



APPLICATION SPECIFICATION

FULL LTE SMT ANTENNA

1.0 SCOPE

This specification including two products, their part numbers are 1462000001 and 1462000011, respectively. And they have same size with image antenna pattern and operating frequency for different location application in device. These two parts can be used individually and also can be used for MIMO application, and both individual application and MIMO application are represented within this document.

This specification describes the antenna application and recommended PCB layout for the Molex Full LTE SMT 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 INDIVIDUAL PRODUCT DESCRIPTION

A. DEFINITIONS OF TERMS

The antenna design is based on carrier size 40mm*5mm*5mm (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.

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AS-1462000001	Liu Hai 2017/12/27	Chris Zhong 2017/12/27	Welson Tan 2017/12/27



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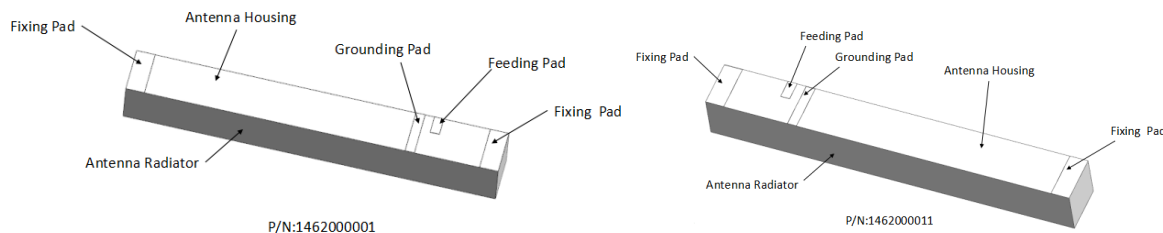


FIGURE 1 1462000001 AND 1462000011 SMT ANTENNA

B. REFERENCE IMPLEMENTATION

I. REFERENCE PCB DESCRIPTION

The reference design is based on a recommended double sided PCB size of 130 mm *60 mm*1 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*10mm. 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

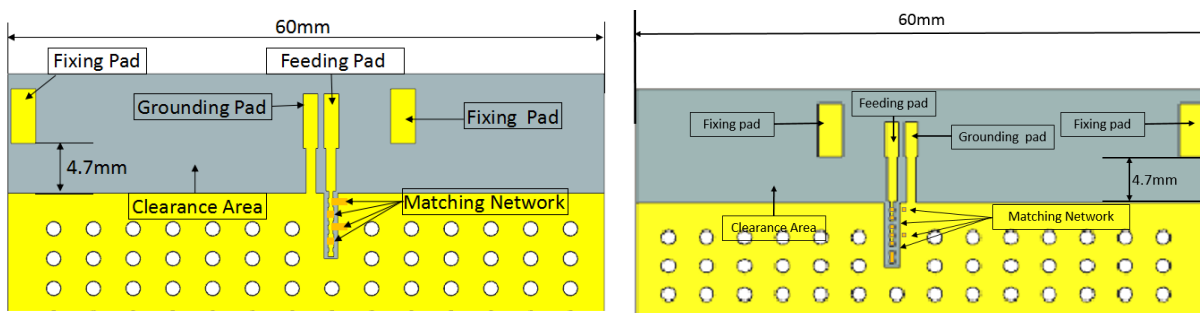


FIGURE 2.1: RECOMMENDED PCB LAYOUT

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

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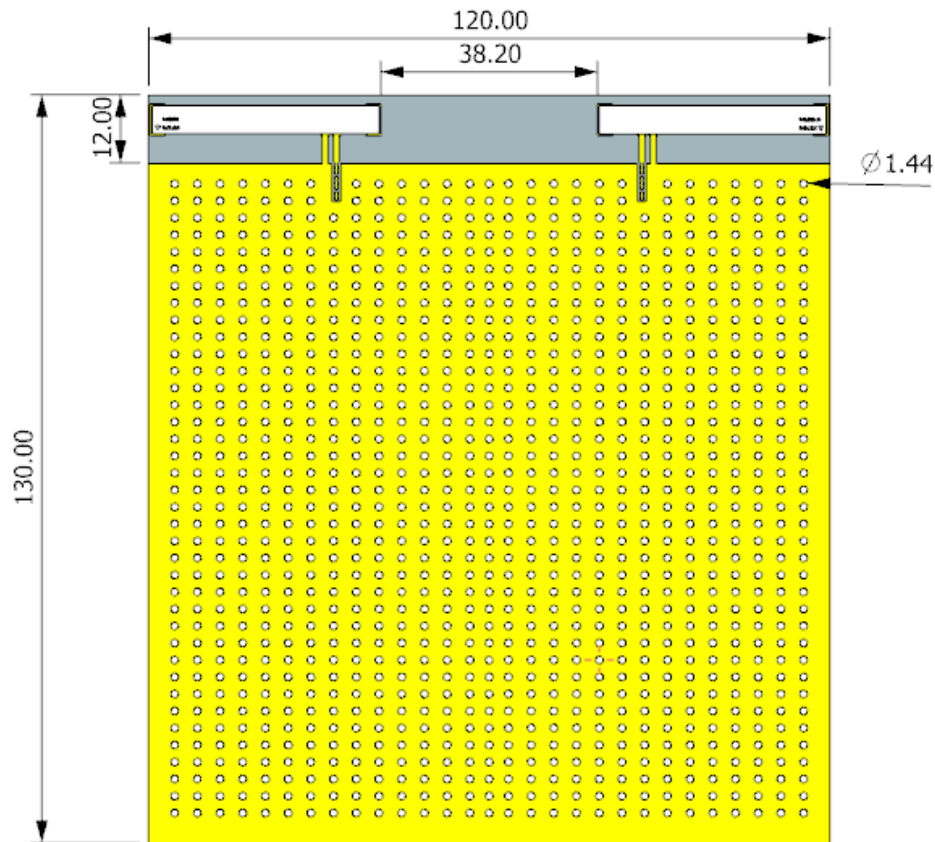


FIGURE 2.2 RECOMMENDED PCB LAYOUT FOR MIMO APPLICATION

Antenna	1462000001		1462000011	
Frequency Range	698-960MHz	1710-2700MHz	698-960MHz	1710-2700MHz
Return Loss	>-4dB	>-5dB	>-5dB	>-5dB
Peak Gain	0.2 dBi	3.8 dBi	0.5 dBi	3.7 dBi
Total Efficiency	>40%	>60%	>45%	>60%
Polarization	Linear			
Input Impedance	50Ohms			

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III. PERFORMANCE AT REFERENCE ANTENNA LOCATION

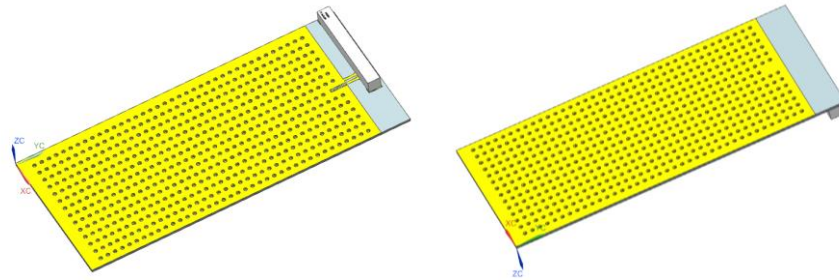


Figure 3.1 REFERENCE ANTENNA LOCATION FOR 1462000001

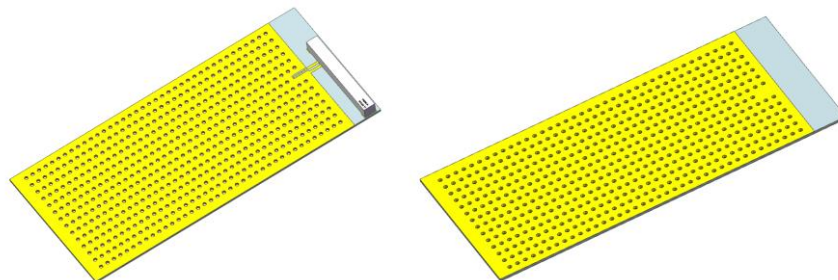


Figure 3.2 REFERENCE ANTENNA LOCATION FOR 1462000011

The reference antenna location is at the top of the PCB as show in Figure 3.1 and 3.2. The clearance size for this antenna is 60*10mm.

DESCRIPTION	TEST CONDITION	REQUIREMENTS(FOR 1462000001)		REQUIREMENTS(FOR 1462000011)	
Frequency Range	Measure antenna on recommended PCB through VNA E5071C	698-960MHz	1.7-2.7GHz	698-960MHz	1.7-2.7GHz
Return Loss	Measure antenna on recommended PCB through VNA E5071C	< -5 dB			
Peak Gain	Measure antenna on recommended PCB through OTA chamber	1.1dBi	4.5dBi	0.5dBi	4dBi
Total Efficiency	Measure antenna on recommended PCB through OTA chamber	60%	70%	50%	65%
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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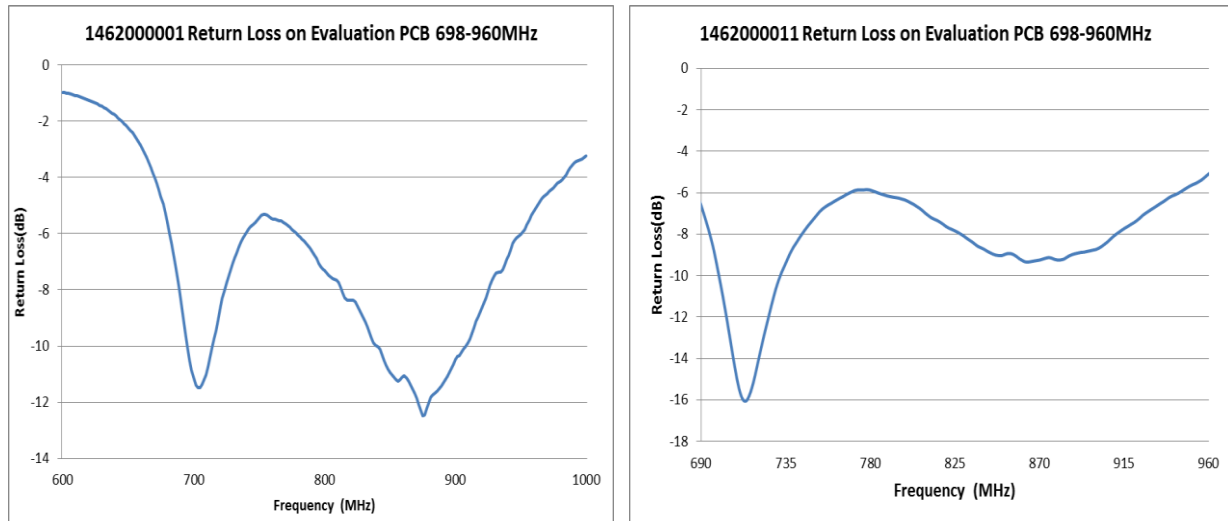


