



APPLICATION SPECIFICATION

HELIX SMT GPS ANTENNA

1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Helix SMT GPS Antenna. The information in this document is for reference and benchmark purposes only. The user is responsible for validating antenna RF performance based on users own PCB and matching circuits. The antenna RF performance can meet various bands including GPS, Glonass and Beidou.

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

A. DEFINITIONS OF TERMS

The antenna design is based on carrier size 5mm x 3mm x 4mm (Length* Width *Height). There are one feeding pad, three fixing pads and antenna radiator. See Figure 1.

1. FEEDING PAD

SMT mounted to feeding pad on PCB. The signal from the transmission line must feed into the feeding pad on the PCB.

2. FIXING PAD

SMT mounted to dummy pads on PCB. Anchoring the antenna to the PCB

3. ANTENNA RADIATOR

To act as a transducer that converts unguided electromagnetic wave to guided electromagnetic wave and vice versa.

4. PICK AND PLACE FEATURE

To enable the antenna to be picked up by SMT machine pick up nozzle.

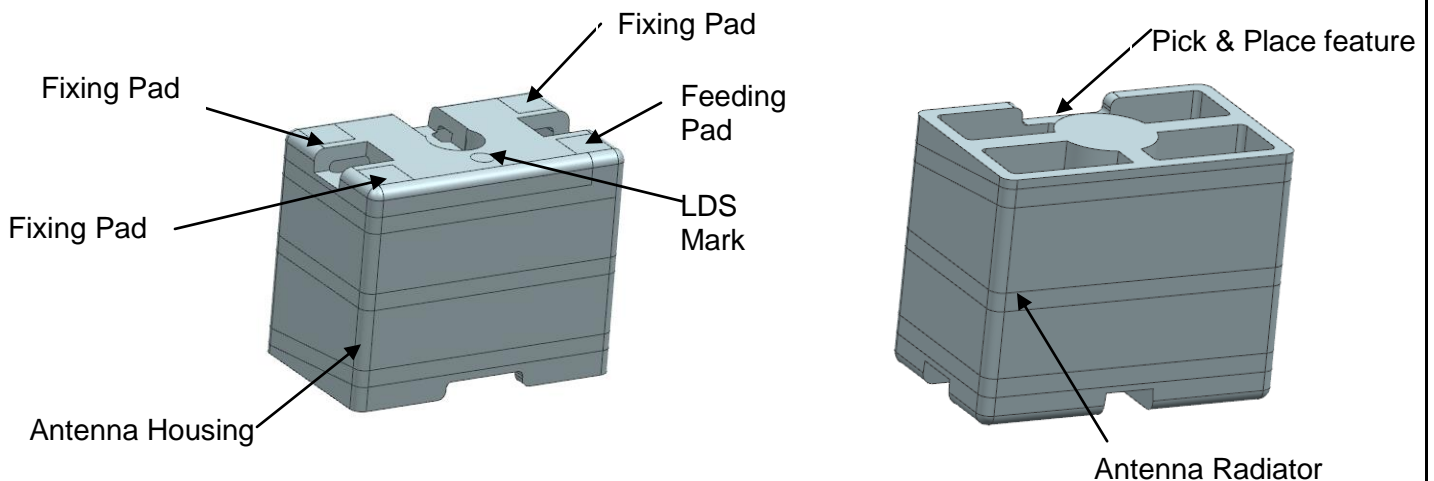


FIGURE1. HELIX SMT GPS ANTENNA

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B. REFERENCE IMPLEMENTATION

I. REFERENCE PCB DESCRIPTION

The reference design is based on a recommended double sided PCB size of 100 mm* 50 mm *1 mm. There are one feeding pad and three fixing pads. Furthermore there is a “L” type matching network reserved close to feeding pad. The PCB ground should be at least 1mm far away from fixing pads. See figure 2 and 2.1.

1. FEEDING PAD

The signal from transmission line must be fed into the feeding pad.

2. FIXING PAD

Anchoring the antenna to the PCB

3. MATCHING CIRCUIT

Recommended to reserve PCB space for a “L” type matching circuit in case it should be necessary to adjust the return loss due to loading by the device housing and surrounding components.

II. REFERENCE PCB LAYOUT

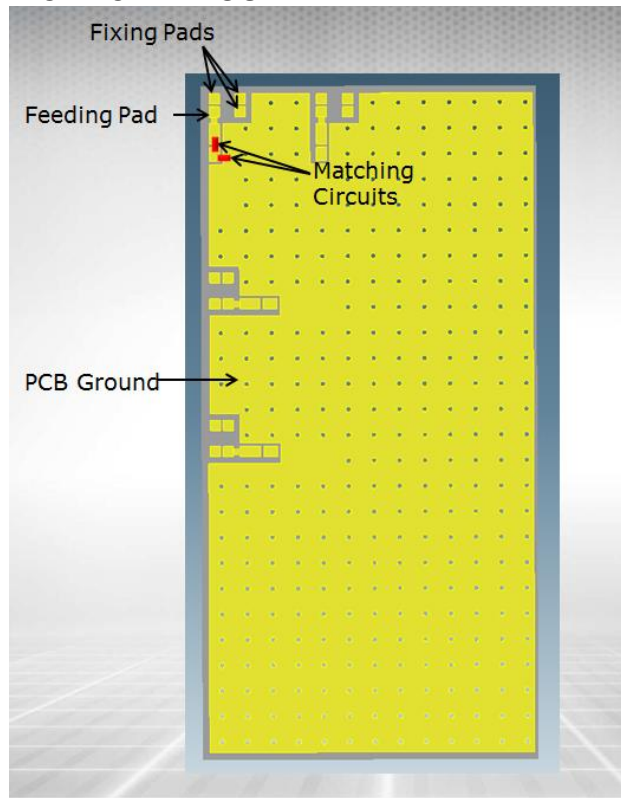


FIGURE 2: RECOMMENDED PCB LAYOUT
(Note: PCB size of 100 mm x 50 mm x1mm)

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III. PERFORMANCE AT REFERENCE ANTENNA LOCATION

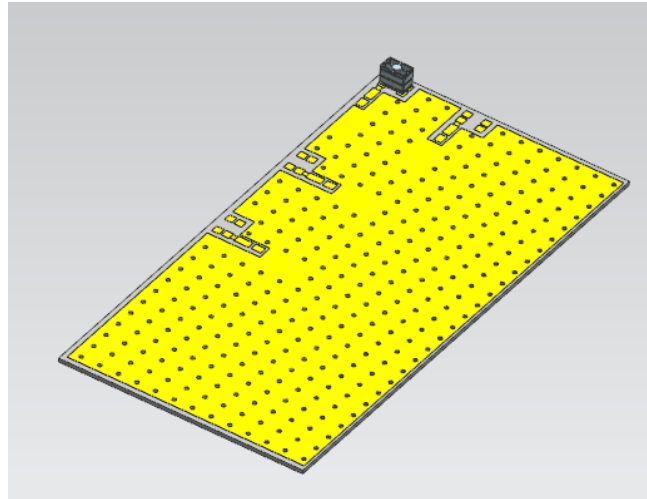


Figure 2.1 REFERENCE ANTENNA LOCATION

The reference antenna location is at the corner of the PCB as show in Figure 2.1.

DESCRIPTION	Test Condition	Requirements		
		1561MHz +/-5MHz	1575MHz +/-5MHz	1602MHz +/-5MHz
Frequency Range	Measure antenna on recommended PCB through VNA E5071C	1561MHz +/-5MHz	1575MHz +/-5MHz	1602MHz +/-5MHz
Return Loss	Measure antenna on recommended PCB through VNA E5071C	< -8 dB		
Peak Gain	Measure antenna on recommended PCB through OTA chamber	0.7dBi	1.1dBi	1.1dBi
Avg. Total Efficiency	Measure antenna on recommended PCB through OTA chamber	>50%	>55%	>50%
Polarization	Measure antenna on recommended PCB through OTA chamber	RHCP		
Axial Ratio	Measure antenna on recommended PCB through OTA chamber	<6dB		
Input Impedance	Measure antenna on recommended PCB through VNA E5071C	50Ohms		

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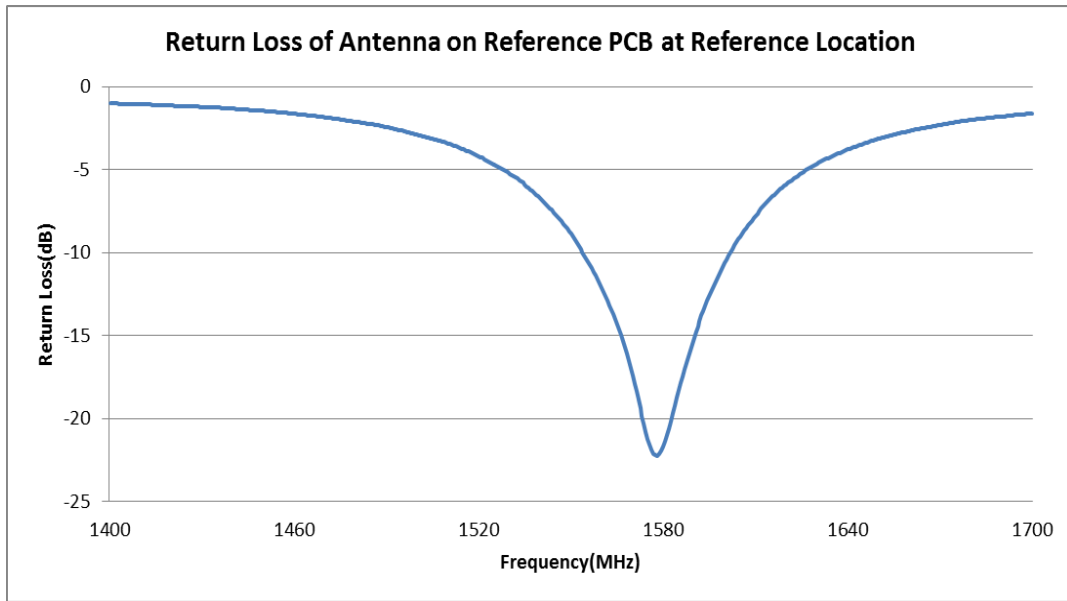


