

**NIC Series:** Dual Band WiFi NGCL Ceramic Loop Chip Antenna  
[NGCL1206UW2R442G2TRF](#)

**Purpose:** This application note is made for guiding users to install NIC's NGCL Ceramic Loop Chip Antennas properly on their PCB (Printed Circuit Board) or devices.

### Studies:

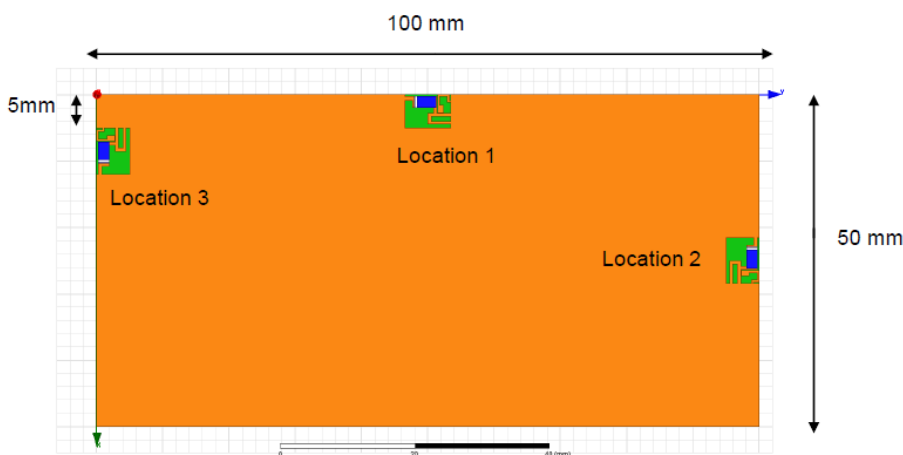
1. Dimensions and Applications
2. Typical Electrical Properties
3. Performance at different locations on test board
4. Performance at different sizes of ground clearance area
5. Performance at different gaps between chip antenna and metallic object
6. Layout Considerations
  1. Antenna Footprint
  2. Antenna Frequency Tuning
  3. Matching Circuits – Impedance Optimization Metallic Component Interference
  4. Location Choice

**Prepared by** NIC Components, [nic-tpmg@niccomp.com](mailto:nic-tpmg@niccomp.com)

### The effects of antenna's placement:

Installing chip antenna in vertical and horizontal direction in various positions on the circuit board and measure their radiation performance in a 3D anechoic chamber.

More detail is shown in the below figure, green area means the ground clearance area, and orange area means the ground plane of PCB.



### Radiation Efficiency vs. Frequency

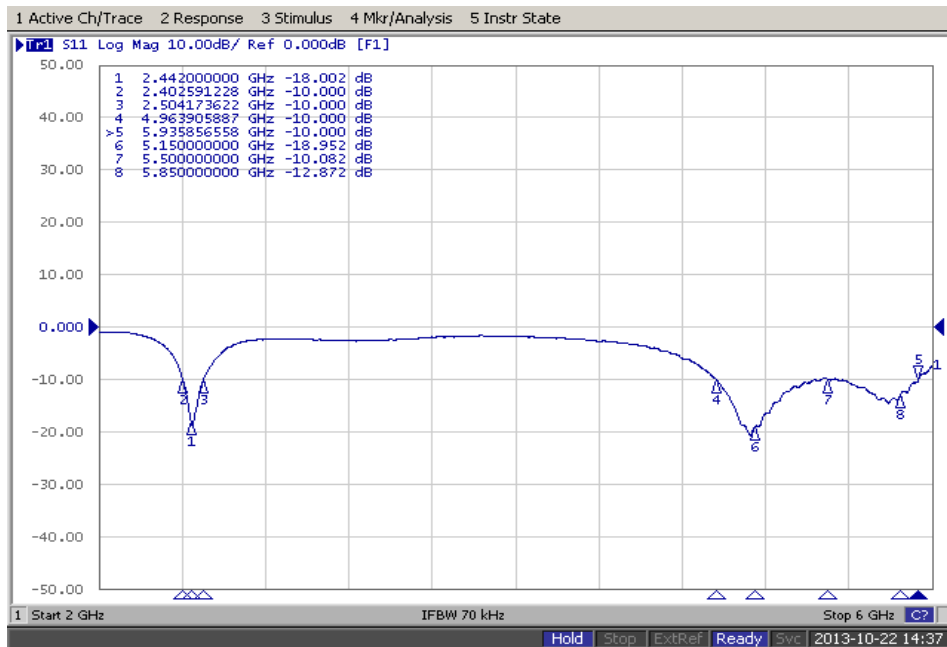
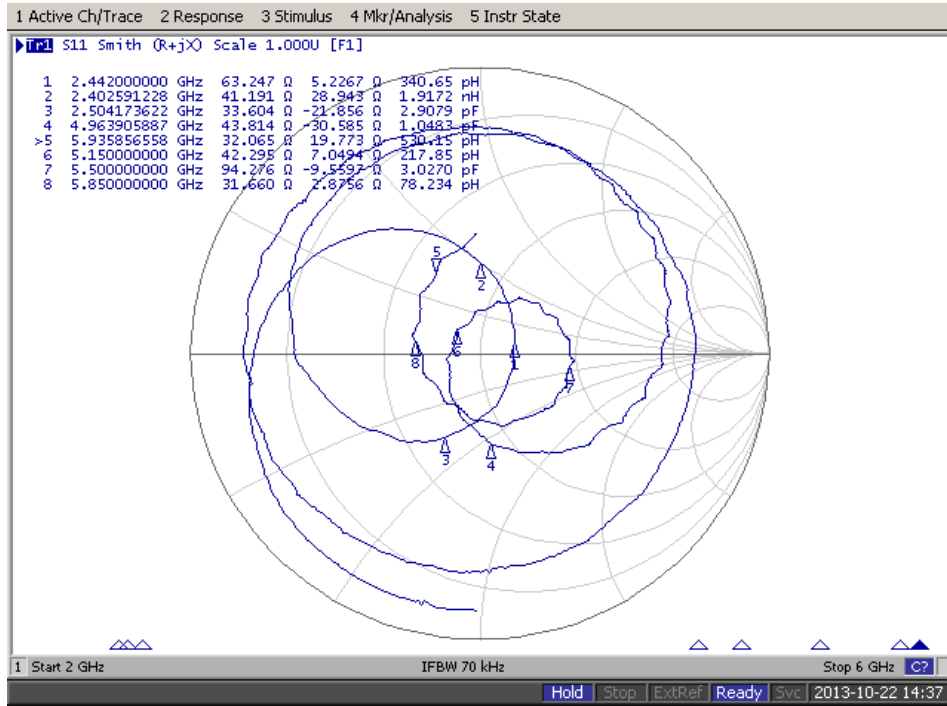
#### 2.4 GHz

Frequency (GHz)	2.4	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.485
Location 1	59.43	62.37	64.86	66.37	67.3	67.92	68.71	66.99	67.14	68.08	69.02	69.34	68.55	66.68	65.31
Location 2	58.75	59.7	60.67	61.66	63.1	63.24	63.97	61.66	61.52	61.52	60.95	61.8	60.26	58.08	57.81
Location 3	44.77	47.53	50	52.48	55.08	55.85	56.23	54.58	54.83	53.95	53.58	53.83	51.05	48.75	48.31

