TITLE

GPS RHCP PATCH CERAMIC ANTENNA (25MM*25MM*4MM)

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GPS RHCP PATCH 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.

All measurements are done of the antenna mounted on the recommended PCB with VNA Agilent 5071C and OTA chamber.

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: GPS RHCP PATCH CERAMIC ANTENNA

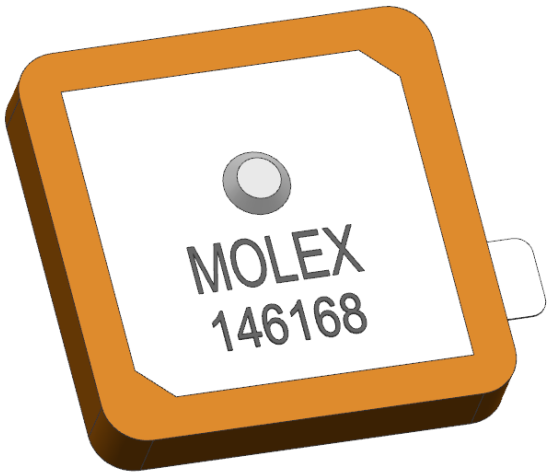
Series Number: 146168

2.2 DESCRIPTION

146168 is a ceramic GPS passive patch antenna, 25mm square and height 4mm. It is tuned and tested on a 70mmx70mm ground plane, working at GPS 1575.42MHz, with 5.50dBi peak gain, efficiency > 75%, axial ratio < 3dB. This antenna is perfect for applications in telematic, vehicle tracking, navigation, m2m/IOT… devices.

2.3 PRODUCT STRUCTURE INFORMATION

Please refer to PS-1461680001 for full information.



Molex 1461680001 GPS RHCP PATCH CERAMIC ANTENNA 3D VIEW

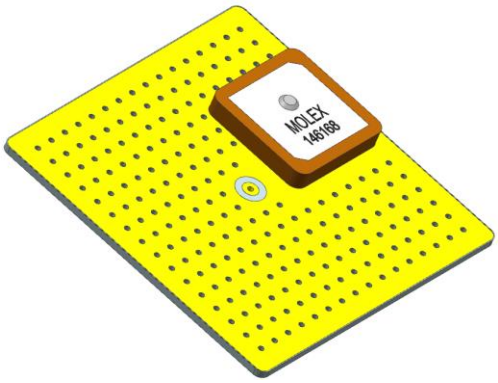
3.0 APPLICABLE DOCUMENTS

DOCUMENT	NUMBER	DESCRIPTION
Sale Drawing (SD)	SD-1461680001	Mechanical Dimension of the product
Product Specification (PS)	PS-1461680001	Product Specification
Packing Drawing (PK)	PK-1461680001	Product packaging specifications

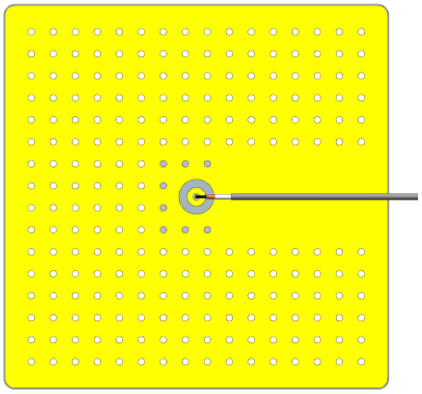
4.0 ANTENNA PERFORMANCE

4.1 TEST ASSEMBLY INSTRUCTIONS

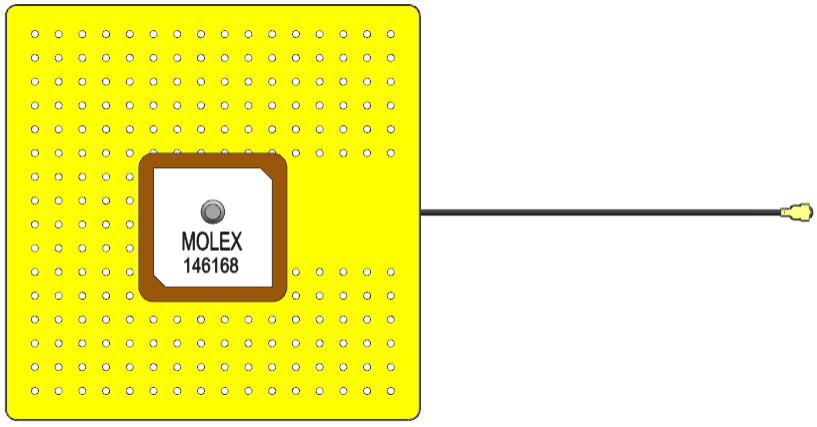
THE FOLLOWING STEPS ARE FOR ASSEMBLY INSTRUCTION:



Release the liner and stick the antenna on the PCB



Solder antenna pin on PCB



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

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 100mm.

4.2 RF TEST CONDITIONS

All measurements are done of the antenna mounted on a 70*70mm PCB with VNA Agilent 5071C and Over-The-Air (OTA) chamber. All measurements in this document are done with the part no.1461680001 with reference PCB.

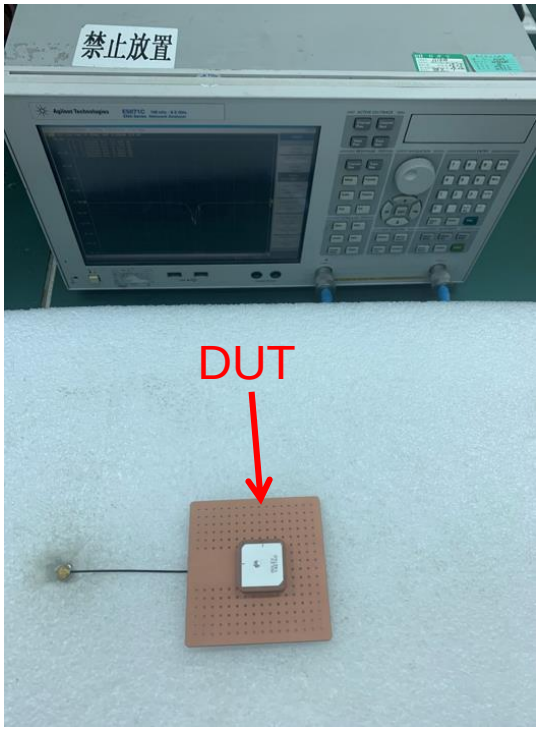


FIGURE4.2.1 ANTENNA LOADED WITH REFERENCE PCB WITH VNA

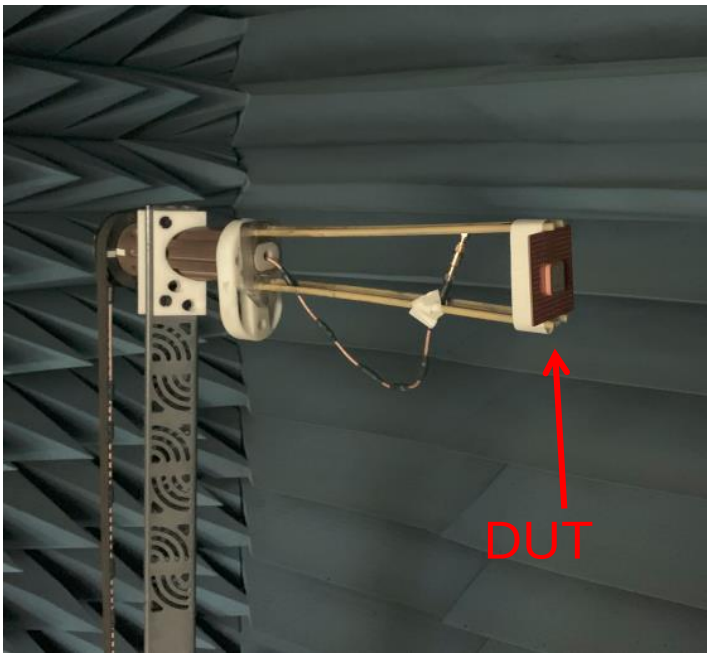


FIGURE4.2.2 ANTENNA LOADED WITH REFERENCE PCB WITH OTA CHAMBER

4.3 ANTENNA PERFORMANCE

DESCRIPTION	EQUIPMENT	REQUIREMENT
Frequency Range	VNA E5071C	1575.42 +/- 3MHz
Return Loss	VNA E5071C	< -15 dB
Peak Gain	OTA Chamber	5.5dBi
Average Total Efficiency	OTA Chamber	>75%
Axial Ratio	OTA Chamber	<3dB
Polarization	OTA Chamber	RHCP
Input Impedance	VNA E5071C	50Ω

Note that the above antenna performance is measured with just the antenna mounted on a 70mm*70mm PCB to simulate 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.

4.4 RETURN LOSS PLOT

All measurements in this document are done on the reference PCB.

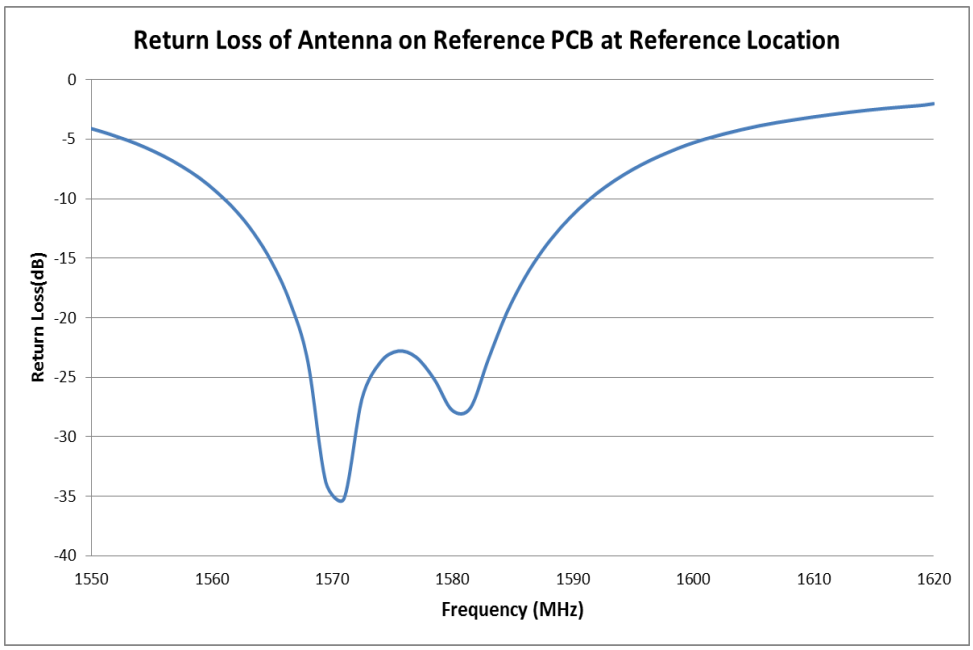


FIGURE 4.4 RETURN LOSS OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

4.5 EFFICIENCY PLOT

All measurements in this document are done on the reference PCB.

