



# APPLICATION SPECIFICATION

## TITLE

### 18X18MM GPS CERAMIC ANTENNA

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DOCUMENT NUMBER: <b>AS-2088900001</b>	CREATED / REVISED BY: Kang Chang 2018/10/25	CHECKED BY: Andy Zhang 2018/10/25	APPROVED BY: Chris Zhong 2018/10/25

## 18X18MM GPS CERAMIC 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: 18X18MM GPS Ceramic Antenna

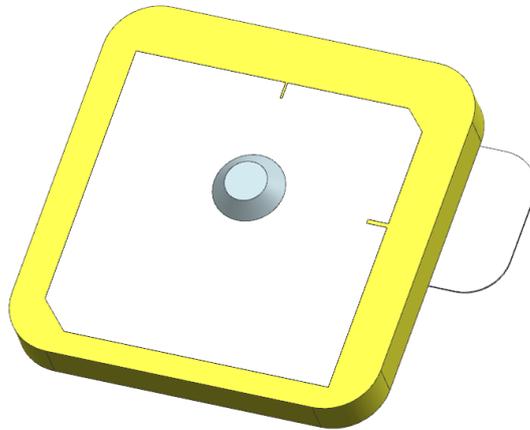
Series Number: 208890

#### 2.2 DESCRIPTION

208890 is a ceramic GPS L1 passive patch antenna, 18mm square and height 2mm. It is tuned and tested on a 70x70mm ground plane, working at GPS 1575.42MHz, with 2.60dBi gain, efficiency > 45%, axial ratio < 2.5dB. This antenna is perfect for applications in telematic, vehicle tracking, navigation, M2M/IoT... devices.

#### 2.3 PRODUCT STRUCTURE INFORMATION

Please refer to PS-2088900001 for full information.



Molex 2088900001 18x18mm GPS Ceramic Antenna 3D View

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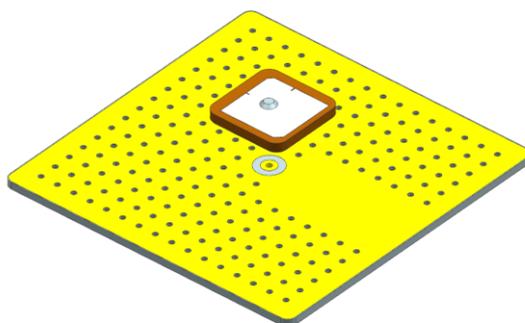
### 3.0 APPLICABLE DOCUMENTS

DOCUMENT	NUMBER	DESCRIPTION
Sale Drawing (SD)	SD-2088900001	Mechanical Dimension of the product
Product Specification (PS)	PS-2088900001	Product Specification
Packing Drawing (PK)	PK-2088900001	Product packaging specifications

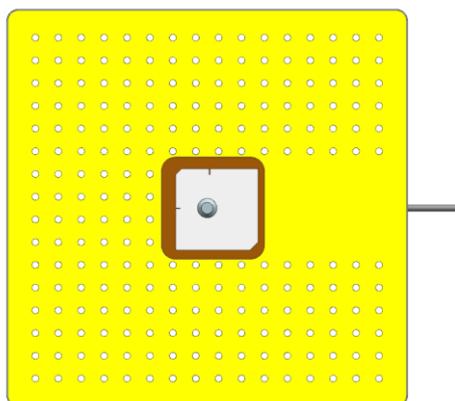
### 4.0 ANTENNA PERFORMANCE

#### 4.1 TEST ASSEMBLY INSTRUCTIONS

THE FOLLOWING STEPS ARE FOR ASSEMBLY INSTRUCTION:

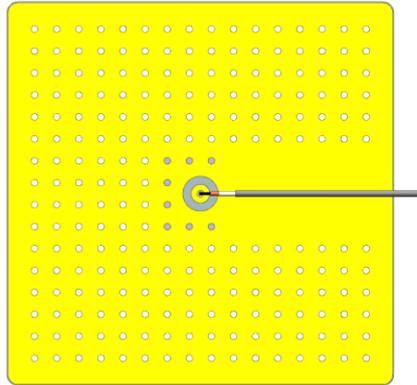


Release the liner and stick the antenna on the PCB



The PCB size is 70mm\*70mm\*1.5mm

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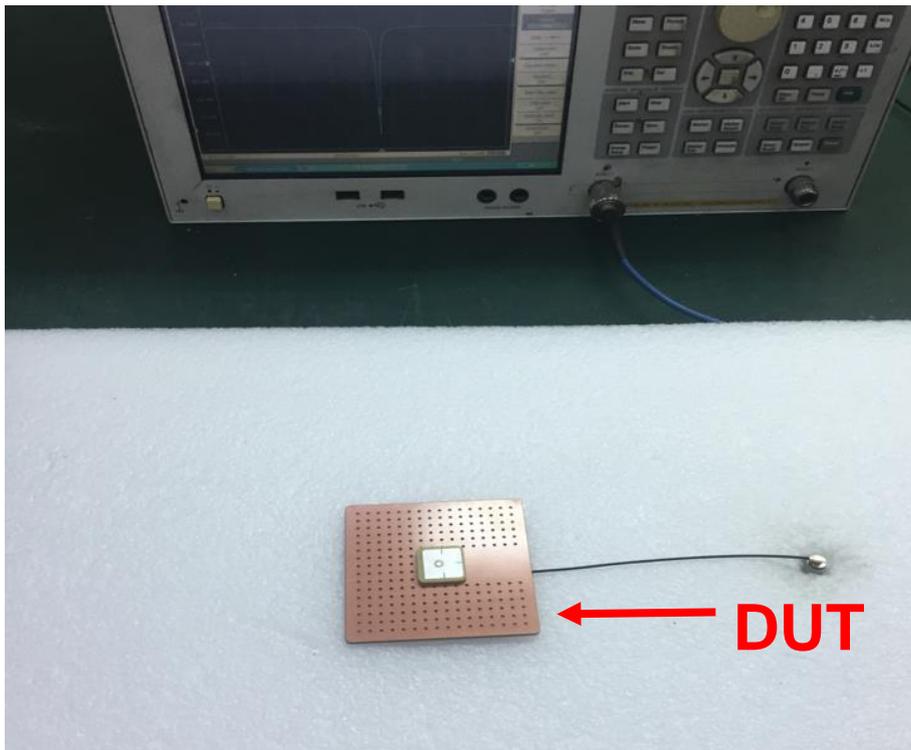


Solder antenna pin on PCB

The Antenna is fixed and soldered at the center of reference PCB with the size of 70mm\*70mm and the test coaxial cable length is 150mm.

#### 4.2 RF TEST CONDITIONS

The antenna is fixed and soldered at the center of reference PCB (70\*70\*1.5 mm) and the test coaxial cable length is 150mm. All measurements are done of the antenna mounted on reference PCB (70\*70\*1.6mm) with VNA Agilent 5071C and Over-The-Air (OTA) chamber. All measurements in this document are done with the part no.2088900001.



**FIGURE4.2.1 ANTENNA LOADED ON REFERENCE PCB (70\*7MM) TESTED WITH VNA E5071C**

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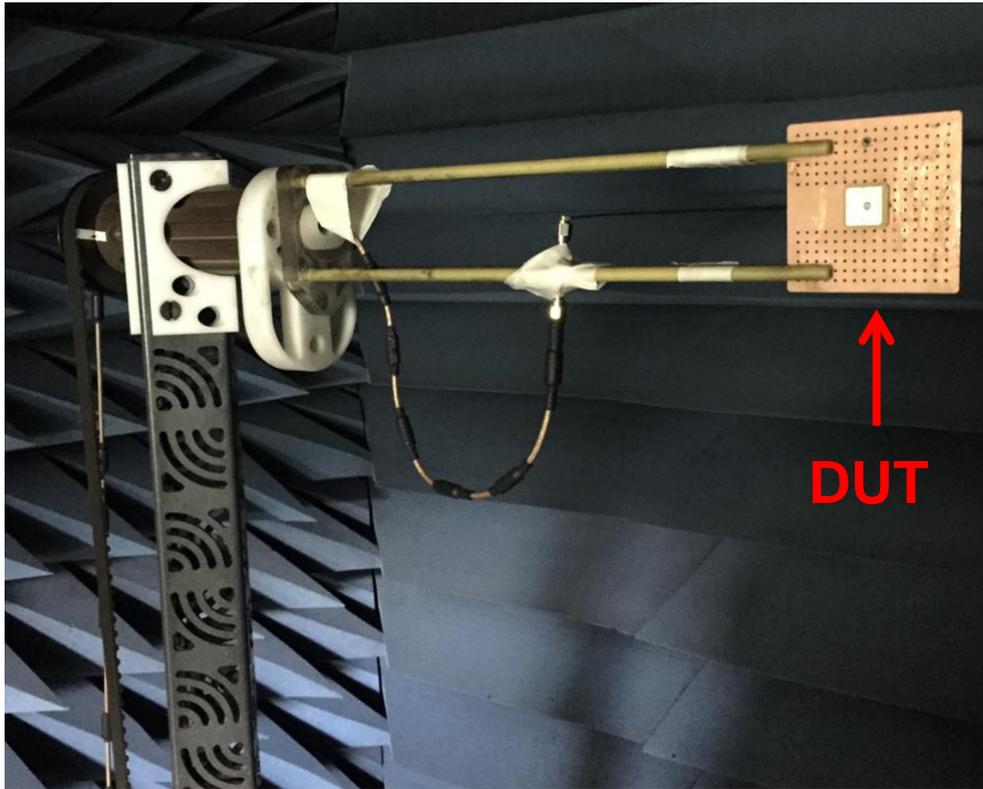


FIGURE4.2.2 ANTENNA LOADED ON REFERENCE PCB (70\*70MM) TESTED IN OTA CHAMBER

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# APPLICATION SPECIFICATION

## 4.3 ANTENNA PERFORMANCE

DESCRIPTION	EQUIPMENT	PARAMETER
Frequency Range	VNA E5071C	1575.42±1.023 MHz
Return Loss	VNA E5071C	<-15dB
Peak Gain (Max)	OTA Chamber	2.6dBi
Average Total Efficiency	OTA Chamber	>45%
Polarization	OTA Chamber	Right-Handed Circular
Input Impedance	VNA E5071C	50 ohms

Note that the above antenna performance is measured with just the antenna mounted on the reference PCB (70\*70mm) in free space. 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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## 4.4 RETURN LOSS PLOT

All measurements in this document are done on the reference PCB (70\*70mm).