#### 5 GHz

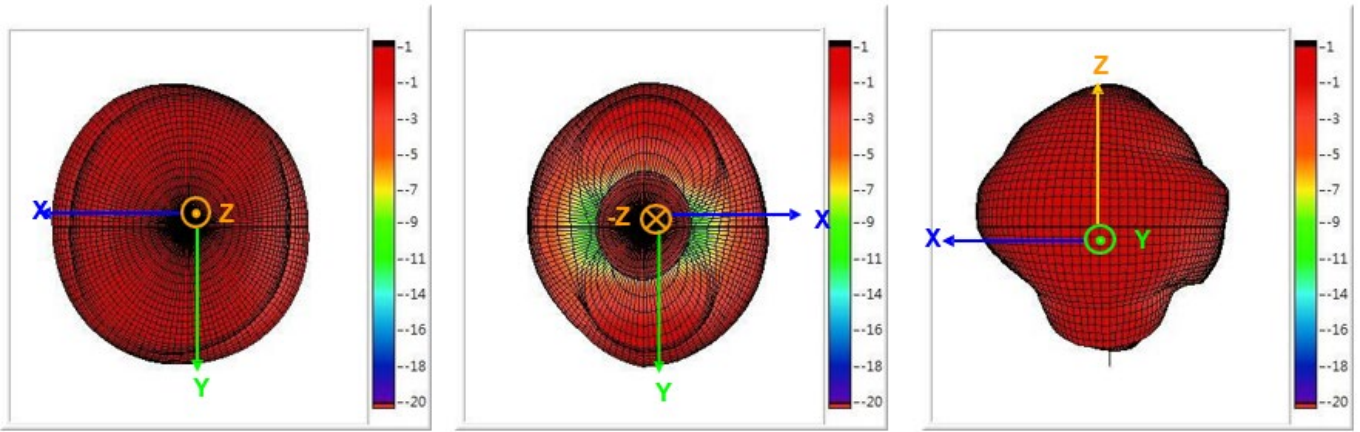
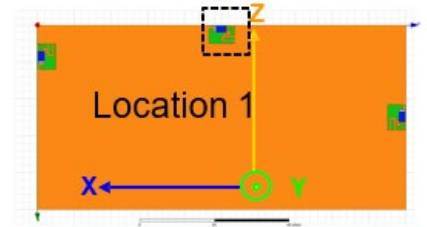
Frequency (GHz)	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9
Location 1	45.83	51.86	62.23	52.07	49.17	44.69	44.44	41.20	44.97
Location 2	57.24	68.95	61.78	54.11	42.55	45.21	51.17	43.32	58.34
Location 3	57.98	68.38	68.42	57.97	61.53	49.31	52.66	52.56	58.78

### Performance at Location 1



### Location 1 for 2.4GHz

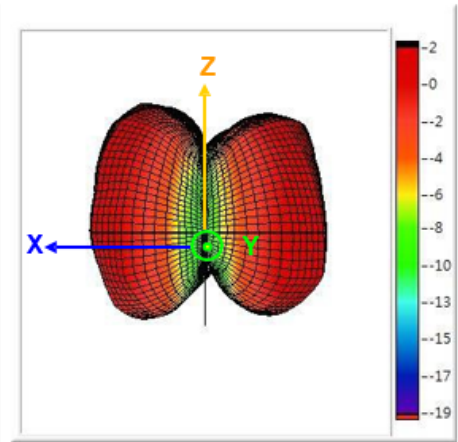
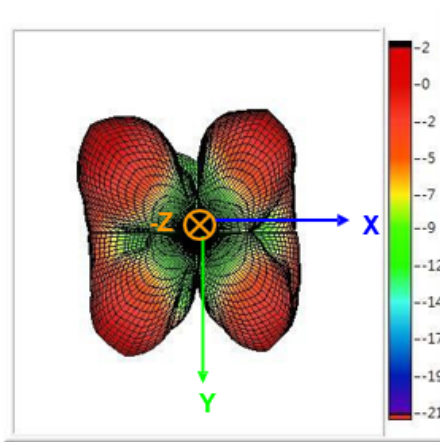
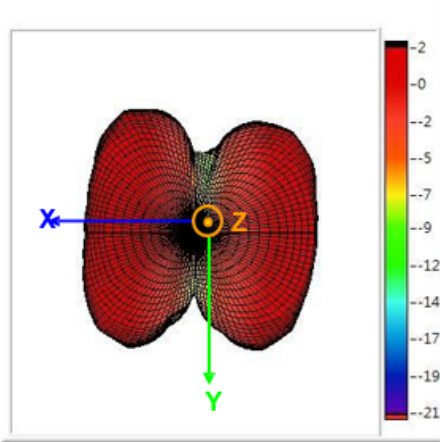
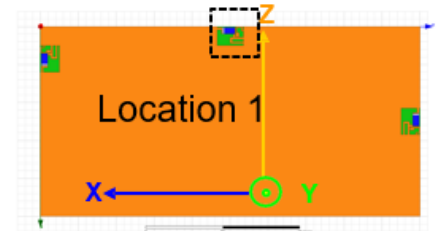
### 3D Gain Patterns & Efficiency



Frequency (GHz)	2.4	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.485
Efficiency (dB)	-2.26	-2.05	-1.88	-1.78	-1.72	-1.68	-1.63	-1.74	-1.73	-1.67	-1.61	-1.59	-1.64	-1.76	-1.85
Efficiency (%)	59.43	62.37	64.86	66.37	67.3	67.92	68.71	66.99	67.14	68.08	69.02	69.34	68.55	66.68	65.31

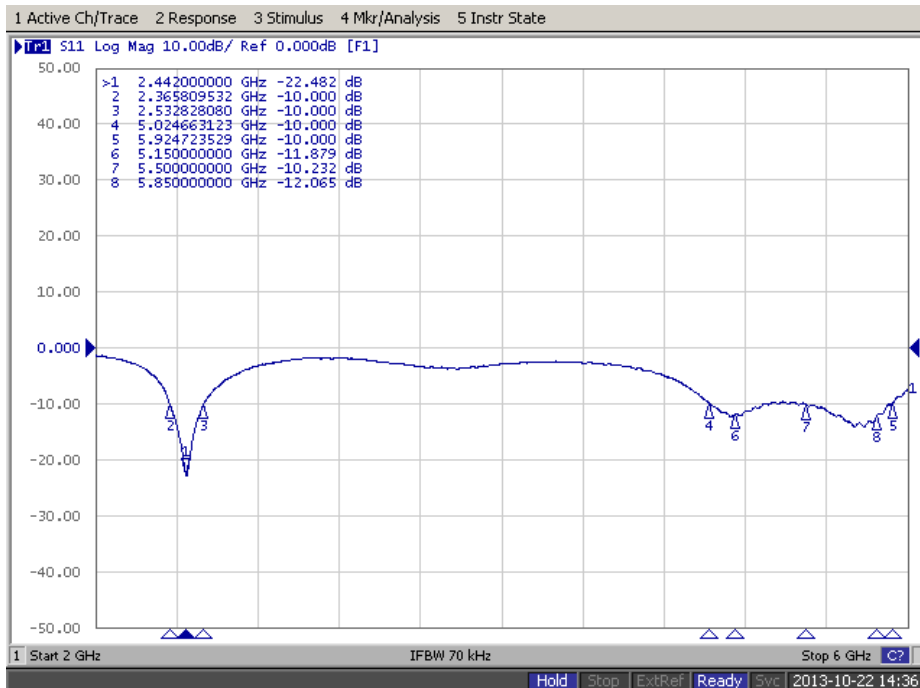
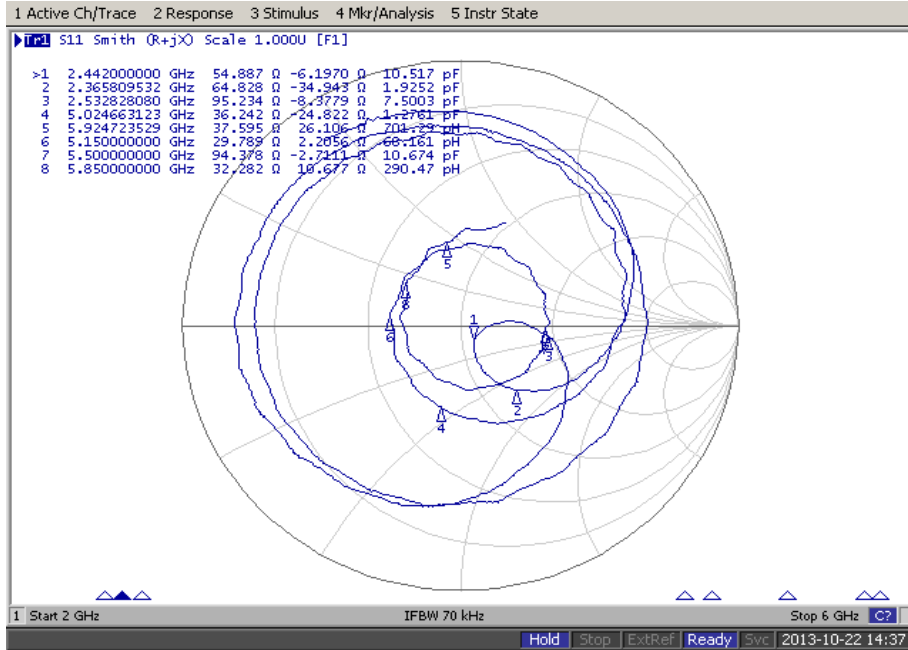
### Location 1 for 5 GHz

