APPLICATION SPECIFICATION

CELLULAR 790-2700MHZ CERAMIC ANTENNA

1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Cellular 790-2700MHz 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.

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 33mm*6mm*3mm (Length *Width *Height). There are one feeding pad, one grounding pad, two fixing pads and antenna radiator. See Figure 1.

1. **FEEDING PAD**
   SMT mounted to feeding pad on 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.

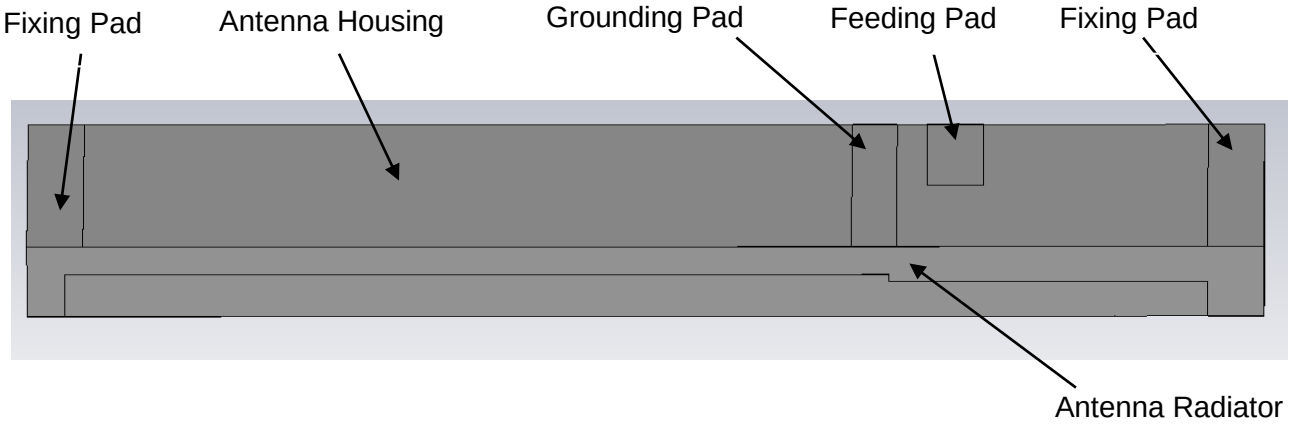

FIGURE 1. CELLULAR 790-2700MHZ CERAMIC ANTENNA

B. REFERENCE IMPLEMENTATION

I. REFERENCE PCB DESCRIPTION

The reference design is based on a recommended double sided PCB size of 130 mm *60 mm*0.8 mm. There are one feeding pad, one grounding pad and two fixing pads. Furthermore there is a signal matching network close to feeding pad. The clearance size is 60*9mm. See figure 2 and 2.1

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 a matching circuit in this design. In order to adjust the return loss due to loading by the device housing and surrounding component, the matching circuits need to be changed according.

II. REFERENCE PCB LAYOUT

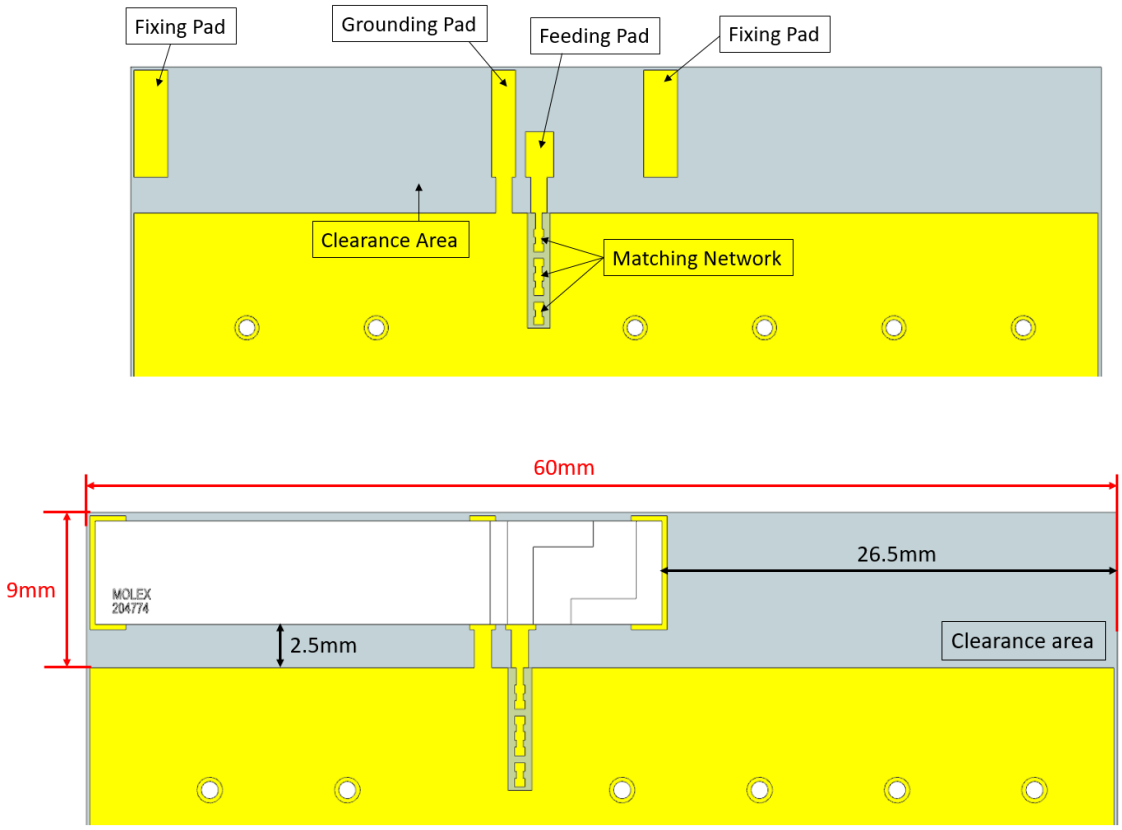

FIGURE 2: RECOMMENDED PCB LAYOUT

(Note: PCB size of 130 mm x 60 mm)

III. PERFORMANCE AT REFERENCE ANTENNA LOCATION

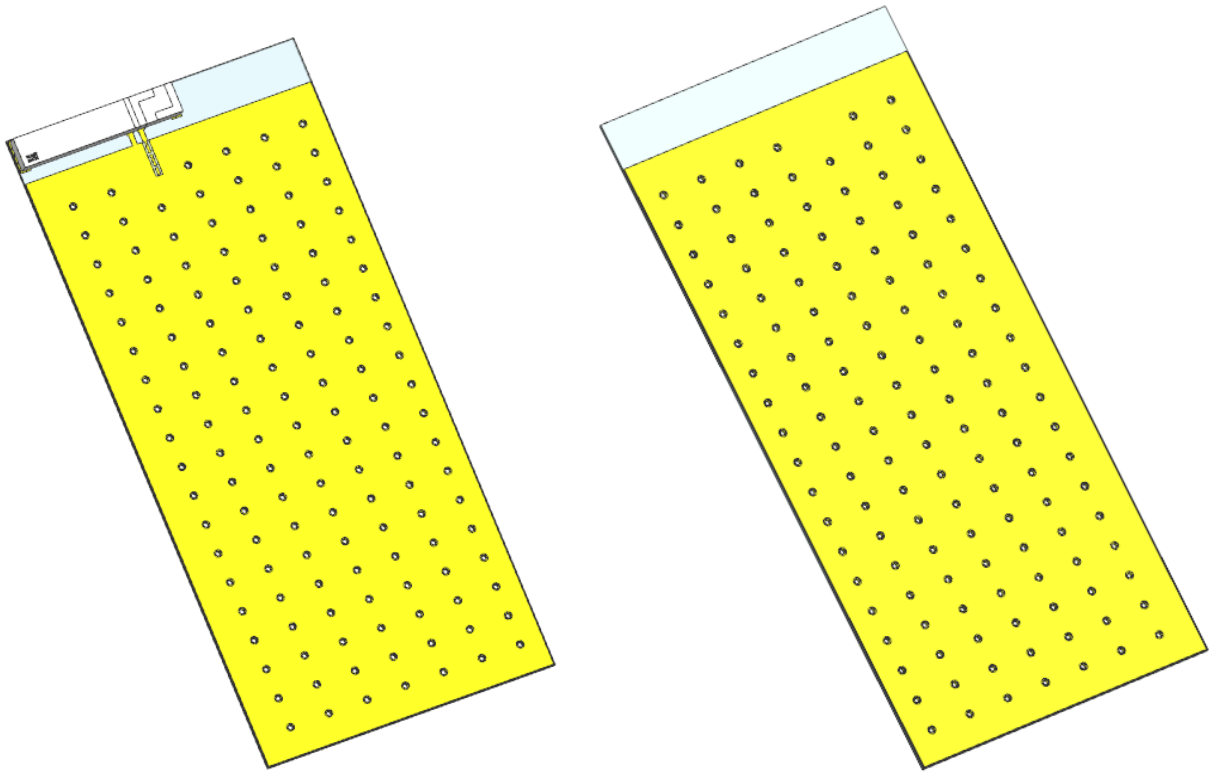

Figure 2.1 REFERENCE ANTENNA LOCATION

The reference antenna location is at the top of the PCB as show in Figure 2.1. The clearance size for this antenna is 60*9mm.

