

# ***APPROVAL SHEET***

**Customer Name:** Whirlpool

**Model Name:** 146153 Series

**Frequency:** 2.4GHz

**Whirlpool P/N:** \_\_\_\_\_

**Customer Model:** Rigel

**Date:** \_\_\_\_\_

<b><i>LITE-ON</i></b>		
<i>Approved by</i>	<i>Checked By</i>	<i>Author</i>
<b><i>Customer Approved By</i></b>		
<i>Sign</i>		

**台灣莫仕股份有限公司**

***Molex Taiwan Ltd.***

**新北市淡水區下圭柔山100-3號**

**No. 100-3, Xiaguirou Mt., Tamsui Dist., New Taipei City  
251004, Taiwan**

***TEL: 886-2-26202300***



# PRODUCT SPECIFICATION

## TITLE

### WIFI 6E FLEX CABLE BALANCE ANTENNA

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<u>REVISION:</u> <b>F3</b>	<u>ECR/ECN INFORMATION:</u> EC No: 729862 DATE: 2022/11/25	<u>TITLE:</u> <b>WIFI 6E CABLE FLEX BALANCE ANTENNA PRODUCT SPECIFICATION</b>	<u>SHEET No.</u> <b>1 of 11</b>
<u>DOCUMENT NUMBER:</u> <b>PS-1461530100</b>		<u>CREATED / REVISED BY:</u> <b>Kang Cheng</b>	<u>CHECKED BY:</u> <b>Ma Horace</b>
		<u>APPROVED BY:</u> <b>Benson Hung</b>	



# PRODUCT SPECIFICATION

## WIFI 6E FLEX CABLE BALANCE ANTENNA

### 1.0 SCOPE

This Product Specification covers the mechanical, electrical and environmental performances specification for WiFi 6E flex cable balance antenna.

### 2.0 PRODUCT DESCRIPTION

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

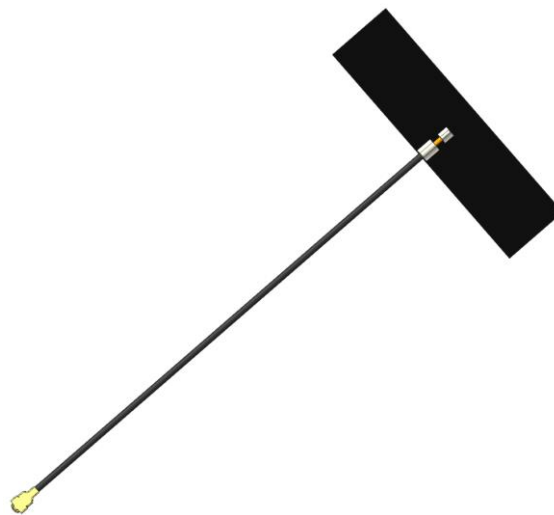
Product name: WiFi 6E flex cable balance antenna  
Series Number: 146153 Series

#### 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 FEATURES

- 2400~2500MHz,5150~5850MHz,5925~7125MHz, linear polarization
- Ground plane independent, balanced dual band antenna
- Flex size 35 x 9 x 0.1mm (not contain solder area)
- MHF & U.FL compatible connector (Such as MHF1/MHF4)
- Cable Ø1.13mm, 6 standard length options (50/100/150/200/250/300mm)
- Cable and connector can be customized



Molex 146153 SERIES 3D VIEW

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DOCUMENT NUMBER: <b>PS-1461530100</b>	CREATED / REVISED BY: <b>Kang Cheng</b>	CHECKED BY: <b>Ma Horace</b>	APPROVED BY: <b>Benson Hung</b>



# PRODUCT SPECIFICATION

## 3.0 GENERAL SPECIFICATION

<b>Product name</b>	WIFI 6E FLEX CABLE BALANCE ANTENNA		
<b>Part number</b>	146153		
<b>Frequency</b>	2.4GHz-2.5GHz	5.15GHz-5.85GHz	5.925GHz-7.125GHz
<b>Polarization</b>	Linear		
<b>Operating with matching</b>	-40°C to 85°C		
<b>Storage with matching</b>	-40°C to 85°C		
<b>RF Power</b>	2 Watts		
<b>Impedance with matching</b>	50 Ohms		
<b>Antenna type</b>	Flex		
<b>Connector type</b>	146153 0XXX	146153 1XXX	
	Compatible MHF1	Compatible MHF4L	
<b>User Implementation type</b>	Adhesive 3M9077		
<b>Cable diameter</b>	Ø1.13mm		
<b>Cable length</b>	50 mm (P/N for 1461530050/1461531050)		
	100 mm (P/N for 1461530100/1461531100)		
	150 mm (P/N for 1461530150/1461531150)		
	200 mm (P/N for 1461530200/1461531200)		
	250 mm (P/N for 1461530250/1461531250)		
	300 mm (P/N for 1461530300/1461531300)		

### Adhesive Application

Bond strength is dependent upon the amount of adhesive-to-surface contact developed. Firm application pressure helps develop better adhesive contact and improves bond strength.

To obtain optimum adhesion, the bonding surfaces must be clean, dry, and well unified. Some typical surface cleaning solvents are isopropyl alcohol/water mixture or heptane.

Ideal tape application temperature range is 70°F to 100°F (21°C to 38°C). Initial tape application to surfaces at temperatures below 50°F (10°C) is not recommended because the adhesive becomes too firm to adhere readily. However, once properly applied, low temperature holding is generally satisfactory.

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<b>DOCUMENT NUMBER:</b> <b>PS-1461530100</b>	<b>CREATED / REVISED BY:</b> <b>Kang Cheng</b>	<b>CHECKED BY:</b> <b>Ma Horace</b>	<b>APPROVED BY:</b> <b>Benson Hung</b>

## 4.0 PRODUCT STRUCTURE INFORMATION

P/N	146153 0XXX		
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ITEM	MATERIAL NO.	CABLE LENGTH "L1"
1	1461530050	43.3 mm
2	1461530100	93.3 mm
3	1461530150	143.3 mm
4	1461530200	193.3 mm
5	1461530250	243.3 mm
6	1461530300	293.3 mm

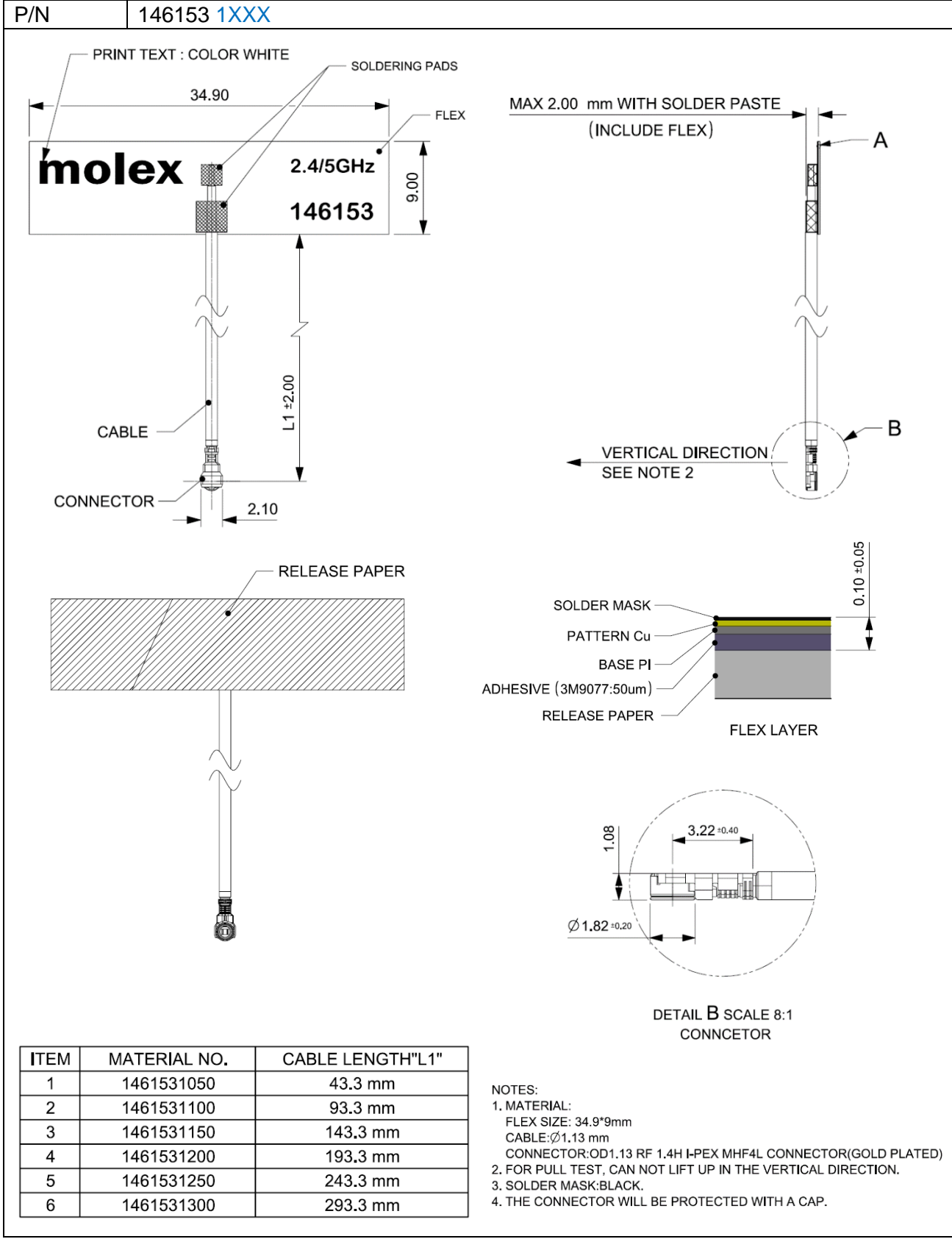
  

**NOTES:**

- MATERIAL:  
FLEX SIZE: 34,9\*9mm  
CABLE:  $\varnothing$ 1.13 mm  
CONNECTOR: OD1.13 RF 2.5H U.FL CONNECTOR-PLUG GOLD PLATED (IPEX MHF-I COMPATIBLE)
- FOR PULL TEST, CAN NOT LIFT UP IN THE VERTICAL DIRECTION.
- SOLDER MASK: BLACK.
- THE CONNECTOR WILL BE PROTECTED WITH A CAP.

Mechanical Structure Information for 1461530XXX

<b>REVISION:</b>	<b>ECR/ECN INFORMATION:</b>	<b>TITLE:</b>	<b>SHEET No.</b>
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<b>PS-1461530100</b>	<b>Kang Cheng</b>	<b>Ma Horace</b>	<b>Benson Hung</b>



Mechanical Structure Information for 1461531XXX

<b>REVISION:</b>	<b>ECR/ECN INFORMATION:</b>	<b>TITLE:</b>		<b>SHEET No.</b>
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<b>PS-1461530100</b>	<b>Kang Cheng</b>	<b>Ma Horace</b>	<b>Benson Hung</b>	



# PRODUCT SPECIFICATION

## 5.0 APPLICABLE DOCUMENTS

DOCUMENT	NUMBER	DESCRIPTION
Sale Drawing (SD)	SD-1461530050	Mechanical Dimension of the product
	SD-1461531050	
Application Guide (AS)	AS-1461530100	Antenna Application and surrounding
Packing Drawing (PK)	PK-1461530100	Product packaging specifications

## 6.0 ANTENNA SPECIFICATION

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

### 6.1 ELECTRICAL REQUIREMENT

6.1.1 ELECTRICAL REQUIREMENTS FOR CABLE LENGTH 50mm			
P/N	1461530050		
Frequency Range	2.4GHz-2.5GHz	5.15GHz-5.85GHz	5.925-7.125GHz
Peak Gain (Max)	3.2dBi	4.25dBi	5.8dBi
Average Total efficiency	>78%	>79%	>75%
Return Loss	< -10 dB	< -10 dB	< -10 dB

6.1.2 ELECTRICAL REQUIREMENTS FOR CABLE LENGTH 100mm			
P/N	1461530100		
Frequency Range	2.4GHz-2.5GHz	5.15GHz-5.85GHz	5.925-7.125GHz
Peak Gain (Max)	3.0dBi	4.0dBi	5.5dBi
Average Total efficiency	>75%	>75%	>70%
Return Loss	< -10 dB	< -10 dB	< -10 dB

6.1.3 ELECTRICAL REQUIREMENTS FOR CABLE LENGTH 150mm			
P/N	1461530150		
Frequency Range	2.4GHz-2.5GHz	5.15GHz-5.85GHz	5.925-7.125GHz
Peak Gain (Max)	2.8dBi	3.7dBi	5.2dBi
Average Total efficiency	>72%	>70%	>65%
Return Loss	< -10 dB	< -10 dB	< -10 dB

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DOCUMENT NUMBER:	CREATED / REVISED BY:	CHECKED BY:	APPROVED BY:
<b>PS-1461530100</b>	<b>Kang Cheng</b>	<b>Ma Horace</b>	<b>Benson Hung</b>



# PRODUCT SPECIFICATION

6.1.4 ELECTRICAL REQUIREMENTS FOR CABLE LENGTHH 200mm			
P/N	1461530200		
Frequency Range	2.4GHz-2.5GHz	5.15GHz-5.85GHz	5.925-7.125GHz
Peak Gain (Max)	2.6dBi	3.5dBi	4.8dBi
Average Total efficiency	>69%	>66%	>60%
Return Loss	< -10 dB	< -10 dB	< -10 dB

6.1.5 ELECTRICAL REQUIREMENTS FOR CABLE LENGTHH 250mm			
P/N	1461530250		
Frequency Range	2.4GHz-2.5GHz	5.15GHz-5.85GHz	5.925-7.125GHz
Peak Gain (Max)	2.4dBi	3.2dBi	4.5dBi
Average Total efficiency	>66%	>63%	>56%
Return Loss	< -10 dB	< -10 dB	< -10 dB

6.1.6 ELECTRICAL REQUIREMENTS FOR CABLE LENGTHH 300mm			
P/N	1461530300		
Frequency Range	2.4GHz-2.5GHz	5.15GHz-5.85GHz	5.925-7.125GHz
Peak Gain (Max)	2.2dBi	2.8dBi	4.2dBi
Average Total efficiency	>63%	>59%	>51%
Return Loss	< -10 dB	< -10 dB	< -10 dB

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.

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# PRODUCT SPECIFICATION

## 6.2 CABLE LOSS

DESCRIPTION	TEST CONDITION	REQUIREMENTS		
Frequency Range	2 GHz~7.125GHz	2.0GHz~3.0GHz	5GHz~6GHz	6GHz~7.125G Hz
Attenuation	1m cable measured by VNA5071C	≤3.5dB/m	≤5.5dB/m	≤6.5dB/m

Balance antenna resonance is insensitive to cable's length, but the cable's loss will affect the total efficiency.

## 7.0 MECHANICAL SPECIFICATION

All measurements in this document are done with the part no.1461530100 for different cable length.