### 3D Gain Patterns & Efficiency



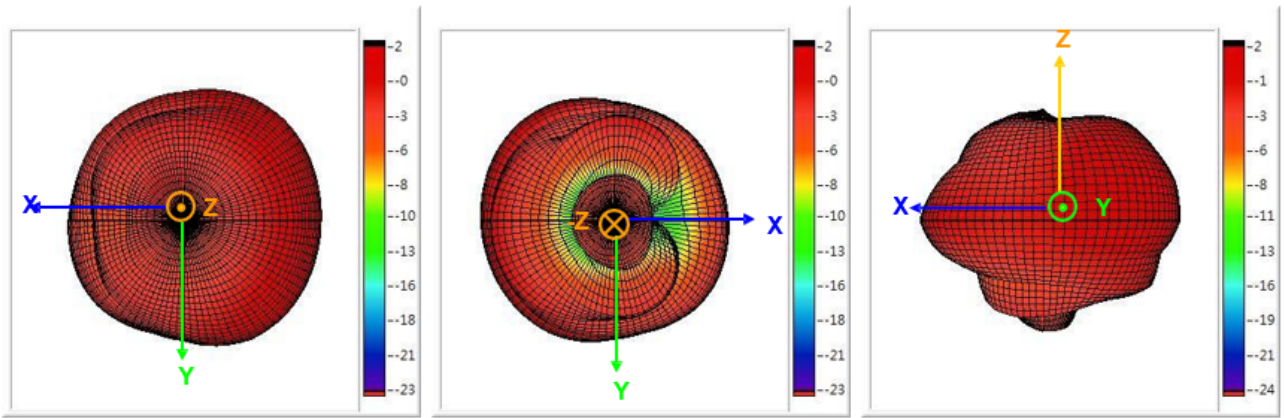
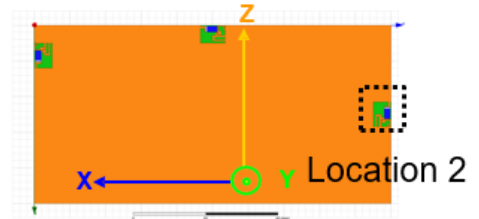
Frequency (GHz)	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9
Efficiency (dB)	-3.39	-2.85	-2.06	-2.83	-3.08	-3.50	-3.52	-3.85	-3.47
Efficiency (%)	45.83	51.86	62.23	52.07	49.17	44.69	44.44	41.20	44.97

### Performance at Location 2



### Location 2 for 2.4GHz

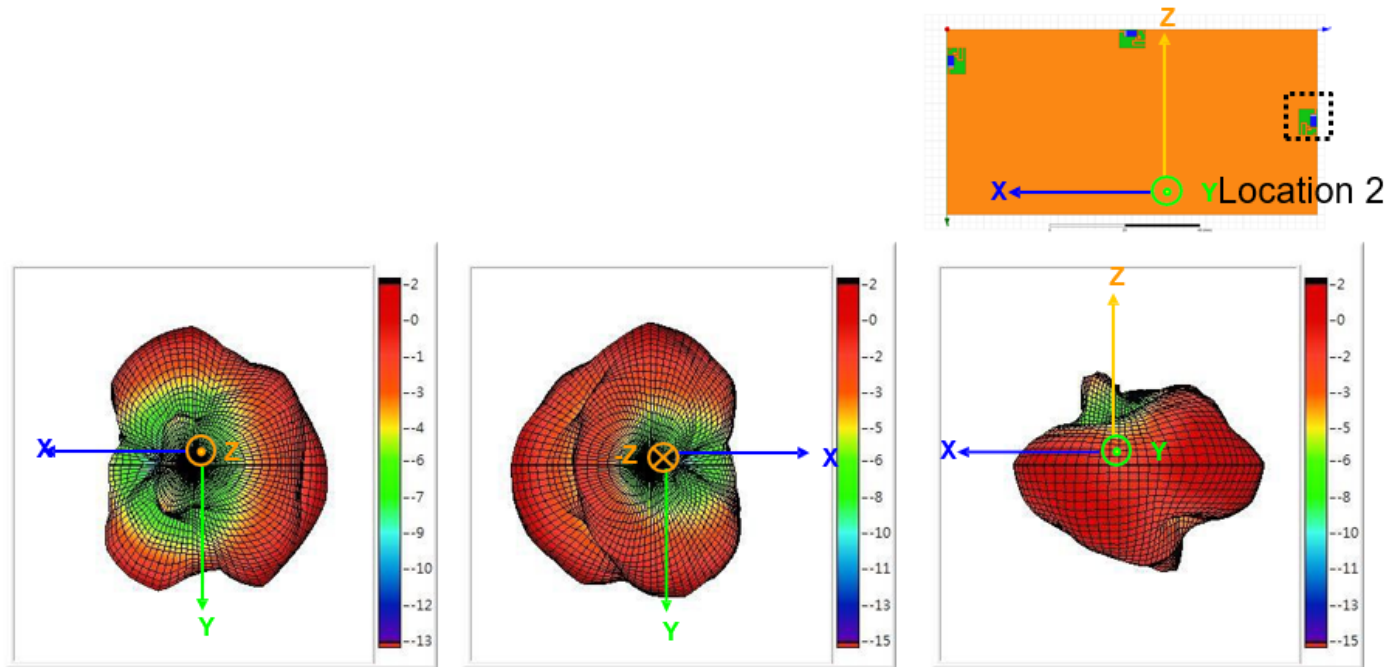
### 3D Gain Patterns & Efficiency



Frequency (GHz)	2.4	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.485
Efficiency (dB)	-2.31	-2.24	-2.17	-2.1	-2	-1.99	-1.94	-2.1	-2.11	-2.11	-2.15	-2.09	-2.2	-2.36	-2.38
Efficiency (%)	58.75	59.7	60.67	61.66	63.1	63.24	63.97	61.66	61.52	61.52	60.95	61.8	60.26	58.08	57.81

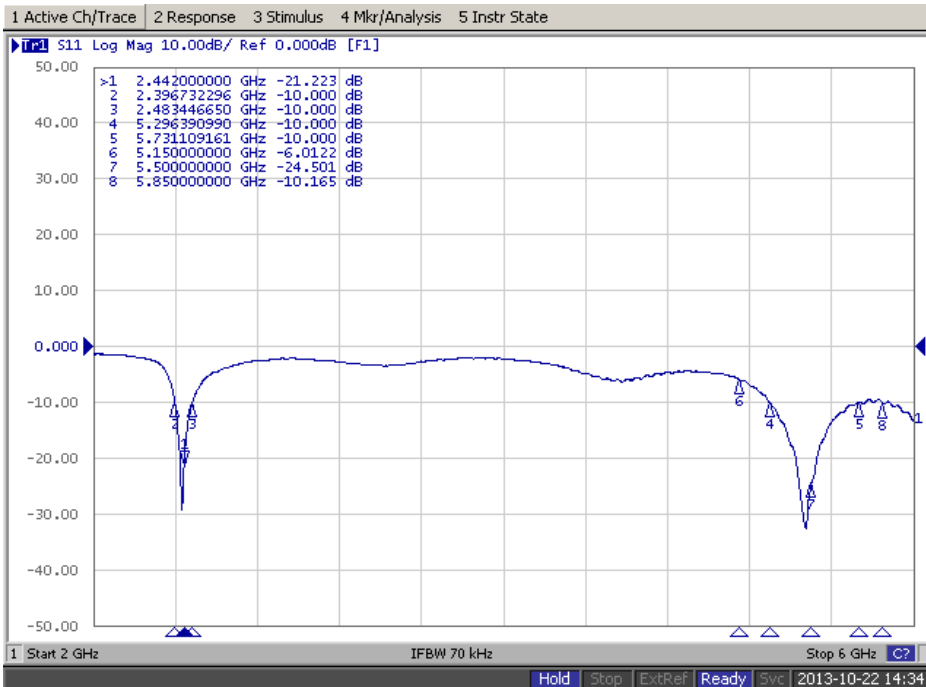
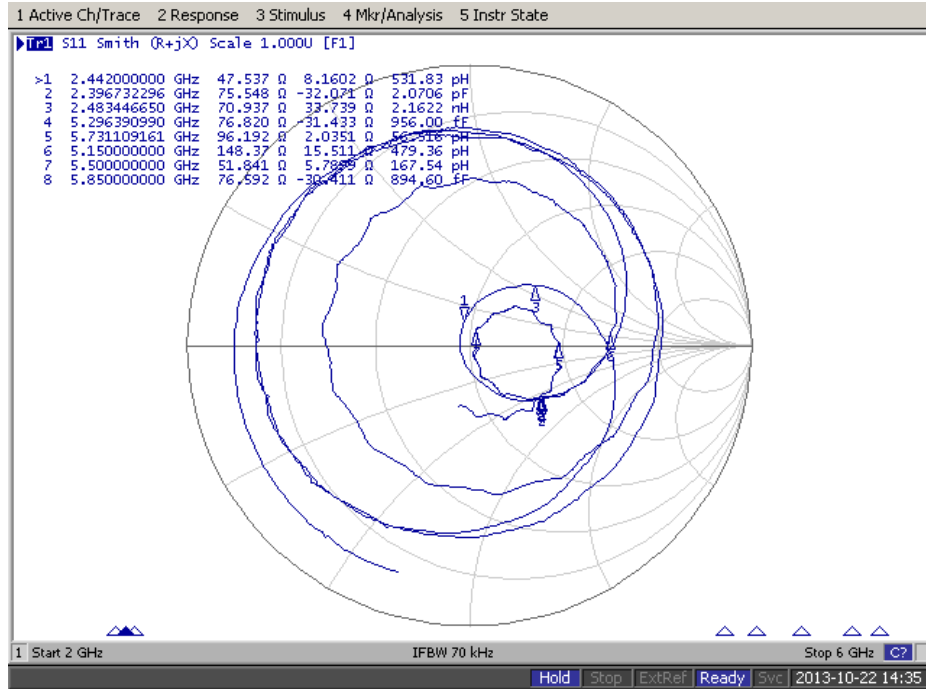
### Location 2 for 5 GHz