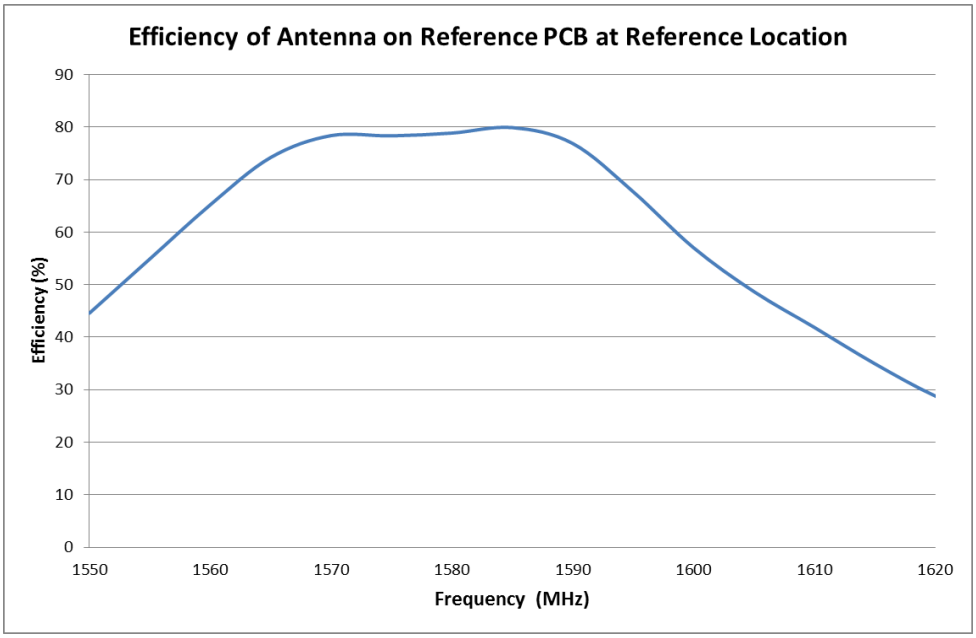


FIGURE 4.5 EFFICIENCY OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

4.6 PEAK GAIN PLOT

All measurements in this document are done on the reference PCB.

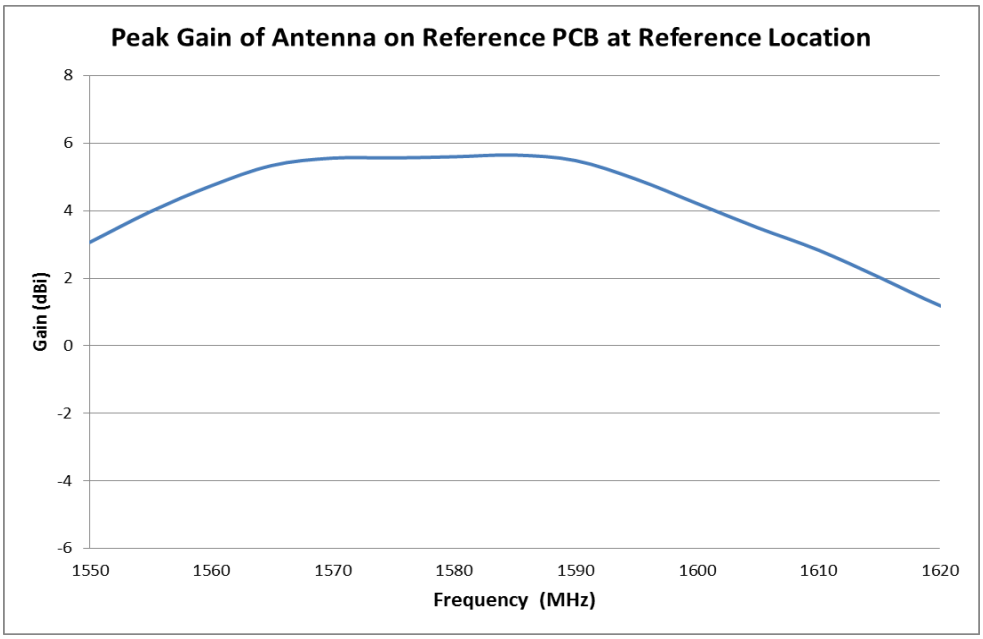


FIGURE 4.6 PEAK GAIN OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

4.7 AXIAL RATIO PLOT

All measurements in this document are done on the reference PCB.

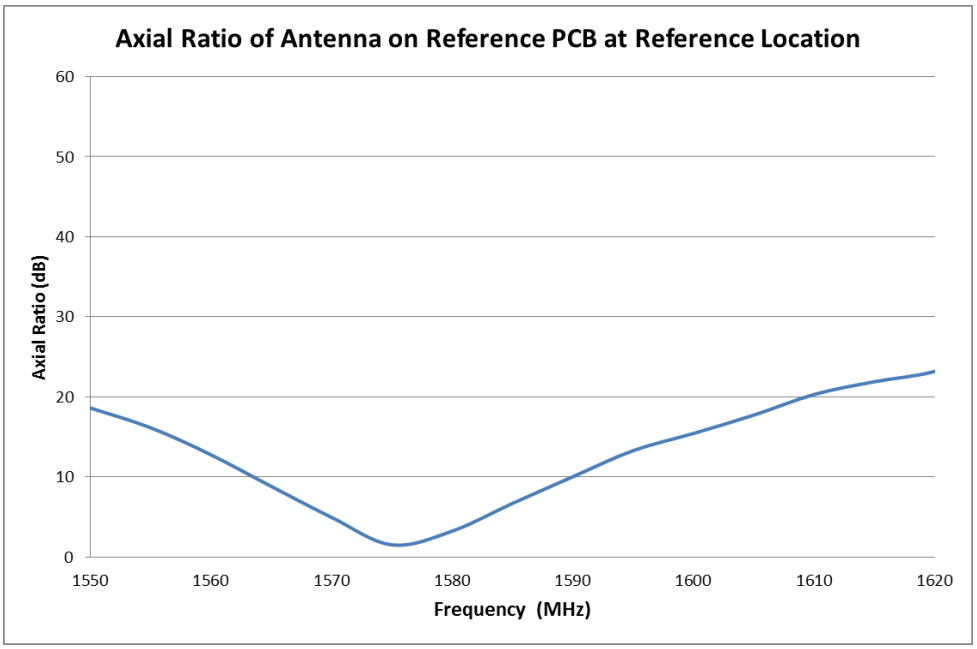
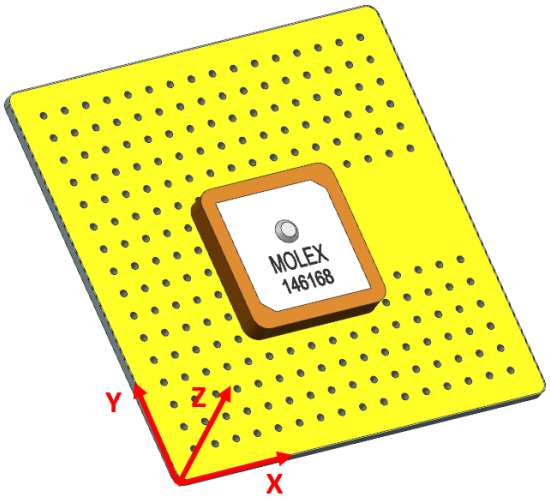
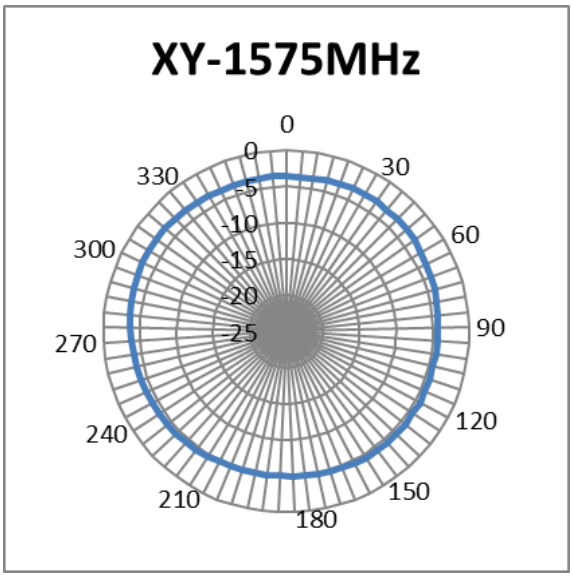


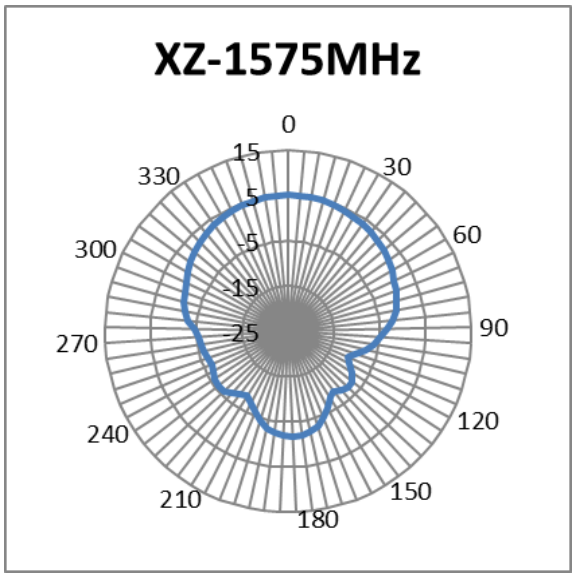
FIGURE 4.7 AXIAL RATIO OF ANTENNA AT GPS L5 BAND IN FREE SPACE

4.8 RADIATION PATTERN

All measurements in this document are done on the reference PCB.







