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# Application Note no.004

Chip Antenna Series

Bluetooth \ WLAN Chip Antenna

ACA-5036-A2-CC-S

| Prepared                | Checked    | Approved     |
|-------------------------|------------|--------------|
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## Application Note

## Bluetooth \ WLAN Chip Antenna – ACA-5036-A2-CC-S

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Revision History: 2010-05-25 Rev.A2

| Previous Version : |                                                                   |         |
|--------------------|-------------------------------------------------------------------|---------|
| Page               | Subjects (major changes since last revision)                      | Version |
| All                | Make up all document                                              | A0      |
| 17~22              | Adding recommended layout B and related electrical characteristic | A1      |
| 1                  | Adding dimension raw data                                         | A2      |
|                    |                                                                   |         |
|                    |                                                                   |         |
|                    |                                                                   |         |
|                    |                                                                   |         |

## ACA-5036-A2-CC-S Application Note

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## Applications

This antenna is designed for Bluetooth\WLAN application and it's suitable for cellular phones, PDA, notebook, navigator, and all devices which have Bluetooth\WLAN function.

## Features

- Omni-directional radiation
- High Efficiency
- Low profile and compact size(5.2 x 3.7 x 0.7mm)
- Low cost
- Lead free soldering compatible
- RoHS compliant
- Tape and reel packing

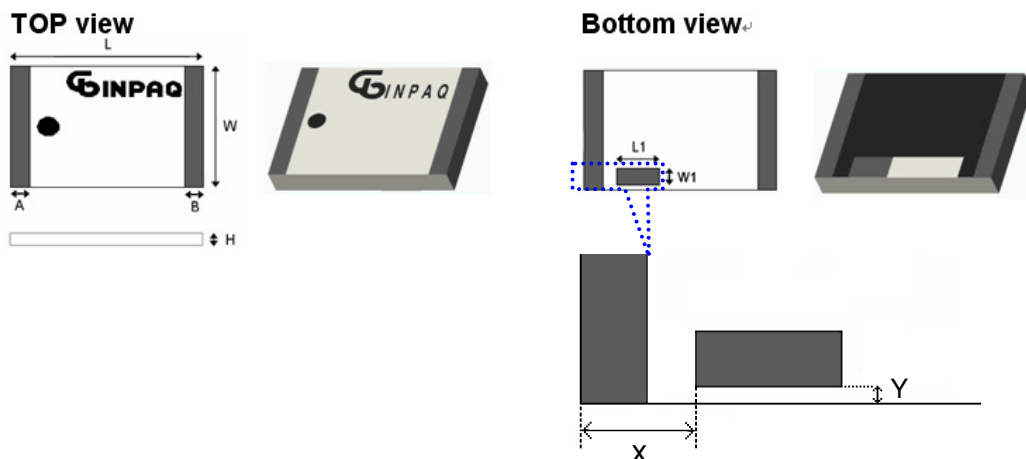
## Electrical Characteristics

| ITEM           |          | SPECIFICATION   |
|----------------|----------|-----------------|
| Frequency Band |          | 2.40GHz~2.50GHz |
| VSWR           |          | Less than 2.5   |
| Polarization   |          | Linear          |
| *Peak Gain     | Layout A | -2.6 dBi Typ.   |
|                | Layout B | -2.5 dBi Typ.   |
| *Efficiency    | Layout A | 80% Typ.        |
|                | Layout B | 74% Typ         |
| Impedance      |          | 50Ω Typ.        |

\* Test condition: Test board size 80\*40 mm

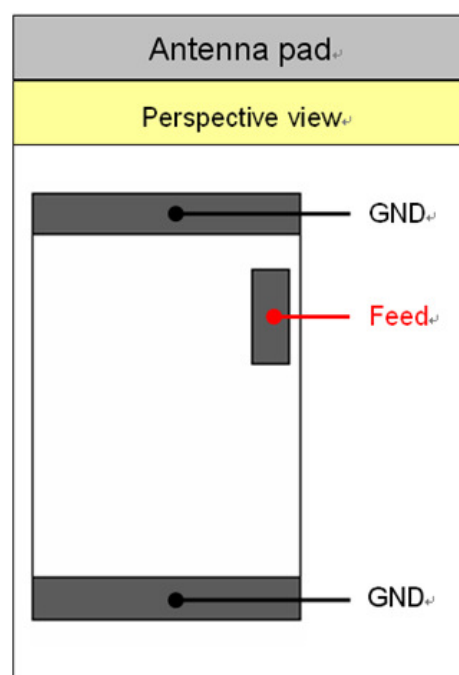
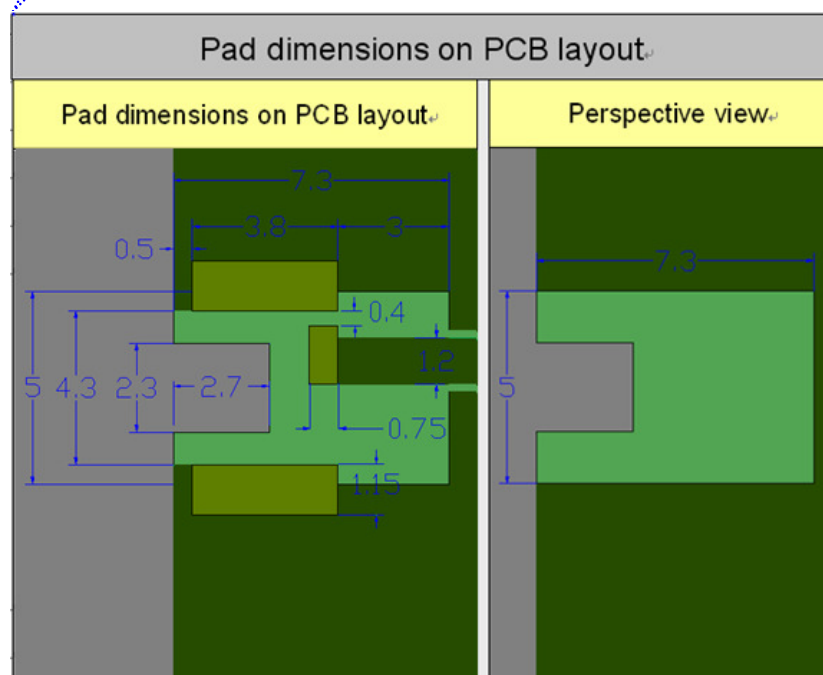
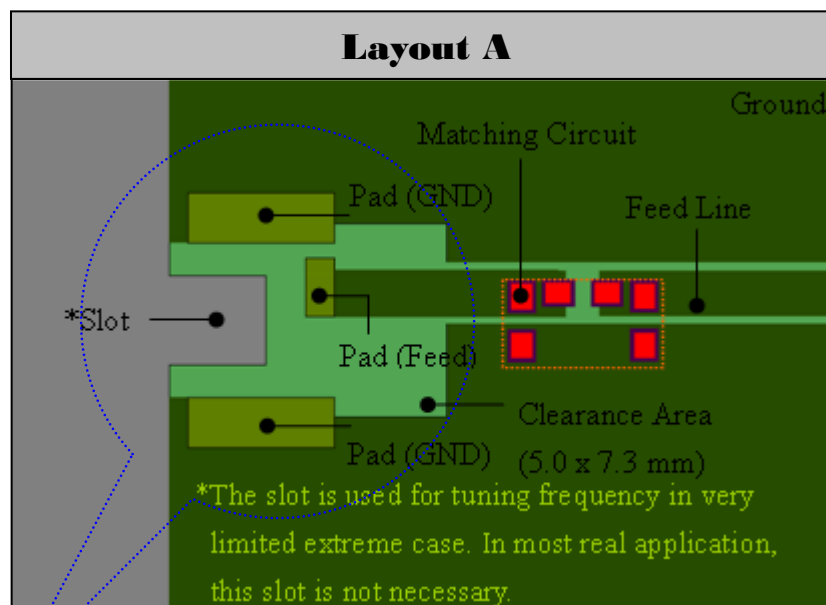
Matching circuit: Pi matching circuit will be required

## Antenna Dimension



| Chip Antenna | L       | W       | A         | B         | L1       | W1        | H         | X         | Y         |
|--------------|---------|---------|-----------|-----------|----------|-----------|-----------|-----------|-----------|
| ACA5036      | 5.2±0.3 | 3.7±0.3 | 0.45±0.25 | 0.45±0.25 | 1.1±0.20 | 0.55±0.20 | 0.70±0.15 | 0.85±0.25 | 0.12±0.06 |

## Recommended PCB layout (unit:mm)

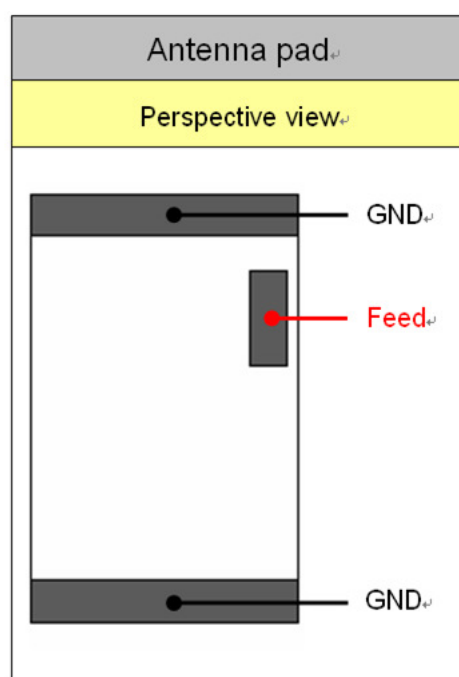
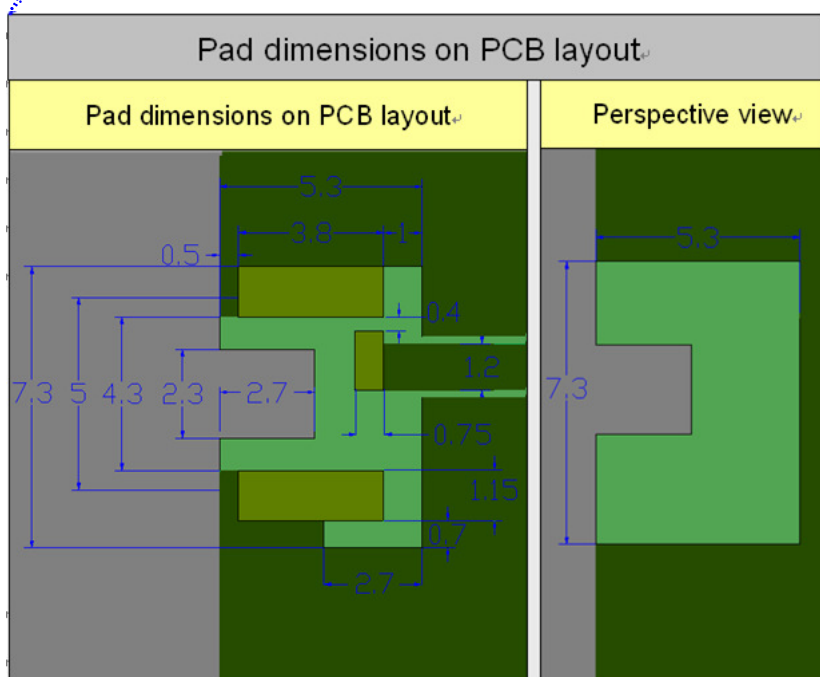
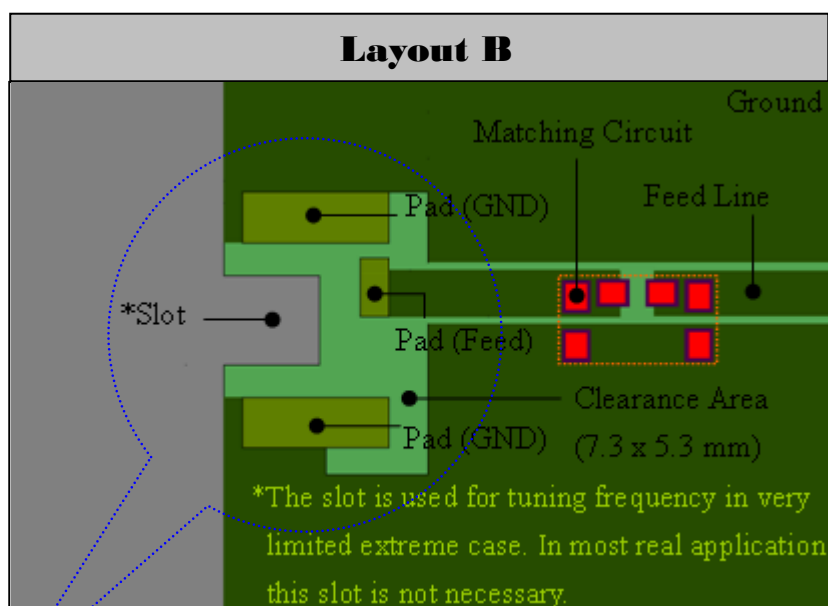


### PCB pad dimensions

| Terminal name | Terminal Dimensions |
|---------------|---------------------|
| Pad (Feed)    | 1.2 X 0.75          |
| Pad (GND)     | 3.8 X 1.15          |
| Pad (GND)     | 3.8 X 1.15          |

