



# APPLICATION SPECIFICATION

## LOW PROFILE GNSS CERAMIC ANTENNA

### 1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Molex Low Profile GNSS Ceramic 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, GALILEO, BEIDOU and GLONASS bands.

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 one feeding pad, three grounding pads and antenna radiator. See figure 1.

**1. FEEDING PAD**

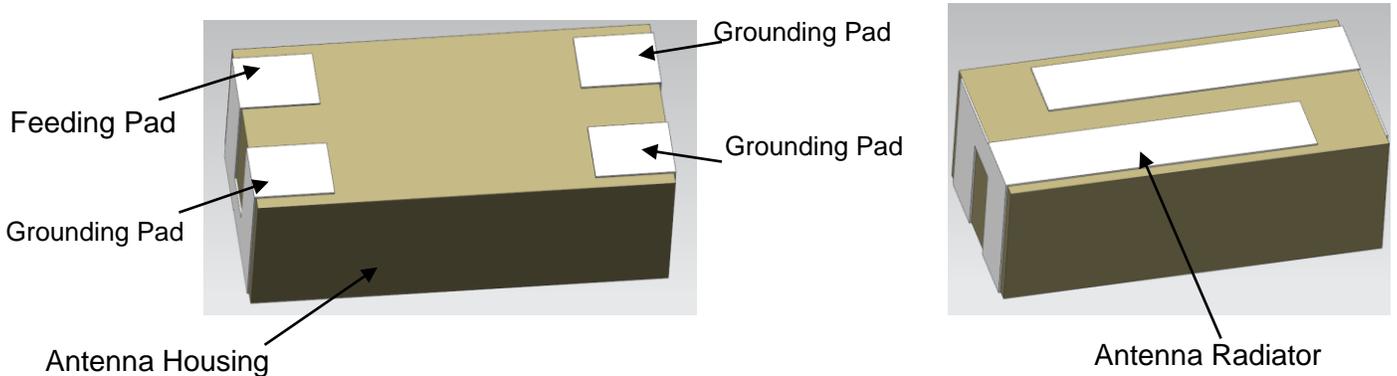
SMT mounted to feeding pad on PCB. The signal from the transmission line must be fed into the feeding pad on the PCB.

**2. GROUNDING PAD**

SMT mounted to grounding pad on PCB.

**3. ANTENNA RADIATOR**

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



**FIGURE1. LOW PROFILE GNSS CERAMIC ANTENNA**

#### B. REFERENCE IMPLEMENTATION

REVISION: <b>A</b>	ECR/ECN INFORMATION: EC No: 116780 DATE: 2017/05/17	TITLE: <b>Low Profile GNSS Ceramic Antenna Application Specification</b>	SHEET No. <b>1 of 21</b>
DOCUMENT NUMBER: <b>AS-2042830001</b>	CREATED / REVISED BY: <b>Benson Liu 2017/05/17</b>	CHECKED BY: <b>Chris Zhong 2017/05/17</b>	APPROVED BY: <b>Welson Tan 2017/05/17</b>

## 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 one feeding pad and three grounding pads. Furthermore, there is one “L” type matching network reserved close to feeding pad. The clearance size is 5mm\*6mm. See figure 2.

### 1. FEEDING PAD

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

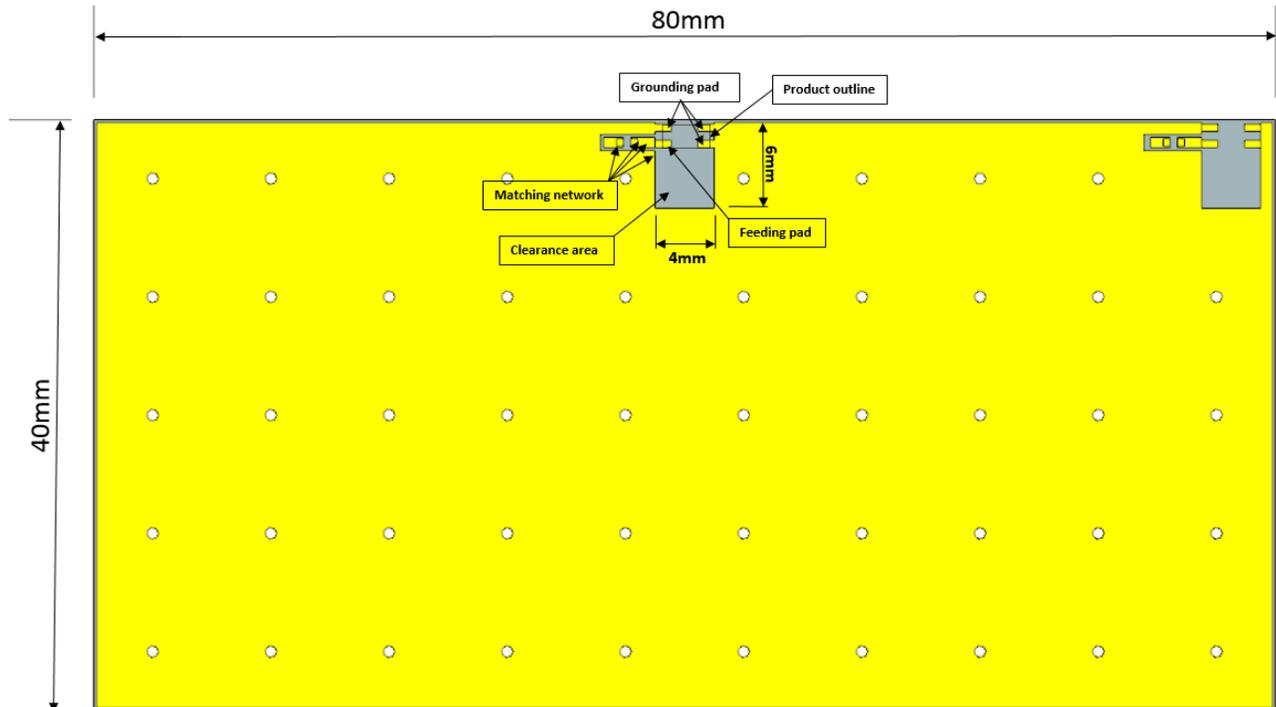
### 2. GROUNDING PAD

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

### 3. MATCHING CIRCUIT

It is necessary to reserve PCB space for one “L” type matching circuit 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)

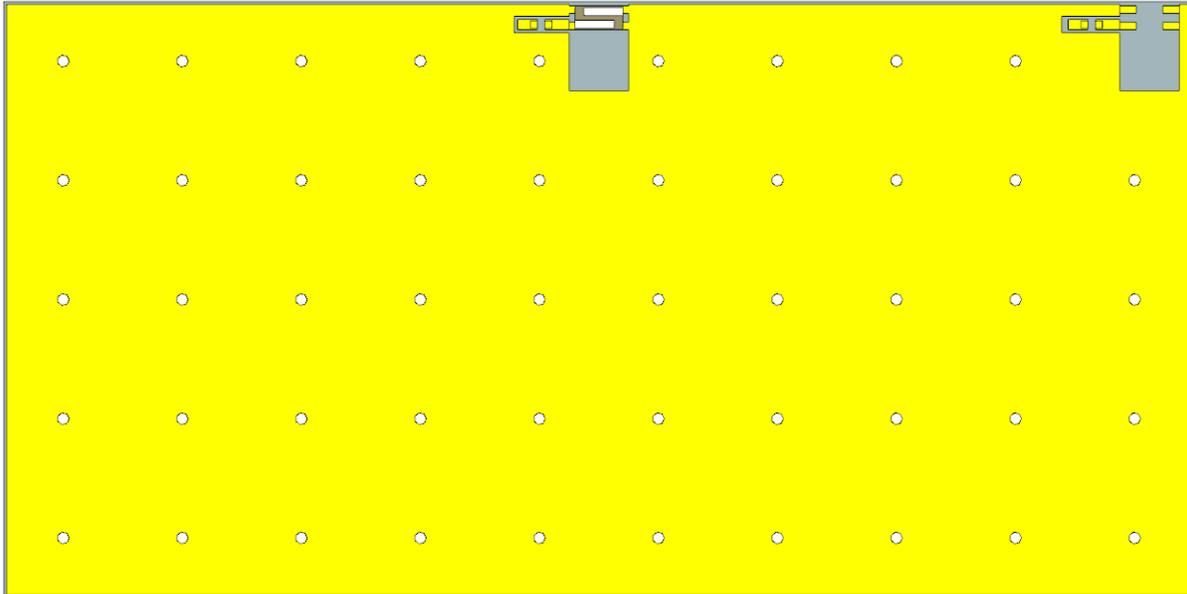
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## III. ANTENNA PERFORMANCE AT RECOMMENDED LOCATION