DESCRIPTION	TEST CONDITION	REQUIREMENTS	
Frequency Range	Measure antenna on recommended PCB through VNA E5071C	790-960MHz	1.7-2.7GHz
Return Loss	Measure antenna on recommended PCB through VNA E5071C	< -6 dB	< -6 dB
Peak Gain (Max)	Measure antenna on recommended PCB through OTA chamber	0.6dBi	4.8dBi
Total Efficiency (Avg.)	Measure antenna on recommended PCB through OTA chamber	>50%	>70%
Polarization	Measure antenna on recommended PCB through OTA chamber	Linear	Linear
Input Impedance	Measure antenna on recommended PCB through VNA E5071C	50Ohms	50Ohms

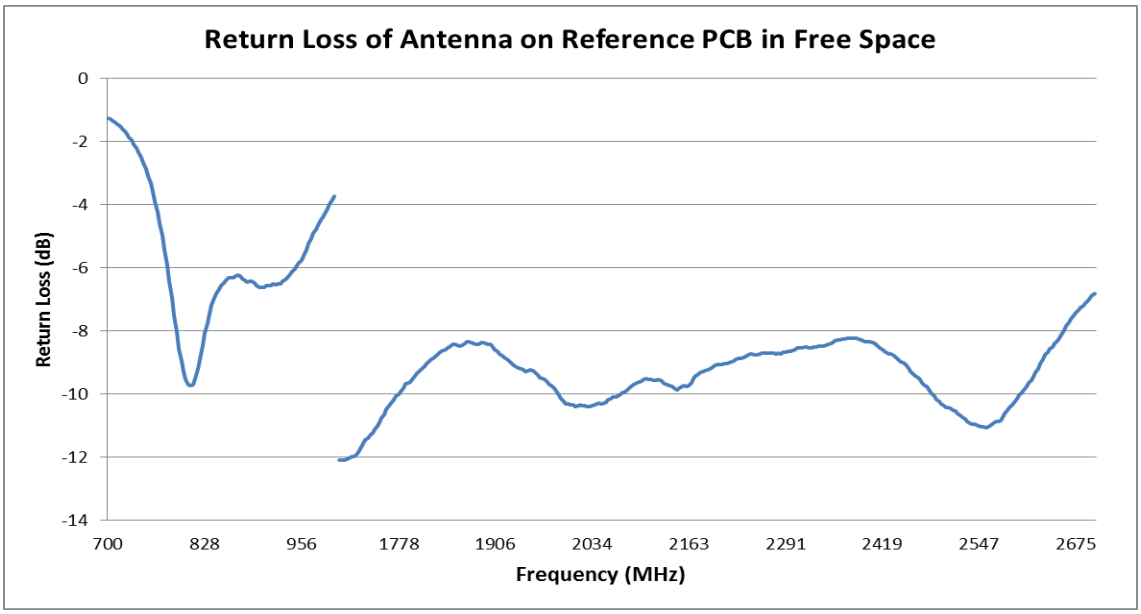

FIGURE 2.2 RETURN LOSS OF ANTENNA AT 790-960MHZ AND 1.7-2.7GHZ BAND AT REFERENCE LOCATION IN FREE SPACE

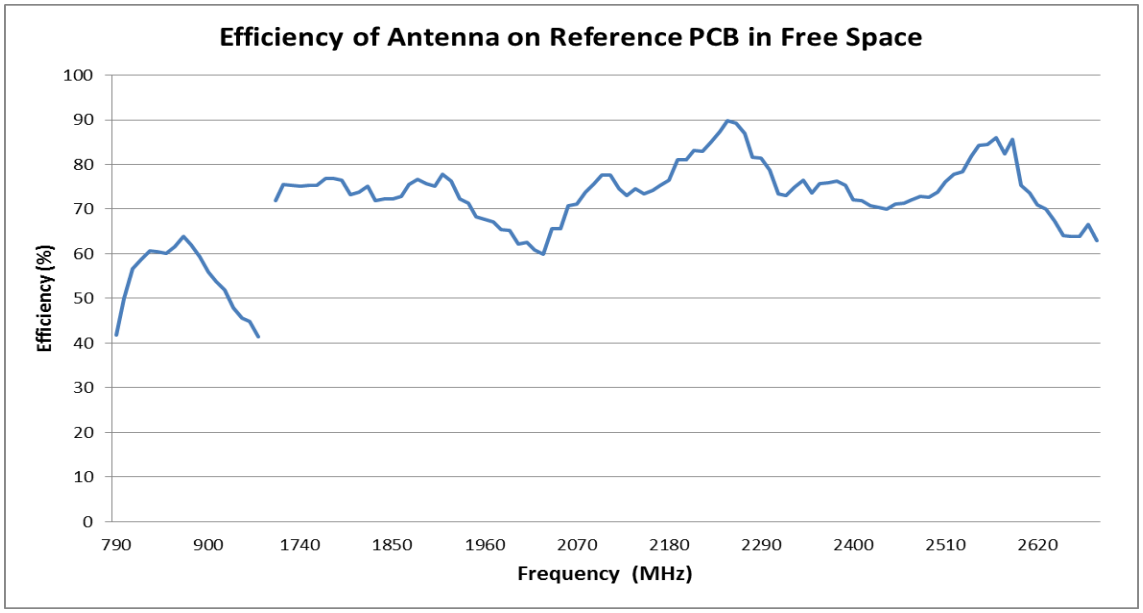

FIGURE 2.3 EFFICIENCY OF ANTENNA AT 790-960MHZ AND 1.7-2.7GHZ BAND AT REFERENCE LOCATION IN FREE SPACE

3.0 REFERENCE DOCUMENTS

- Sales Drawing: SD-2047740001
- Product Specification: PS-2047740001
- Packaging Information: PK-2047740001

4.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

4.0.1 ANTENNA RF PERFORMANCE INFLUENCED BY NEARBY SHIELDING CAN

A shielding can with size of 30mm*30mm*2mm was used for this study.

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

From the study, we recommend that a shielding can 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 4.1.1- 4.1.2.