FIGURE 2.2 RETURN LOSS OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

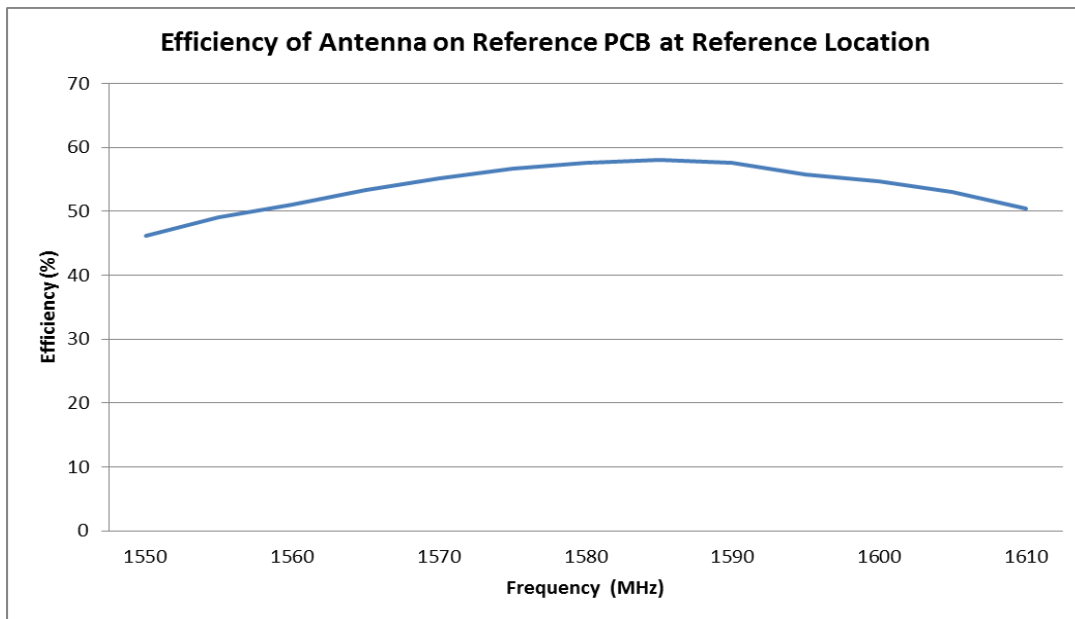


FIGURE 2.3 EFFICIENCY OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

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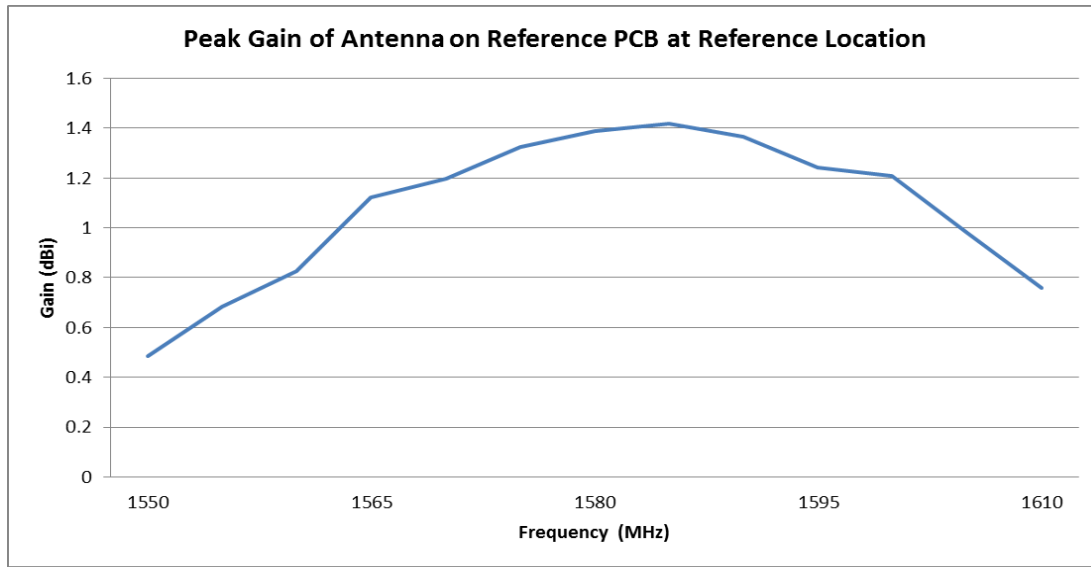


FIGURE 2.4 PEAK GAIN OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

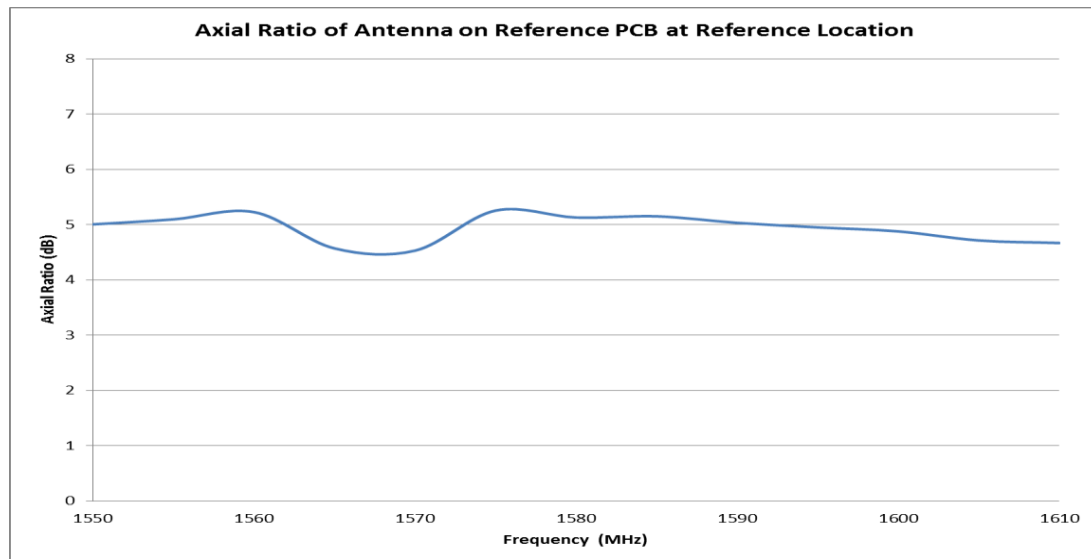


FIGURE 2.5 AXIAL RATIO OF ANTENNA AT GPS BAND AT REFERENCE LOCATION

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3.0 REFERENCE DOCUMENTS

- Engineering Drawing :AS-146235-001
- Product Specification: PS-146235-001
- Packaging Information – Refer to the Molex related packaging drawings.

4.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

4.1 ANTENNA RF PERFORMANCE AS A FUNCTION OF LOCATION ON THE PCB

Four locations have been evaluated RF performance and these locations are shown in figure 4.1. Figure 4.1.1, Figure 4.1.2, Figure 4.1.3 and Figure 4.1.4 comparatively present the return loss, efficiency, peak gain and axial ratio at GPS band at four locations.

The location which gives the best RF performance is location 1. Location 1 (corner location) is the recommended location for the antenna.