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



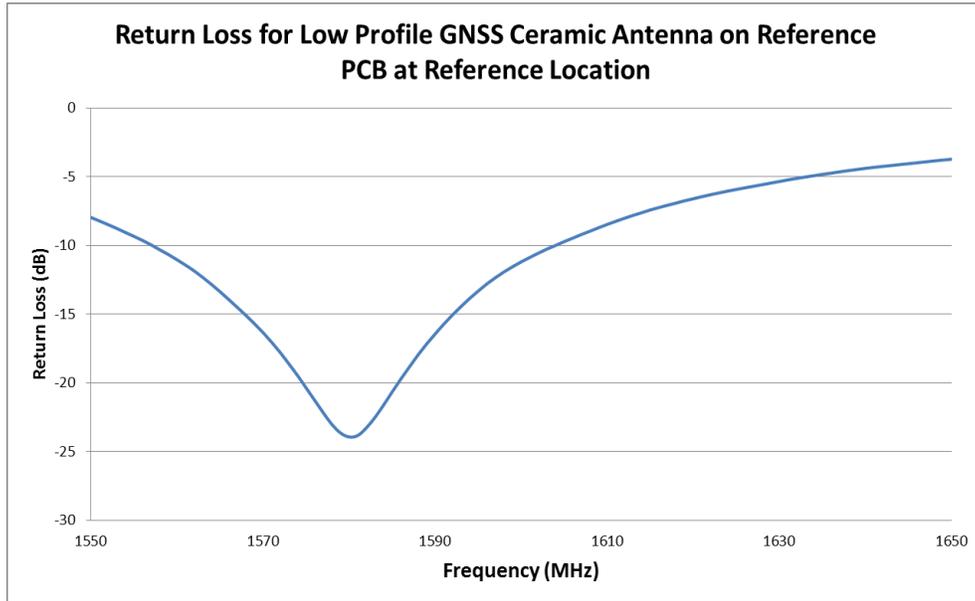
**FIGURE 2.1 RECOMMENDED ANTENNA LOCATION**

DESCRIPTION	Test Condition	Requirements		
		1561±5MHz	1575±5MHz	1602±5MHz
Frequency Range	Measure antenna on recommended PCB through VNA E5071C	1561±5MHz	1575±5MHz	1602±5MHz
Return Loss	Measure antenna on recommended PCB through VNA E5071C	< -8 dB	< -10 dB	< -8 dB
Peak Gain (Max)	Measure antenna on recommended PCB through OTA chamber	1.5dBi	2.0dBi	1.6dBi
Avg. Total Efficiency	Measure antenna on recommended PCB through OTA chamber	>60%	>65%	>60%
Polarization	Measure antenna on recommended PCB through OTA chamber	Linear		
Input Impedance	Measure antenna on recommended PCB through VNA E5071C	50 Ohms		

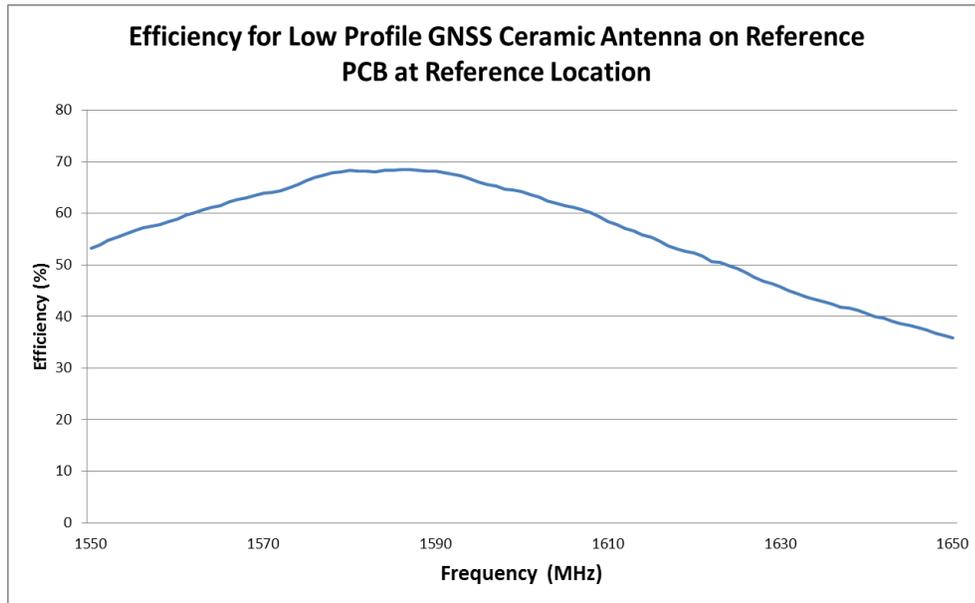
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**FIGURE 2.2 RETURN LOSS OF ANTENNA AT GPS/GALILEO/BEIDOU/GLONASS BAND ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE**

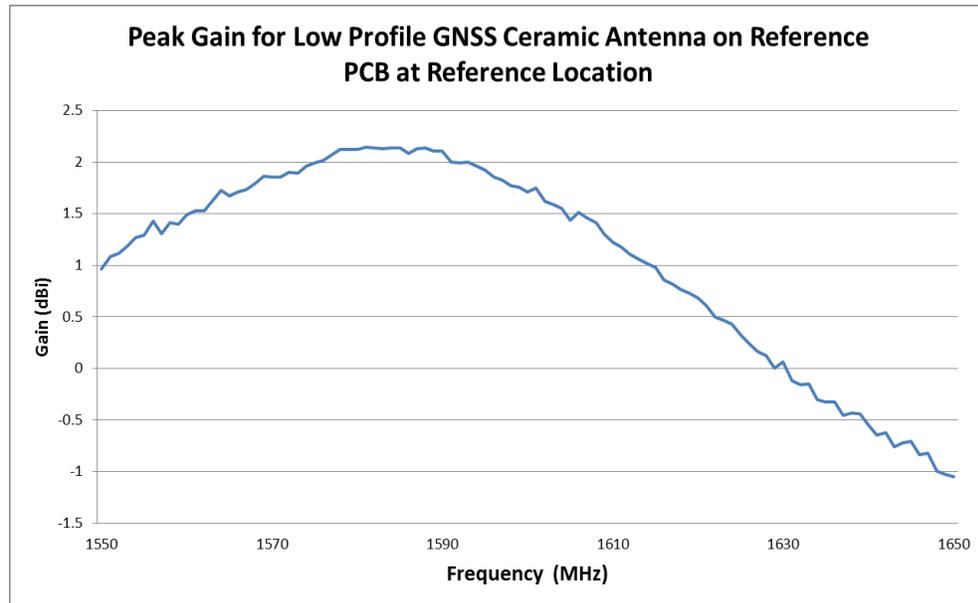


**FIGURE 2.3 EFFICIENCY OF ANTENNA AT GPS/GALILEO/BEIDOU/GLONASS BAND ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE**

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**FIGURE 2.4 PEAK GAIN OF ANTENNA AT GPS/GALILEO/BEIDOU/GLONASS BAND ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE**

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## 3.0 REFERENCE DOCUMENTS

- Sales Drawing: SD-2042830001
- Product Specification: PS-2042830001
- Packaging Information – Refer to the Molex related packaging drawings

## 4.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

### 4.0.1 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS ON THE REFERENCE PCB

Two locations have been evaluated RF performance and these locations are shown in figure 4.1. Figure 4.1.1, figure 4.1.2, and figure 4.1.3 comparatively present the return loss, efficiency, and peak Gain at two locations. The antenna performances at these two locations have been optimized with matching circuits.

