



# APPLICATION SPECIFICATION

## GNSS/WIFI COMBO CERAMIC ANTENNA

### 1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Molex GNSS/WIFI Combo Ceramic Antenna. This antenna has two feeding pads. One feeding pad is used for GNSS band and the other feeding pad is used for WIFI (2.4GHz/5GHz) band. 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.

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 3.2mm x 1.6mm x 1.1mm (Length\*Width\* Height). There are two feeding pads, two grounding pads, one fixing pad 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. GROUNDING PAD**

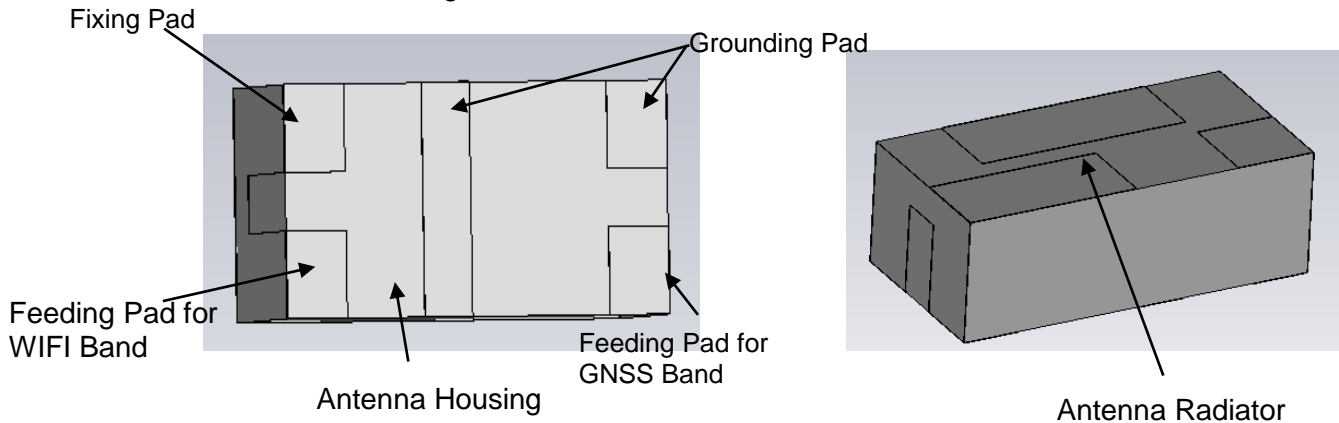
SMT mounted to grounding pad on PCB.

**3. FIXING PAD**

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

**4. ANTENNA RADIATOR**

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



**FIGURE 1. GNSS/WIFI COMBO CERAMIC ANTENNA**

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## B. REFERENCE IMPLEMENTATION

### I. REFERENCE PCB DESCRIPTION

The size of reference PCB design is 80mm\* 40mm \*0.8mm, which is used for this antenna performance verification. There are two feeding pads, two grounding pads and one fixing pad. The clearance size is also 6mm\*8mm. See figure 2.

#### 1. FEEDING PAD

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

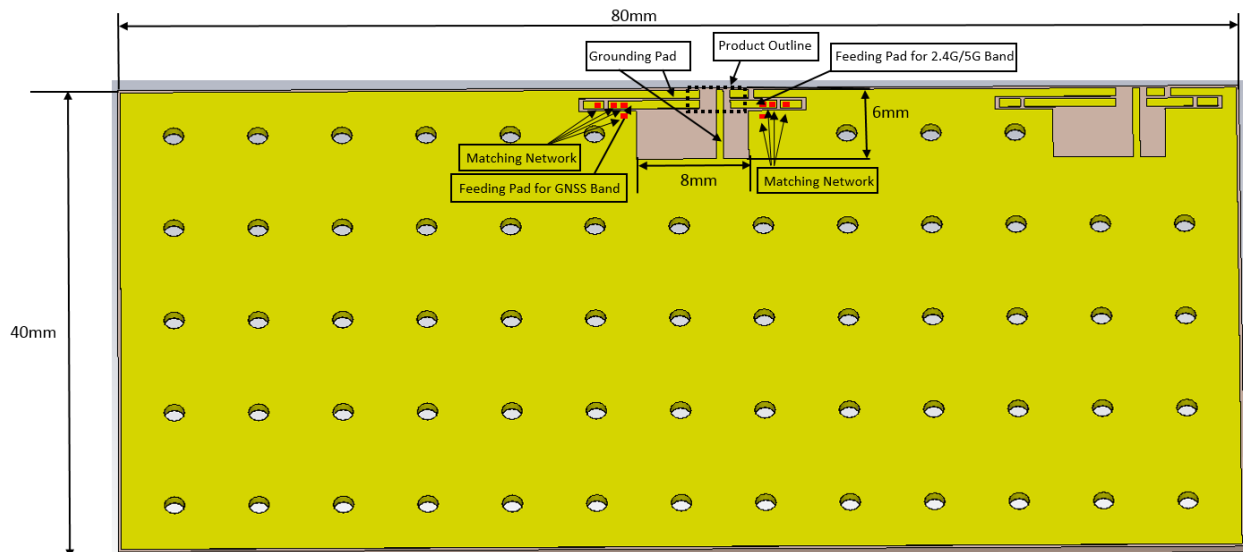
#### 2. GROUNDING PAD

The antenna must be SMT mounted to grounding pad on PCB.

#### 3. MATCHING CIRCUIT

It is necessary to reserve PCB space for “L” type matching circuits in this design. In order to adjust the return loss due to loading by the device housing and surroundings, the matching circuits need to be changed accordingly.

### II. REFERENCE PCB LAYOUT



**FIGURE 2: REFERENCE PCB LAYOUT**

(Note: PCB Ground Size of 80 mm x 40 mm x 0.8 mm)

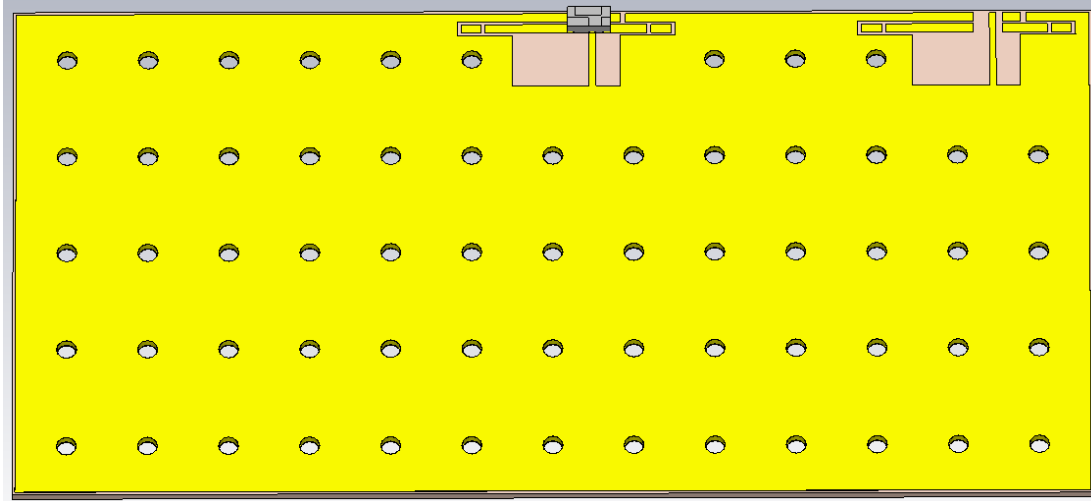
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## III. ANTENNA PERFORMANCE AT RECOMMENDED LOCATION

The recommended antenna location is at the upper center of the PCB as shown in Figure 2.1.



**FIGURE 2.1 RECOMMENDED ANTENNA LOCATION**

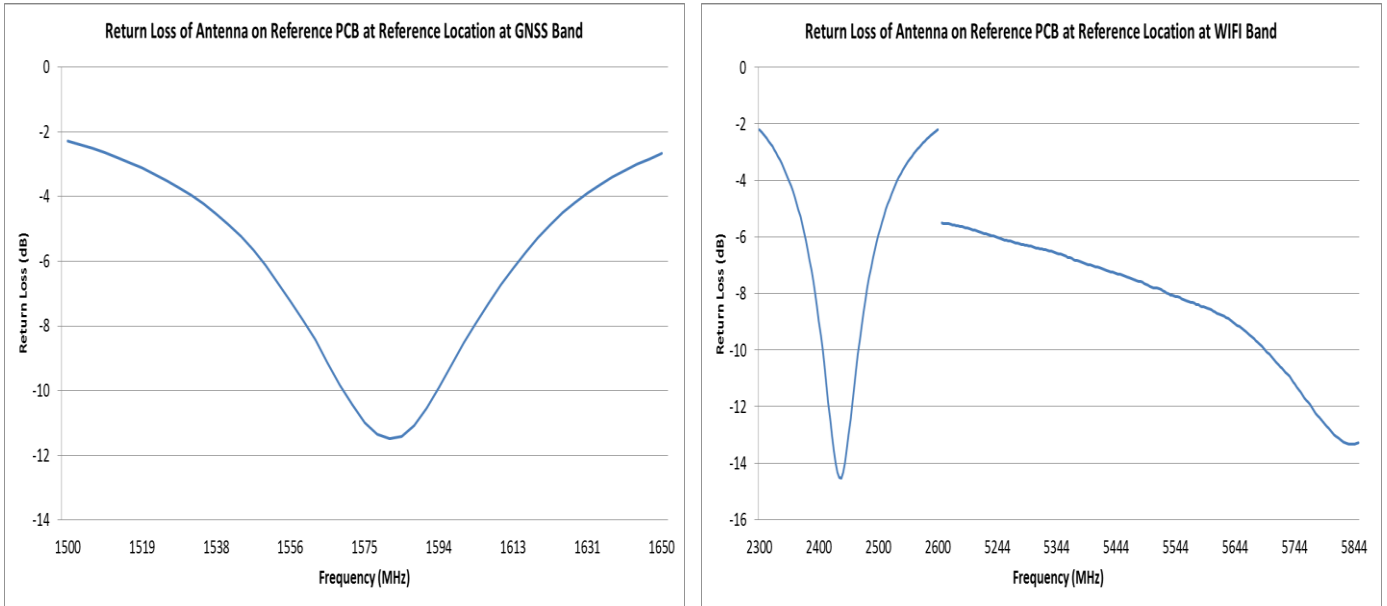
DESCRIPTION	Test Condition	Requirement				
		1561MHz	1575MHz	1602MHz	2.4-2.5GHz	5.15-5.85GHz
Frequency Range	Measure antenna on recommended PCB through VNA E5071C	1561MHz	1575MHz	1602MHz	2.4-2.5GHz	5.15-5.85GHz
Return Loss	Measure antenna on recommended PCB through VNA E5071C	< -6 dB	< -10 dB	< -6 dB	< -6 dB	< -5.5 dB
Peak Gain (Max)	Measure antenna on recommended PCB through OTA chamber	0.9dBi	1dBi	0.3dBi	0.6dBi	1dBi
Avg. Total Efficiency	Measure antenna on recommended PCB through OTA chamber	>55%	>55%	>50%	>55%	>50%
Polarization	Measure antenna on recommended PCB through OTA chamber	Linear				
Input Impedance	Measure antenna on recommended PCB through VNA E5071C	50Ohms				