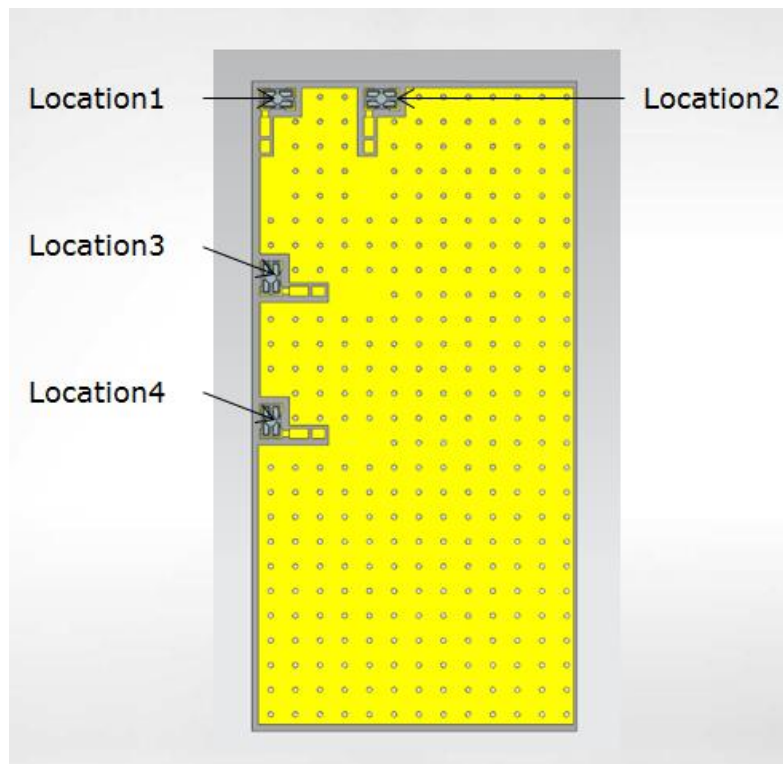


FIGURE 4.1 FOUR LOCATIONS ON REFERENCE PCB

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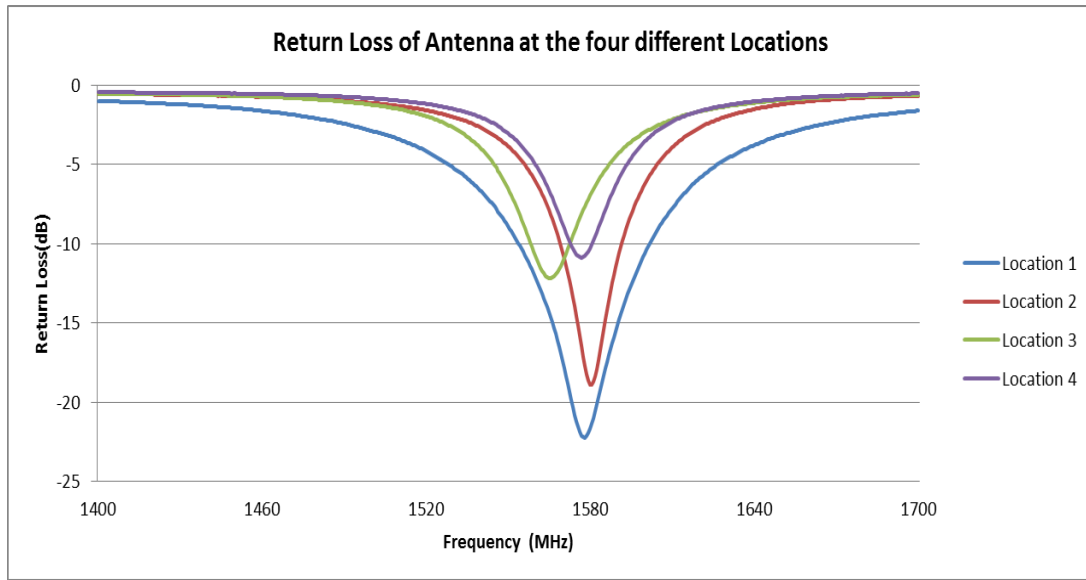


Figure 4.1.1 RETURN LOSS OF ANTENNA AT GPS BAND AT FOUR LOCATIONS

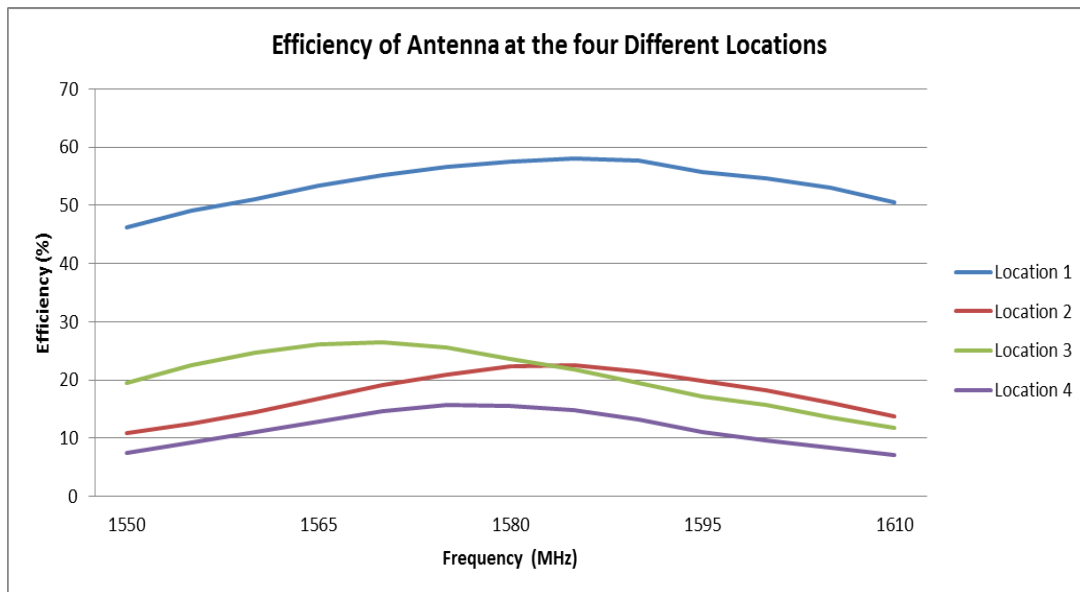


Figure 4.1.2 EFFICIENCY OF ANTENNA AT GPS BAND AT FOUR LOCATIONS

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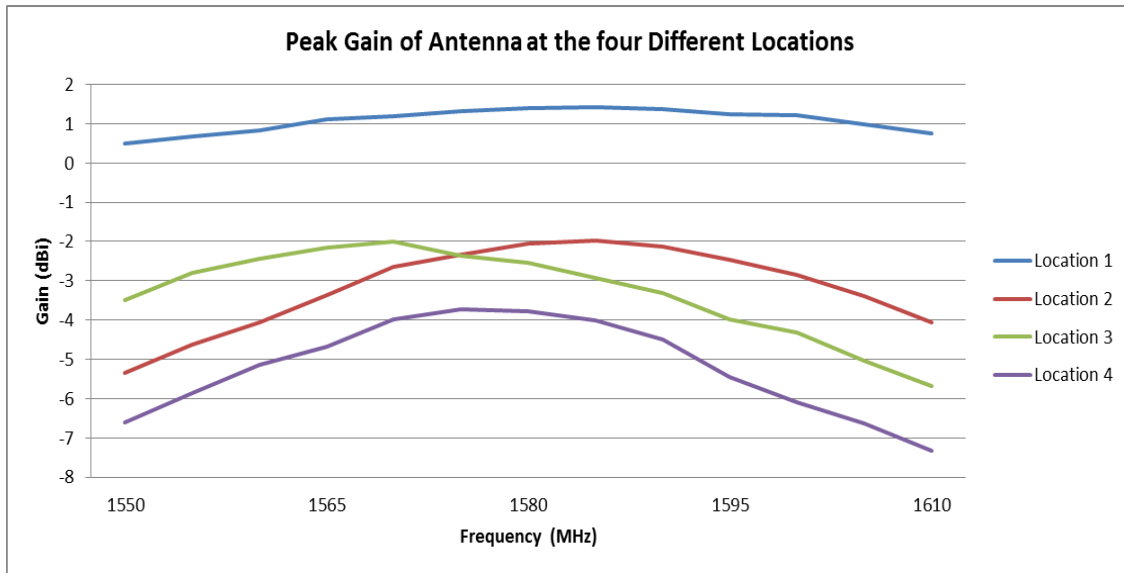


Figure 4.1.3 PEAK GAIN OF ANTENNA AT GPS BAND AT FOUR LOCATIONS

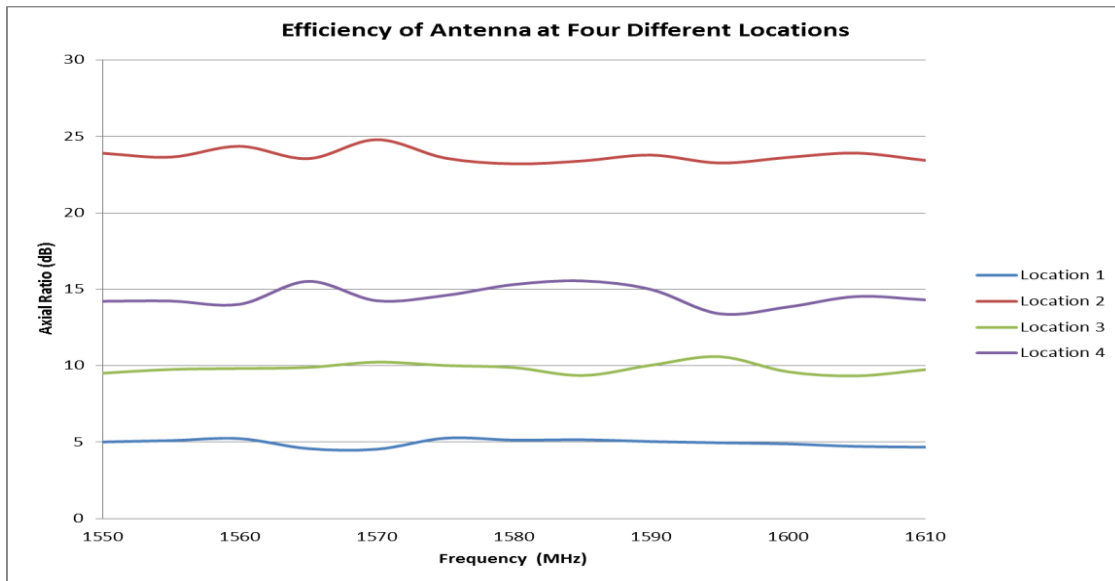


Figure 4.1.4 AXIAL RATIO OF ANTENNA AT GPS BAND AT FOUR LOCATIONS

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4.2 ANTENNA RF PERFORMANCE INFLUENCED BY NEARBY SHIELDING CAN

The effect of shielding can is evaluated with three different distances from the antenna at recommended location. The three distances are as following: 1mm, 3mm and 5mm.