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

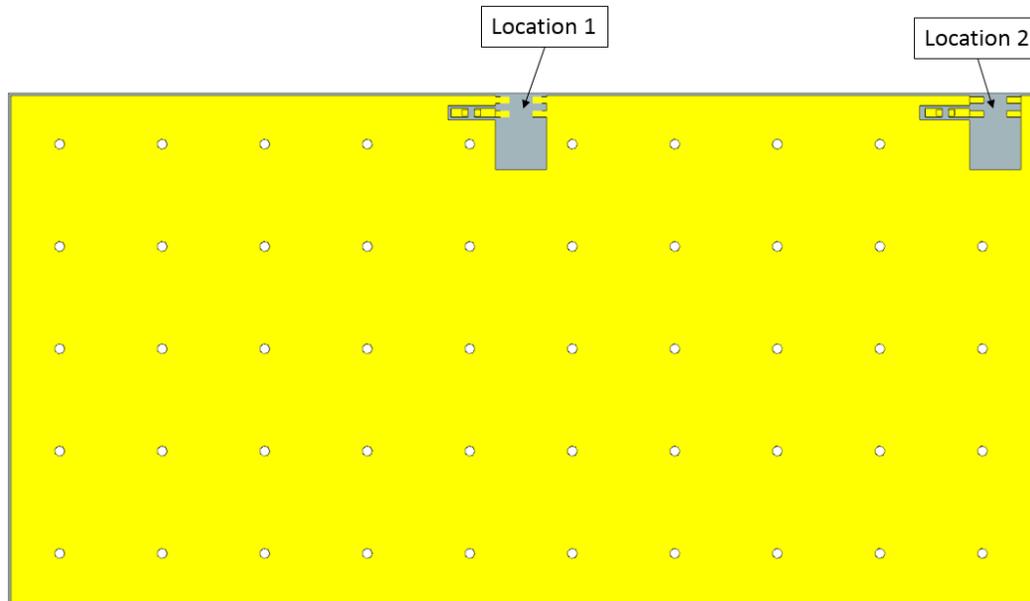
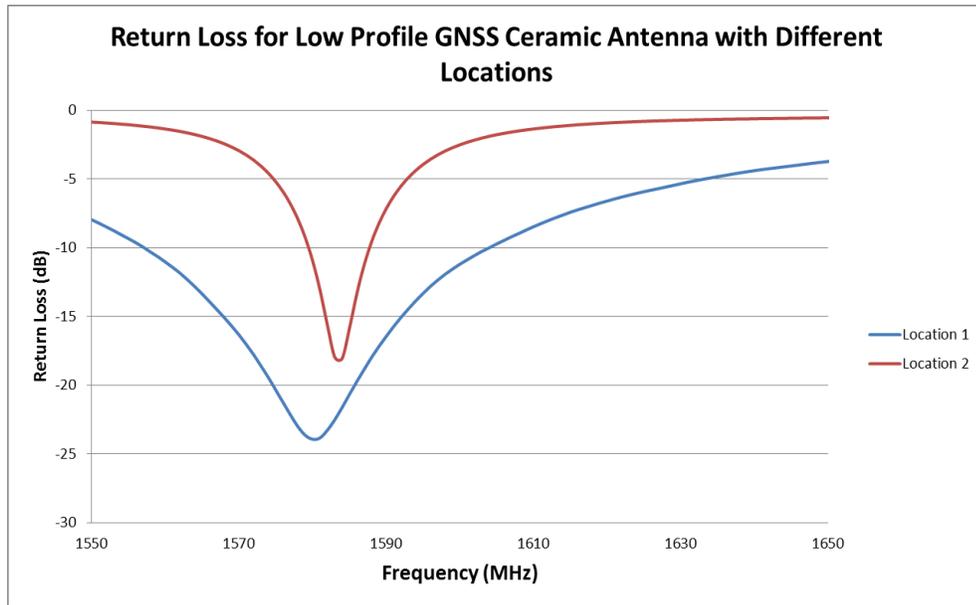


FIGURE 4.1 TWO LOCATIONS ON REFERENCE PCB

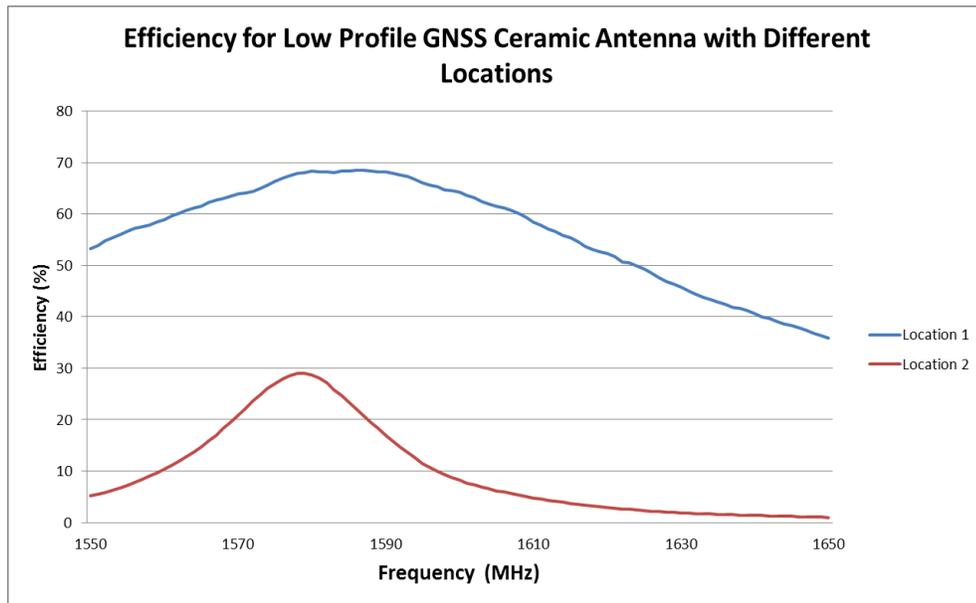
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**Figure 4.1.1 RETURN LOSS OF ANTENNA AT GPS/GALILEO/BEIDOU/GLONASS BAND AT TWO DIFFERENT LOCATIONS**