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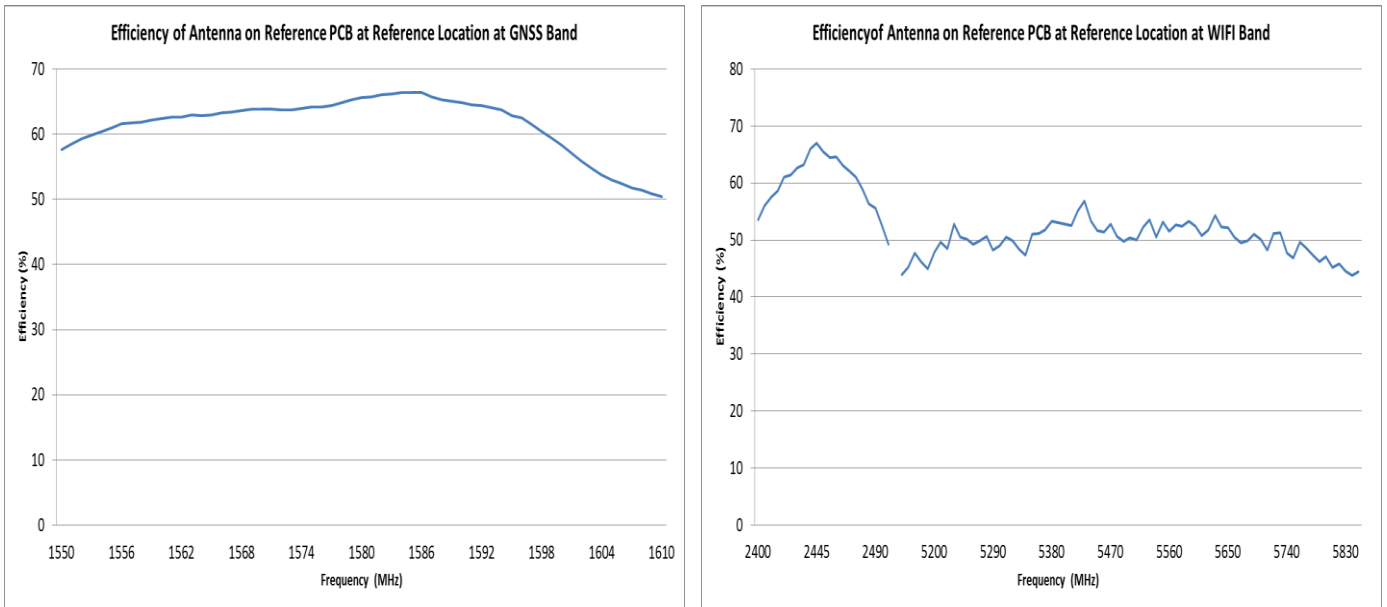


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## 2.1 RF PERFORMANCE AT REFERENCE LOCATION IN FREE SPACE



**FIGURE 2.2 RETURN LOSS OF ANTENNA AT GNSS AND 2.4GHZ/5GHZ ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE**

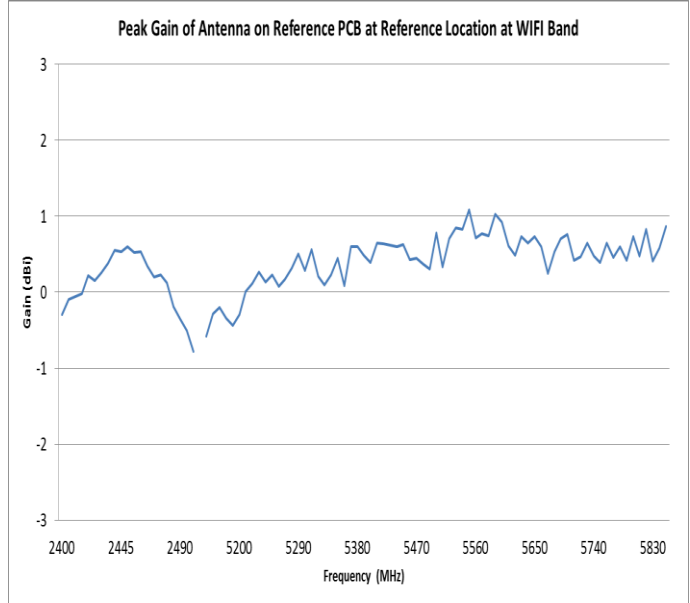
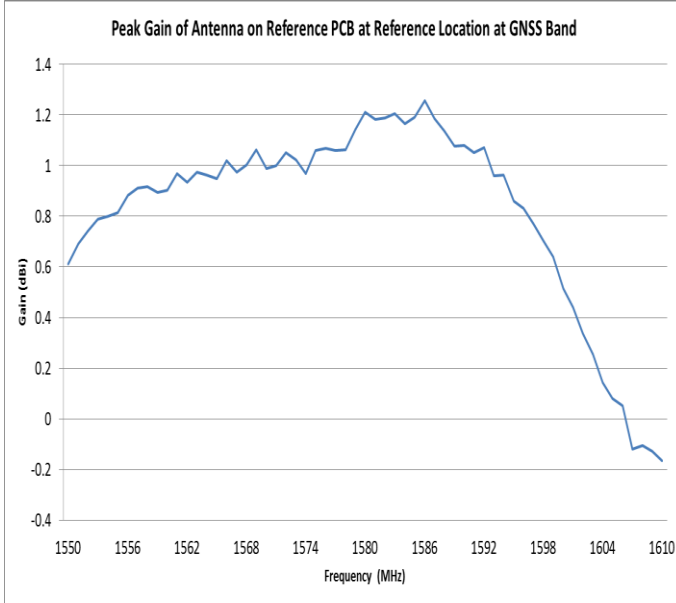


**FIGURE 2.3 EFFICIENCY OF ANTENNA AT GNSS AND 2.4GHZ/5GHZ ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE**

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**FIGURE 2.4 PEAK GAIN OF ANTENNA AT GNSS AND 2.4GHZ/5GHZ ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE**

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### 3.0 REFERENCE DOCUMENTS

- Sales Drawing: SD-2030070001
- Product Specification: PS-2030070001
- Packaging Information – Refer to the Molex related packaging drawings.

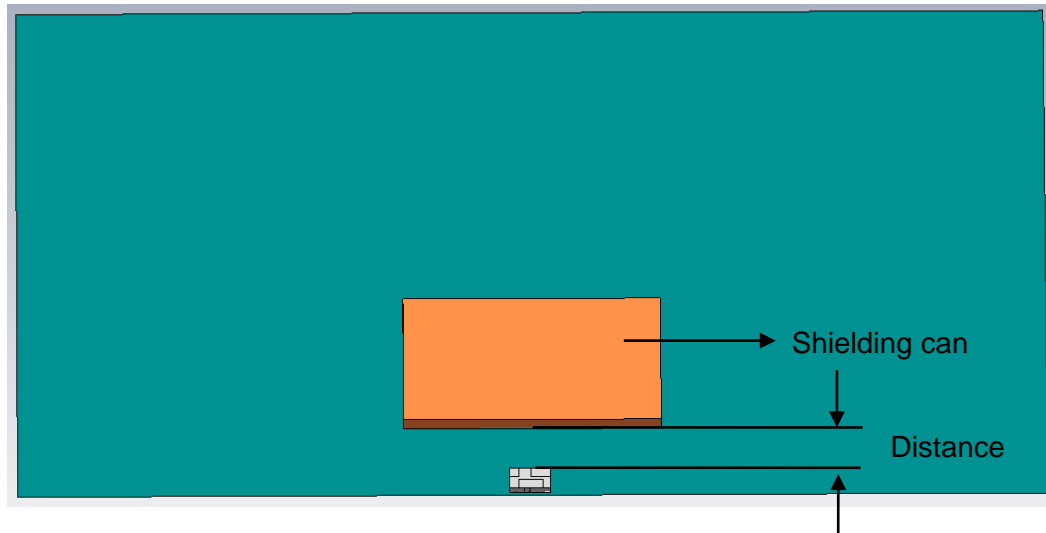
### 4.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

#### 4.1 ANTENNA RF PERFORMANCE INFLUENCED BY NEARBY SHIELDING CAN

A shielding can with size of 20mm\*10mm\*2mm was used for this study.

An evaluation was done with 3 different distances from the antenna which located at the recommended location to the shielding can. The 3 distances are as following: 1mm, 3mm and 5mm.

From the study, we recommend that a shielding can 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 4.1.1-4.1.3.