From the study, we recommend that a shielding can (30mm x 30mm x 2mm) should be placed 5mm away from the antenna. When the distance is less than 5mm, the antenna performance will be significantly degraded. Refer to figure 4.2.1- 4.2.4

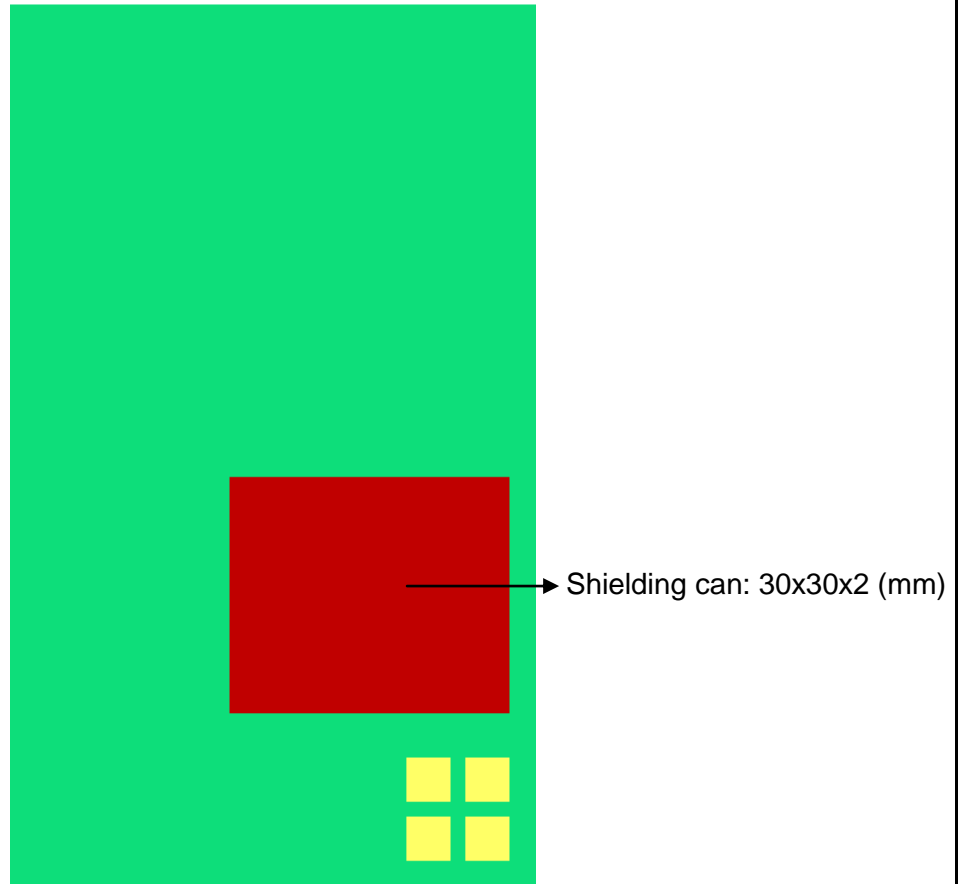


Figure 4.2 SHIELDING CAN FIXED ON REFERENCE PCB

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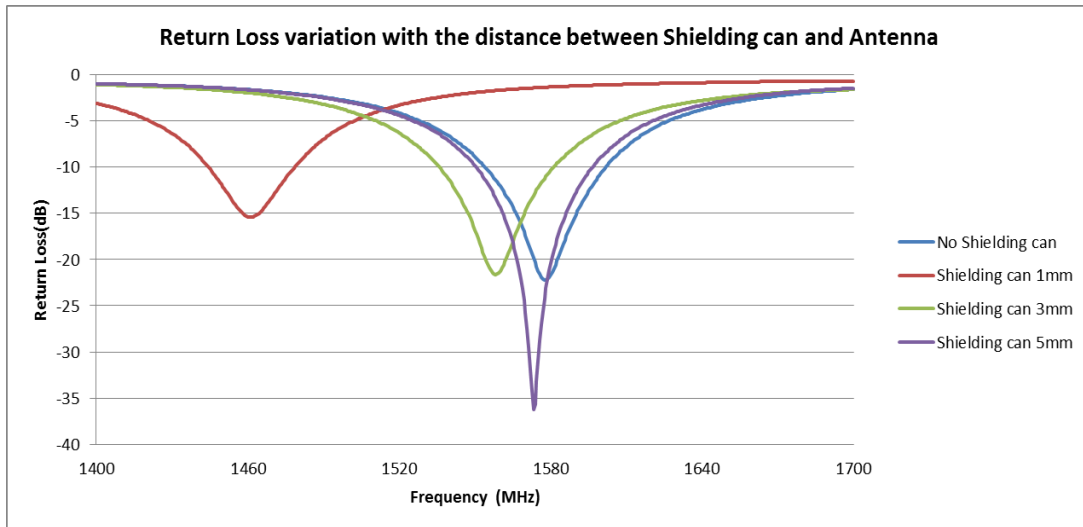


FIGURE 4.2.1 RETURN LOSS COMPARISON AT GPS BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

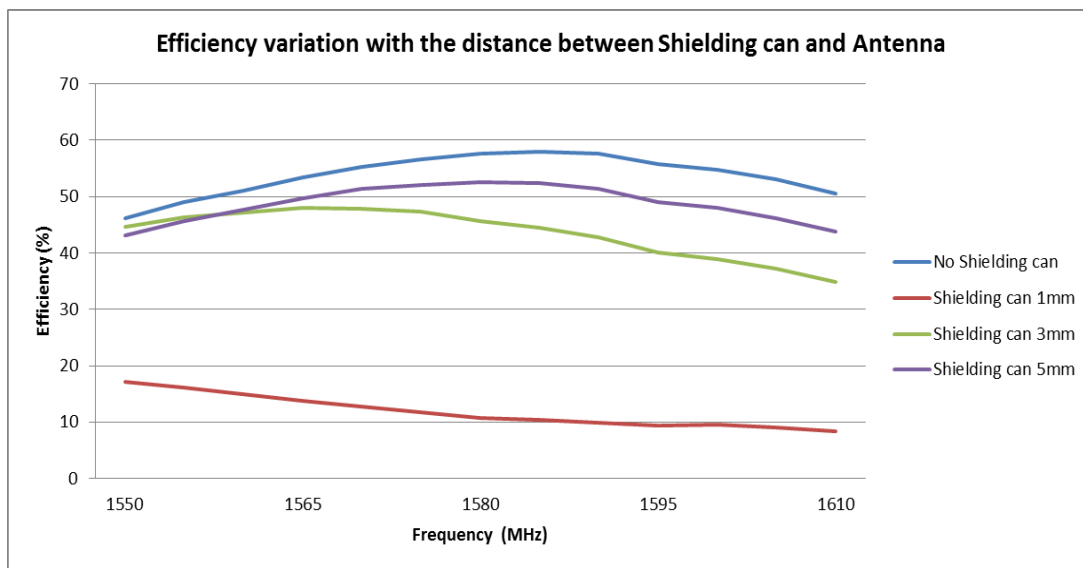


FIGURE 4.2.2 EFFICIENCY COMPARISON AT GPS BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

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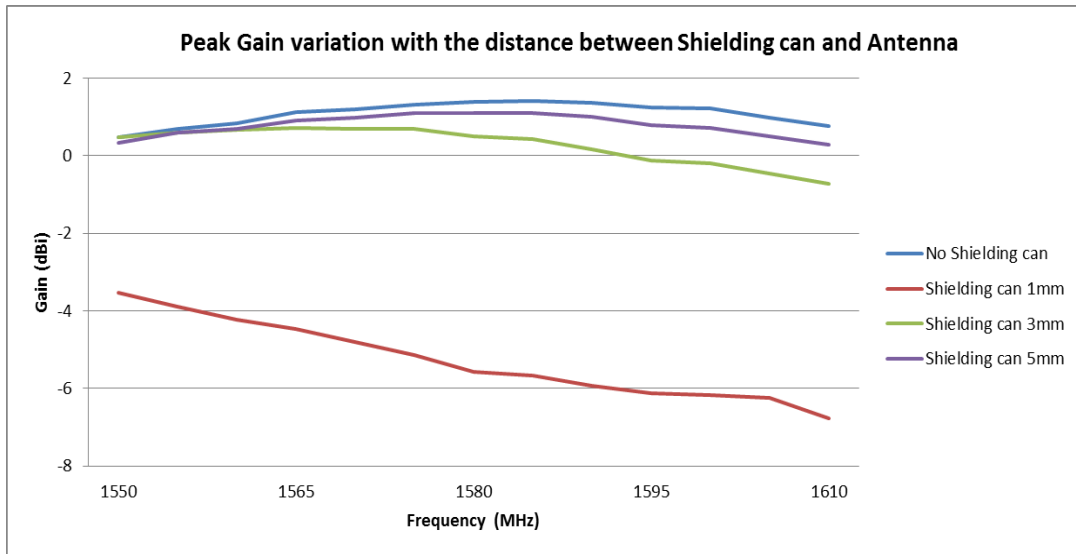


FIGURE 4.2.3 PEAK GAIN COMPARISON AT GPS BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

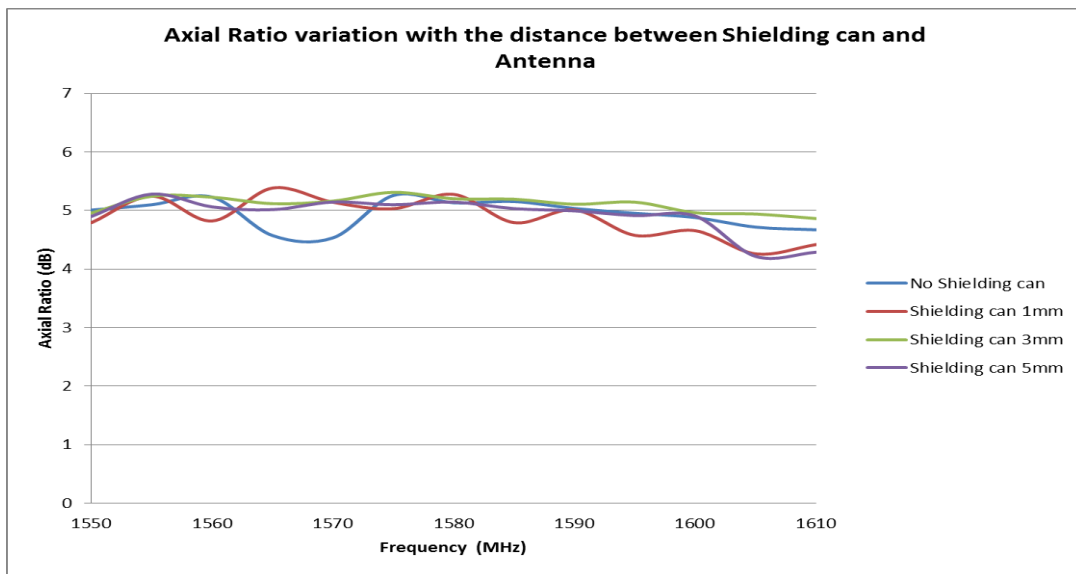


FIGURE 4.2.4 AXIAL RATIO COMPARISON AT GPS BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

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4.3 RF PERFORMANCE INFLUENCED BY NEARBY BATTERY

The effect of battery is evaluated with 3 different distances from the antenna which located at the recommended location. The 3 distances are as follow: 1mm, 3mm and 5mm.