### Antenna pad dimensions

| Terminal name | Terminal Dimensions |
|---------------|---------------------|
| Feed          | 1.1 X 0.55          |
| GND           | 3.7 X 0.45          |
| GND           | 3.7 X 0.45          |



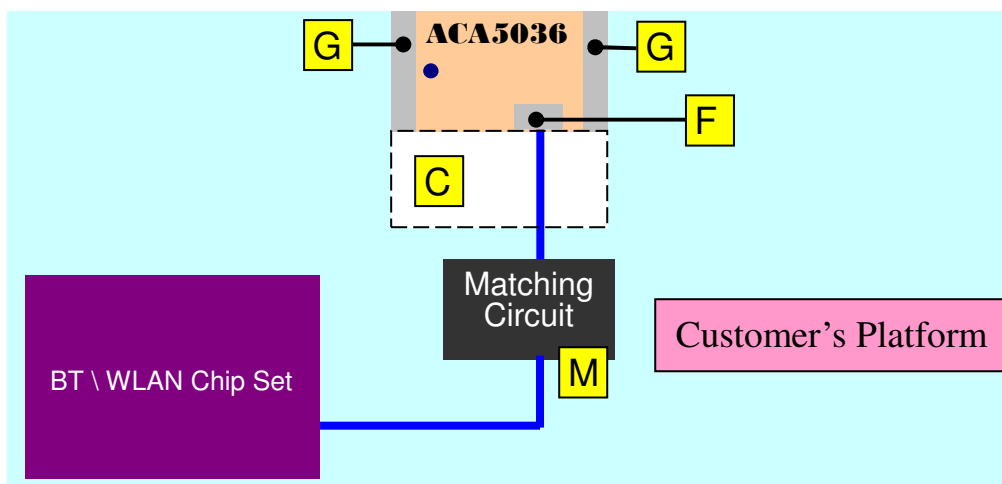
### PCB pad

| Terminal name | Terminal Dimensions |
|---------------|---------------------|
| Pad (Feed)    | 1.2 X 0.75          |
| Pad (GND)     | 3.8 X 1.15          |
| Pad (GND)     | 3.8 X 1.15          |

### Antenna pad dimensions

| Terminal name | Terminal Dimensions |
|---------------|---------------------|
| Feed          | 1.1 X 0.55          |
| GND           | 3.7 X 0.45          |
| GND           | 3.7 X 0.45          |

## Layout Description



### F. Feeding Pad

The signal from system must feed into the feeding pad.

### G. Ground Pad

This pad must connect to ground plane of PCB.

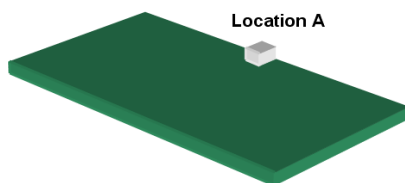
### C. Clearance Area

To achieve antenna performance, the clearance area is necessary and all metallization should be removed from all PCB layers.

### M. Matching Circuit

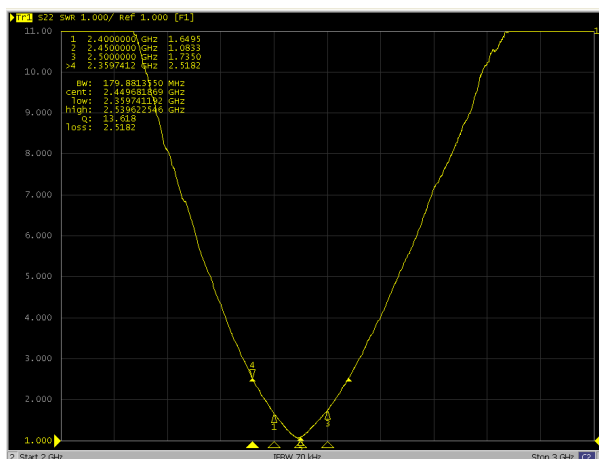
Please keep the pads for PI-matching circuit to reduce return loss and shift the band to meet Bluetooth application.

## Performance on Middle of Long Side

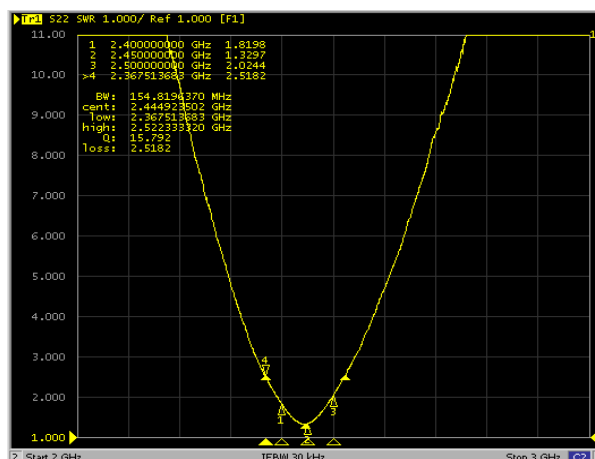


## Typical VSWR

### Layout A

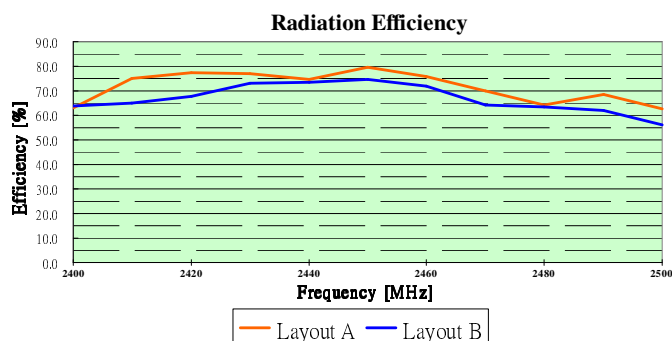
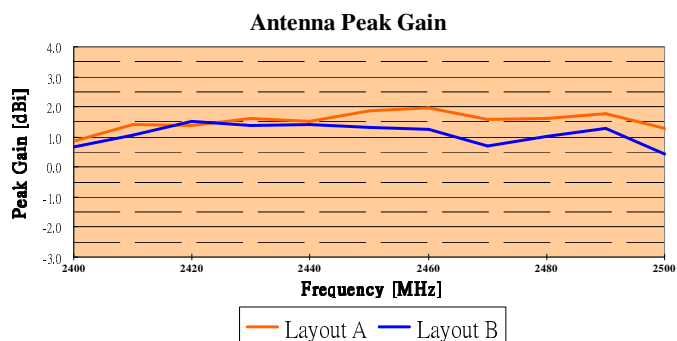


### Layout B



| Frequency | Layout A VSWR | Layout B VSWR |
|-----------|---------------|---------------|
| 2400 MHz  | 1.65          | 1.82          |
| 2450 MHz  | 1.08          | 1.33          |
| 2500 MHz  | 1.74          | 2.02          |

## Typical Free Space Peak Gain and Efficiency

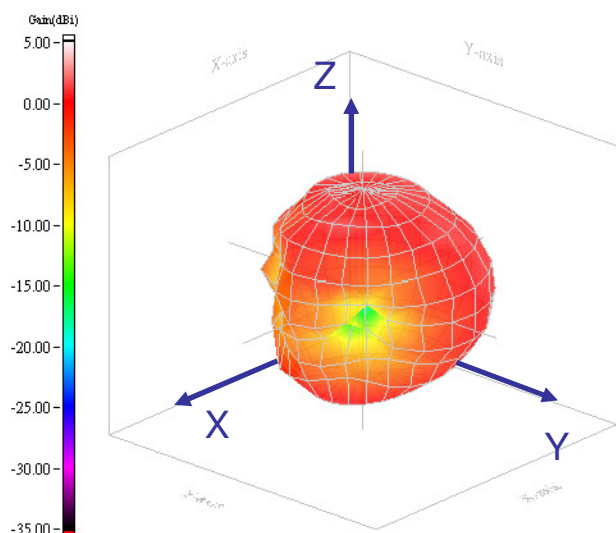


| Frequency | Layout A Peak Gain | Layout B Peak Gain | Layout A Efficiency | Layout B Efficiency |
|-----------|--------------------|--------------------|---------------------|---------------------|
| 2400 MHz  | -2.6 dBi           | -2.5 dBi           | 63.02%              | 63.80%              |
| 2450 MHz  | -2.6 dBi           | -2.5dBi            | 79.60%              | 74.61%              |
| 2500 MHz  | -2.6dBi            | -2.5dBi            | 62.65%              | 56.31%              |

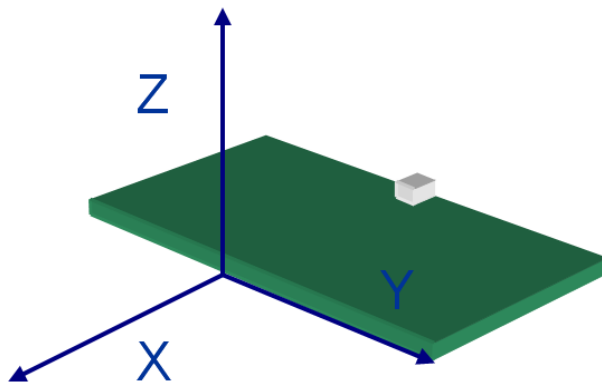
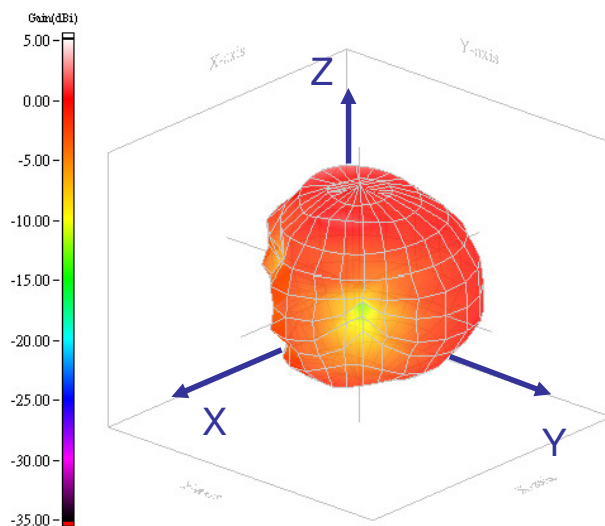
## Typical Free Space Radiation Pattern

### 3D Radiation Pattern

Layout A 2450 MHz



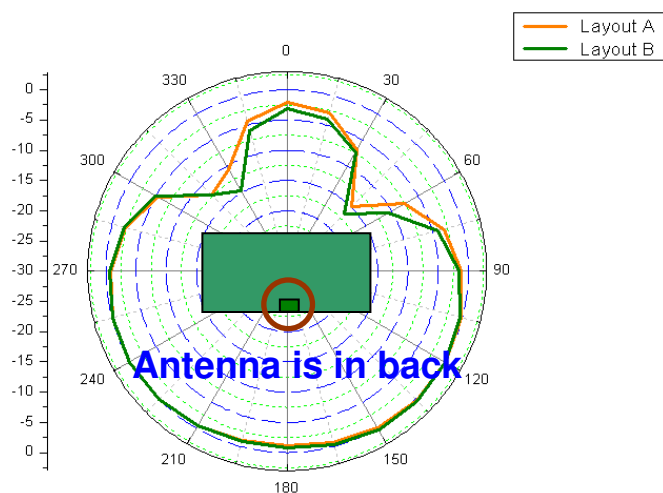
Layout B 2450 MHz



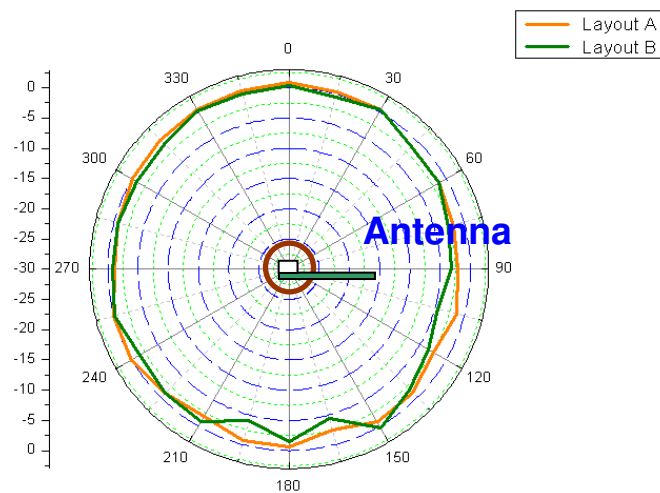
# Typical Free Space Radiation Pattern

## 2D Radiation Pattern

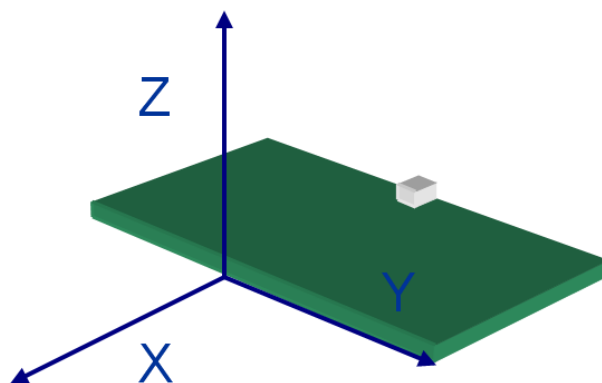
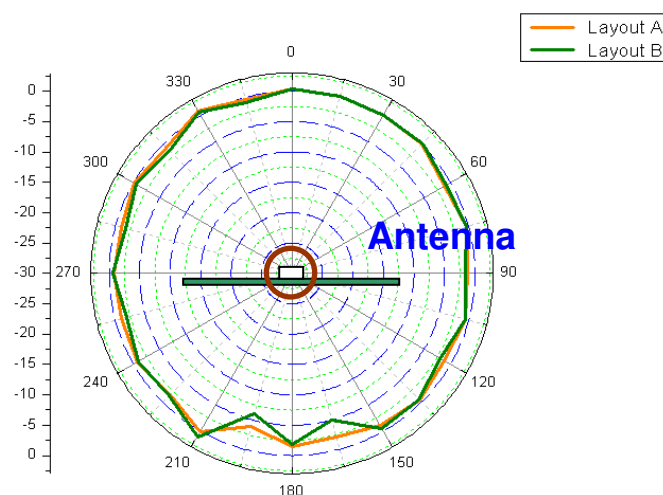
**X-Y Plane 2450 MHz**