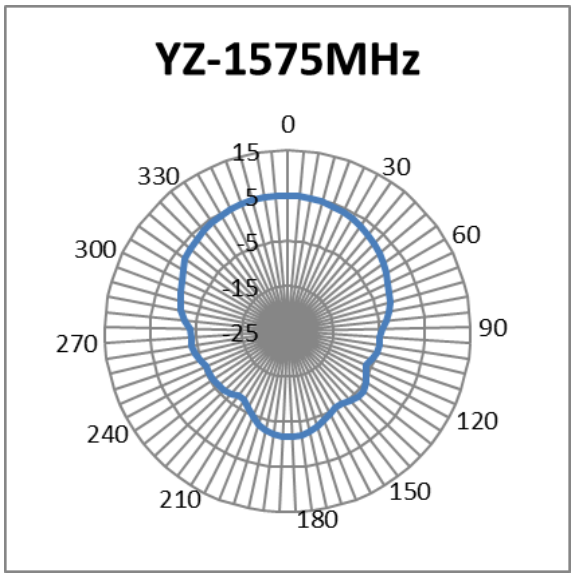


FIGURE 4.8.1 2D RADIATION PATTERN OF ANTENNA AT 1575MHZ IN FREE SPACE

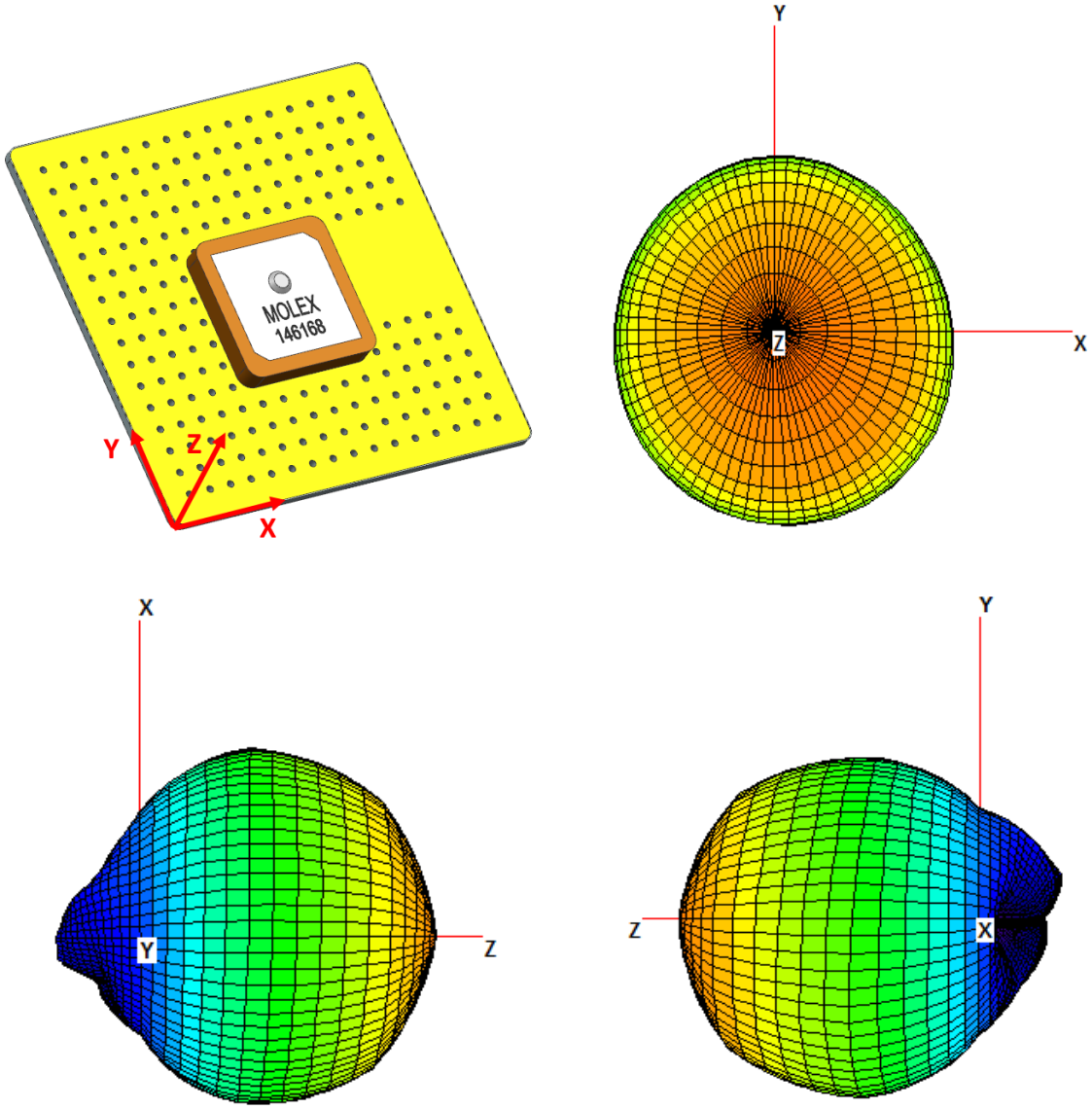


FIGURE 4.8.2 3D RADIATION PATTERN OF ANTENNA AT 1575MHZ IN FREE SPACE

5.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

5.1 ANTENNA RF PERFORMANCES AS A FUNCTION OF DIFFERENT LOCATIONS ON THE GROUND PLANE

Three locations have been evaluated, and these configurations are show in figure 5.1.0. The figure 5.1.1-5.1.4 show the return loss, the efficiency, the peak gain and axial ratio.

The location which gives the best RF performance is location 3. Location 3 (center location) is the recommended location for the antenna.