From the study, we recommend that a battery (30mm x 60mm x 3mm) should be placed at least 5mm away from the antenna. When the distance is less than 5mm, the antenna performance will be significantly degraded. Refer to figure 4.3.1-4.3.4.

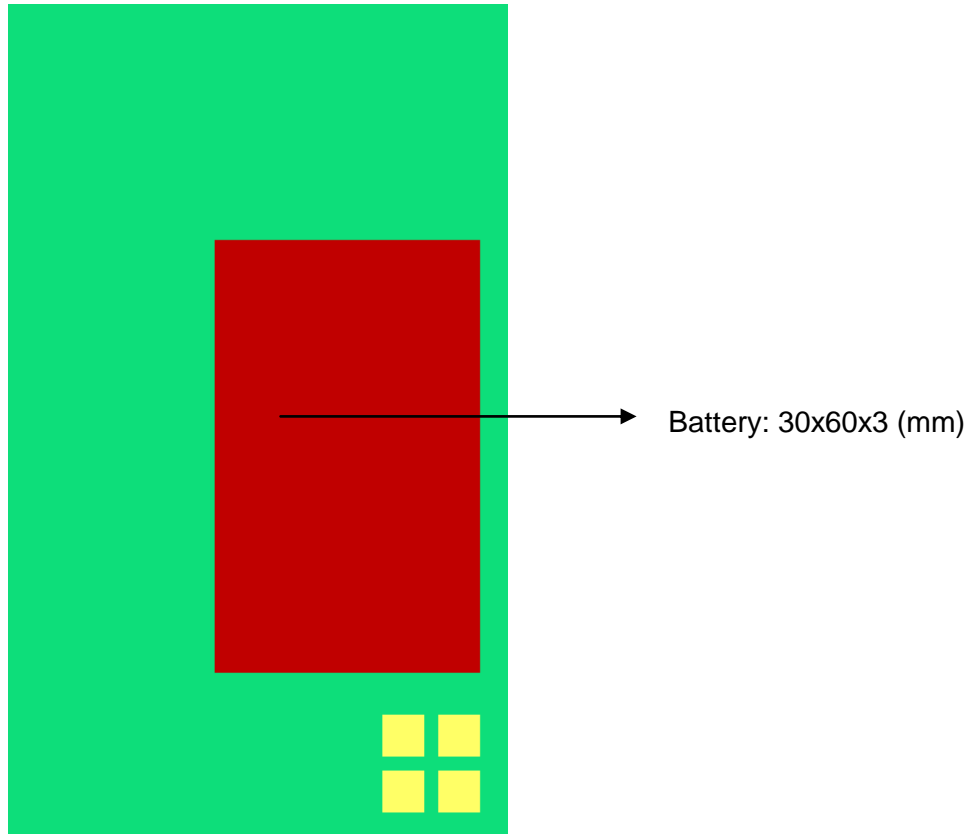


FIGURE 4.3 BATTERY FIXED ON REFERENCE PCB

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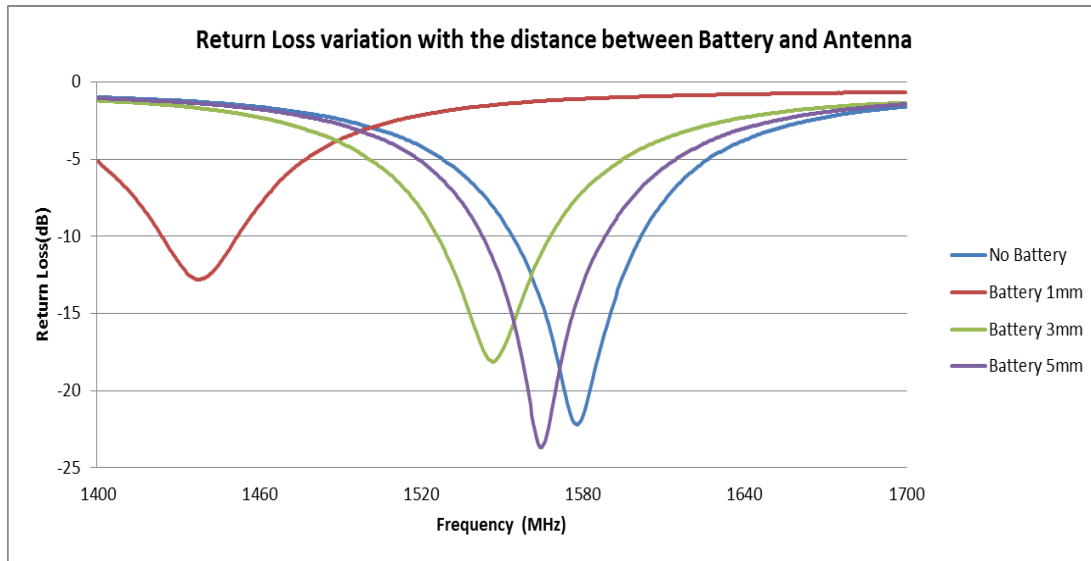


FIGURE 4.3.1 RETURN LOSS COMPARISON AT GPS BAND OF BATTERY DISTANCE FROM ANTENNA

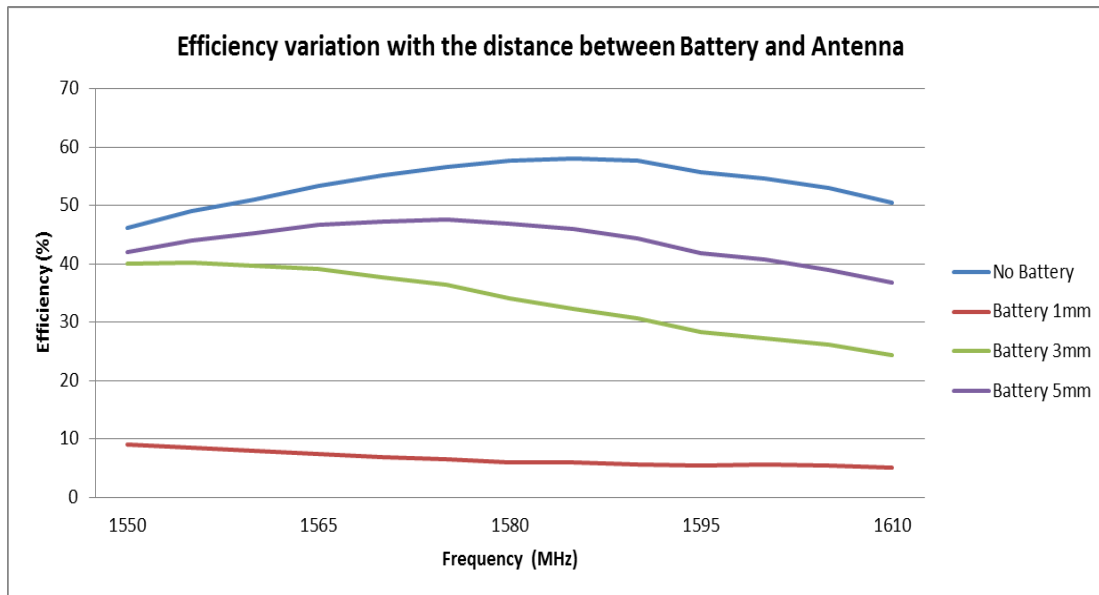


FIGURE 4.3.2 EFFICIENCY COMPARISON AT GPS BAND OF BATTERY DISTANCE FROM ANTENNA

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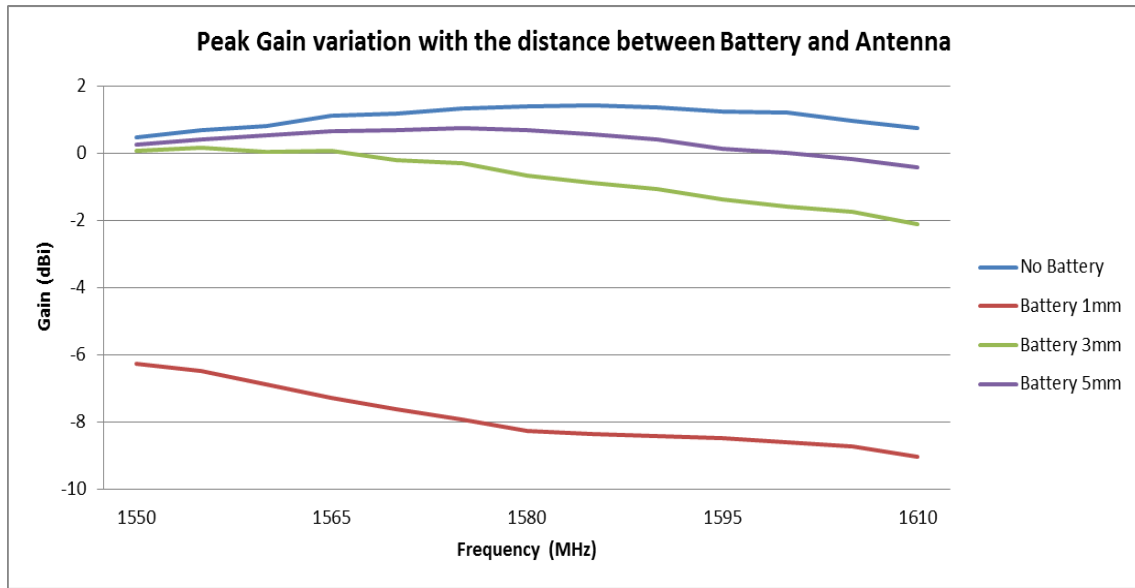