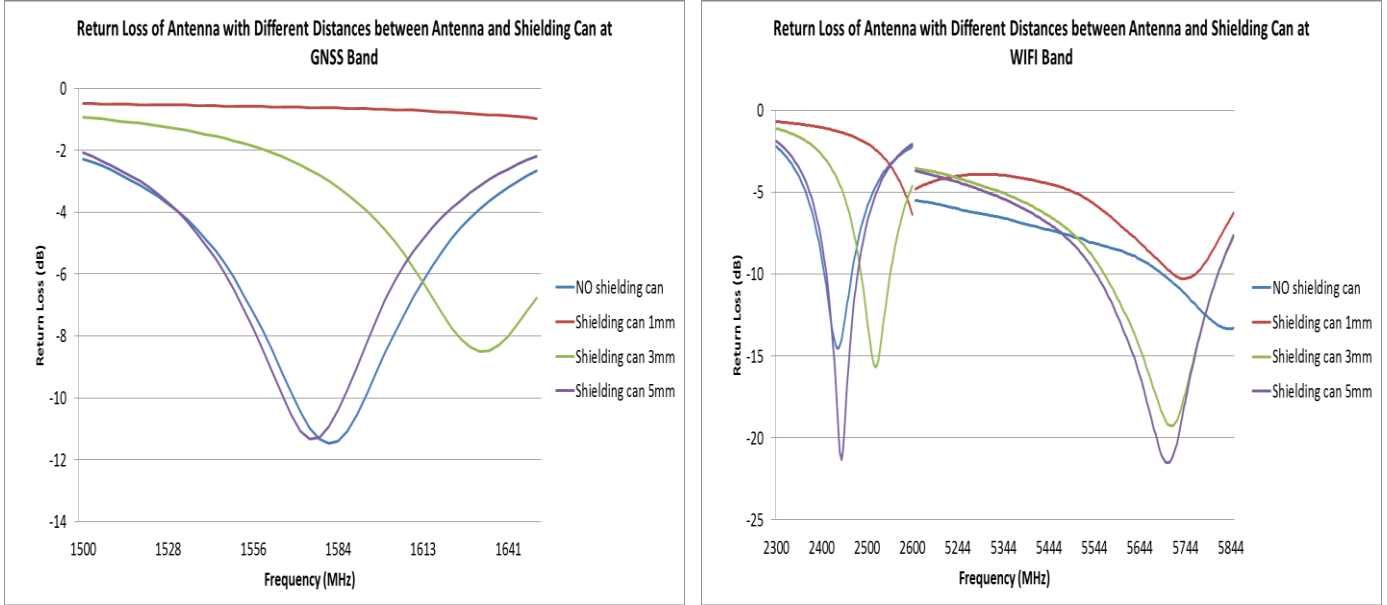


**Figure 4.1 SHIELDING CAN FIXED ON REFERENCE PCB**

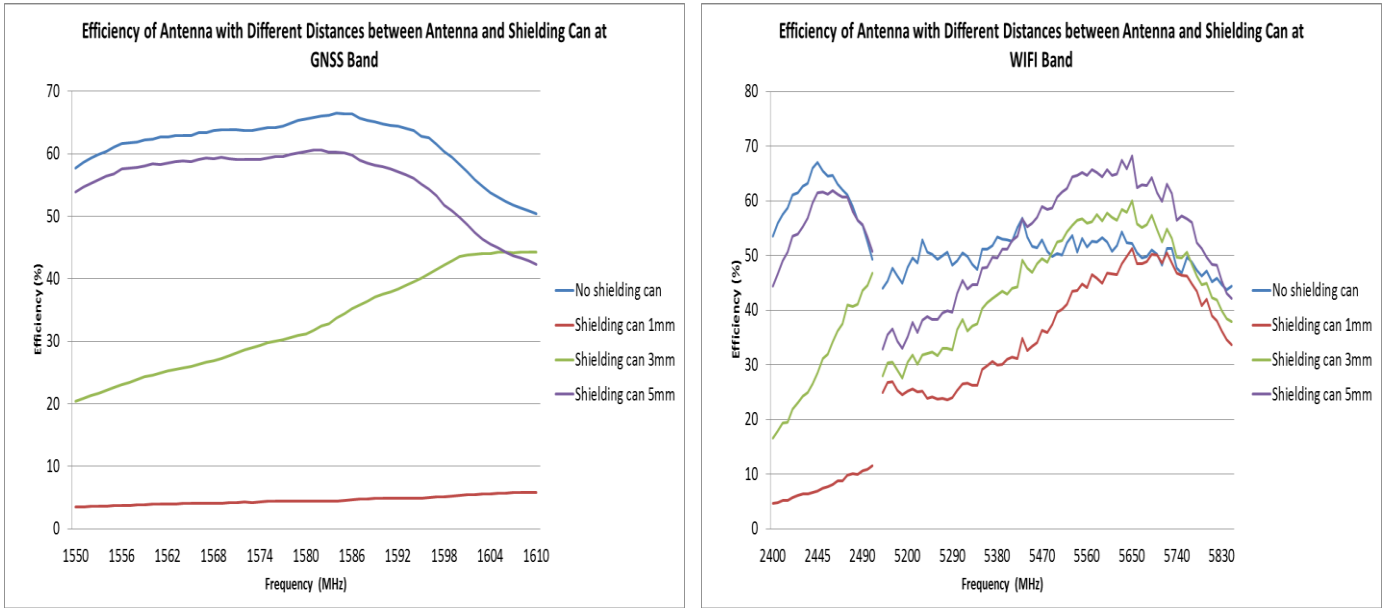
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**FIGURE 4.1.1 RETURN LOSS COMPARISON AT GNSS AND 2.4GHZ/5GHZ OF SHIELDING CAN DISTANCE FROM ANTENNA**

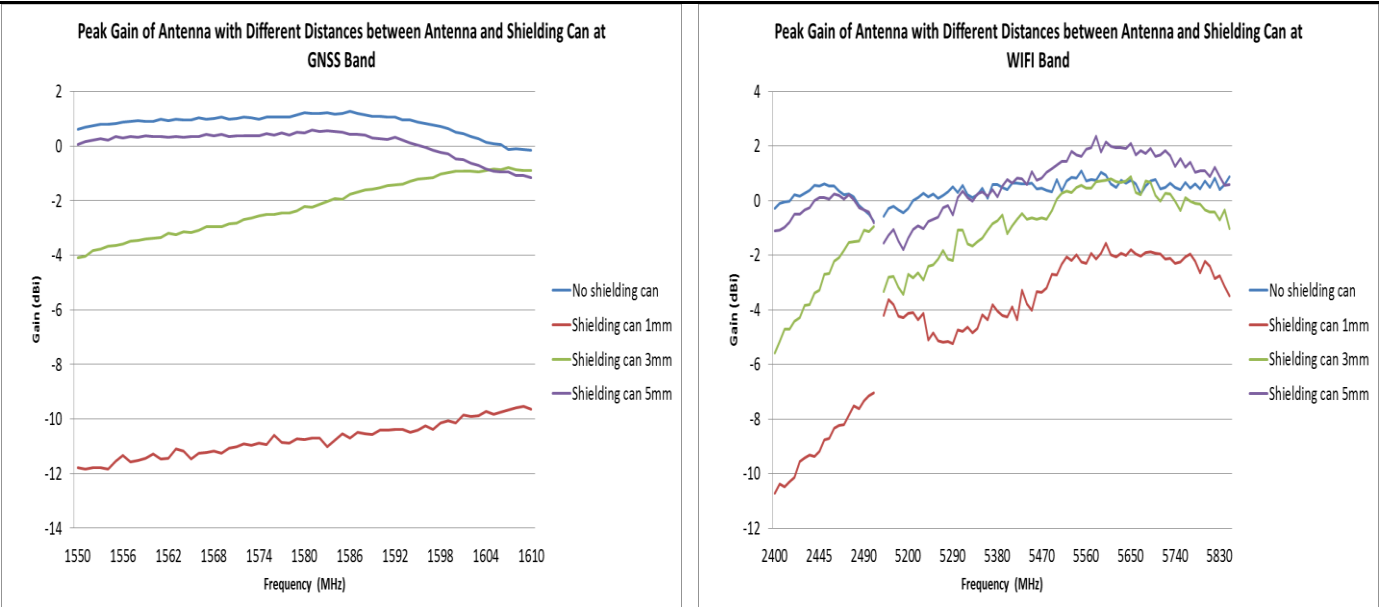


**FIGURE 4.1.2 EFFICIENCY COMPARISON AT GNSS AND 2.4GHZ/5GHZ OF SHIELDING CAN DISTANCE FROM ANTENNA**

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**FIGURE 4.1.3 PEAK GAIN COMPARISON AT GNSS AND 2.4GHZ/5GHZ OF SHIELDING CAN DISTANCE FROM ANTENNA**

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## 4.2 RF PERFORMANCE AS AN EFFECT OF PCB GROUND SIZE

Three kinds of PCB ground size have been evaluated and these configurations are shown in figure 4.2. Figure 4.2.1-4.2.3 comparatively show the return loss, the efficiency, and the peak gain of this antenna with three kinds of PCB. 60mm\*40mm is the recommended minimum PCB ground size for this antenna. When the ground size is less than 60mm\*40mm, the performance will be significantly decreased.