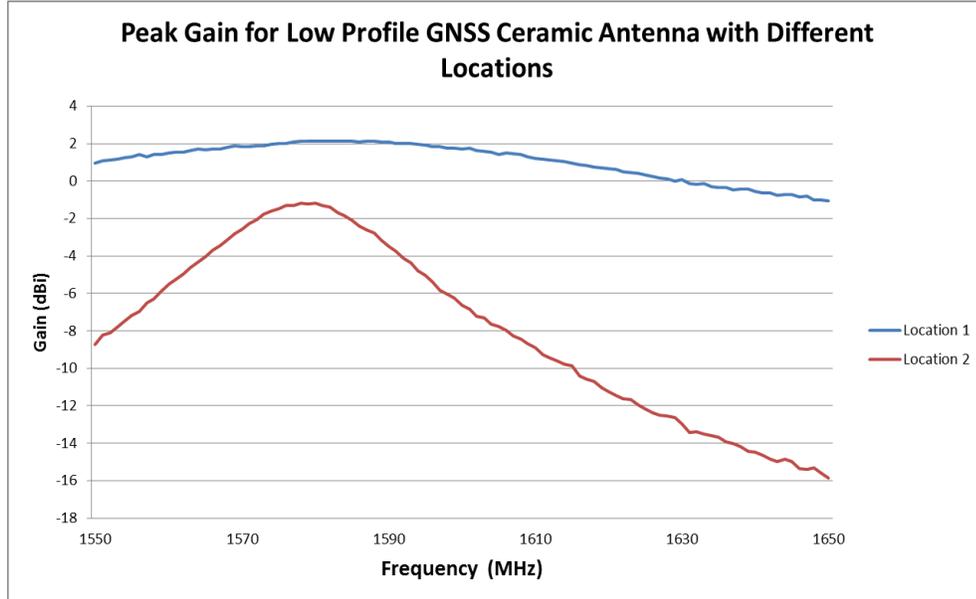


**Figure 4.1.2 EFFICIENCY OF ANTENNA AT GPS/GALILEO/BEIDOU/GLONASS BAND AT TWO DIFFERENT LOCATIONS**

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**Figure 4.1.3 PEAK GAIN OF ANTENNA AT GPS/GALILEO/BEIDOU/GLONASS BAND AT TWO DIFFERENT LOCATIONS**

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## 4.0.2 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 are 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 figures 4.2.1-4.2.3.

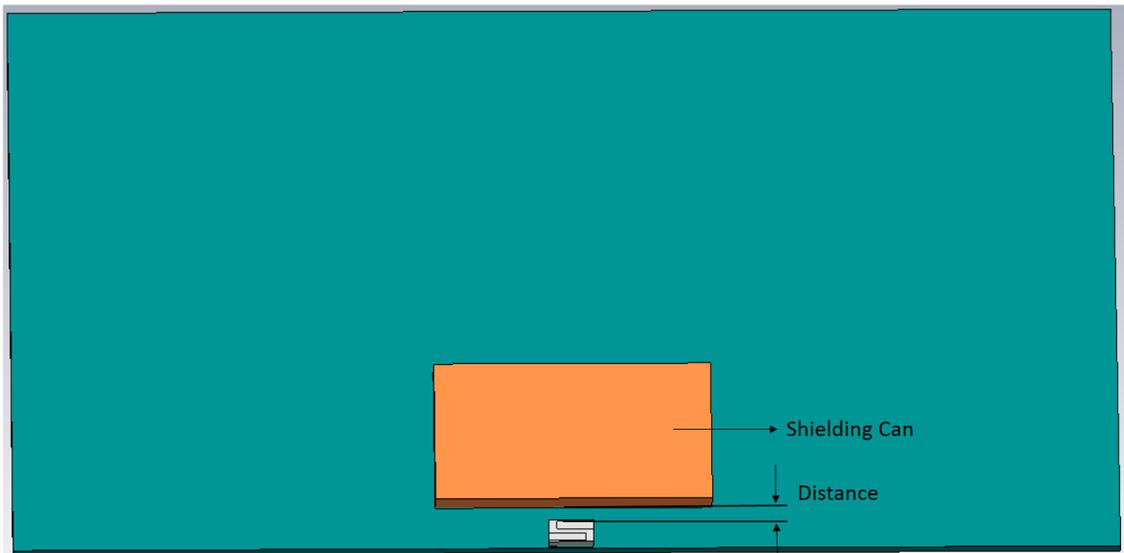
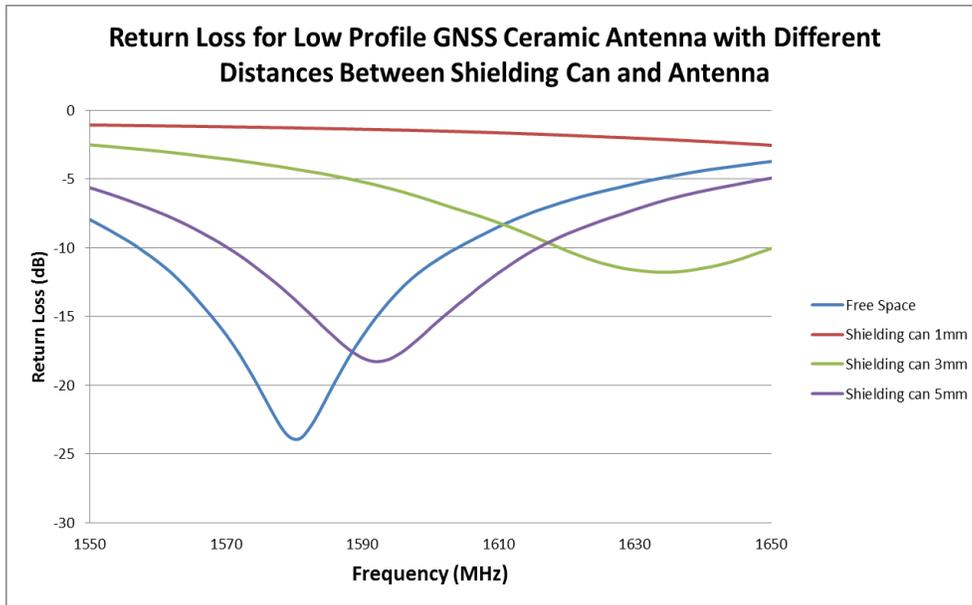


Figure 4.2 SHIELDING CAN FIXED ON REFERENCE PCB

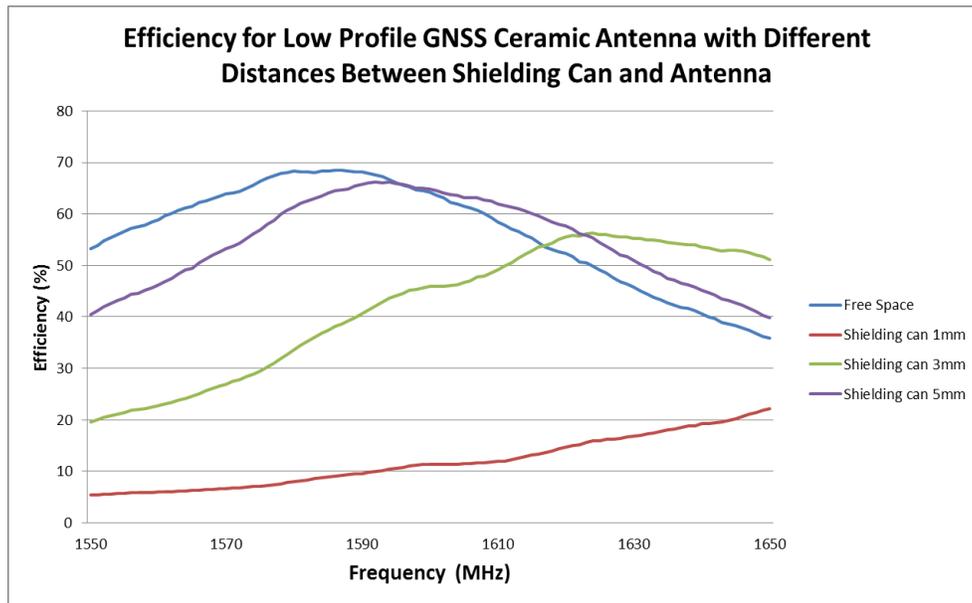
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**FIGURE 4.2.1 RETURN LOSS OF ANTENNA COMPARISON AT GPS/GALILEO/BEIDOU/GLONASS BAND WITH DIFFERENT DISTANCES BETWEEN SHIELDING CAN AND ANTENNA**