**X-Z Plane 2450 MHz**



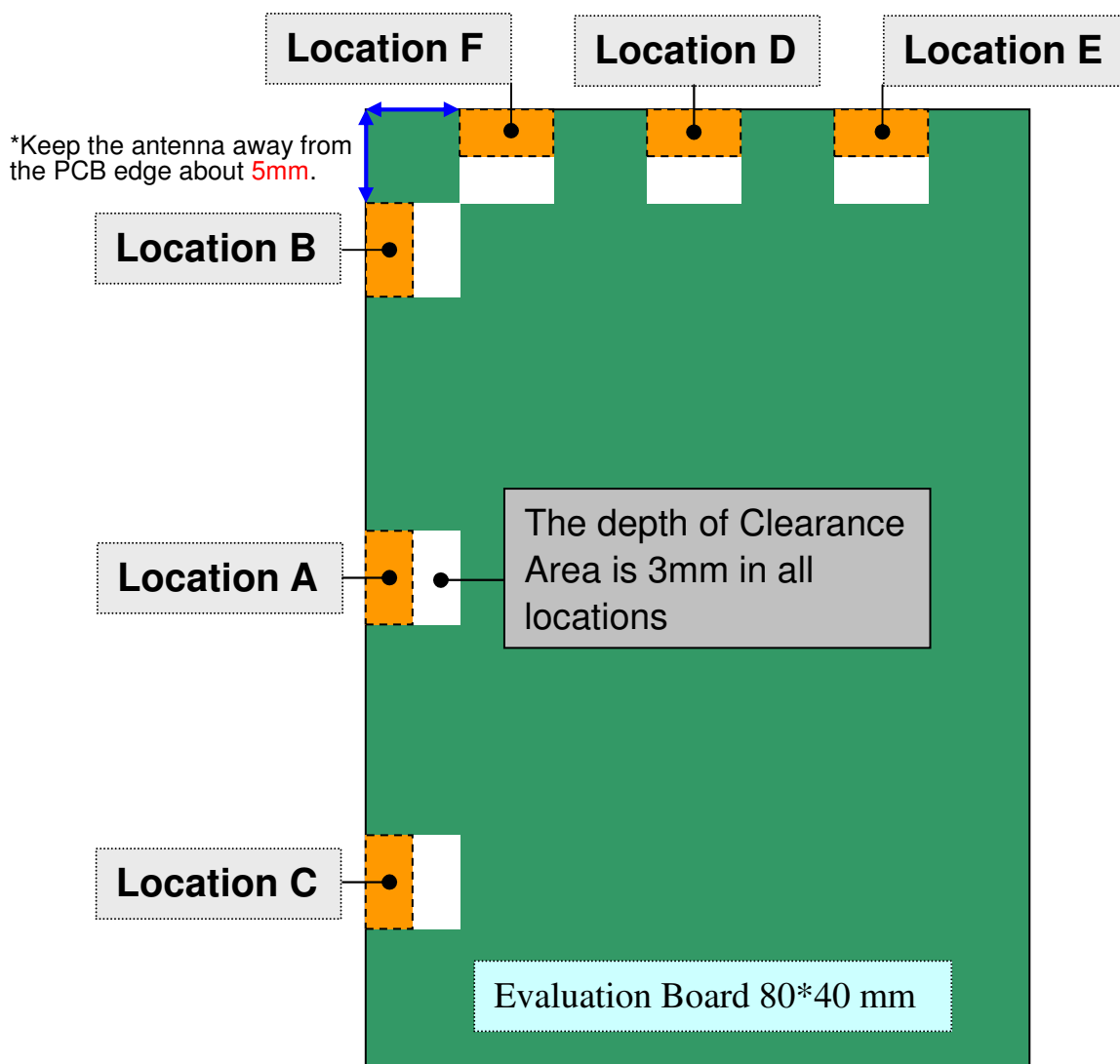
**Y-Z Plane 2450 MHz**



## The Efficiency and Bandwidth for Different Location

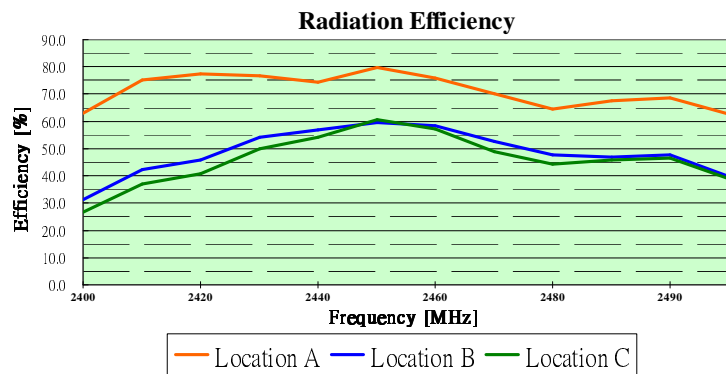
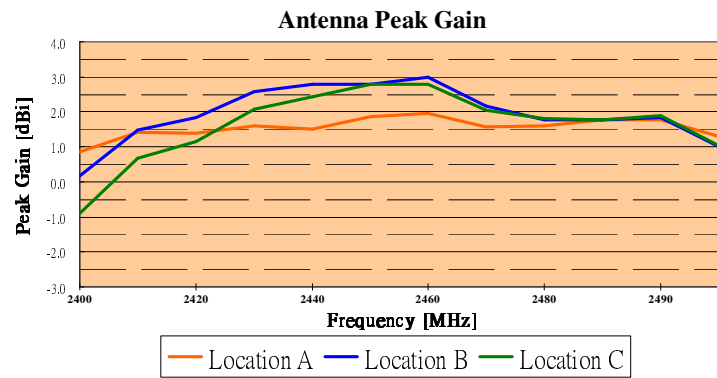
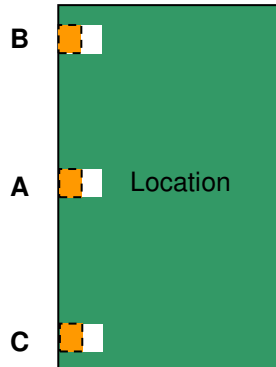
### Layout A

\* All electrical characteristic depend on INPAQ 80 x 40mm evaluation board with matching circuit.

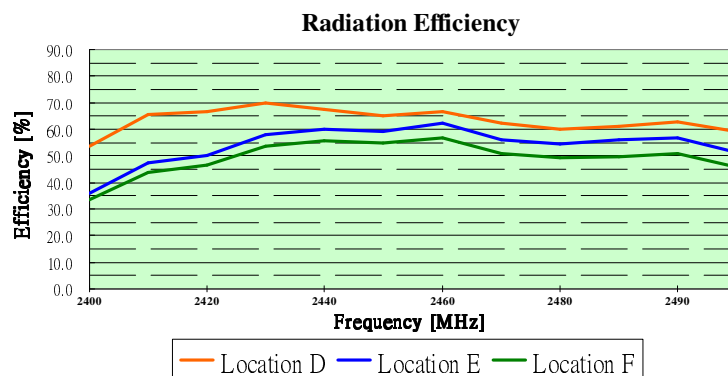
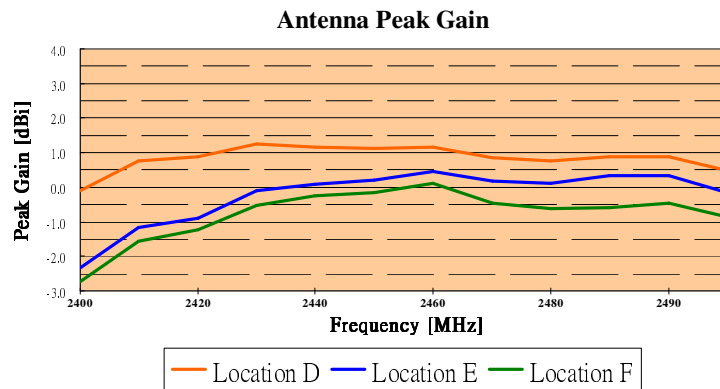


| Locations<br>Test Item      |                 |      | Long side |       |       | Short side |       |       |
|-----------------------------|-----------------|------|-----------|-------|-------|------------|-------|-------|
|                             |                 |      | A         | B     | C     | D          | E     | F     |
| Bandwidth [MHz]<br>VSWR<2.5 |                 |      | 180       | 73    | 67    | 151        | 96    | 85    |
| Gain                        | Linear<br>[dBi] | Peak | -2.6      | 3.00  | 2.98  | -2.5       | 0.55  | 0.28  |
|                             |                 | Avg. | -2.7      | -2.19 | -2.22 | -2.6       | -1.86 | -2.13 |
| Efficiency                  | Linear<br>[%]   |      | 79.55     | 60.44 | 59.94 | 71.39      | 65.23 | 61.29 |

## Peak Gain and Efficiency on Long Side

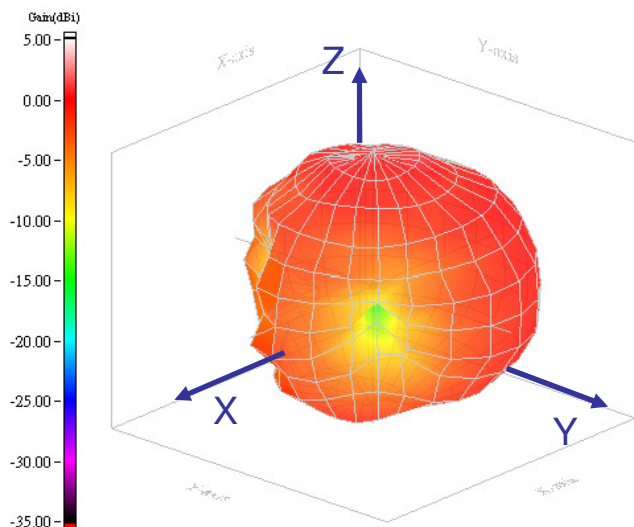


## Peak Gain and Efficiency on Short Side

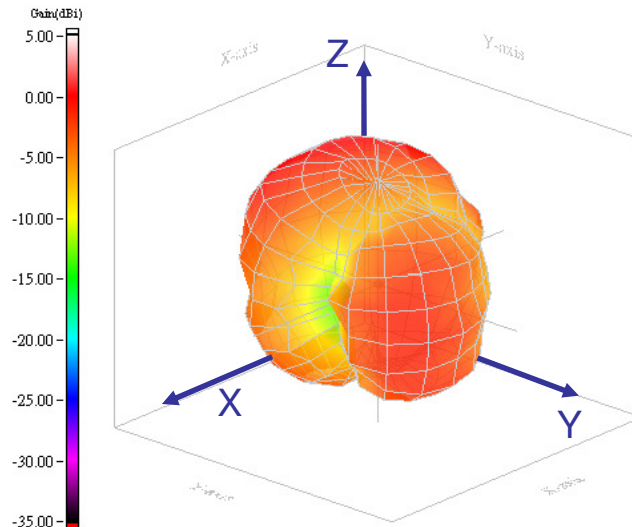


## 3D Gain Pattern on Long Side

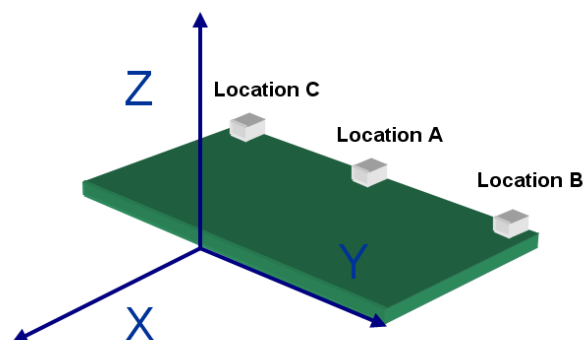
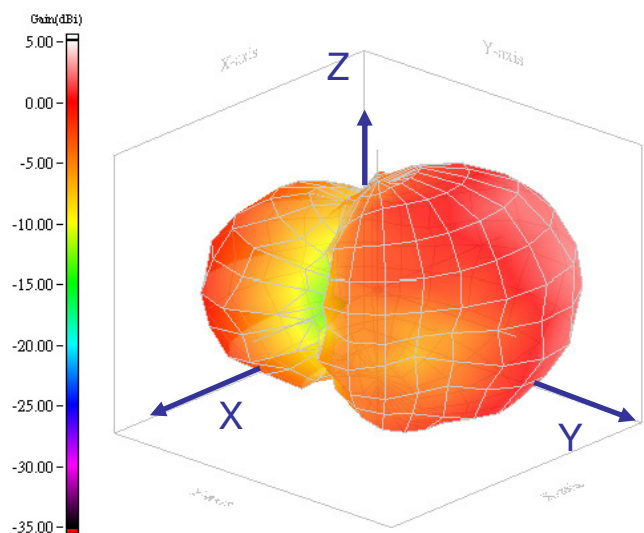
Location A 2450 MHz