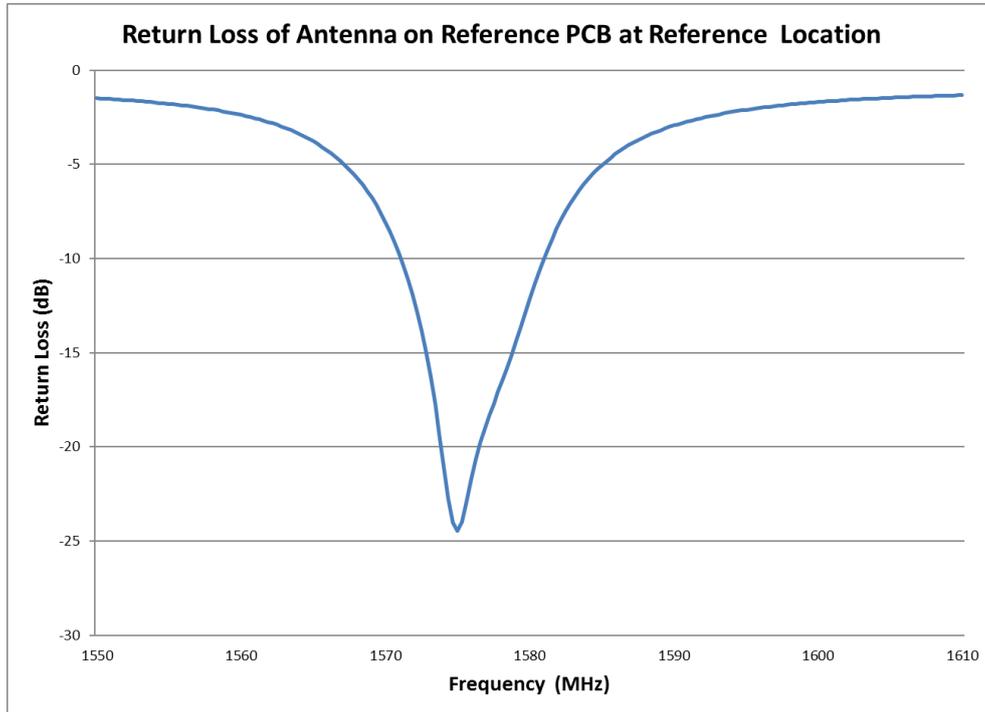


FIGURE 4.4.1 RETURN LOSS OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

## 4.5 EFFICIENCY PLOT

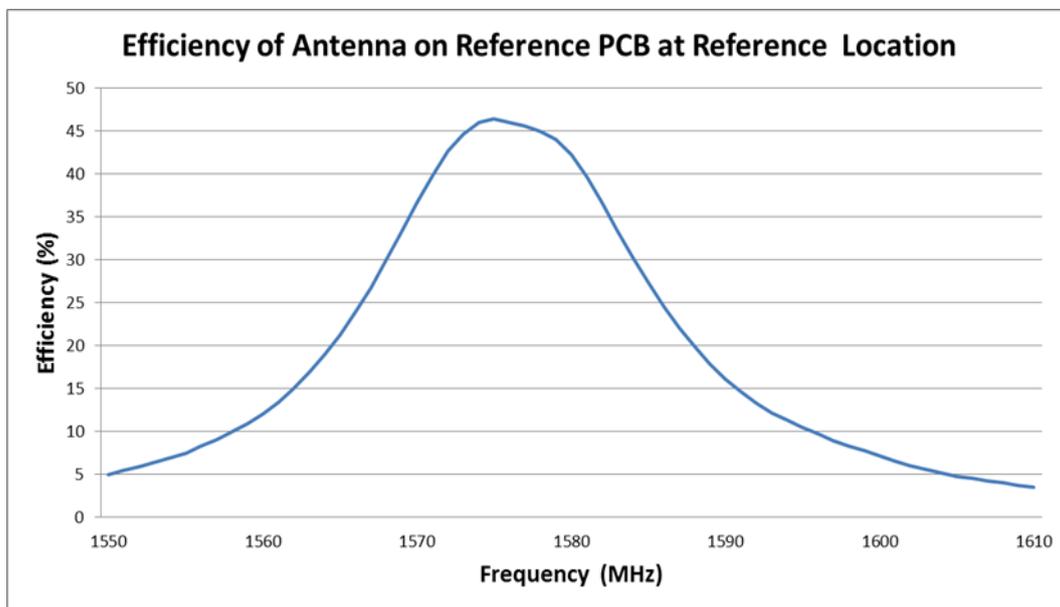


FIGURE 4.5.1 EFFICIENCY OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

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## 4.6 PEAK GAIN PLOT

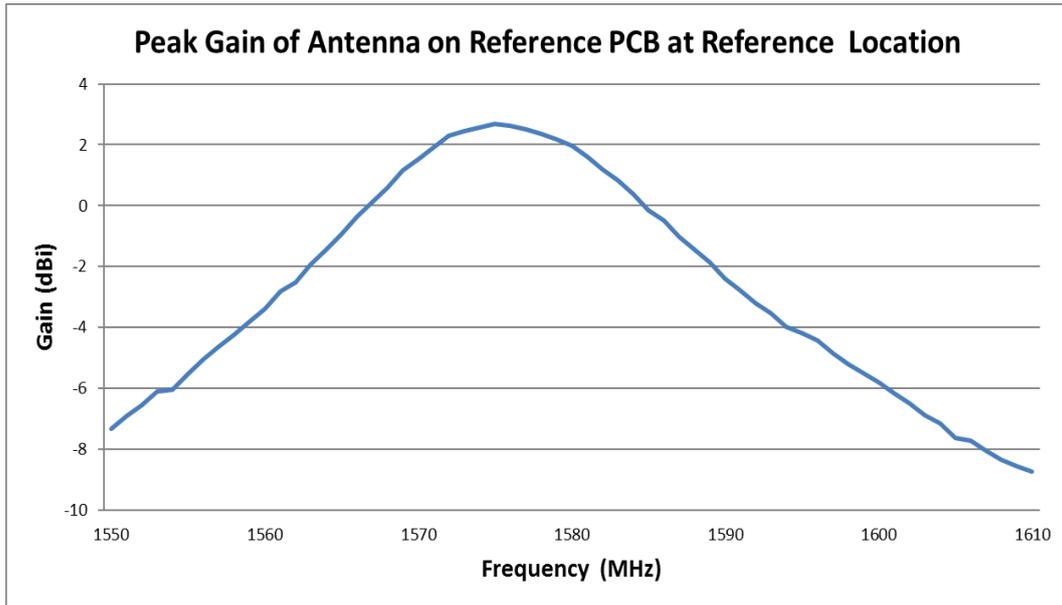


FIGURE 4.6.1 EFFICIENCY OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

## 4.7 AXIAL RATIO PLOT

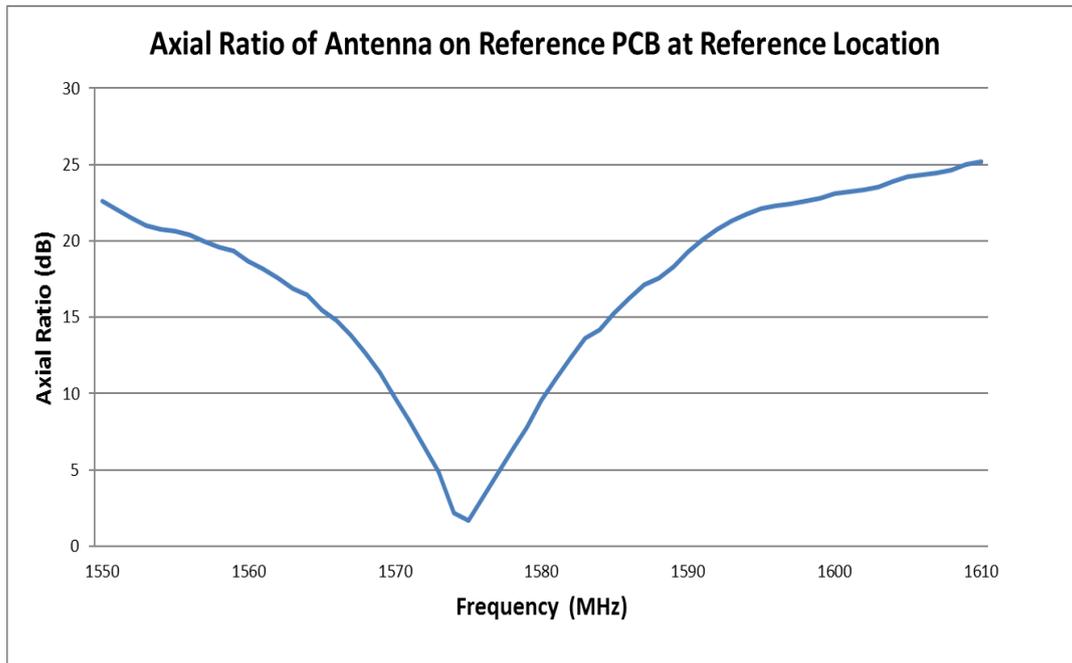
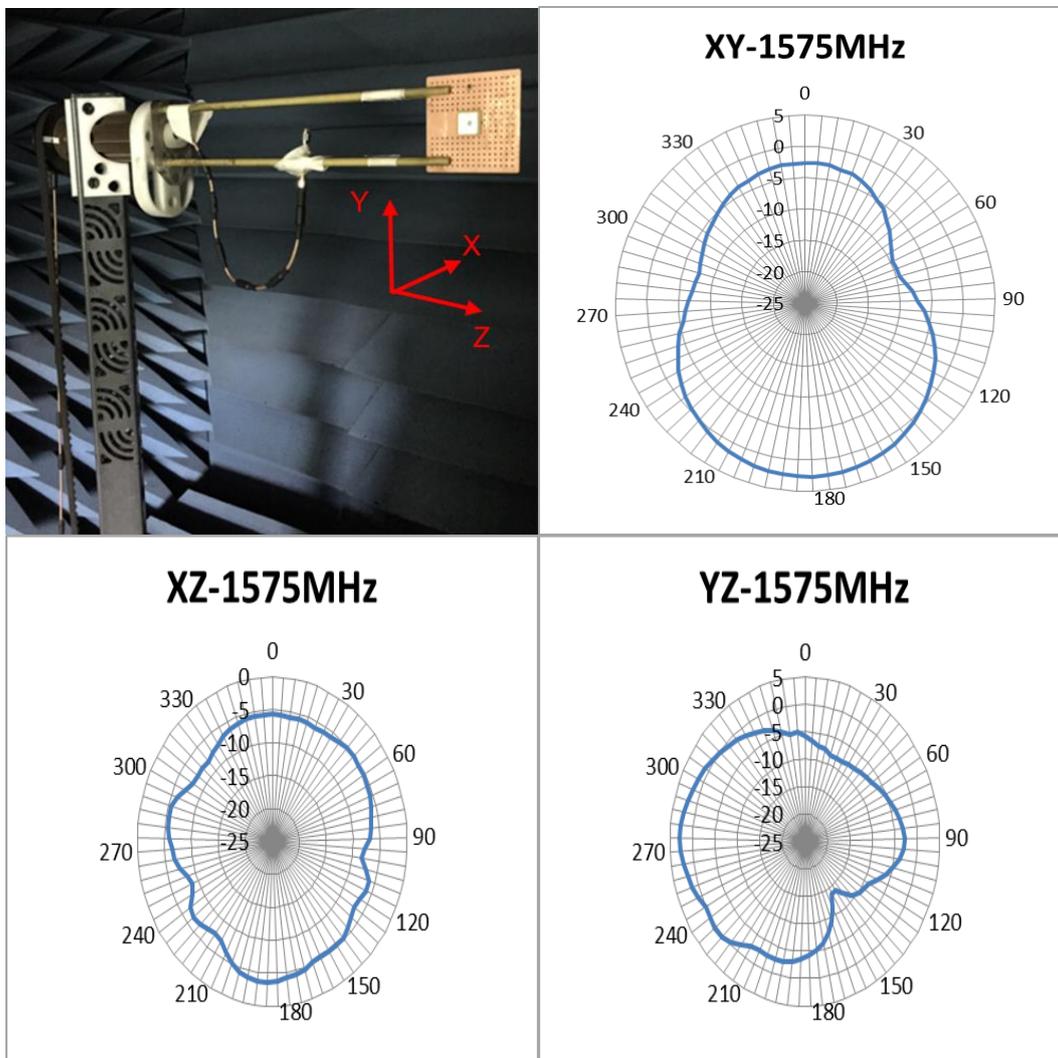


FIGURE 4.7.1 AXIAL RATIO OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

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## 4.8 RADIATION PATTERN

All measurements in this document are done on the reference PCB (70\*70mm).



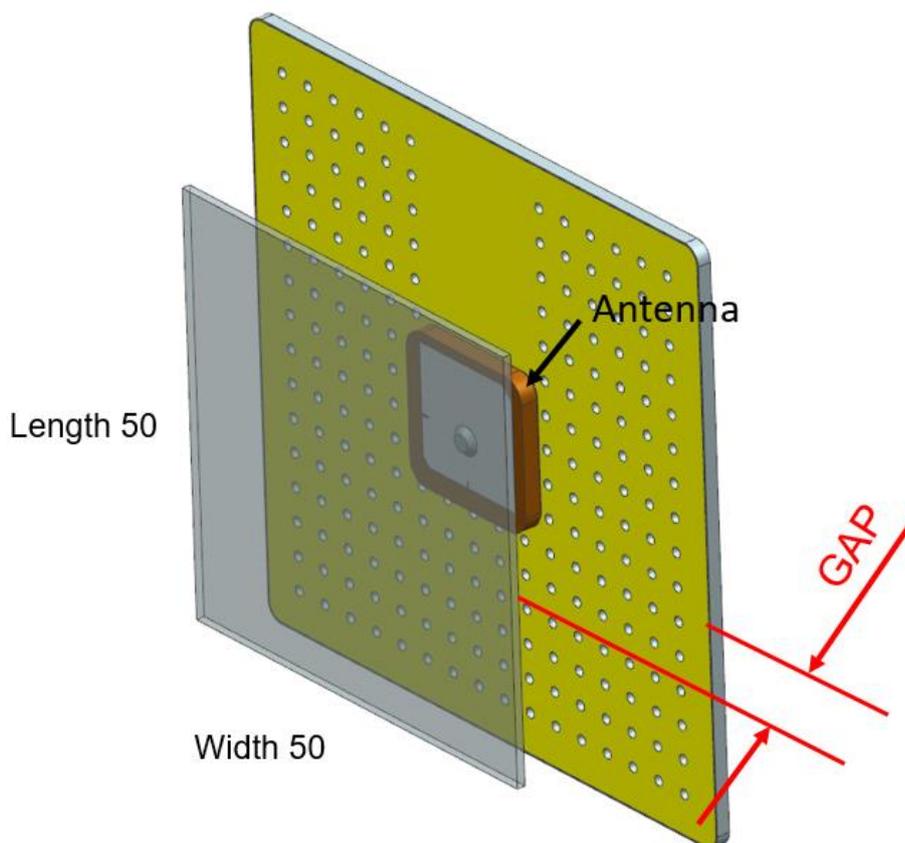