DESCRIPTION	TEST CONDITION	TEST RESULT
Pull Test	1. Test machine: Max intelligent load tester 2. Stick the flex antenna on a plastic board, pull cable in axial direction.	Pull force >8N
Un-mating force (connector)	Solder the receptacle connector to the test board ,then place the board and plug on push-on/pull-off machine, and repeat mating and un-mating 30 cycles at a speed 25±3mm/min. along the mating axis.	Un-mating force : 0.5 kgf min

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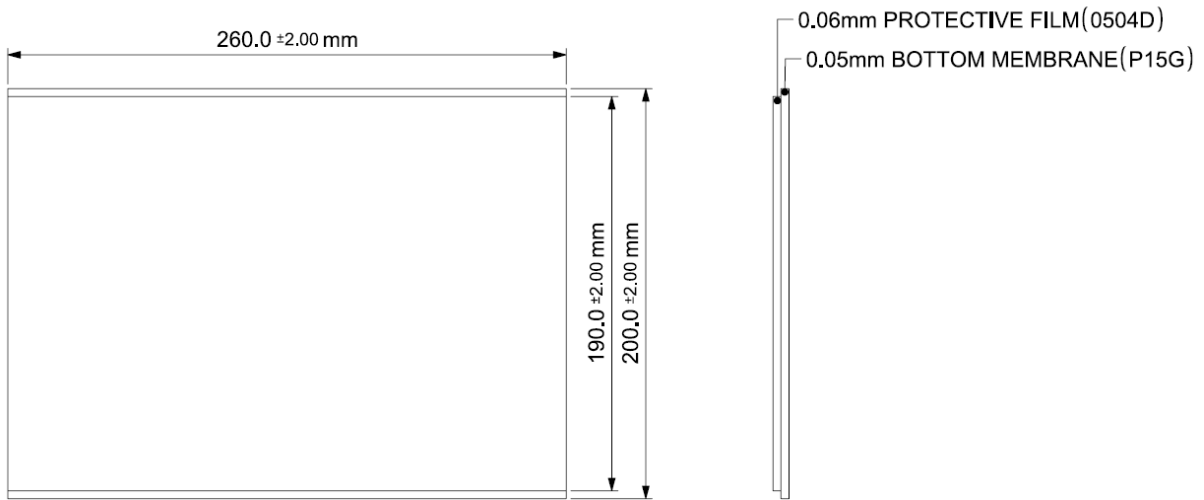
# PRODUCT SPECIFICATION

## 8.0 ENVIRONMENTAL SPECIFICATION

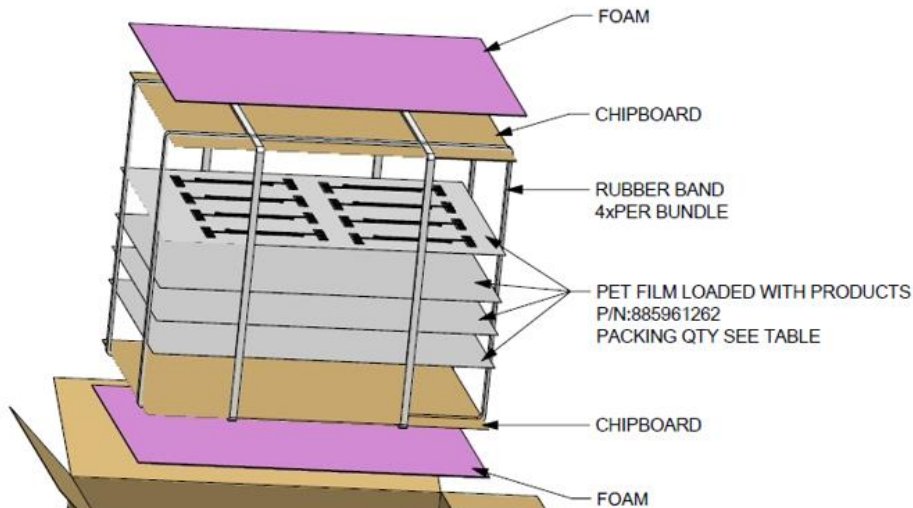
DESCRIPTION	SPECIFICATION
Temperature /Humidity cycling	<ol style="list-style-type: none"> <li>1.The device under test is kept for 30 mins in an environment with a temperature of -40 °C.</li> <li>2. Kept for 4 Hours in an environment with a temperature of 85 °C.</li> <li>3. Kept for 2 Hours in an environment with a temperature of 125 °C.</li> <li>4. The cycle is repeated until a total of 40 cycles have been completed. Hereafter the conditions are stabilized at room temperature. Transfer temperature 8°C per min.</li> <li>5. Parts should meet RF spec before and after test.</li> <li>6. No cosmetic problem (No damage, no corrosion.)</li> </ol>
Temperature Shock	<ol style="list-style-type: none"> <li>1.The device under test at -40 °C-125 °C by 100 cycles, Dwell of 30 mins, transition time between Dwell 30 secs (~ 61 mins / cycle) and each item should be measured after exposing them in normal temperature and humidity for 24 h.</li> <li>2. Parts should meet RF spec before and after test.</li> <li>3. No cosmetic problem (No damage, no corrosion) .</li> </ol>
High Temperature	<ol style="list-style-type: none"> <li>1.Temperature:125°C, time:1008 hours</li> <li>2.There is no substantial obstruction to air flow across and around the samples, and the samples are not touching each other</li> <li>3. Parts should meet RF spec before and after test.</li> <li>4. No cosmetic problem (No damage, no corrosion) .</li> </ol>
Salt mist test	<ol style="list-style-type: none"> <li>1. The device under test is exposed to a spray of a 5% (by volume) resolution of NACL in water for 2 hours. Thereafter the device under test is left for 1 week in room temperature at a relative humidity of 95%. The cycle is repeated until a total of 2 cycles have been completed. Here after the conditions are stabilized at room temperature.</li> <li>2. Parts should meet RF spec before and after test.</li> <li>3. No visible corrosion. Discoloration accept.</li> </ol>

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## 9.0 PACKING



PET FILM



PART NUMBER	PCS/FILM	FILM/BUNDLE	BUNDLE/CARTON	QTY/CARTON
1461530050/1461531050	32	40	4	5120PCS
1461530100/1461531100	16	40	5	3200PCS
1461530150/1461531150	12	40	5	2400PCS
1461530200/1461531200	12	40	5	2400PCS
1461530250/1461531250	8	40	5	1600PCS
1461530300/1461531300	8	40	5	1600PCS

NOTES:

- 1.PRODUCTS MUST BE PACKED IN CARTONS AND SEALED UP WITH TAPE.
- 2.STICK LABEL WITH PART NUMBER AND DATE CODE
- 3.STANDARD PACKAGING QUANTITY:SEE TABLE
- 4.THIS PACKAGING SPECIFICATION TO BE USED FOR "2.4/5GHz BALANCE FLEX ANTENNA".
5. WHEN TAKING PRODUCT FROM PET FILM, PLEASE REMOVE THE COVER TAPE FIRST, THEN PICK UP THE PART FROM FLEX NOT THE CABLE, TO AVOID SOLDER JOINT DAMAGE.

MOLEX  
XXXXXX  
XXXXXX

SHIPPING CARTON  
385x285x320mm

MOLEX LABEL

### PACKAGING INFORMATION FOR 146153 Series

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# PRODUCT SPECIFICATION

## 10.0 OTHER MOLEX ANTENNA PRODUCT

Please refer to the Antenna products in Molex home page to view all the Molex Antenna products.

<https://www.molex.com>

Molex, LLC  
2222 Wellington Court  
Lisle, IL 60532  
USA

## 11.0 CHANGE HISTORY

CHANGE HISTORY		
REV	DATA	DESCRIPTION
F	2020/07/09	Add 6-7.125GHz Frequency Range
F1	2020/08/31	Optimized Part 6.1 Peak Gain
F2	2021/09/06	Updated General Specification Text
F3	2022/11/14	Added section : Other Molex Antenna Product.

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# APPLICATION SPECIFICATION

## TITLE

# WIFI 6E FLEX CABLE BALANCE ANTENNA

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8.0 OTHER MOLEX ANTENNA PRODUCTS

9.0 CHANGE HISTORY

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DOCUMENT NUMBER:	CREATED / REVISED BY:	CHECKED BY:	APPROVED BY:
<b>AS-1461530100</b>	Liu Hai	Andy Zhang	Chris Zhong



# APPLICATION SPECIFICATION

## 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

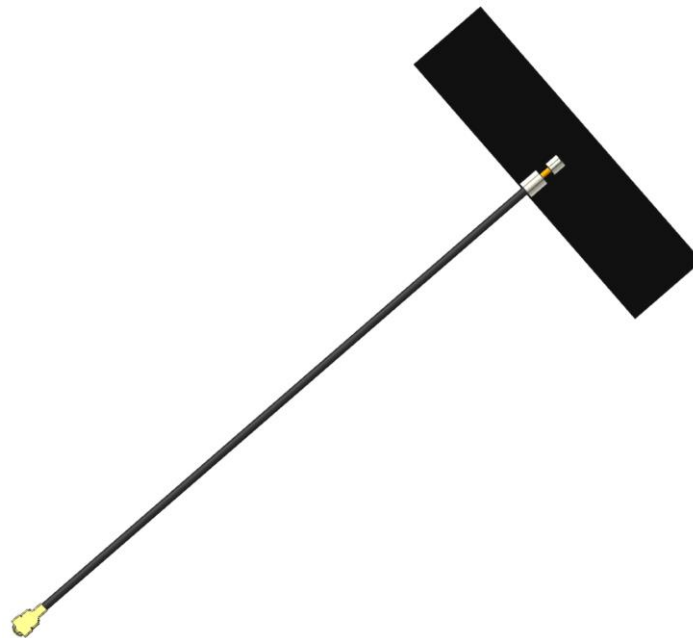
Series Number: 146153

#### 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

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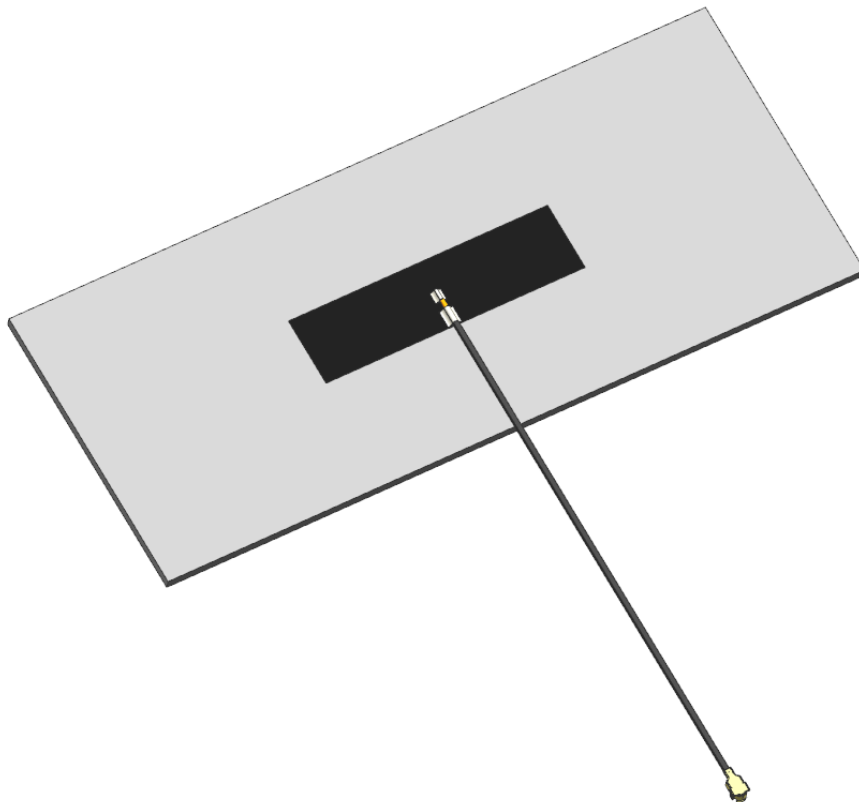
### 3.0 APPLICABLE DOCUMENTS