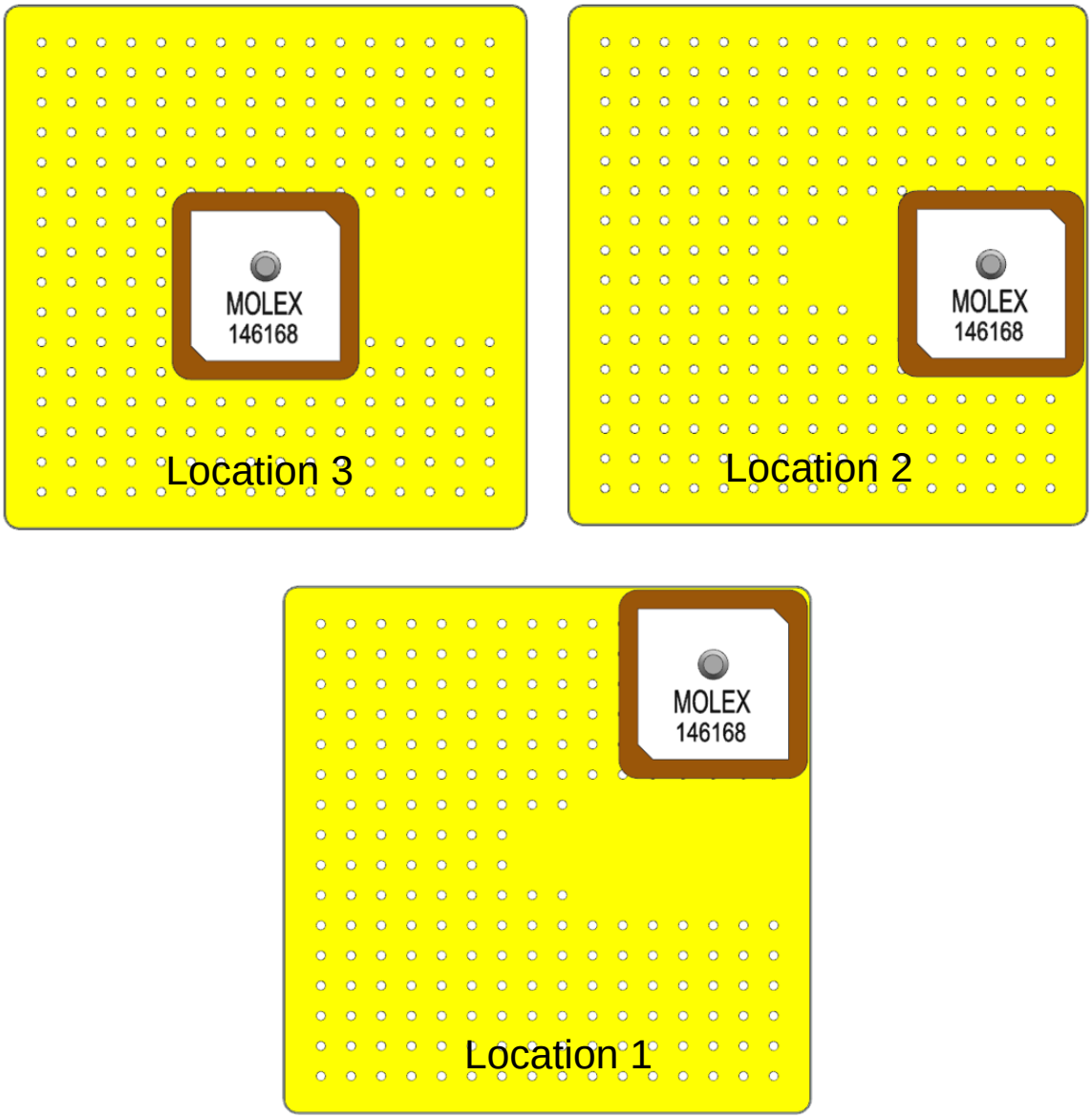


FIGURE 5.1.0 THREE LOCATIONS ON REFERENCE PCB

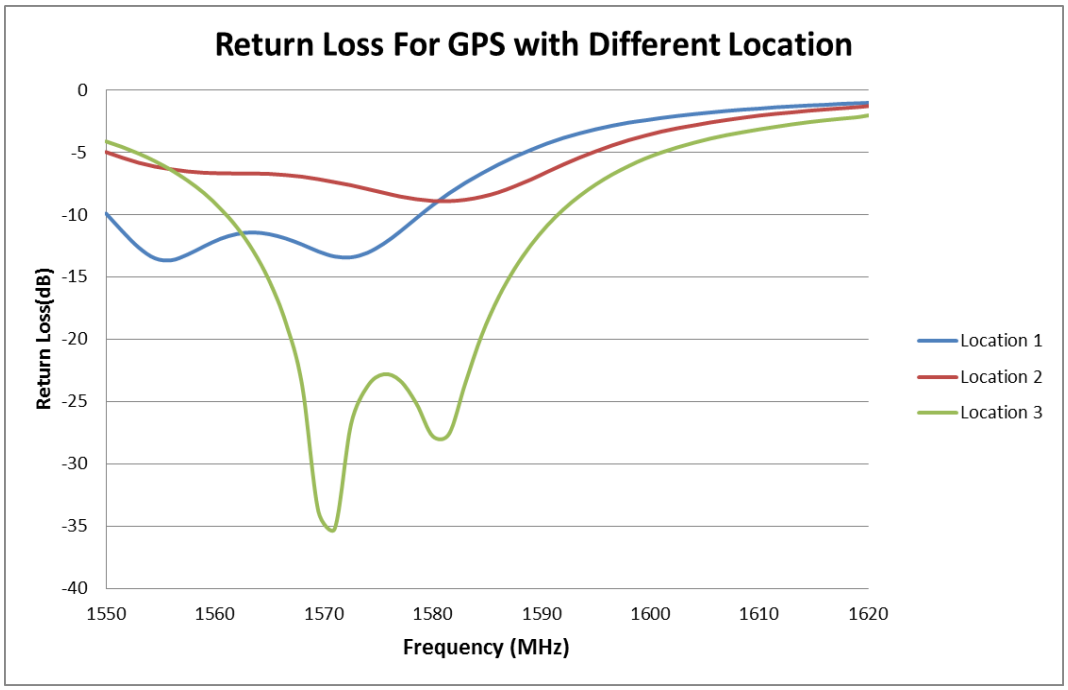


FIGURE 5.1.1 RETURN LOSS OF ANTENNA AT GPS BAND AT THREE LOCATIONS

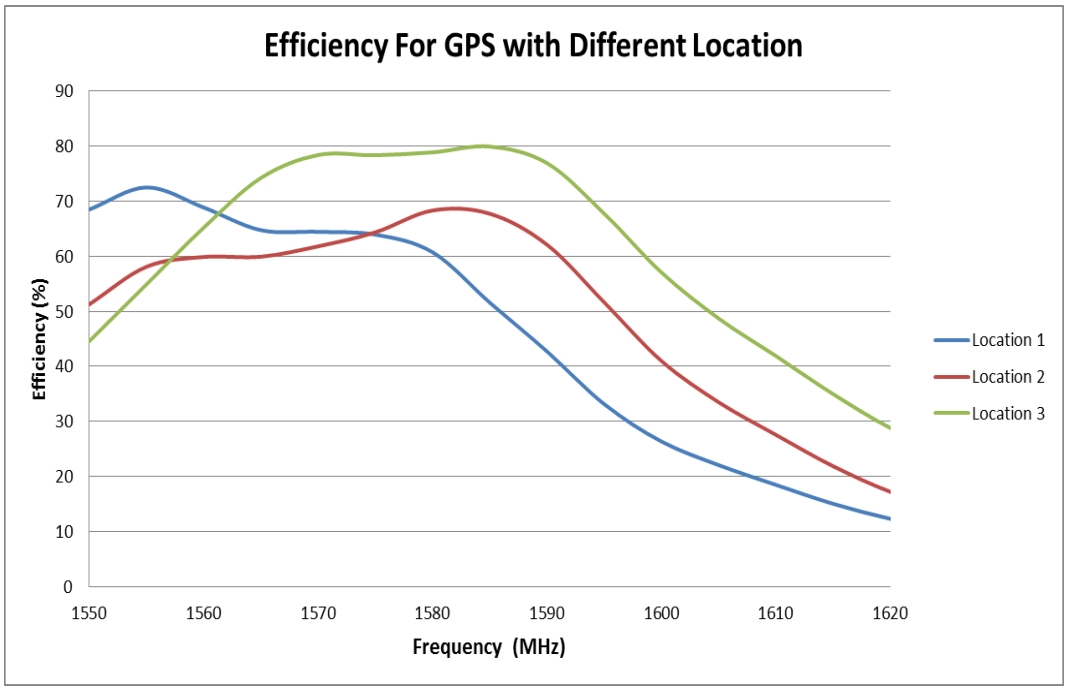