**FIGURE 4.8.1 2D RADIATION PATTERN OF ANTENNA AT 1575MHZ IN FREE SPACE**

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## 5.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

### 5.1 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH PARALLEL PLASTIC COVER

Five locations with a parallel plastic cover have been evaluated and the locations are shown in figure 5.1.1. The plastic cover size is 50mm\*50mm\*2mm and we move the plastic cover to 5 locations for each test. The plastic cover should be placed at least 4 mm away from the PCB. When the distance is less than 4 mm, the antenna performance will be significantly degraded. Refer to figure 5.1.2-5.1.5.



**FIGURE 5.1.1 FIVE LOCATIONS WITH PARALLEL PLANE GROUND**

Plastic Cover Size: 50mm\*50mm\*2mm;

Location 1: Distance between PCB and plane (GAP) ground is about 2 mm;

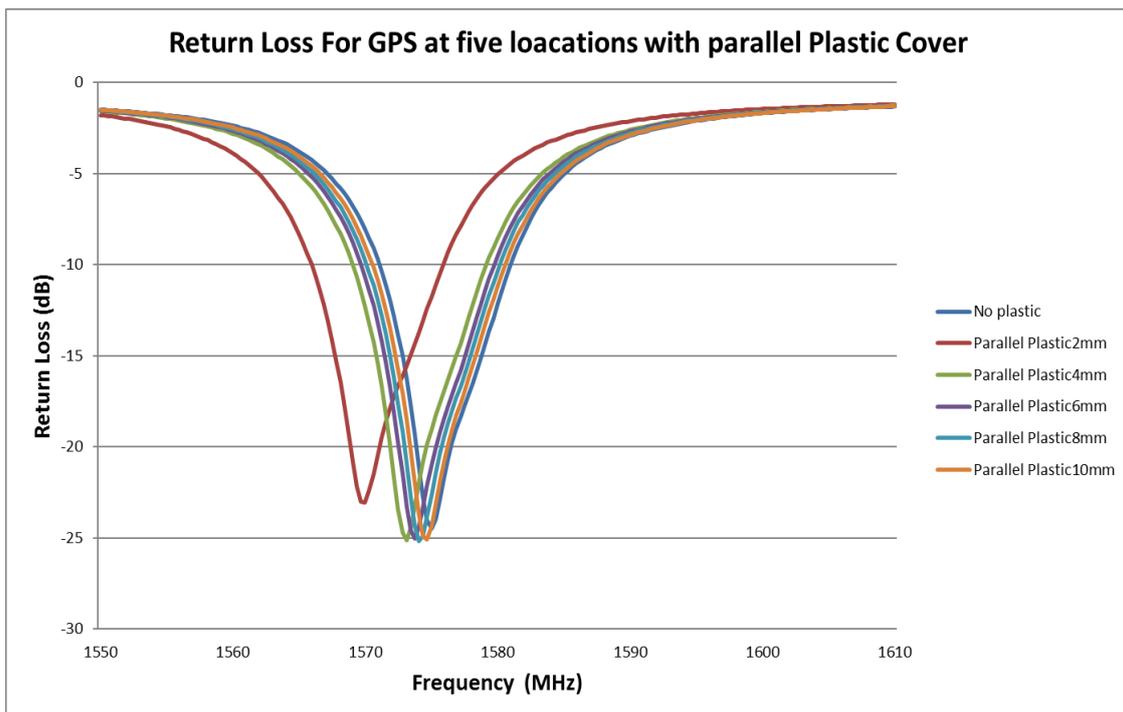
Location 2: Distance between PCB and plane (GAP) ground is about 4 mm;

Location 3: Distance between PCB and plane (GAP) ground is about 6 mm;

