525B100   | 2.4            | 2             | 50             | 1.87/47.7         | 10/254              | N/A           |
| W3525B039T  | 2.4            | 2             | 50             | 1.87/47.7         | 3.9/100             | Required      |

Dimension unit: mm/inch

Issue: 2105

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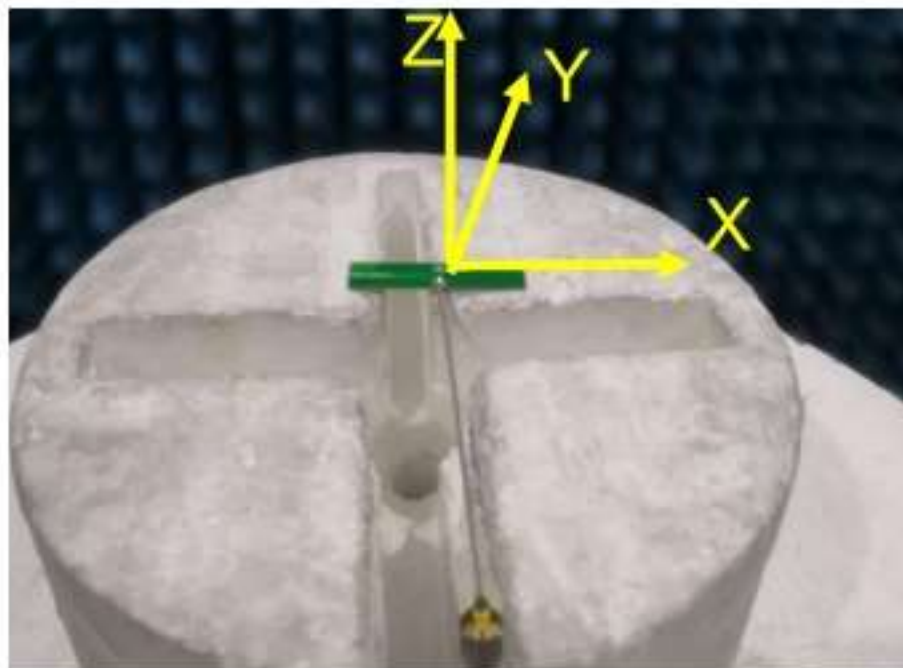
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**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

## TEST SETUP



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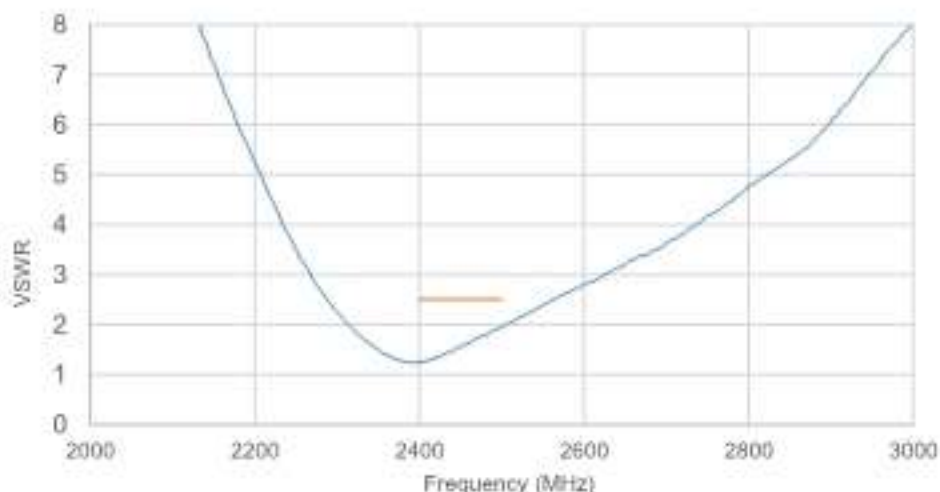
**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