FIGURE 2.2 RETURN LOSS OF ANTENNA AT 698-960MHZ BAND AT REFERENCE LOCATION IN FREE SPACE

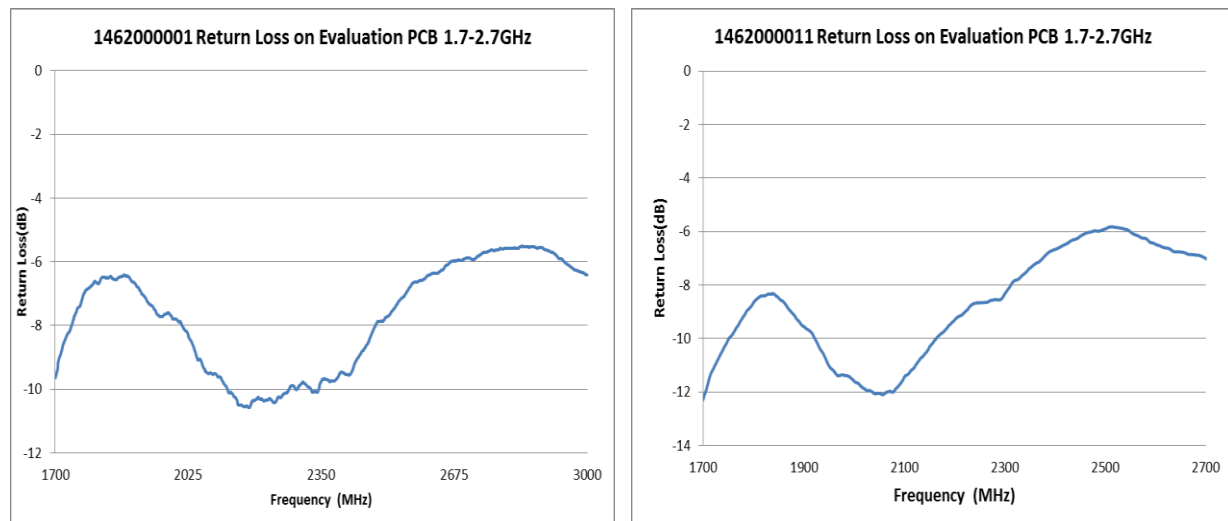


FIGURE 2.3 RETURN LOSS OF ANTENNA AT 1.7-2.7GHZ BAND AT REFERENCE LOCATION IN FREE SPACE

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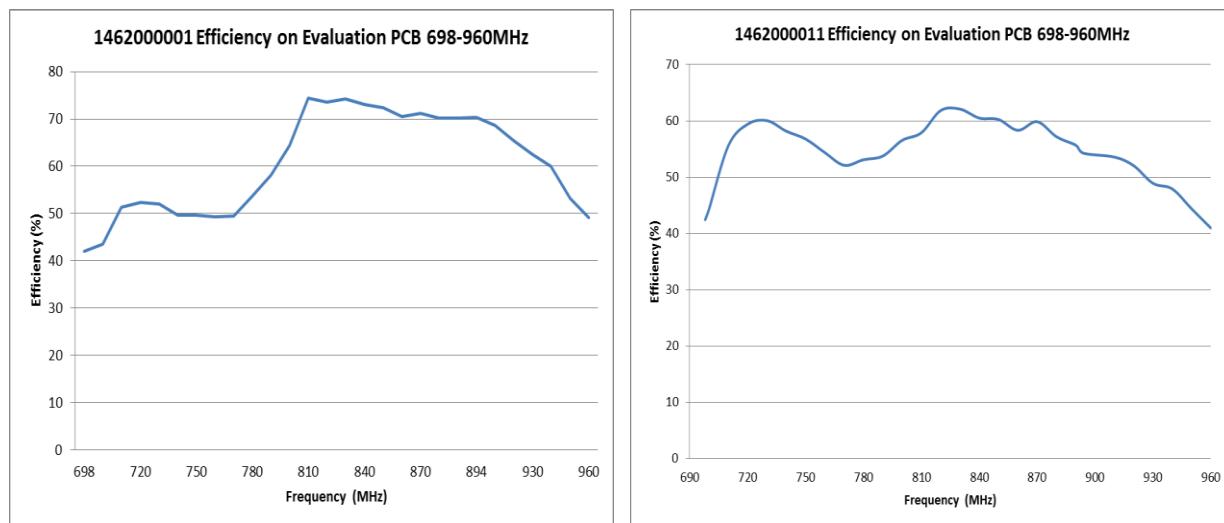


FIGURE 2.4 EFFICIENCY OF ANTENNA AT 698-960MHZ BAND AT REFERENCE LOCATION IN FREE SPACE

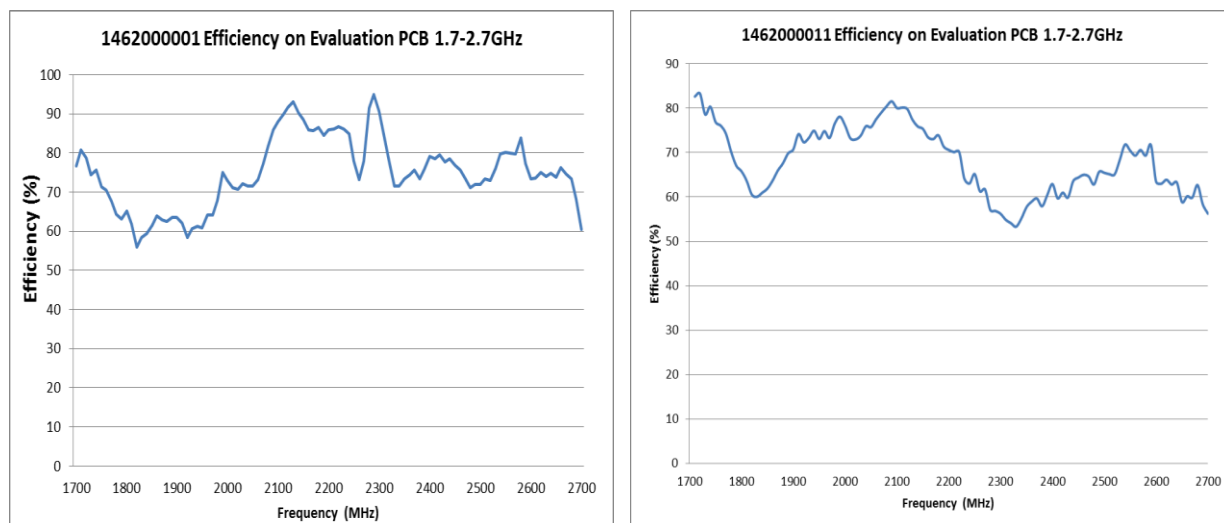


FIGURE 2.5 EFFICIENCY OF ANTENNA AT 1.7-2.7GHZ BAND AT REFERENCE LOCATION IN FREE SPACE

3.0 REFERENCE DOCUMENTS

- Sales Drawing: SD-1462000001
- Product Specification: PS-1462000001
- Packaging Information – Refer to the Molex related packaging drawings.

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4.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

As these two products has image pattern and very similar performance, we will use 1462000001 as example to evaluate environment impact only.

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- 4.1.4.

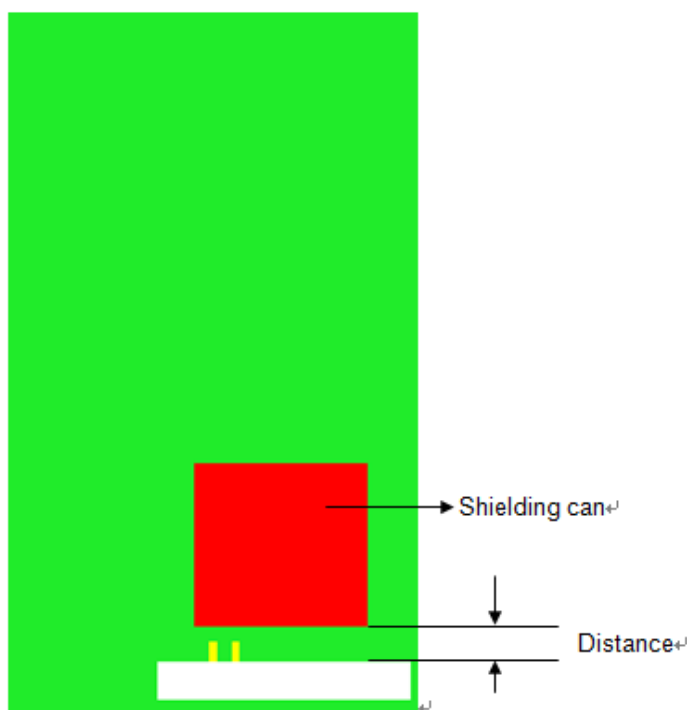


Figure 4.1 SIMULATED CONDITION: SHIELDING CAN FIXED ON REFERENCE PCB

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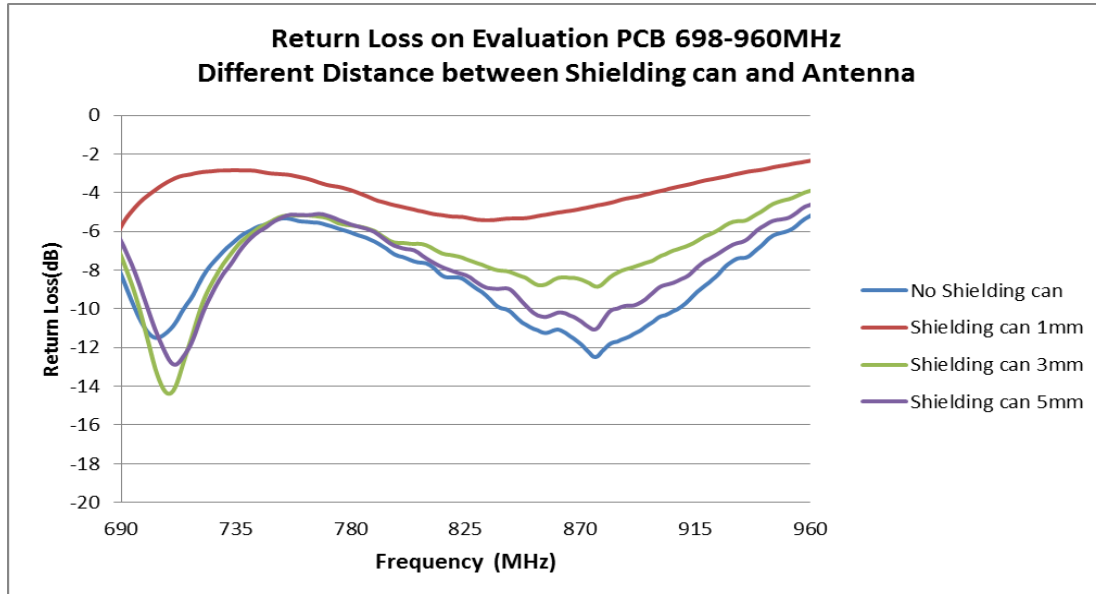


