

Bluetooth Antenna Design Specification Document

Model	Inverted-F antenna
Manufacturer	Shenzhen Feasycom Technology Co., Ltd.
Antenna type	PCB
Test date	2019-19-2

1、Antenna basic parameters

- 1、Voltage Standing Wave Ratio (VSWR) indicates whether an antenna is matched with a radio transmitter. If the value of SWR is equal to 1, it means that none of the radio waves transmitted to the antenna are reflected and all are sent out, which is the most ideal situation.
- 2、Return loss, also known as reflection loss, is the reflection caused by impedance mismatch. .
- 3、The higher the antenna gain, the better the directivity and the more concentrated the energy.

The table comparing standing wave ratio, return loss and transmission power is as follows:

VSWR	Return Loss (dB)	Power Trans (%)	Power Refl (%)
1	∞	100	.0
1.1	26.4	99.8	.2
1.2	20.8	99.2	.8
1.3	17.7	98.3	1.7
1.4	15.6	97.2	2.8
1.5	14	96	4
1.6	12.7	94.7	5.3
1.7	11.7	93.3	6.7
1.8	10.9	91.8	8.2
1.9	10.2	90.4	9.6
2	9.5	88.9	11.1
2.5	7.4	91.6	18.4

As shown in the table, when VSWR = 1.5, the return loss is 14 and the theoretical transmission power is 96%. When VSWR = 2, the return loss is 9.5 and the transmission power is 88.9%. Generally, the minimum required VSWR is 2. When selecting an antenna, the lower the VSWR, the better.

2、Antenna selection

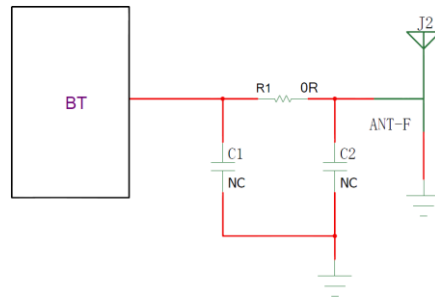
- 1、Built-in antenna: The antenna is integrated with the PCB board, resulting in very low cost, good adjustability, and limited performance. .

- 2、 Ceramic antenna: Small in size, medium performance, medium cost.
- 3、 External antenna: Excellent performance, high gain, easy to replace, no need for adjustment, high cost. When used with FPC type antennas, the backside is adhered to the non-metallic outer shell of the machine.

3、 Antenna matching circuit design

When designing the circuit, a π -type circuit should be added between the antenna and the RF output pin of the chip. The antenna's impedance will be significantly affected by the ground layout, surrounding components, and installation position, causing a significant deviation from the antenna's impedance. The π -type circuit can make the antenna match to 50 ohms. When drawing the circuit diagram, the components should be placed close to the antenna end, and the microstrip line should be as short as possible and perpendicular to the ground plane when it reaches the clearance area.。

If the antenna is of standard 50 ohms, then the matching circuits C1 and C2 do not need to be attached, and R1 can be simply connected as OR. See the figure below:

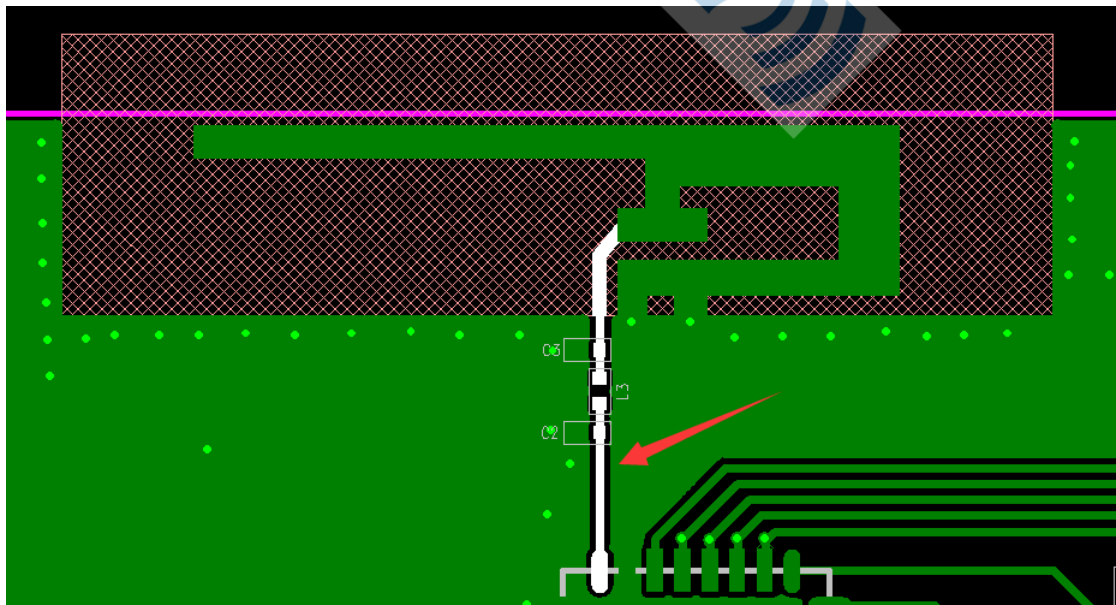


4、Microstrip line design

A microstrip line refers to the wire connecting the RF pins on the chip to the antenna. Since the impedance for transmission between the module and the antenna is 50 ohms,

the microstrip line should be designed with a 50 ohm impedance when drawing the layout to reduce signal reflection. When marking that a microstrip line segment requires a 50 ohm impedance,

the manufacturer will design the impedance for you. For a two-layer board, the reference layer for 50 ohms is the bottom layer, and for a four-layer board, it is the second layer. The backside of the microstrip line must be complete. There should be more vias on both sides of the wire, and it should be as short as possible. The routing accessories should not have high-frequency signal lines. Stay away from all devices that transmit high-frequency signals, such as crystal oscillators, DDR, and some high-frequency clocks. .

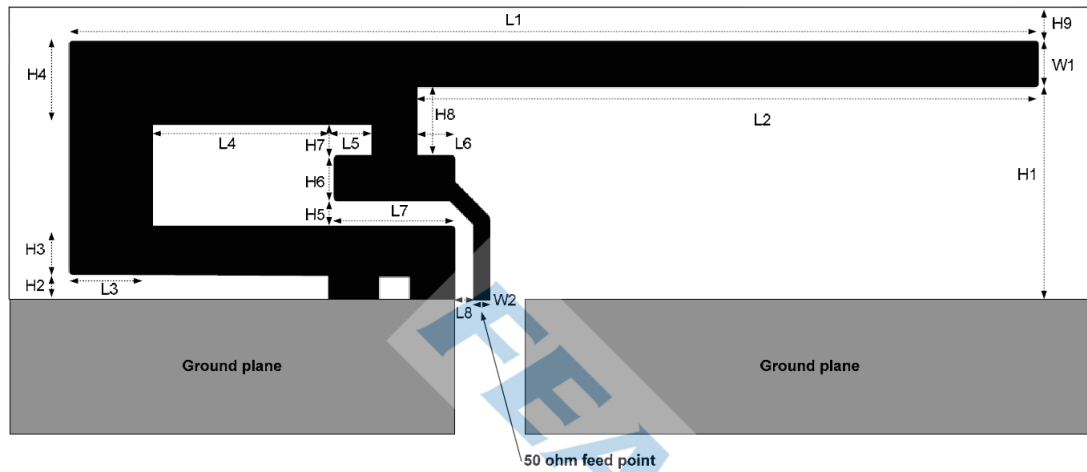


5、Antenna Recommendation

1、Built-in antenna

Recommendation 1: The size of the inverted-F antenna designed by TI 25.7*7.5mm

The dimensions are as shown in the figure below:

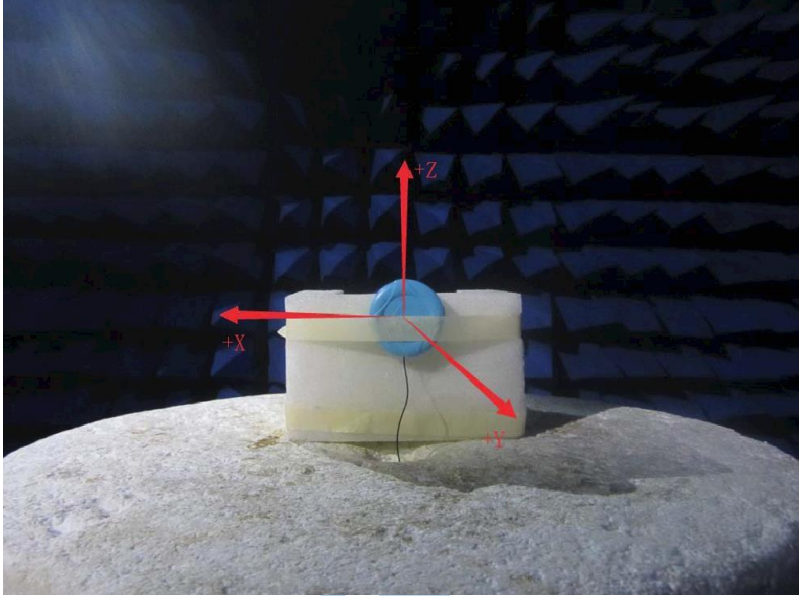


H1	5.70 mm	W2	0.46 mm
H2	0.74 mm	L1	25.58 mm
H3	1.29 mm	L2	16.40 mm
H4	2.21 mm	L3	2.18 mm
H5	0.66 mm	L4	4.80 mm
H6	1.21 mm	L5	1.00 mm
H7	0.80 mm	L6	1.00 mm
H8	1.80 mm	L7	3.20 mm
H9	0.61 mm	L8	0.45 mm
W1	1.21 mm		

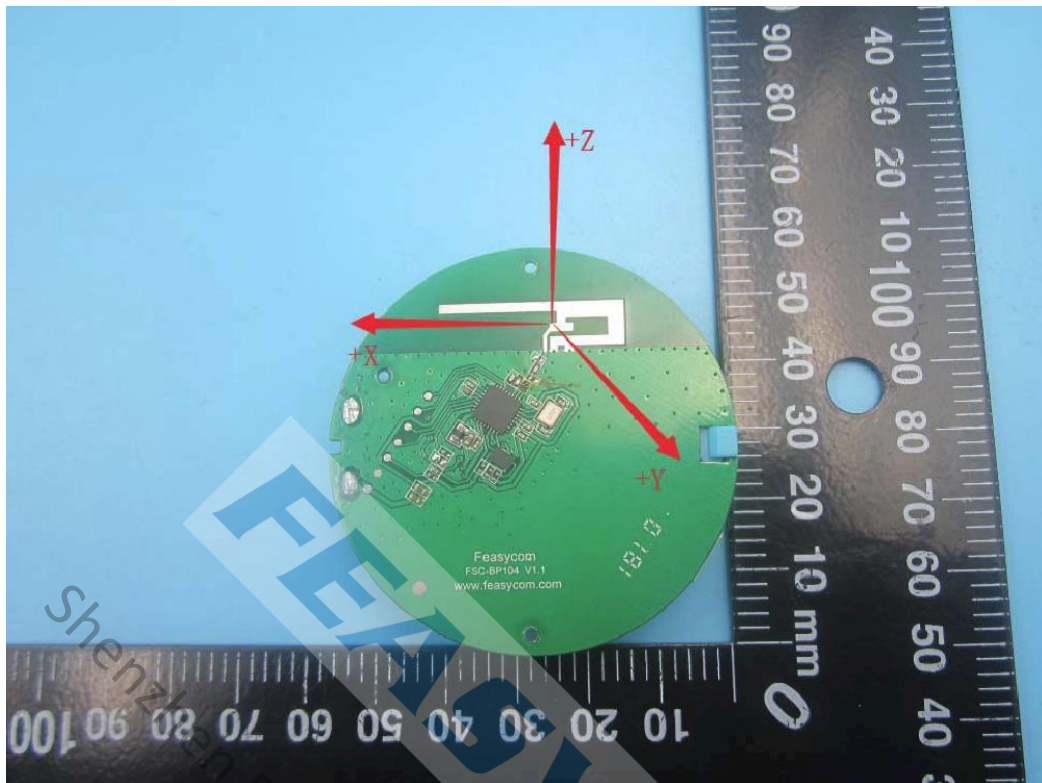
6、Inverted F Antenna OTA Test Report

Below are the test data for our product when using the inverted F antenna.