### 3D Gain Patterns & Efficiency



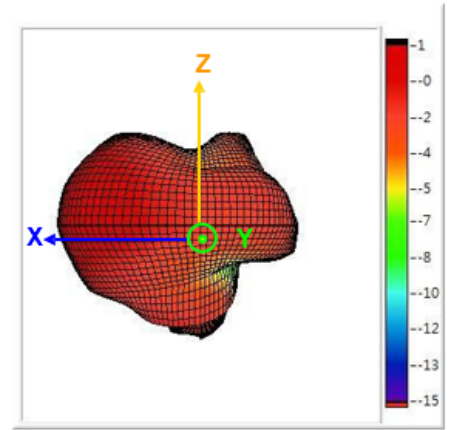
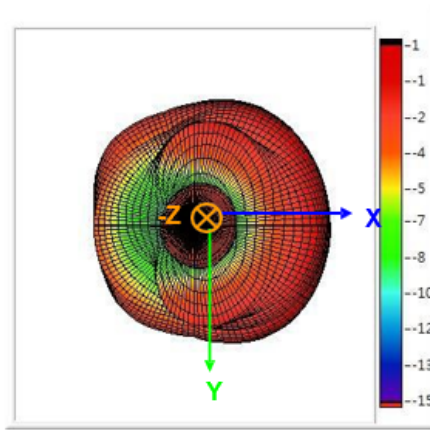
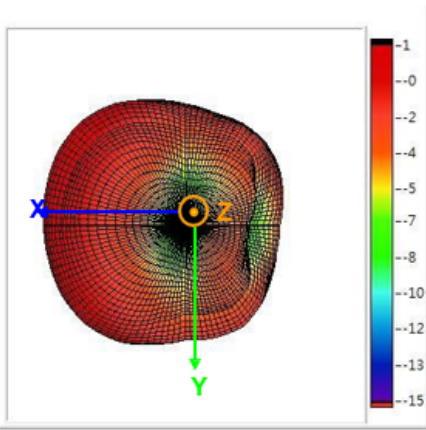
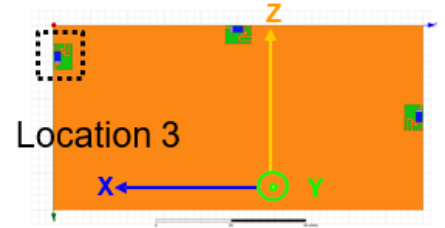
Frequency (GHz)	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9
Efficiency (dB)	-2.42	-1.61	-2.09	-2.67	-3.71	-3.45	-2.91	-3.63	-2.34
Efficiency (%)	57.24	68.95	61.78	54.11	42.55	45.21	51.17	43.32	58.34

### Performance at Location 3



### Location 3 for 2.4GHz

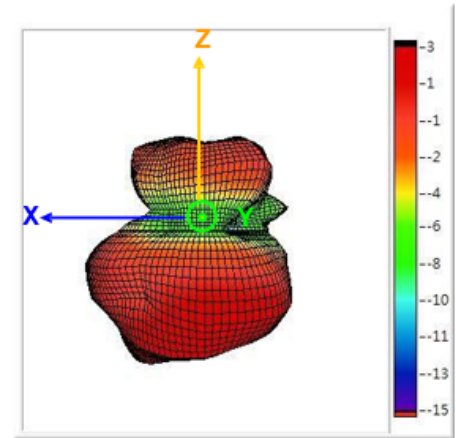
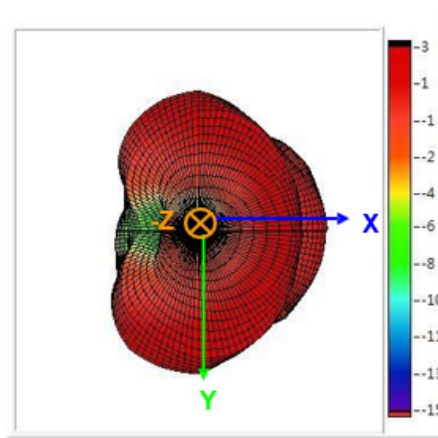
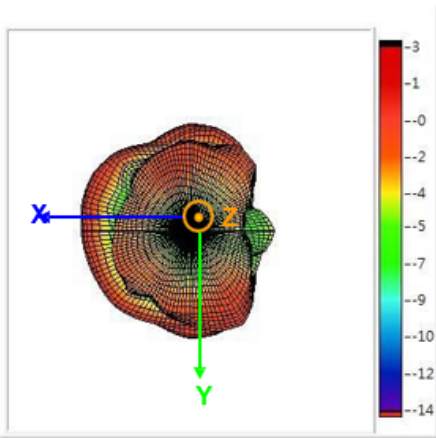
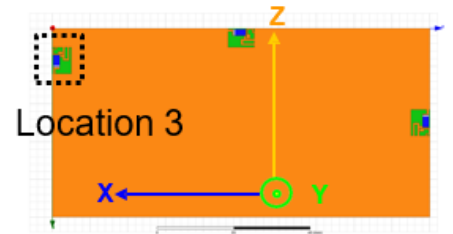
#### 3D Gain Patterns & Efficiency



Frequency (GHz)	2.4	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.485
Efficiency (dB)	-3.62	-2.59	-2.36	-2.25	-2.22	-2.16	-2.09	-2.02	-1.89	-1.76	-1.64	-1.63	-1.74	-1.94	-2.45
Efficiency (%)	43.43	55.04	58.03	59.51	59.98	60.87	61.78	62.84	64.64	66.66	68.57	68.68	66.96	64.04	56.86

### Location 3 for 5 GHz

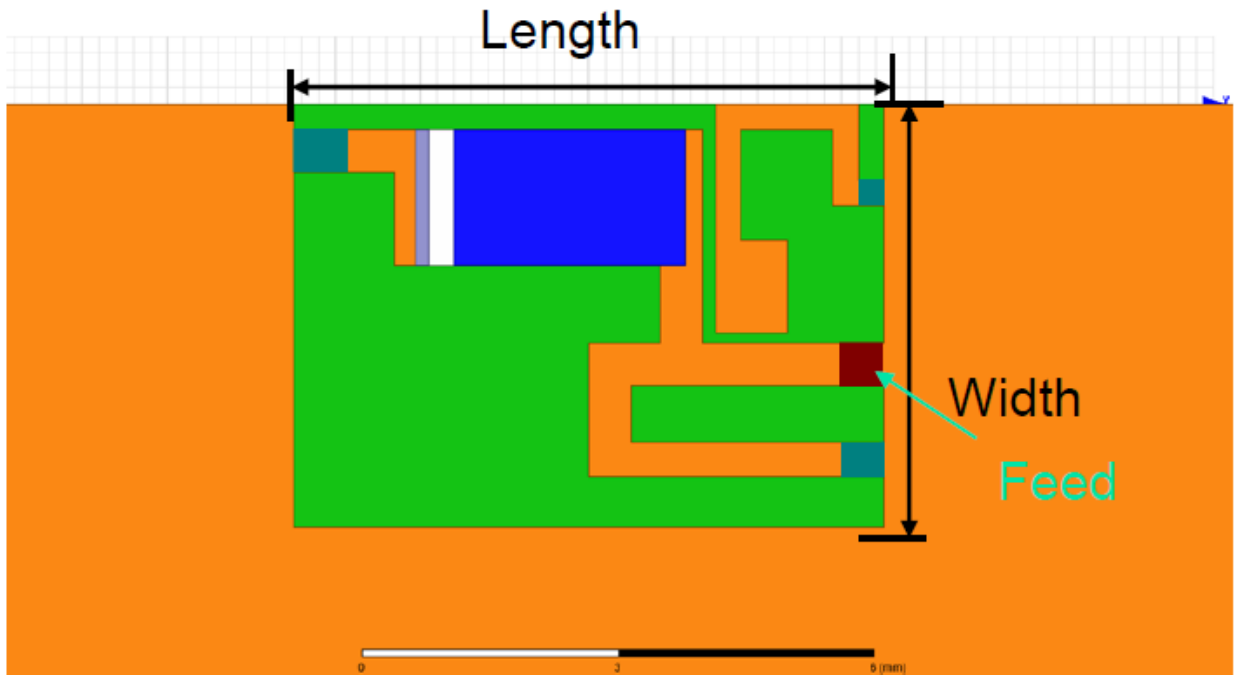
### 3D Gain Patterns & Efficiency



Frequency (GHz)	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9
Efficiency (dB)	-2.37	-1.65	-1.65	-2.37	-2.11	-3.07	-2.79	-2.79	-2.31
Efficiency (%)	57.98	68.38	68.42	57.97	61.53	49.31	52.66	52.56	58.78