FIGURE 4.1.1 RETURN LOSS COMPARISON AT 698-960MHz BAND OF DIFFERENT SHIELDING CAN DISTANCE FROM ANTENNA

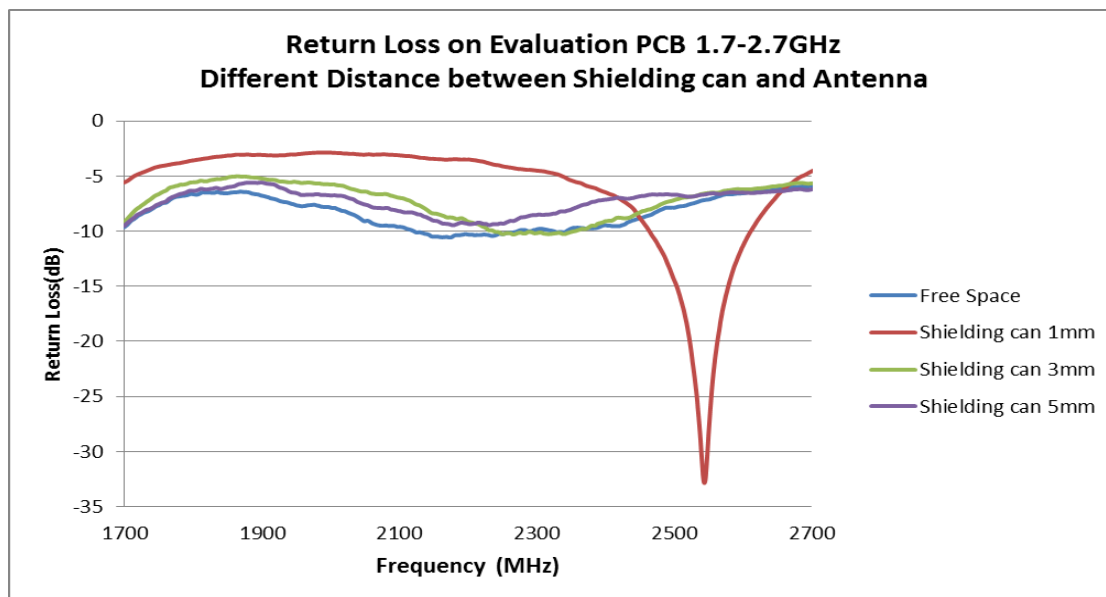


FIGURE 4.1.2 RETURN LOSS COMPARISON AT 1.7-2.7GHz BAND OF DIFFERENT SHIELDING CAN DISTANCE FROM ANTENNA

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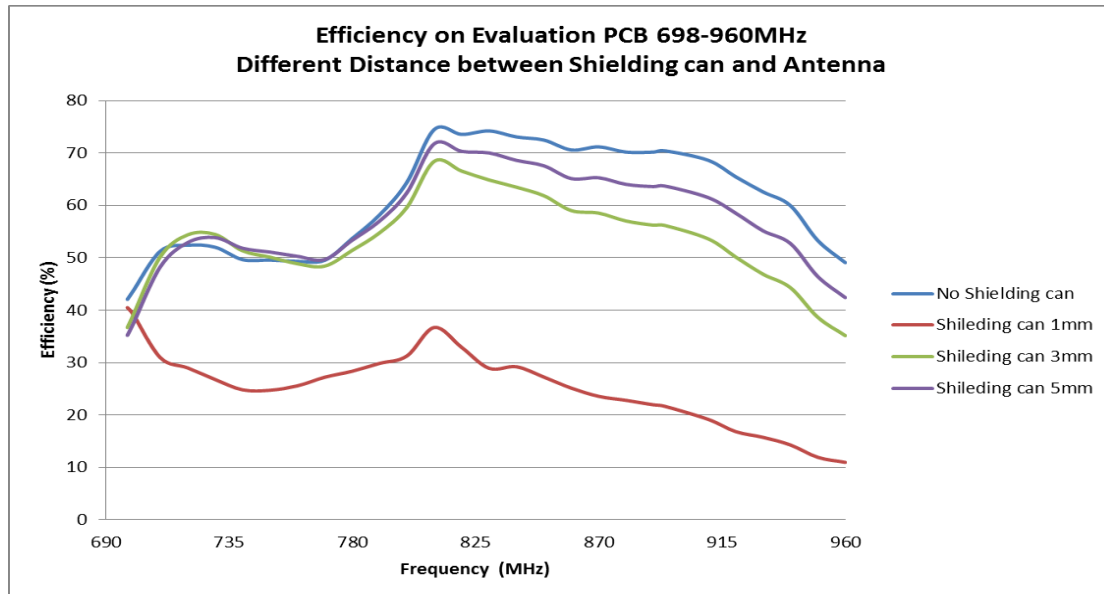


FIGURE 4.1.3 EFFICIENCY COMPARISON AT 698-960MHz BAND OF DIFFERENT SHIELDING CAN DISTANCE FROM ANTENNA

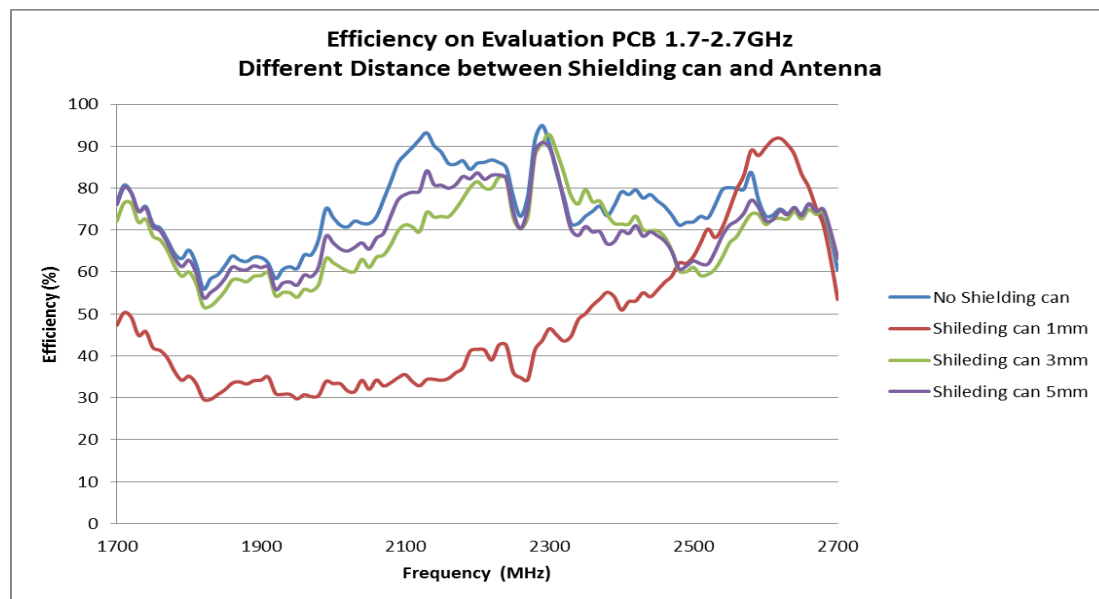


FIGURE 4.1.4 EFFICIENCY COMPARISON AT 1.7-2.7GHz BAND OF DIFFERENT SHIELDING CAN DISTANCE FROM ANTENNA

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4.0.2 RF PERFORMANCE INFLUENCED BY NEARBY BATTERY

A battery with size of 30mm*60mm*3mm 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 4.2.1-4.2.4

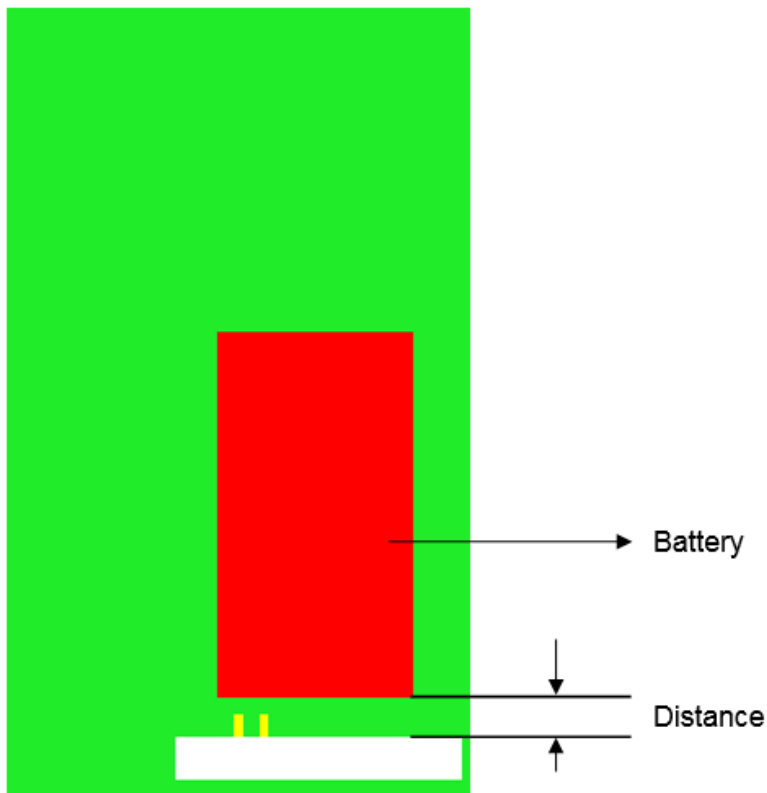


FIGURE 4.2 SIMULATED CONDITION: BATTERY FIXED ON REFERENCE PCB

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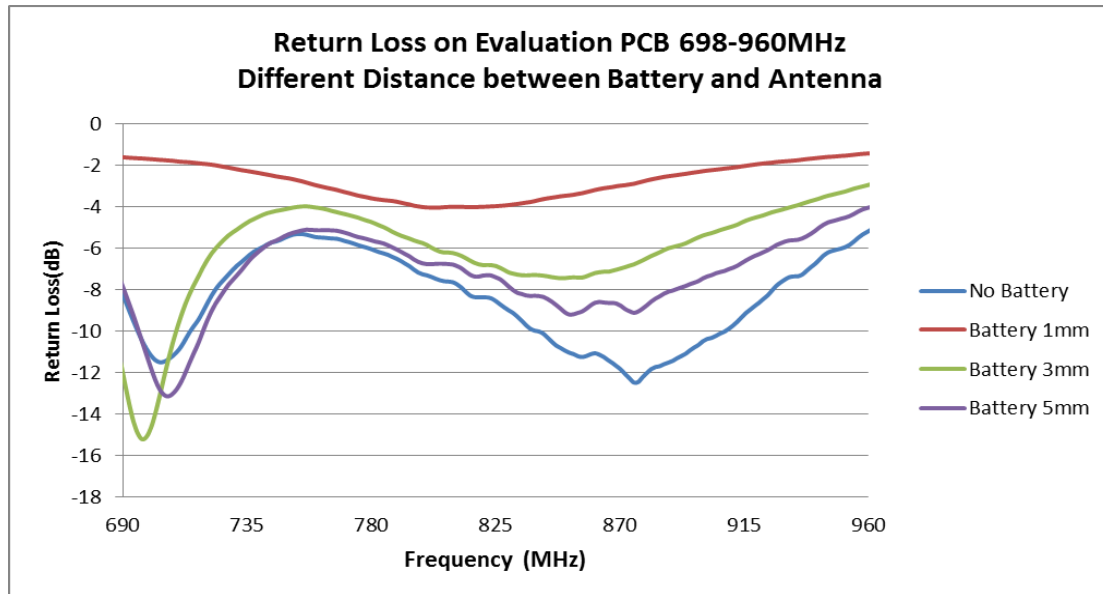