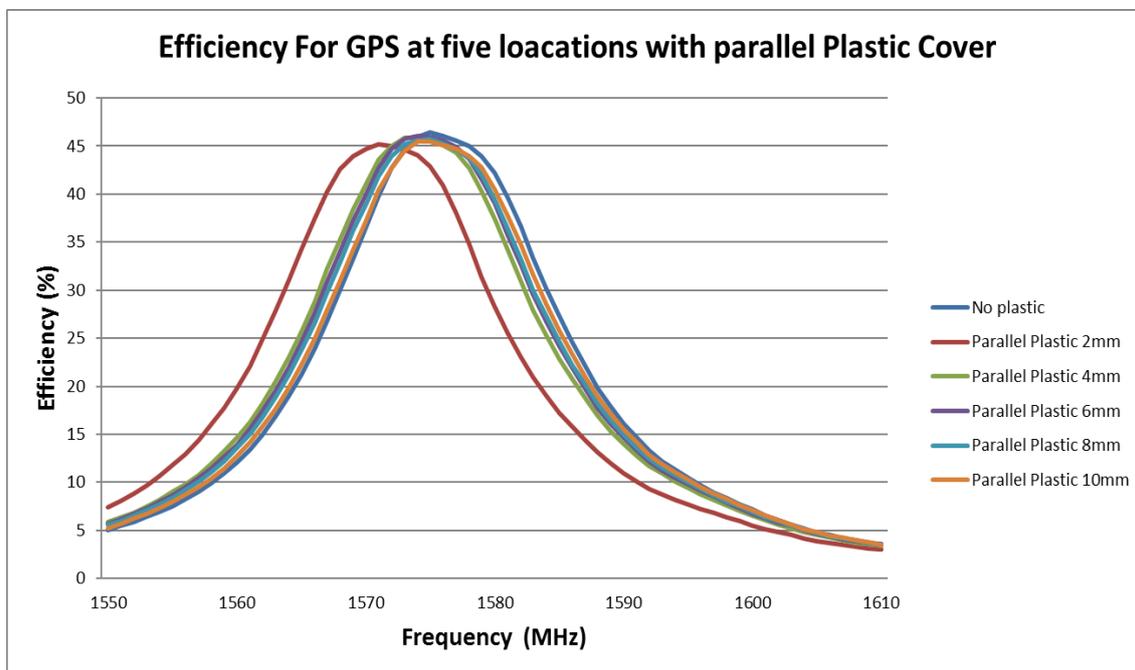
Location 4: Distance between PCB and plane (GAP) ground is about 8 mm;

Location 5: Distance between PCB and plane (GAP) ground is about 10 mm;

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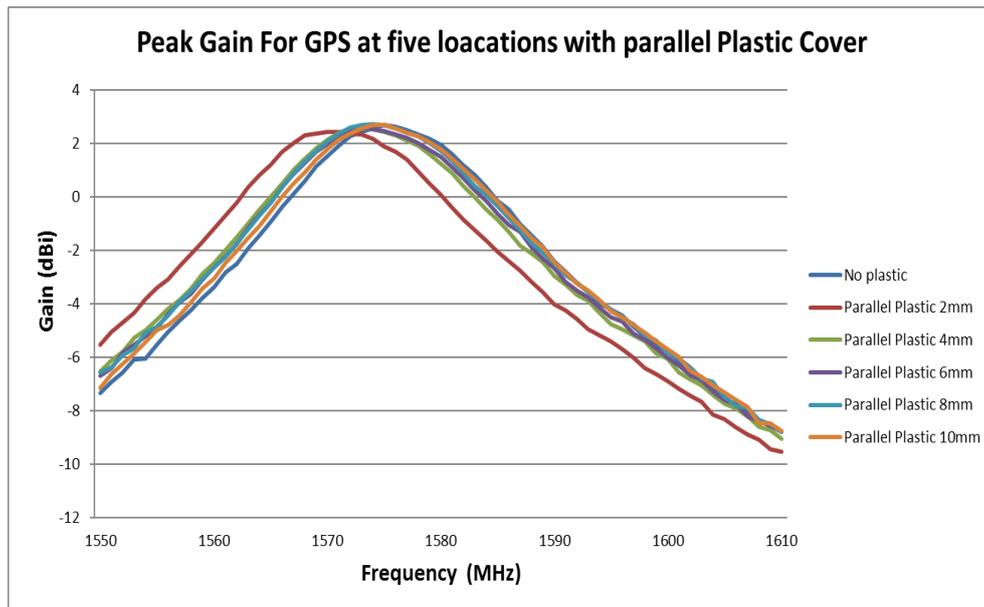


**FIGURE 5.1.2 RETURN LOSS OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS PARALLEL PLASTIC COVER**

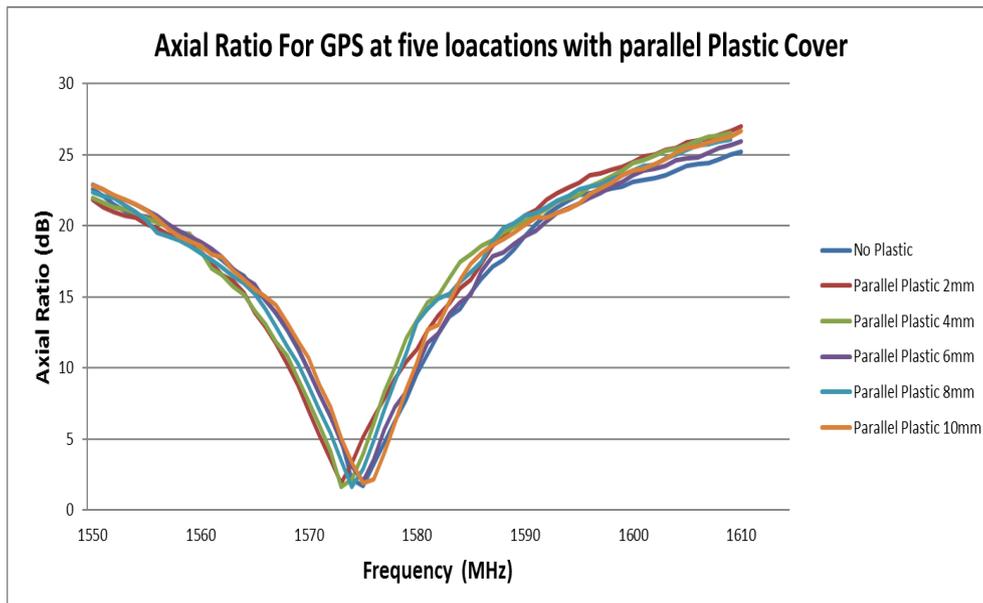


**FIGURE 5.1.3 EFFICIENCY OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS PARALLEL PLASTIC COVER**

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**FIGURE 5.1.4 PEAK GAIN OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS PARALLEL PLASTIC COVER**

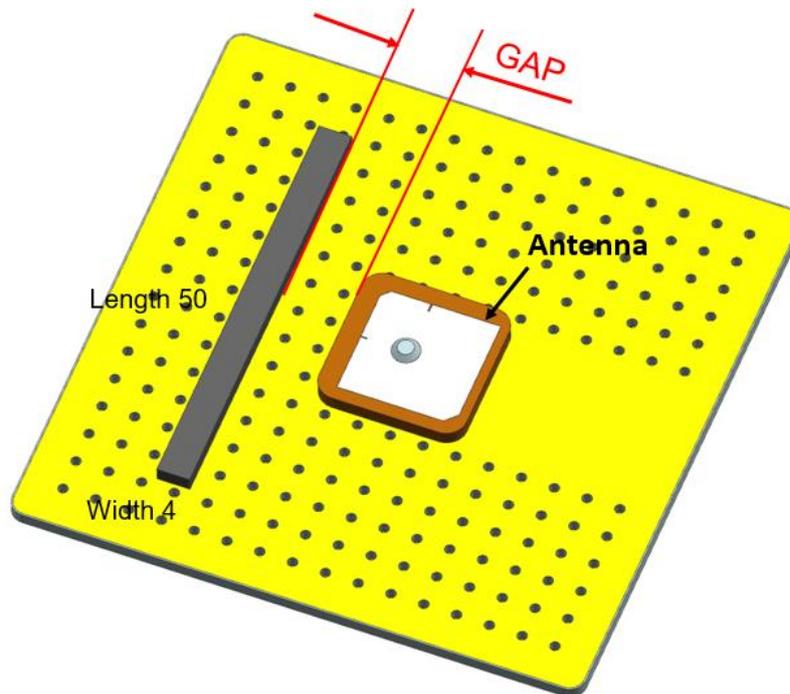


**FIGURE 5.1.5 AXIAL RATIO OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS PARALLEL PLASTIC COVER**

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## 5.2 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH VERTICAL PLASTIC MATERIAL

Five locations with a vertical plastic material have been evaluated and the locations are shown in figure 5.2.1. The plastic material size is 50mm\*4mm\*2mm and we move the plastic material to 5 locations for each test. We suggest that the vertical plastic material should be placed at least 1mm away from the antenna. Refer to figure 5.2.2-5.2.5.