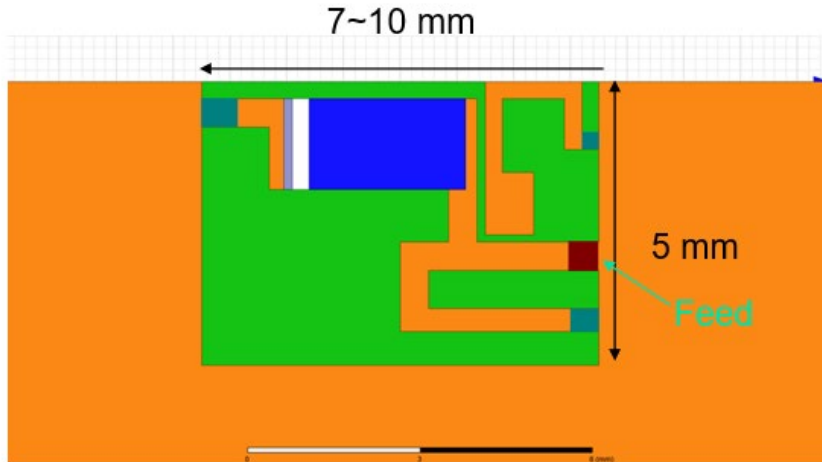
### The effect of the dimensions of ground clearance area

The performance of chip antenna will be influenced when the dimension of ground clearance area is changed. The influence of length and width of the ground clearance area have been shown in next few pages.



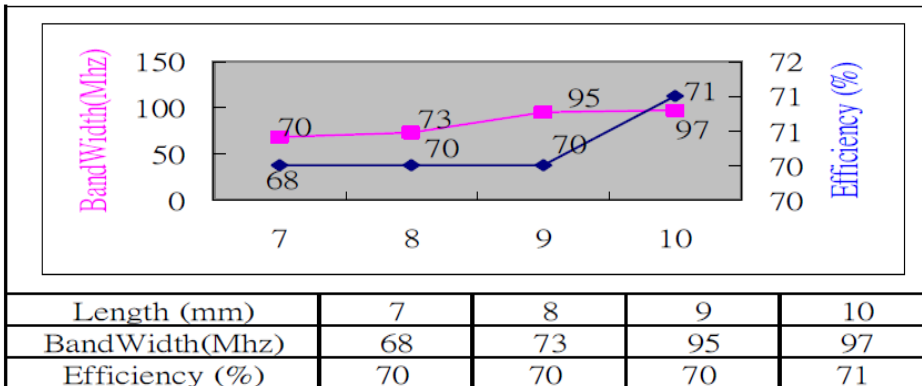
**Case 1: Keeping the width of the ground clearance area at 5 mm:**

The width of ground clearance area is kept at 5mm and change the length from 7mm to 10mm.

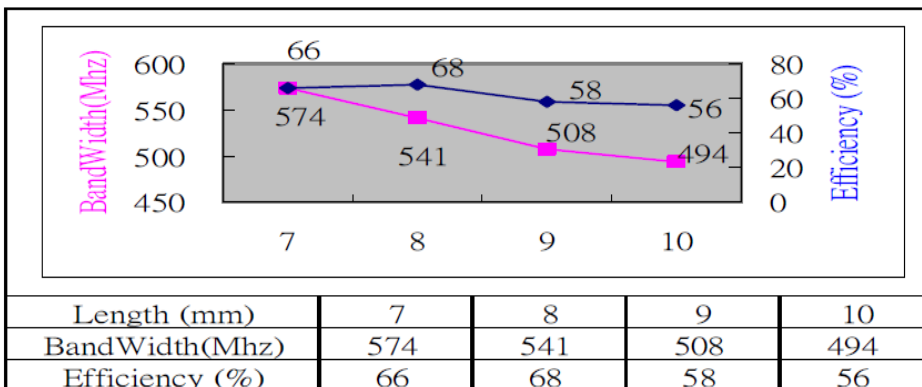


**Frequency vs Radiation Efficiency**

2.4G Band

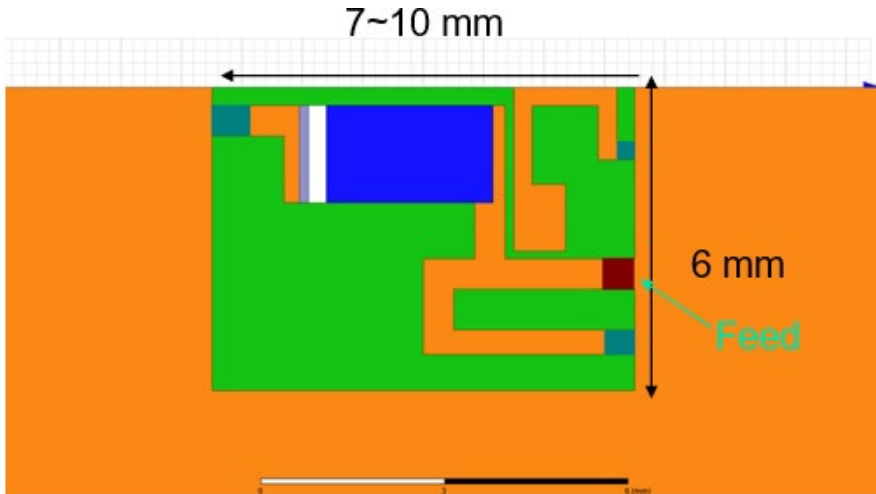


5G Band



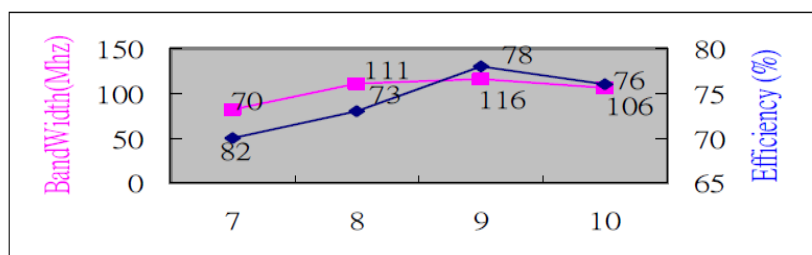
### Case 2: Keeping the width of the ground clearance area at 6 mm

The width of ground clearance area is kept at 6mm and change the length from 7mm to 10mm.