Location B 2450 MHz

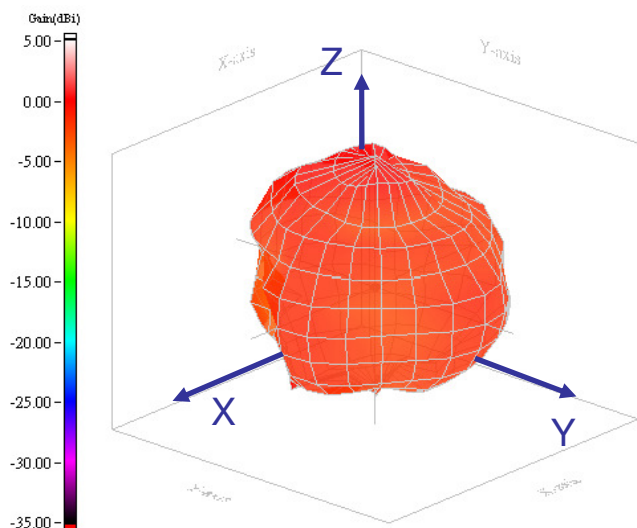


Location C 2450 MHz

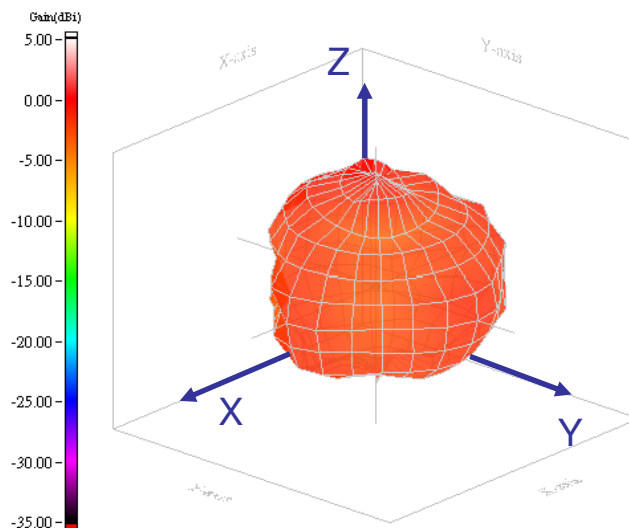


## 3D Gain Pattern on Short Side

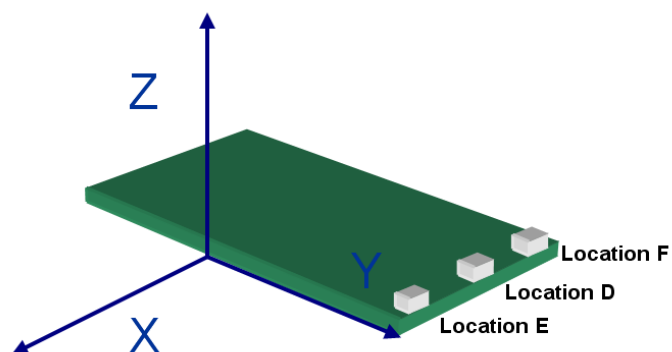
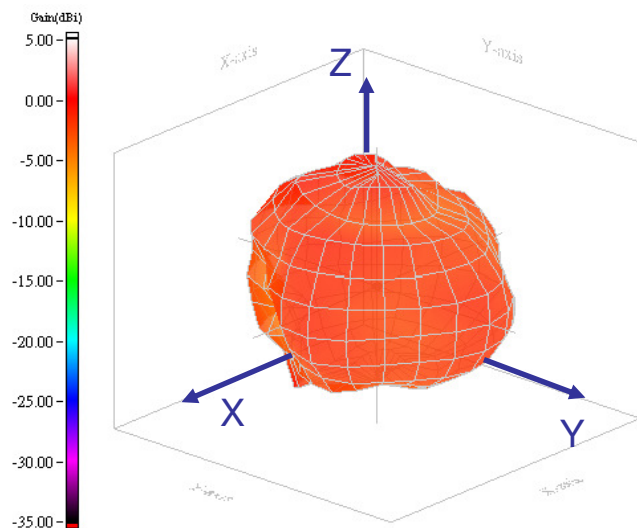
Location D 2450 MHz



Location E 2450 MHz

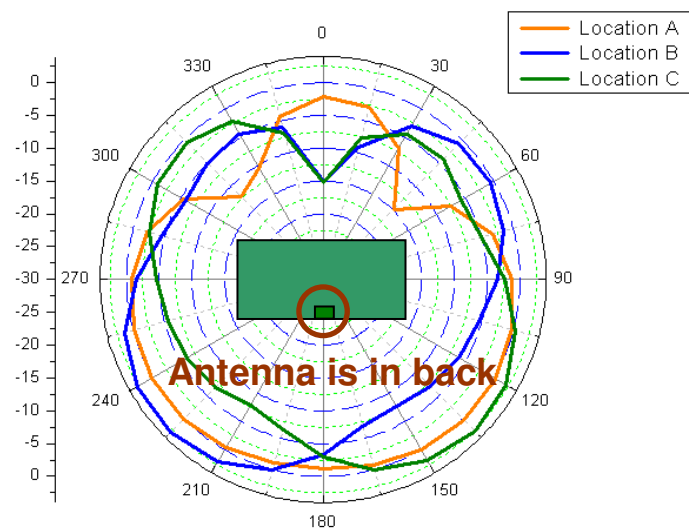


Location F 2450 MHz

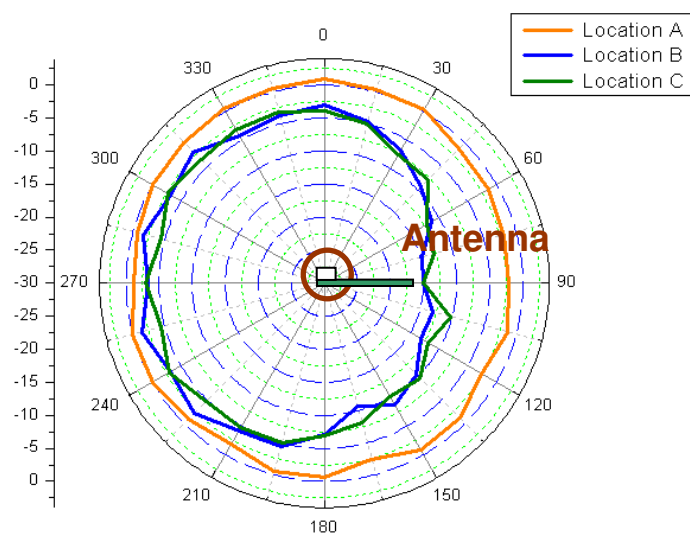


## 2D Gain Pattern on Long Side

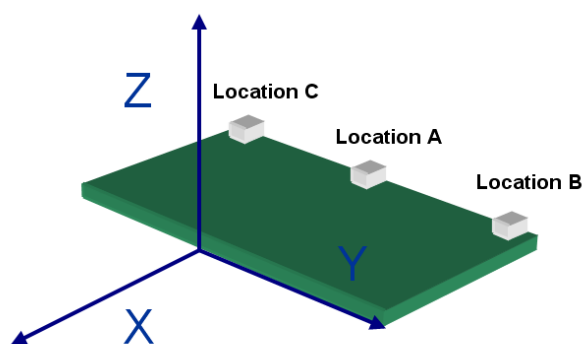
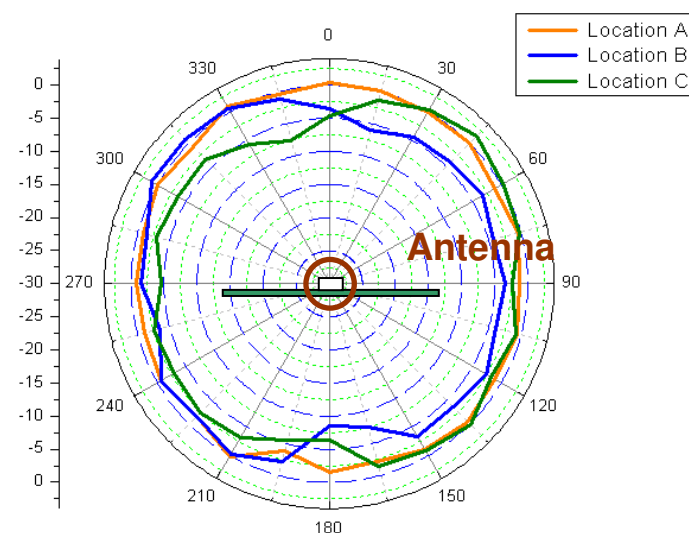
X-Y plane 2450 MHz



X-Z plane 2450 MHz

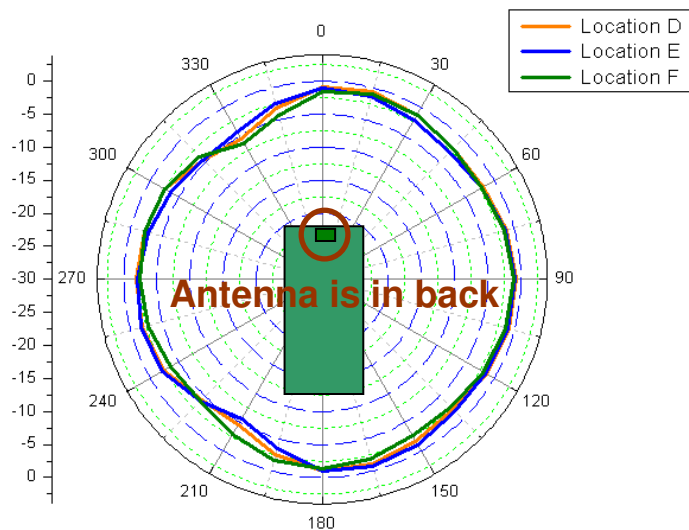


Y-Z plane 2450 MHz

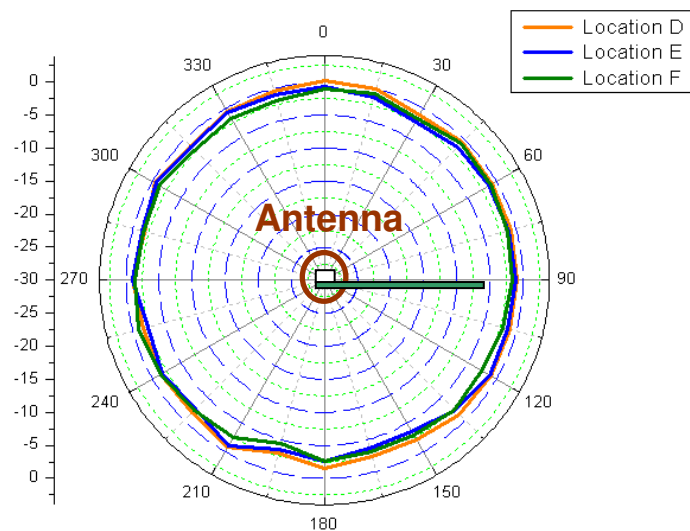


## 2D Gain Pattern on Short Side

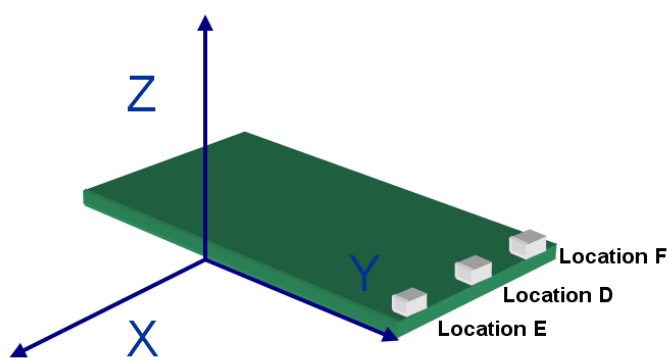
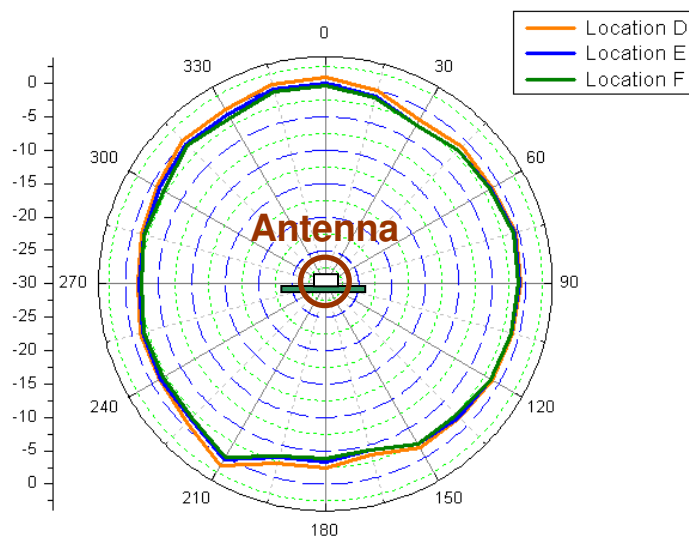
X-Y plane 2450 MHz