1、Placement of the testing environment

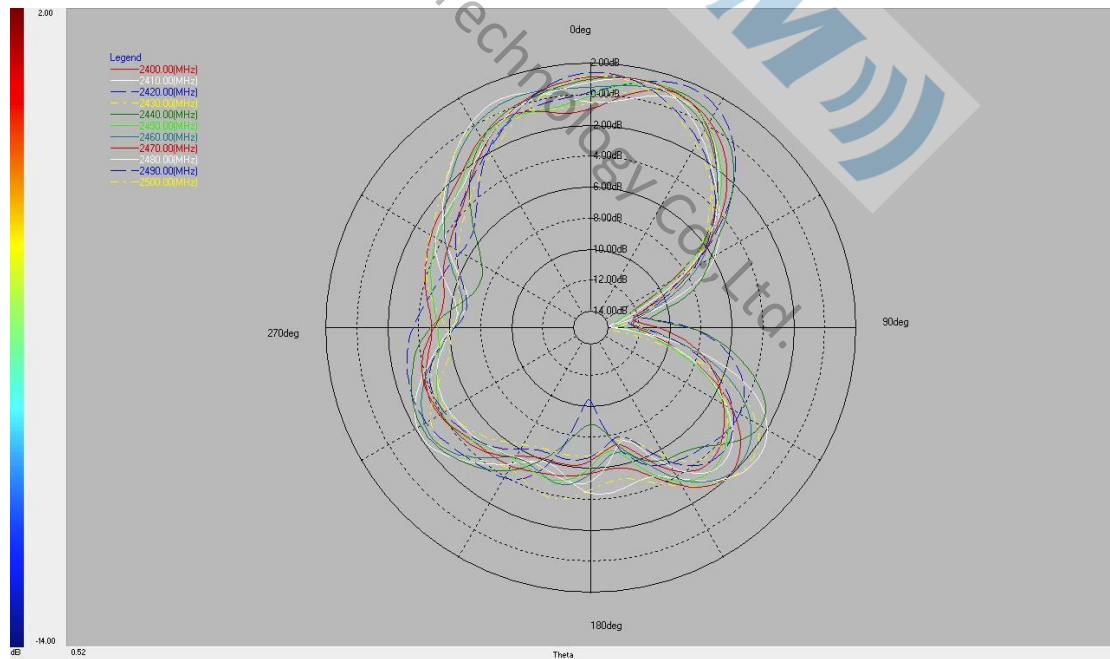


2、PCB

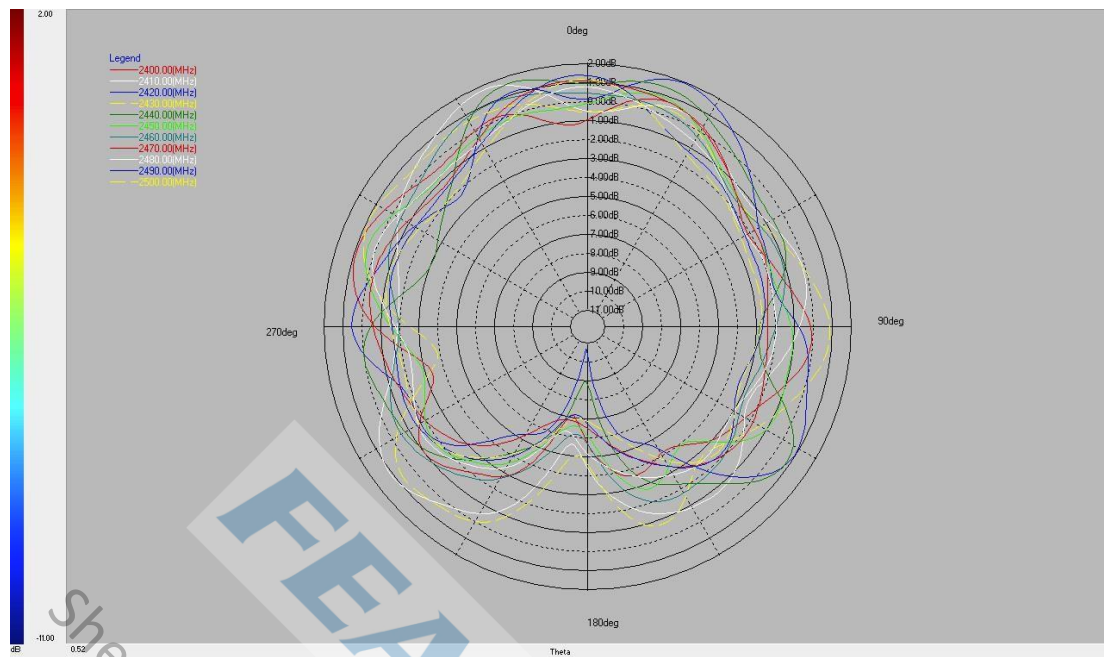


3、2D Radiation Pattern

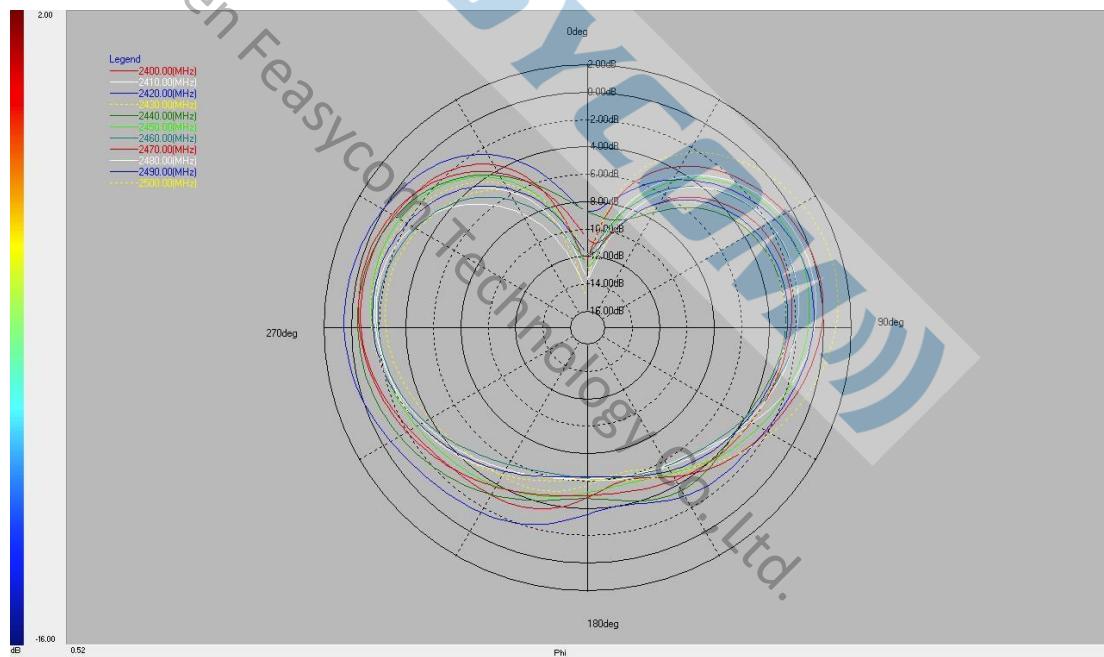
Phi=0°



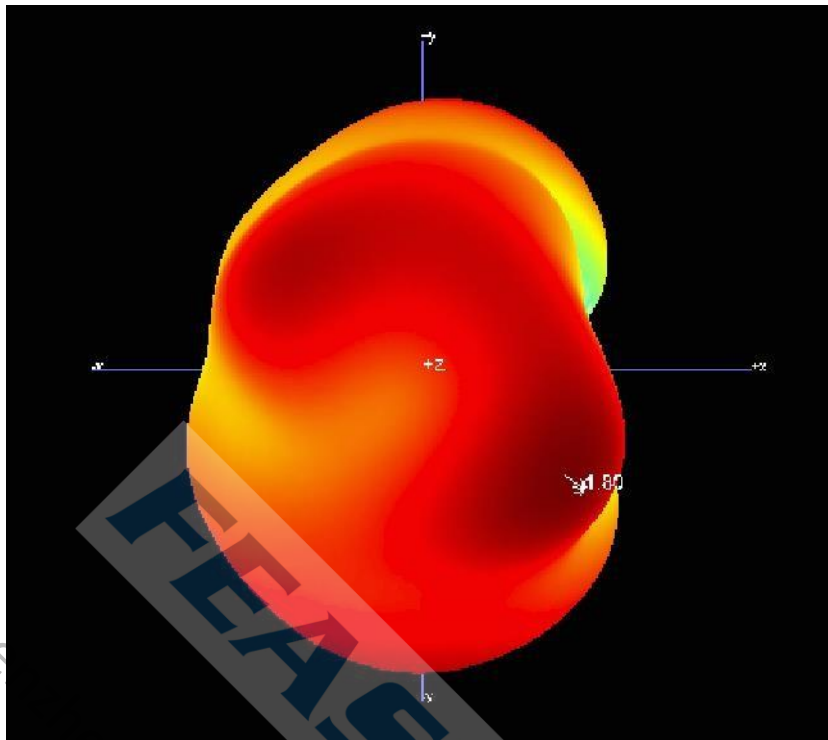