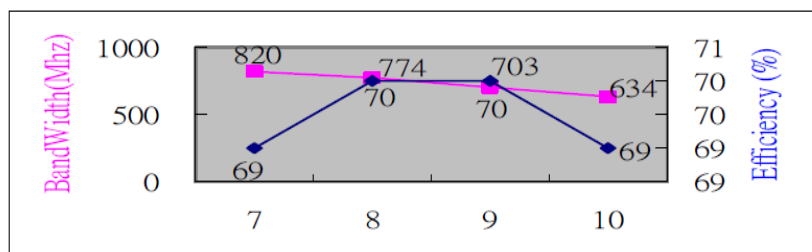
### Frequency vs Radiation Efficiency

2.4G Band



Length (mm)	7	8	9	10
BandWidth(Mhz)	82	111	116	106
Efficiency (%)	70	73	78	76

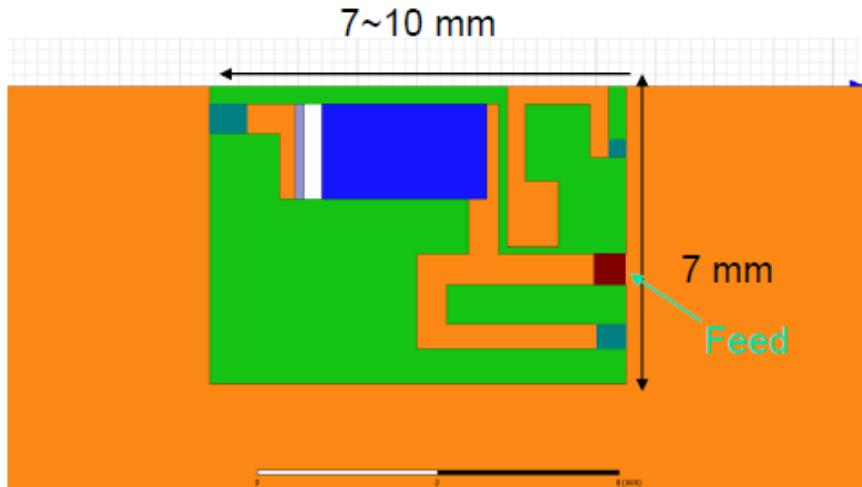
5G Band



Length (mm)	7	8	9	10
BandWidth(Mhz)	820	774	703	634
Efficiency (%)	69	70	70	69

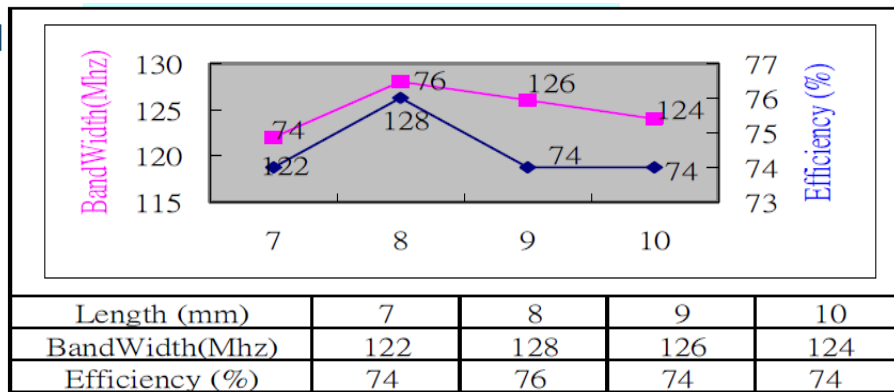
### Case 3: Keeping the width of the ground clearance area at 7 mm

The width of ground clearance area is kept at 7mm and change the length from 7mm to 10mm.

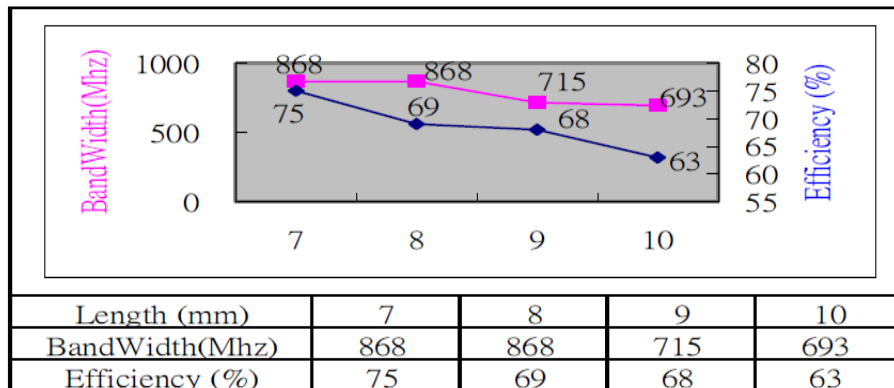


### Frequency vs Radiation Efficiency

2.4G Band



5G Band



**Effect of ground clearance dimensions on 2.4G Band performance**

Bandwidth (MHz)

Length (mm) \ Width (mm)	5	6	7
7	68	82	122
8	73	111	128
9	95	116	126
10	97	106	124

Efficiency (%)

Length (mm) \ Width (mm)	5	6	7
7	70	70	74
8	70	73	76
9	70	78	74
10	71	76	74

**Effect of ground clearance dimensions on 5G Band performance**

Bandwidth (MHz)

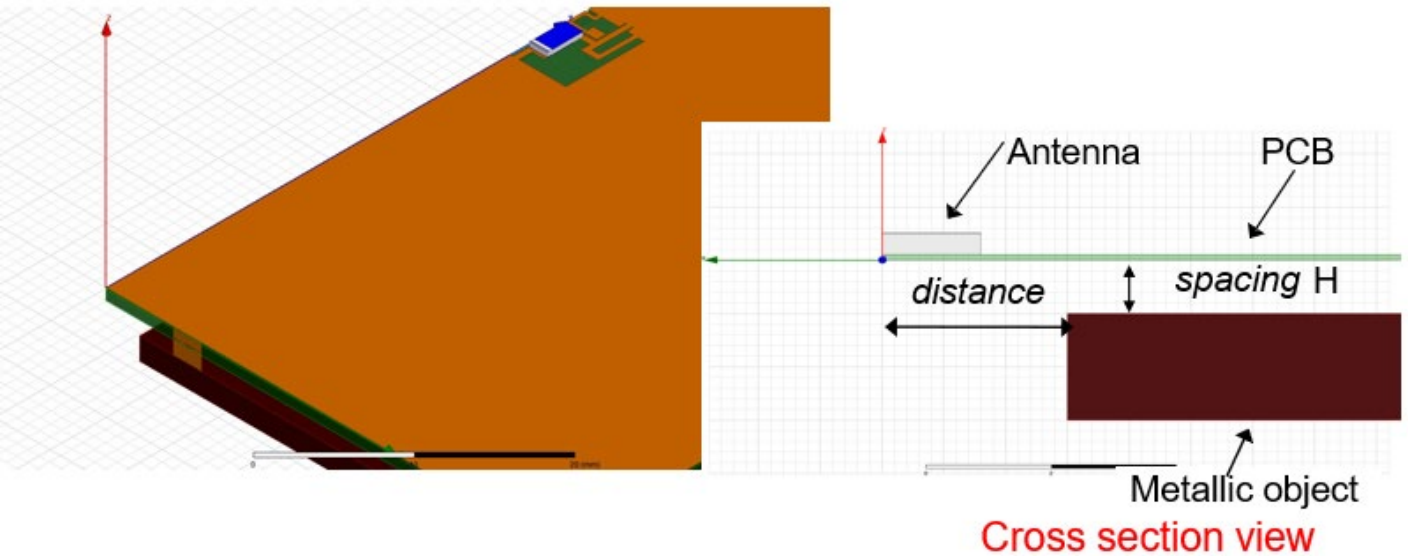
Length (mm) \ Width (mm)	5	6	7
7	459	574	868
8	433	541	868
9	406	509	715
10	395	494	693

Efficiency (%)

Length (mm) \ Width (mm)	5	6	7
7	66	69	75
8	68	70	69
9	58	70	68
10	56	69	63

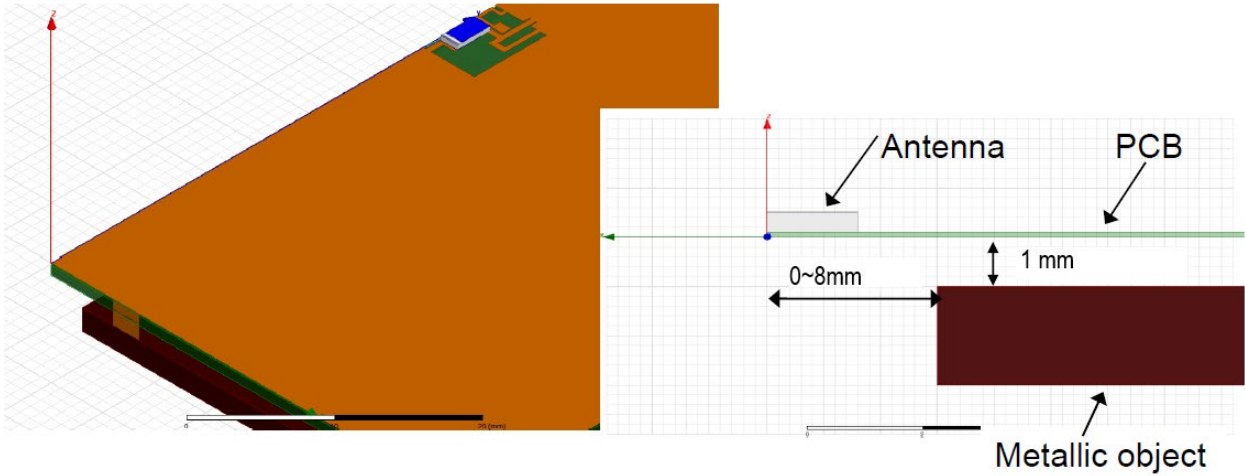
**The effect of the position of chip antenna relative to large metallic object  
(for example: LCD panel)**

The spacing and distance of the antenna to a metallic object is varied, it will also affect the chip antenna's performance. The typical measurements will be shown in the following pages.