**FIGURE 5.2.1 FIVE LOCATIONS WITH VERTICAL PLASTIC MATERIAL**

Plastic Cover Size: 50mm\*4mm\*2mm;

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

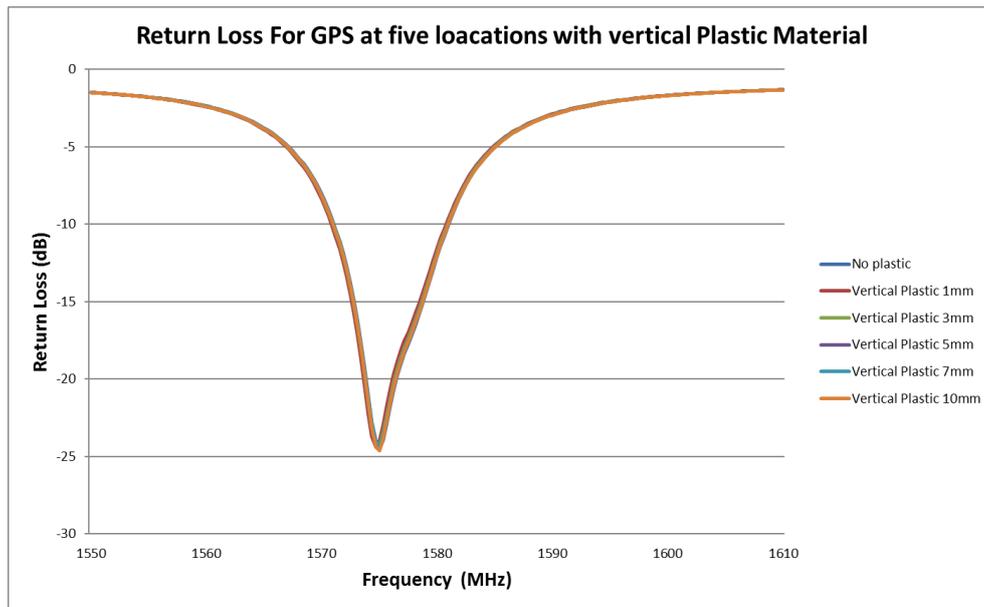
Location 2: Distance between antenna and plastic (GAP) ground is about 3 mm;

Location 3: Distance between antenna and plastic (GAP) ground is about 5 mm;

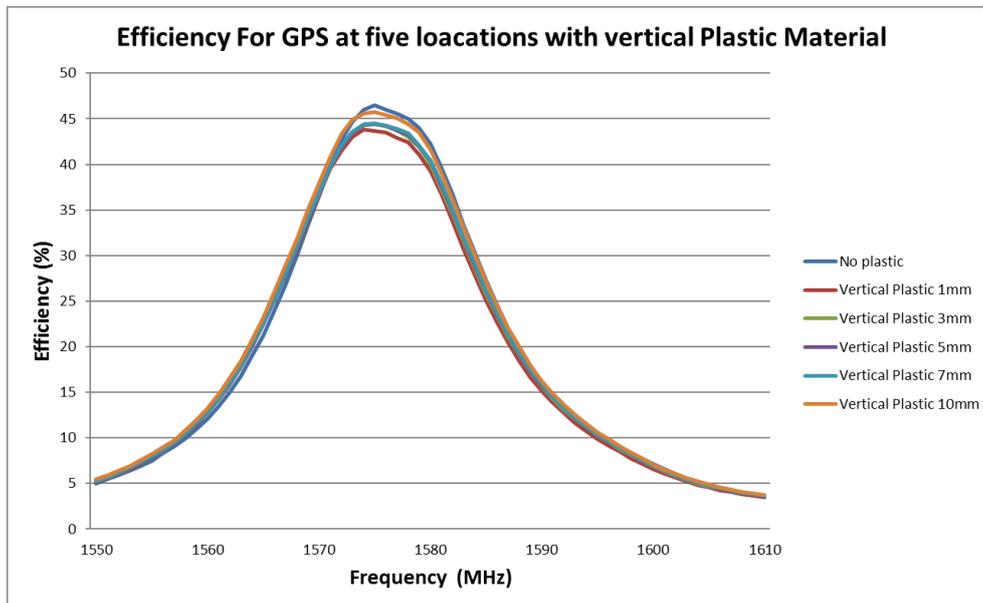
Location 4: Distance between antenna and plastic (GAP) ground is about 7 mm;

Location 5: Distance between antenna and plastic (GAP) ground is about 10 mm;

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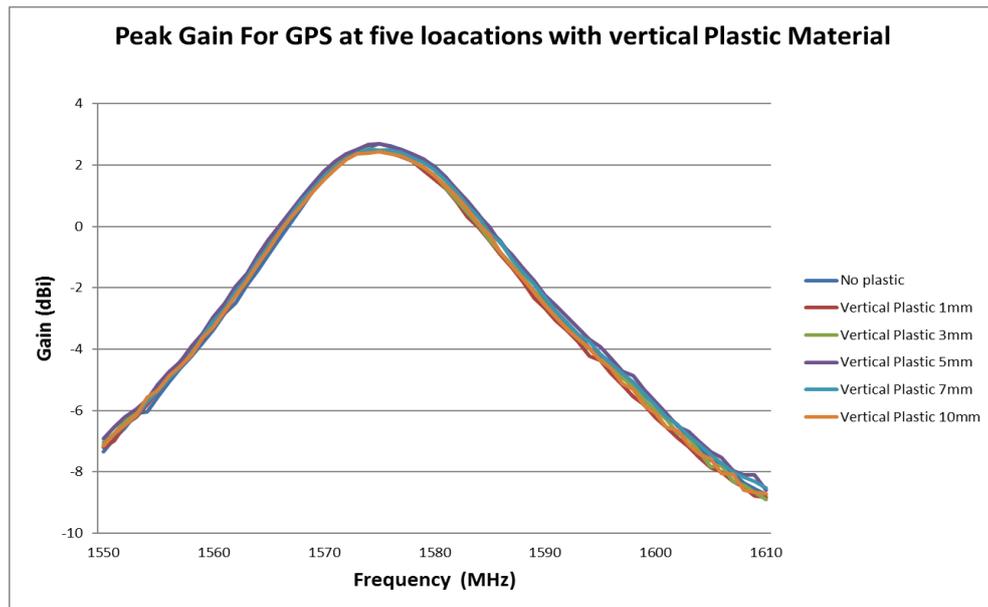


**FIGURE 5.2.2 RETURN LOSS OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL PLASTIC MATERIAL**

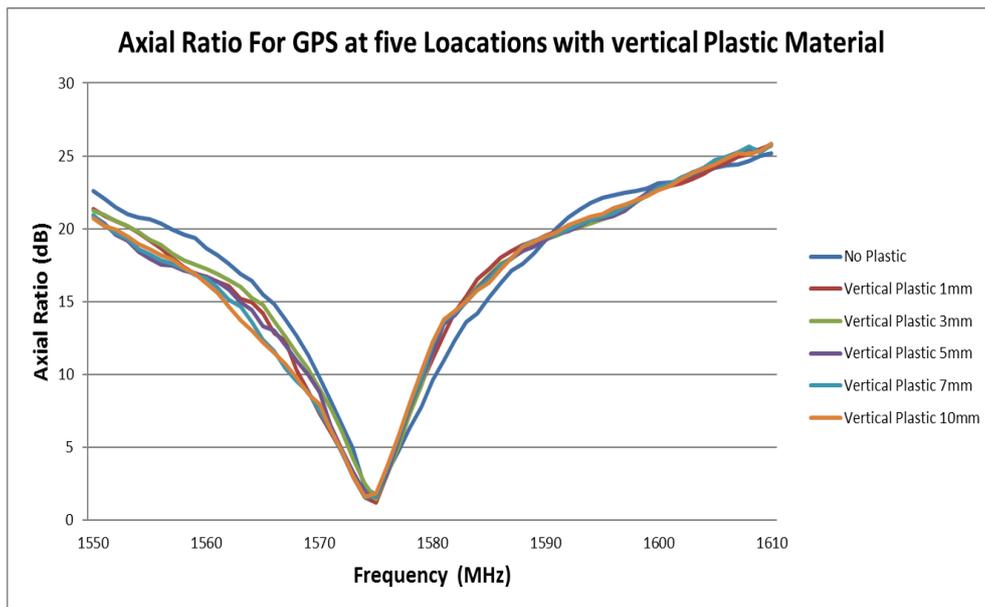


**FIGURE 5.2.3 EFFICIENCY OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL PLASTIC MATERIAL**

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**FIGURE 5.2.4 PEAK GAIN OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL PLASTIC MATERIAL**

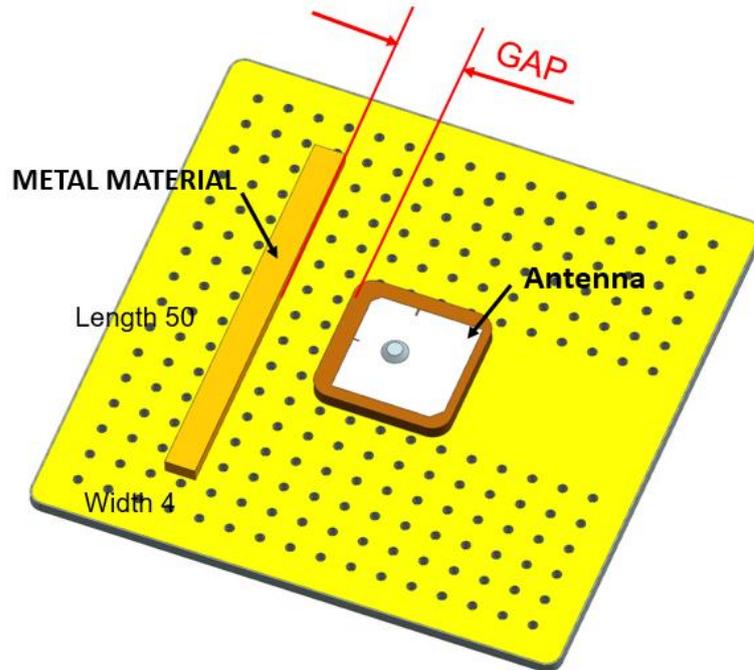


**FIGURE 5.2.5 AXIAL RATIO OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL PLASTIC MATERIAL**

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## 5.3 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH VERTICAL METAL MATERIAL

Five locations with a vertical metal material have been evaluated and the locations are shown in figure 5.3.1. The metal material size is 50mm\*4mm\*2mm and we move the metal material to 5 locations for each test. The metal material should be placed at least 10 mm away from the antenna. When the distance is less than 10 mm, the antenna performance will be significantly degraded. Refer to figure 5.3.2-5.3.5.