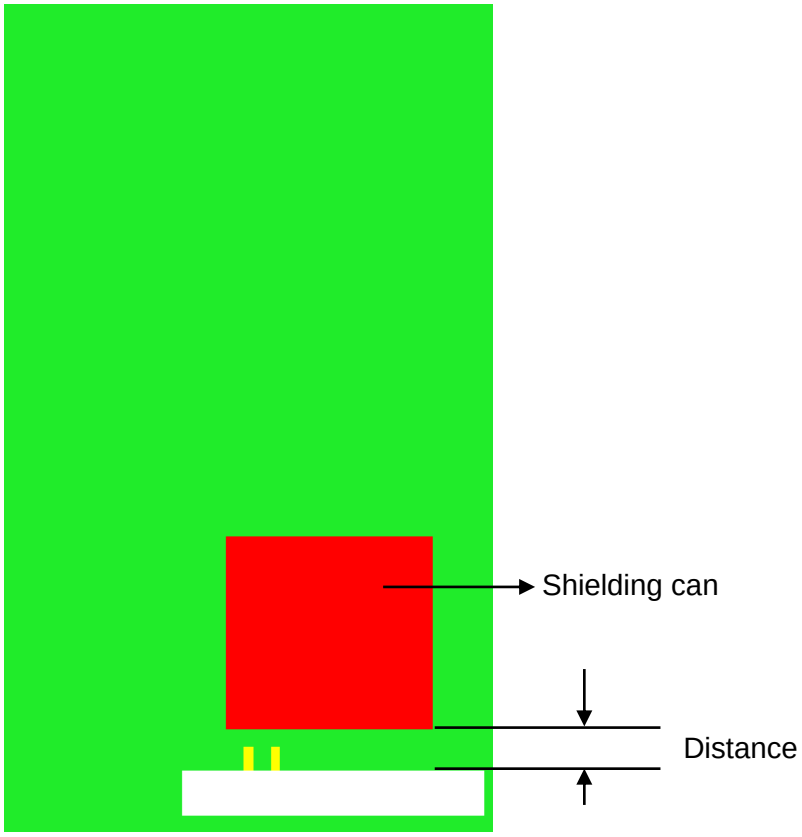

Figure 4.1 SIMULATED CONDITION: SHIELDING CAN FIXED ON REFERENCE PCB

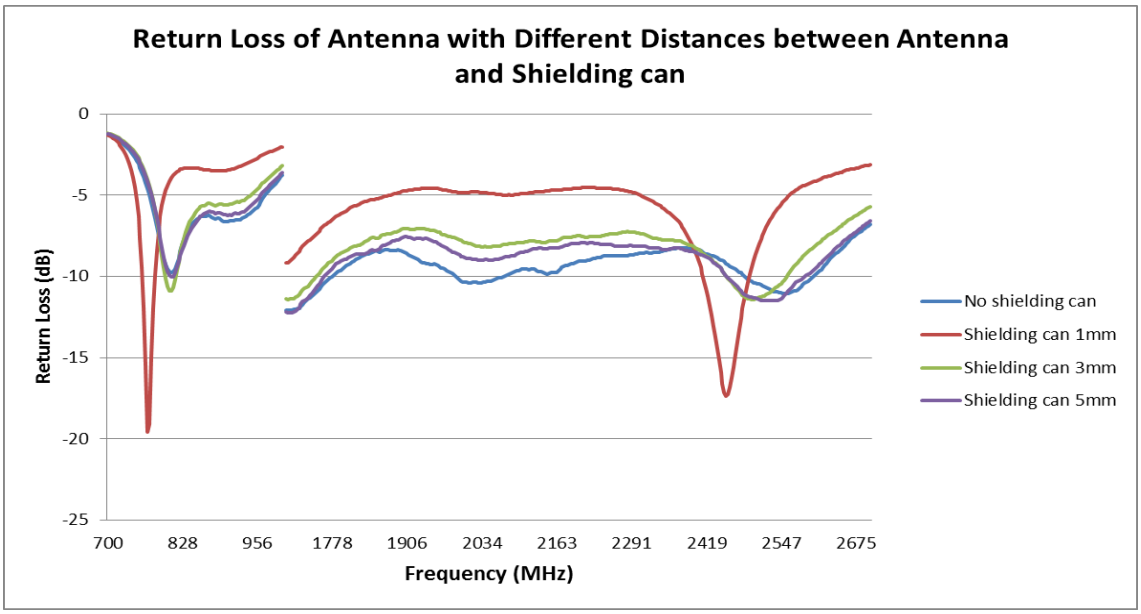

FIGURE 4.1.1 RETURN LOSS COMPARISON AT 790-960MHz AND 1.7-2.7GHZ BAND OF DIFFERENT SHIELDING CAN DISTANCE FROM ANTENNA

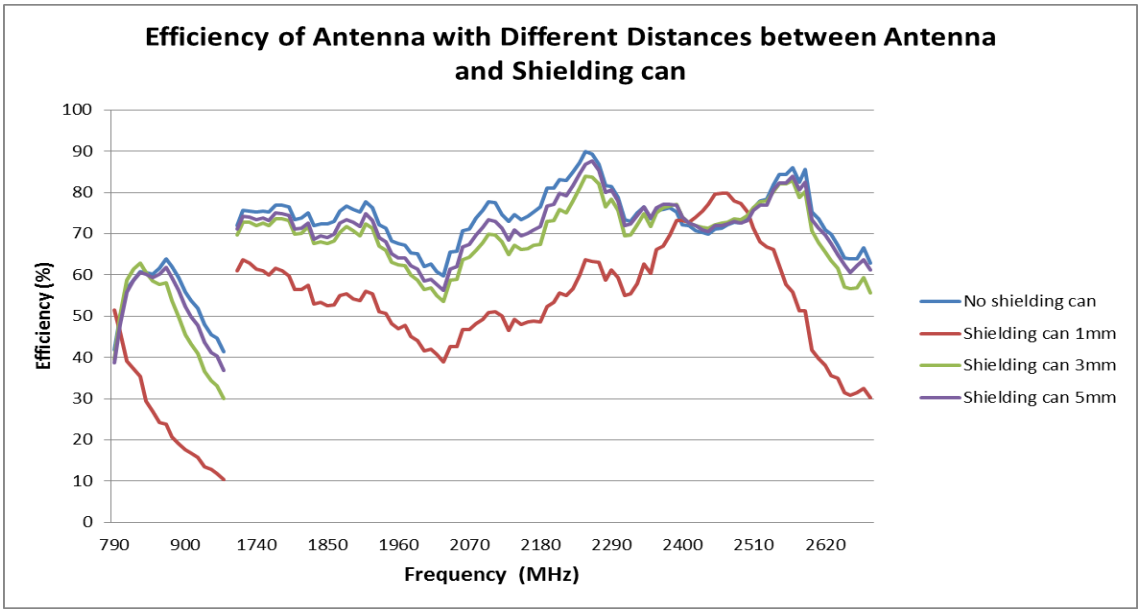

FIGURE 4.1.2 EFFICIENCY COMPARISON AT 790-960MHz AND 1.7-2.7GHZ BAND OF DIFFERENT SHIELDING CAN DISTANCE FROM ANTENNA

4.0.2 RF PERFORMANCE INFLUENCED BY NEARBY BATTERY

A battery with size of 30mm*60mm*2mm was used for this study.

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

From the study, we recommend that a battery 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 4.2.1-4.2.2

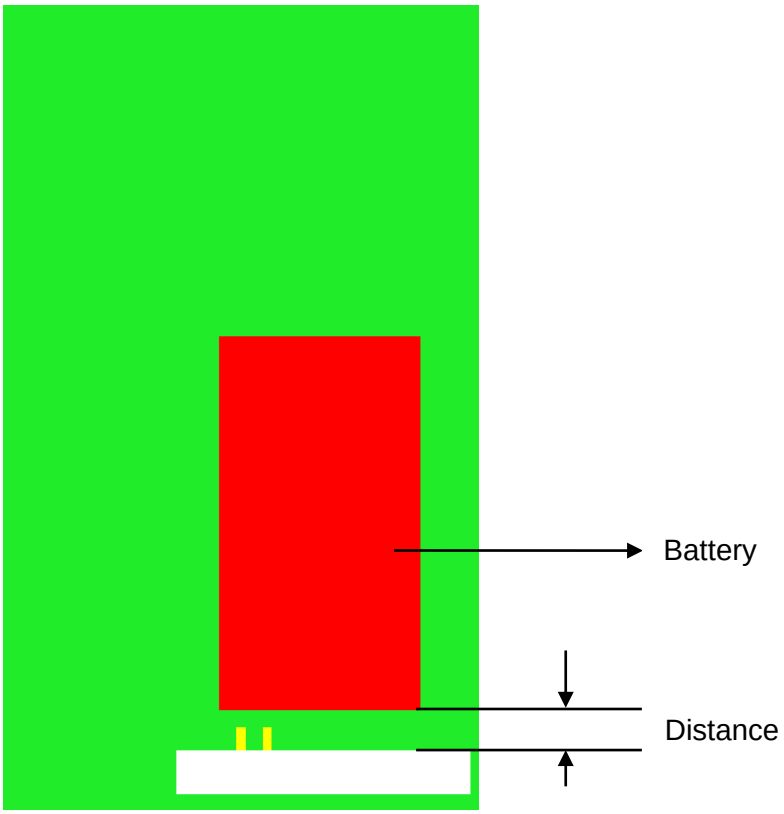

FIGURE 4.2 SIMULATED CONDITION: BATTERY FIXED ON REFERENCE PCB

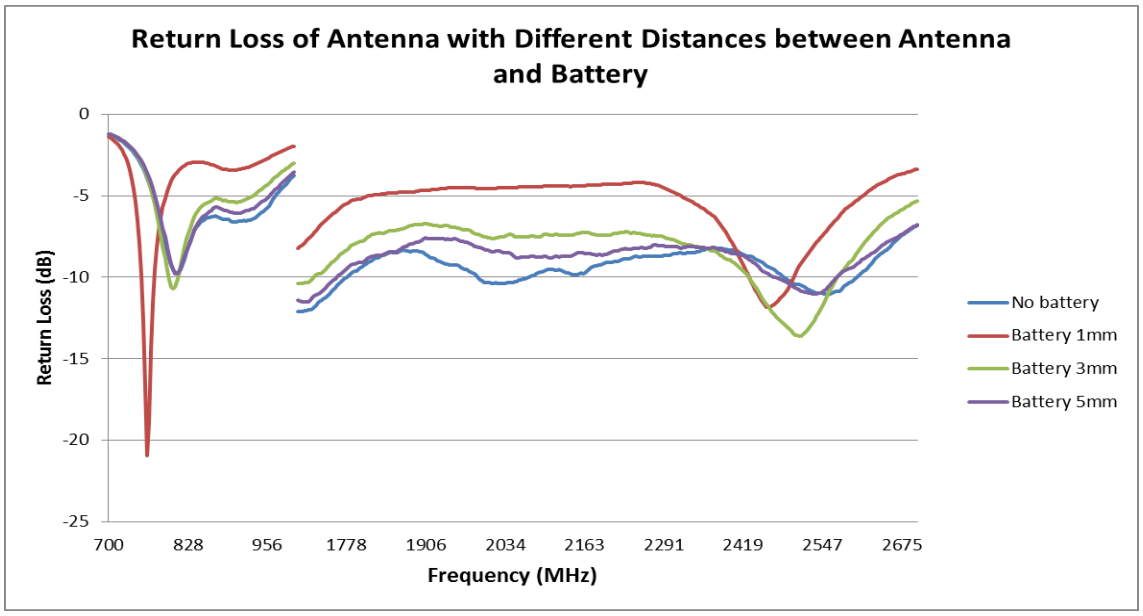

FIGURE 4.2.1 RETURN LOSS COMPARISON AT 790-960MHZ AND 1.7-2.7GHZ BAND OF DIFFERENT BATTERY DISTANCE FROM ANTENNA

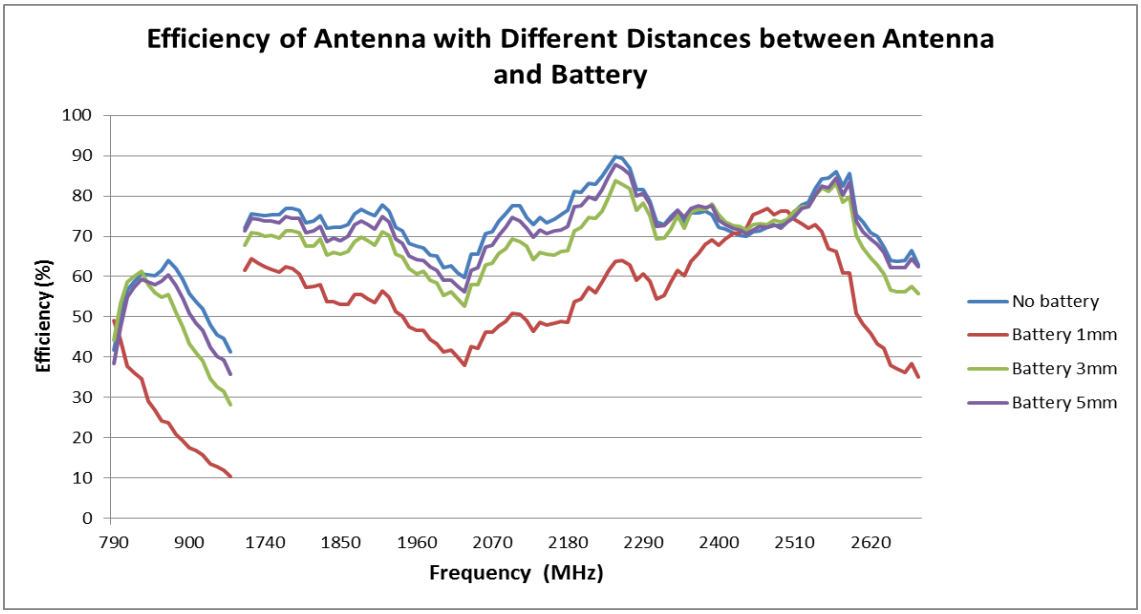

FIGURE 4.2.2 EFFICIENCY COMPARISON AT 790-960MHZ AND 1.7-2.7GHZ BAND OF DIFFERENT BATTERY DISTANCE FROM ANTENNA

4.0.3 RF PERFORMANCE AS A FUNCTION OF DIFFERENT DISTANCE BETWEEN VERTICAL PLASTIC COVER AND ANTENNA

An evaluation was done with 3 different distances from the antenna which is located at the recommended location to the vertical plastic cover. The 3 distances are as following: 1mm, 3mm and 5mm. Though the vertical plastic cover shifts the antenna resonance a bit lower, it has less effect on antenna performance according to the results. The vertical plastic has less effect on antenna performance, but we also suggest that the vertical plastic be placed at least 1mm away from the antenna. Refer to figure 4.3.1-4.3.2.