FIGURE 4.3.3 PEAK GAIN COMPARISON AT GPS BAND OF BATTERY DISTANCE FROM ANTENNA

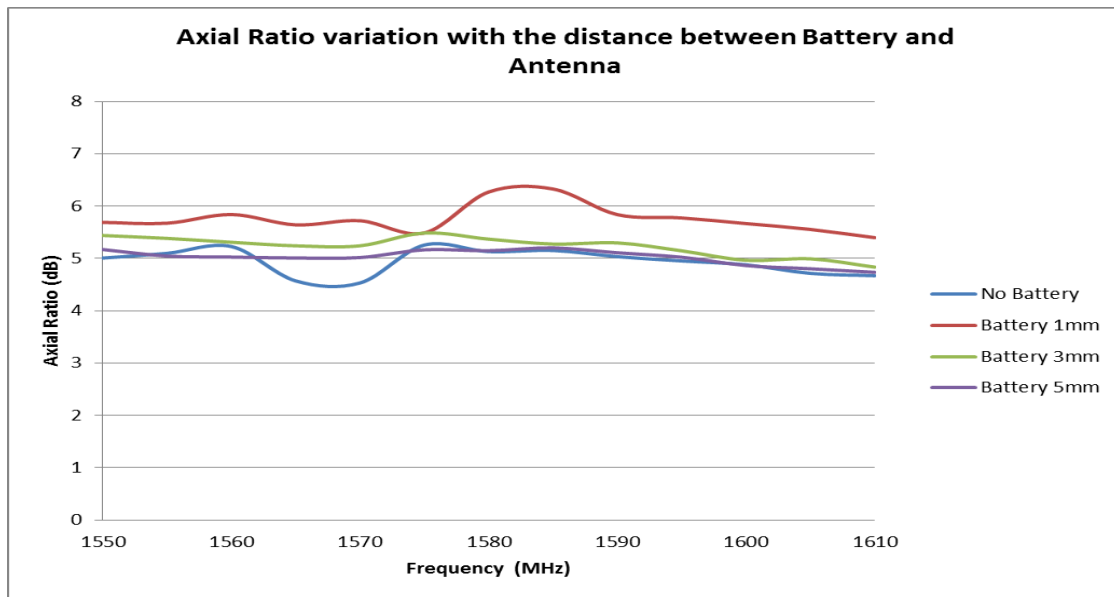


FIGURE 4.3.4 AXIAL RATIO COMPARISON AT GPS BAND OF BATTERY DISTANCE FROM ANTENNA

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4.4 RF PERFORMANCE AS AN EFFECT OF NEARBY BATTERY

4 kinds of ground plane size have been evaluated, and these configurations are shown in figure 4.4. The figures 4.4.1-4.4.4 show the return loss, the efficiency, the peak gain and axial ratio. The ground plane size for this antenna is recommended to be 100*50mm to meet the antenna specification.

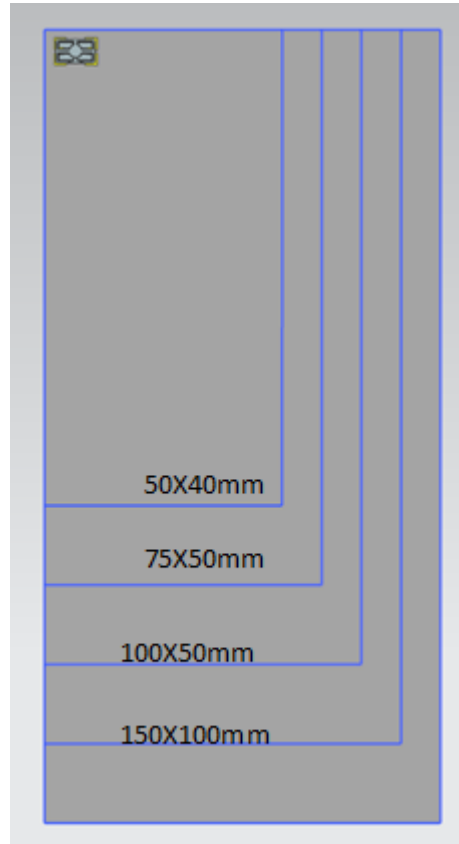


FIGURE 4.4 DIFFERENT GROUND PCB SIZE

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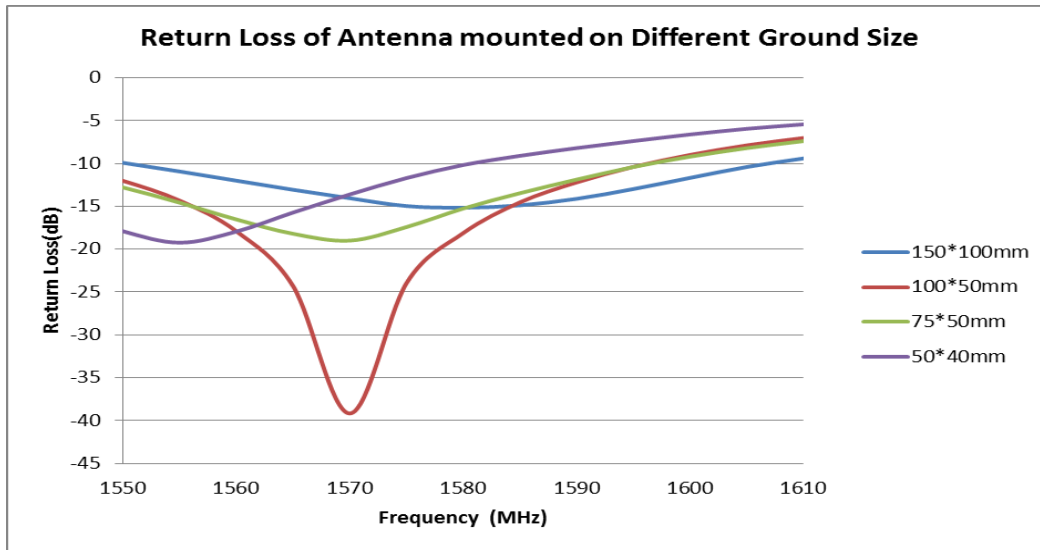


FIGURE 4.4.1 RETURN LOSS COMPARISON AT GPS BAND OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZE

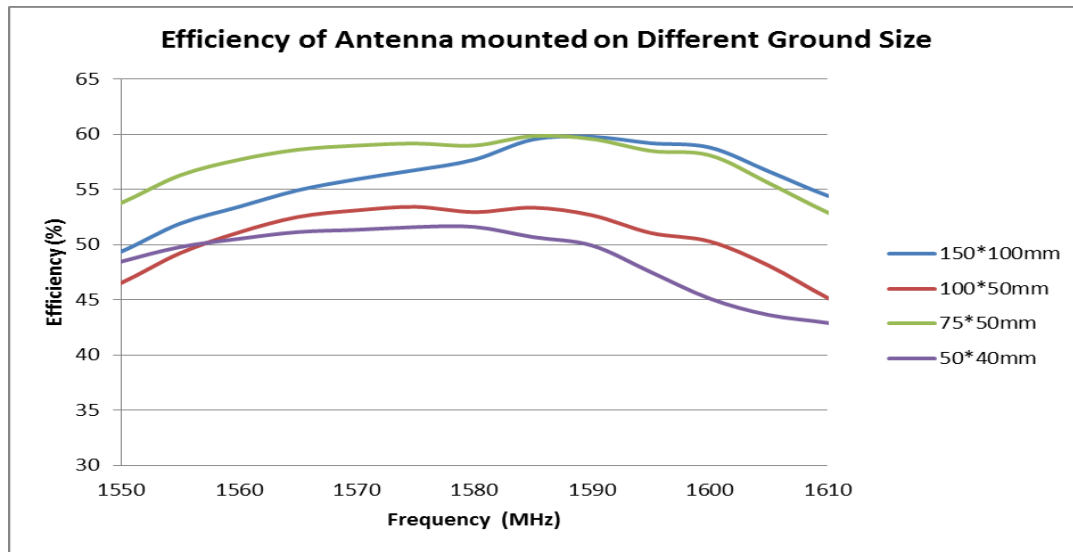


FIGURE 4.4.2 EFFICIENCY COMPARISON AT GPS BAND OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZE

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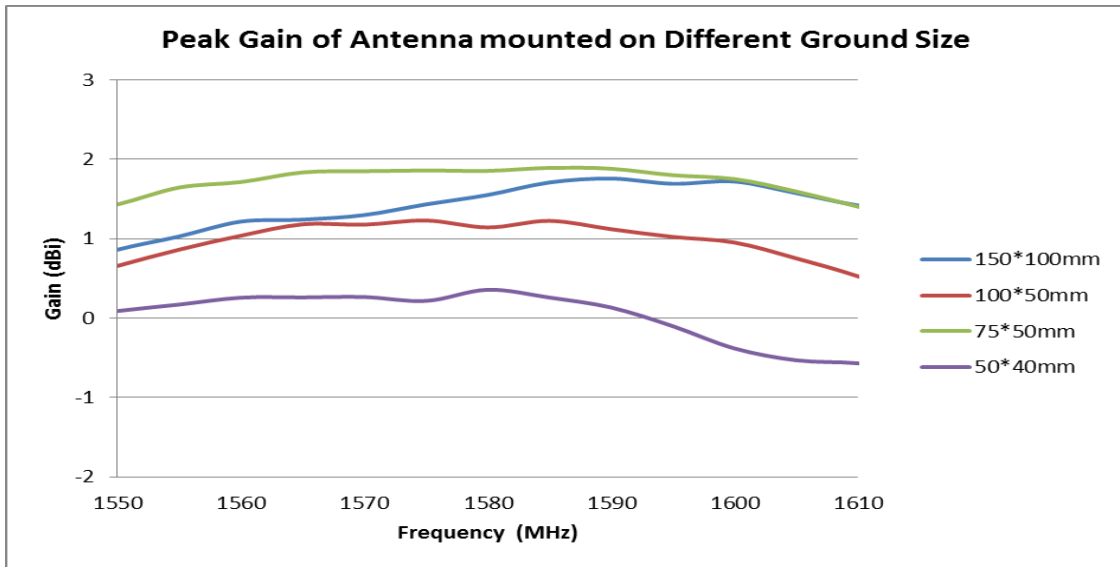