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

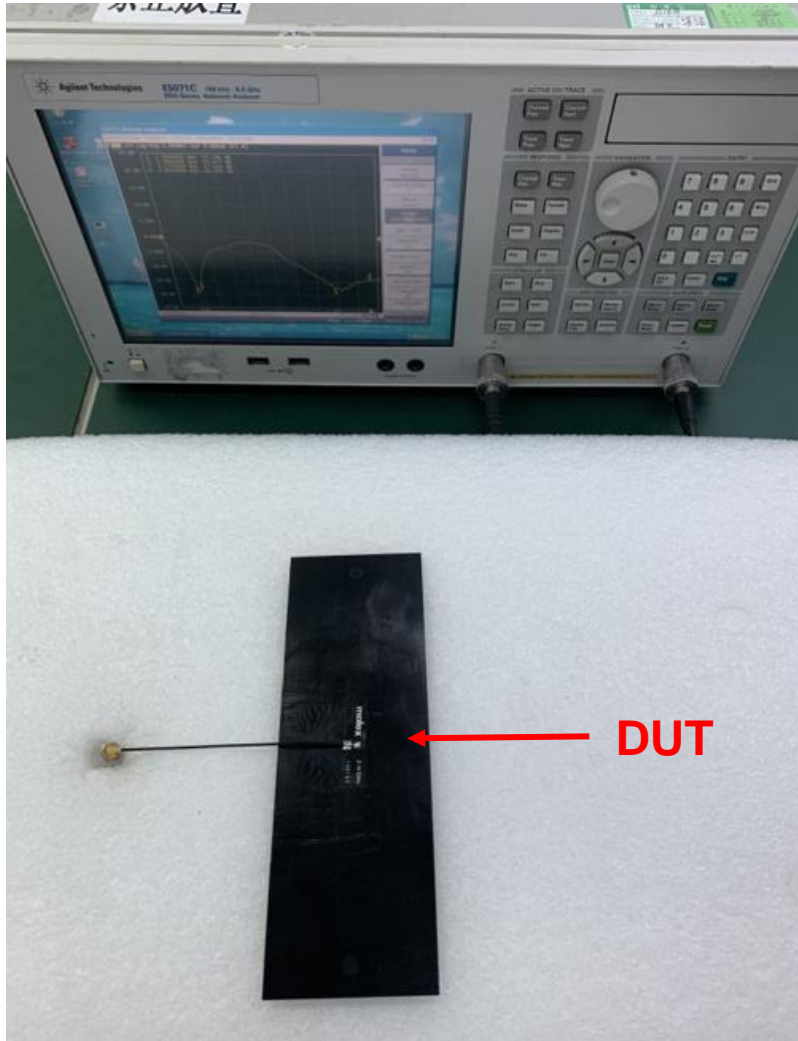
#### 4.1 RF TEST CONDITIONS

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**

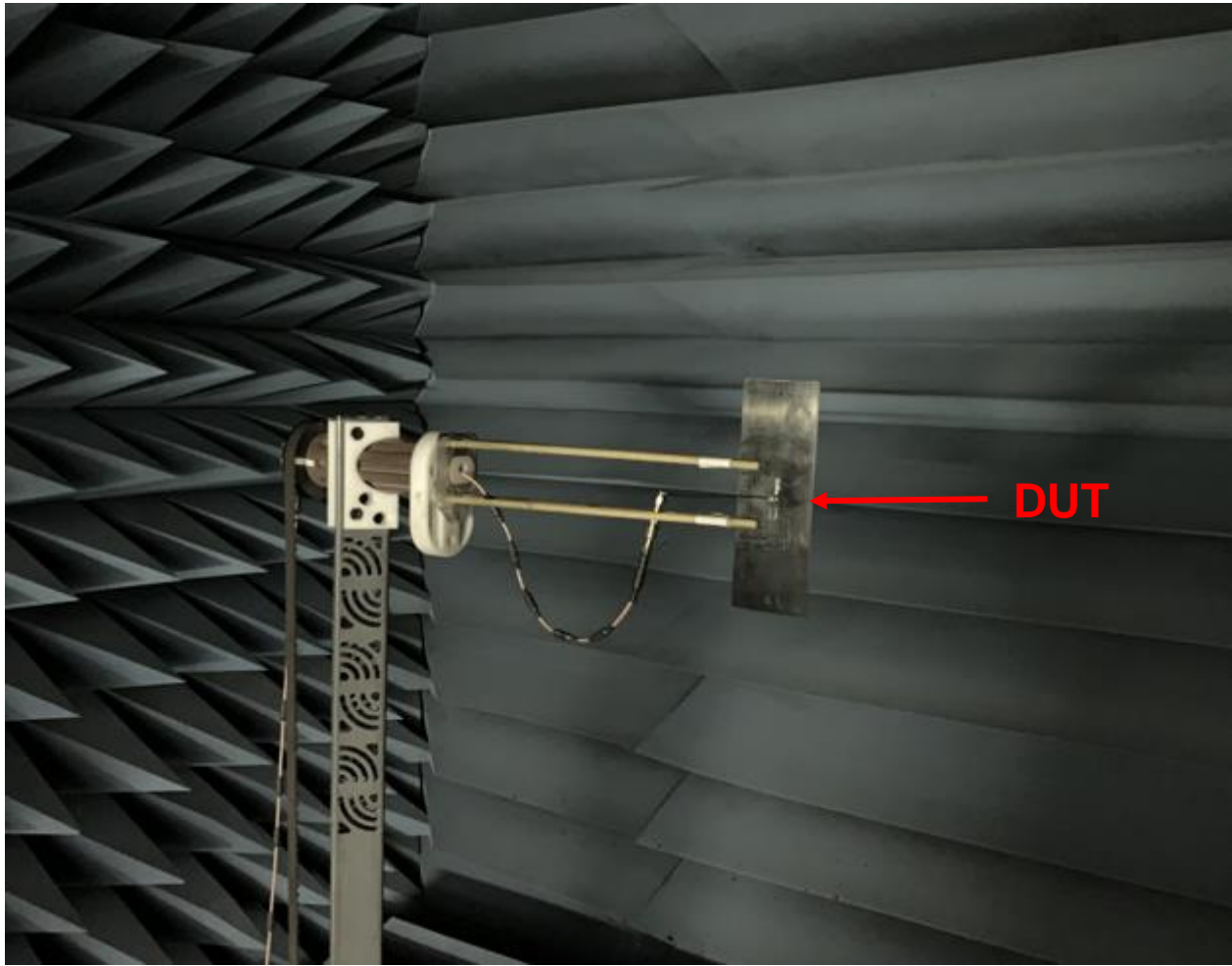
REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>3 of 31</b>
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**FIGURE4.1.2 ANTENNA LOADED WITH PC/ABS BLOCK OF 1.5 MM THICKNESS WITH VNA**

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DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: <b>Liu Hai</b>	CHECKED BY: <b>Andy Zhang</b>	APPROVED BY: <b>Chris Zhong</b>





**FIGURE4.1.3 ANTENNA LOADED WITH PC/ABS BLOCK OF 1.5 MM THICKNESS WITH OTA CHAMBER**

<u>REVISION:</u>  <b>J1</b>	<u>ECR/ECN INFORMATION:</u> <u>EC No:</u> 729862 <u>DATE:</u> 2022/11/25	<u>TITLE:</u> <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	<u>SHEET No.</u>  <b>5 of 31</b>
<u>DOCUMENT NUMBER:</u> <b>AS-1461530100</b>	<u>CREATED / REVISED BY:</u> <b>Liu Hai</b>	<u>CHECKED BY:</u> <b>Andy Zhang</b>	<u>APPROVED BY:</u> <b>Chris Zhong</b>



# APPLICATION SPECIFICATION

## 4.2 ANTENNA PERFORMANCE

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

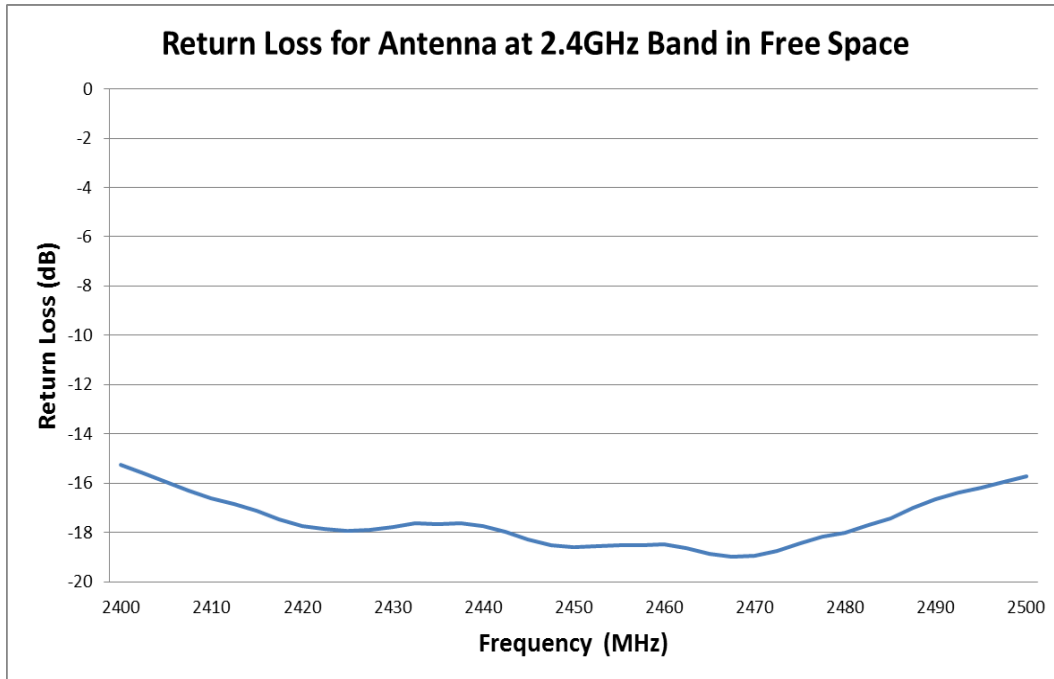
DESCRIPTION	EQUIPMENT	REQUIREMENT		
		2.4-2.5GHz	5.15-5.85GHz	5.925-7.125GHz
Frequency Range	VNA E5071C	2.4-2.5GHz	5.15-5.85GHz	5.925-7.125GHz
Return Loss	VNA E5071C	<- 10dB		
Peak Gain (Max)	OTA Chamber	3.0dBi	4.0dBi	5.5dBi
Average Total Efficiency	OTA Chamber	>75%	>75%	>70%
Polarization	OTA Chamber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

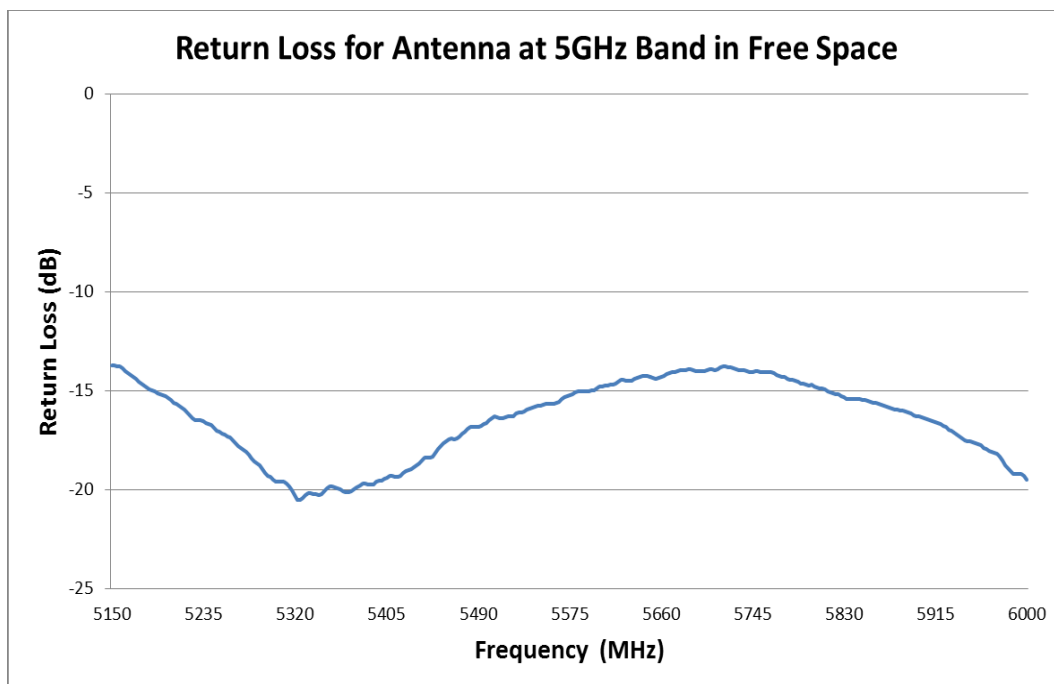
<b>REVISION:</b> <b>J1</b>	<b>ECR/ECN INFORMATION:</b> EC No: 729862 DATE: 2022/11/25	<b>TITLE:</b> <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	<b>SHEET No.</b> <b>6 of 31</b>
<b>DOCUMENT NUMBER:</b> <b>AS-1461530100</b>		<b>CREATED / REVISED BY:</b> Liu Hai	<b>CHECKED BY:</b> Andy Zhang
		<b>APPROVED BY:</b> Chris Zhong	

## 4.3 RETURN LOSS PLOT

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

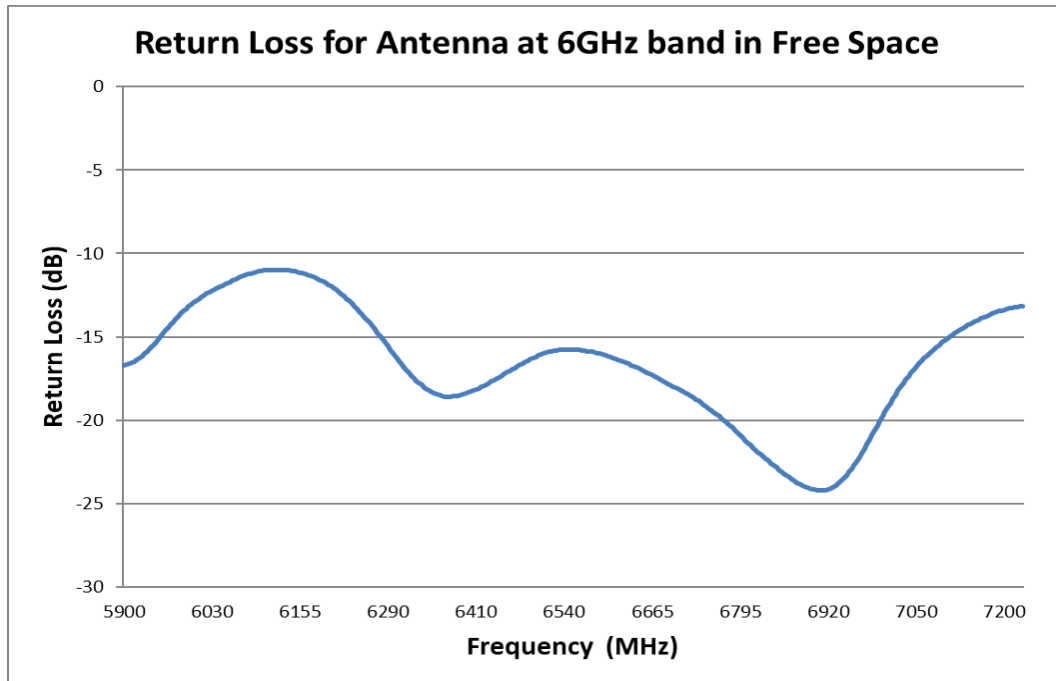


**FIGURE 4.3.1 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND IN FREE SPACE**



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

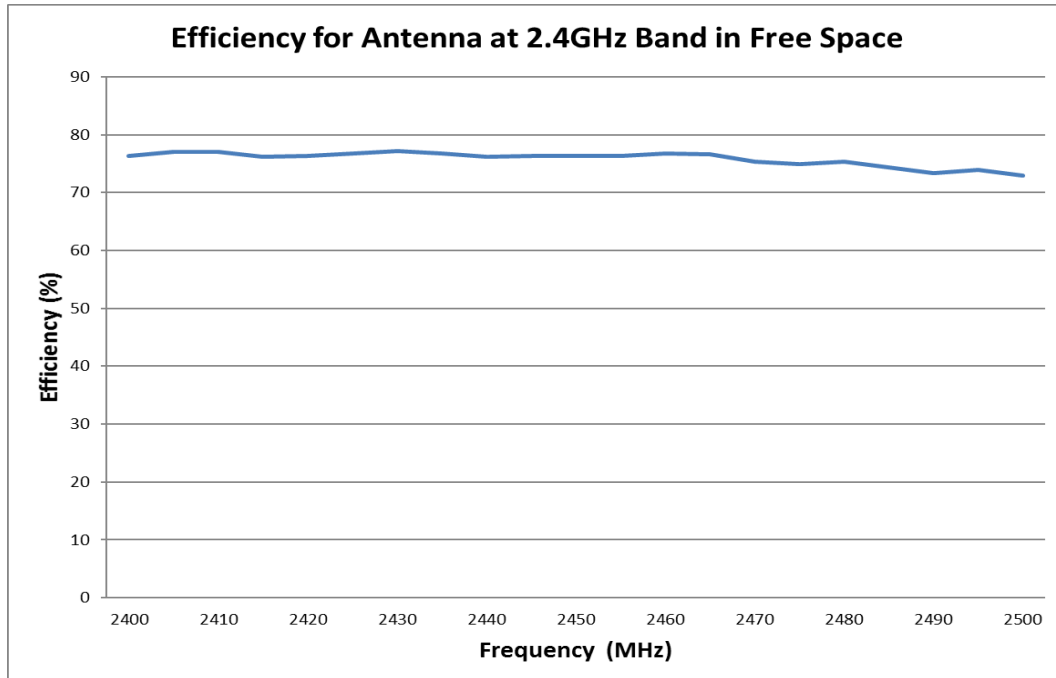
REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: <b>729862</b> DATE: <b>2022/11/25</b>	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>7 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: <b>Liu Hai</b>	CHECKED BY: <b>Andy Zhang</b>	APPROVED BY: <b>Chris Zhong</b>