FIGURE 4.2.1 RETURN LOSS COMPARISON AT 698-960MHZ BAND OF DIFFERENT BATTERY DISTANCE FROM ANTENNA

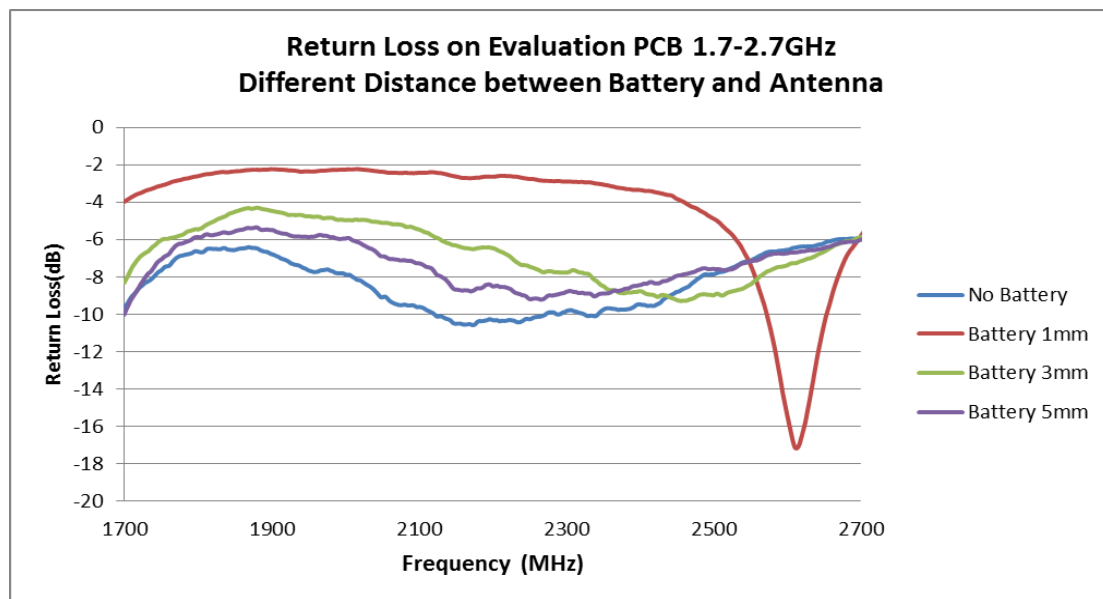


FIGURE 4.2.2 RETURN LOSS COMPARISON AT 1.7-2.7GHZ BAND OF DIFFERENT BATTERY DISTANCE FROM ANTENNA

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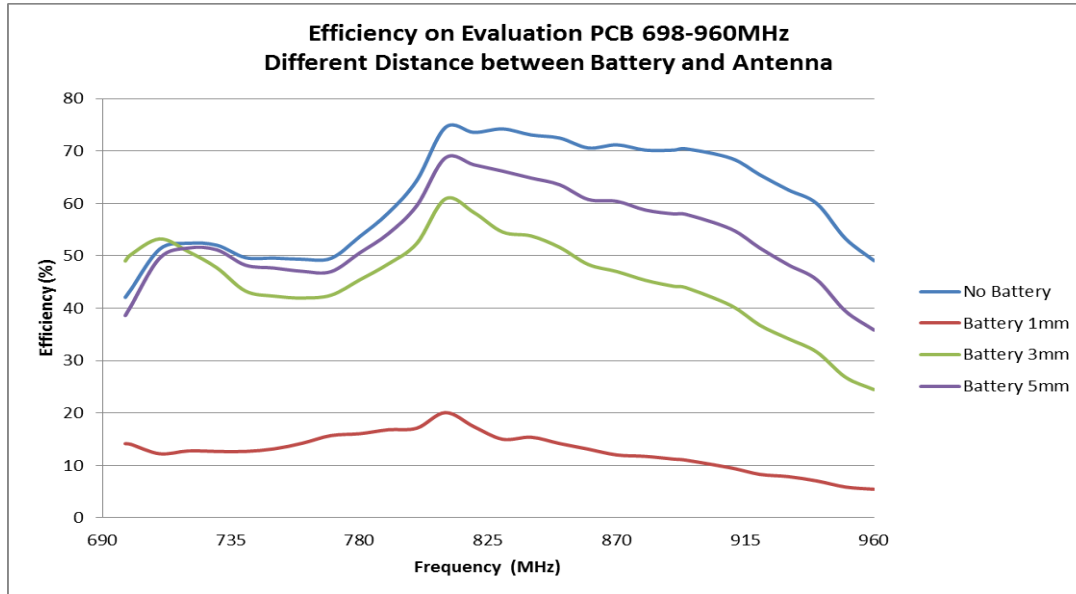


FIGURE 4.2.3 EFFICIENCY COMPARISON AT 698-960MHZ BAND OF DIFFERENT BATTERY DISTANCE FROM ANTENNA

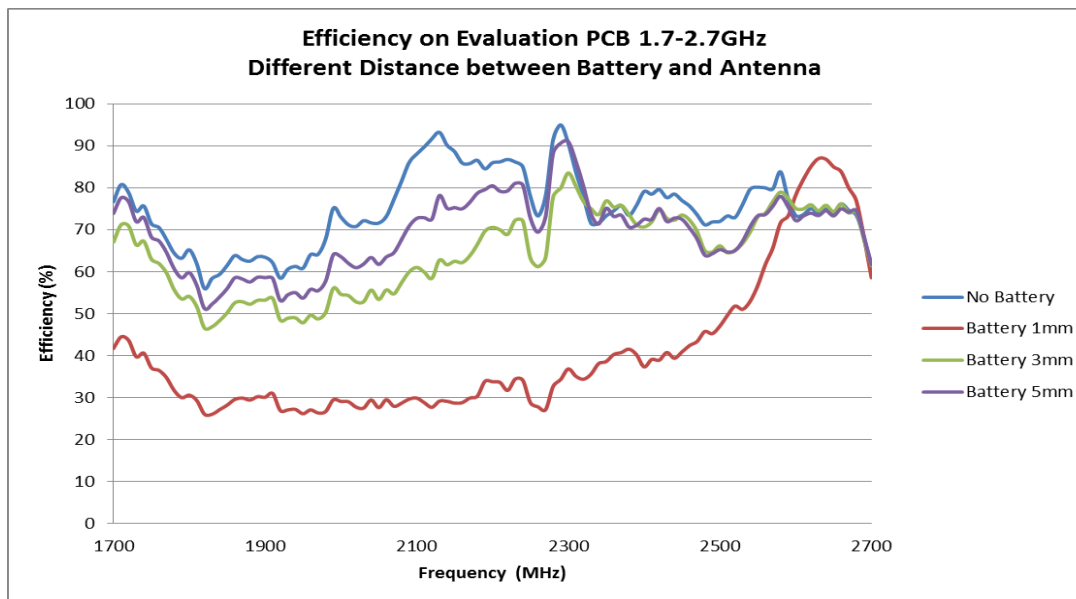


FIGURE 4.2.4 EFFICIENCY COMPARISON AT 1.7-2.7GHZ BAND OF DIFFERENT BATTERY DISTANCE FROM ANTENNA

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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 4.3.1-4.3.4.