Phi=90°



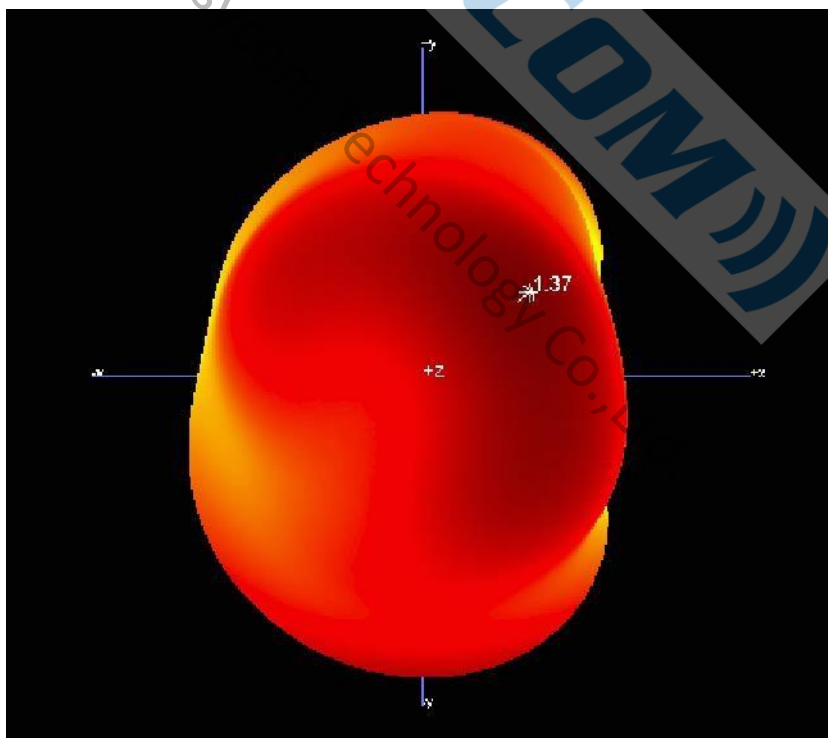
Theta=90°



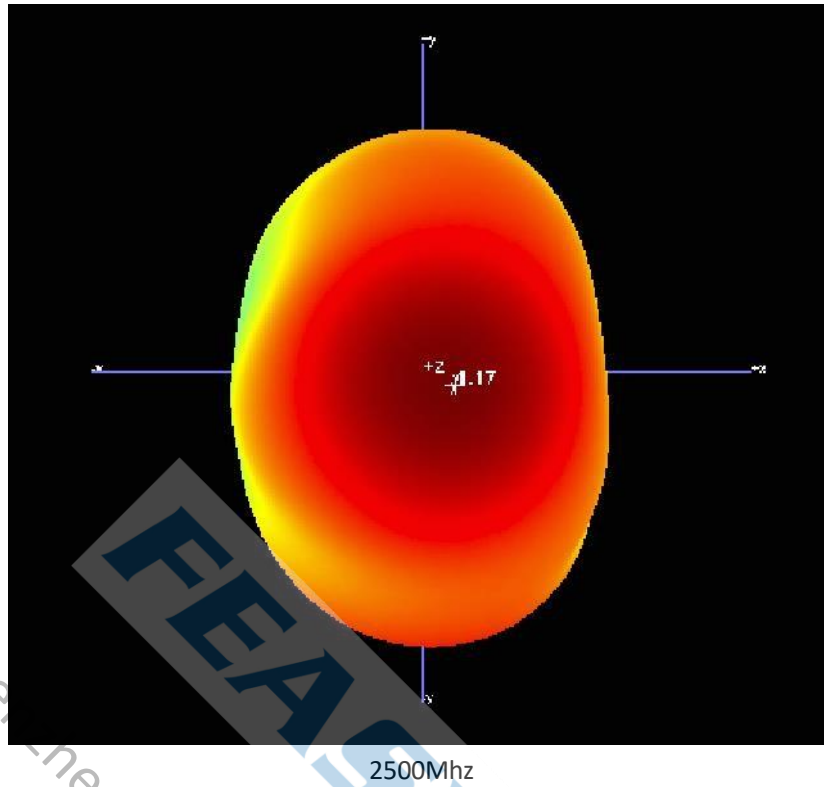
4、3D Radiation Pattern



2400Mhz



2450Mhz



5、 Gain and Efficiency

Frequency	Gain(dBi)	Efficiency
2400MHz	1.80	59.18%
2410MHz	1.78	66.84%
2420MHz	2.84	62.90%
2430MHz	1.71	66.49%
2440MHz	2.46	61.66%
2450MHz	1.37	55.31%
2460MHz	0.95	58.67%
2470MHz	1.23	54.70%
2480MHz	1.28	52.47%
2490MHz	1.37	49.41%
2500MHz	1.17	47.19%

The inverted F antenna performs very well on this board and has a high efficiency.