FIGURE 4.13 PEAK GAIN COMPARISON AT GPS BAND OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZE

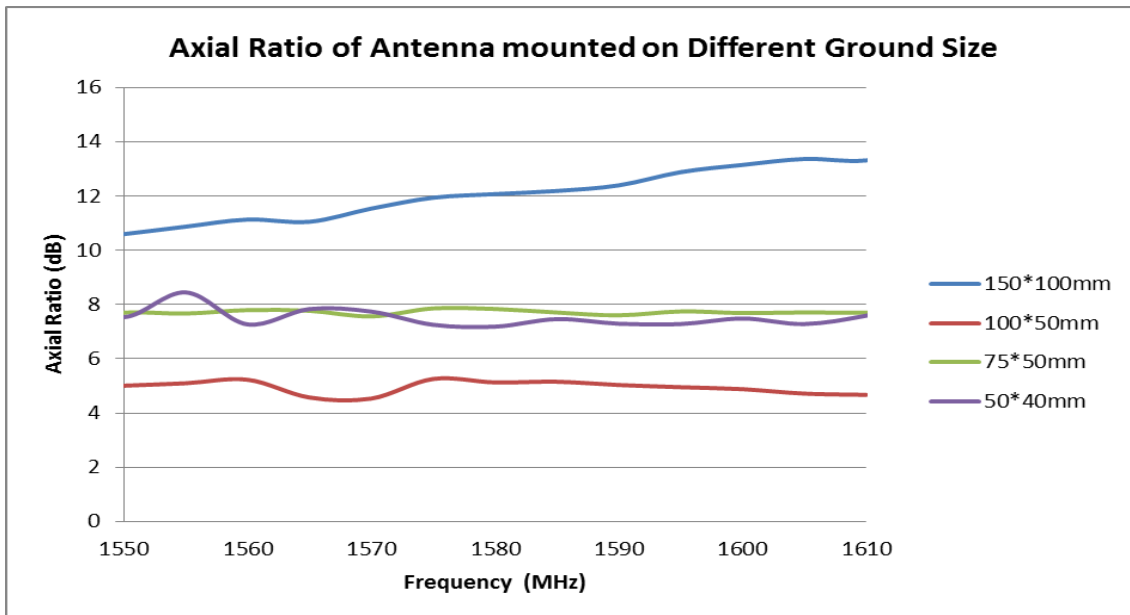


FIGURE 4.14 AXIAL RATIO COMPARISON AT GPS BAND OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZE

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5.0 MATCHING NETWORK DESCRIPTION

A matching circuit is needed if the resonance frequency needs adjustment due to loading by the device housing and surrounding components effect.

The “L” type matching circuit is recommended to be applied for this GPS antenna. The matching network is a series element1 following with a parallel element2. The sequence of series element and parallel element depends on the impedance of antenna in smith chart. When this antenna is fixed at the corner position on reference PCB, the element 1 is a 5.1nH inductor and the element 2 is a 1.8nH inductor. Figure 5.2 and Figure 5.3 comparatively show the return loss and smith chart of this antenna with and without matching circuits.

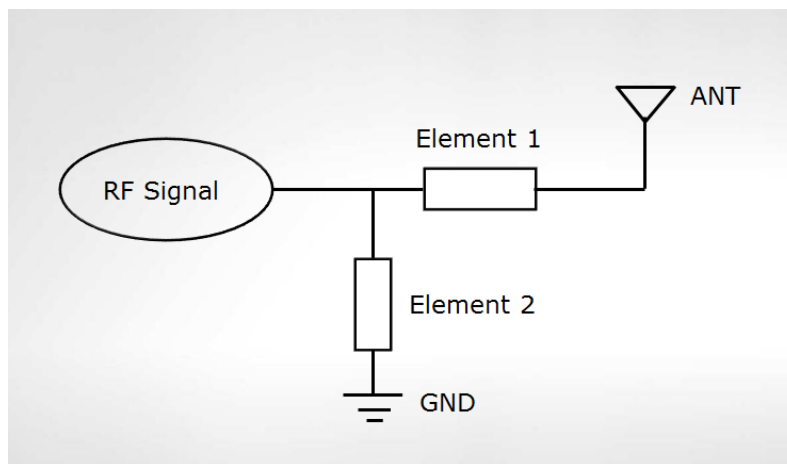


FIGURE 5.1 MATCHING TOPOLOGY FOR GPS BAND

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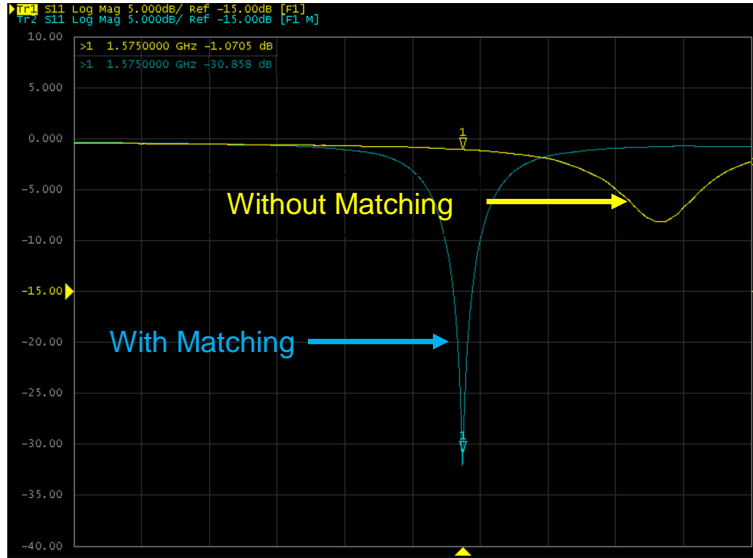