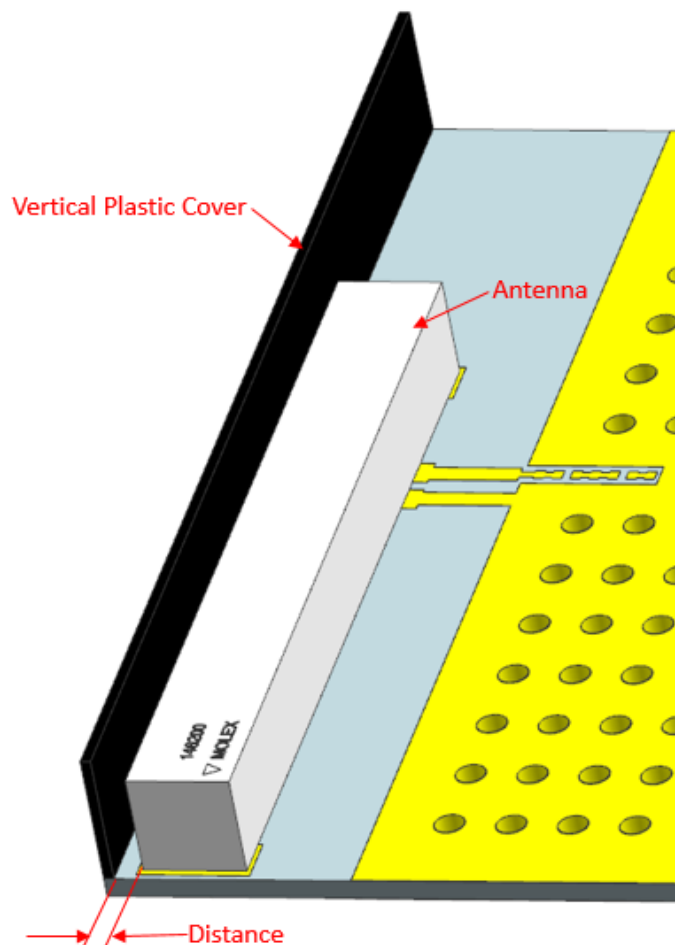


FIGURE 4.3 DIFFERENT DISTANCE BETWEEN VERTICAL PLASTIC COVER AND ANTENNA

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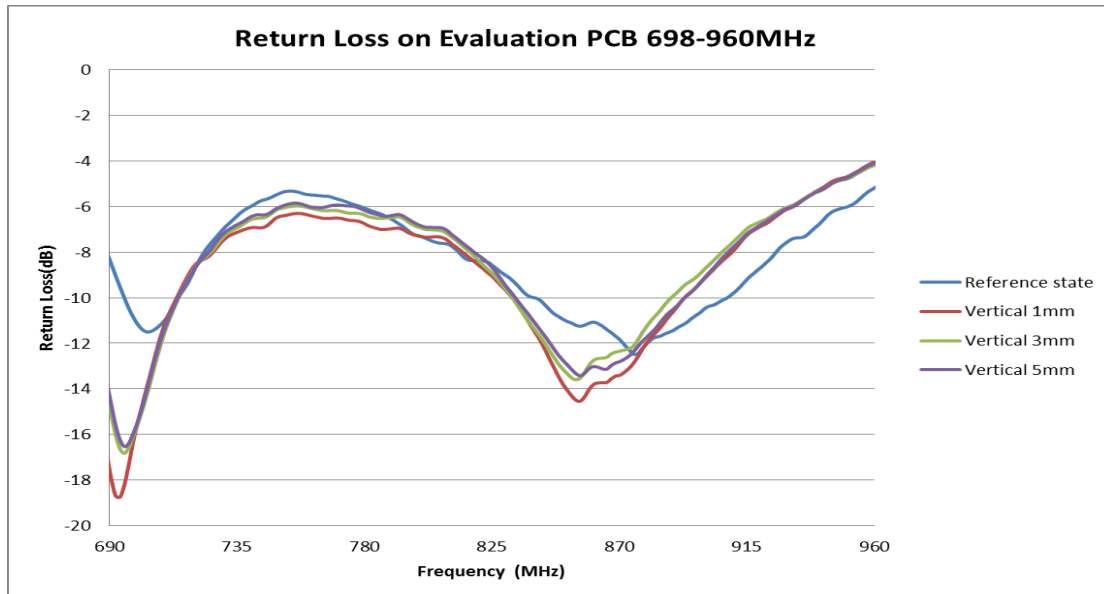


FIGURE 4.3.1 RETURN LOSS COMPARISON AT 698-960MHZ BAND OF DIFFERENT VERTICAL PLASTIC COVER DISTANCE FROM ANTENNA

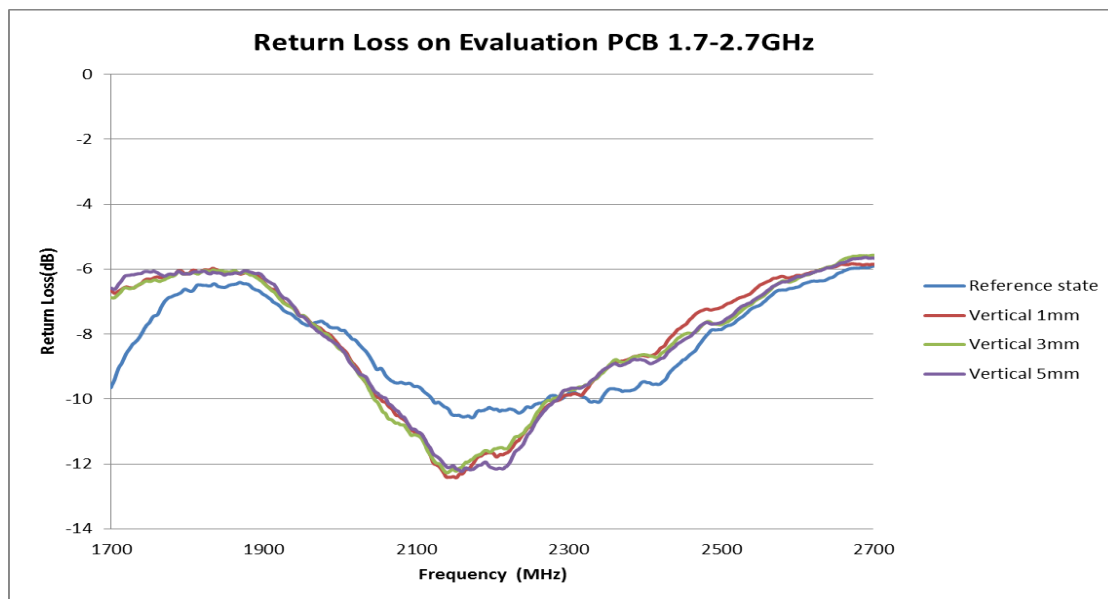


FIGURE 4.3.2 RETURN LOSS COMPARISON AT 1.7-2.7GHz BAND OF DIFFERENT VERTICAL PLASTIC COVER DISTANCE FROM ANTENNA

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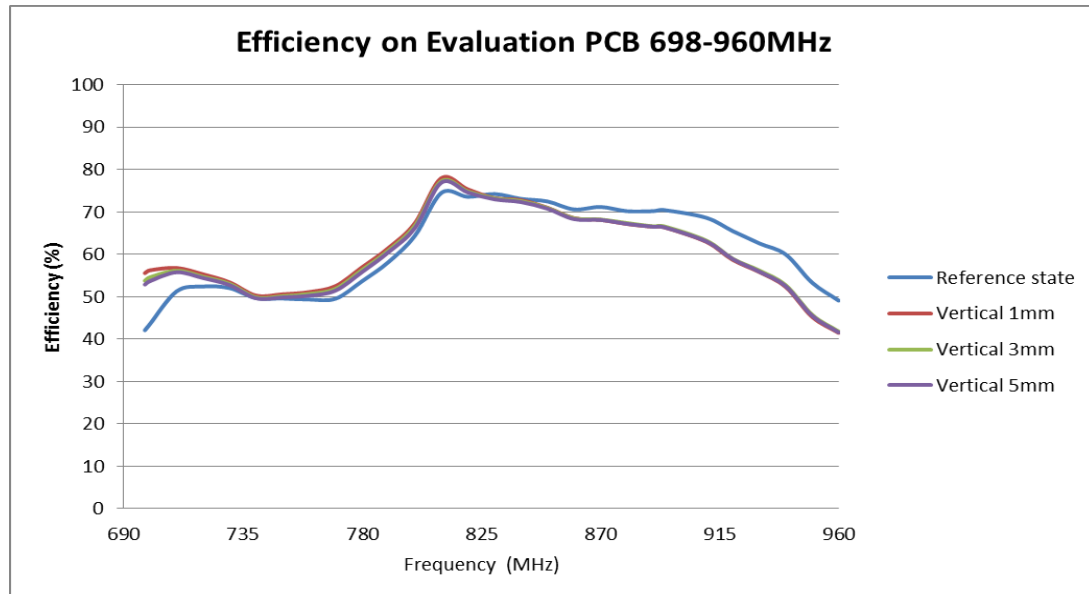


FIGURE 4.3.3 EFFICIENCY COMPARISON AT 698-960MHZ BAND OF DIFFERENT VERTICAL PLASTIC COVER DISTANCE FROM ANTENNA

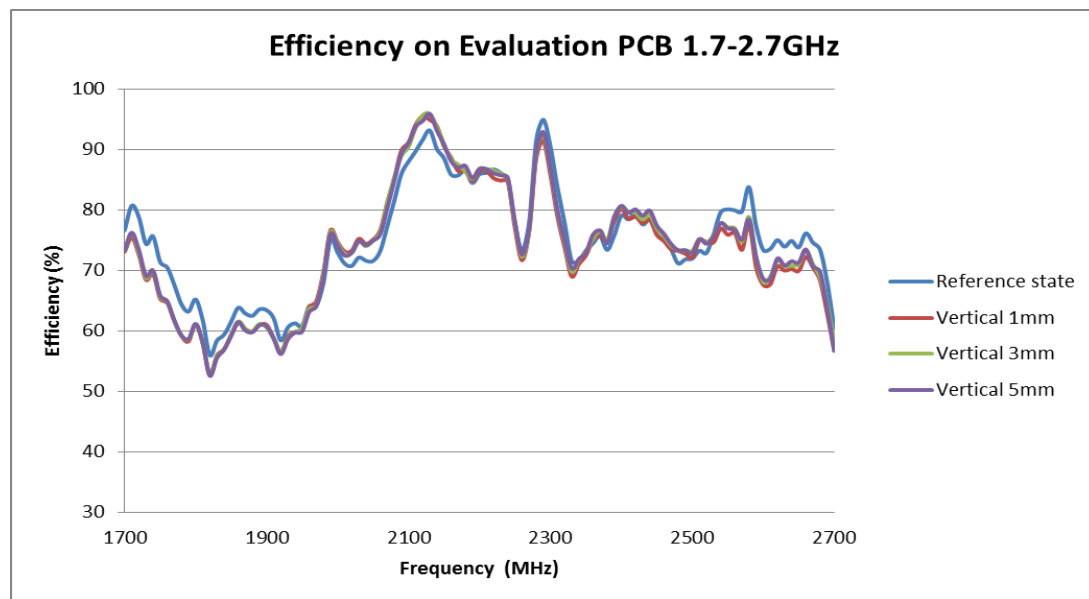


FIGURE 4.3.4 EFFICIENCY COMPARISON AT 1.7-2.7GHz BAND OF DIFFERENT VERTICAL PLASTIC COVER DISTANCE FROM ANTENNA

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4.0.4 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 4.4.1-4.4.4.