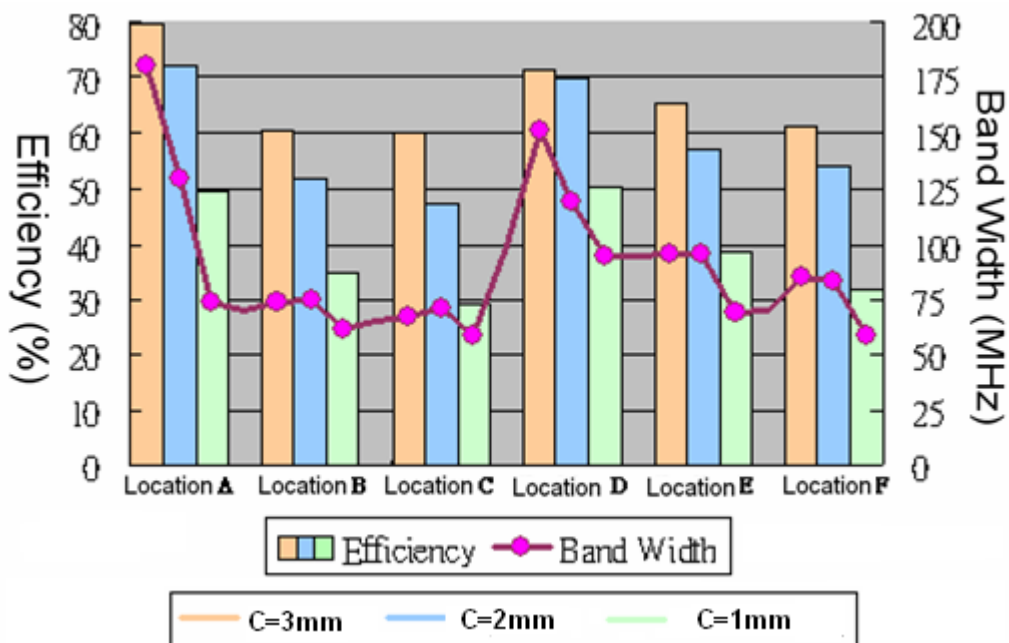
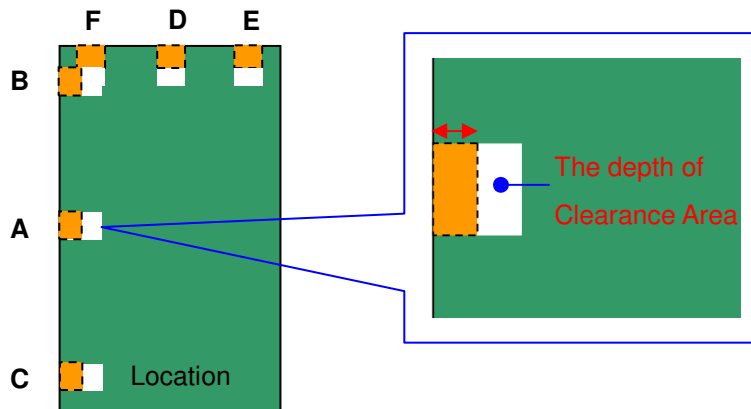
X-Z plane 2450 MHz



Y-Z plane 2450 MHz



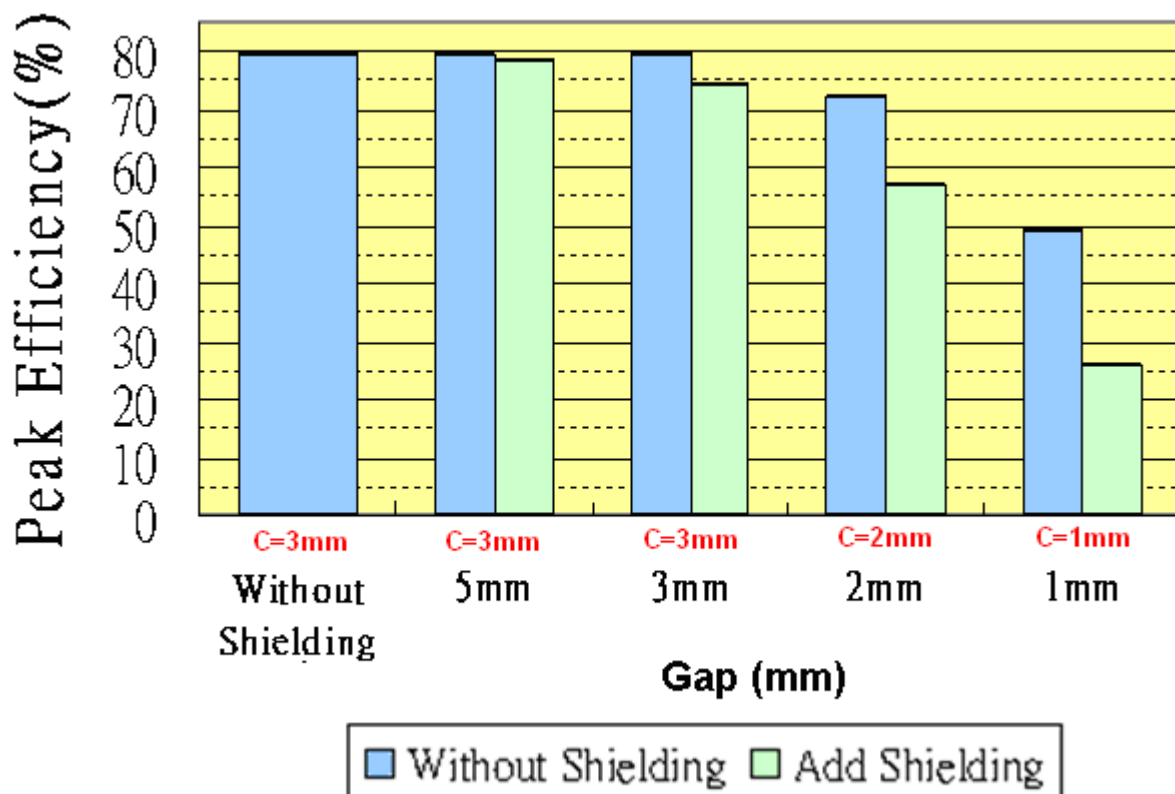
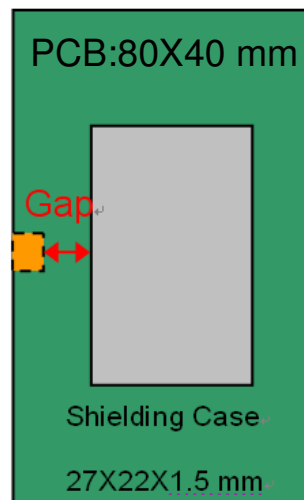
## Efficiency and Band Width V.S Different Depths of Clearance Area



**\*C=Clearance Area**

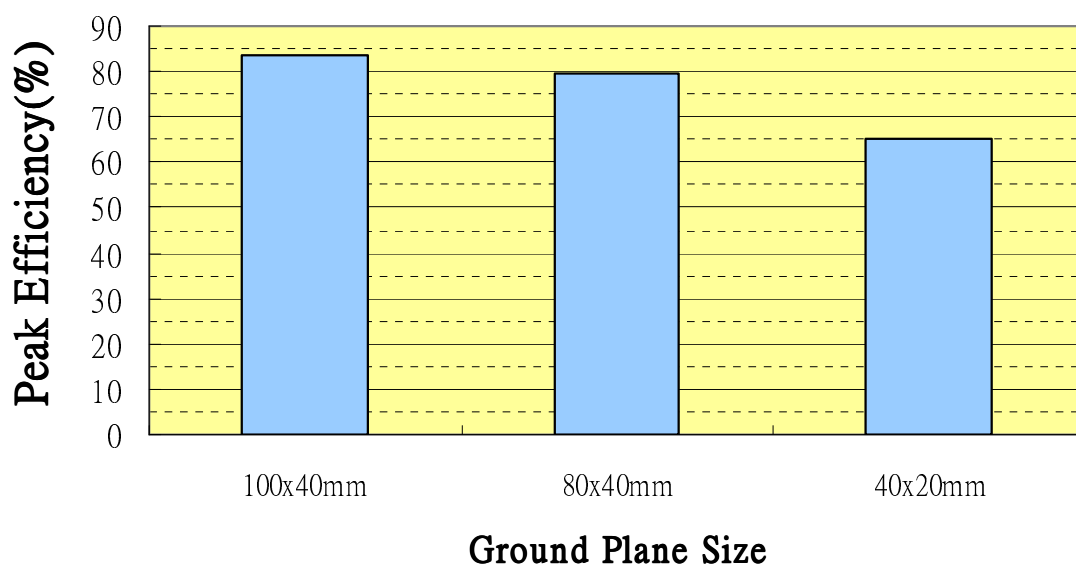
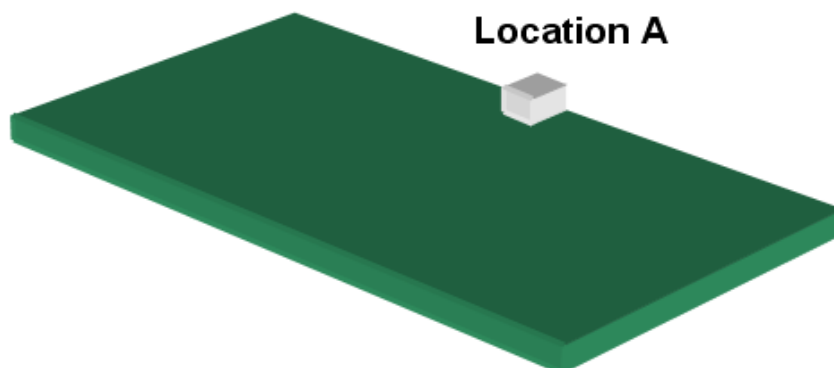
**\*Clearance Area → All metallization should be removed from all PCB layers**