## CHARTS

### VSWR



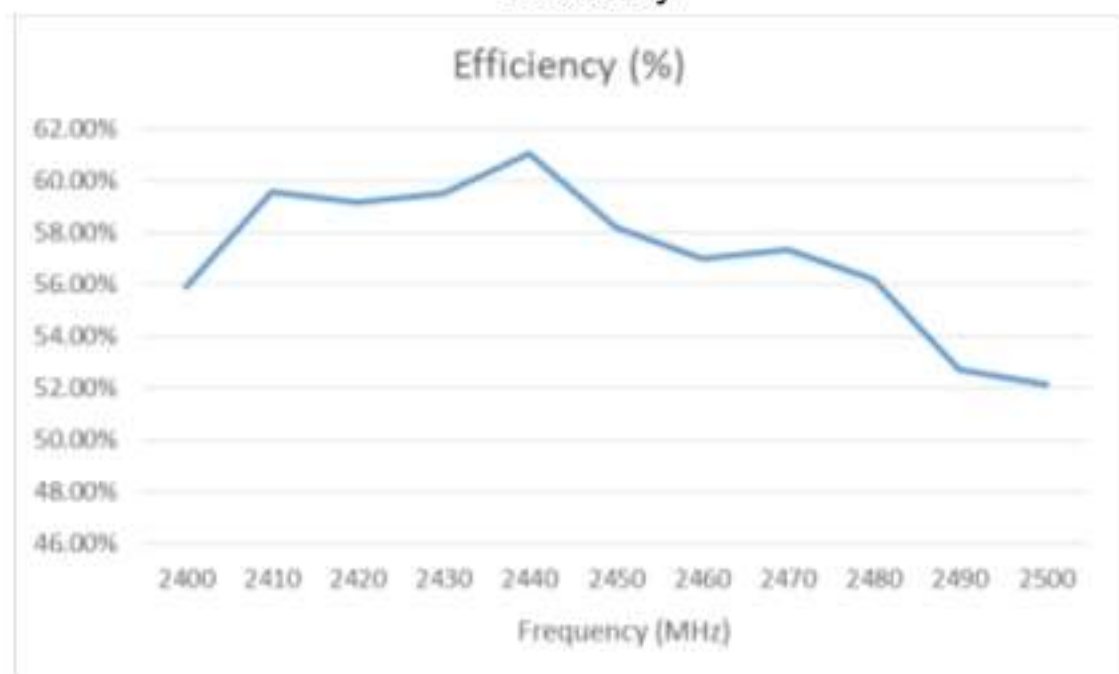
**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

### CHARTS

#### Efficiency



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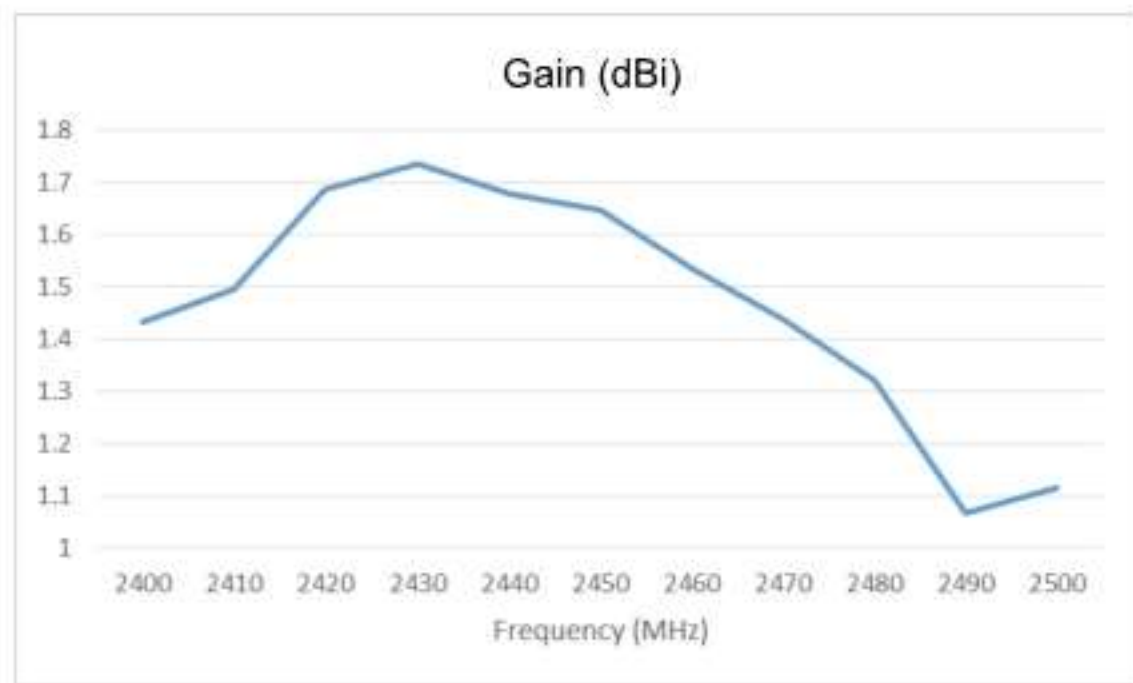
**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