FIGURE 5.1.2 EFFICIENCY OF ANTENNA AT GPS BAND AT THREE LOCATIONS

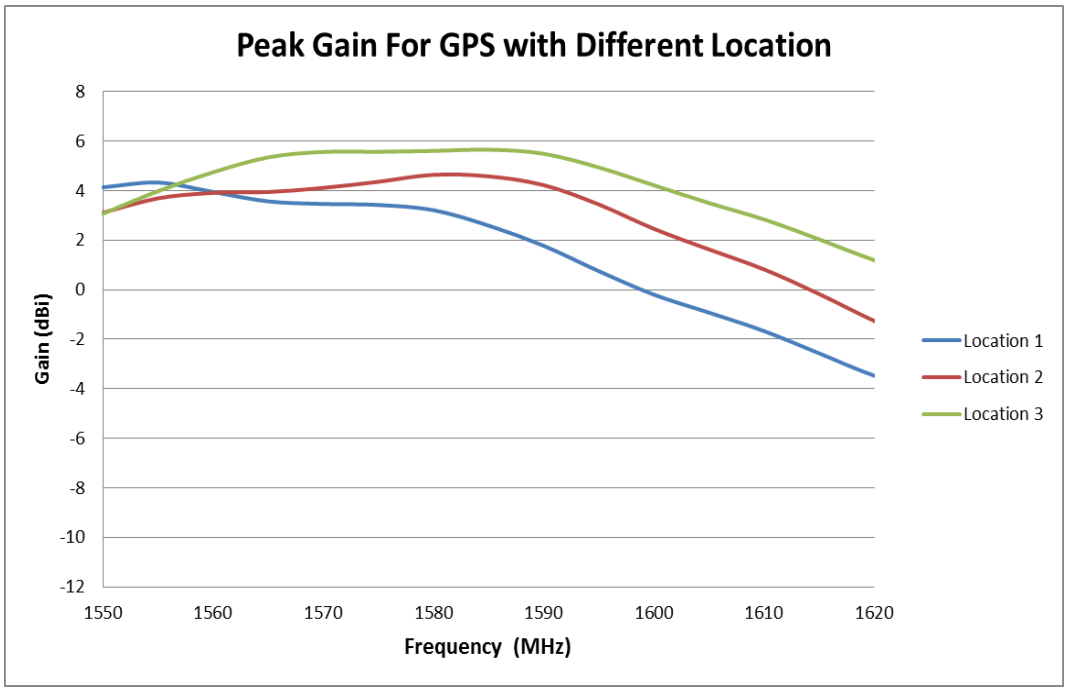


FIGURE 5.1.3 PEAK GAIN OF ANTENNA AT GPS BAND AT THREE LOCATIONS

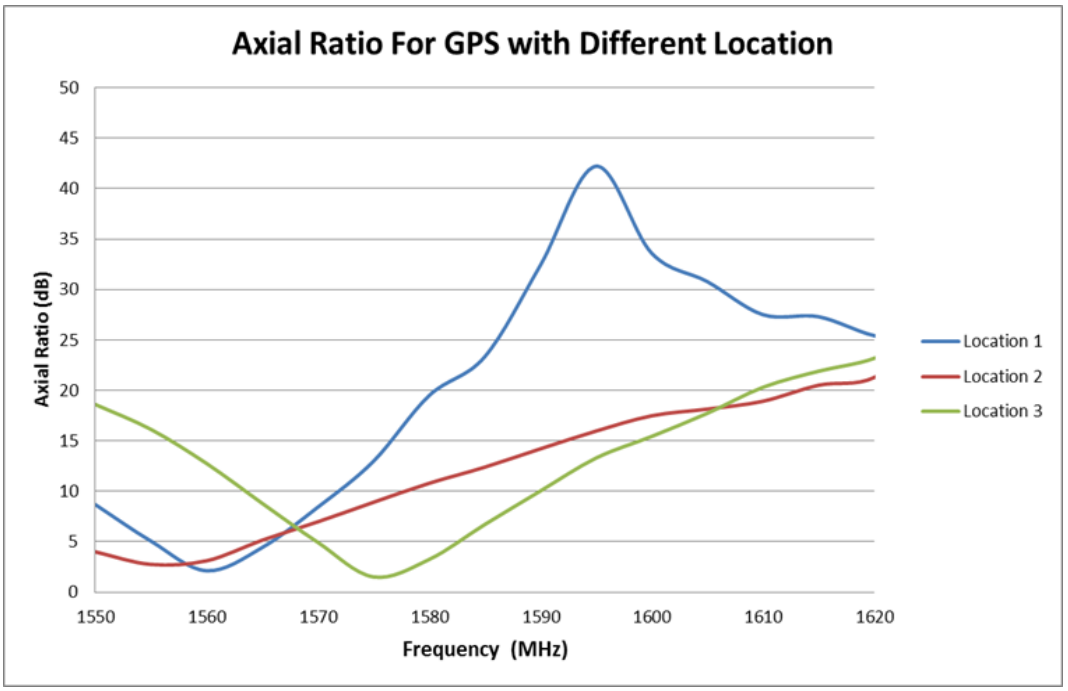
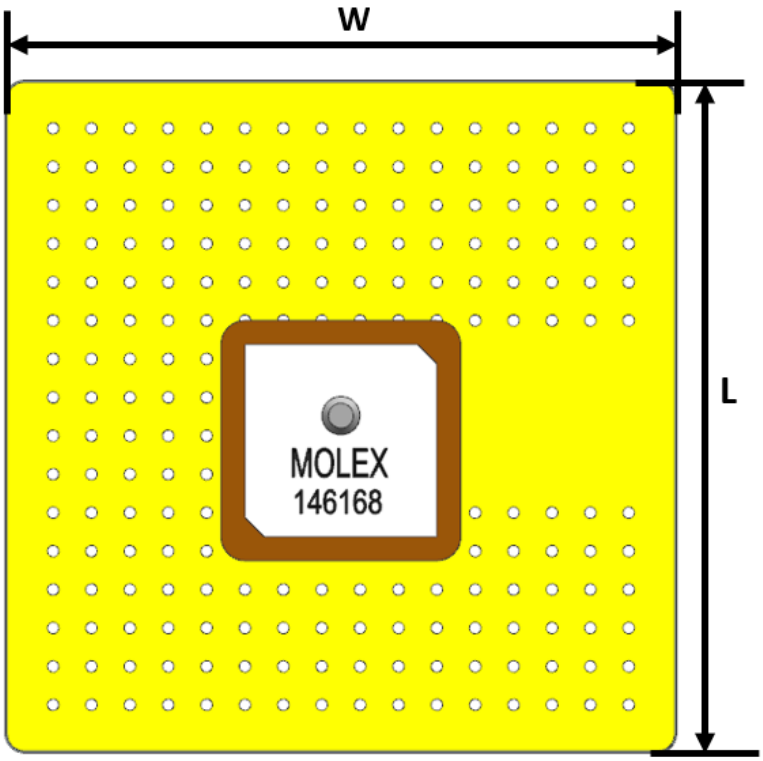