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

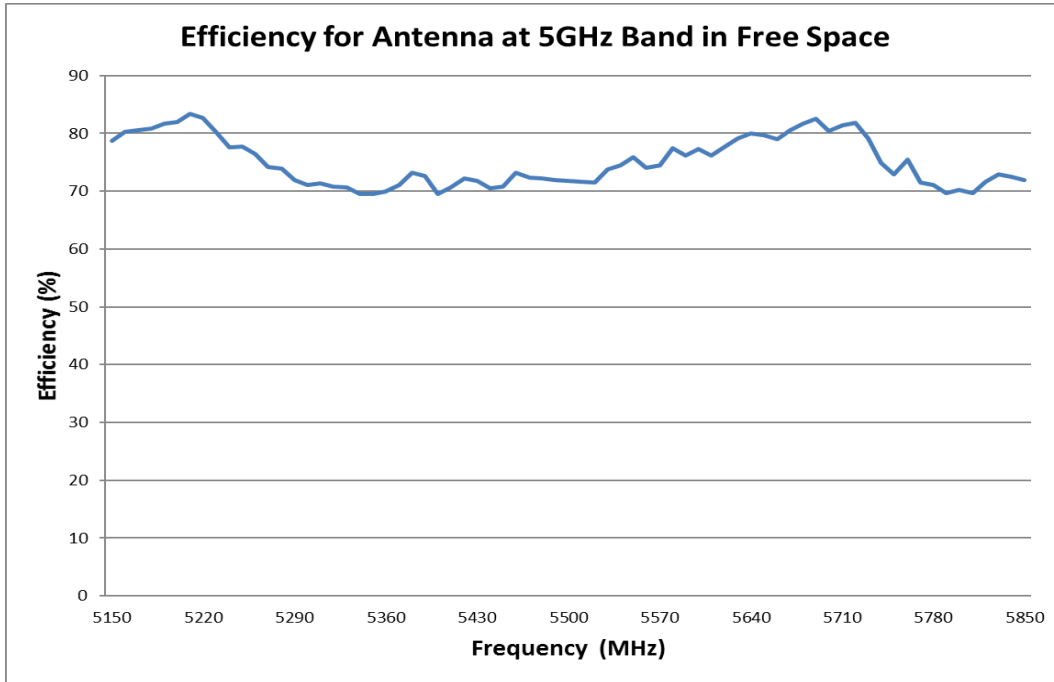
#### 4.4 EFFICIENCY PLOT

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

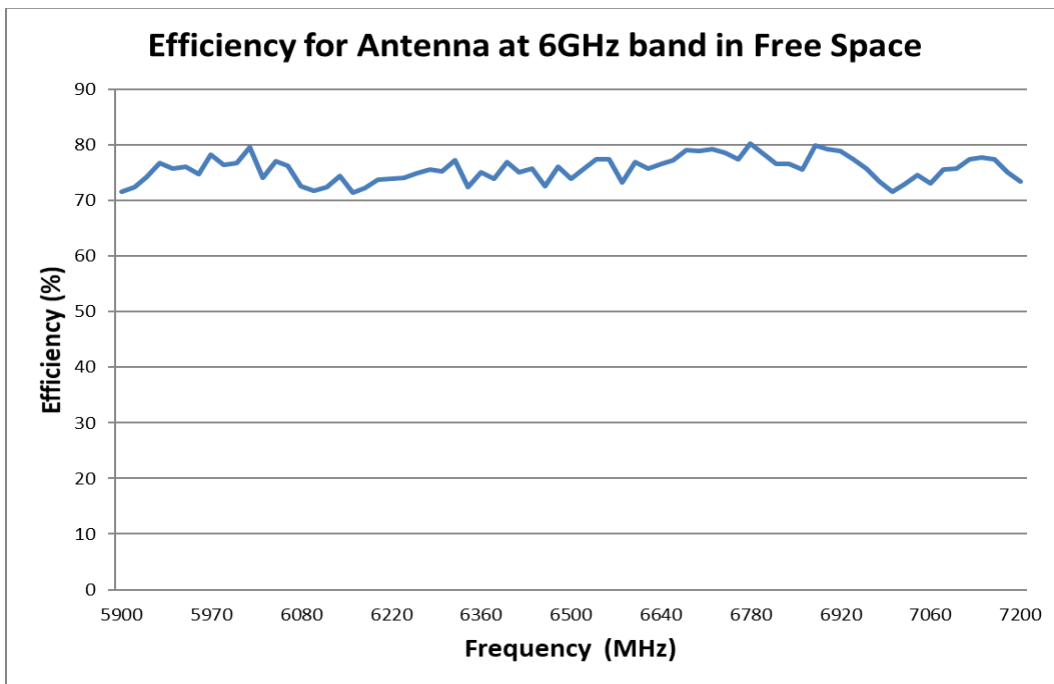


**FIGURE 4.4.1 EFFICIENCY OF ANTENNA AT 2.4GHZ BAND IN FREE SPACE**

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>8 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong



**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: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>9 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong

## 4.5 RADIATION PATTERN

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

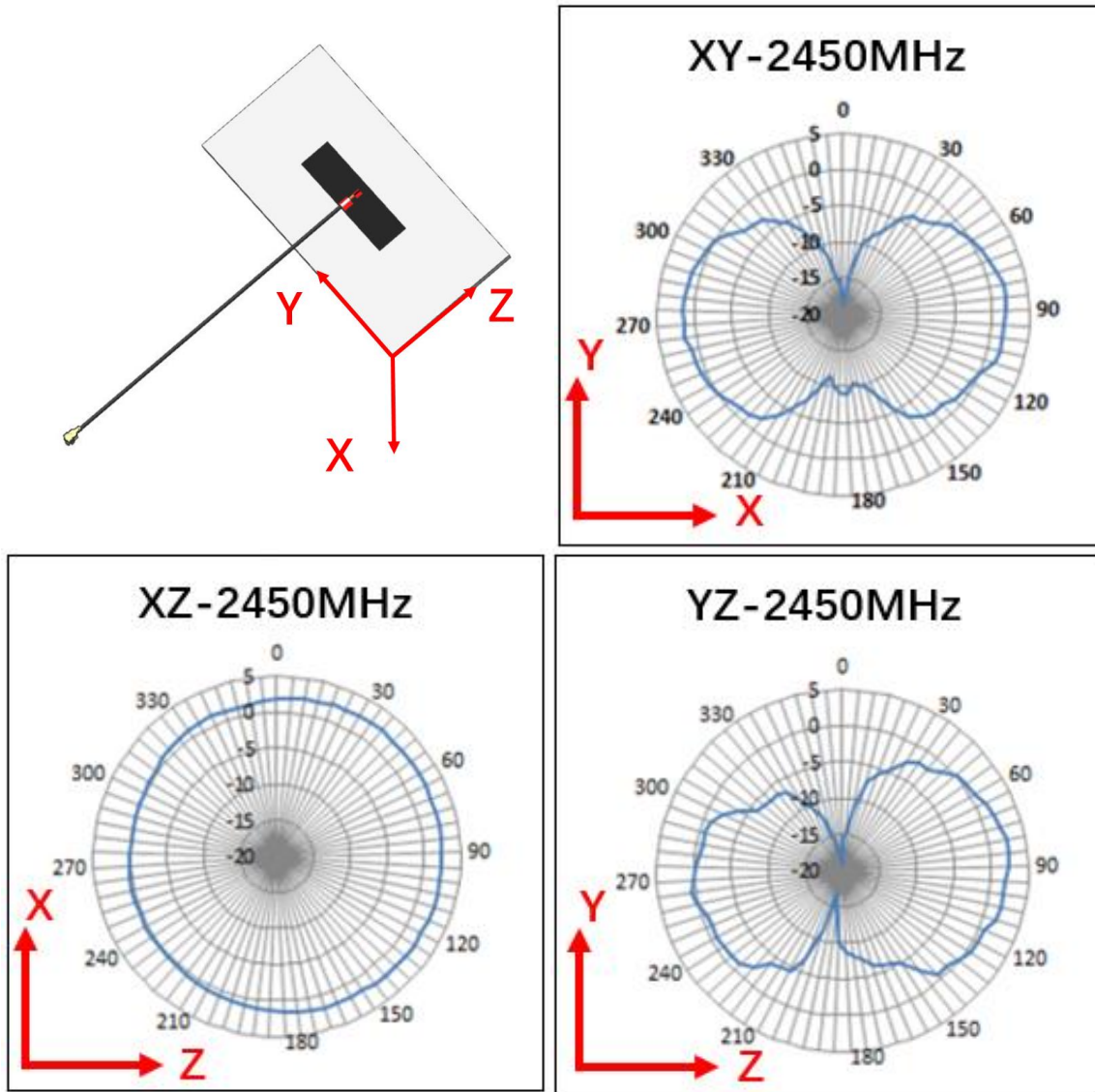


FIGURE 4.5.1 2D RADIATION PATTERN OF ANTENNA AT 2450MHZ IN FREE SPACE

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>10 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong

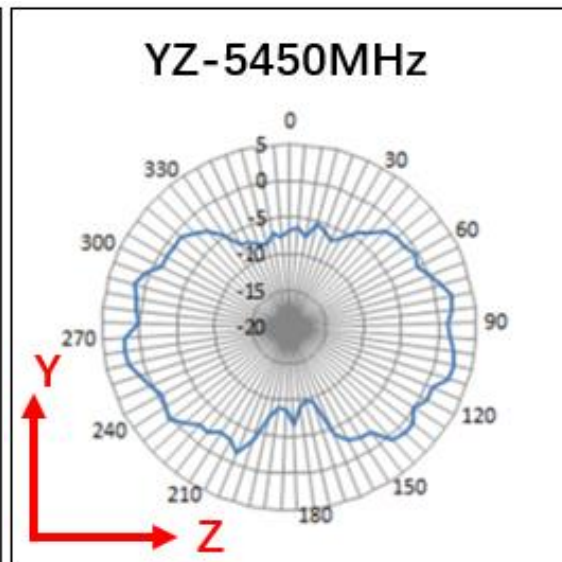
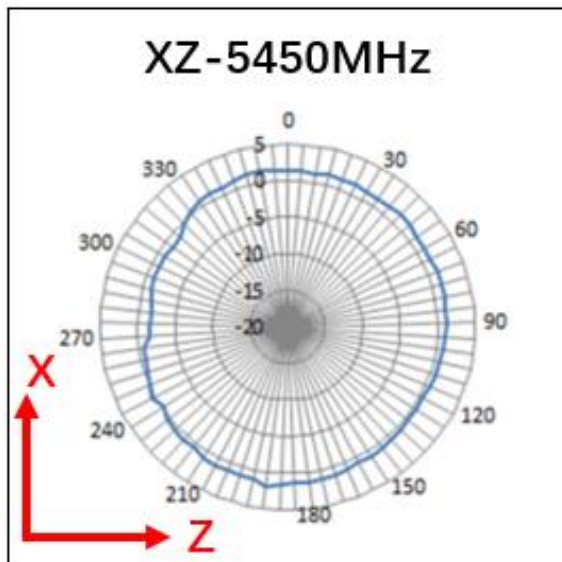
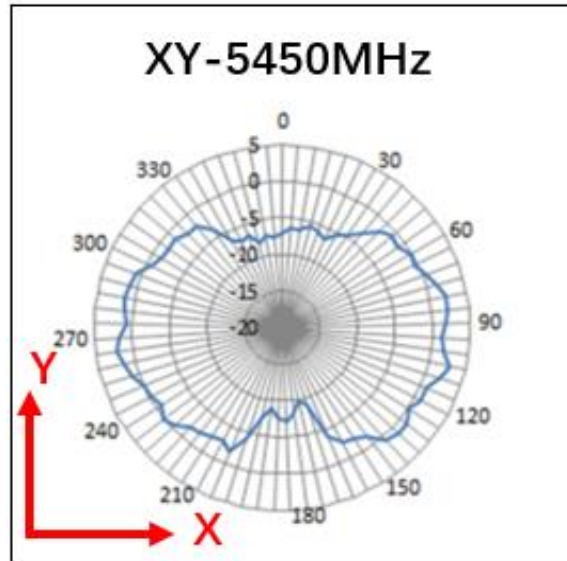
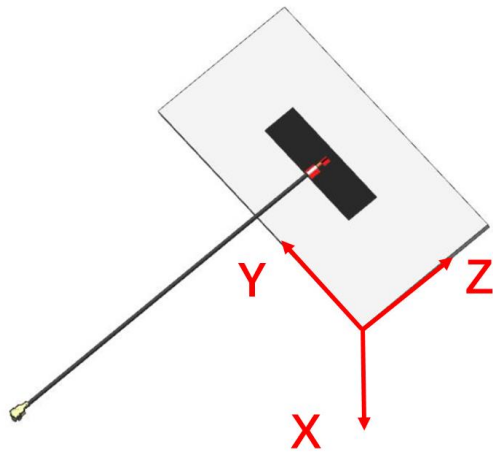


FIGURE 4.5.2 2D RADIATION PATTERN OF ANTENNA AT 5450MHZ IN FREE SPACE

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>11 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong

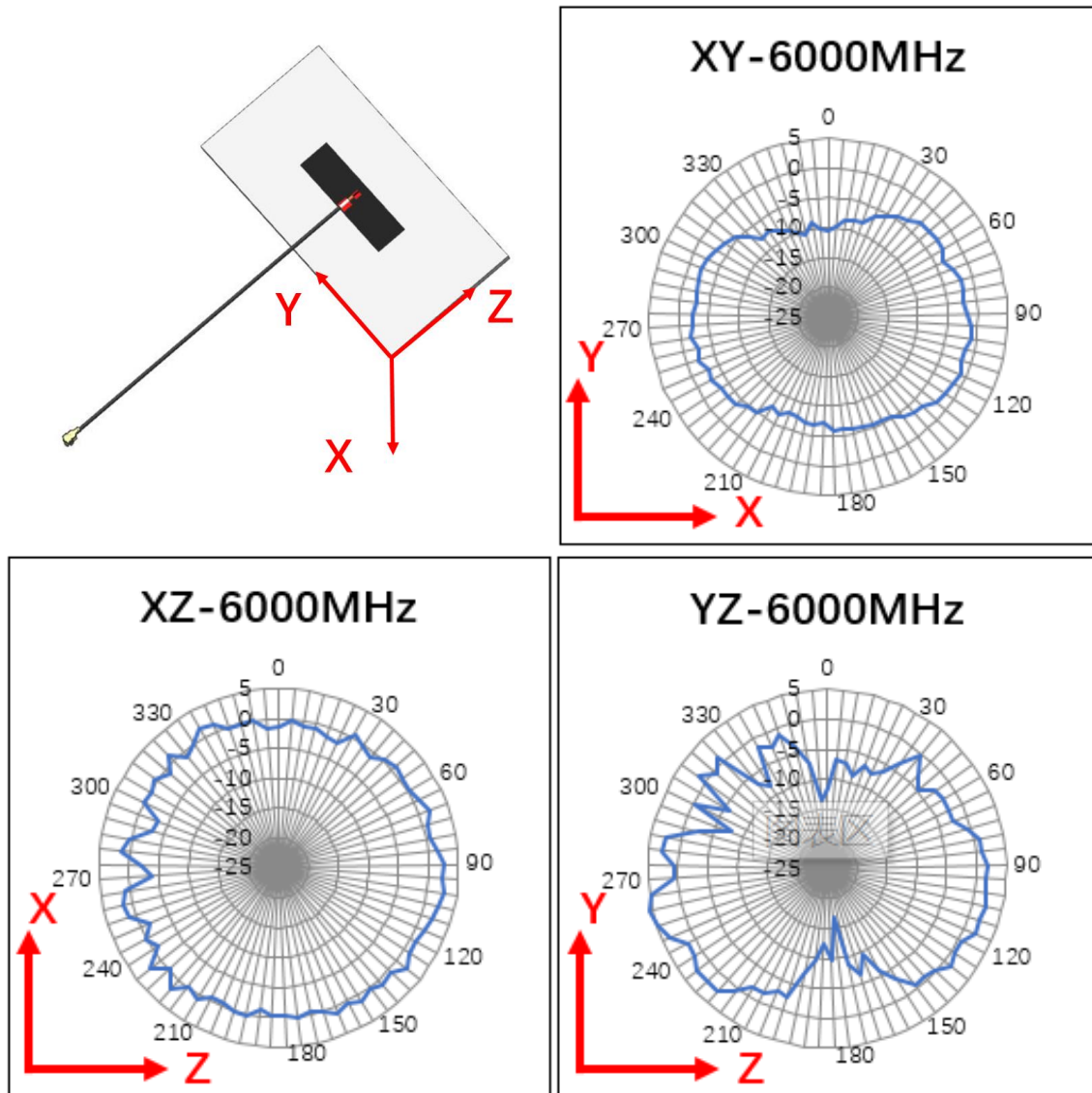


FIGURE 4.5.3 2D RADIATION PATTERN OF ANTENNA AT 6000MHZ IN FREE SPACE

REVISION:	ECR/ECN INFORMATION:	TITLE:		SHEET No.
<b>J1</b>	EC No: 729862 DATE: 2022/11/25	<b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>		<b>12 of 31</b>
DOCUMENT NUMBER:	CREATED / REVISED BY:	CHECKED BY:	APPROVED BY:	
<b>AS-1461530100</b>	Liu Hai	Andy Zhang	Chris Zhong	