## CHARTS

### Gain



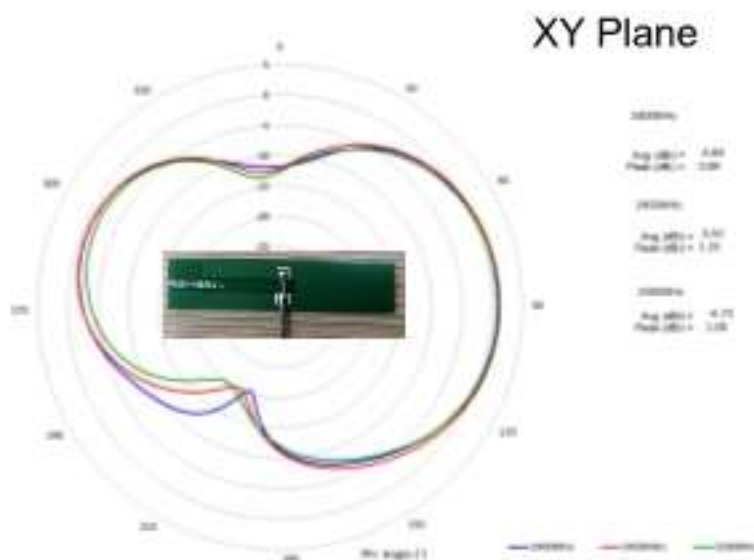
**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

## CHARTS

### Free Space Radiation Pattern



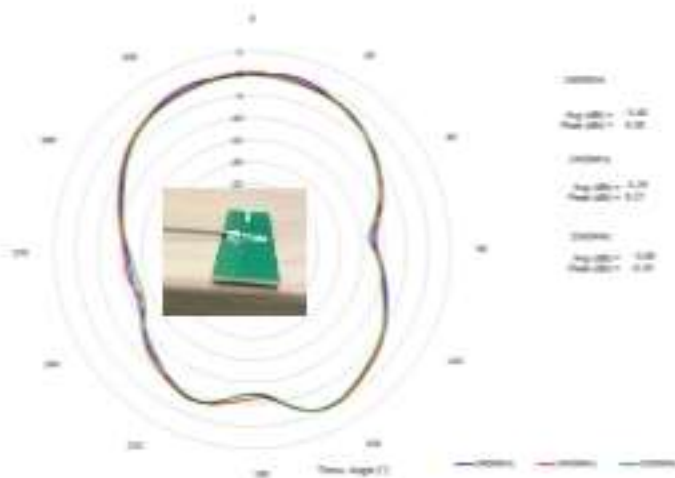
**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

## CHARTS

### Free Space Radiation Pattern

#### XZ Plane



**Description:** 2.4-2.5GHz PCB Antenna with coax feed

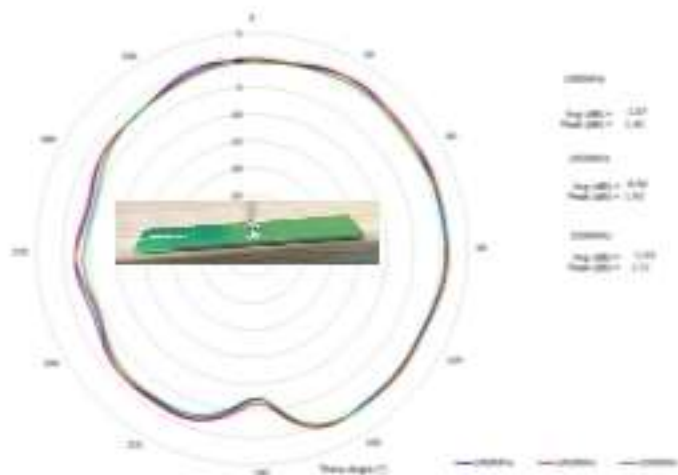
**PART NUMBER:** W3525BXXX

**Series:** Internal PCB

## CHARTS

### Free Space Radiation Pattern

#### YZ Plane



**Description:** 2.4-2.5GHz PCB Antenna with coax feed

**PART NUMBER:** W3525BXXX

### PACKAGING

For W3525B039 and W3525B039T and W3525B052

10pcs antennas packing packed in 1 sealed bag

10pcs sealed bags (total 100pcs antennas) packed in 1 foam bag

12pcs foam bags (total 1200pcs antennas) packed in 1 carton

460x235x140mm

For W3525B100

5pcs antennas packing packed in 1 sealed bag

20pcs sealed bags (total 100pcs antennas) packed in 1 foam bag

12pcs foam bags (total 1200pcs antennas) packed in 1 carton

460x235x140mm