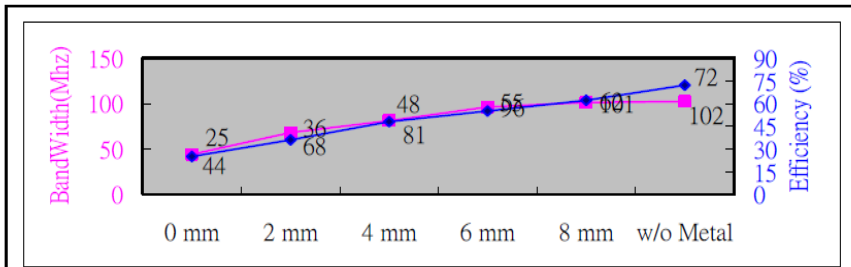
### Case 1: When the spacing H is fixed at 1 mm

When the spacing H is fixed at 1 mm, and change the distance L from 0~8 mm.



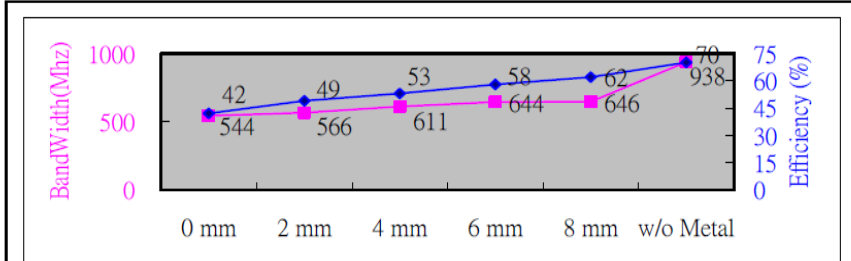
### Frequency vs Radiation Efficiency

2.4G Band



Distance (mm)	0 mm	2 mm	4 mm	6 mm	8 mm	w/o Metal
BandWidth(MHz)	44	68	81	96	101	102
Efficiency (%)	25	36	48	55	62	72

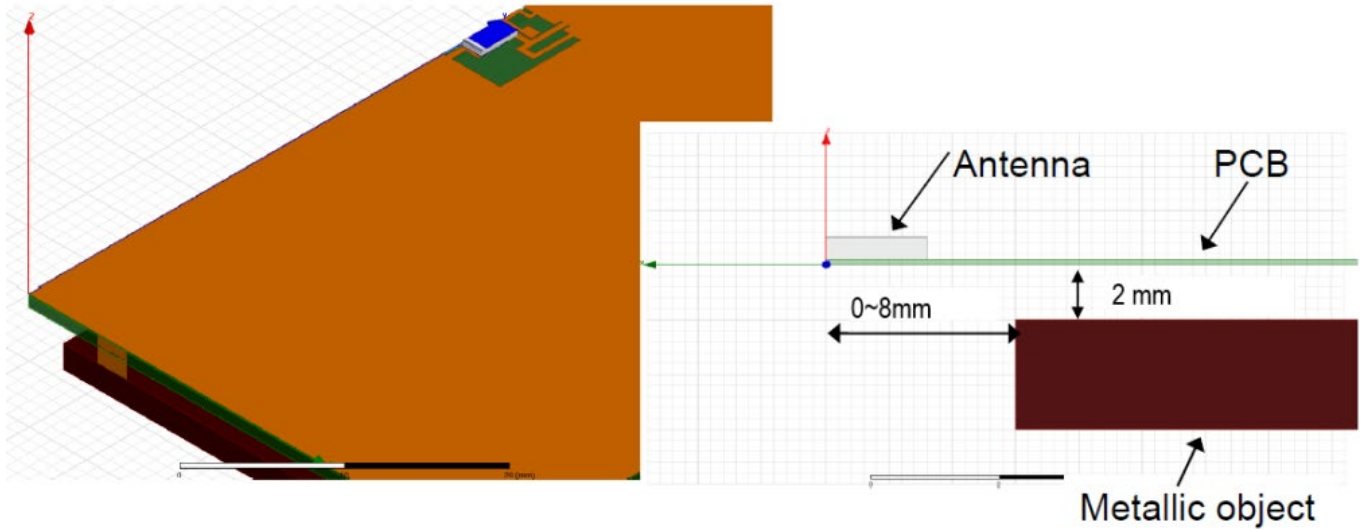
5G Band



Distance (mm)	0 mm	2 mm	4 mm	6 mm	8 mm	w/o Metal
BandWidth(MHz)	544	566	611	644	646	938
Efficiency (%)	42	49	53	58	62	70

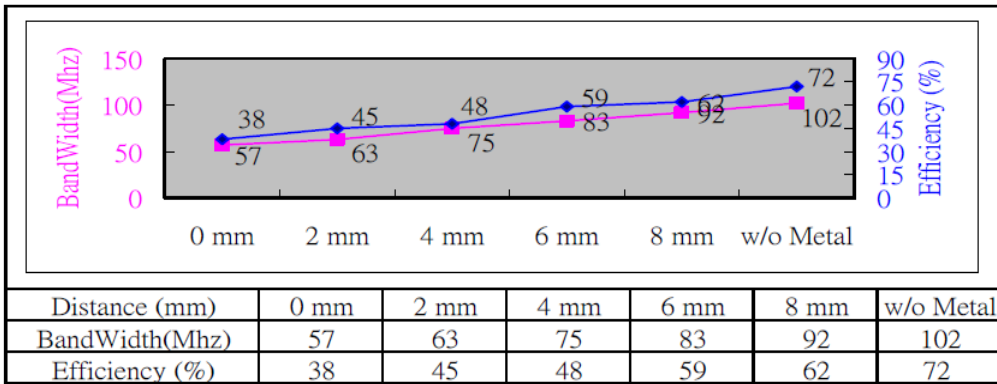
### Case 2: When the spacing H is fixed at 2 mm

When the spacing H is fixed at 2 mm, and change the distance L from 0~8 mm.