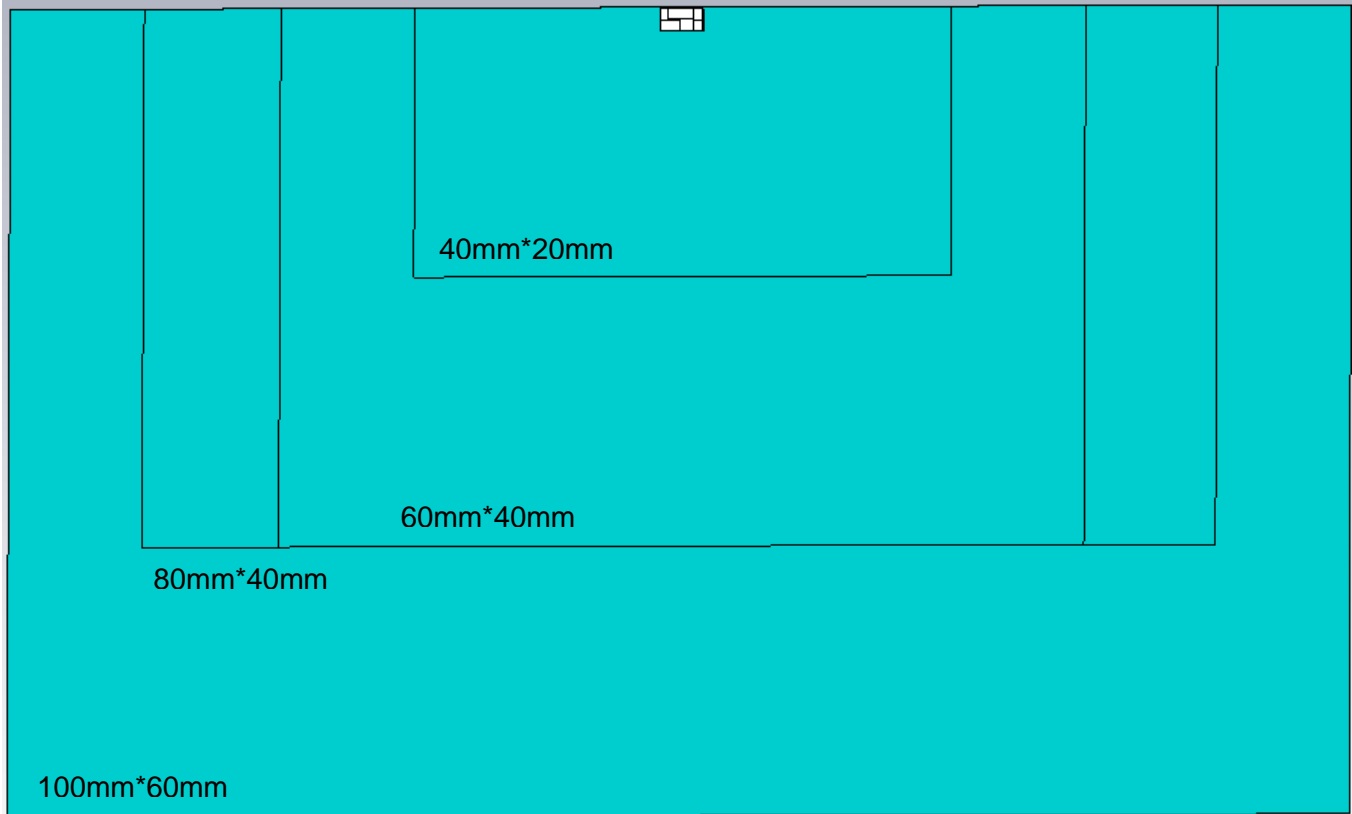
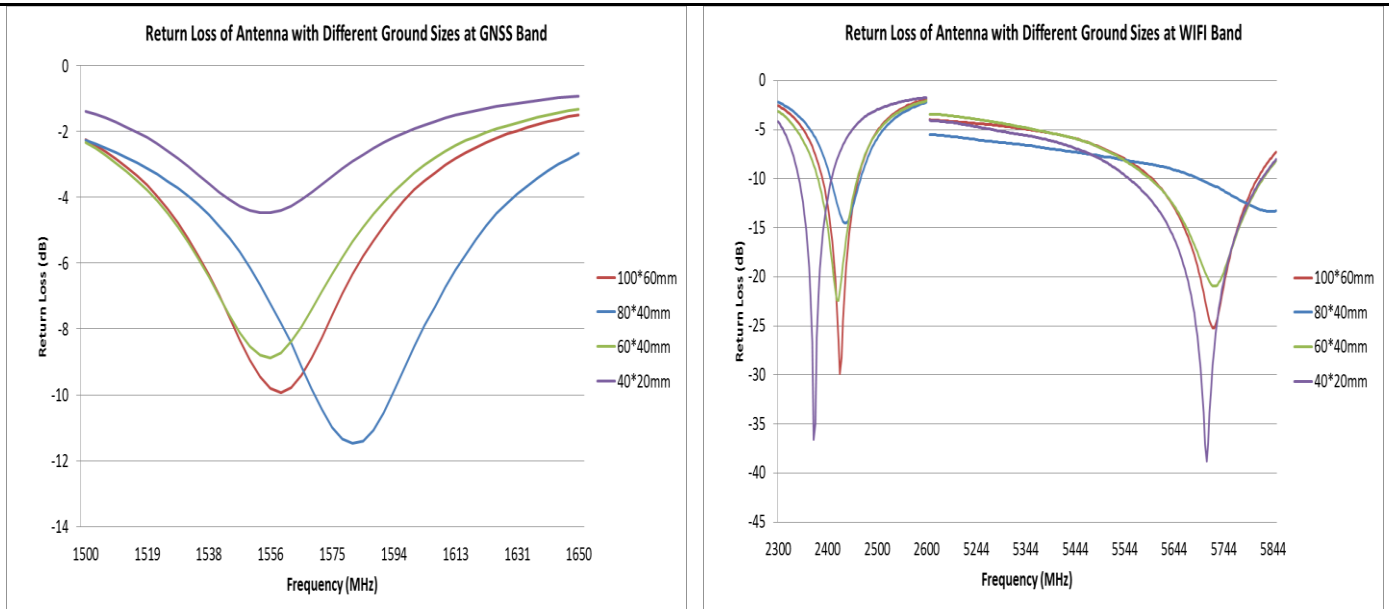


FIGURE 4.2 DIFFERENT GROUND PCB SIZES

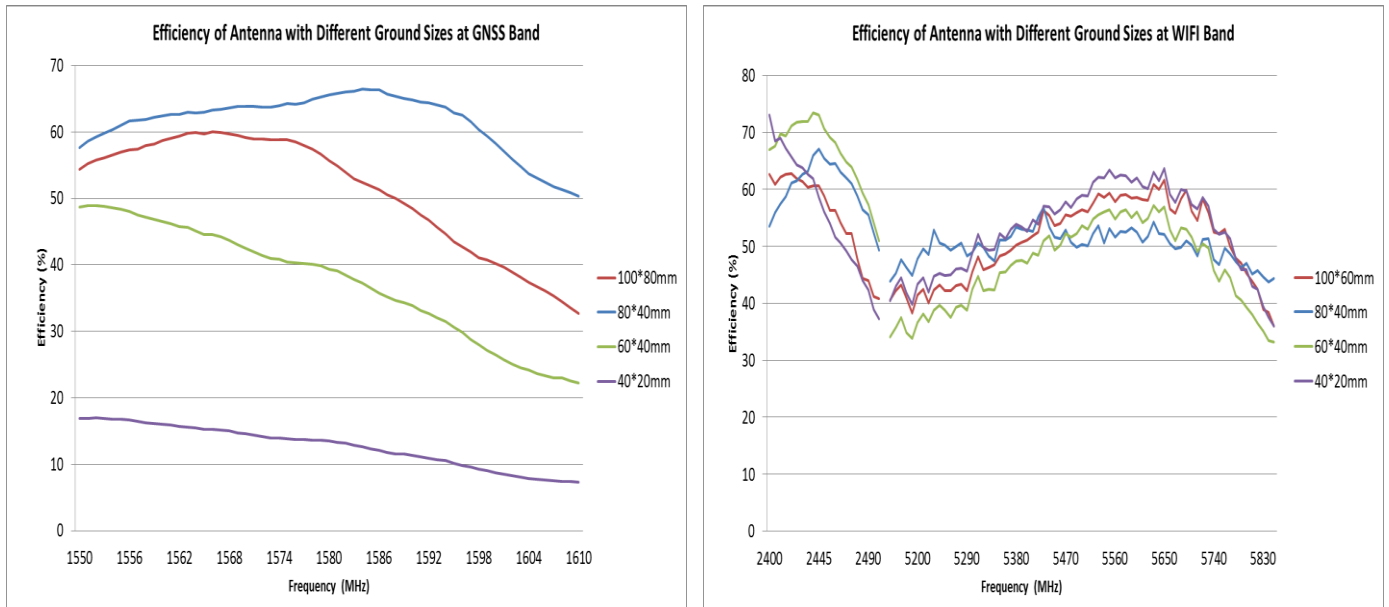
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**FIGURE 4.2.1 RETURN LOSS COMPARISON GNSS AND 2.4GHZ/5GHZ OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZE**

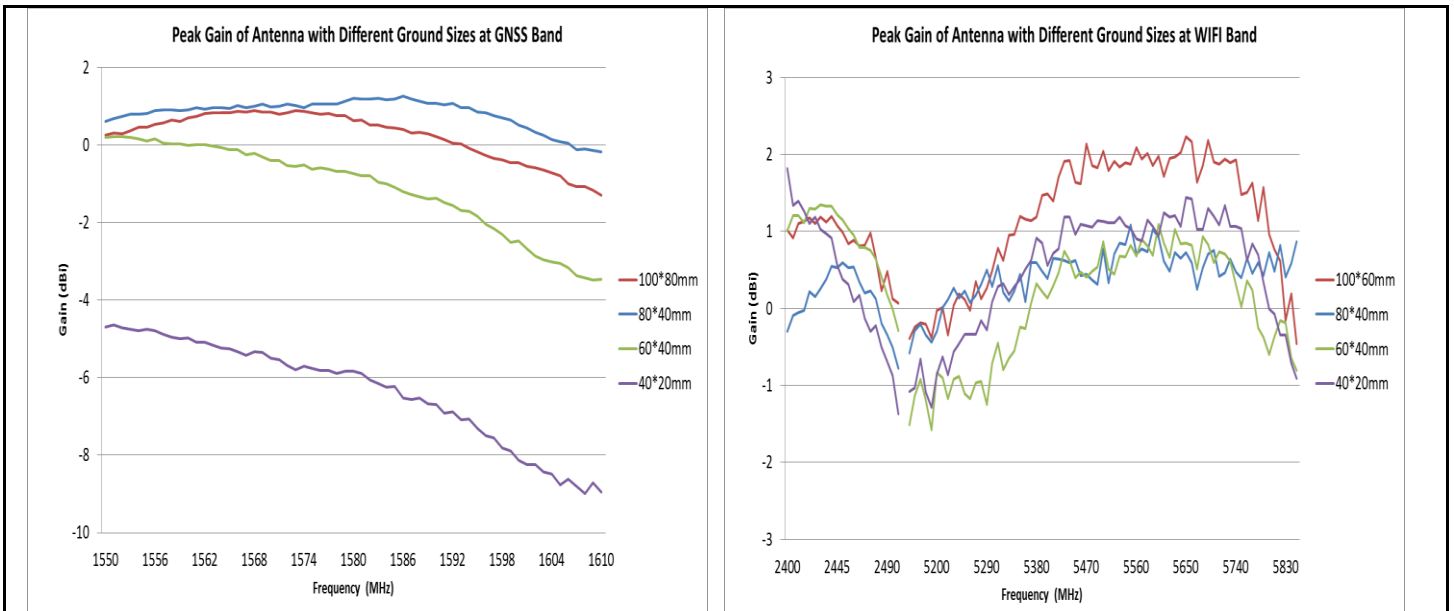


**FIGURE 4.2.2 EFFICIENCY COMPARISON AT GNSS AND 2.4GHZ/5GHZ OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZE**

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**FIGURE 4.2.3 PEAK GAIN COMPARISON AT GNSS AND 2.4GHZ/5GHZ OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZE**