**FIGURE 5.3.1 FIVE LOCATIONS WITH VERTICAL METAL MATERIAL**

Metal material Size: 50mm\*4mm\*2mm;

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

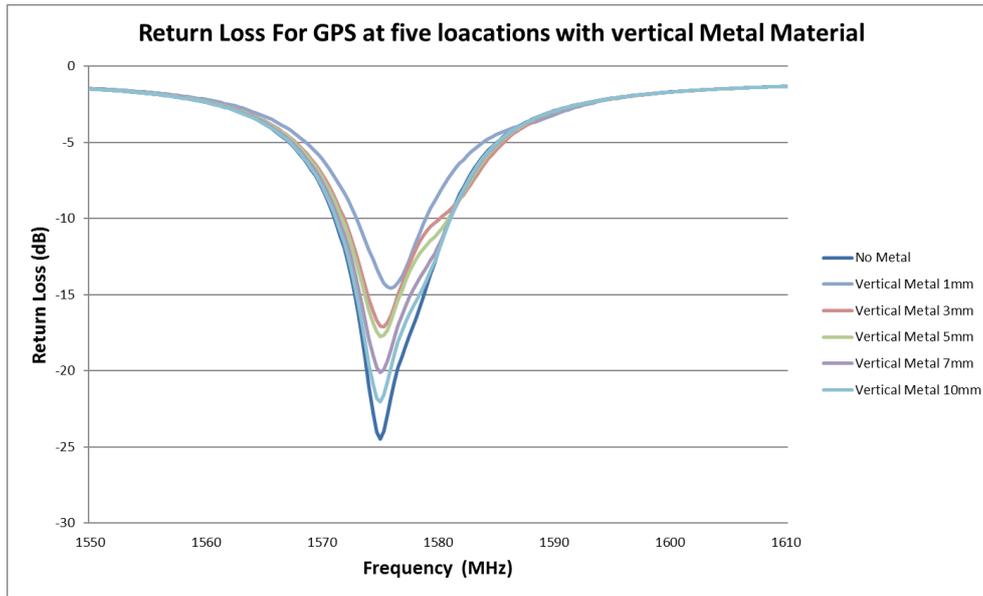
Location 2: Distance between antenna and metal (GAP) ground is about 3 mm;

Location 3: Distance between antenna and metal (GAP) ground is about 5 mm;

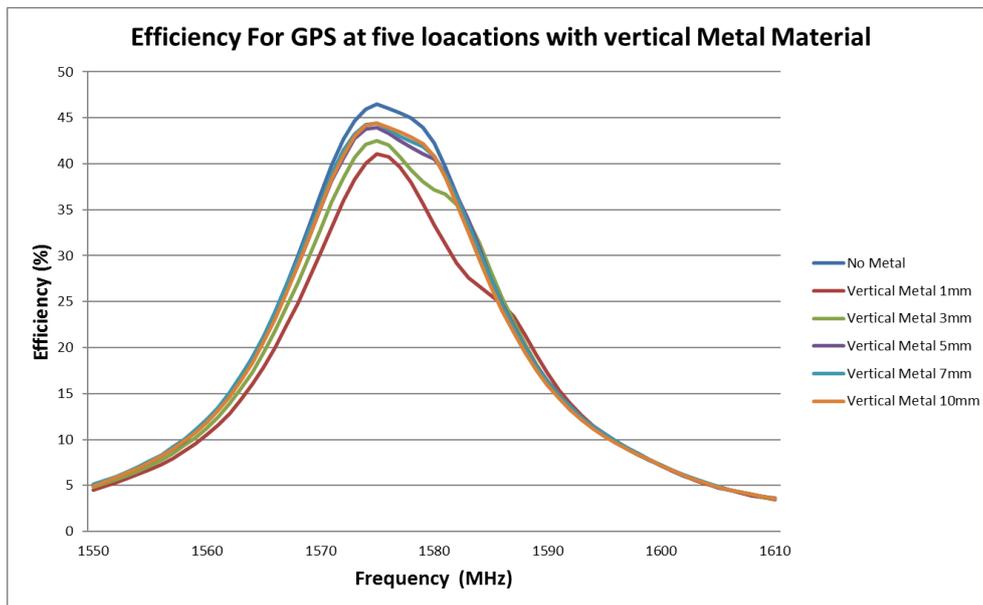
Location 4: Distance between antenna and metal (GAP) ground is about 7 mm;

Location 5: Distance between antenna and metal (GAP) ground is about 10 mm;

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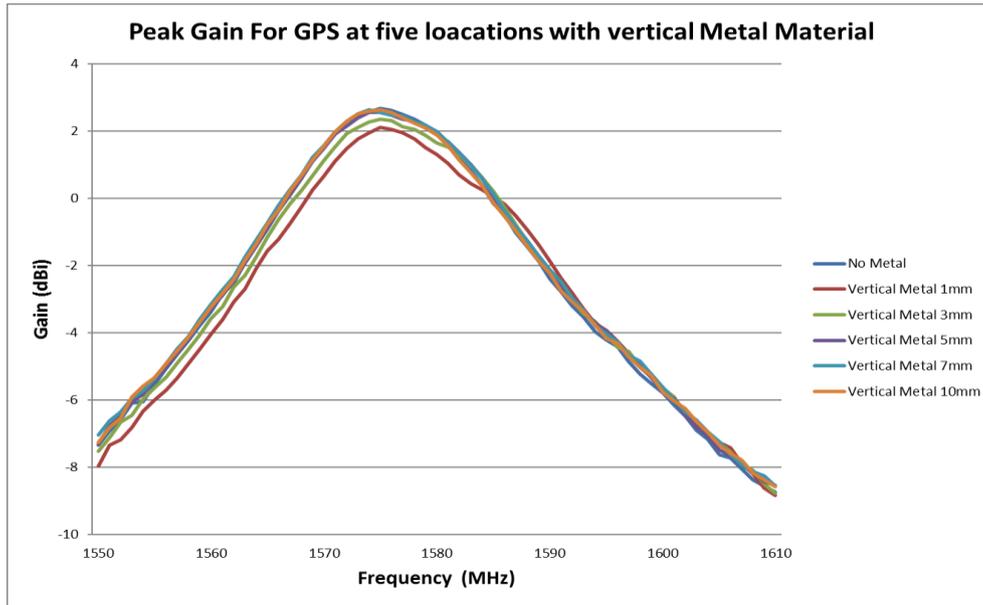


**FIGURE 5.3.2 RETURN LOSS OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL METAL MATERIAL**

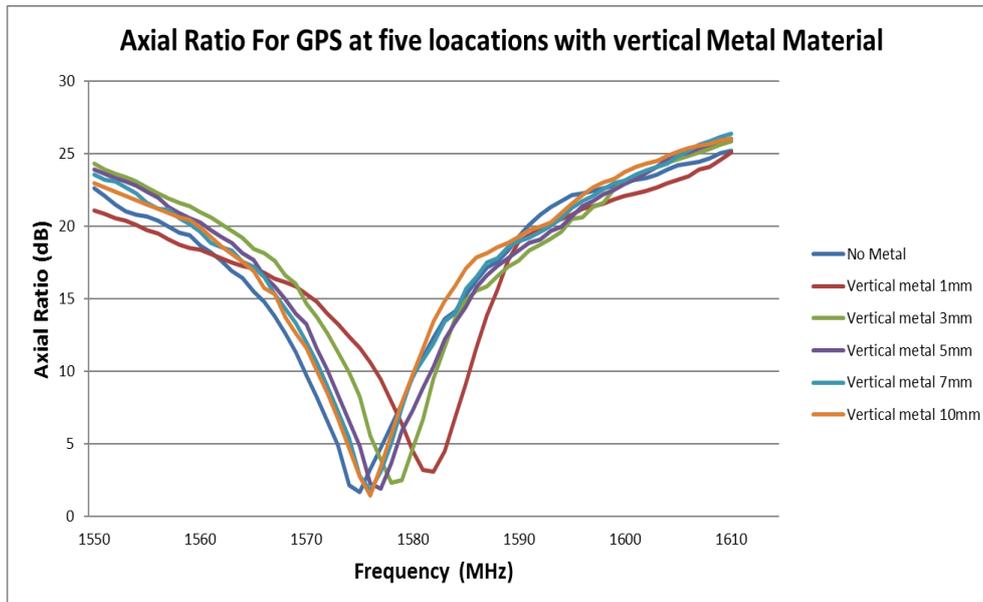


**FIGURE 5.3.3 EFFICIENCY OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL METAL MATERIAL**

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**FIGURE 5.3.4 PEAK GAIN OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL METAL MATERIAL**



**FIGURE 5.3.5 AXIAL RATIO OF ANTENNA AT GPS BAND WITH FIVE LOCATIONS VERTICAL METAL MATERIAL**

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## 5.4 RF PERFORMANCE AS A FUNCTION ON DIFFERENT PCB LOCATION

Three locations have been evaluated, and these configurations are shown in figure 5.4.1. The figure 5.4.2-5.4.5 show the return loss, the efficiency, the peak gain and axial ratio at different locations. The antenna at location 3 can get the best RF performance. Location 3 (center location) is the recommended location for the antenna.