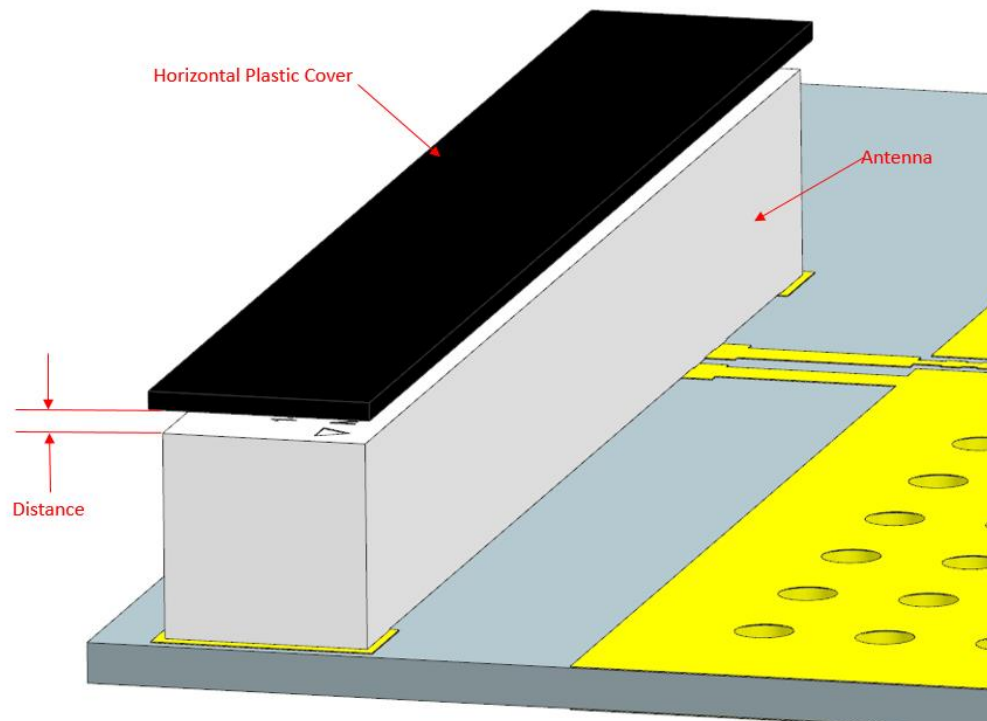


FIGURE 4.4 DIFFERENT DISTANCE BETWEEN HORIZONTAL PLASTIC COVER AND ANTENNA

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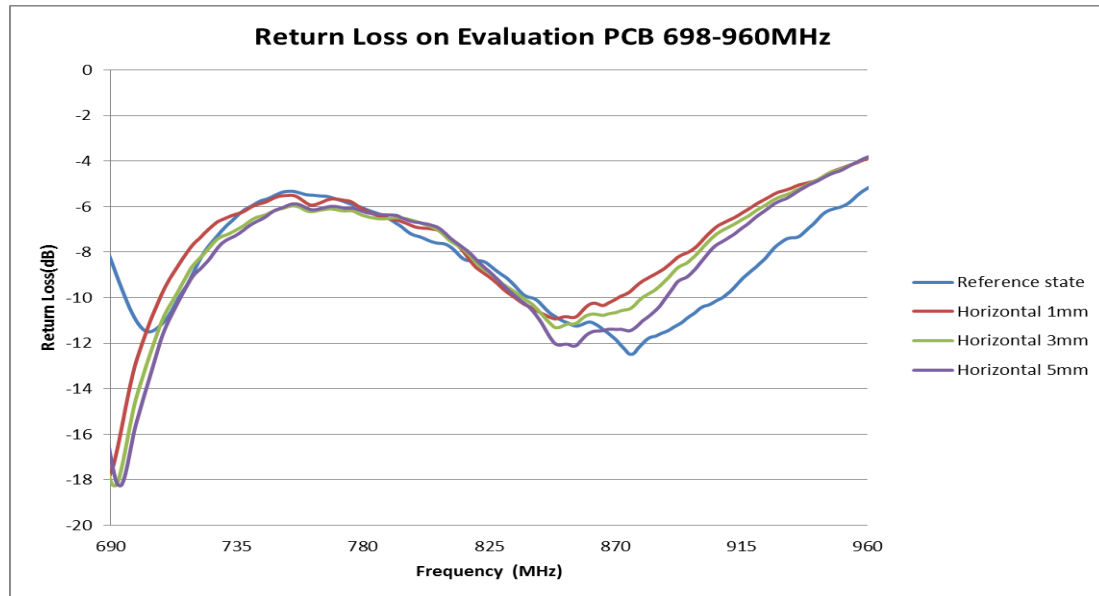


FIGURE 4.4.1 RETURN LOSS COMPARISON AT 698-960MHZ BAND OF DIFFERENT HORIZONTAL PLASTIC COVER DISTANCE FROM ANTENNA

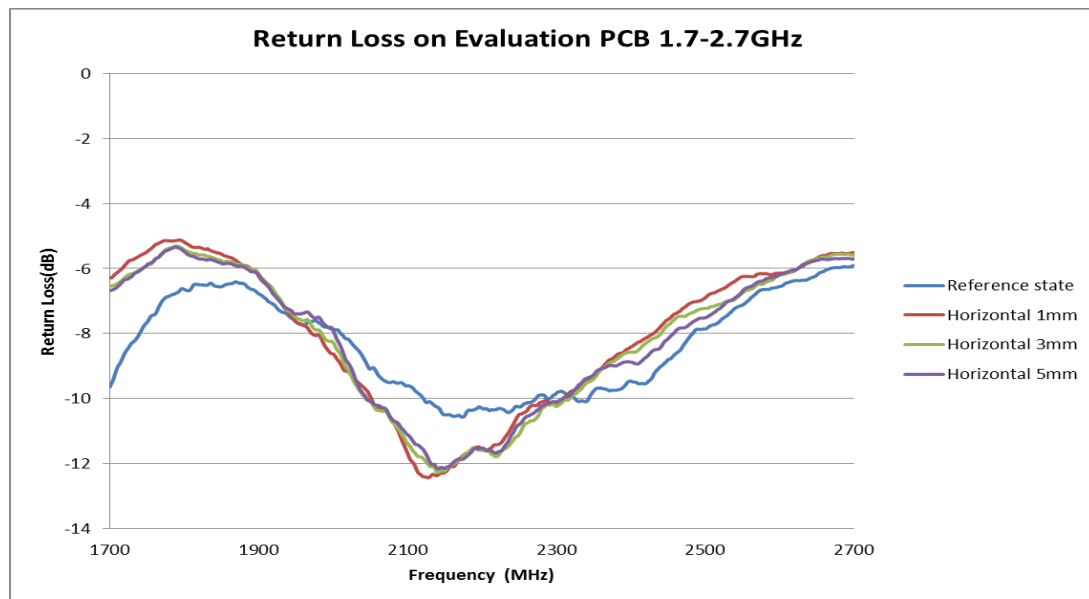


FIGURE 4.4.2 RETURN LOSS COMPARISON AT 1.7-2.7GHZ BAND OF DIFFERENT HORIZONTAL PLASTIC COVER DISTANCE FROM ANTENNA

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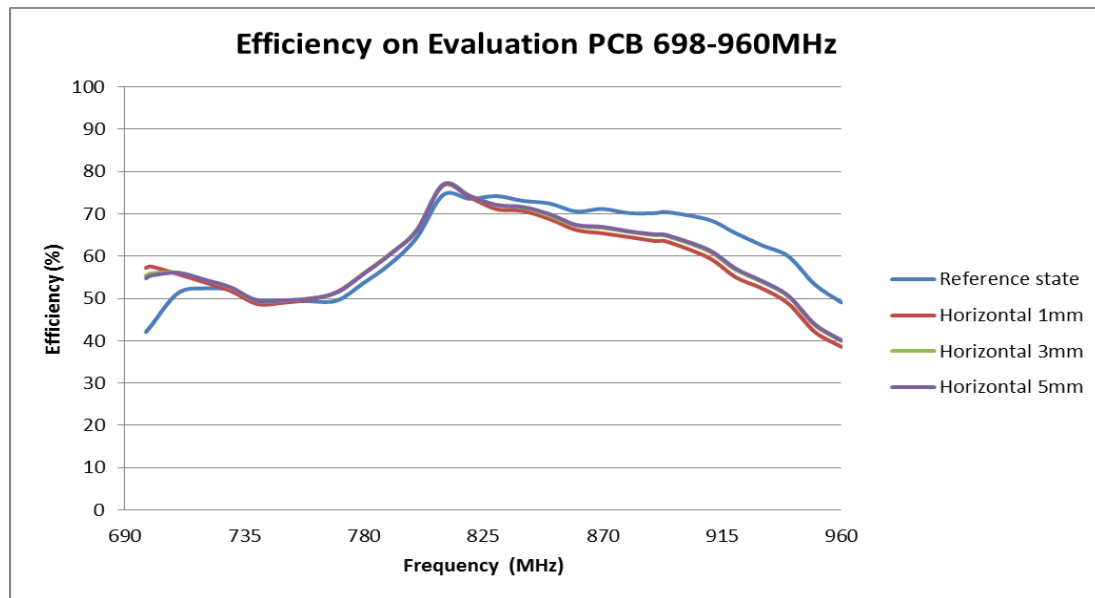


FIGURE 4.4.3 EFFICIENCY COMPARISON AT 698-960MHZ BAND OF DIFFERENT HORIZONTAL PLASTIC COVER DISTANCE FROM ANTENNA

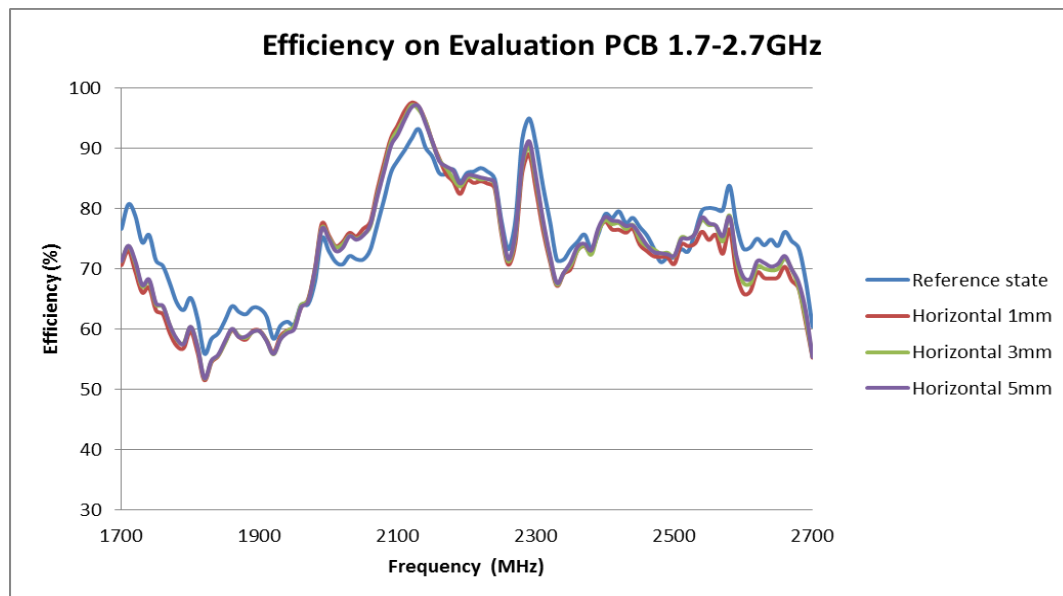


FIGURE 4.4.4 EFFICIENCY COMPARISON AT 1.7-2.7GHZ BAND OF DIFFERENT HORIZONTAL PLASTIC COVER DISTANCE FROM ANTENNA

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4.0.5 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 4.5.1-4.5.4. 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).