## Near Metal Effect



**\*C=Clearance Area**

## Ground Size V.S Efficiency

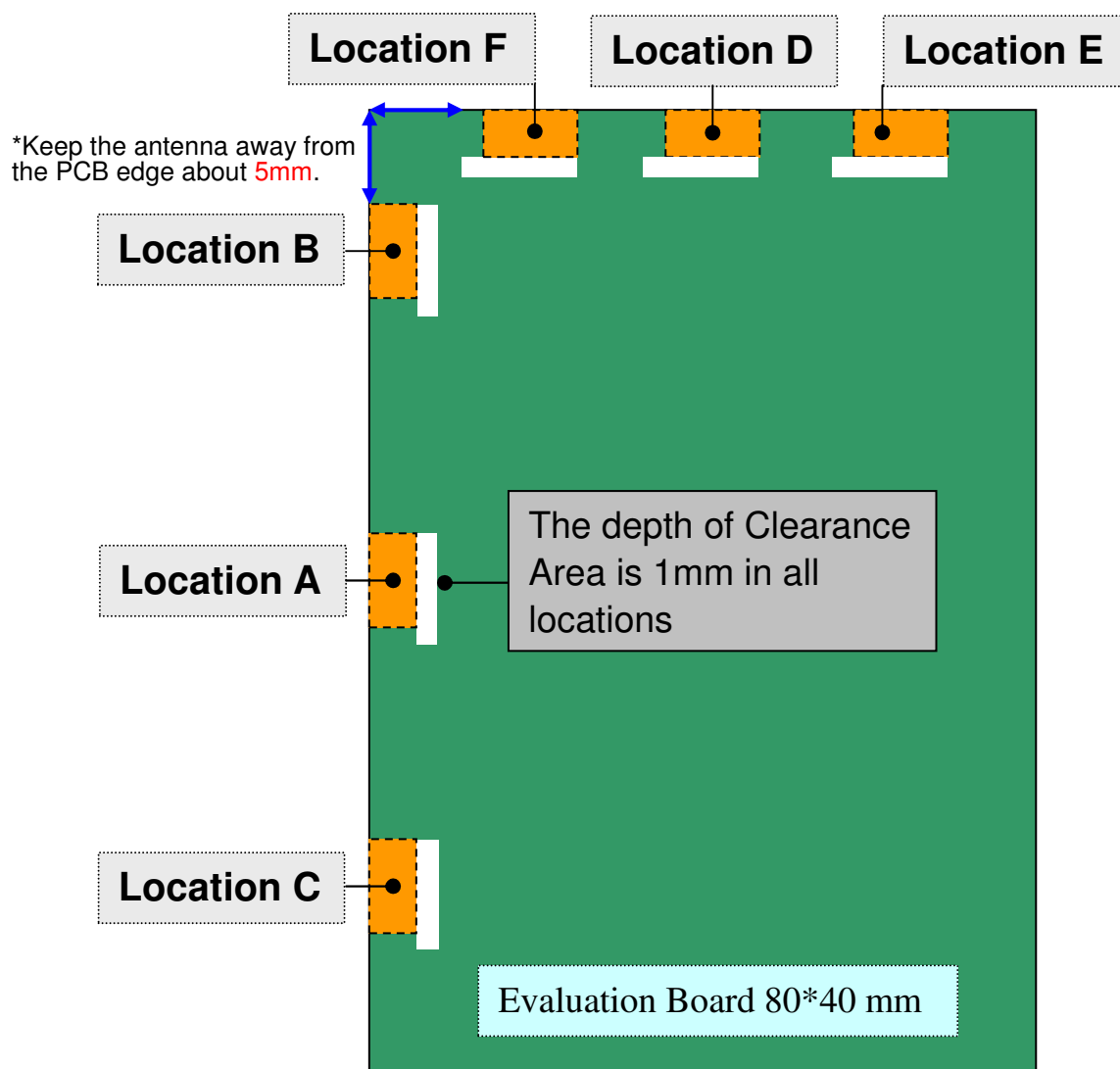


**\*The depth of Clearance Area is 3mm**

## The Efficiency and Bandwidth for Different Location

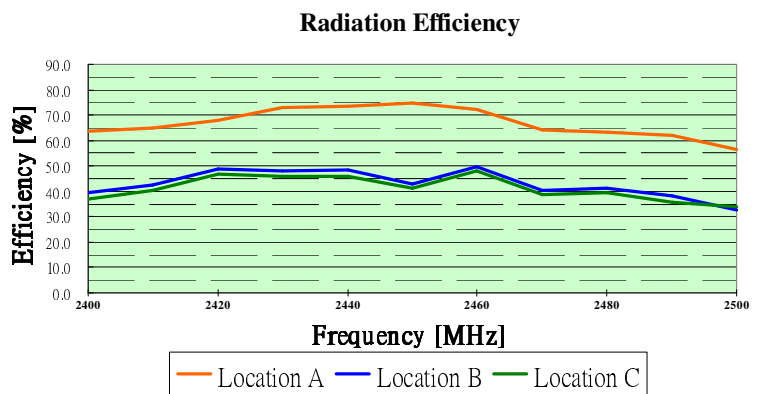
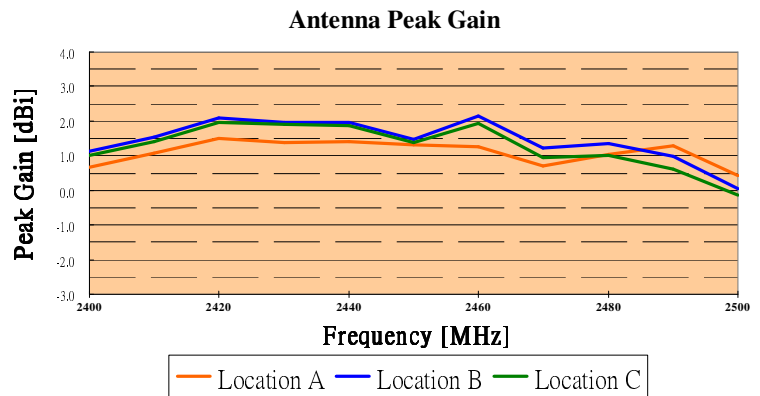
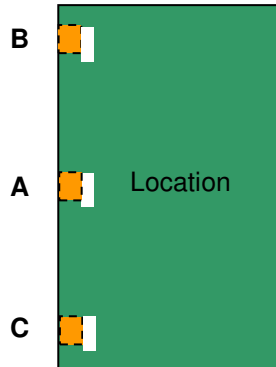
### Layout B

\* All electrical characteristic depend on INPAQ 80 x 40mm evaluation board with matching circuit.

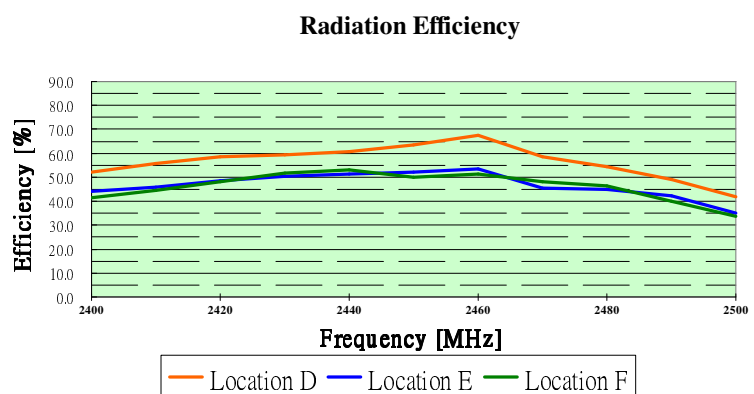
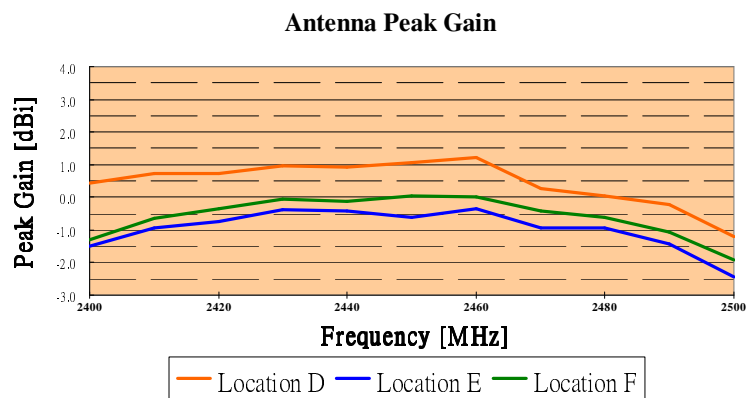


| Locations<br>Test Item      |                 |      | Long side |       |       | Short side |       |       |
|-----------------------------|-----------------|------|-----------|-------|-------|------------|-------|-------|
|                             |                 |      | A         | B     | C     | D          | E     | F     |
| Bandwidth [MHz]<br>VSWR<2.5 |                 |      | 154       | 90    | 88    | 152        | 107   | 100   |
| Gain                        | Linear<br>[dBi] | Peak | 1.4       | 2.10  | 1.93  | 1.21       | -0.35 | 0.08  |
|                             |                 | Avg. | -1.08     | -3.60 | -3.70 | -1.63      | -2.80 | -2.84 |
| Efficiency                  | Linear<br>[%]   |      | 74.61     | 49.72 | 47.87 | 67.57      | 53.52 | 53.07 |

## Peak Gain and Efficiency on Long Side

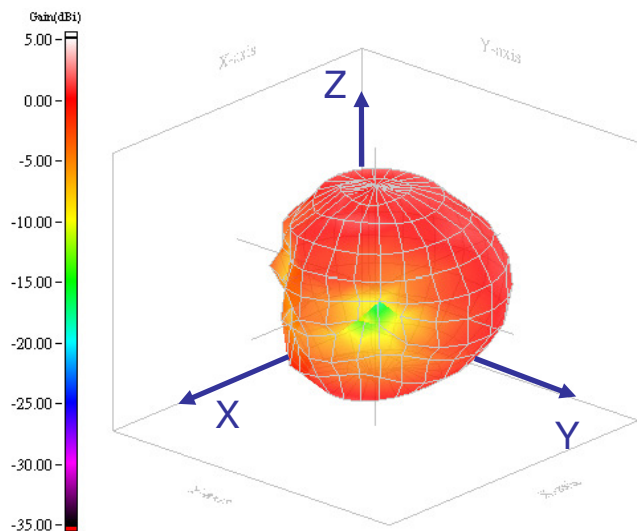


## Peak Gain and Efficiency on Short Side

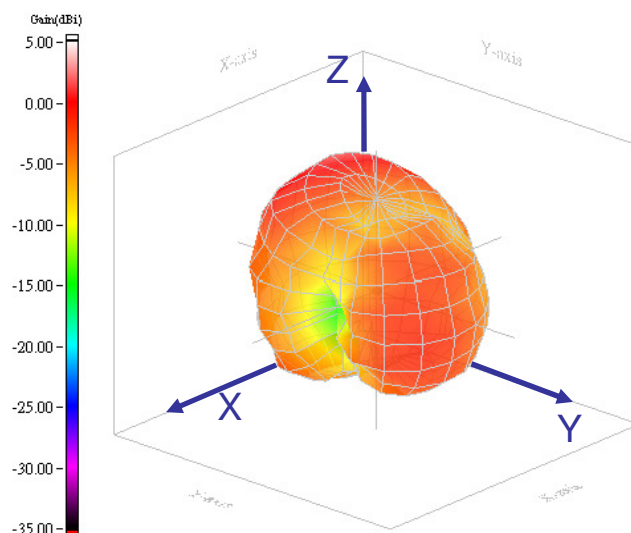


## 3D Gain Pattern on Long Side

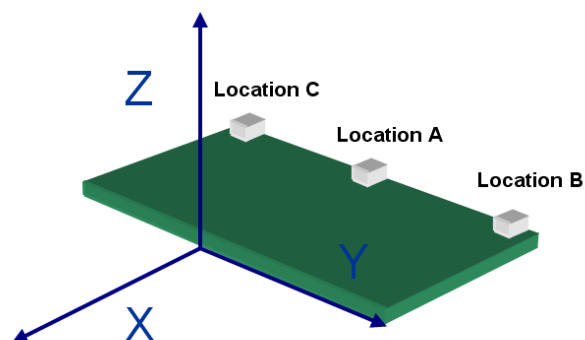
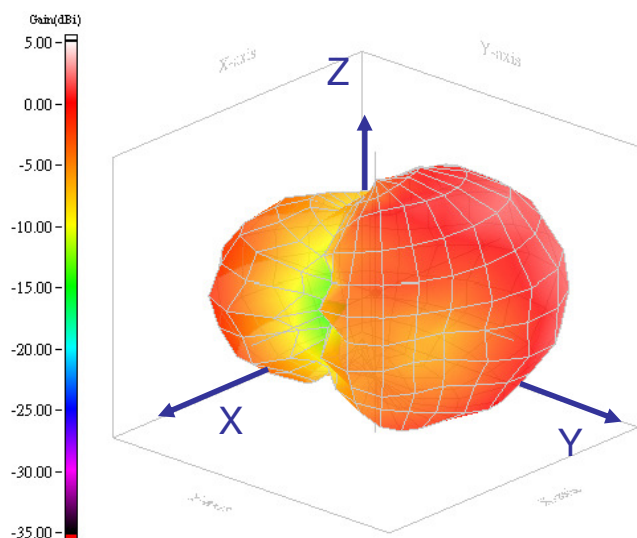
**Location A      2450 MHz**



**Location B      2450 MHz**

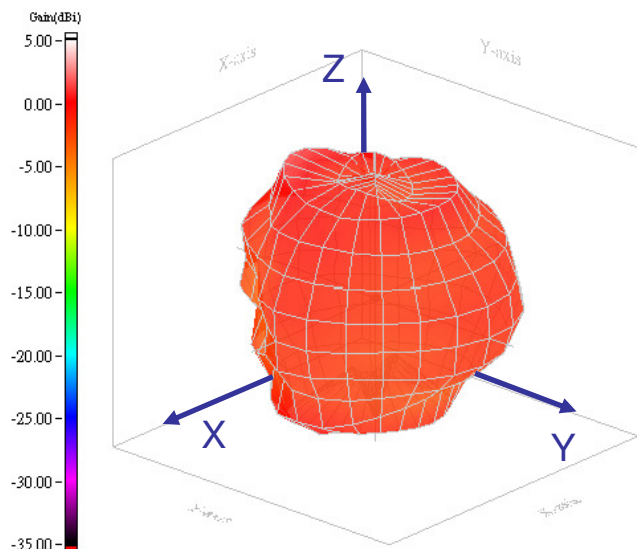


**Location C      2450 MHz**

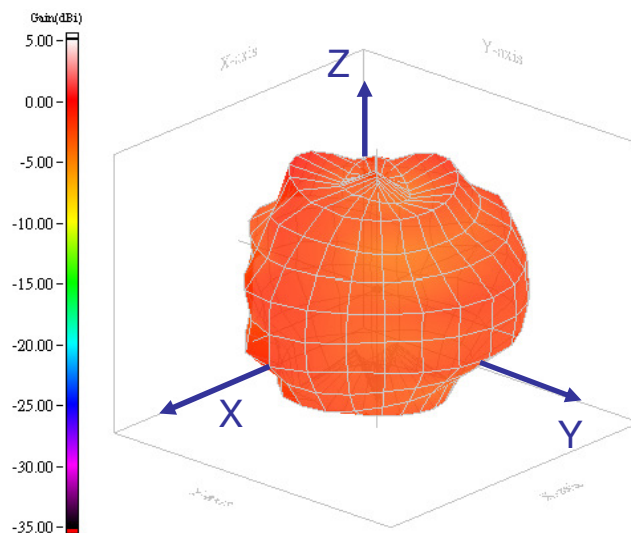


## 3D Gain Pattern on Short Side

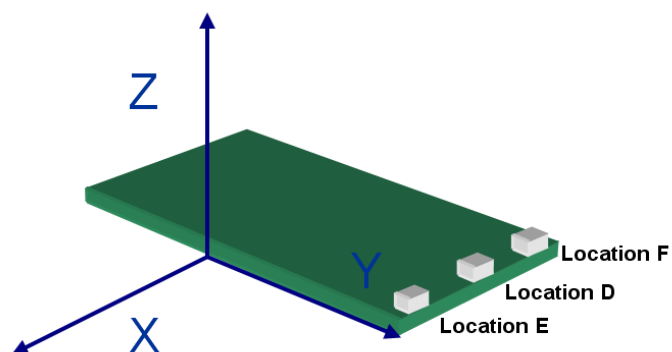
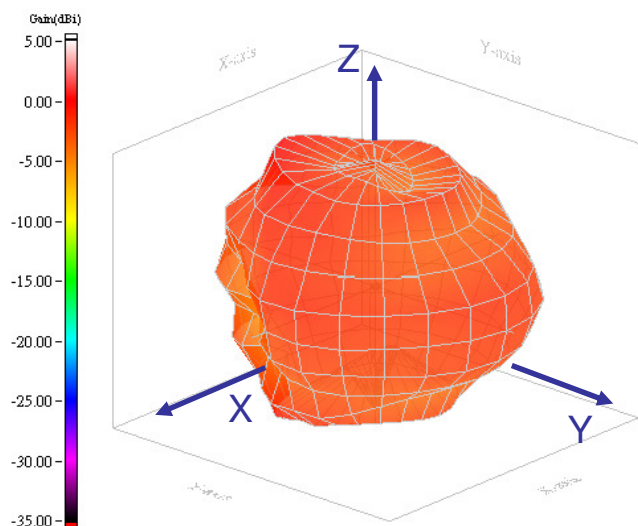
Location D 2450 MHz