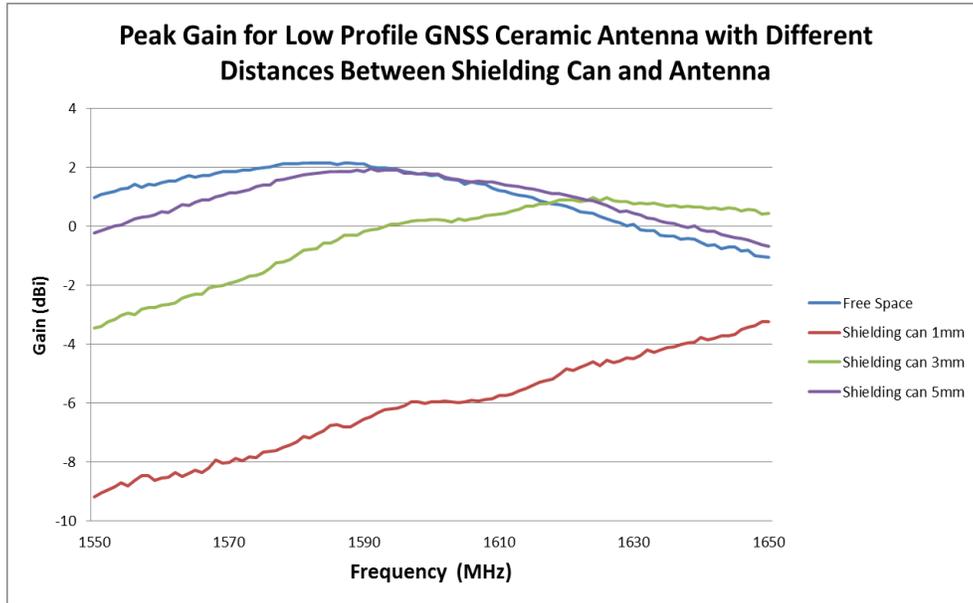


**FIGURE 4.2.2 EFFICIENCY OF ANTENNA COMPARISON AT GPS/GALILEO/BEIDOU/GLONASS BAND WITH DIFFERENT DISTANCES BETWEEN SHIELDING CAN AND ANTENNA**

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**FIGURE 4.2.3 PEAK GAIN OF ANTENNA COMPARISON AT GPS/GALILEO/BEIDOU/GLONASS BAND WITH DIFFERENT DISTANCES BETWEEN SHIELDING CAN AND ANTENNA**

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## 4.0.3 RF PERFORMANCE AS AN EFFECT OF PCB GROUND SIZES

4 kinds of PCB ground size have been evaluated and these configurations are shown in figure 4.3. Figures 4.3.1-4.3.3 comparatively show the return loss, the efficiency, and the peak gain of this antenna with 4 kinds of PCB ground sizes.

The recommended minimum PCB ground size for this antenna is 80mm\*40mm. When the ground size is less than 80mm\*40mm, the performance will be significantly decreased.

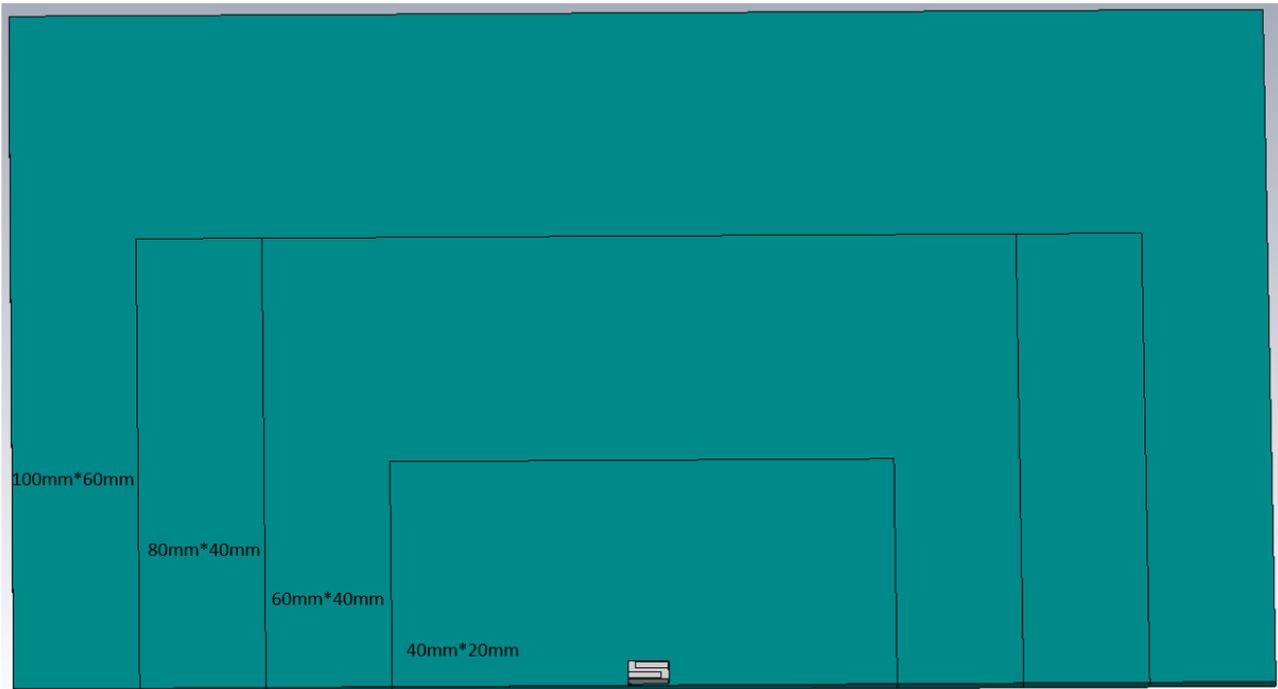
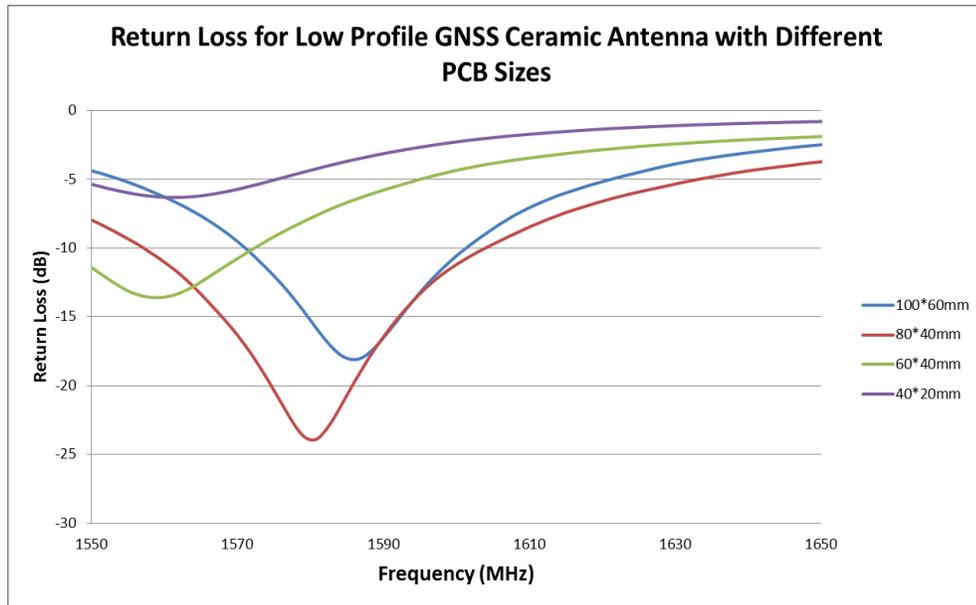