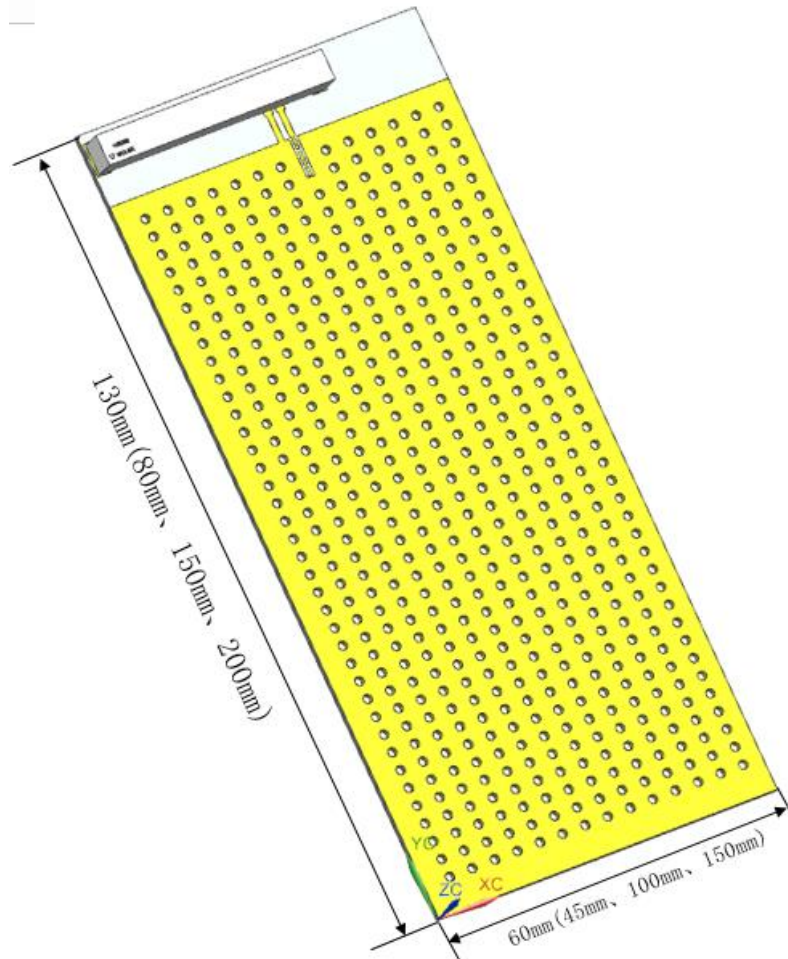


FIGURE 4.5 FOUR KINDS OF GROUND PLANE SIZE

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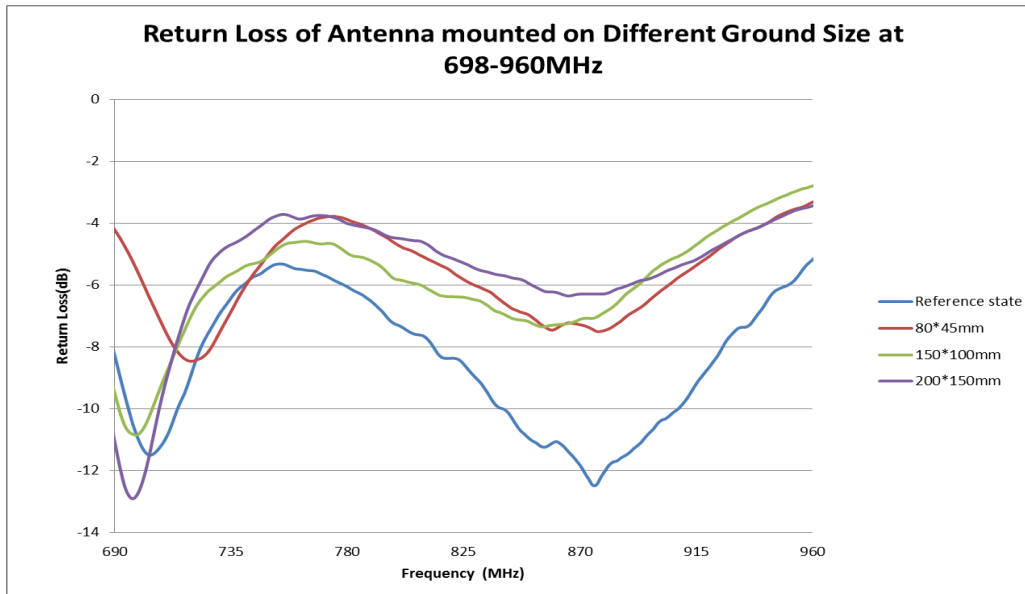


FIGURE 4.5.1 RETURN LOSS COMPARISON AT 698-960MHZ OF ANTENNA MOUNTED ON DIFFERENT SIZE GROUND

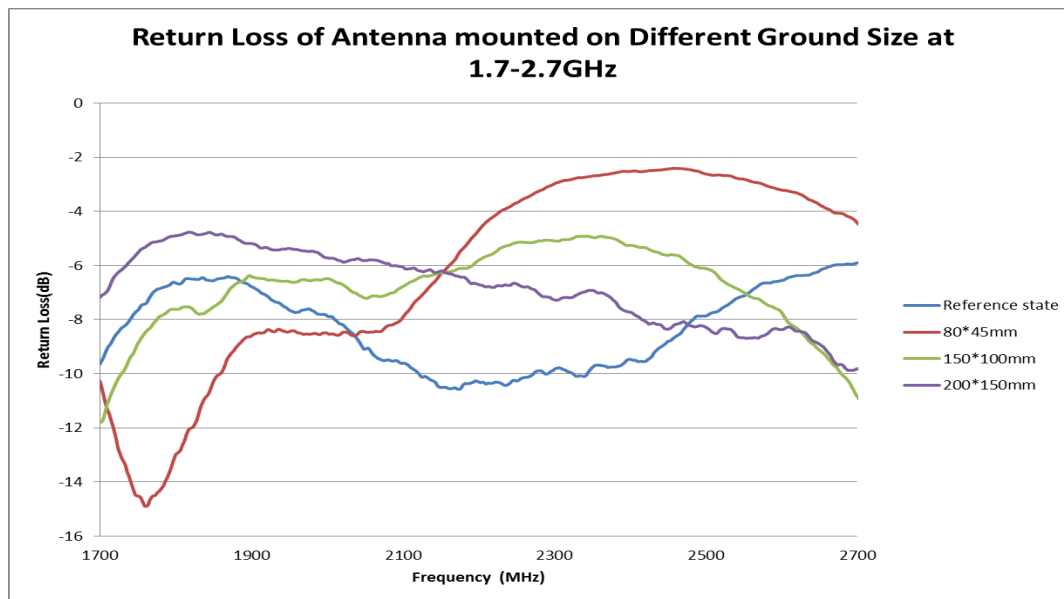


FIGURE 4.5.2 RETURN LOSS COMPARISON AT 1.7-2.7GHZ OF ANTENNA MOUNTED ON DIFFERENT SIZE GROUND

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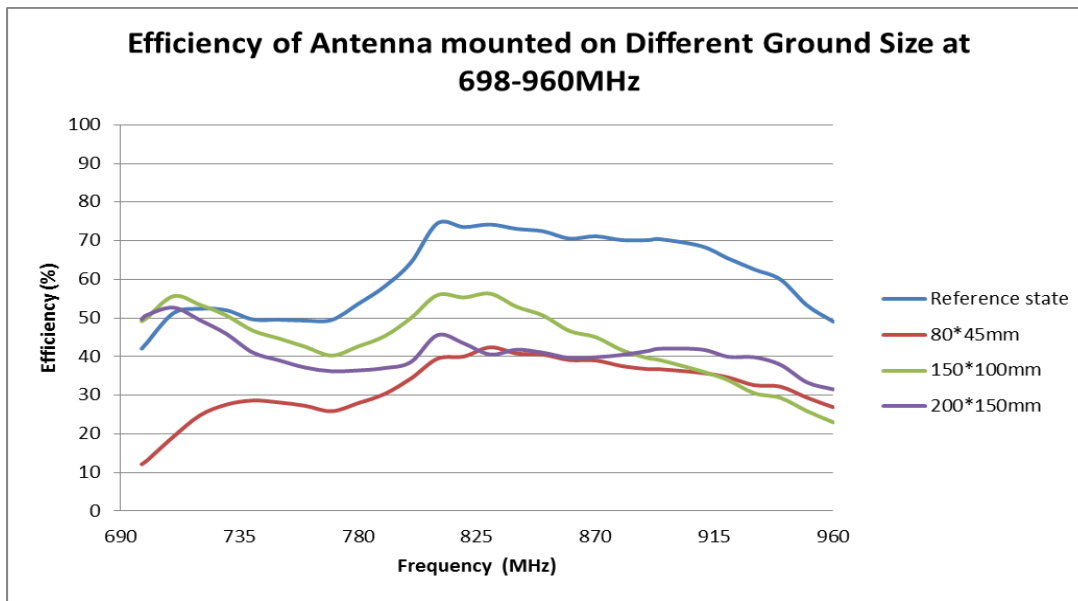


FIGURE 4.5.3 EFFICIENCY COMPARISON AT 698-960MHZ OF ANTENNA MOUNTED ON DIFFERENT SIZE GROUND

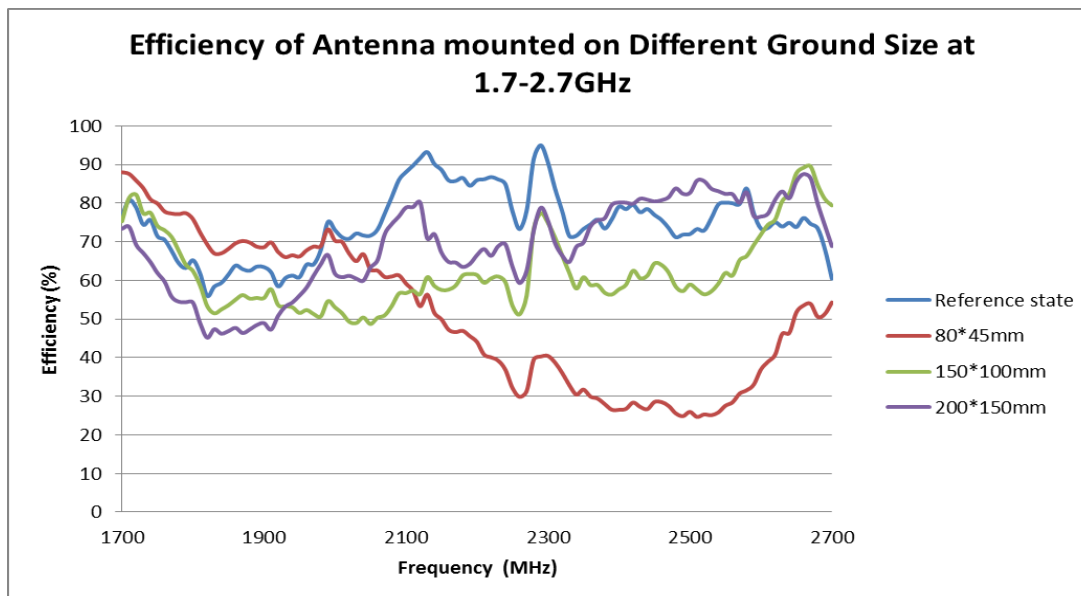


FIGURE 4.5.4 EFFICIENCY COMPARISON AT 1.7-2.7GHZ OF ANTENNA MOUNTED ON DIFFERENT SIZE GROUND

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APPLICATION SPECIFICATION

5.0 MATCHING NETWORK DESCRIPTION

As these two products has image pattern and very similar performance, so the matching network is the same for these two products. We choose 1462000001 as example for matching tuning explanation.