Location E 2450 MHz

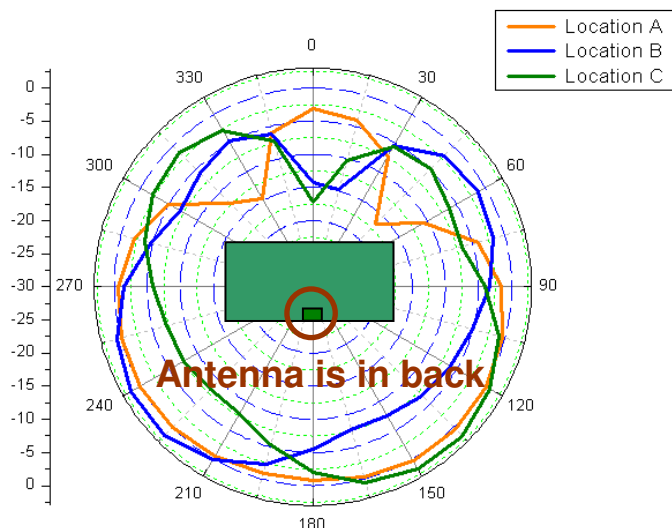


Location F 2450 MHz

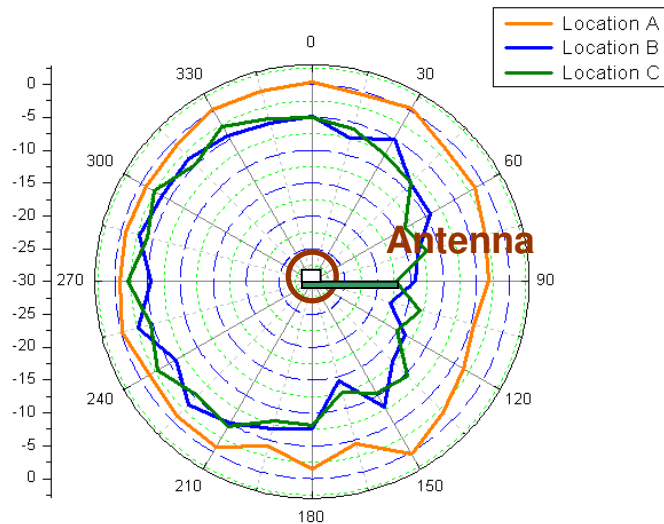


## 2D Gain Pattern on Long Side

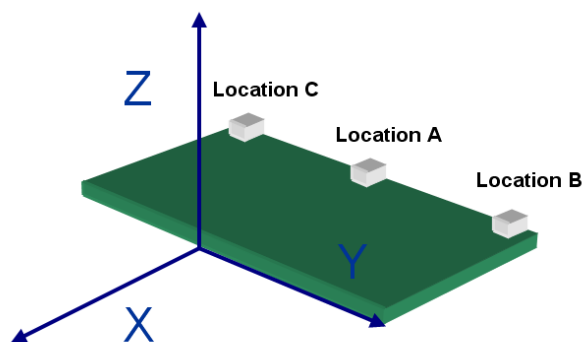
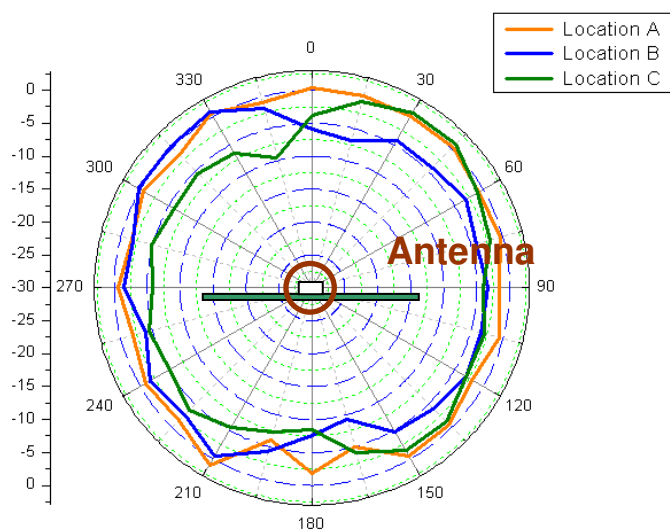
X-Y plane 2450 MHz



X-Z plane 2450 MHz

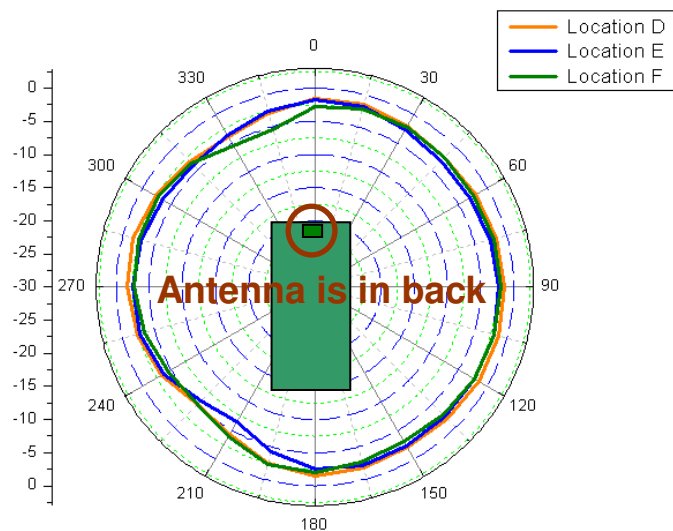


Y-Z plane 2450 MHz

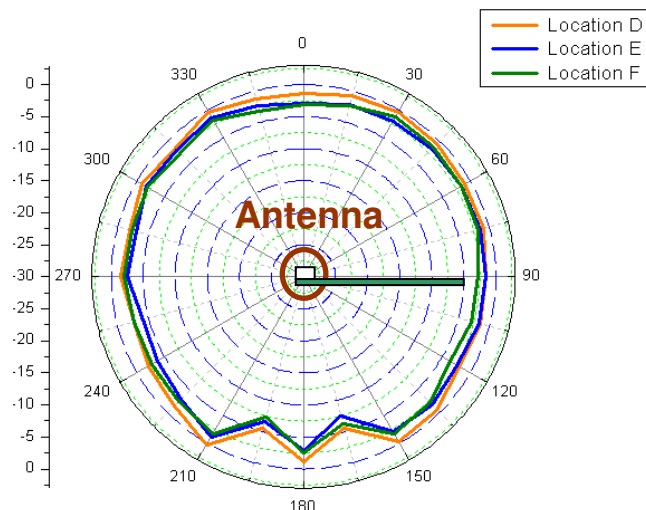


## 2D Gain Pattern on Short Side

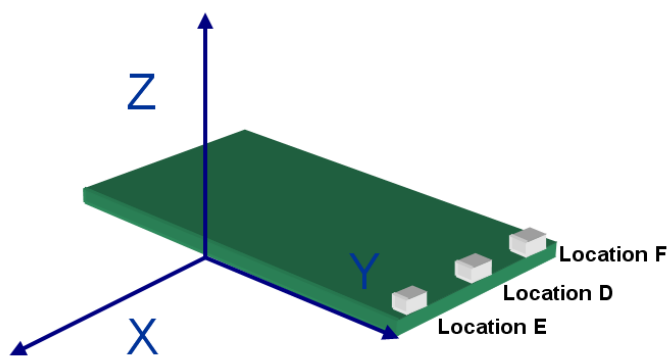
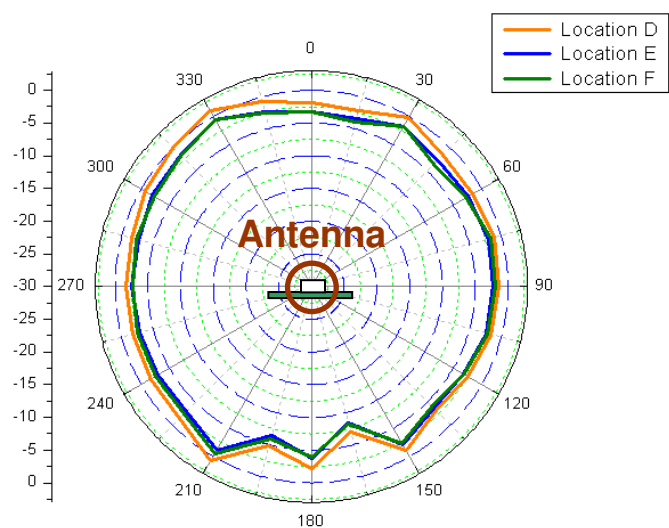
X-Y plane 2450 MHz



X-Z plane 2450 MHz

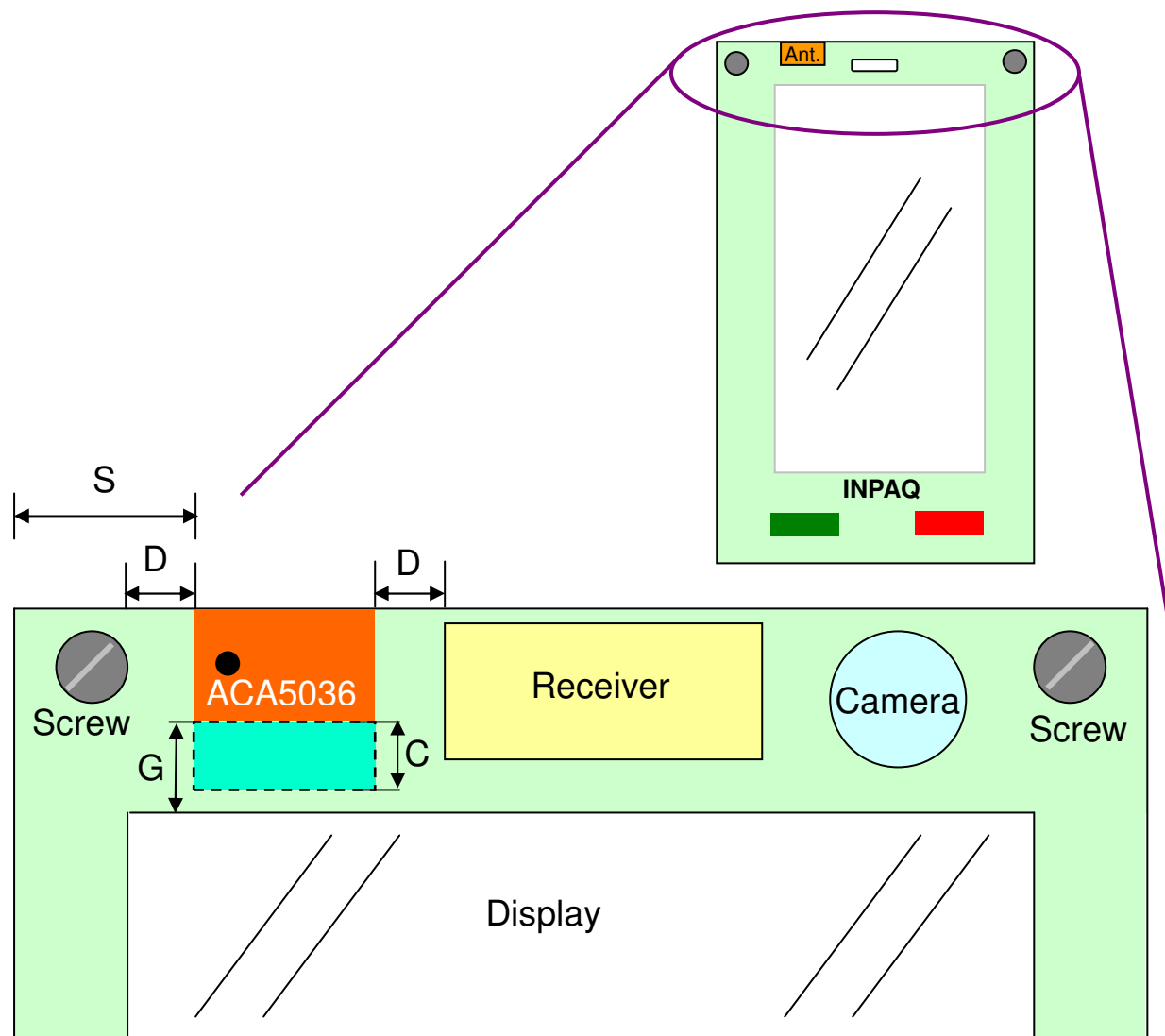


Y-Z plane 2450 MHz



## Mobile Phone Applications

- For the mobile phone applications, because most of the key components are arranged along the long side of the PCB, there is no space to place our antenna. So we move the antenna to top edge of PCB as showed as follow picture. And the impedance of PCB in top edge is smaller than in long side edge, we get narrower bandwidth and lower performance than in long side of PCB. But we still get a workable performance by arranging antenna and components in a reasonable position.



| Symbol | Suggested Distance | Remark                                                           |
|--------|--------------------|------------------------------------------------------------------|
| S      | $\geq 5\text{mm}$  | The distance between PCB edge and antenna edge                   |
| D      | $\geq 3\text{mm}$  | The distance between antenna and receiver(or shielding case)edge |
| C      | $\geq 3\text{mm}$  | The width of clearance area needs 3mm from antenna edge.         |
| G      | $\geq 3\text{mm}$  | The edge of display must keep away 3mm from antenna edge.        |

## PND Applications

- For the PND applications, Bluetooth antenna usually place at the long side of PCB. To make the device thinner, it usually cut a part of PCB to put the battery in it and result in a shorter PCB than mobile phone application. In order to increase the performance of Bluetooth antenna, we suggest to keep some part of PCB to make it look as L-shape as figure E. However, the distance between panel and PCB will affect the antenna performance, we suggest keep the panel away from antenna edge at least 3mm in distance as Figure F.