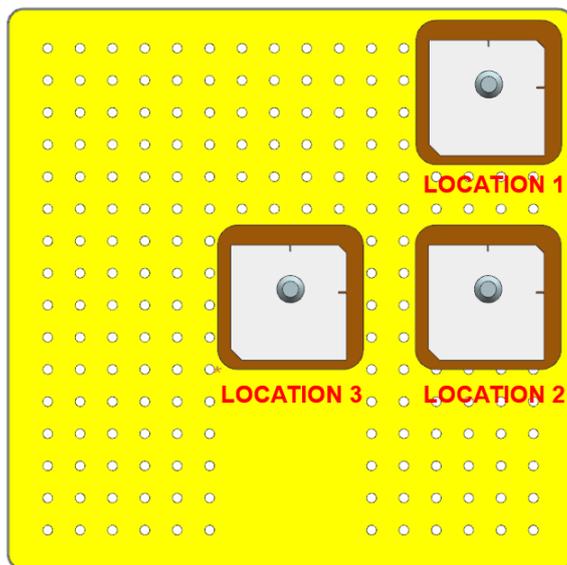
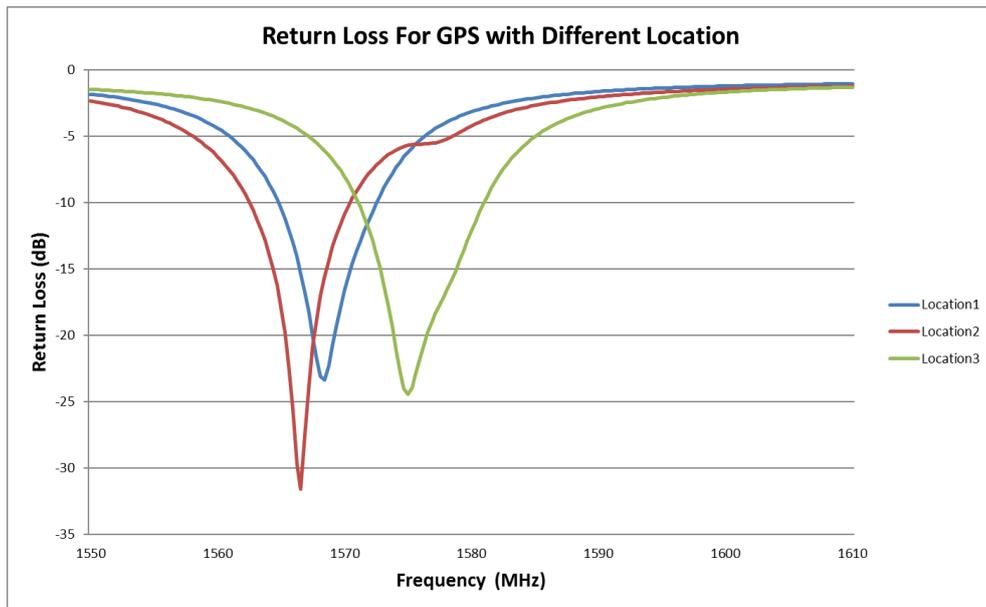
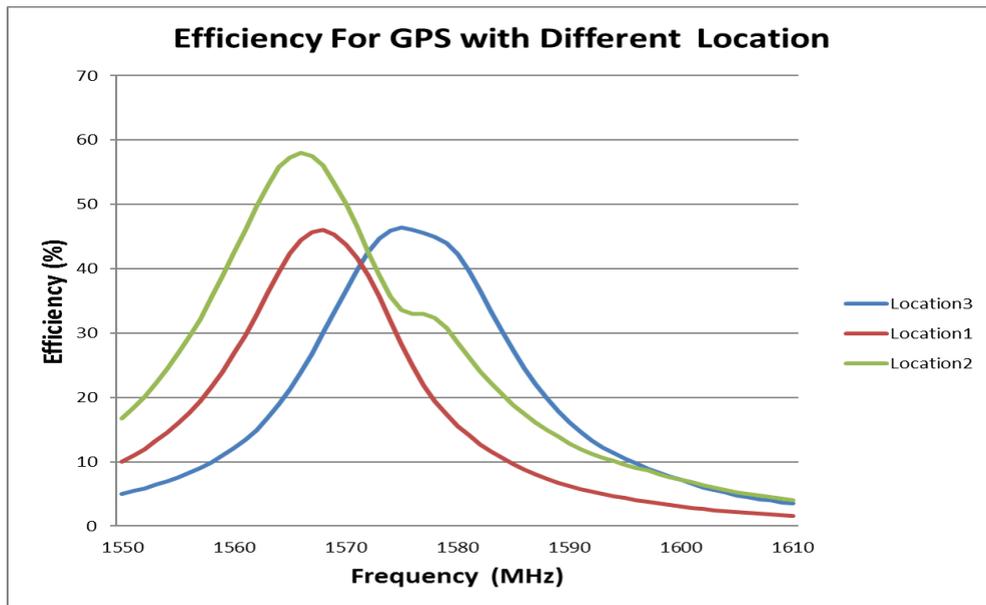


Figure 5.4.1 THREE DIFFERENT PCB LOCATIONS

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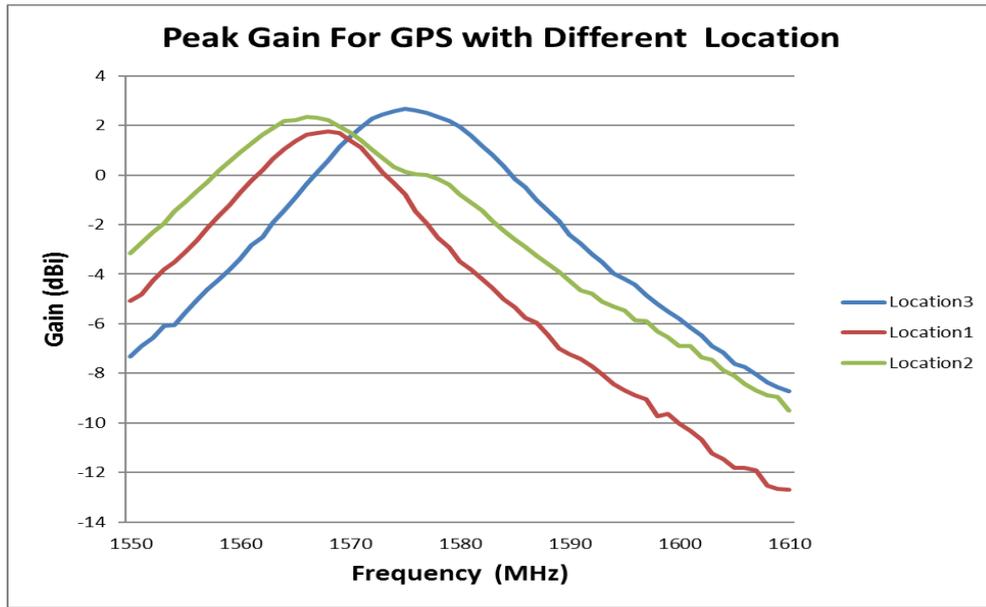


**FIGURE 5.4.2 RETURN LOSS OF ANTENNA AT GPS BAND AT THREE LOCATIONS**

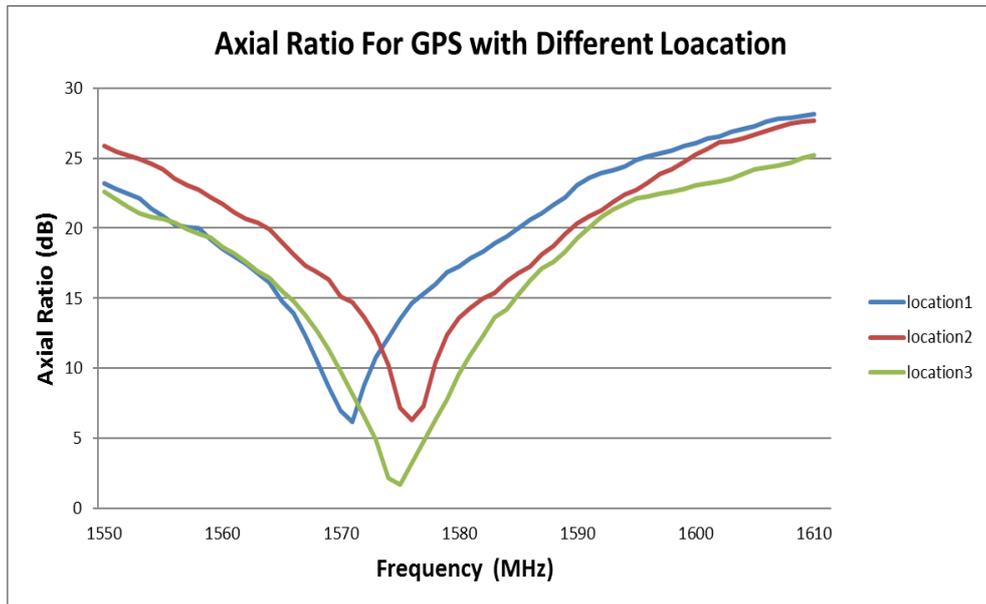


**FIGURE 5.4.3 EFFICIENCY OF ANTENNA AT GPS BAND AT THREE LOCATIONS**

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**FIGURE 5.4.4 PEAK GAIN OF ANTENNA AT GPS BAND AT THREE LOCATIONS**



**FIGURE 5.4.5 AXIAL RATIO OF ANTENNA AT GPS BAND AT THREE LOCATIONS**

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DOCUMENT NUMBER: <b>AS-2088900001</b>	CREATED / REVISED BY: Kang Chang 2018/10/25	CHECKED BY: Andy Zhang 2018/10/25	APPROVED BY: Chris Zhong 2018/10/25

## 5.5 RF PERFORMANCE AS A FUNCTION ON DIFFERENT PCB SIZE

Five kinds of ground plane size were used for this study(L\*W), which were 35mm\*35mm, 50\*50mm, 70mm\*70mm (Reference PCB), 90mm\*90mm, 100mm\*100mm. The PCB configurations are shown in figure 6.4.1. 70mm\*70mm is the recommend PCB size.