FIGURE 5.1.4 AXIAL RATIO OF ANTENNA AT GPS L1 BAND AT THREE LOCATIONS

5.2 ANTENNA RF PERFORMANCES AS A FUNCTION OF DIFFERENT SIZED GROUNDS

Five kinds of ground plane size have been evaluated, and these configurations are show in figure 5.2. The figure 5.2.1-5.2.4 show the return loss, the efficiency, the peak gain and axial ratio. The ground plane size for this antenna is recommended to be 70mm*70mm (reference size) to meet the antenna specification.



(W*L:35mm*35mm、50mm*50mm、70mm*70mm、90mm*90mm、110mm*110mm)

FIGURE 5.2 FIVE KINDS OF GROUND PLANE SIZE

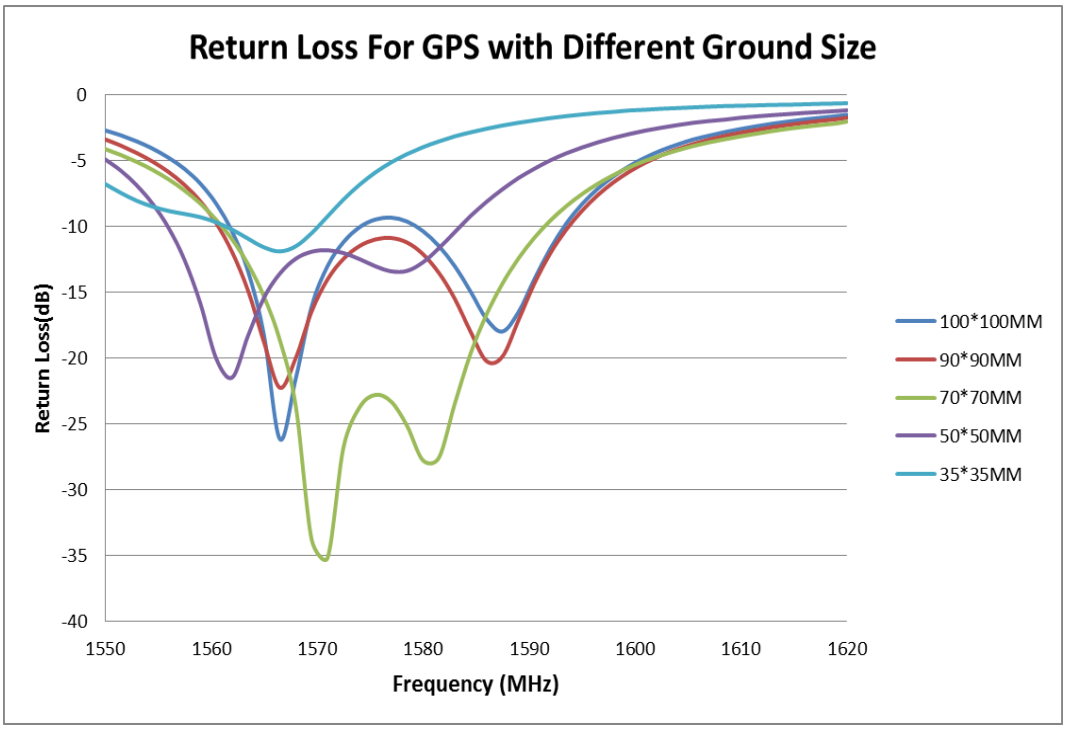


FIGURE 5.2.1 RETURN LOSS OF ANTENNA AT GPS BAND WITH DIFFERENT GROUND SIZES

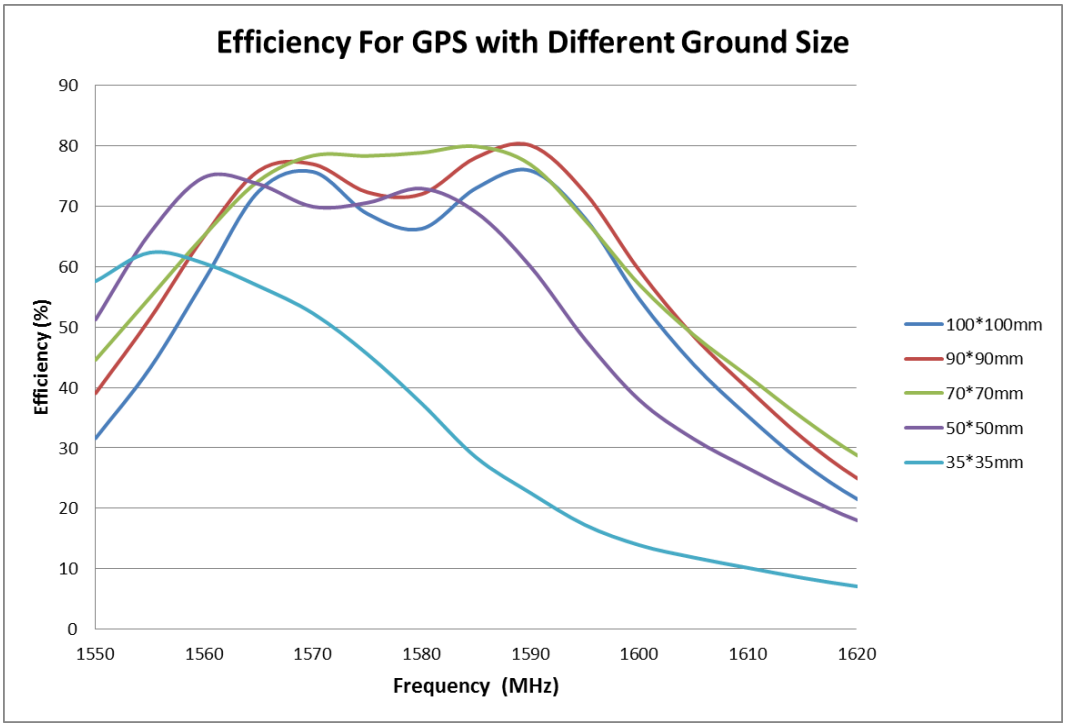


FIGURE 5.2.2 EFFICIENCY OF ANTENNA AT GPS BAND WITH DIFFERENT GROUND SIZES

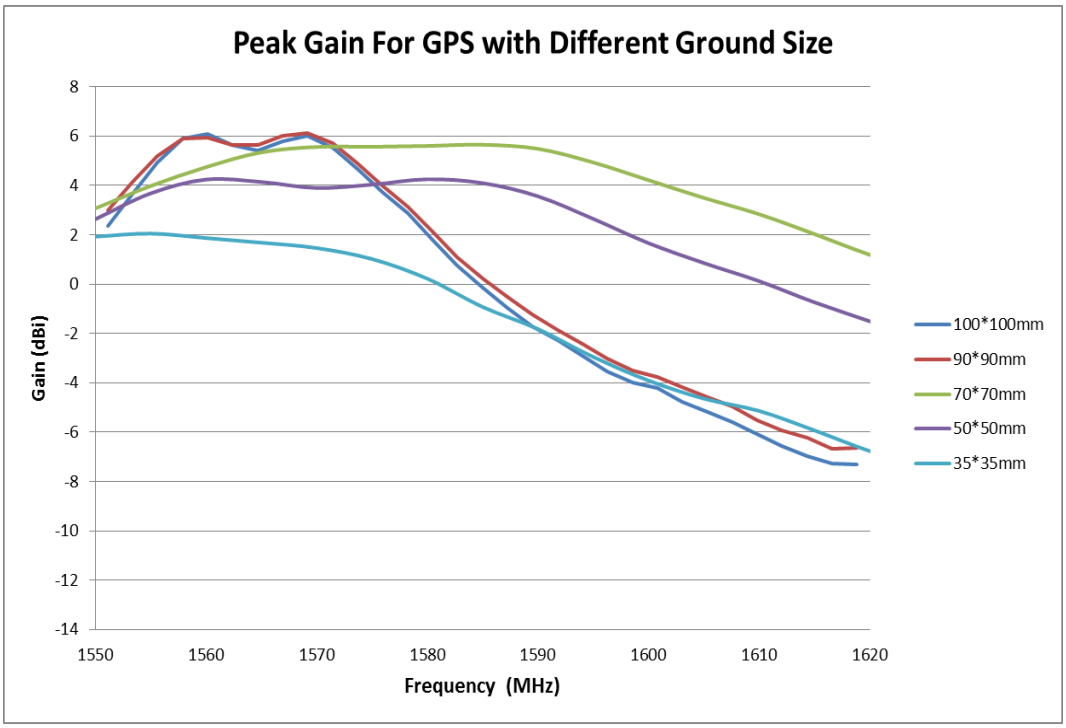


FIGURE 5.2.3 PEAK GAIN OF ANTENNA AT GPS BAND WITH DIFFERENT GROUND SIZES

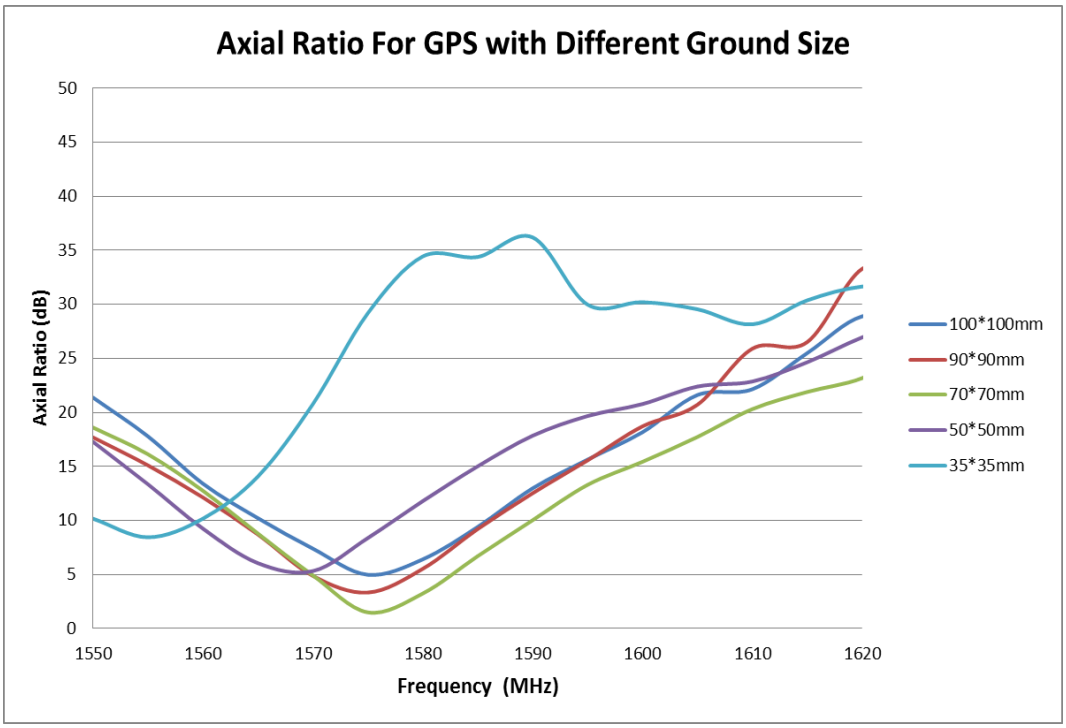


FIGURE 5.2.4 AXIAL RATIO OF ANTENNA AT GPS BAND WITH DIFFERENT GROUND SIZES

5.3 RF PERFORMANCE AS A FUNCTION OF DIFFERENT DISTANCE BETWEEN VERTICAL METAL MATERIAL AND ANTENNA

An evaluation was done with 5 different distances from the antenna which is located at the recommended location to the vertical metal material (50mm x 4mm x 2mm). The 5 distances are as following: 1mm, 3mm, 5mm, 7mm, 10mm.

From the study, we recommend that a metal material (50mm x 4mm x 2mm) should be placed at least 10mm away from the antenna. When the distance is less than 10mm, the antenna performance will be significantly degraded. Refer to figure 5.3.1-5.3.4.

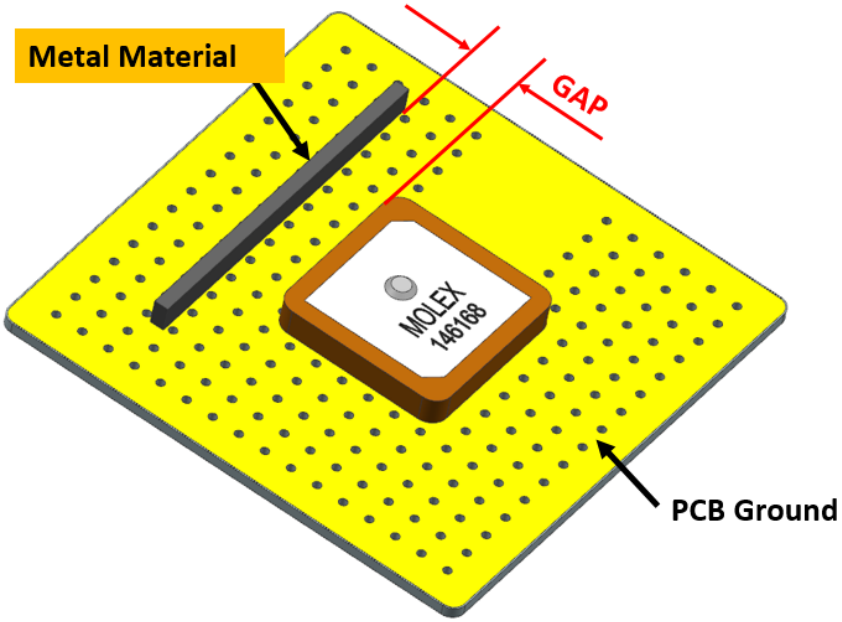


FIGURE 5.3 METAL MATERIAL FIXED ON REFERENCE PCB

Metal Material Size: 50mm*4mm*2mm;
Location 1: Distance between antenna and metal material (GAP) ground is about 1 mm;
Location 2: Distance between antenna and metal material (GAP) ground is about 3 mm;
Location 3: Distance between antenna and metal material (GAP) ground is about 5 mm;
Location 4: Distance between antenna and metal material (GAP) ground is about 7 mm;
Location 5: Distance between antenna and metal material (GAP) ground is about 10 mm;