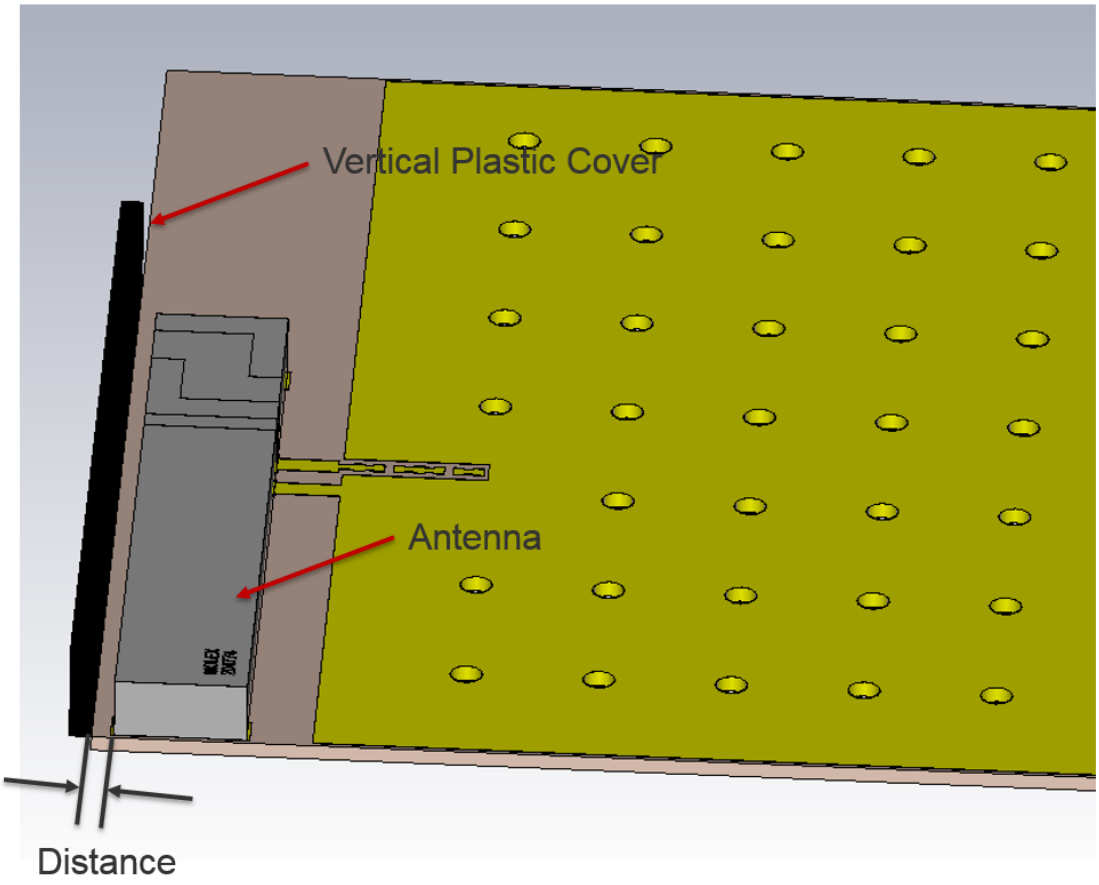

FIGURE 4.3 DIFFERENT DISTANCE BETWEEN VERTICAL PLASTIC COVER AND ANTENNA

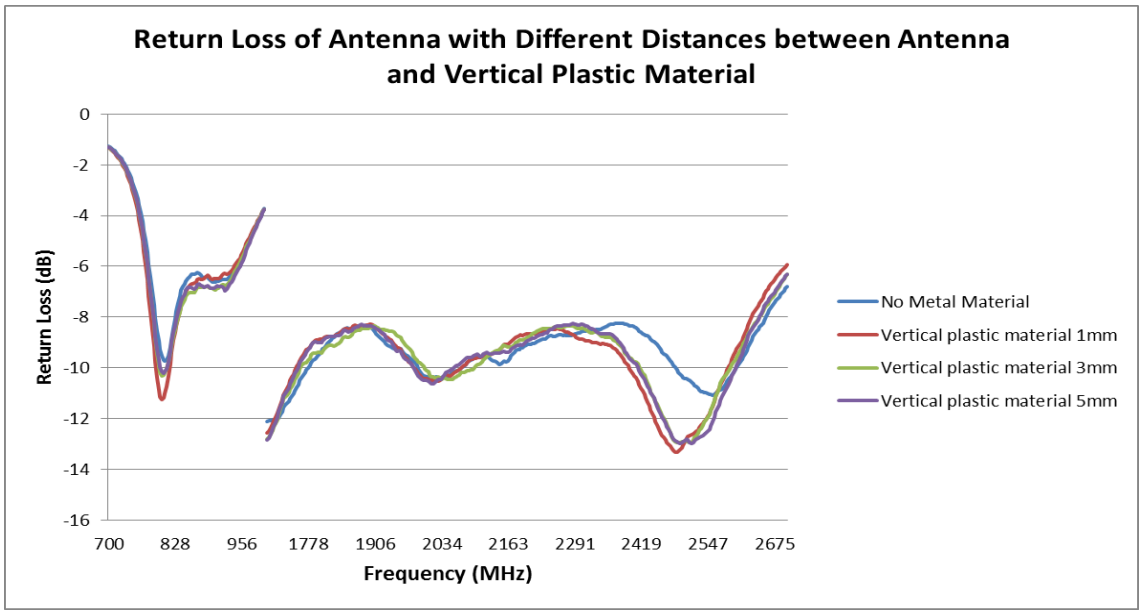

FIGURE 4.3.1 RETURN LOSS COMPARISON AT 790-960MHZ AND 1.7-2.7GHZ BAND OF DIFFERENT VERTICAL PLASTIC COVER DISTANCE FROM ANTENNA

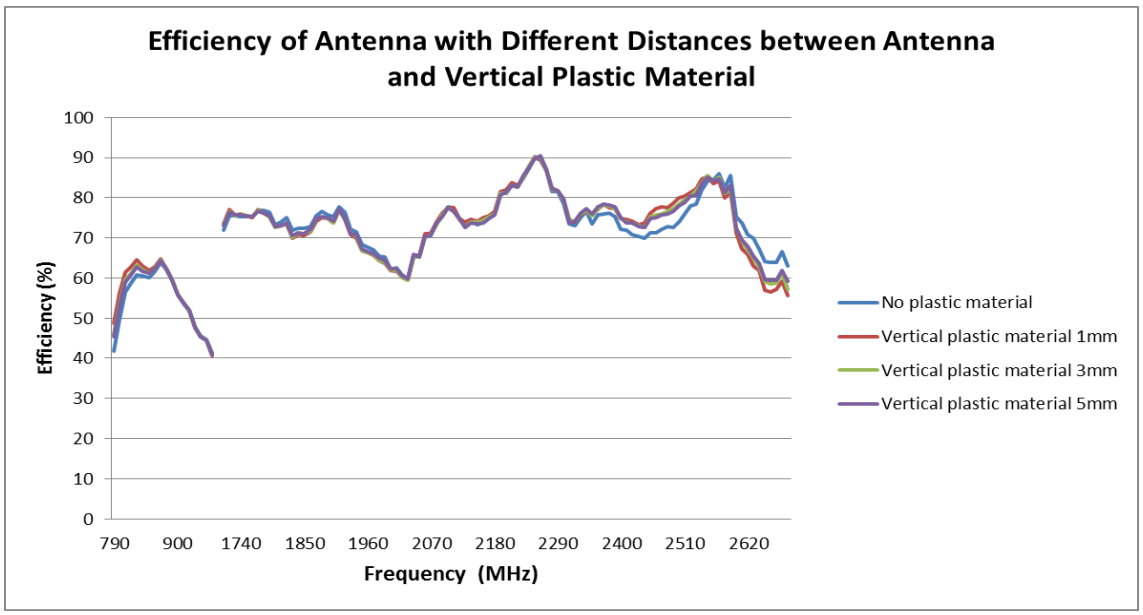

FIGURE 4.3.2 EFFICIENCY COMPARISON AT 790-960MHZ AND 1.7-2.7GHZ BAND OF DIFFERENT VERTICAL PLASTIC COVER DISTANCE FROM ANTENNA

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

An evaluation was done with 3 different distances from the antenna which is located at the recommended location to the horizontal plastic cover. The 3 distances are as following: 1mm, 3mm and 5mm. Though the horizontal plastic cover shifts the antenna resonance a bit lower, it has less effect on antenna performance according to the results. The horizontal plastic has less effect on antenna performance, but we also suggest that the horizontal plastic be placed at least 1mm away from the antenna. Refer to figure 4.4.1-4.4.2.