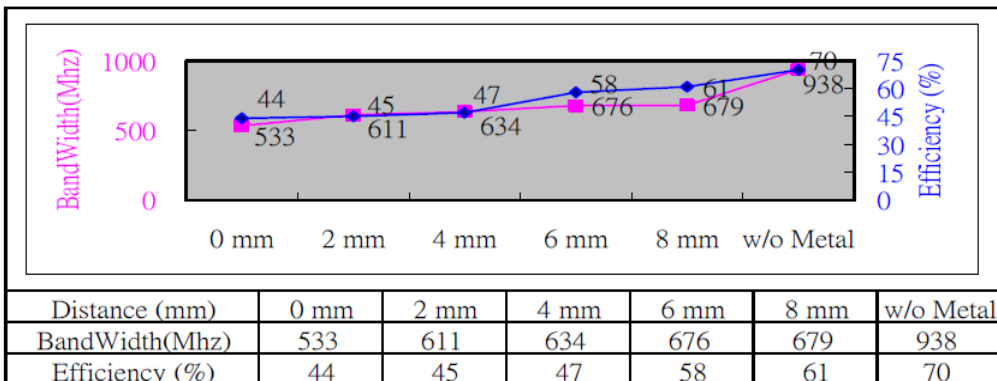


### Frequency vs Radiation Efficiency

#### 2.4G Band

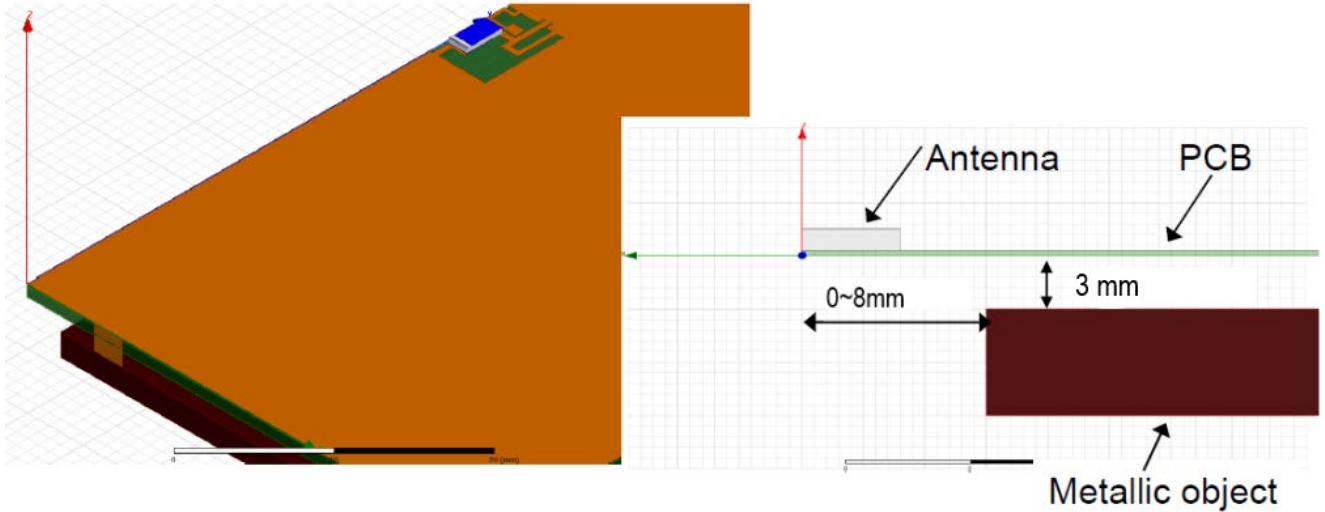


#### 5G Band



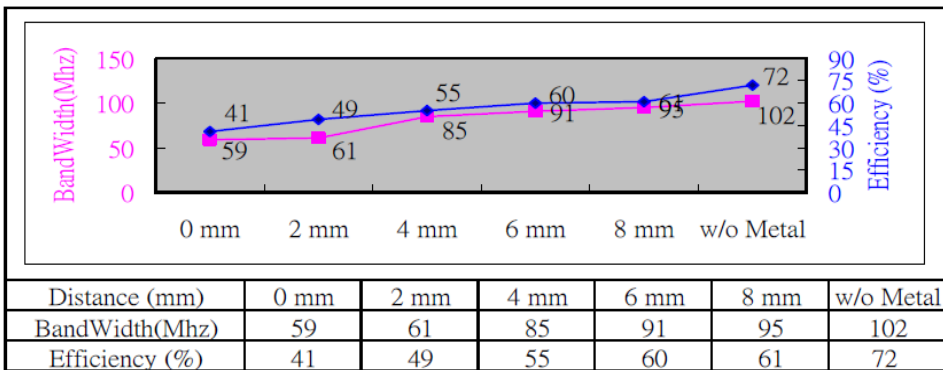
### Case 3: When the spacing H is fixed at 3 mm

When the spacing H is fixed at 3 mm, and change the distance L from 0~8 mm.

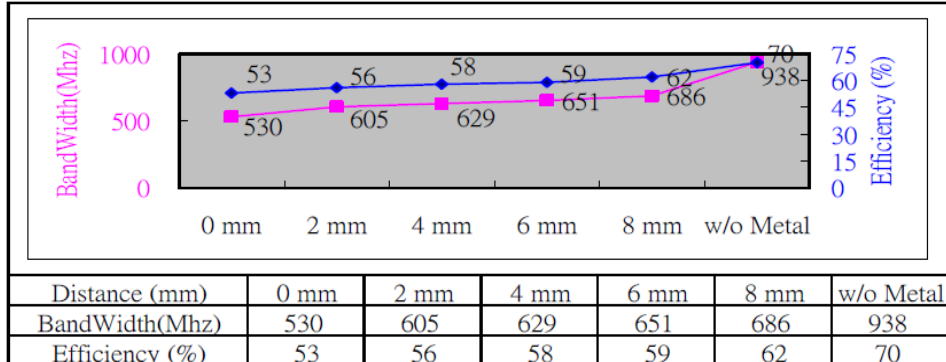


### Frequency vs Radiation Efficiency

#### 2.4G Band



#### 5G Band



**Summary of the effect of LCD panel on 2.4G band**

Bandwidth (MHz)

Spacing (mm) \ Distance (mm)	1	2	3
0	44	57	59
2	68	63	61
4	81	75	85
6	96	83	91
8	101	92	95
without Metal	102	102	102

Efficiency (%)

Spacing (mm) \ Distance (mm)	1	2	3
0	25	38	41
2	36	45	49
4	48	48	55
6	55	59	60
8	62	62	61
without Metal	72	72	72

**Summary of the effect of LCD panel on 5G band**

Bandwidth (MHz)

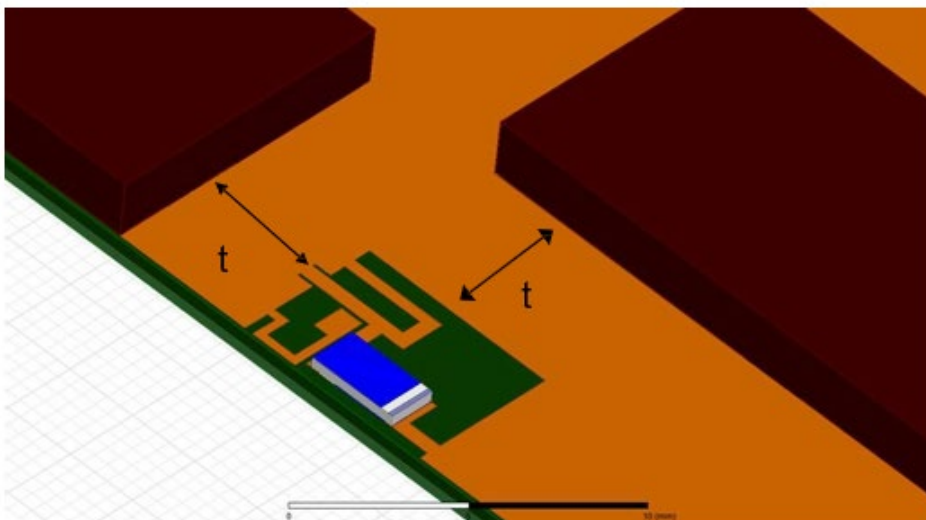
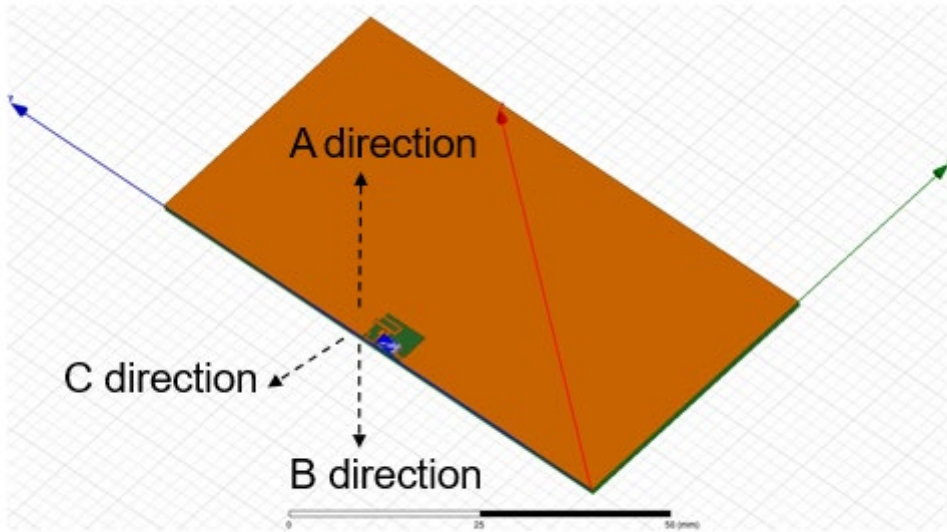
Spacing (mm) \ Distance (mm)	1	2	3
0	544	533	530
2	566	611	605
4	611	634	629
6	644	676	651
8	646	679	686
without Metal	938	938	938

Efficiency (%)

Spacing (mm) \ Distance (mm)	1	2	3
0	42	44	53
2	49	45	56
4	53	47	58
6	58	58	59
8	62	61	62
without Metal	70	70	70

**The Influences of metallic part:**

A, B and C directions should not have any metallic components. If metallic components are presented below antenna (B direction), at least 3 mm distance is required. The distance (t) should be greater than 2 mm when the height of metallic component is under 2 mm. The distance (t) should be greater than 5mm when the height of metallic component is above 3mm.



**Conclusion:**

1. Location 1 is the recommended position for the chip antenna
2. The recommended minimum dimensions of circuit board is 35 x 10 mm.
3. The antenna should be placed 35 mm side
4. The minimum distance recommended between chip antenna and corner is 5 mm