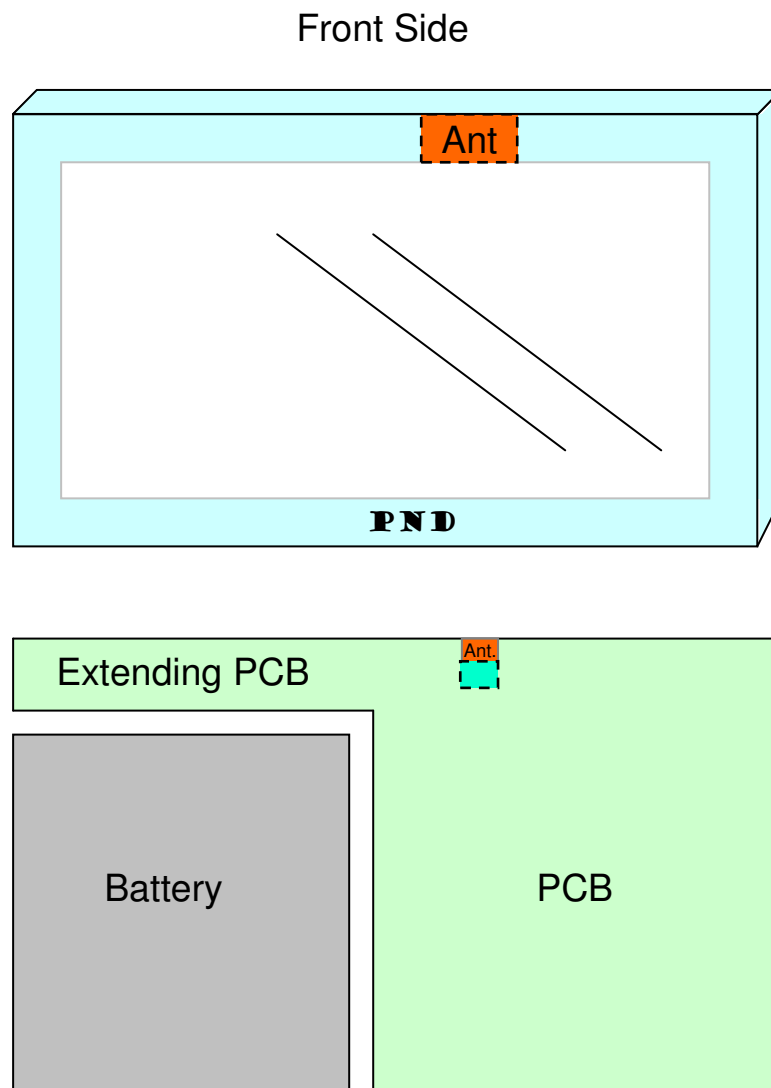


Figure E. Make the extending PCB to get the better performance

### Back Side

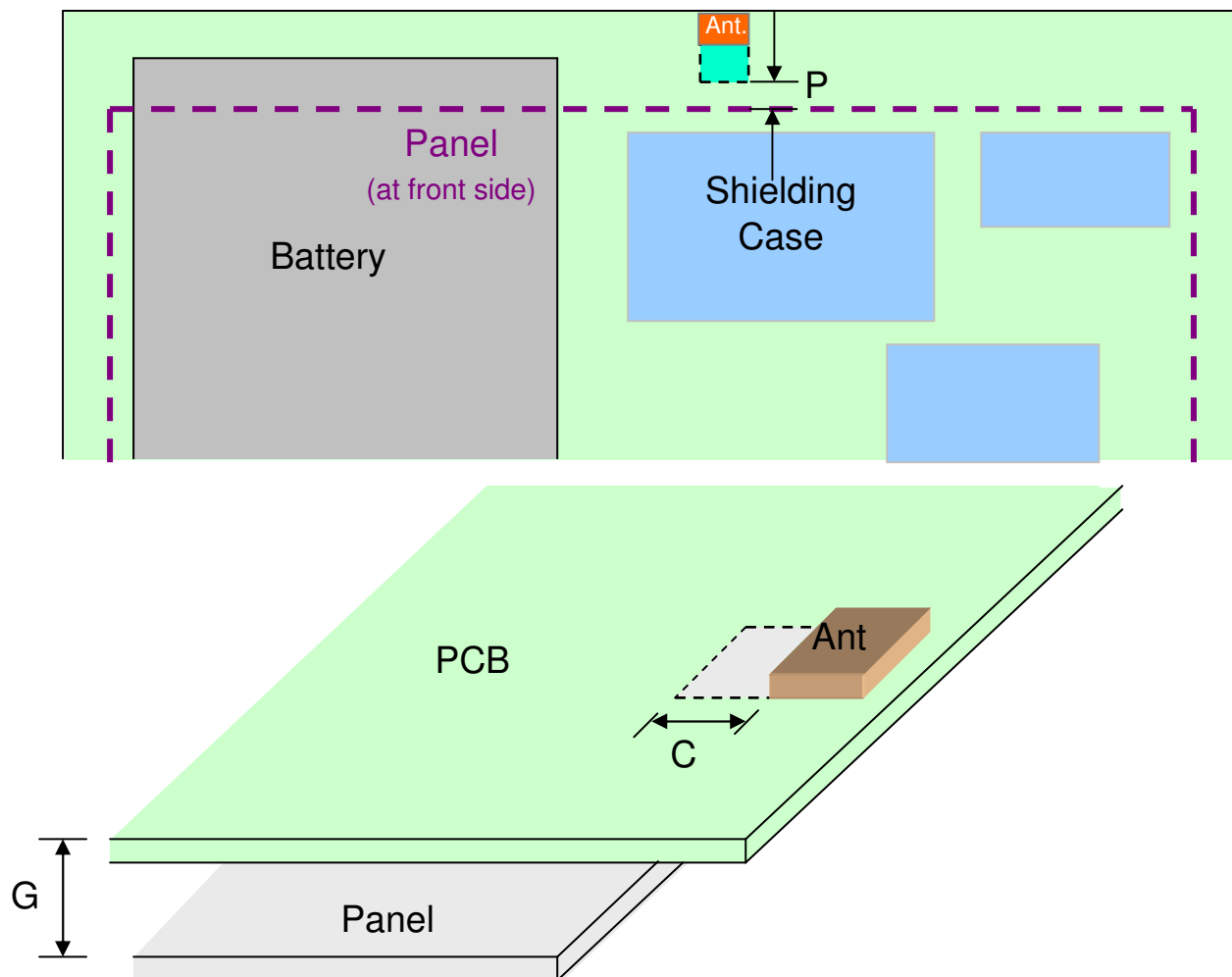
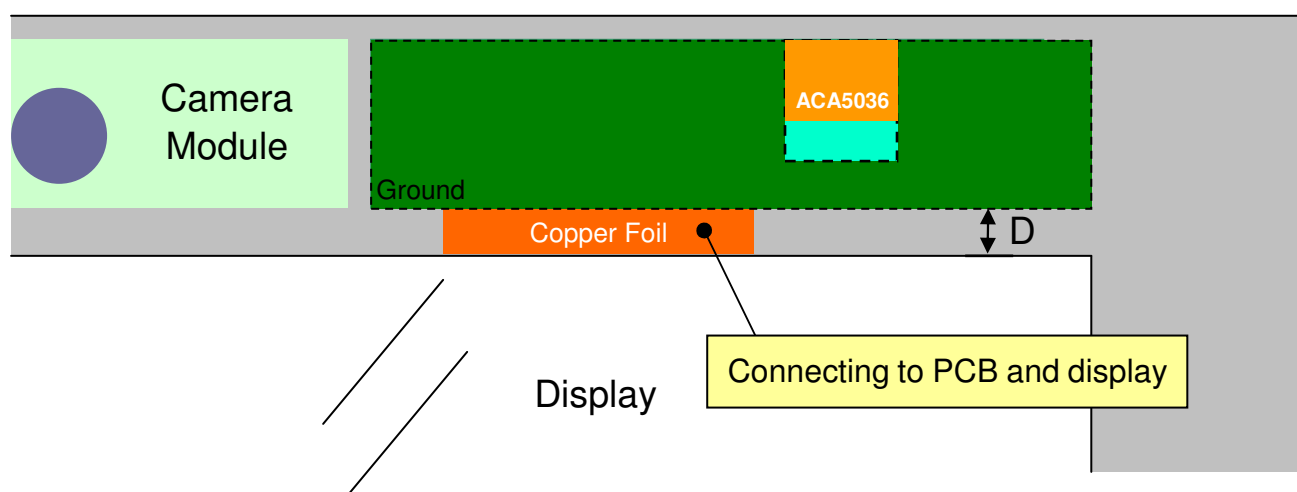
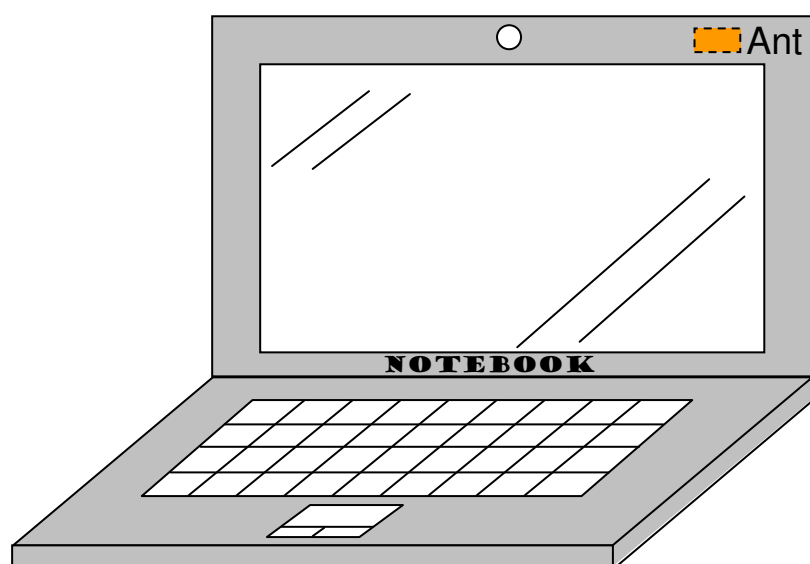


Figure F. Keep the panel away from the PCB more than 3mm.

| Symbol | Suggested Distance | Remark                                                    |
|--------|--------------------|-----------------------------------------------------------|
| P      | $\geq 1\text{mm}$  | The edge of display must keep away 3mm from antenna edge. |
| C      | $\geq 3\text{mm}$  | The width of clearance area needs 3mm from antenna edge.  |
| G      | $\geq 3\text{mm}$  | The distance between antenna and panel metal              |

## Notebook Applications

- For the notebook applications, the space is too small to place a larger PCB. As we know, the smaller PCB we have, the worst antenna performance we get. But according to characteristic of this antenna, because the radiation efficiency depends on the size of the metal layer, so we can extend metal layer from PCB to panel by using copper foil. And if the radiation plane can be extended to metal of panel, the PCB size becomes a minor factor of antenna performance; it means we can use smaller PCB to get the similar performance. By the way, the cable which connects from PCB to main board must fix along the edge of display, and shorter cable will get the better performance due to its cable loss.



| Symbol | Suggested Distance | Remark                                              |
|--------|--------------------|-----------------------------------------------------|
| D      | $\geq 3\text{mm}$  | The distance between antenna and the edge of panel. |

## Contact Information

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