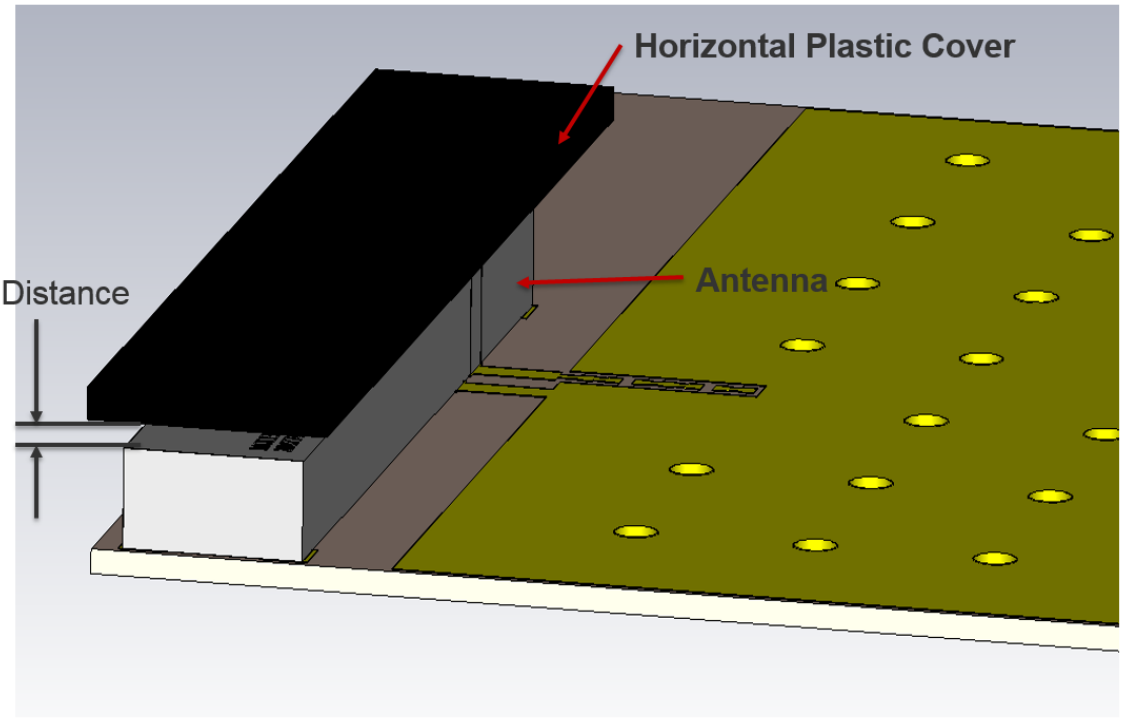

FIGURE 4.4 DIFFERENT DISTANCE BETWEEN HORIZONTAL PLASTIC COVER AND ANTENNA

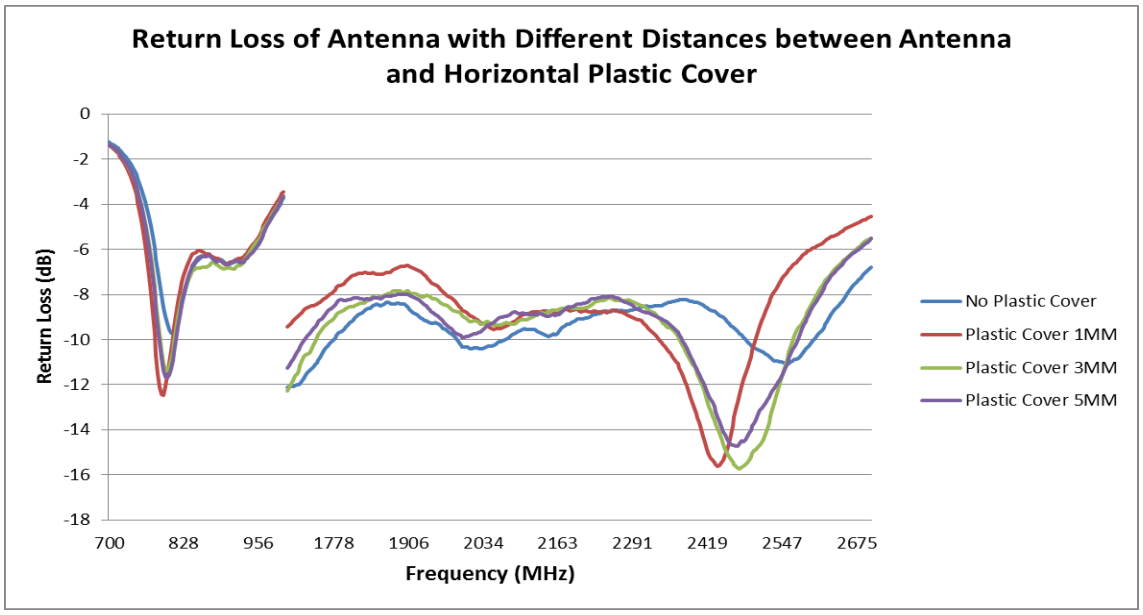

FIGURE 4.4.1 RETURN LOSS COMPARISON AT 790-960MHZ AND 1.7-2.7GHZ BAND OF DIFFERENT HORIZONTAL PLASTIC COVER DISTANCE FROM ANTENNA

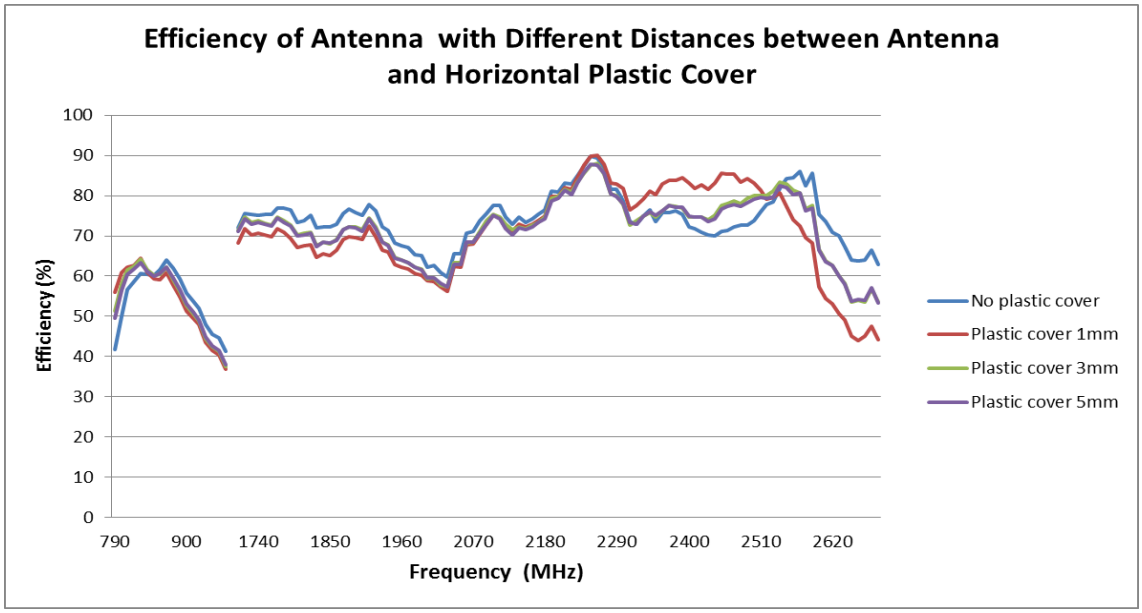

FIGURE 4.4.2 EFFICIENCY COMPARISON AT 790-960MHZ AND 1.7-2.7GHZ BAND OF DIFFERENT HORIZONTAL PLASTIC COVER DISTANCE FROM ANTENNA

4.5 RF PERFORMANCE AS A FUNCTION ON DIFFERENT SIZE GROUD

Four kinds of ground plane size were used for this study, which were 80mm*45mm, 130mm*60mm (Reference PCB), 150*100mm and 200*150mm. The PCB configurations are shown in figure 4.5. The ground size will affect the efficiency at low band more than high band per figure 4.5.1-4.5.2. When customers apply different PCB size ground, new matching network should be used for return loss and efficiency improvement (please refer to figure 5.3-5.5).