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## 4.3 ANTENNA RF PERFORMANCE AS A FUNCTION OF LOCATIONS ON REFERENCE PCB

Two locations have been evaluated RF performance and these locations are shown in figure 4.3. Figure 4.3.1, figure 4.3.2, and figure 4.3.3 comparatively present the return loss, efficiency, and peak Gain at two locations. The antenna performance at these two locations have been optimized with matching circuits.

The performance of location 1 is much better than location 2. So location 1 (upper center location) is the recommended location for this antenna.

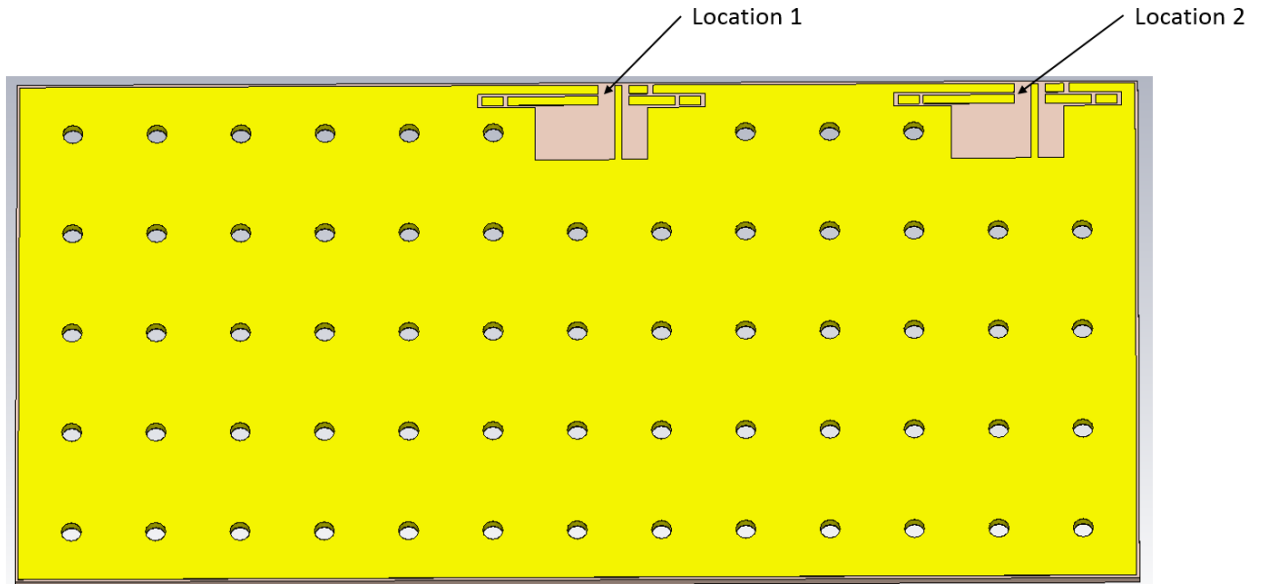
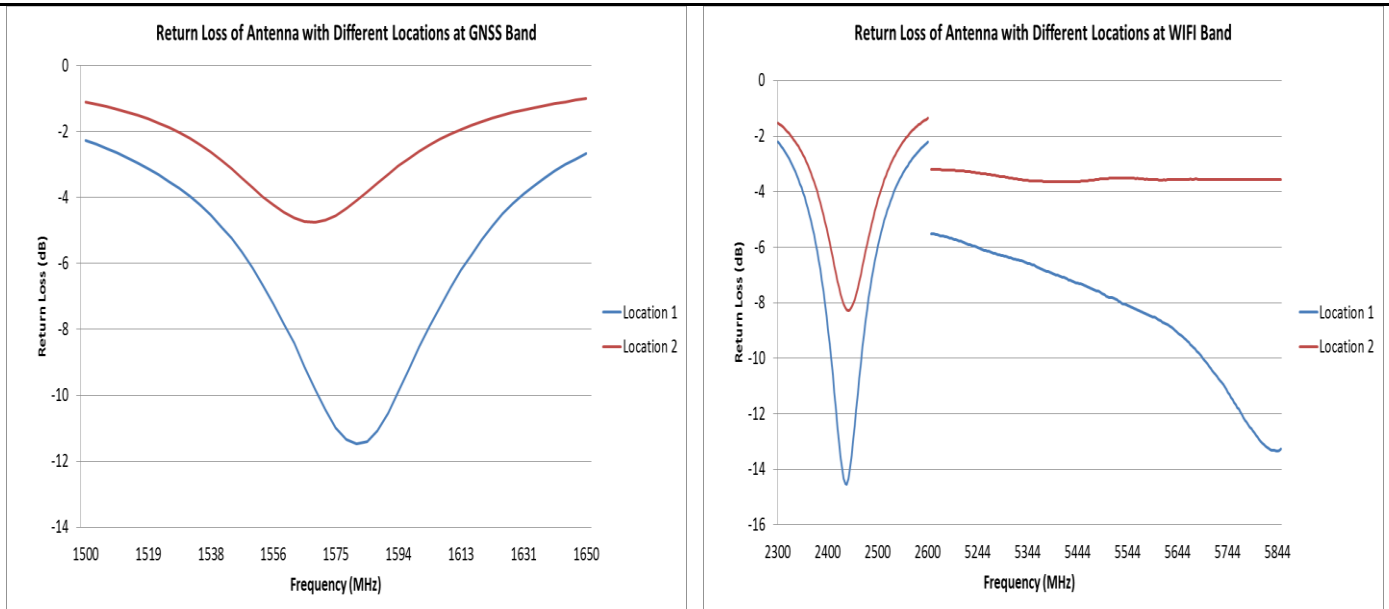


FIGURE 4.3 TWO LOCATIONS ON REFERENCE PCB

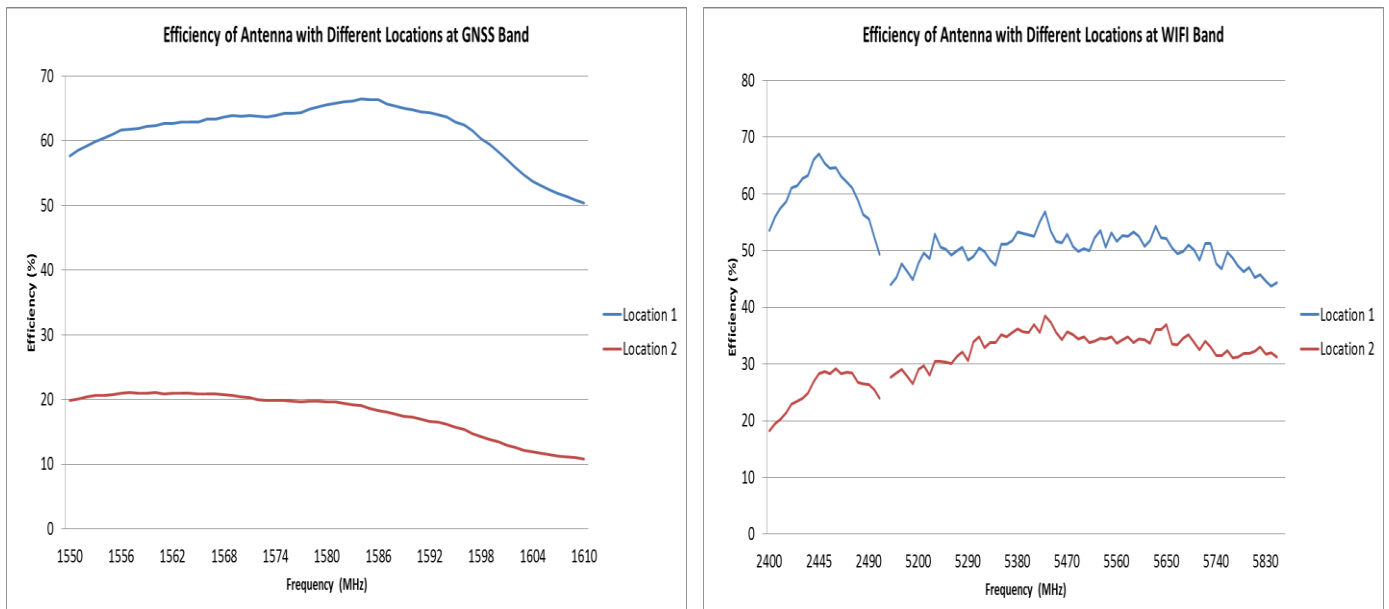
REVISION: <b>A</b>	ECR/ECN INFORMATION: EC No: <b>121094</b> DATE: <b>2017/08/25</b>	TITLE: <b>GNSS/WIFI Combo Ceramic Antenna</b>	SHEET No. <b>12 of 23</b>
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**Figure 4.3.1 RETURN LOSS OF ANTENNA AT GNSS AND 2.4GHZ/5GHZ AT TWO DIFFERENT LOCATIONS**