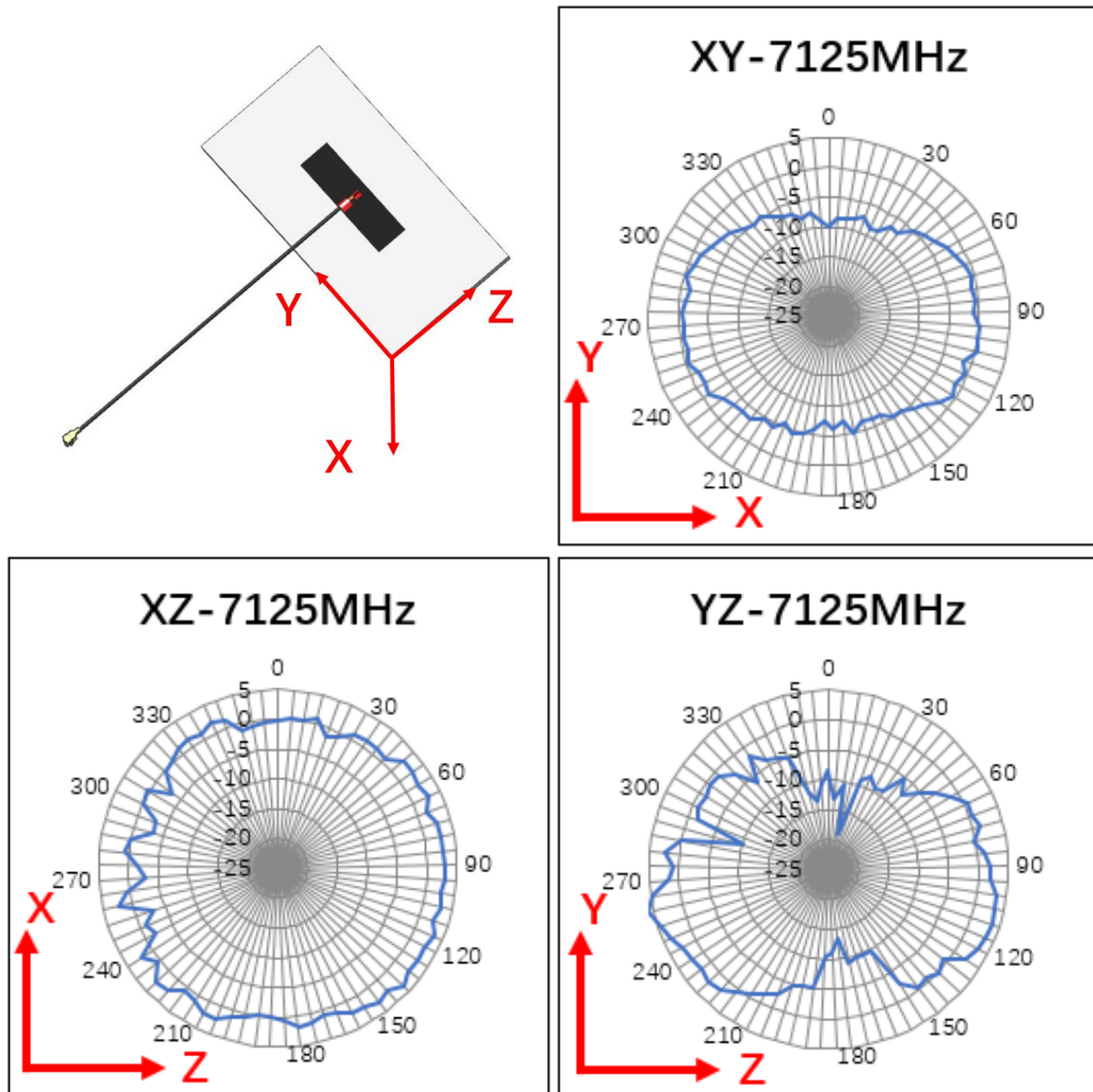
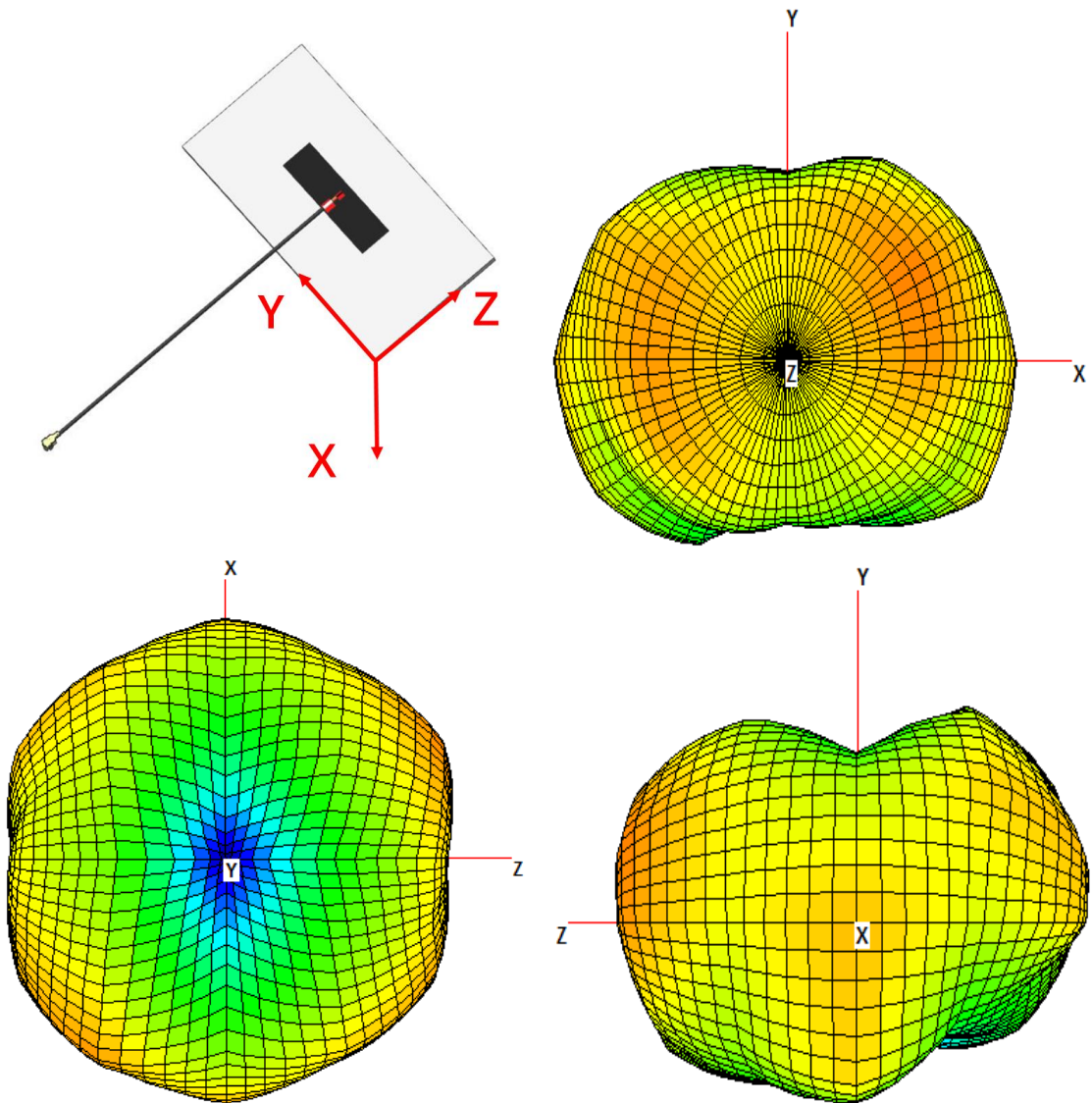


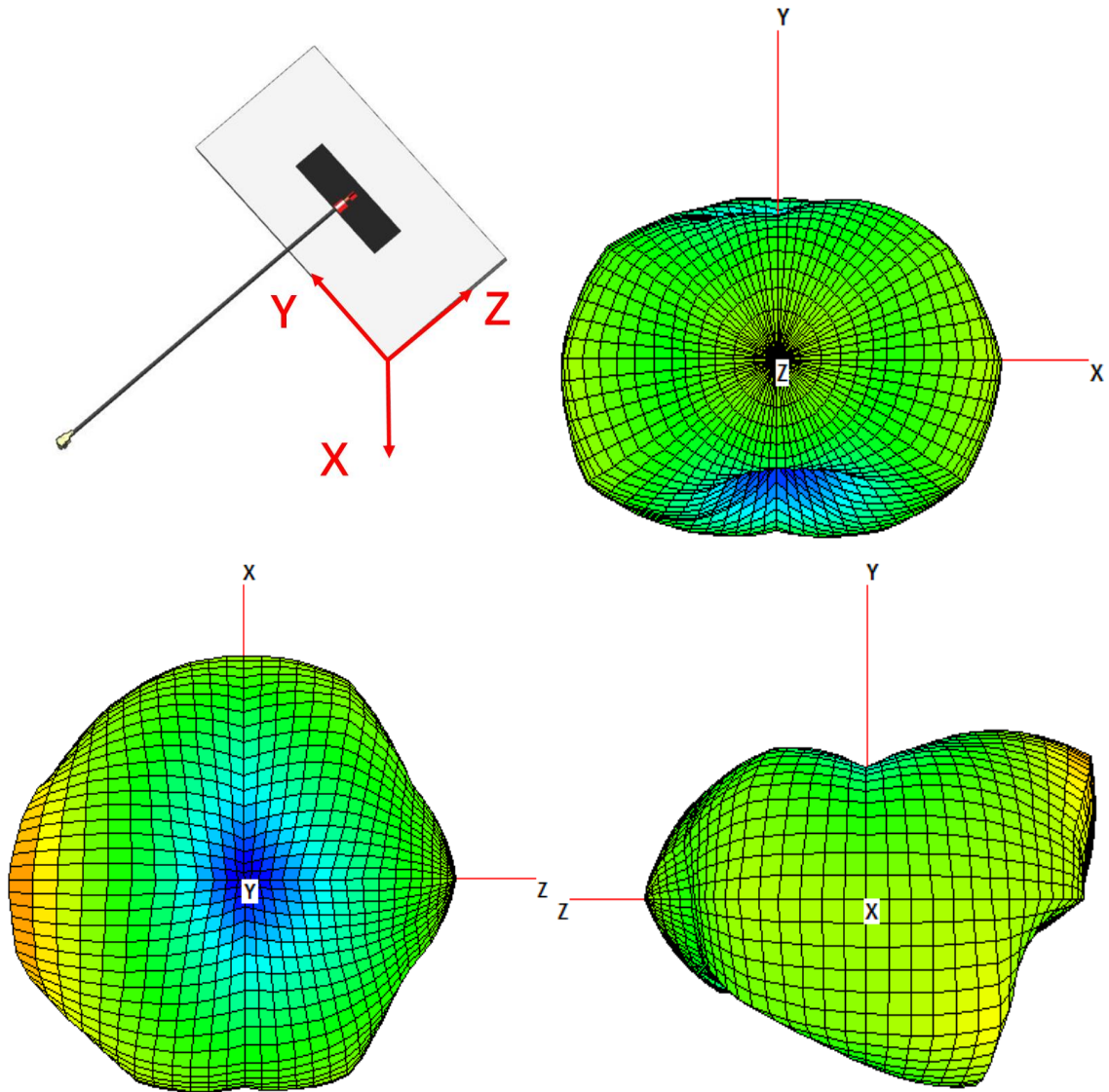
FIGURE 4.5.4 2D RADIATION PATTERN OF ANTENNA AT 7125MHZ IN FREE SPACE

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>13 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong



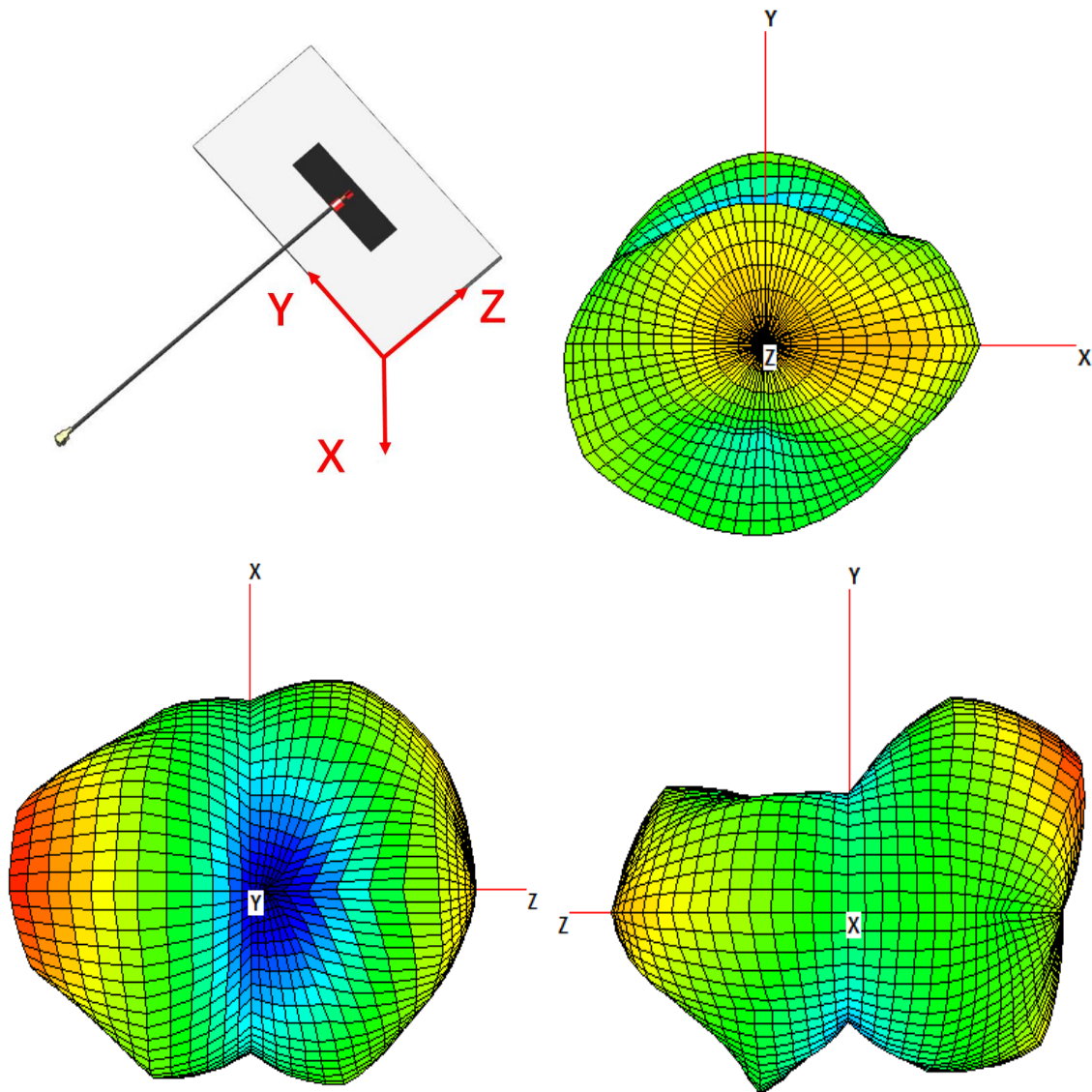
**FIGURE 4.5.5 3D RADIATION PATTERN OF ANTENNA AT 2450MHZ BAND IN FREE SPACE**

REVISION:  <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>		SHEET No.  <b>14 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>		CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong