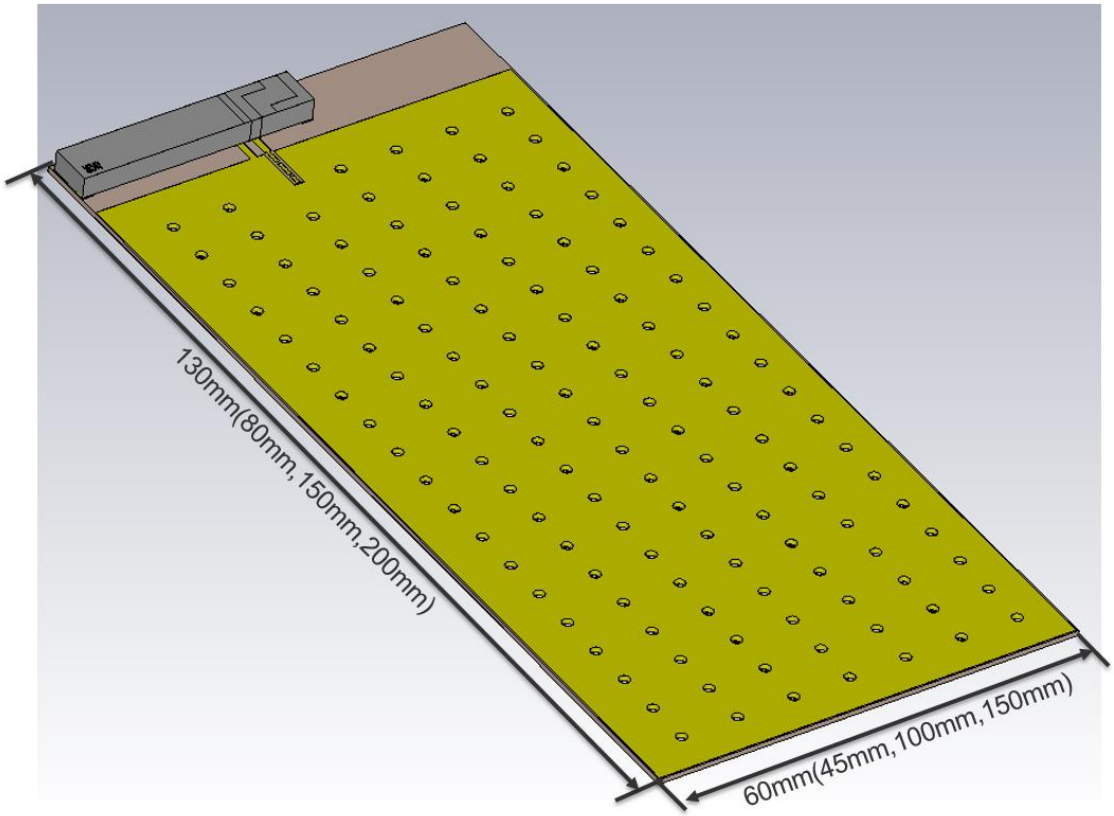

FIGURE 4.5 FOUR KINDS OF GROUND PLANE SIZE

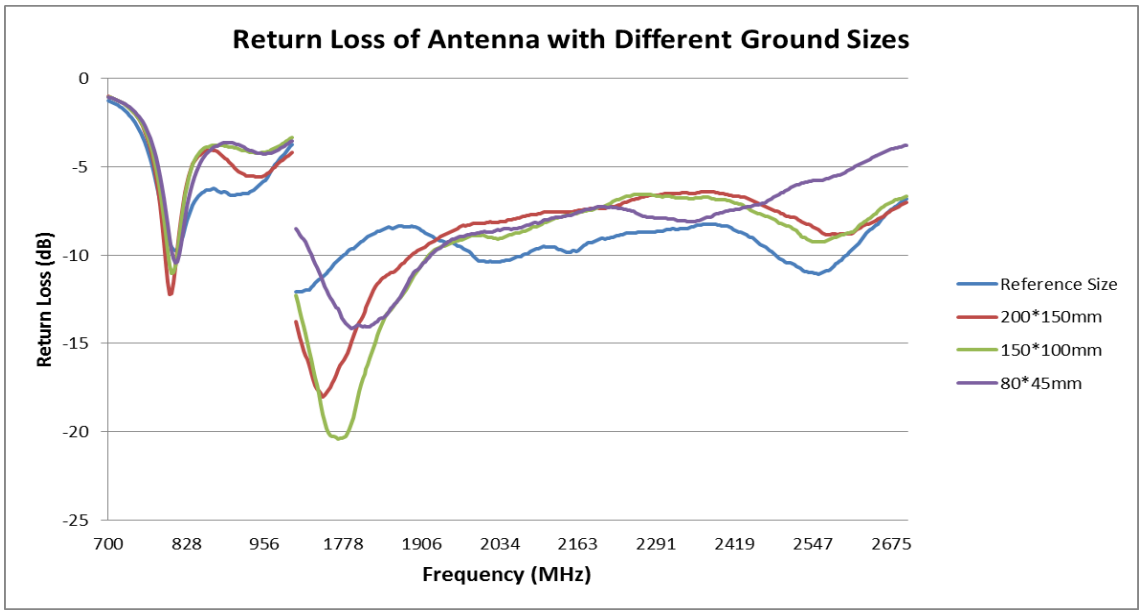

FIGURE 4.5.1 RETURN LOSS COMPARISON AT 790-960MHZ and 1.7-2.7GHz BAND OF ANTENNA MOUNTED ON DIFFERENT SIZE GROUND

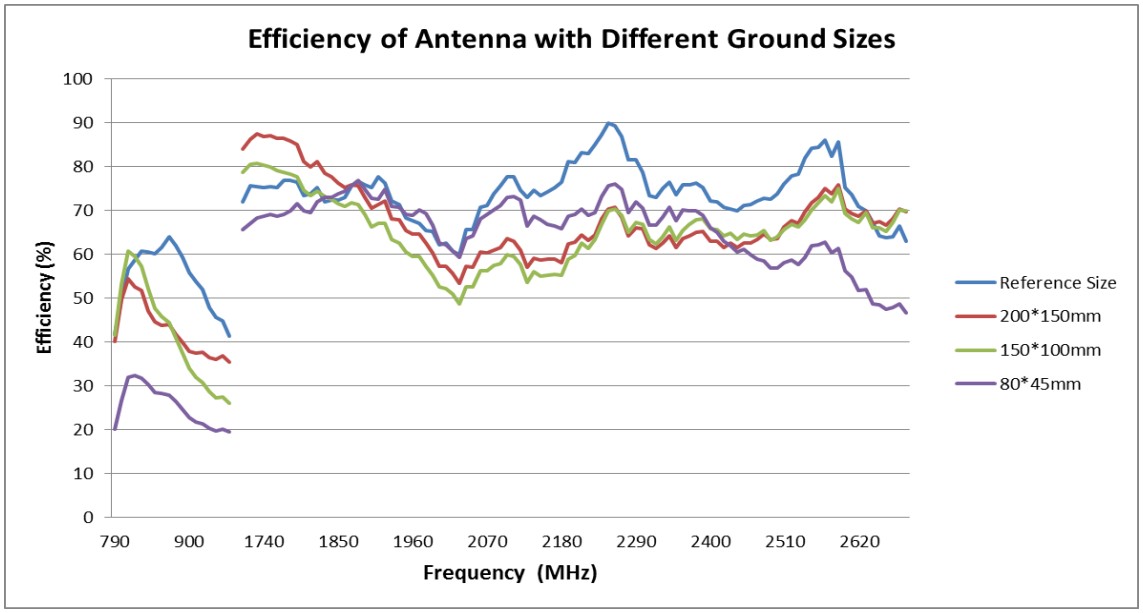

FIGURE 4.5.2 EFFICIENCY COMPARISON AT 790-960MHZ AND 1.7-2.7GHZ BAND OF ANTENNA MOUNTED ON DIFFERENT SIZE GROUND

5.0 MATCHING NETWORK DESRICPTION

Two matching configurations as shown in Figure 5.1 and Figure 5.2 are recommended for low band (790MHz~960MHz) and High band (1710MHz~2700MHz),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 5.3. Figure 5.4 shows the recommended matching networks for this antenna on reference PCB ground size.

Take configure 1 for example, the matching network is a parallel inductor following with a series capacitor. The sequence of parallel inductor and series capacitor 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 configuration 2 and the combination topology in Figure 5.3.

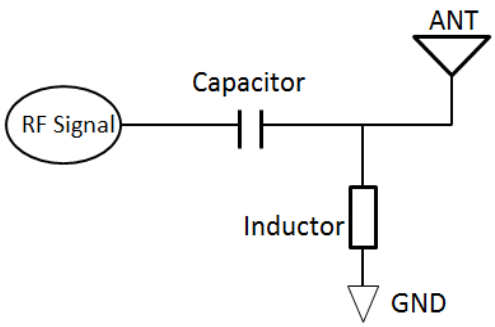

FIGURE 5.1 CONFIG 1 FOR LOW BAND

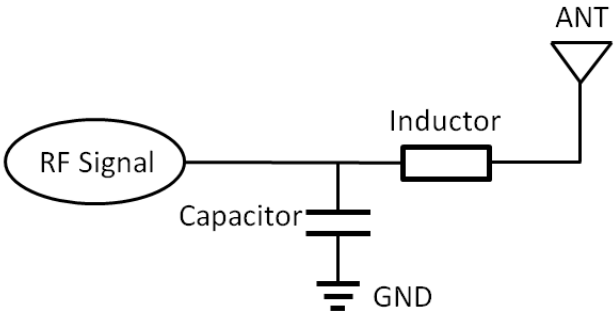

FIGURE 5.2 CONFIG 2 FOR HIGH BAND

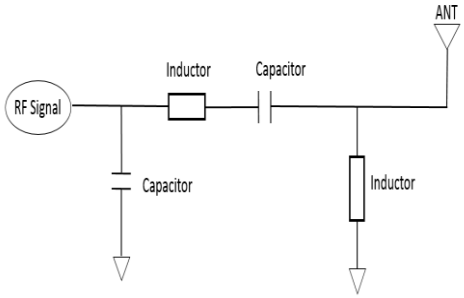

FIGURE 5.3 CONFIG 3 FOR ALL BAND

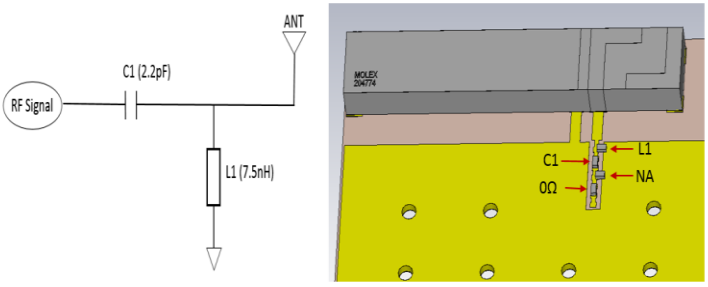

FIGURE 5.4 Matching Circuit for Reference Design

The following figure 5.5 and figure 5.6 are the return loss and smith chart comparison with and without the matching network on 130*60mm ground.