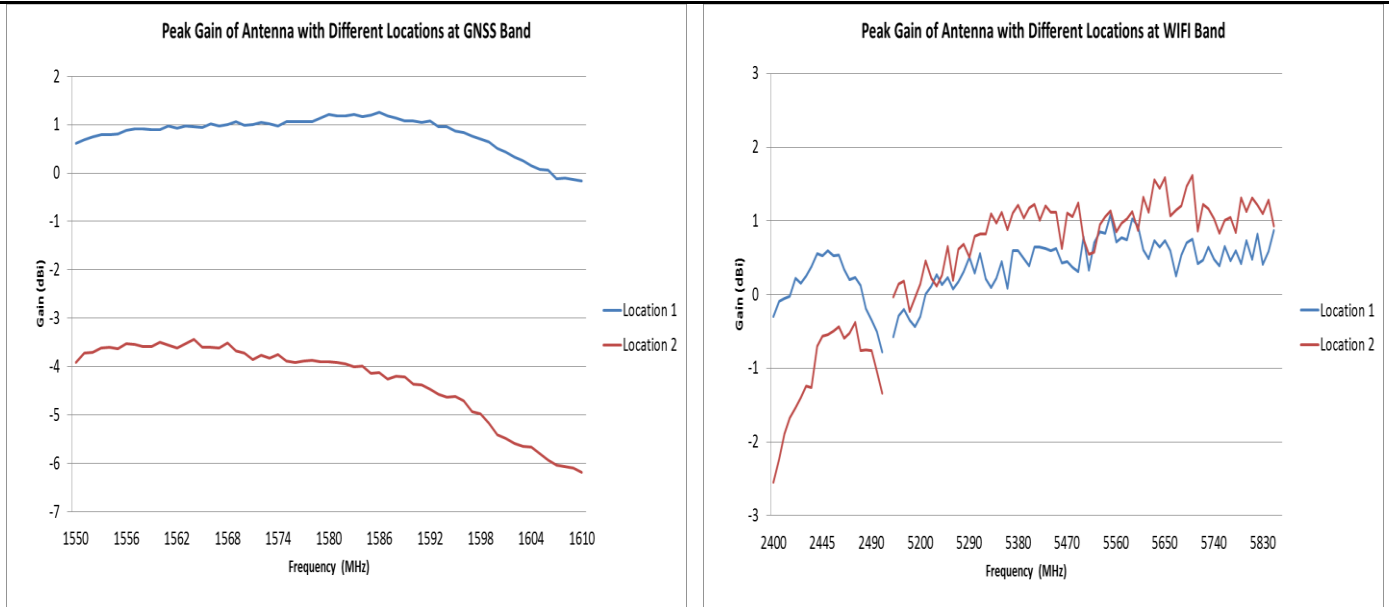


**Figure 4.3.2 EFFICIENCY OF ANTENNA AT GNSS AND 2.4GHZ/5GHZ AT TWO DIFFERENT LOCATIONS**

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**Figure 4.3.3 PEAK GAIN OF ANTENNA AT GNSS AND 2.4GHZ/5GHZ AT TWO DIFFERENT LOCATIONS**

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## 5.0 MATCHING NETWORK

### 5.1 MATCHING NETWORK DESCRIPTION FOR GNSS BAND

The “L” type matching circuit is recommended to be applied for this antenna at the recommended position on reference PCB. The sequence of parallel element and series element depends on the resistance of antenna in smith chart shows in Figure 5.1. Figure 5.2 shows the matching network for this antenna at GNSS band at the recommended position on reference PCB. The matching network is a series 5.6nH for GNSS Band.

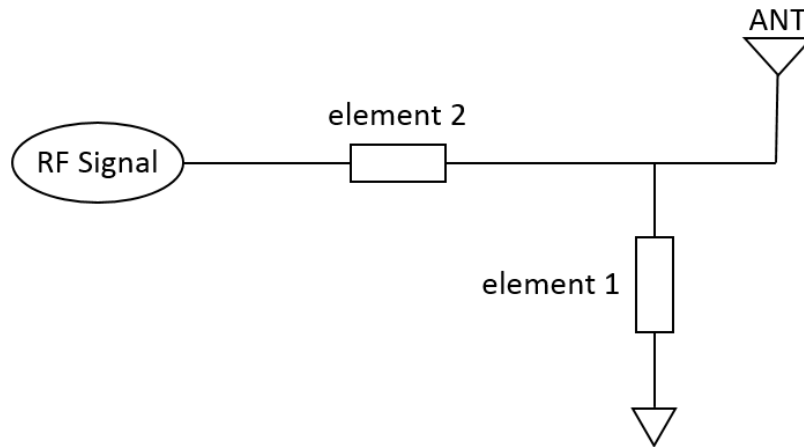


FIGURE 5.1 CONFIGURE 1 FOR GNSS Band

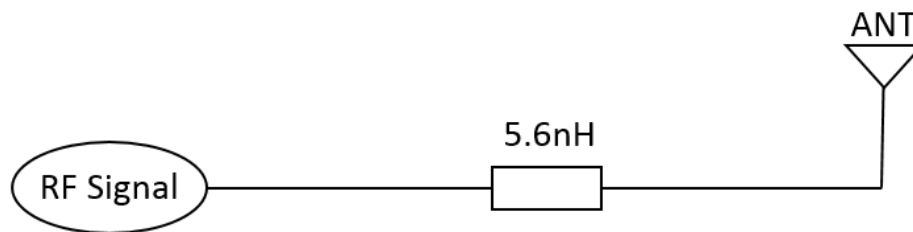
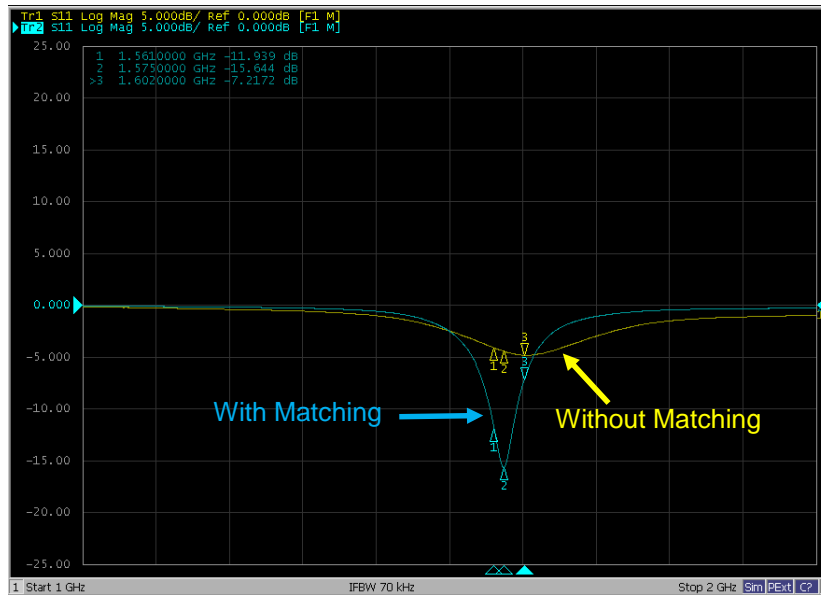


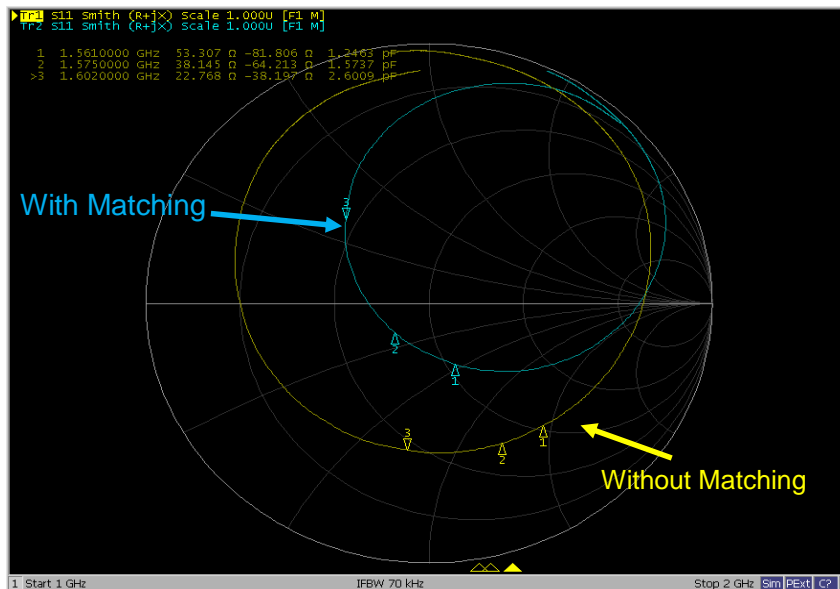
FIGURE 5.2 RECOMMEND MATCHING NETWORK FOR GNSS Band

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The following figure 5.3 and figure 5.4 are the return loss and smith chart comparison without and with the matching network for the antenna at GNSS Band on reference PCB ground size and at reference location.



**FIGURE 5.3 RETURN LOSS OF ANTENNA WITHOUT AND WITH MATCHING ON REFERENCE PCB GROUND SIZE AT REFERENCE LOCATION**



**FIGURE 5.4 SMITH CHART OF ANTENNA WITHOUT AND WITH MATCHING ON REFERENCE PCB GROUND SIZE AT REFERENCE LOCATION**

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## 5.2 MATCHING NETWORK DESCRIPTION FOR 2.4G/5G BAND

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

Two matching configurations as shown in Figure 5.5 and Figure 5.6 are recommended for signal 2.4GHz band and 5GHz band matching, respectively. The combination of these two configurations can be applied for both of the two bands matching at the same time, which can be seen in Figure 5.7. Take configuration 1 for example, the matching network is a series capacitor followed with a parallel inductor. The sequence of series capacitor and parallel inductor depends on the resistance of antenna in smith chart. Furthermore, in some case, only one series capacitor or a parallel inductor can achieve matching purpose. These tips can also be used for configure 2 and the combination topology are shown in Figure 5.7.