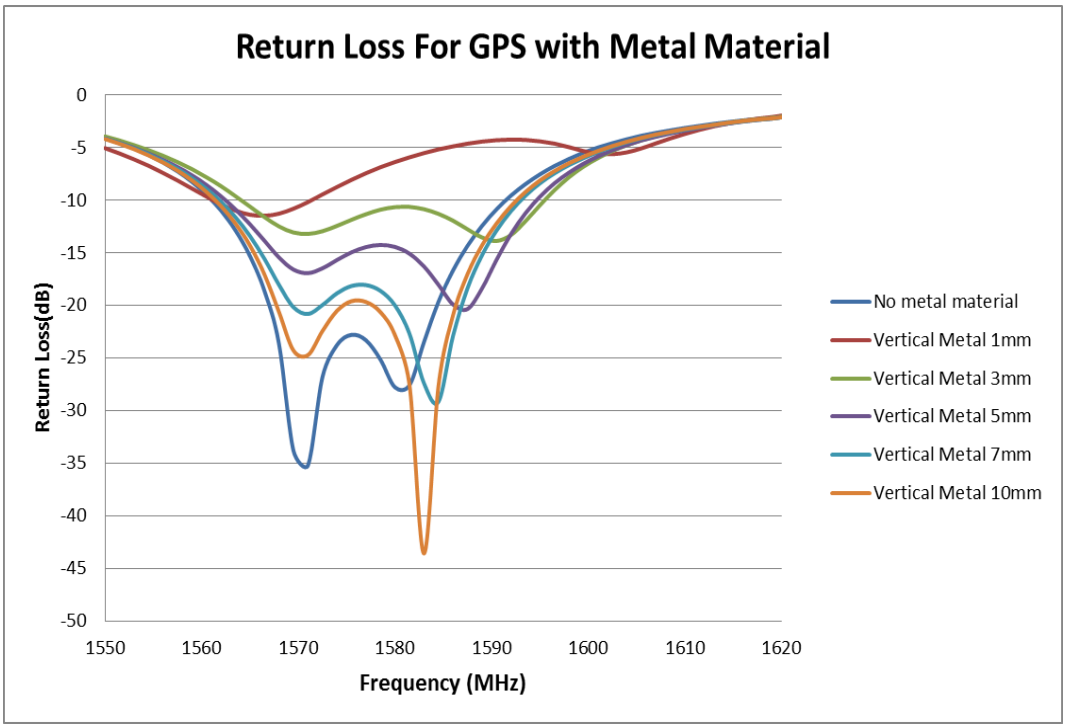


FIGURE 5.3.1 RETURN LOSS OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN ANTENNA AND VERTICAL METAL MATERIAL

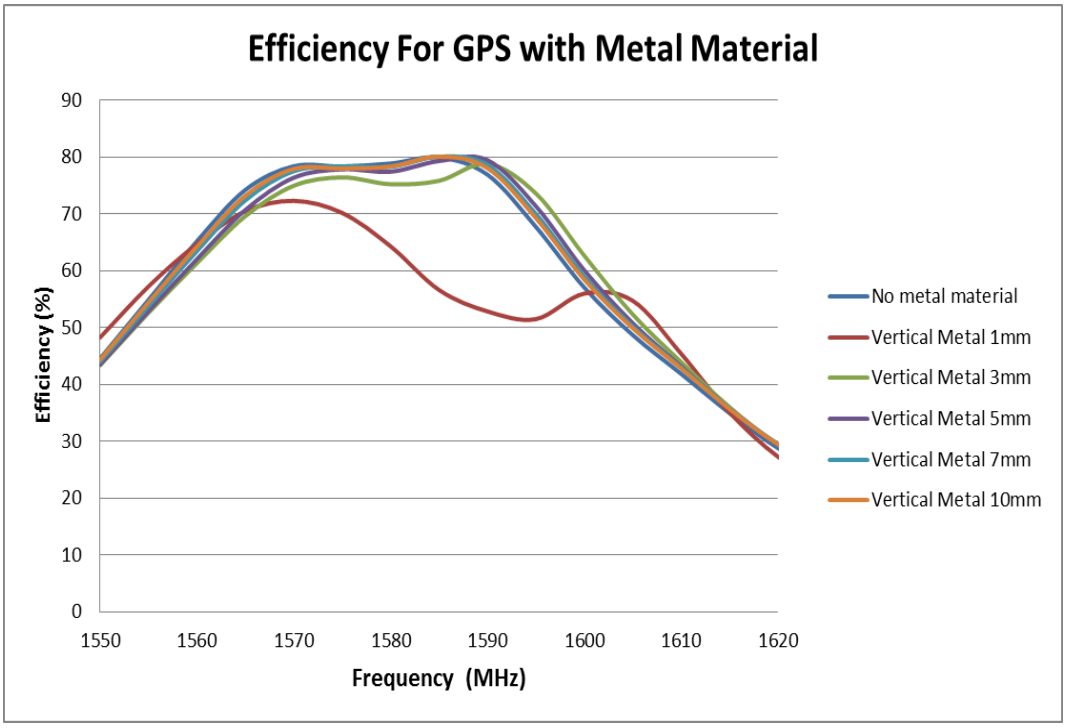


FIGURE 5.3.2 EFFICIENCY OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN ANTENNA AND VERTICAL METAL MATERIAL

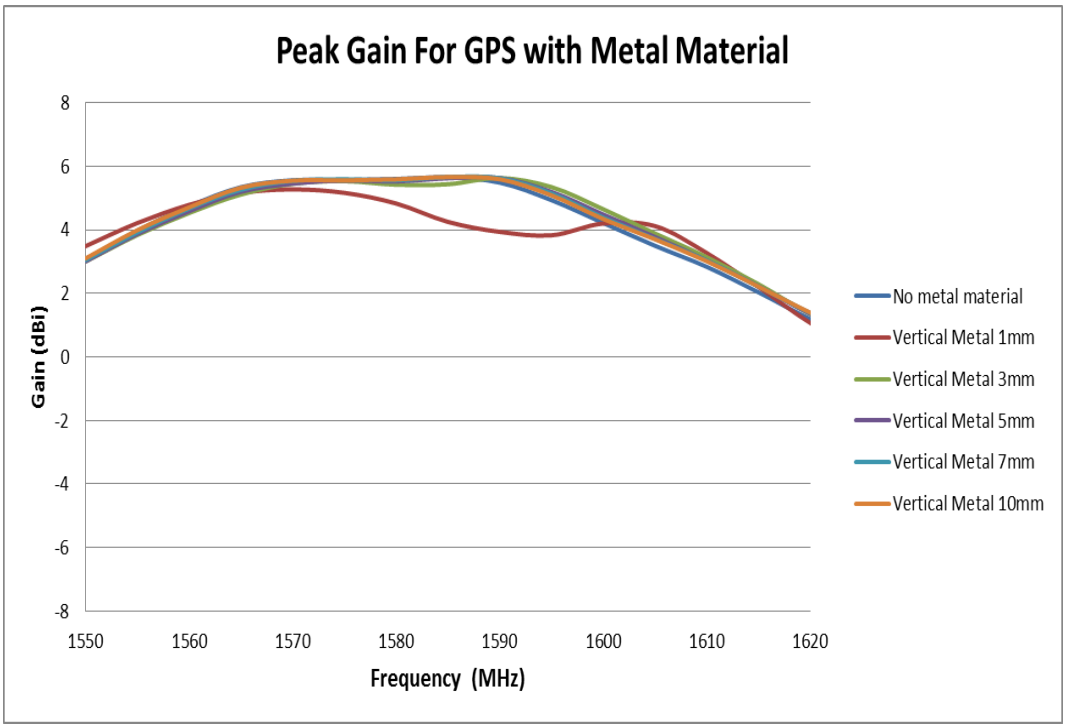


FIGURE 5.3.3 PEAK GAIN OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN ANTENNA AND VERTICAL METAL MATERIAL

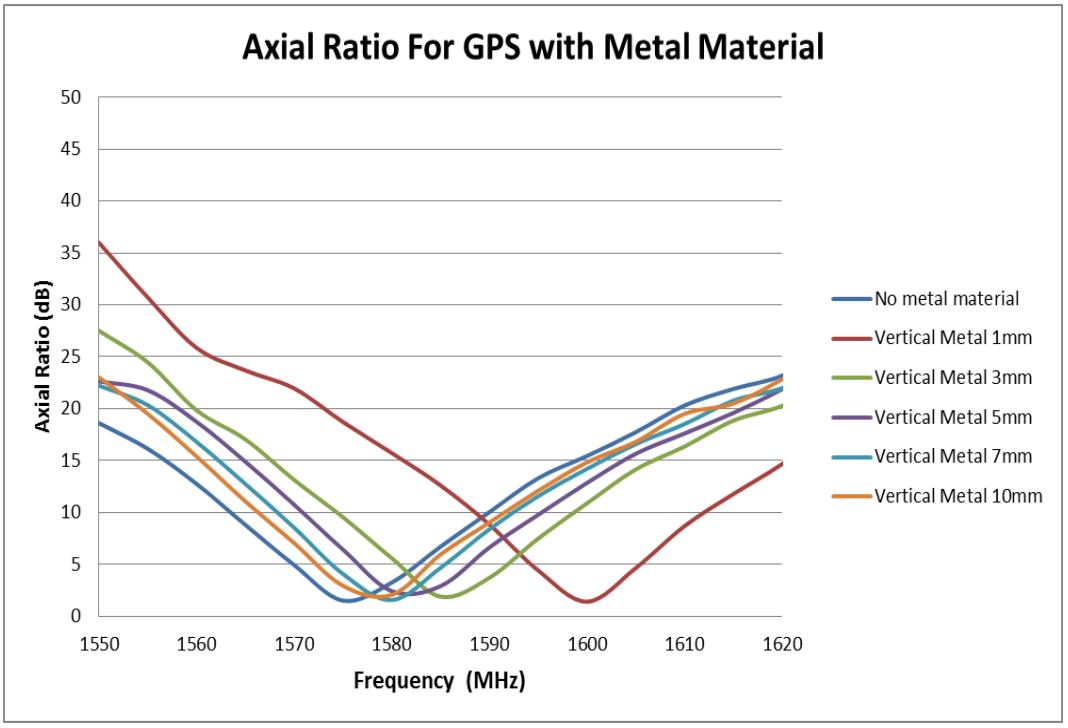


FIGURE 5.3.4 AXIAL RATIO OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN ANTENNA AND VERTICAL METAL MATERIAL

5.4 RF PERFORMANCE AS A FUNCTION OF DIFFERENT DISTANCE BETWEEN HORIZONTAL PLASTIC COVER AND ANTENNA

An evaluation was done with 6 different distances from reference PCB to the horizontal plastic cover (50mm x 50mm x 2mm). The 6 distances are as following: 4mm, 6mm, 8mm, 10mm, 12mm, 14mm.

From the study, we recommend that a plastic cover (50mm x 50mm x 2mm) should be placed at least 4mm away from the antenna. When the distance is less than 4mm, the antenna performance will be significantly degraded. Refer to figure 5.4.1-5.4.4.

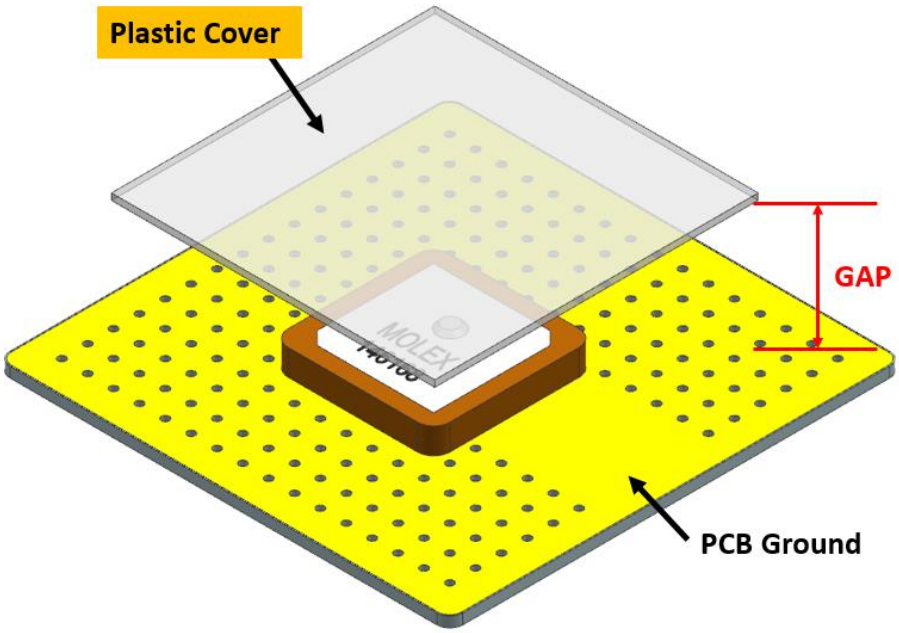


FIGURE 5.4 PLASTIC COVER POSITIONS

Plastic Cover Size: 50mm*50mm*2mm;
Location 1: Distance between PCB and plastic cover (GAP) ground is about 4 mm;
Location 2: Distance between PCB and plastic cover (GAP) ground is about 6 mm;
Location 3: Distance between PCB and plastic cover (GAP) ground is about 8 mm;
Location 4: Distance between PCB and plastic cover (GAP) ground is about 10 mm;
Location 5: Distance between PCB and plastic cover (GAP) ground is about 12 mm;
Location 6: Distance between PCB and plastic cover (GAP) ground is about 14 mm.