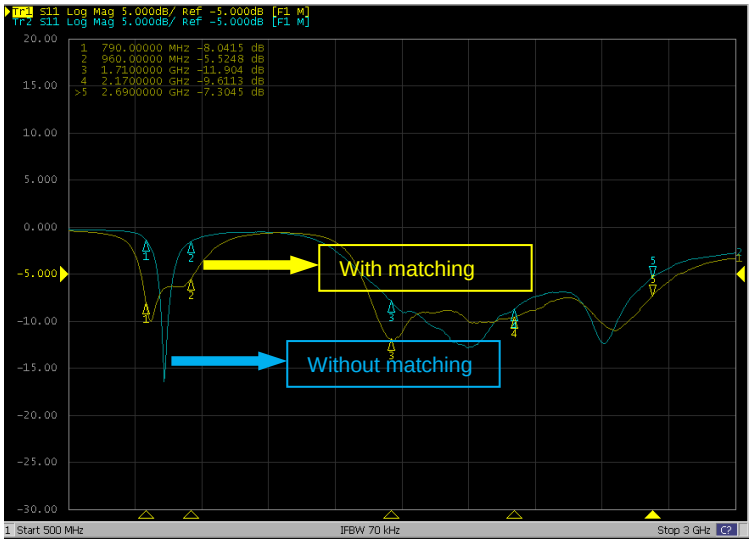

FIGURE 5.5 RETURN LOSS OF ANTENNA WITH AND WITHOUT MATCHING ON 130*60MM GROUND

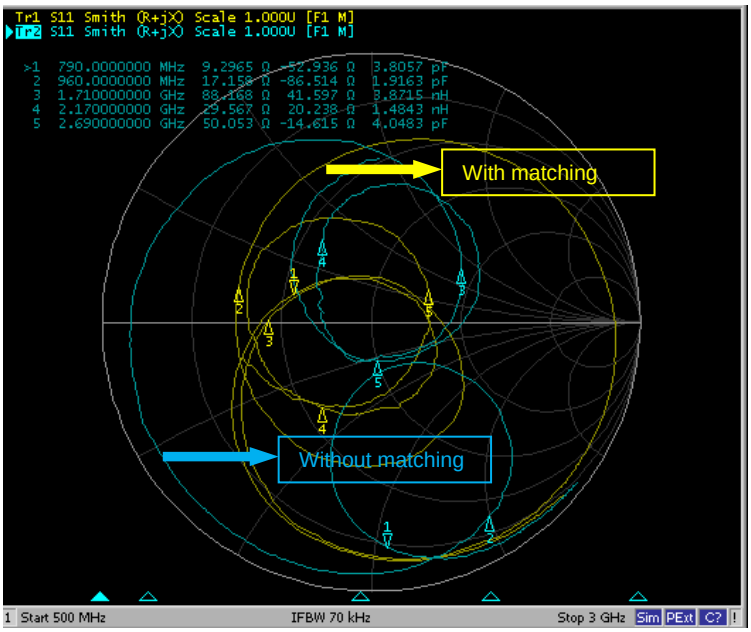

FIGURE 5.6 SMITH CHART OF ANTENNA WITH AND WITHOUT MATCHING ON 130*60MM GROUND

6.0 RADIATION PATTERN

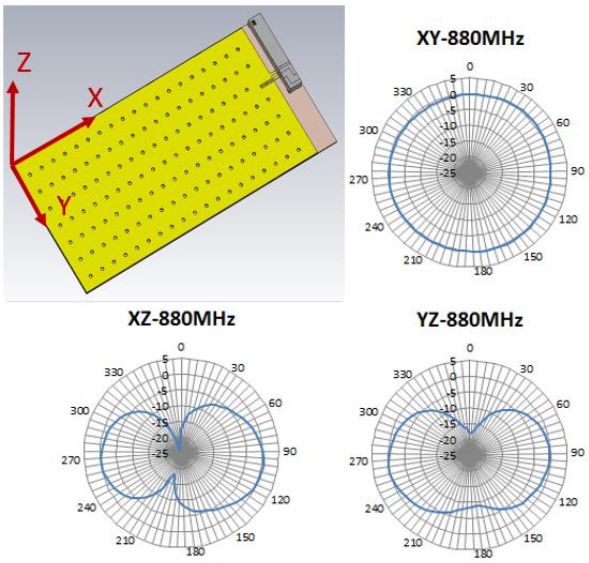

FIGURE 6.1 RADIATION PATTERN OF ATNENNA AT 880MHZ IN FREE SPACE

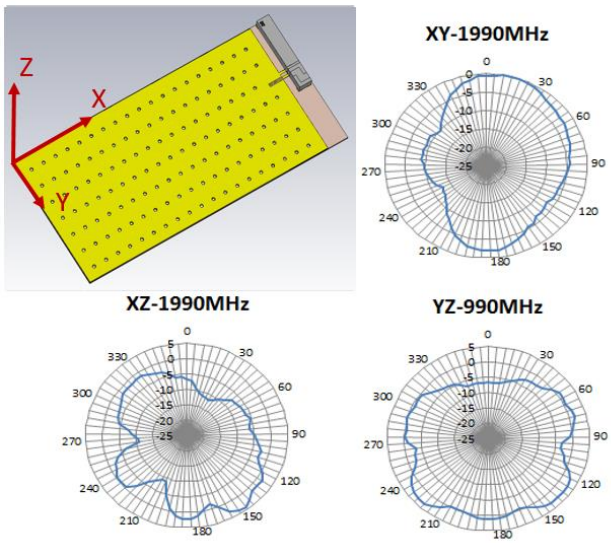

FIGURE 6.2 RADIATION PATTERN OF ATNENNA AT 1990MHZ IN FREE SPACE

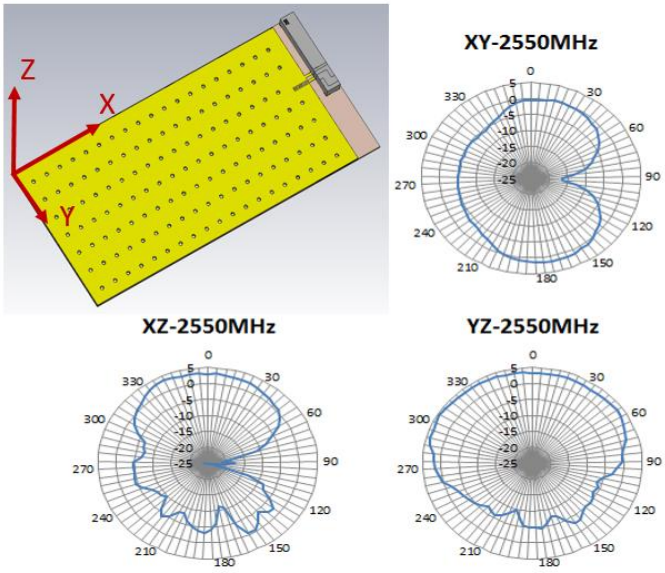

FIGURE 6.3 RADIATION PATTERN OF ATNENNA AT 2550MHZ IN FREE SPACE

7.0 ASSEMBLY INSTRUCTIONS

A. RECOMMENDED SMT REFLOW PROFILE

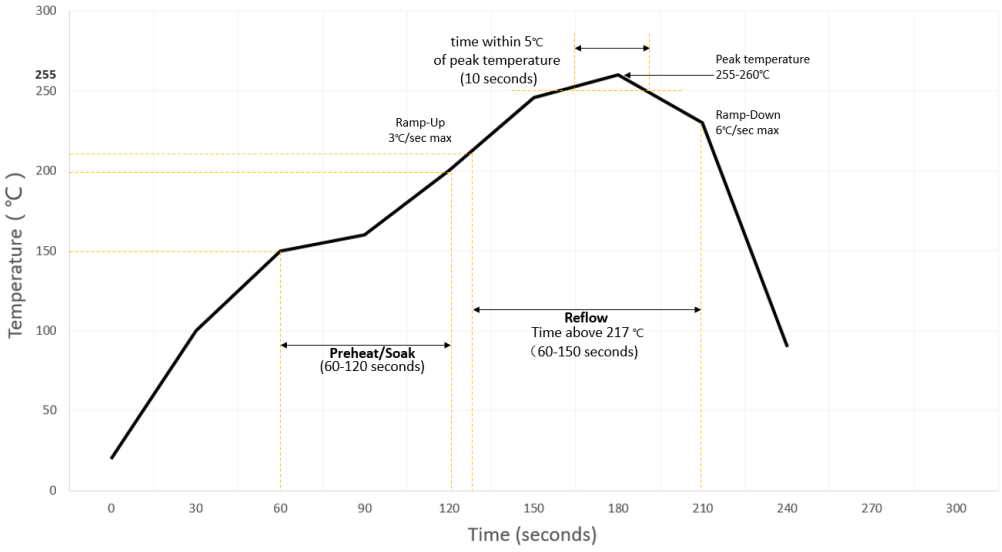

FIGURE 7.1 RECOMMENDED SMT REFLOW PROFILE

B. MECHANICAL INTERFACE

I. GENERAL DESCRIPTION

The overall antenna size is 33mm * 6mm * 3mm (Length*Width*Height)