Figure 6.8 shows the matching network for this antenna at 2.4GHz/5GHz at the recommended position on reference PCB. The matching network is a series 5.6pF capacitor following with a parallel 1.1nH inductance, and following with a parallel 0.2pF capacitor.

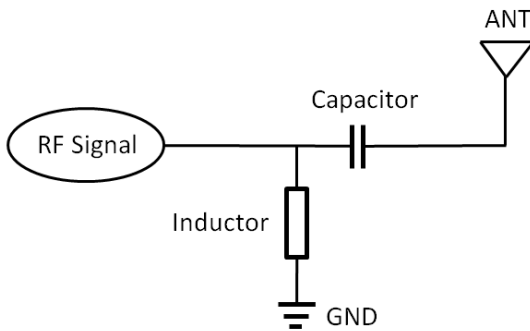


FIGURE 5.5 CONFIG 1 FOR 2.4GHZ BAND

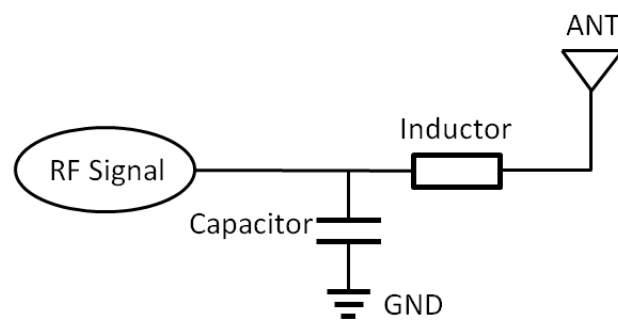


FIGURE 5.6 CONFIG 2 FOR 5GHZ BAND

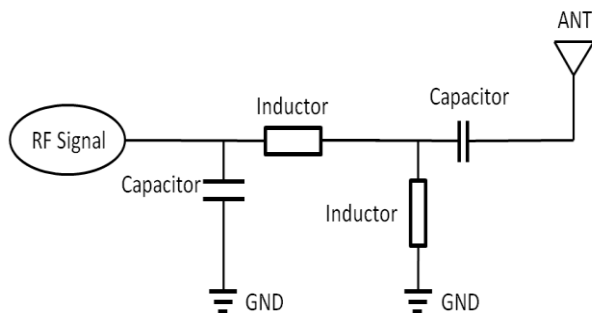


FIGURE 5.7 MATCHING TOPOLOGY FOR BOTH 2.4GHZ AND 5GHZ BAND

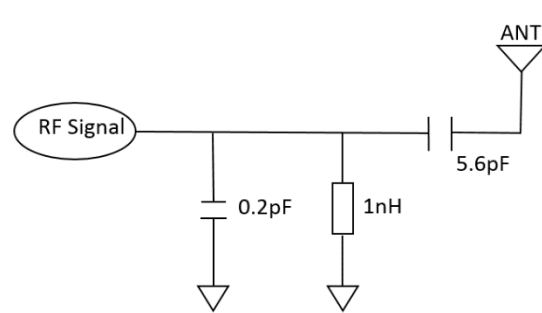


FIGURE 5.8 RECOMMEND MATCHING NETWORK FOR 2.4GHZ/5GHZ

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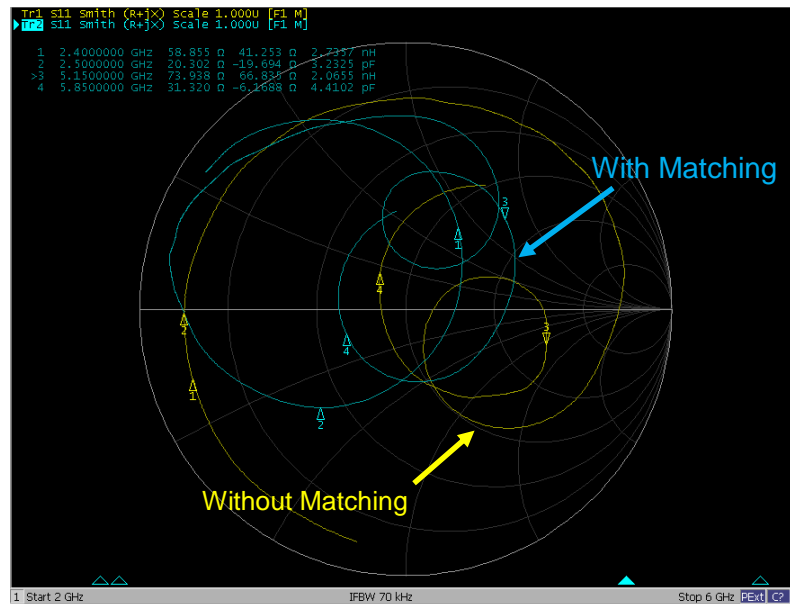


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The following figure 5.9 and figure 5.10 are the return loss and smith chart comparison without and with the matching network for the antenna at 2.4GHz/5GHz on reference PCB ground size and at reference location.



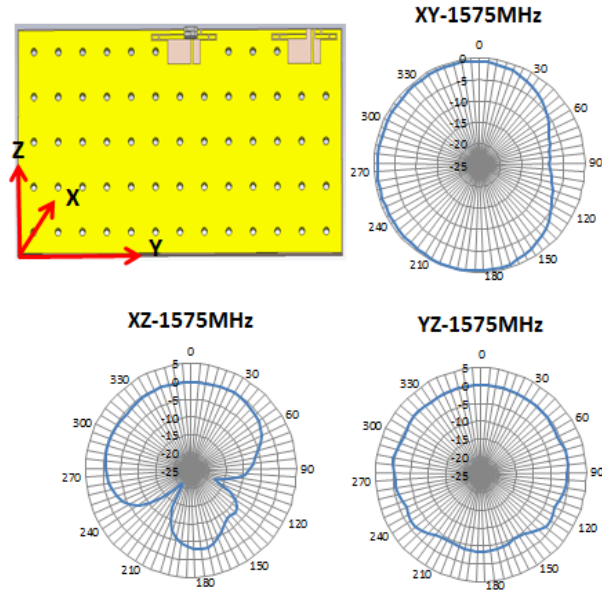
**FIGURE 5.9 RETURN LOSS OF ANTENNA WITHOUT AND WITH MATCHING ON REFERENCE PCB GROUND SIZE AT REFERENCE LOCATION**



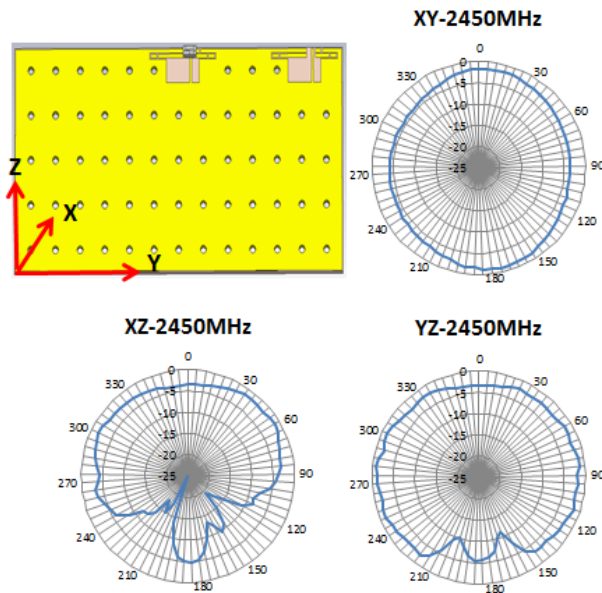
**FIGURE 5.10 SMITH CHART OF ANTENNA WITHOUT AND WITH MATCHING ON REFERENCE PCB GROUND SIZE AT REFERENCE LOCATION**

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DOCUMENT NUMBER: <b>2030070001</b>	CREATED / REVISED BY: <b>Hai Liu 2017/08/25</b>	CHECKED BY: <b>Benson Liu 2017/08/25</b>	APPROVED BY: <b>Chris Zhong 2017/08/25</b>

## 6.0 RADIATION PATTERN

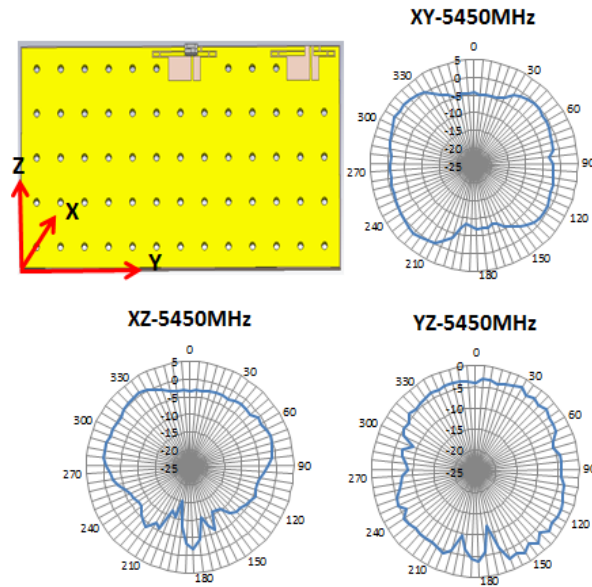


**FIGURE 6.1 RADIATION PATTERN OF ATNENNA AT 1575MHZ AT RECOMMENDED LOCATION**



**FIGURE 6.2 RADIATION PATTERN OF ATNENNA AT 2.45GHZ AT RECOMMENDED LOCATION**

REVISION: <b>A</b>	ECR/ECN INFORMATION: EC No: 121094 DATE: 2017/08/25	TITLE: <b>GNSS/WIFI Combo Ceramic Antenna</b>	SHEET No. <b>19 of 23</b>
DOCUMENT NUMBER: <b>2030070001</b>	CREATED / REVISED BY: Hai Liu 2017/08/25	CHECKED BY: Benson Liu 2017/08/25	APPROVED BY: Chris Zhong 2017/08/25