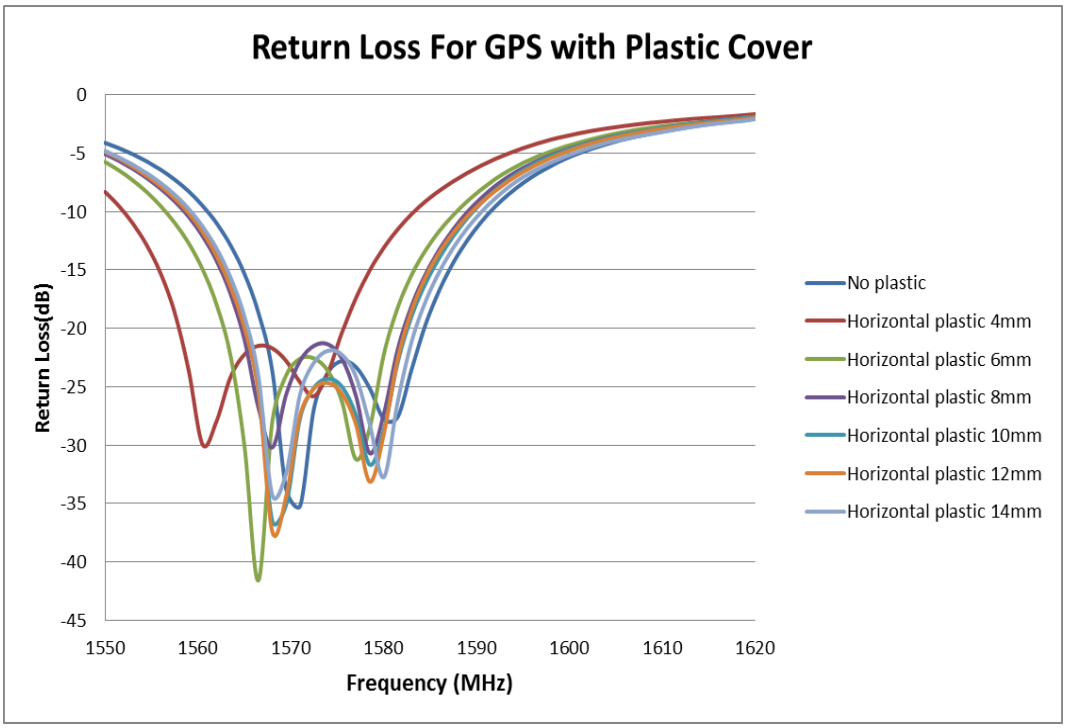


FIGURE 5.4.1 RETURN LOSS OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN REFERENCE PCB AND HORIZONTAL PLASTIC MATERIAL

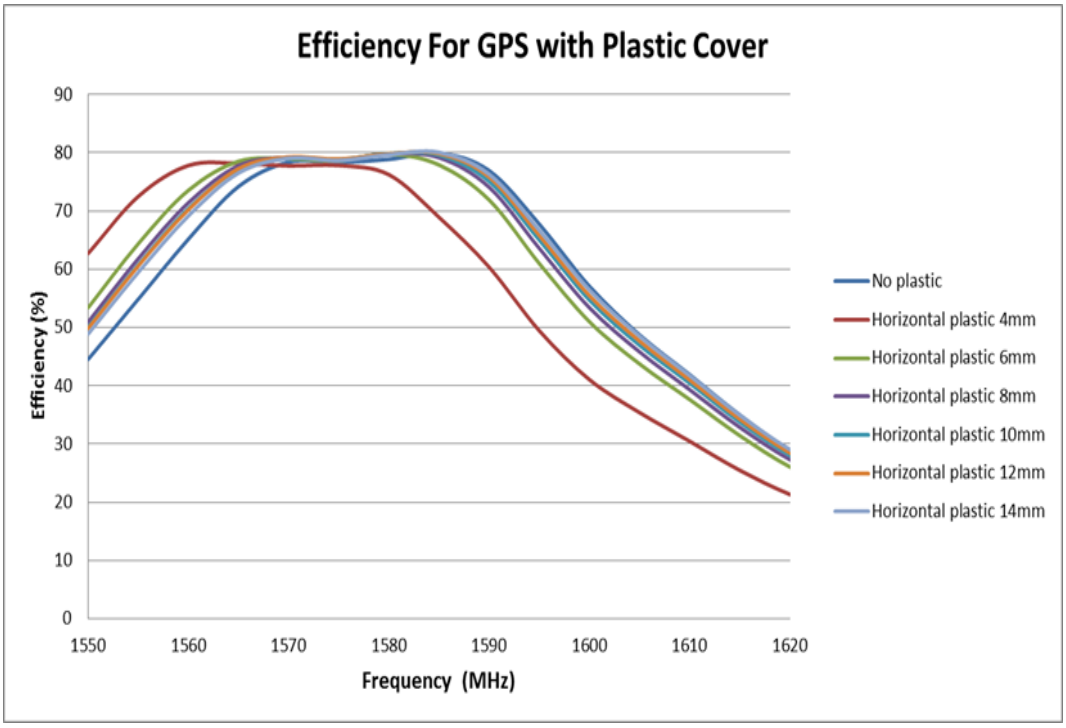


FIGURE 5.4.2 EFFICIENCY OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN REFERENCE PCB AND HORIZONTAL PLASTIC MATERIAL

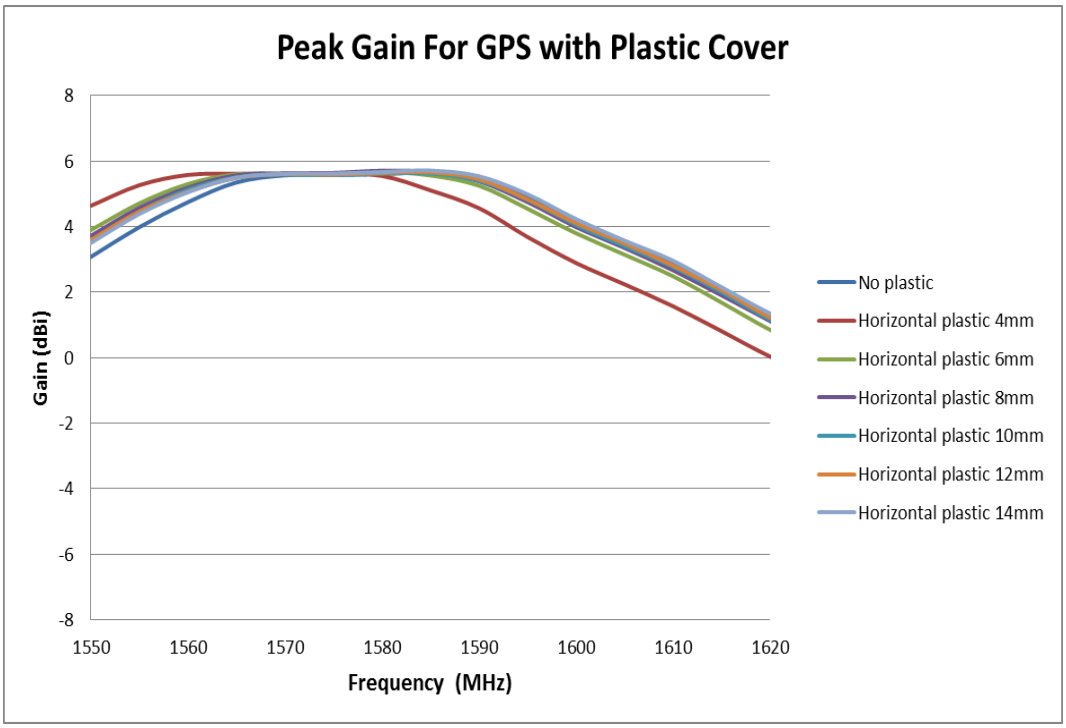


FIGURE 5.4.3 PEAK GAIN OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN REFERENCE PCB AND HORIZONTAL PLASTIC MATERIAL

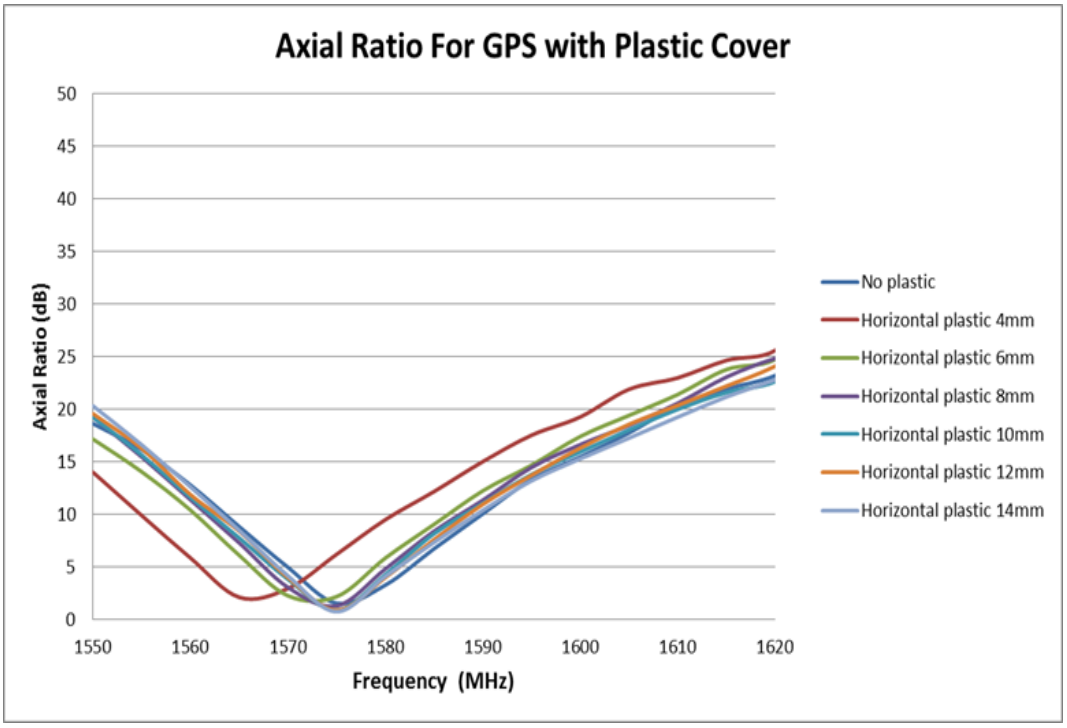


FIGURE 5.4.4 AXIAL RATIO OF ANTENNA FOR GPS BAND AT DIFFERENT DISTANCES BETWEEN REFERENCE PCB AND HORIZONTAL PLASTIC MATERIAL