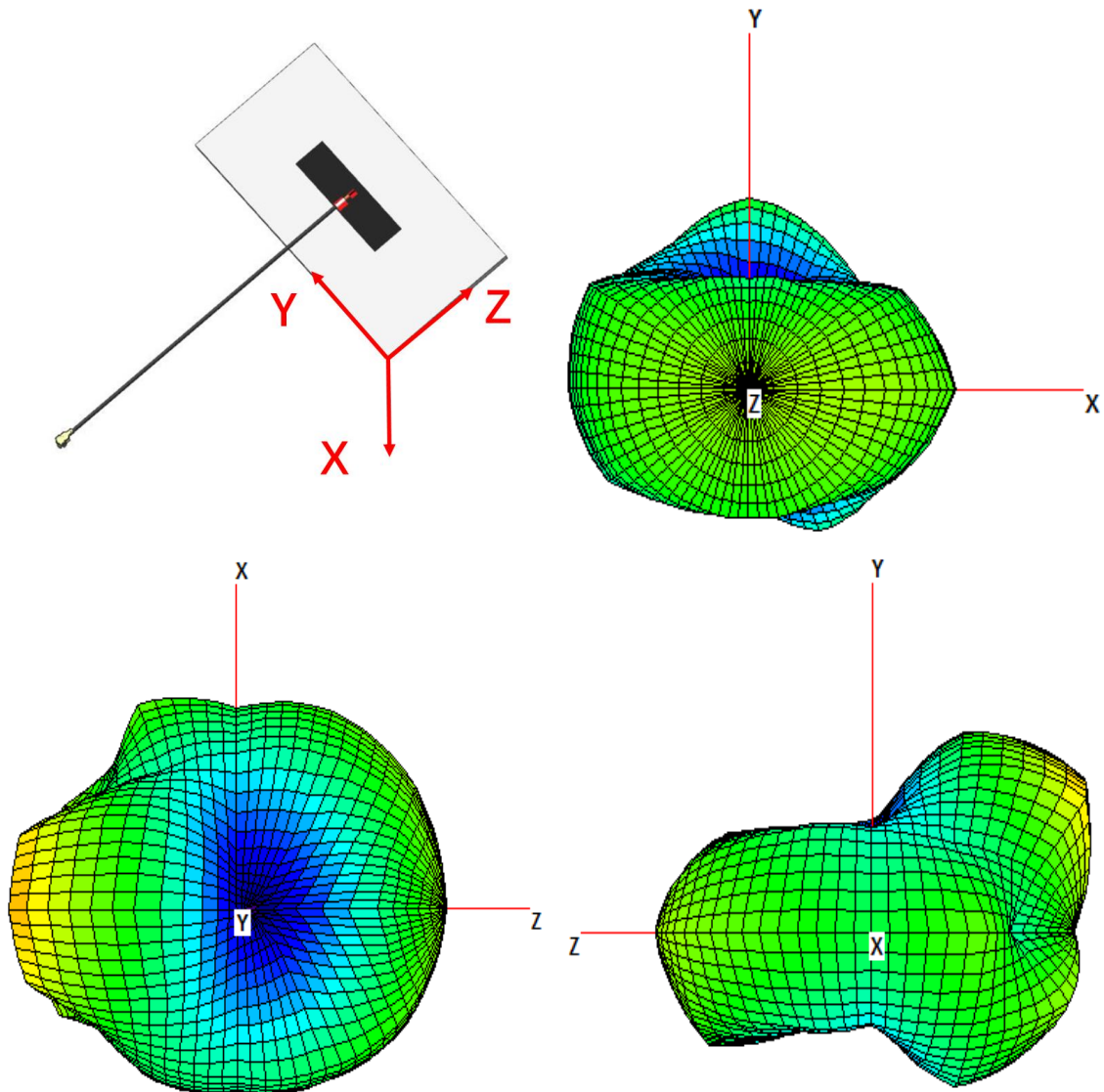
**FIGURE 4.5.6 3D RADIATION PATTERN OF ANTENNA AT 5450MHZ BAND IN FREE SPACE**

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>15 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong



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

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>16 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong



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

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>17 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong

## 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.

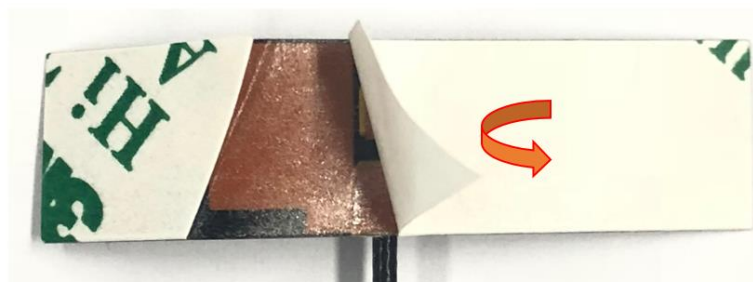
### 5.1 HOW TO TEAR FLEX RELEASE PAPER



1. Find cut line on flex back side



2. Bend flex slight along cut line

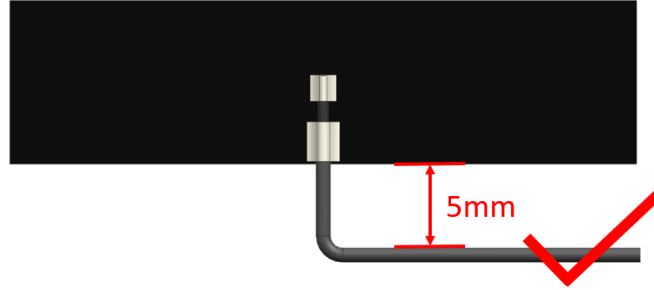


3. Tear release paper

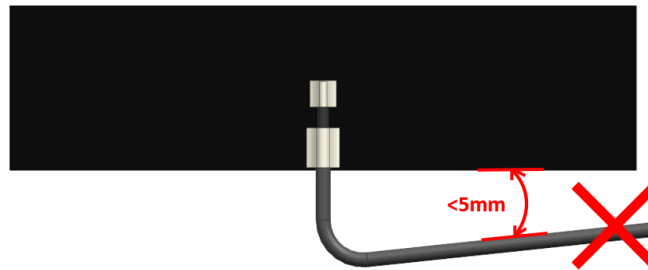
REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>18 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong

## 5.2 CABLE BENDING

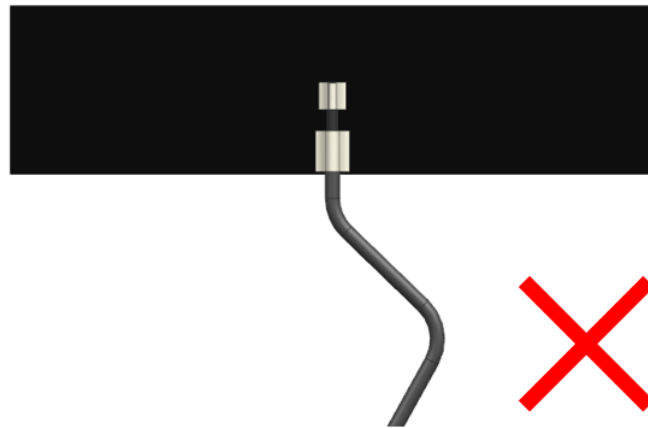
During the assembly of the antenna in a device, the cable needs to be positioned away from the antenna flex to achieve best performance. The cable must be away from the Flex edge at least 5mm as shown in figure 5.2.1. If the cable bends into the antenna flex, the antenna performance will be degraded.



**FIGURE 5.2.1 RECOMMENDED CABLE BENDING RANGE**



**FIGURE 5.2.2 UNRECOMMENDED CABLE BENDING RANGE**



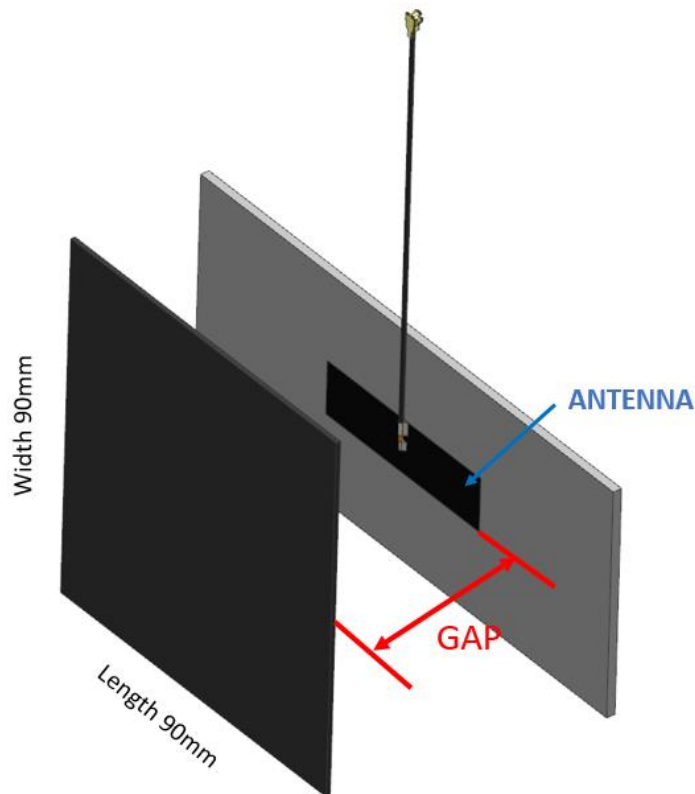
**FIGURE 5.2.3 MULTIPLE BENDING OF CABLES IS NOT RECOMMENDED**

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>19 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong

## 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.



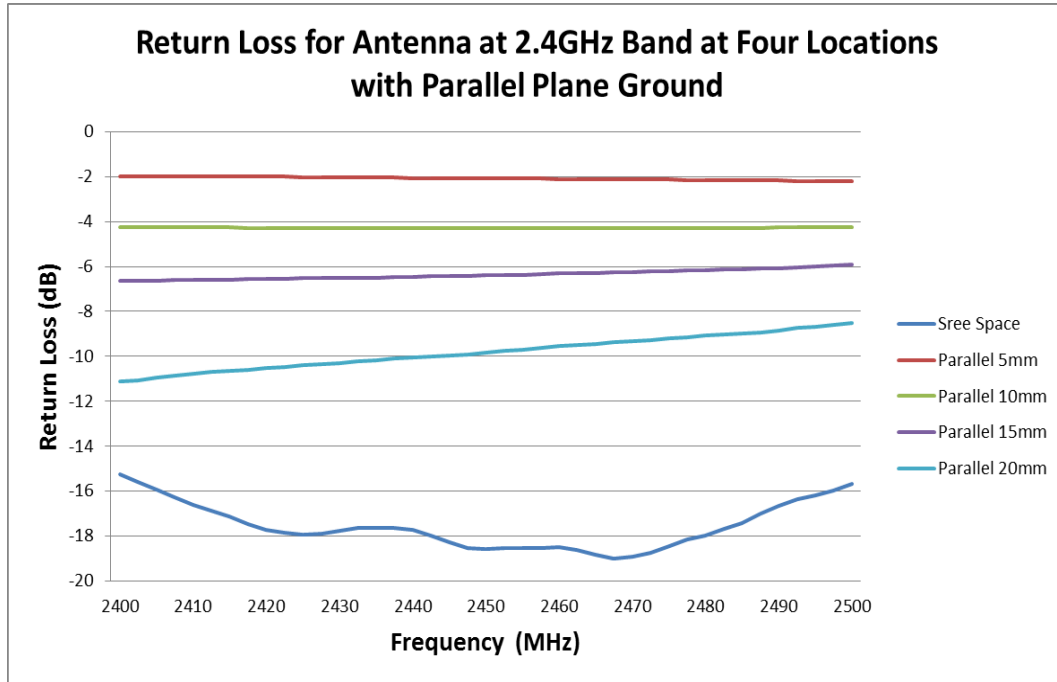
**FIGURE 6.1.1 FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

Ground Size: 90mm\*90mm;

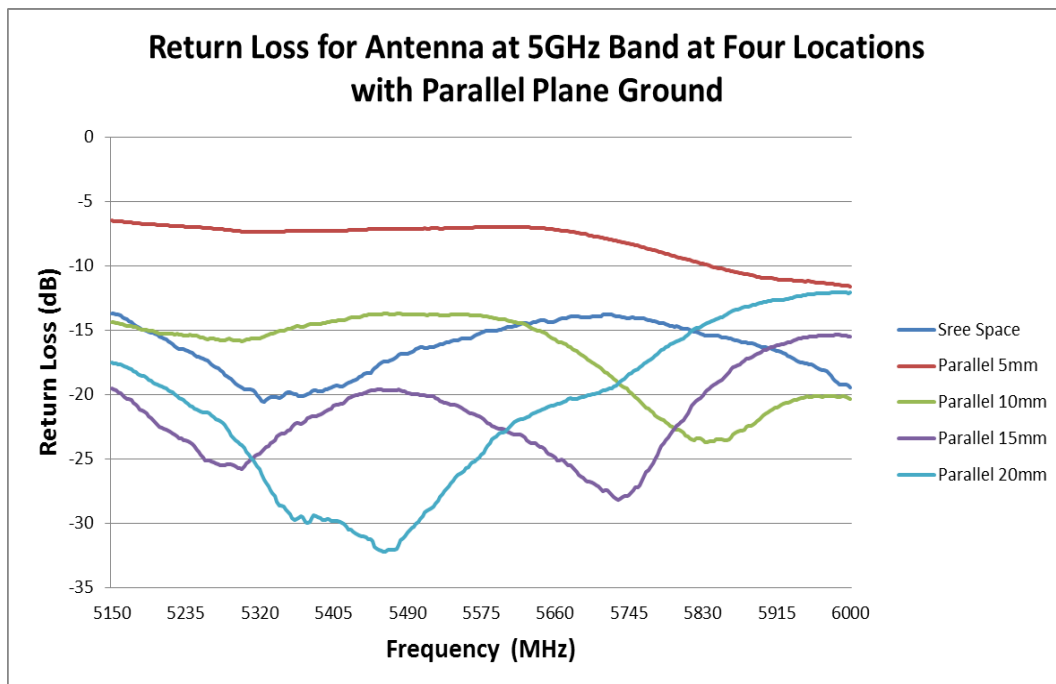
- Location 1: Distance between antenna and plane (GAP) ground is about 5mm;
- Location 2: Distance between antenna and plane (GAP) ground is about 10mm;
- Location 3: Distance between antenna and plane (GAP) ground is about 15mm;
- Location 4: Distance between antenna and plane (GAP) ground is about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

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>20 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: <b>Liu Hai</b>	CHECKED BY: <b>Andy Zhang</b>	APPROVED BY: <b>Chris Zhong</b>