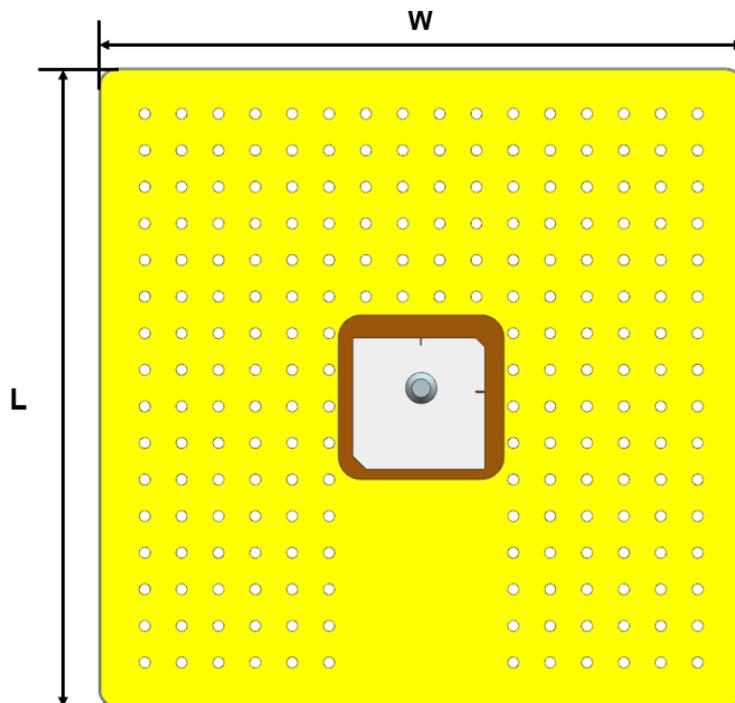
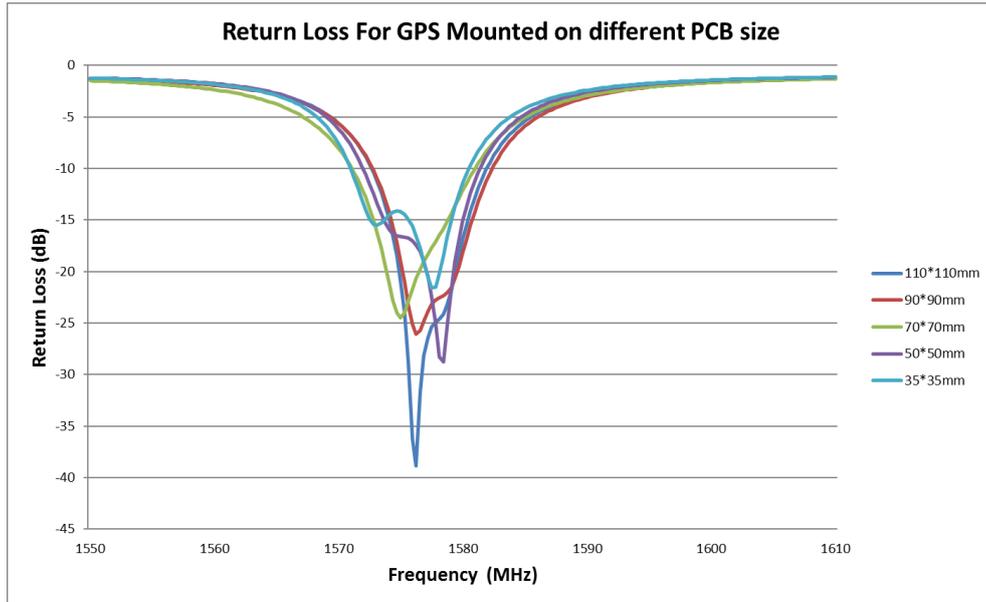
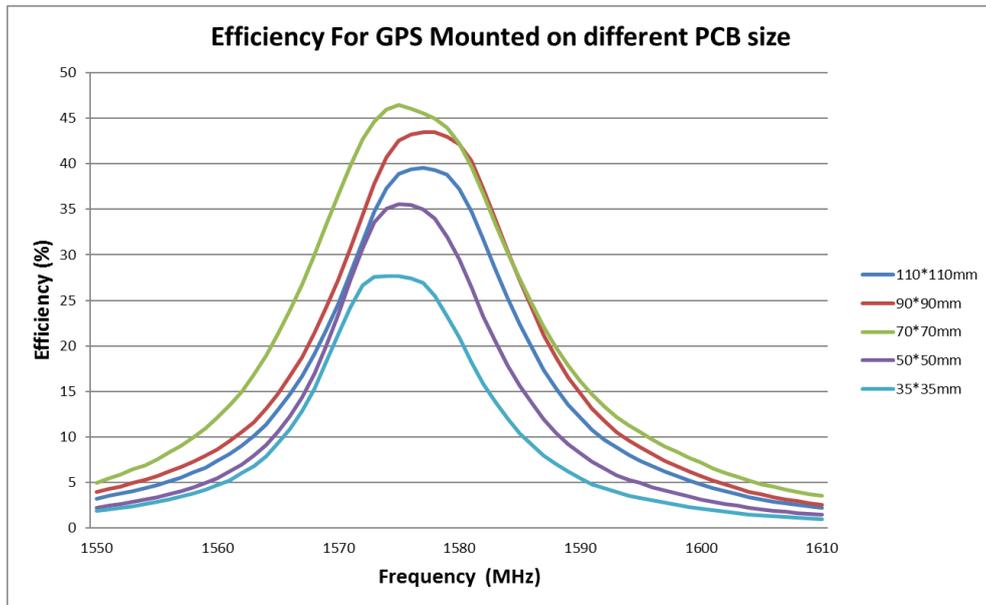


Figure 5.5.1 FIVE KINDS OF GROUND PLANE SIZE

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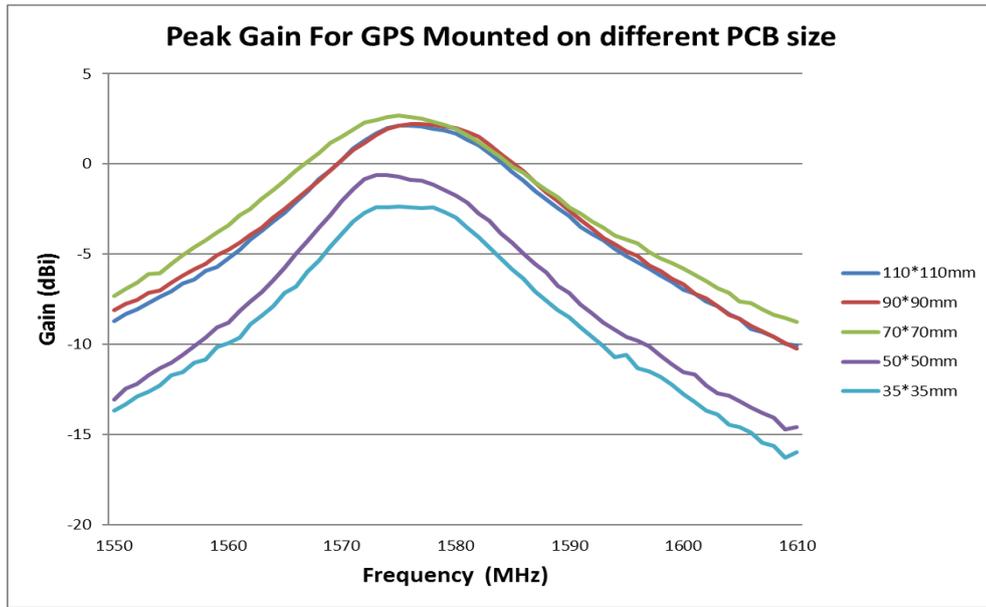


**FIGURE 5.5.2 RETURN LOSS OF ANTENNA AT GPS BAND MOUNTED ON DIFFERENT PCB SIZE**

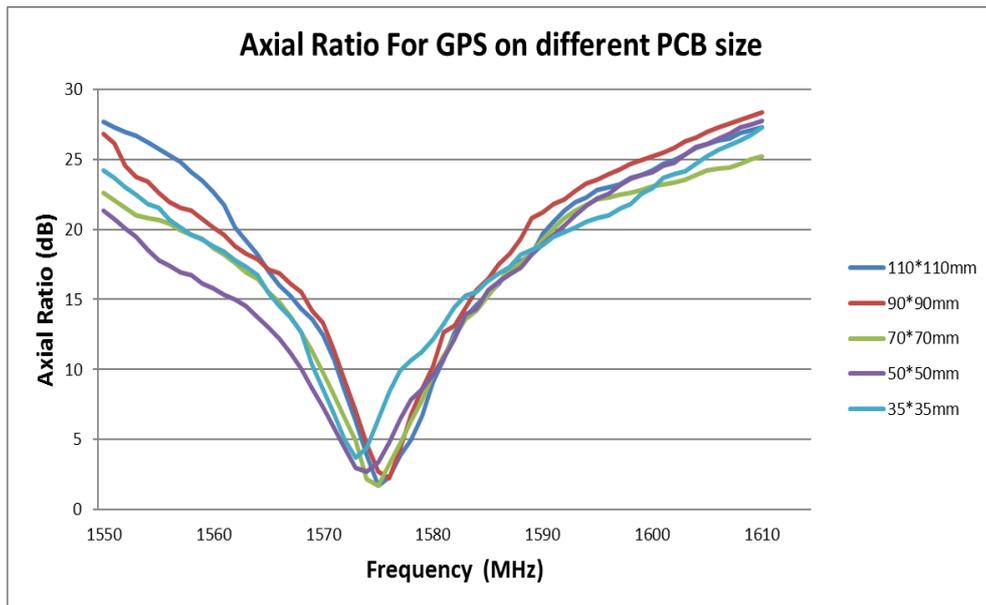


**FIGURE 5.5.3 EFFICIENCY OF ANTENNA AT GPS BAND MOUNTED ON DIFFERENT PCB SIZE**

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DOCUMENT NUMBER: <b>AS-2088900001</b>	CREATED / REVISED BY: Kang Chang 2018/10/25	CHECKED BY: Andy Zhang 2018/10/25	APPROVED BY: Chris Zhong 2018/10/25



**FIGURE 5.5.4 PEAK GAIN OF ANTENNA AT GPS BAND MOUNTED ON DIFFERENT PCB SIZE**



**FIGURE 5.5.5 AXIAL RATIO OF ANTENNA AT GPS BAND MOUNTED ON DIFFERENT PCB SIZE**

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DOCUMENT NUMBER: <b>AS-2088900001</b>	CREATED / REVISED BY: Kang Chang 2018/10/25	CHECKED BY: Andy Zhang 2018/10/25	APPROVED BY: Chris Zhong 2018/10/25