**FIGURE 6.3 RADIATION PATTERN OF ANTENNA AT 5.45GHZ AT RECOMMENDED LOCATIN**

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DOCUMENT NUMBER: <b>2030070001</b>	CREATED / REVISED BY: <b>Hai Liu 2017/08/25</b>	CHECKED BY: <b>Benson Liu 2017/08/25</b>	APPROVED BY: <b>Chris Zhong 2017/08/25</b>



# APPLICATION SPECIFICATION

## 7.0 ASSEMBLY INSTRUCTIONS

### A. RECOMMENDED SMT REFLOW PROFILE

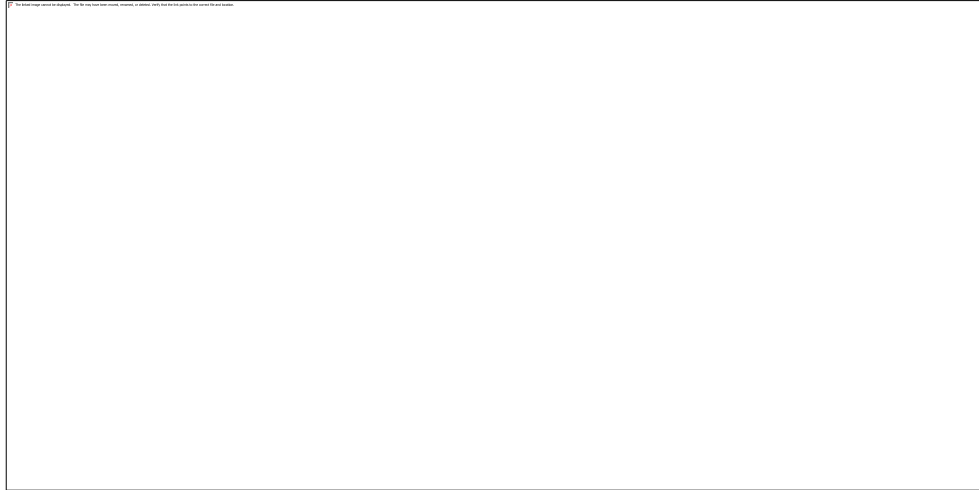


FIGURE 7.1 RECOMMENDED SMT REFLOW PROFILE

### B. MECHANICAL INTERFACE

#### I. GENERAL DESCRIPTION

The overall antenna size is 3.2mm X 1.6mm X 1.1mm

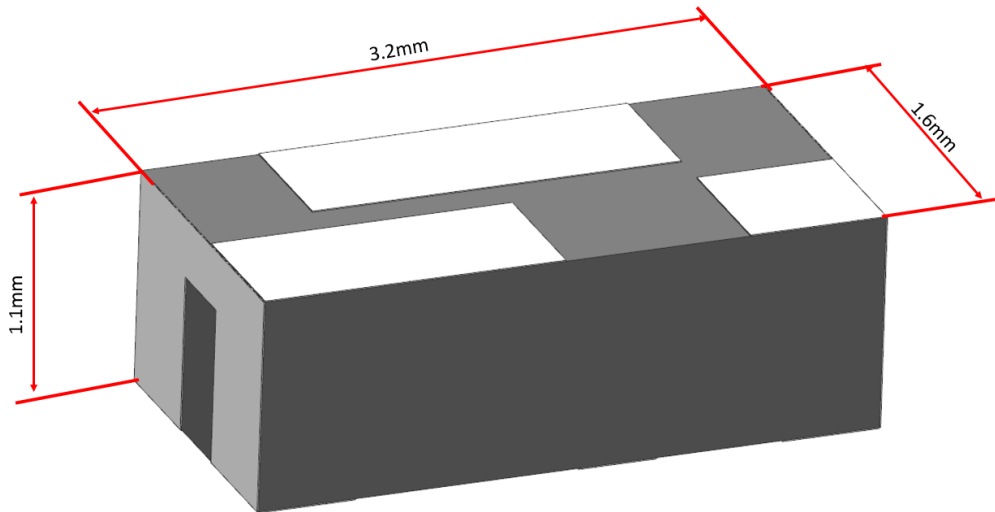


FIGURE 7.2 OVERALL ANTENNA SIZE

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## II. STRUCTURE FUNCTIONAL DESCRIPTION

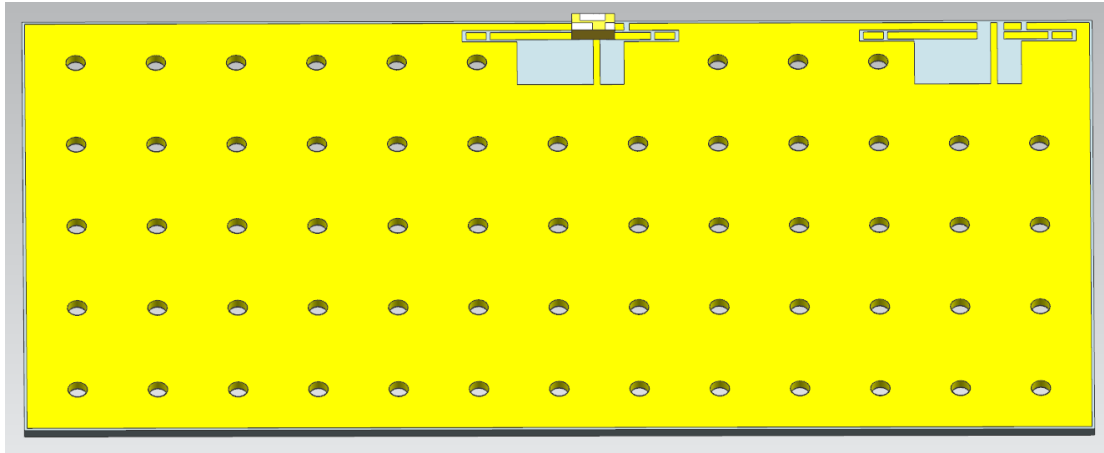


FIGURE 7.3 ANTENNA ASSEMBLE

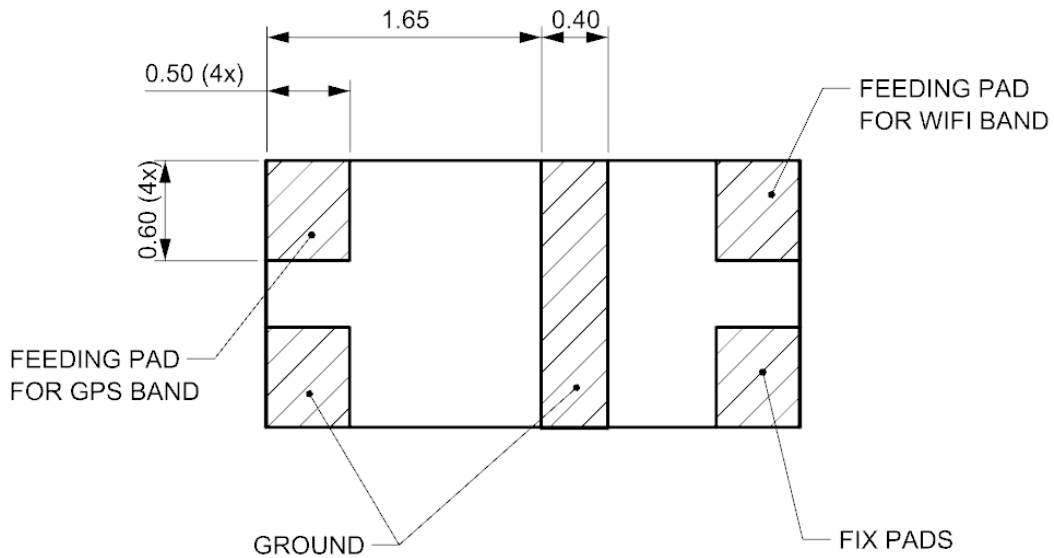
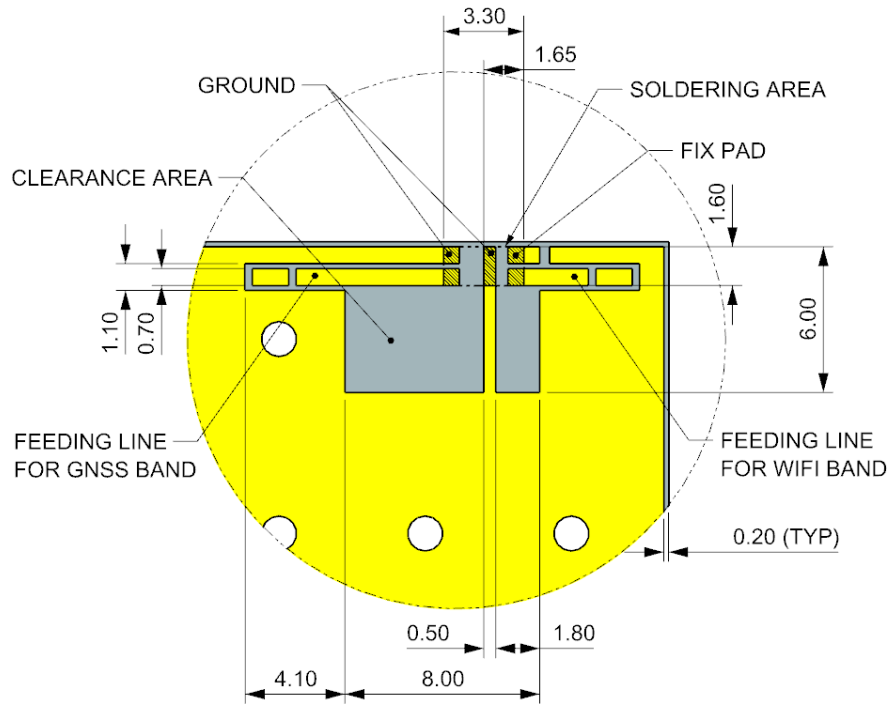


FIGURE 7.4 PADS OF PRODUCT FOR SOLDERING

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# APPLICATION SPECIFICATION



**FIGURE 7.5 RECOMMENDED FOOTPRINT ON PCB FOR SOLDERING**

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