FIGURE 5.2 RETURN LOSS OF ANTENNA WITH AND WITHOUT MATCHING

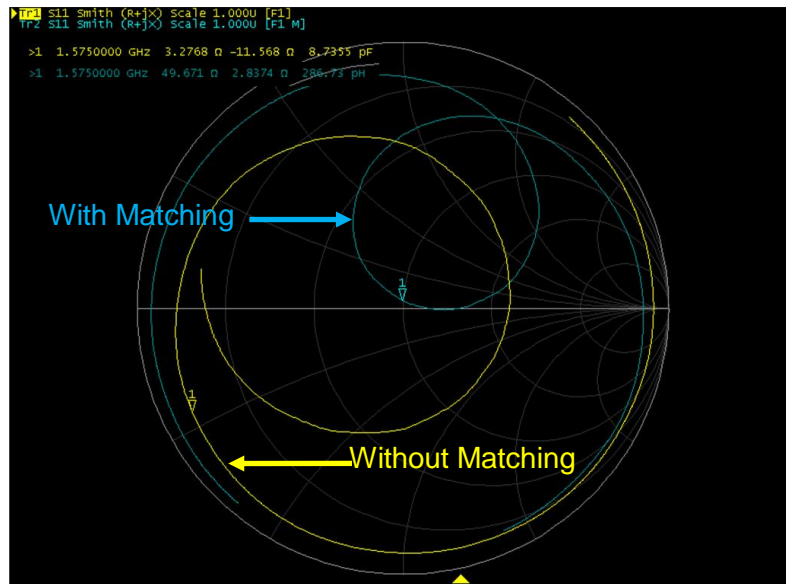


FIGURE 5.3 SMITH CHART OF ANTENNA WITH AND WITHOUT MATCHING

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6.0 RADIATION PATTERN

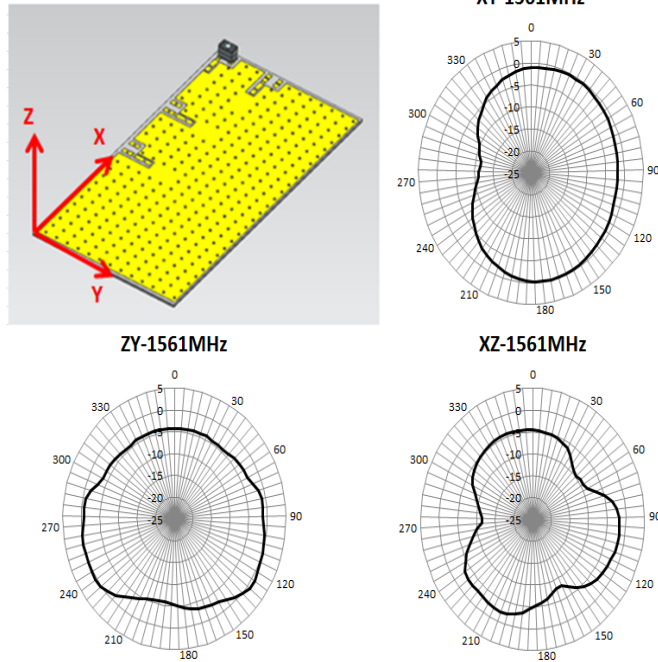


FIGURE 6.1 RADIATION PATTERN OF ATNENNA AT 1561 MHZ AT LOCATION 1

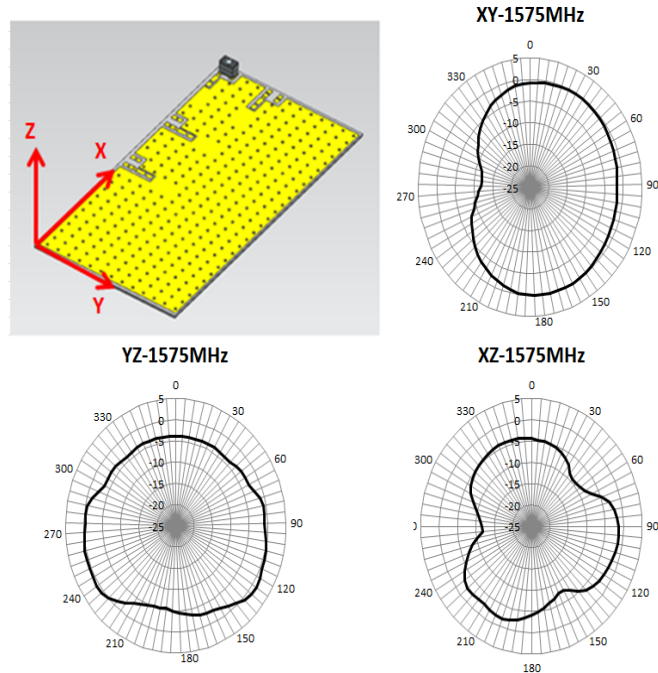


FIGURE 6.2 RADIATION PATTERN OF ATNENNA AT 1575 MHZ AT LOCATION 1

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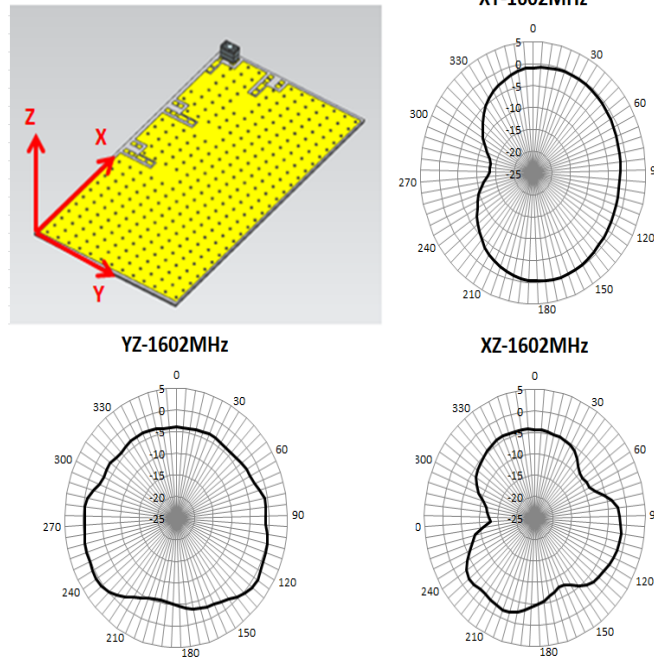


FIGURE 6.2 RADIATION PATTERN OF ATNENNA AT 1602 MHZ AT LOCATION 1

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7.0 ASSEMBLY INSTRUCTIONS

A. RECOMMENDED SMT REFLOW PROFILE

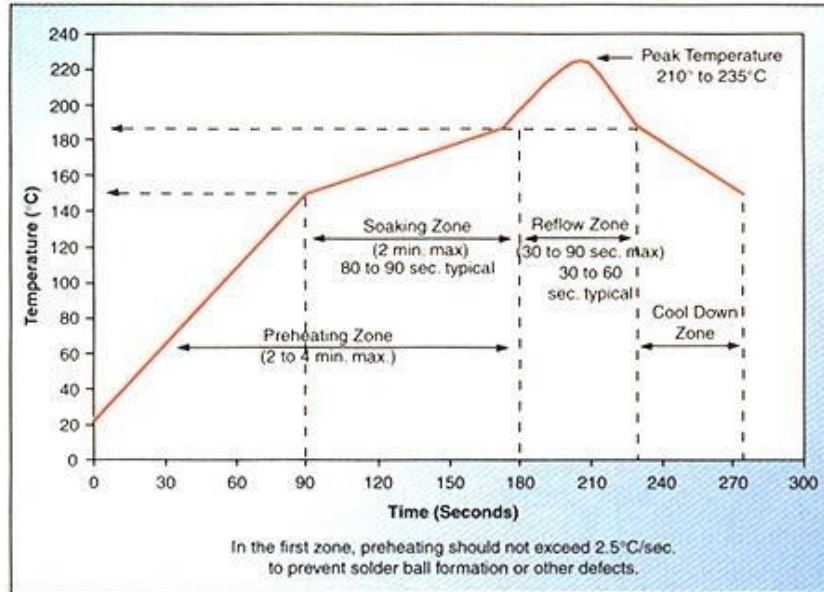


FIGURE 7.1 RECOMMENDED SMT REFLOW PROFILE

B. MECHANICAL INTERFACE

I. GENERAL DESCRIPTION

The overall antenna size is 5mm * 3mm * 4mm (Length * Width * Height).

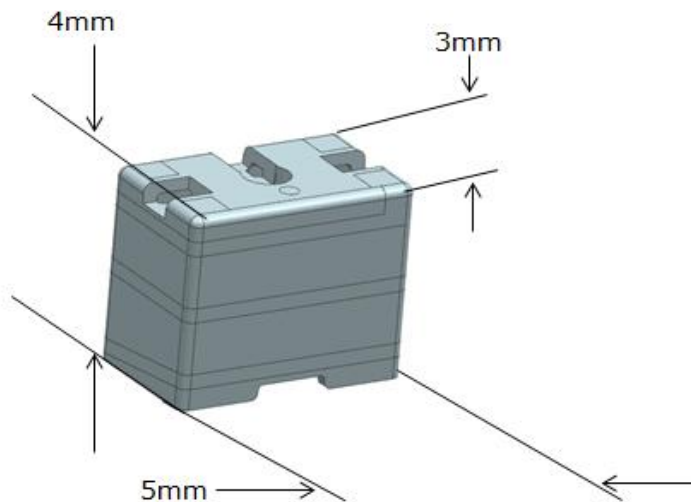


FIGURE 7.2 OVERALL ANTENNA SIZE

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II. STRUCTURE FUNCTIONAL DESCRIPTION

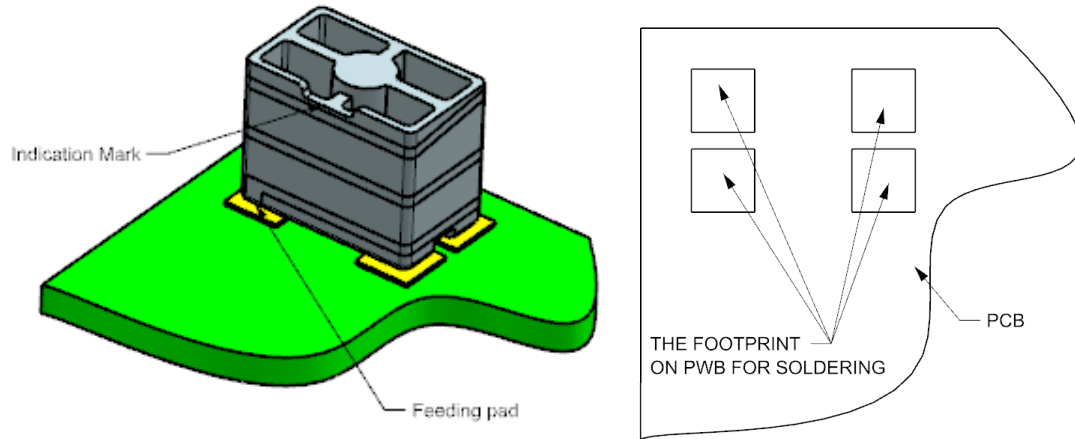


FIGURE 7.3 ANTENNA ASSEMBLY INDICATION

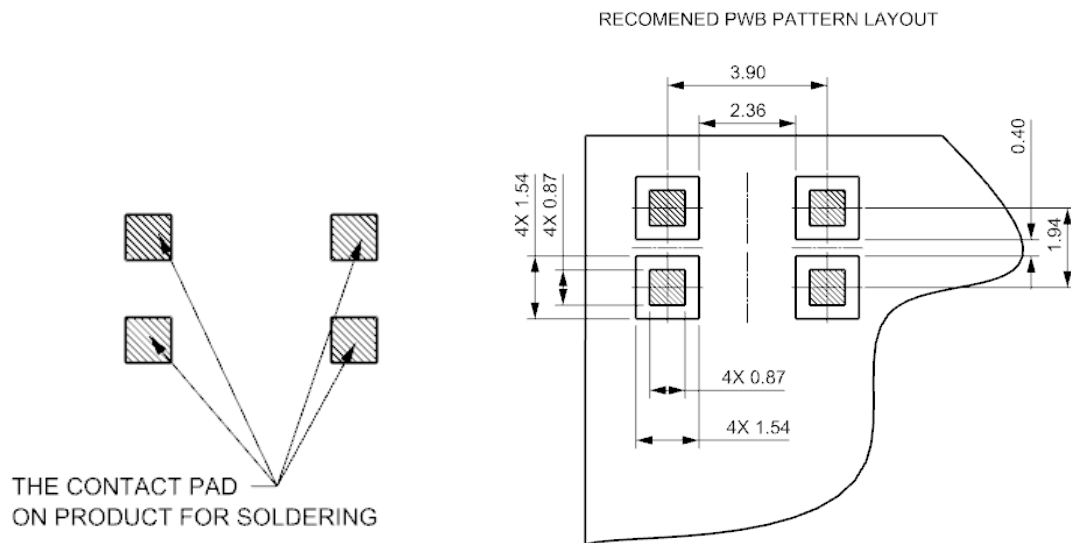


FIGURE 7.4 FOOTPRINT ON PCB FOR SOLDERING

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