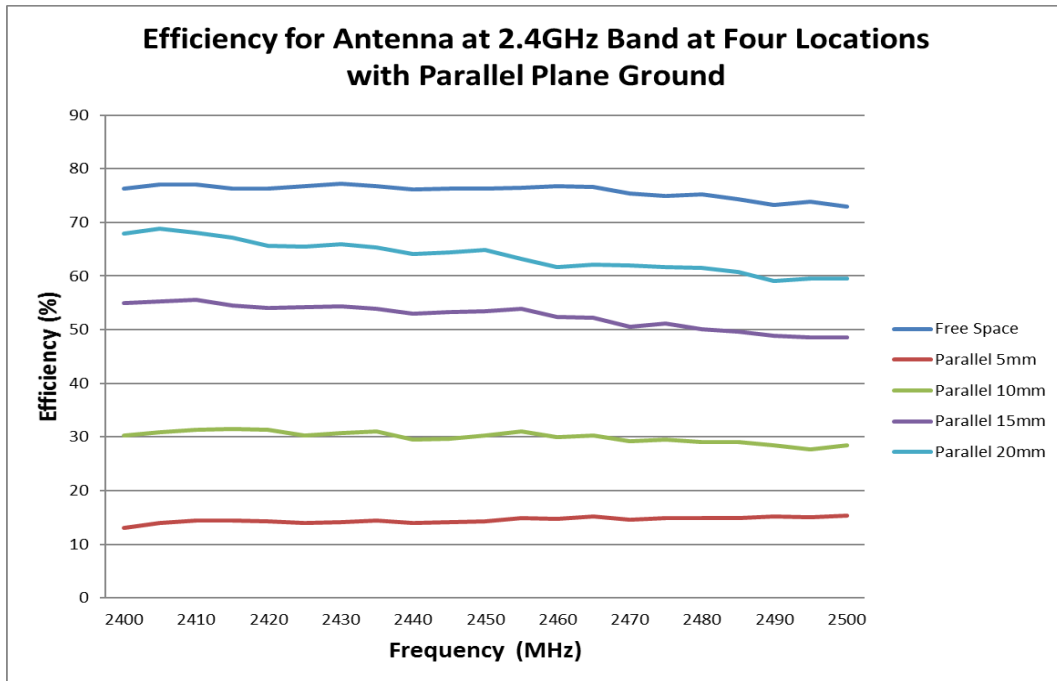


**FIGURE 6.1.2 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

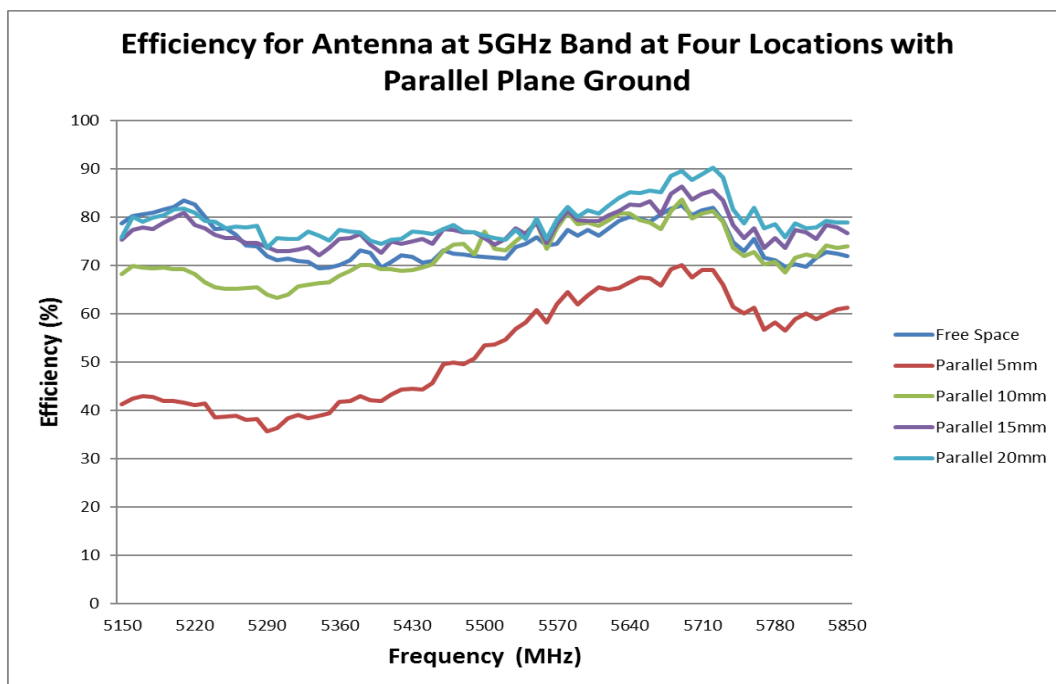


**FIGURE 6.1.3 RETURN LOSS OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>21 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong



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

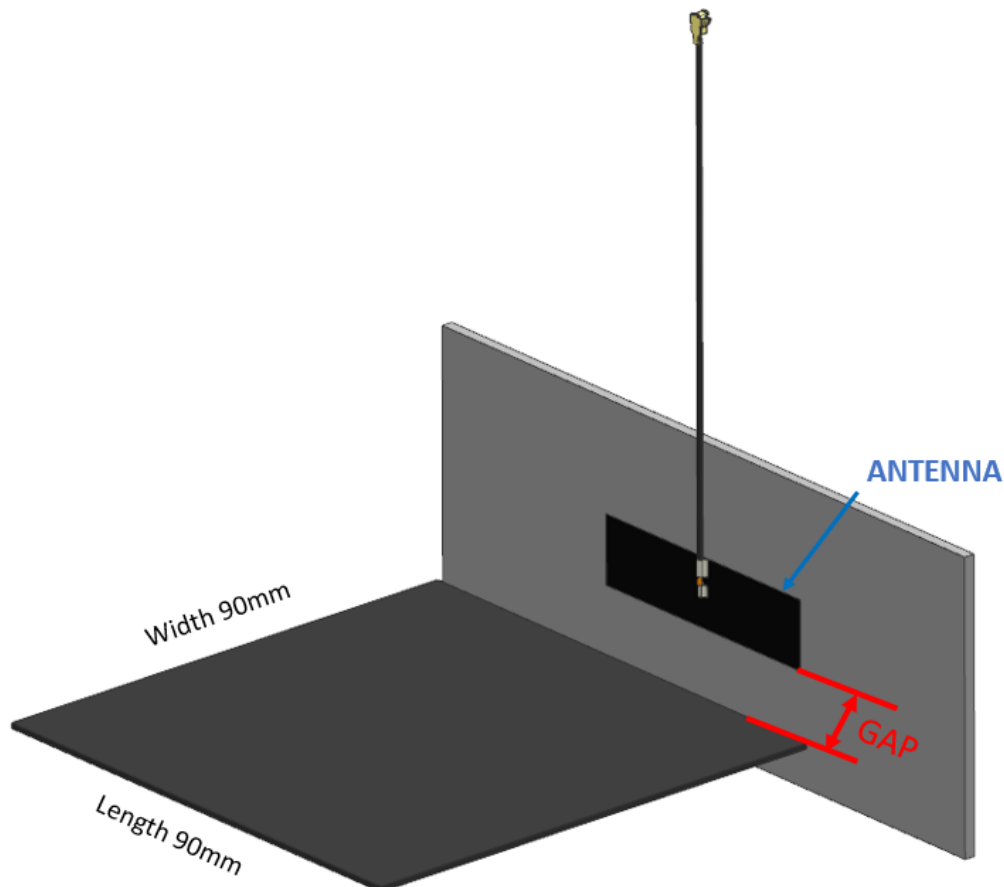


**FIGURE 6.1.5 EFFICIENCY OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>22 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: <b>Liu Hai</b>	CHECKED BY: <b>Andy Zhang</b>	APPROVED BY: <b>Chris Zhong</b>

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

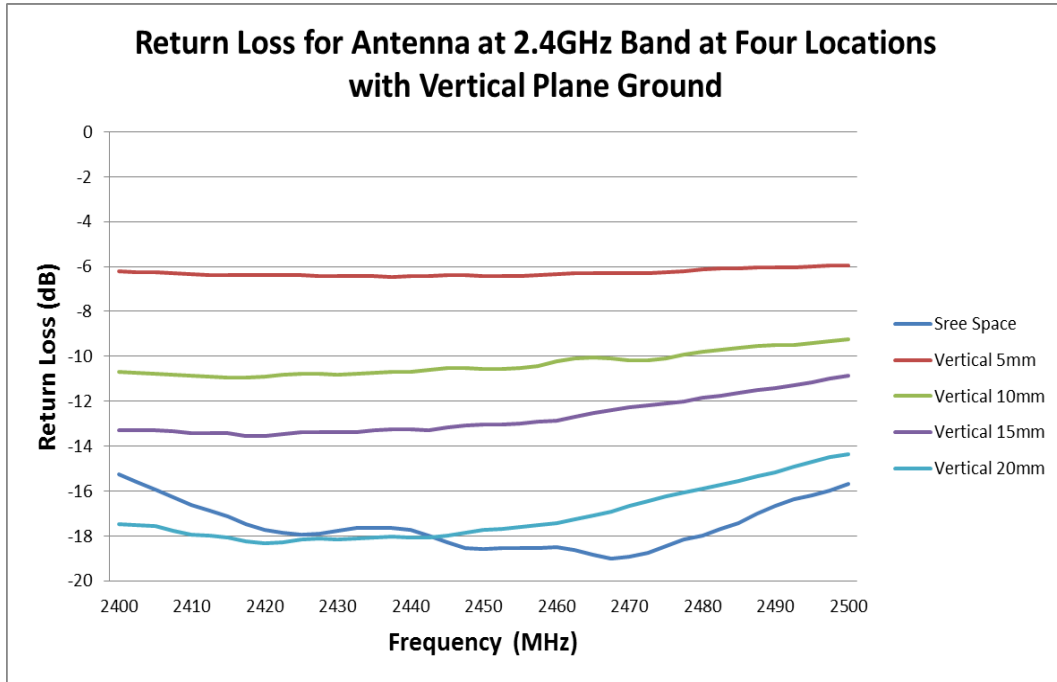
Four locations with vertical plane ground have been evaluated and these locations are shown in figure 6.2.1. The plane ground size is 90mm\*90mm and we move the plane ground to four locations for each test. The antenna performance is better with larger distance between antenna and vertical plane ground.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



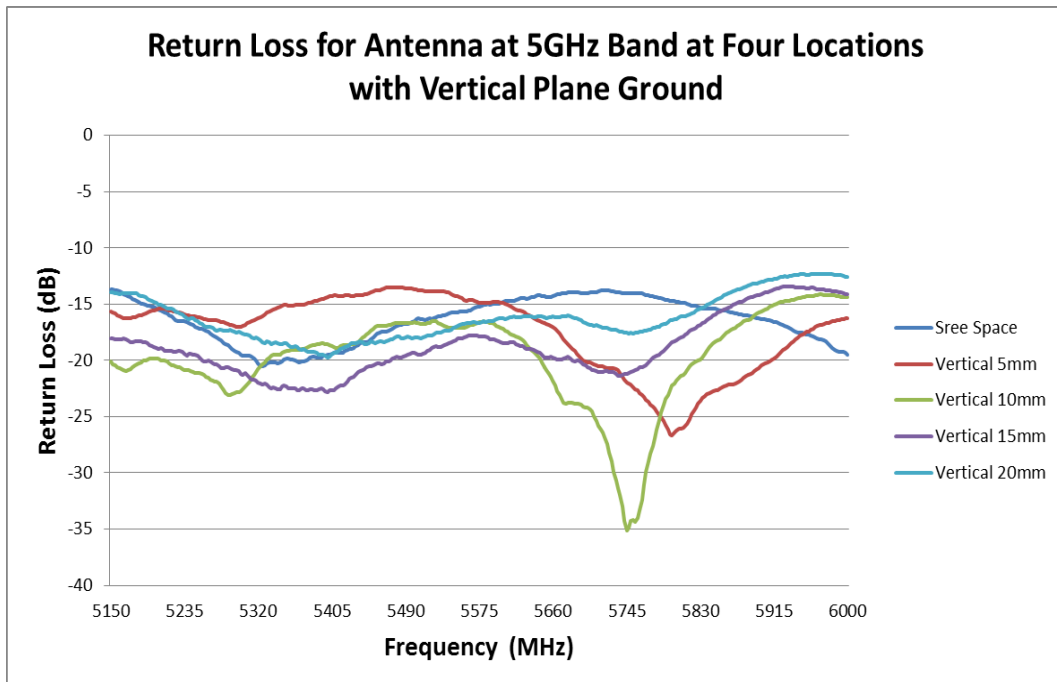
**FIGURE 6.2.1 FOUR LOCATIONS WITH VERTICAL PLANE GROUND**

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: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>23 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: Liu Hai	CHECKED BY: Andy Zhang	APPROVED BY: Chris Zhong