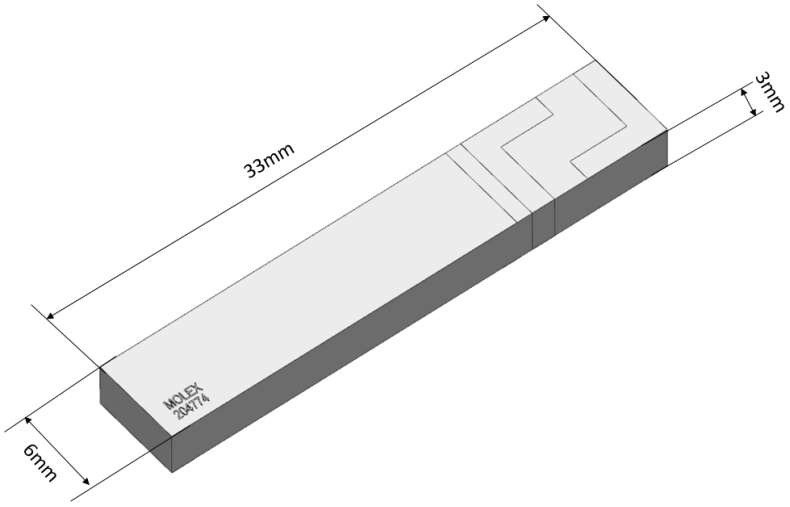

FIGURE 7.2 OVERALL ANTENNA SIZE

II. STRUCTURE FUNCTIONAL DESCRIPTION

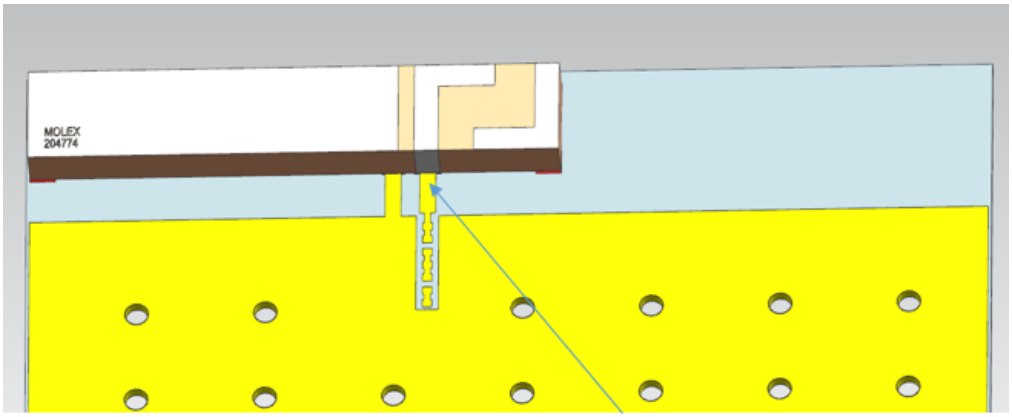

FIGURE 7.3 ANTENNA ASSEMBLY

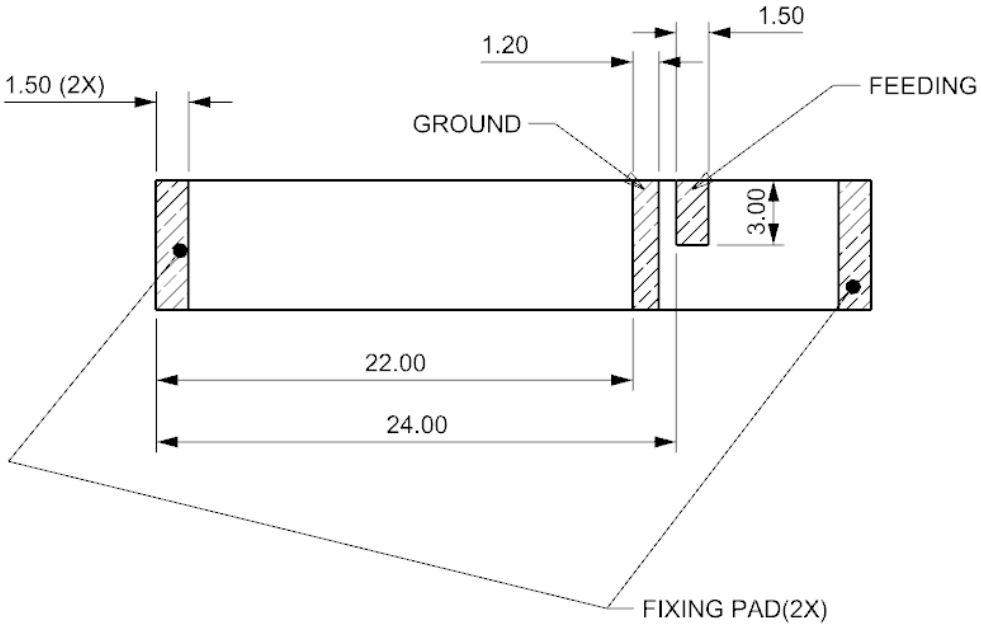

FIGURE 7.4 PADS OF PRODUCT FOR SOLDERING

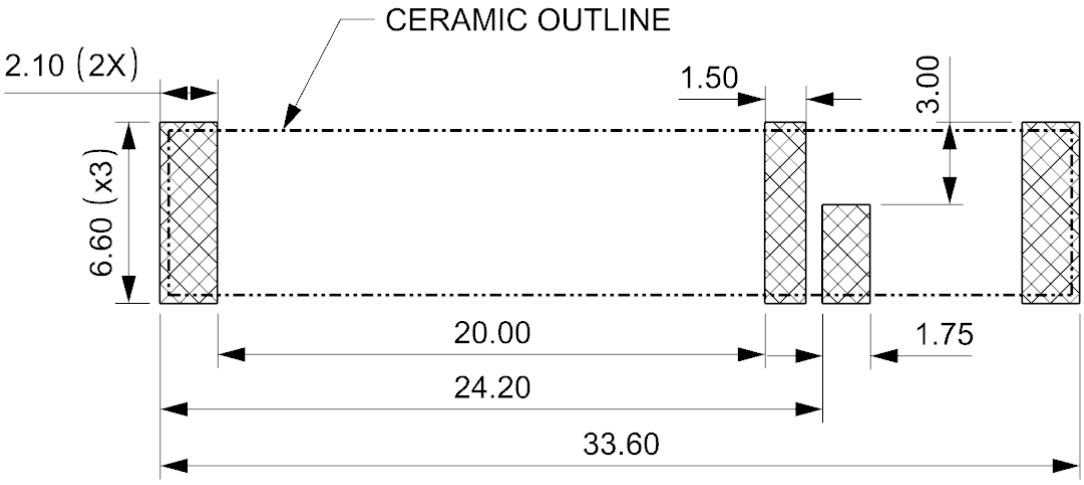

FIGURE 7.5 RECOMMENDED PCB PADS AREA

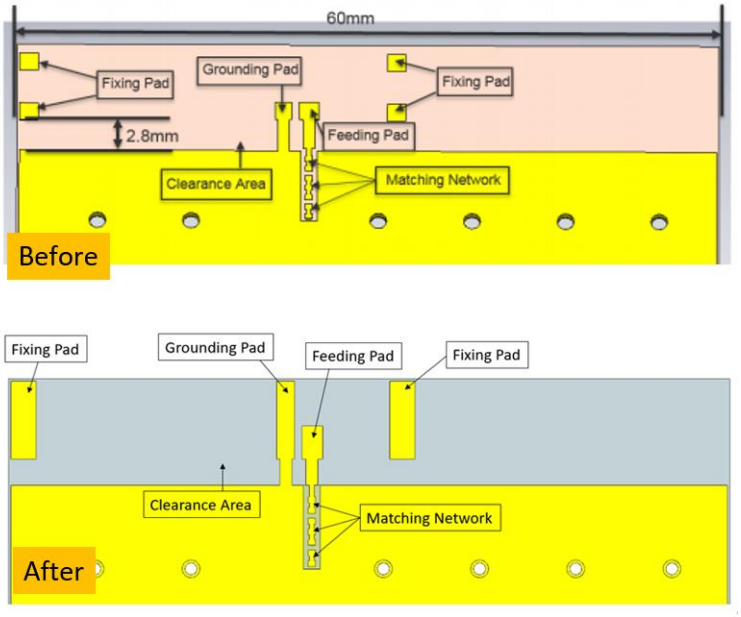

FIGURE 7.6 ANTENNA MOUNTED ON DIFFERENT PADS (BEFORE: ORIGINAL PAD, AFTER: MODIFIED PAD)

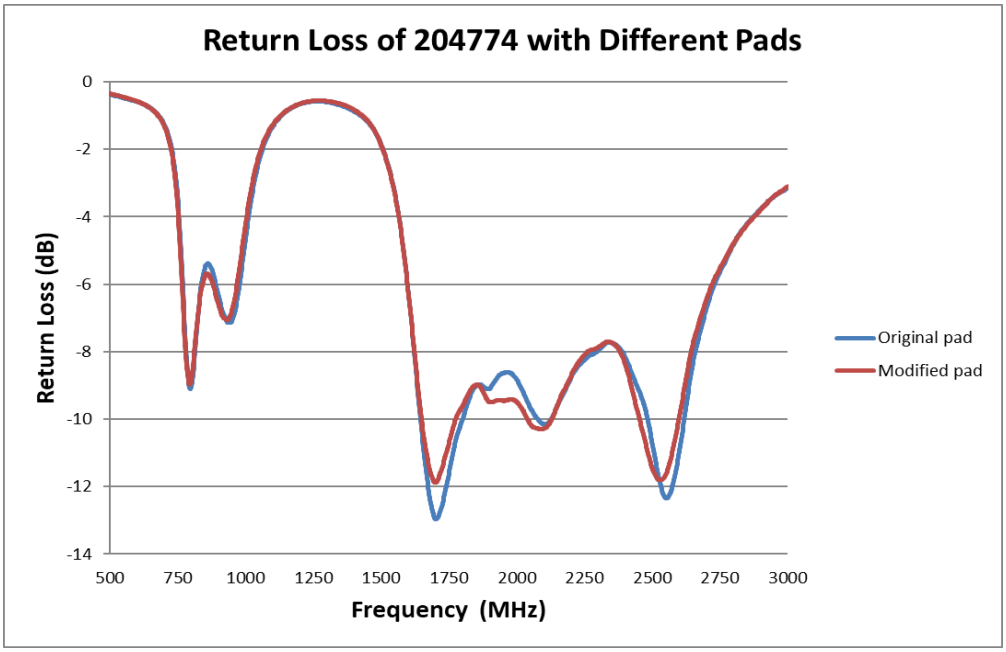

FIGURE 7.7 RETURN LOSS COMPARISON OF DIFFERENT PADS

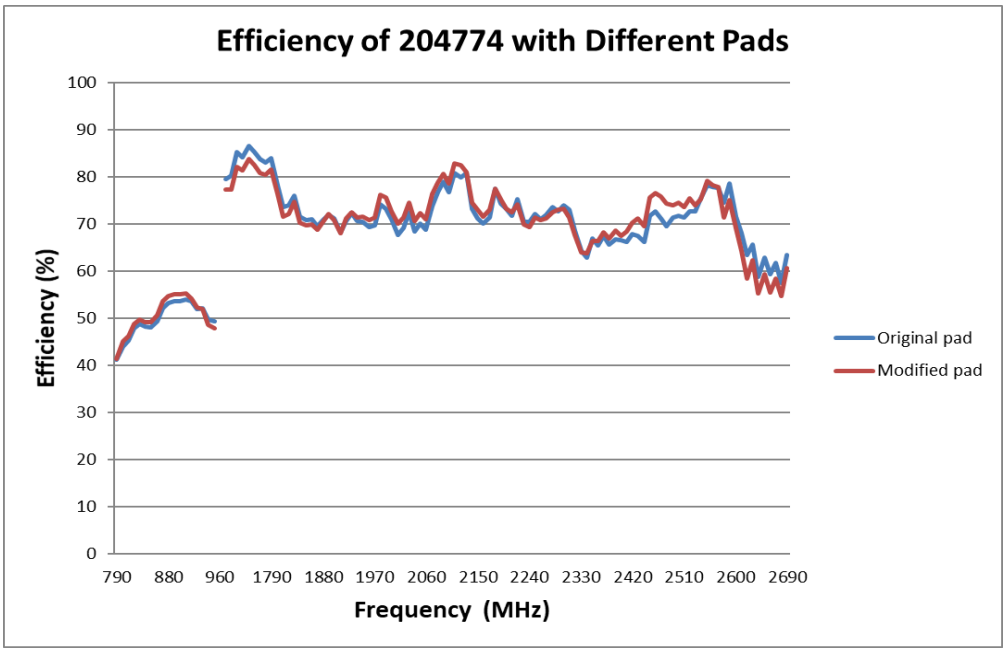

FIGURE 7.8 EFFICIENCY COMPARISON OF DIFFERENT PADS

It can be seen from the figures of return loss and efficiency that different pads have little effect on the return loss, and their efficiency is almost the same.

8.0 CHANGE HISTORY

REV	DATE	DESCRIPTION
A	2017/07/05	First Release
B	2021/03/29	Update recommended PCB pads area sizes