FIGURE 4.3 DIFFERENT GROUND PCB SIZES

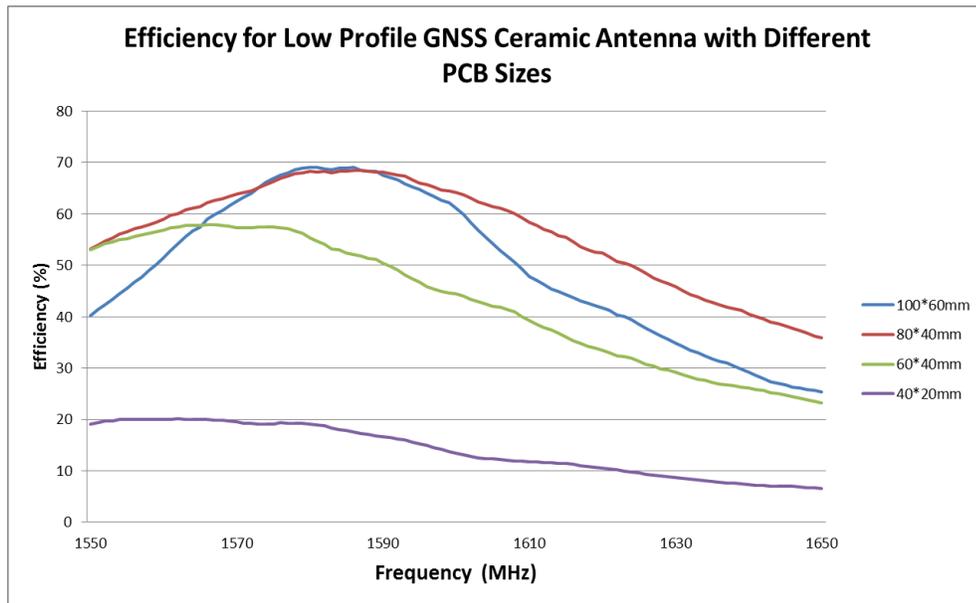
REVISION: <b>A</b>	ECR/ECN INFORMATION: EC No: 116780 DATE: 2017/05/17	TITLE: <b>Low Profile GNSS Ceramic Antenna Application Specification</b>	SHEET No. <b>12 of 21</b>
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**FIGURE 4.3.1 RETURN LOSS OF ANTENNA COMPARISON AT GPS/GALILEO/BEIDOU/GLONASS BAND MOUNTED ON DIFFERENT GROUND SIZES**

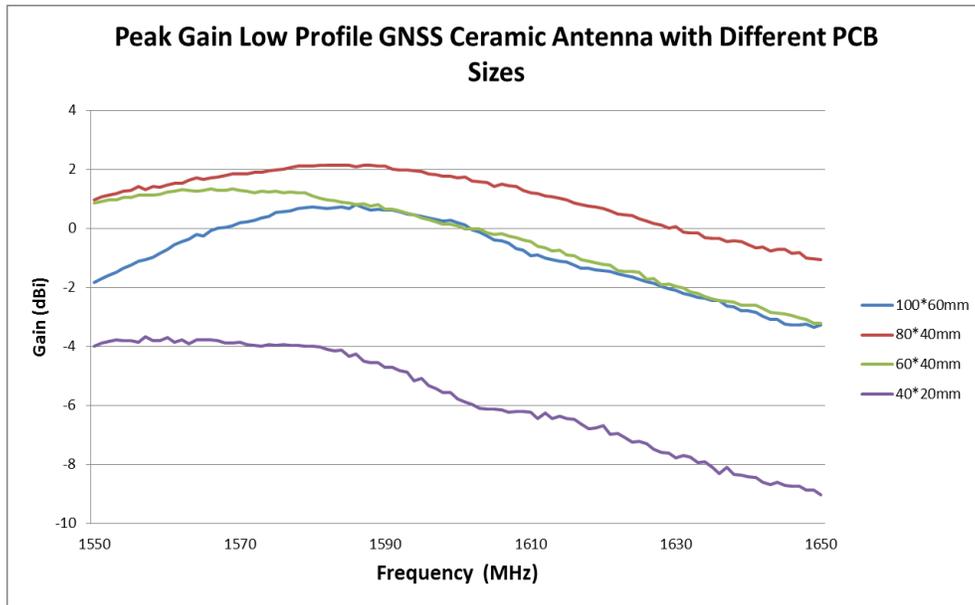


**FIGURE 4.3.2 EFFICIENCY OF ANTENNA COMPARISON AT GPS/GALILEO/BEIDOU/GLONASS BAND MOUNTED ON DIFFERENT GROUND SIZES**

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**FIGURE 4.3.3 PEAK GAIN OF ANTENNA COMPARISON AT GPS/GALILEO/BEIDOU/GLONASS BAND MOUNTED ON DIFFERENT GROUND SIZES**

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## 5.0 MATCHING NETWORK DESCRIPTION

The “L” type matching circuit is recommended to be applied for this antenna at the recommended location on reference PCB. The sequence of parallel element and series element depends on the impedance of antenna in smith chart shows in Figure 5.1.

Figure 5.2 shows the matching network for this antenna at GPS/GALILEO/BEIDOU/GLONASS band at the recommended location on reference PCB. The matching network is a parallel 0.5pF capacitor following with a series 1.2pF capacitor for GPS/GALILEO/BEIDOU/GLONASS Band.