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

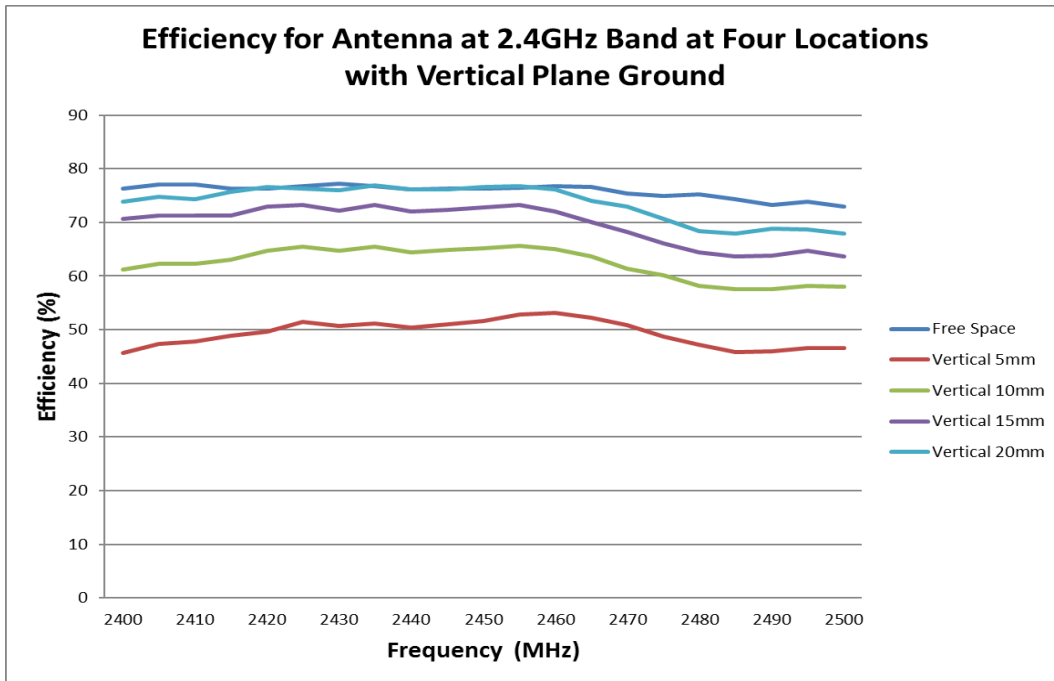


**FIGURE 6.2.3 RETURN LOSS OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND**

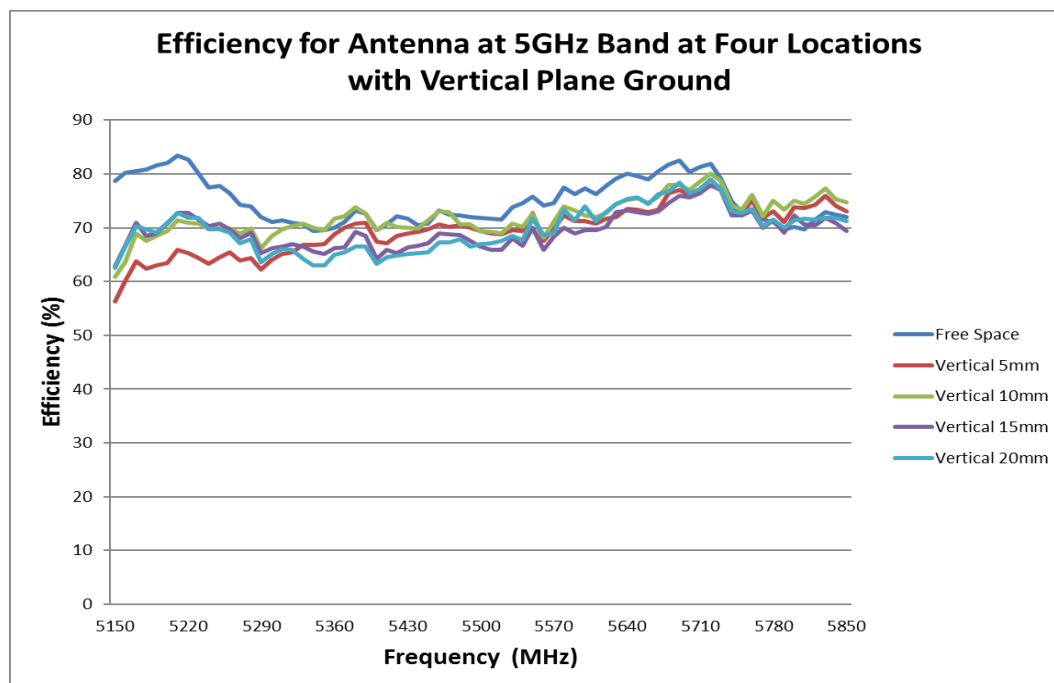
REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>24 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: <b>Liu Hai</b>	CHECKED BY: <b>Andy Zhang</b>	APPROVED BY: <b>Chris Zhong</b>



# APPLICATION SPECIFICATION



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

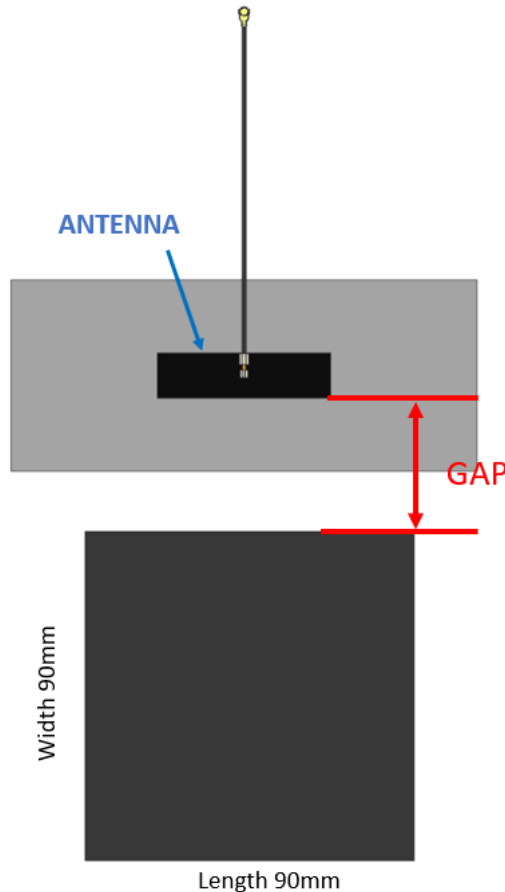


**FIGURE 6.2.5 EFFICIENCY OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND**

REVISION: <b>J1</b>	ECR/ECN INFORMATION: EC No: 729862 DATE: 2022/11/25	TITLE: <b>WIFI 6E FLEX CABLE BALANCE ANTENNA APPLICATION SPECIFICATION</b>	SHEET No. <b>25 of 31</b>
DOCUMENT NUMBER: <b>AS-1461530100</b>	CREATED / REVISED BY: <b>Liu Hai</b>	CHECKED BY: <b>Andy Zhang</b>	APPROVED BY: <b>Chris Zhong</b>

## 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.

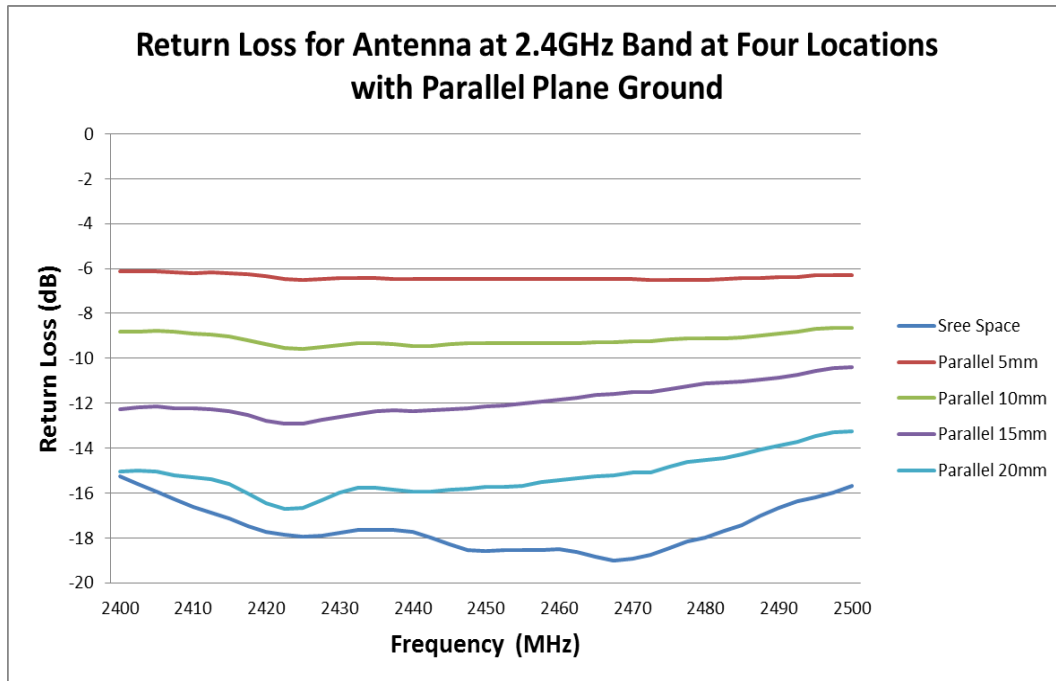


**FIGURE 6.3.1 FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

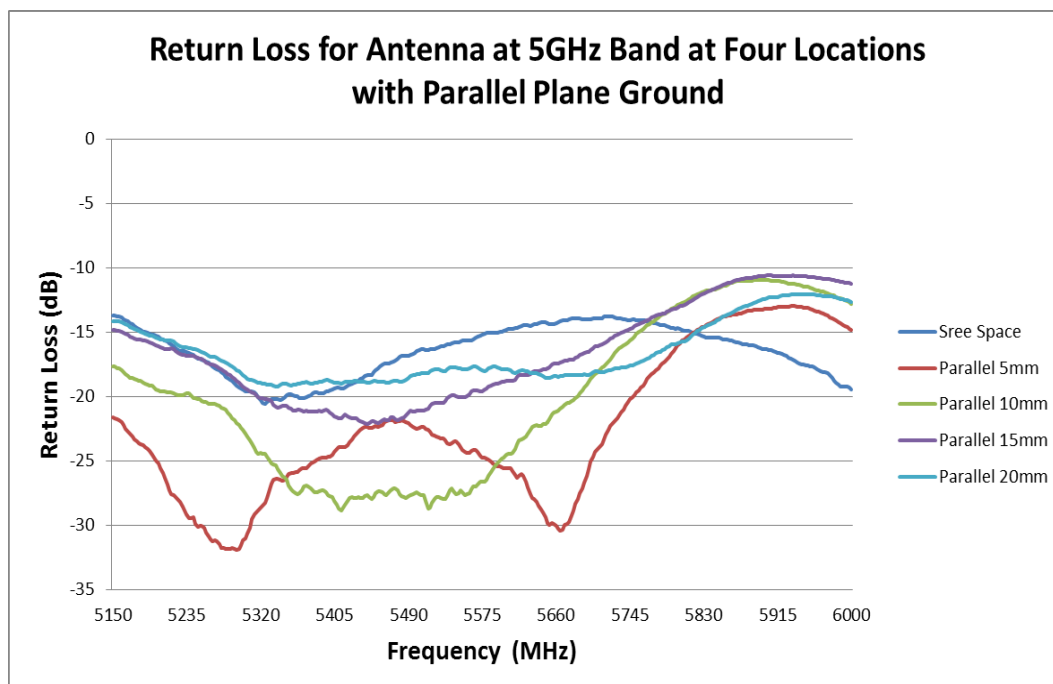
Ground Size: 90mm\*90mm;

- 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.

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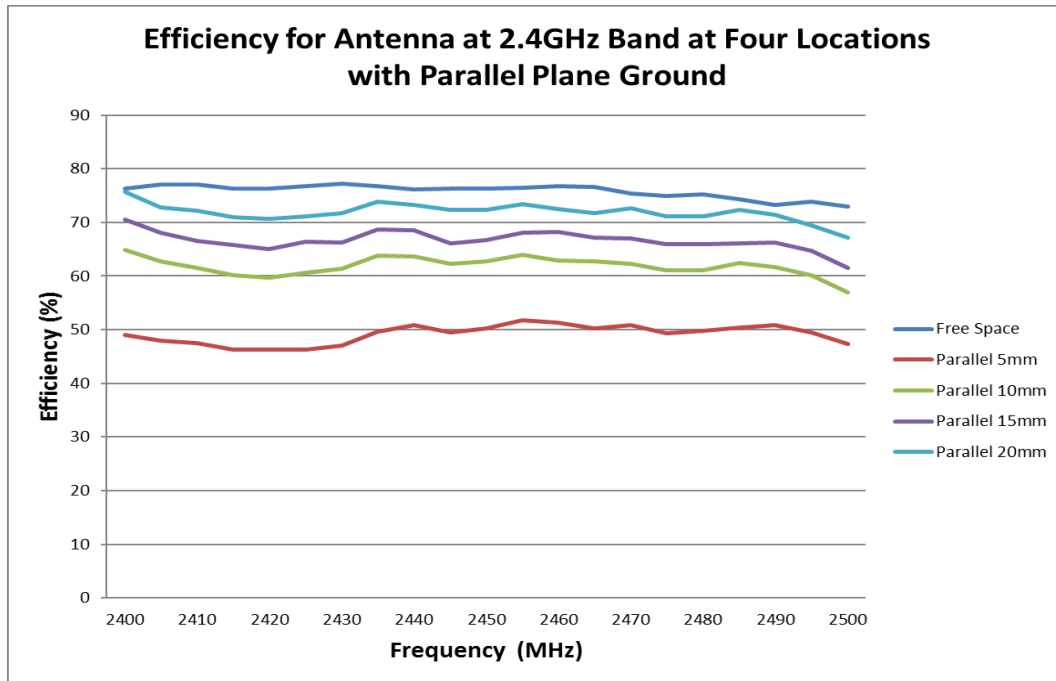


**FIGURE 6.3.2 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

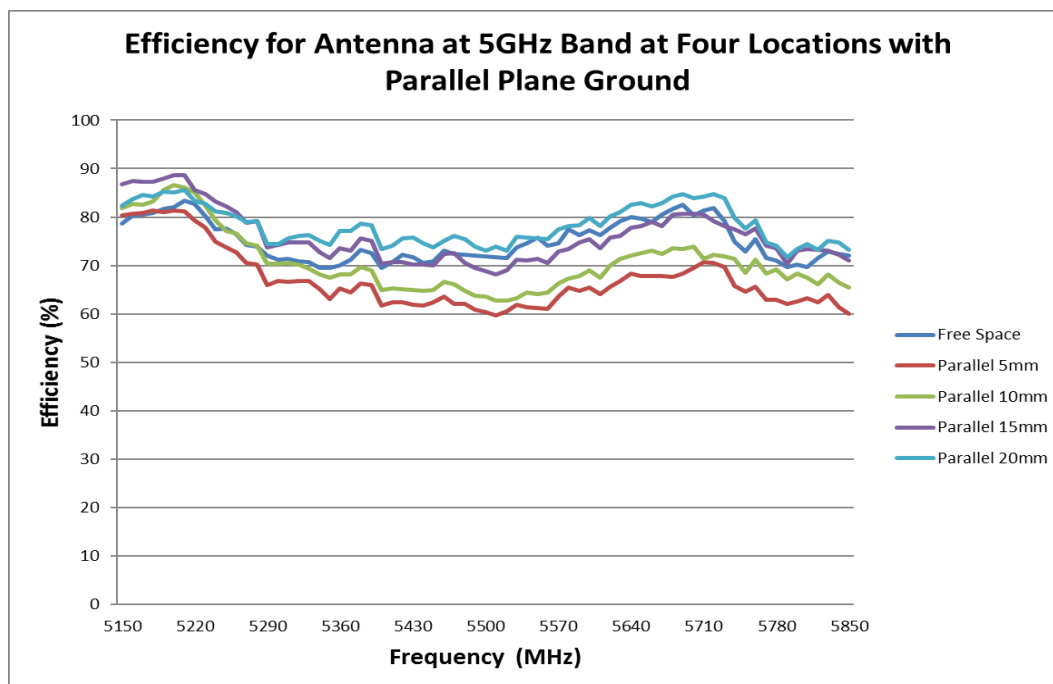


**FIGURE 6.3.3 RETURN LOSS OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

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**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**

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# APPLICATION SPECIFICATION

## 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

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<b>AS-1461530100</b>	Liu Hai	Andy Zhang	Chris Zhong



# APPLICATION SPECIFICATION

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 OTHER MOLEX ANTENNA PRODUCT

Please refer to the Antenna products in Molex home page to view all the Molex Antenna products.

<https://www.molex.com>

Molex, LLC  
2222 Wellington Court  
Lisle, IL 60532  
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# APPLICATION SPECIFICATION

## 9.0 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
J1	2022/11/14	Added section : Other Molex Antenna Product

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# PRODUCT SPECIFICATION

Brand Name	Cable length	Model Name	Ant. Type	Connector	Support	Max Peak Gain	Does the antenna gain include cable loss?
MOLEX	50 mm	1461530050	PIFA	I-PEX	2.4G+BT	3.2dBi	Cable Loss included
MOLEX	100 mm	1461530100	PIFA	I-PEX	2.4G+BT	3.0dBi	Cable Loss included
MOLEX	150 mm	1461530150	PIFA	I-PEX	2.4G+BT	2.8dBi	Cable Loss included
MOLEX	200 mm	1461530200	PIFA	I-PEX	2.4G+BT	2.6dBi	Cable Loss included
MOLEX	250 mm	1461530250	PIFA	I-PEX	2.4G+BT	2.4dBi	Cable Loss included
MOLEX	300 mm	1461530300	PIFA	I-PEX	2.4G+BT	2.2dBi	Cable Loss included