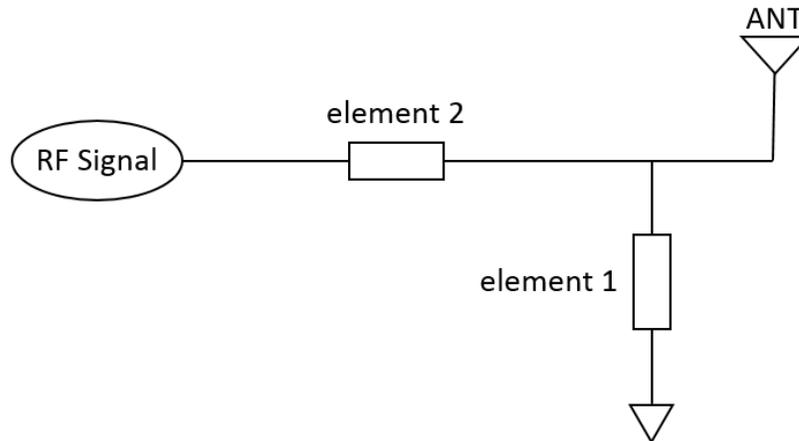


FIGURE 5.1 CONFIGURE 1 FOR GPS/GALILEO/BEIDOU/GLONASS BAND

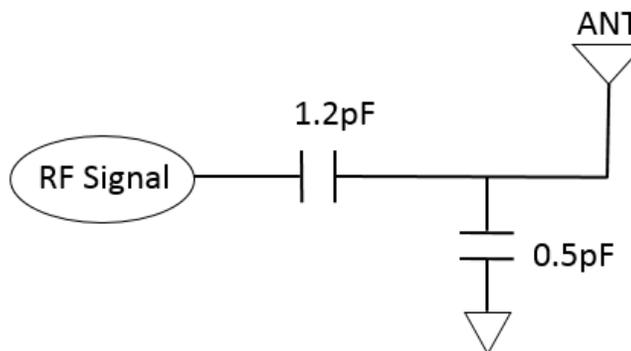


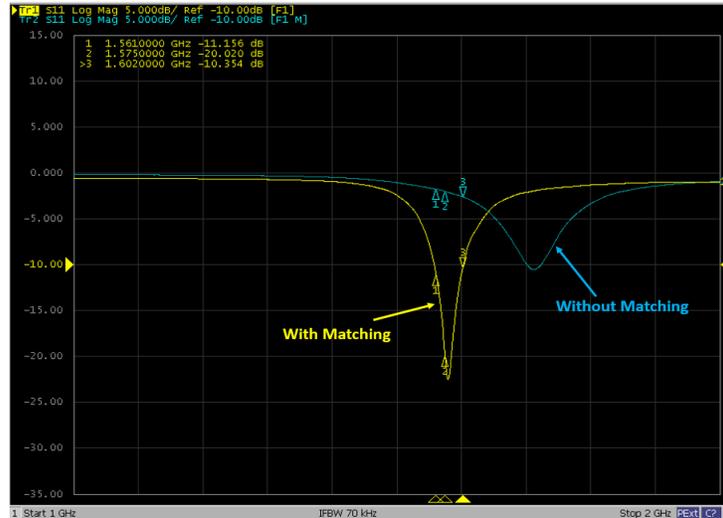
FIGURE 5.2 RECOMMENDED MATCHING NETWORK FOR GPS/GALILEO/BEIDOU/GLONASS BAND

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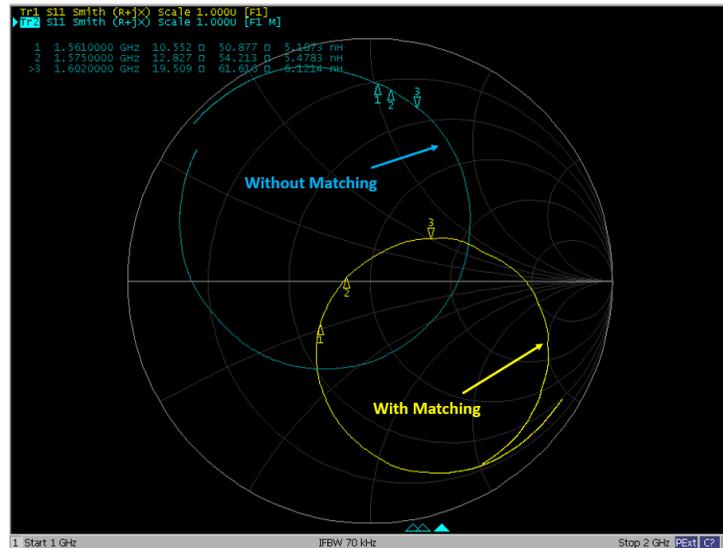


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The following figure 5.3 and figure 5.4 show the return loss and smith chart comparison without and with the matching network for the antenna at GPS/GALILEO/BEIDOU/GLONASS band on reference PCB ground size and at reference location.



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



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

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TEMPLATE FILENAME: APPLICATION_SPEC[SIZE_A](V.1).DOC			



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## 6.0 RADIATION PATTERN

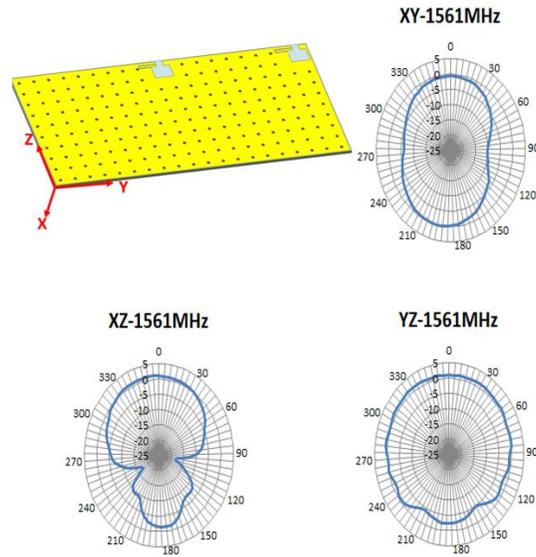


FIGURE 6.1 RADIATION PATTERN OF ATNENNA AT 1561MHZ AT RECOMMENDED LOCATION

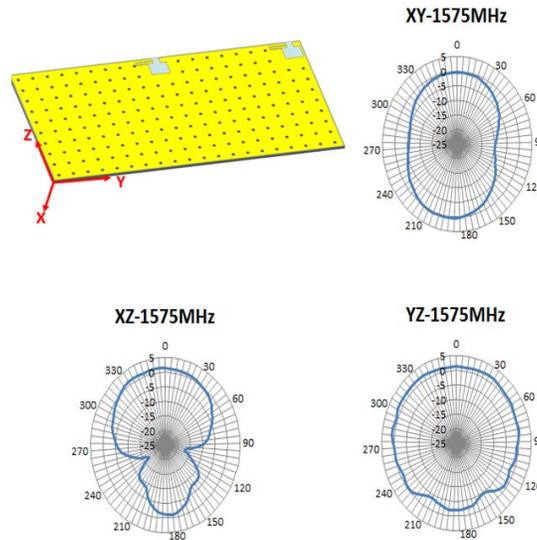


FIGURE 6.2 RADIATION PATTERN OF ATNENNA AT 1575MHZ AT RECOMMENDED LOCATION

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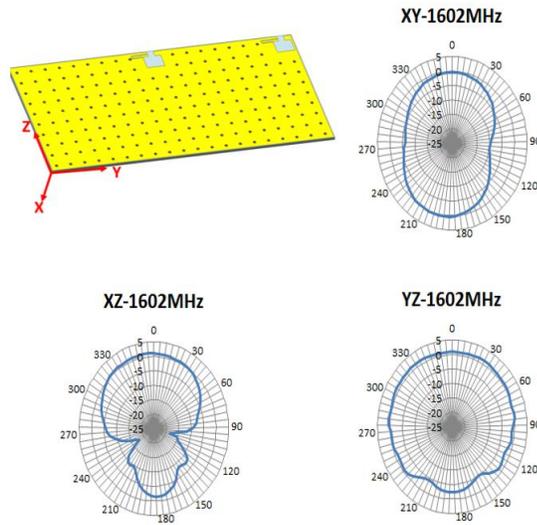


FIGURE 6.3 RADIATION PATTERN OF ATNENNA AT 1602MHZ AT RECOMMENDED LOCATION

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## 7.0 ASSEMBLY INSTRUCTIONS

### A. RECOMMENDED SMT REFLOW PROFILE

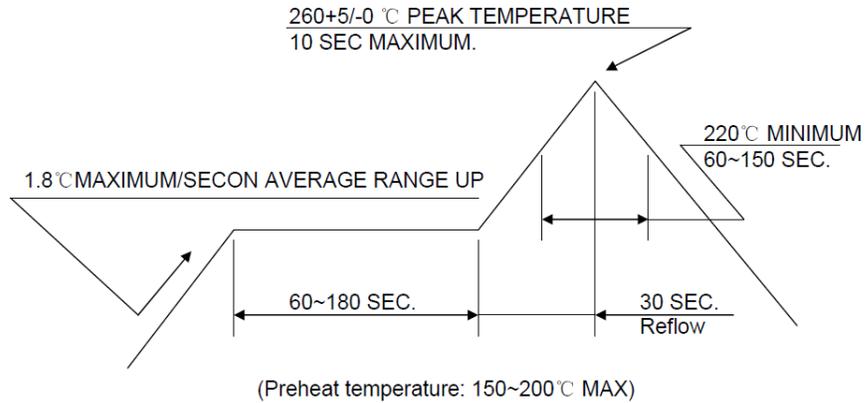


FIGURE 7.1 RECOMMENDED SMT REFLOW PROFILE

### B. MECHANICAL INTERFACE

#### I. GENERAL DESCRIPTION

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

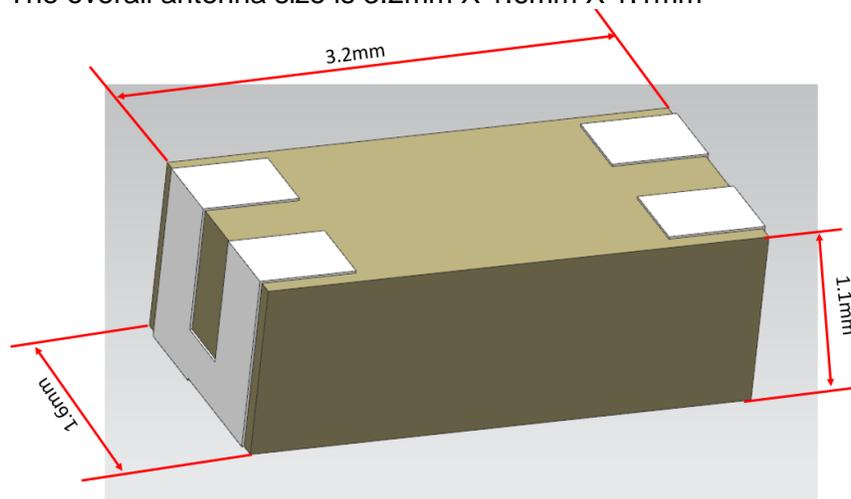


FIGURE 7.2 OVERALL ANTENNA SIZE

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## II. STRUCTURE FUNCTIONAL DESCRIPTION

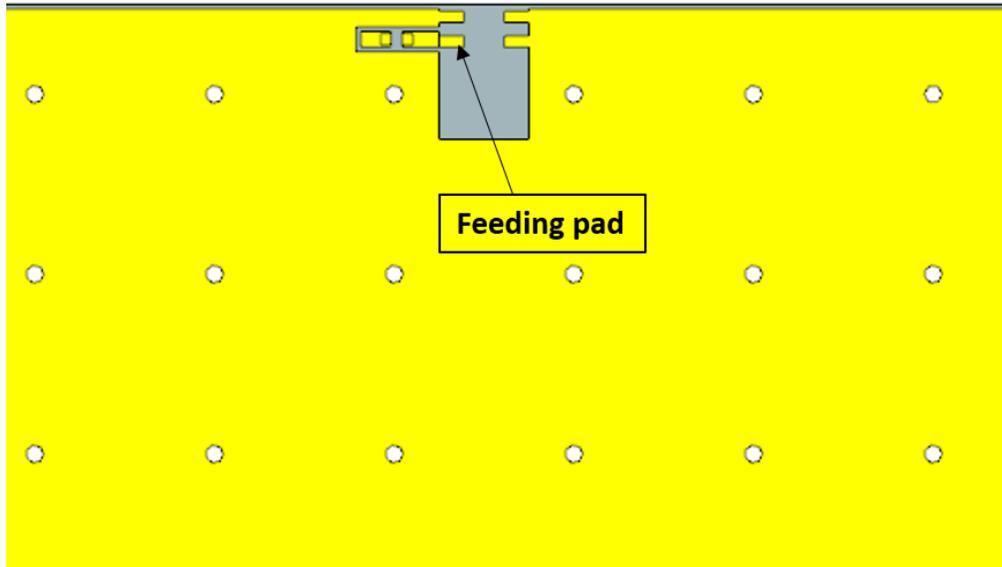


FIGURE 7.3 ANTENNA ASSEMBLE

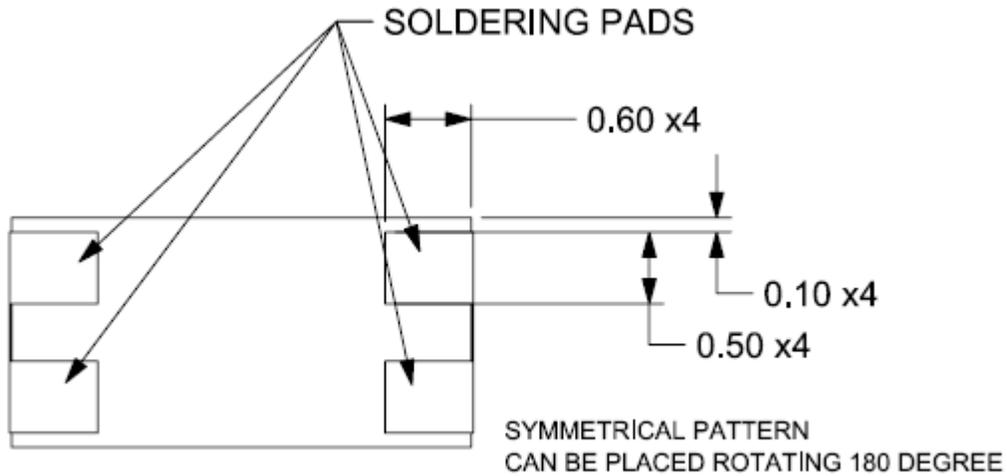
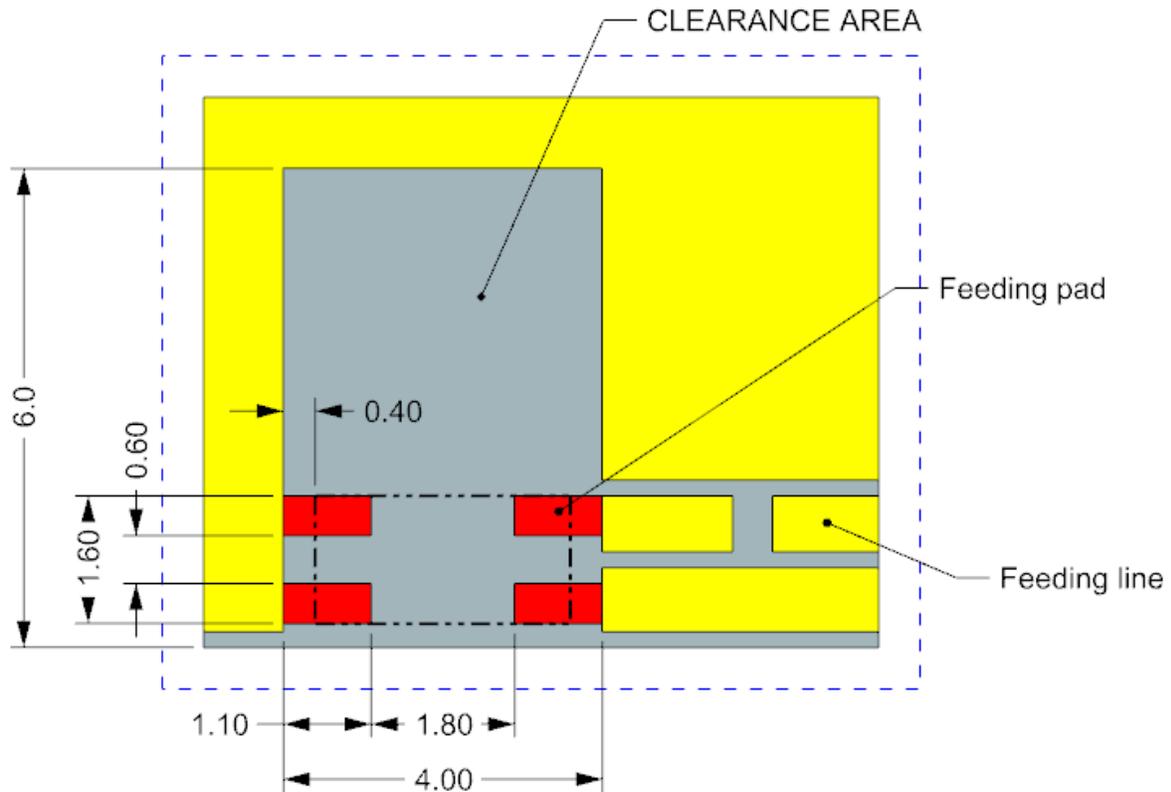


FIGURE 7.4 PADS OF PRODUCT FOR SOLDERING

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

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