Two matching configurations as shown in Figure 5.1 and Figure 5.2 are recommended for low band (689MHz~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 5.4-5.6 shows the recommended matching networks for this antenna on different 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.

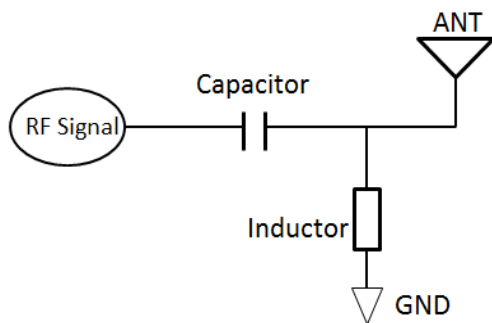


FIGURE 5.1 CONFIG 1 FOR LOW BAND

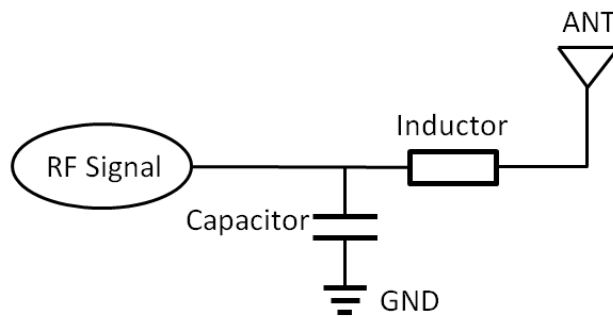


FIGURE 5.2 CONFIG 2 FOR HIGH BAND

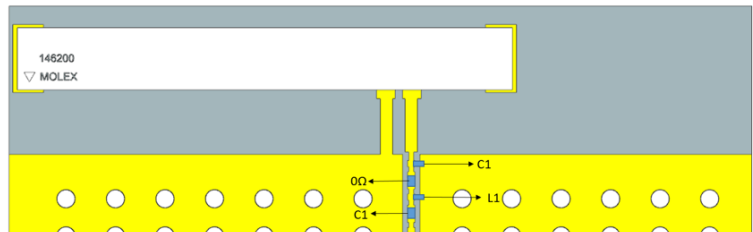
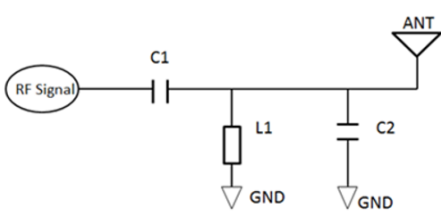


FIGURE 5.3 MATCHING CIRCUIT FOR ALL BAND

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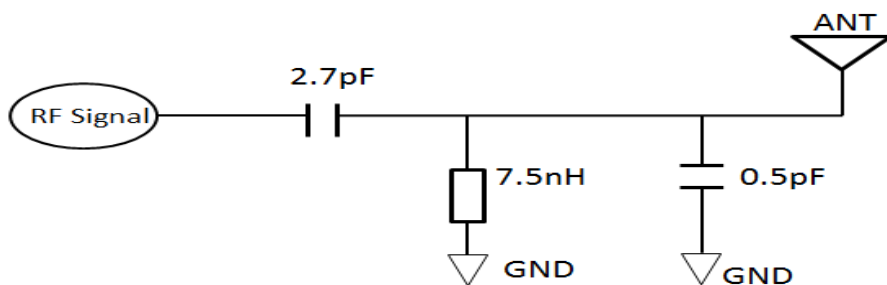


FIGURE5.4 RECOMMENDED MATCHING NETWORK FOR ANTENNA ON 130*60MM GROUND

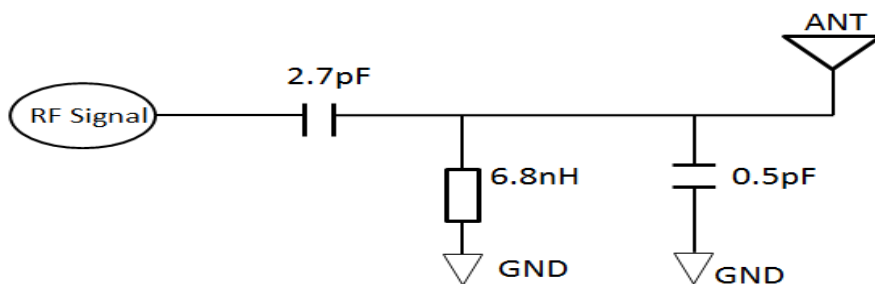


FIGURE5.5 RECOMMENDED MATCHING NETWORK FOR ANTENNA ON 150*100MM GROUND

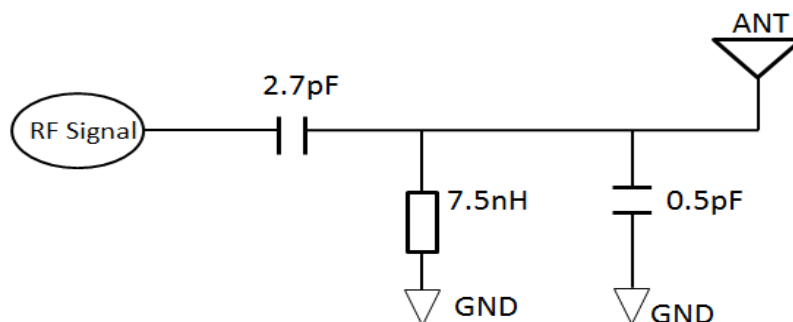


FIGURE5.6 RECOMMENDED MATCHING NETWORK FOR ANTENNA ON 200*150MM GROUND

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The following figure 5.7 and figure 5.8 are the return loss and smith chart comparison with and without the matching network on 130*60mm ground.

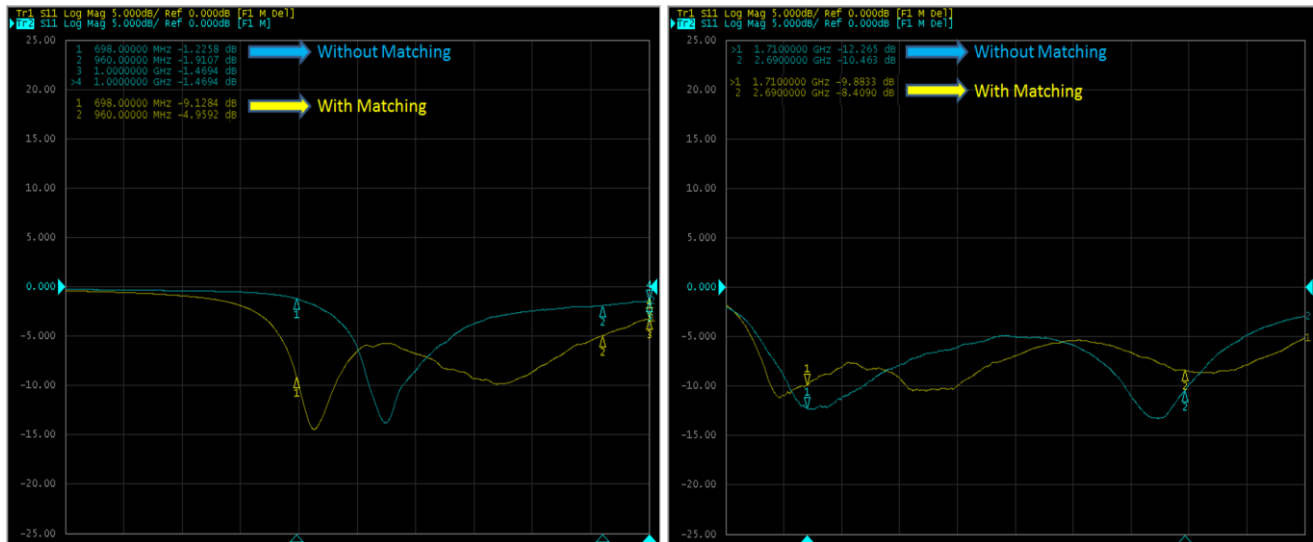


FIGURE 5.7 RETURN LOSS OF ANTENNA WITH AND WITHOUT MATCHING ON 130*60MM GROUND

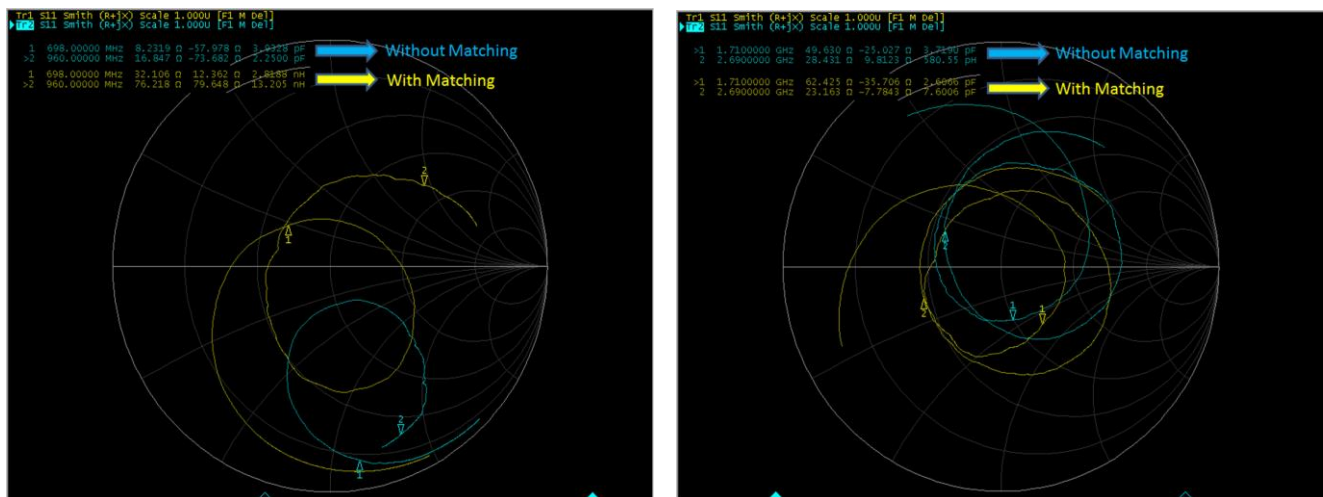


FIGURE 5.8 SMITH CHART OF ANTENNA WITH AND WITHOUT MATCHING ON 130*60MM GROUND

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6.0 RADIATION PATTERN

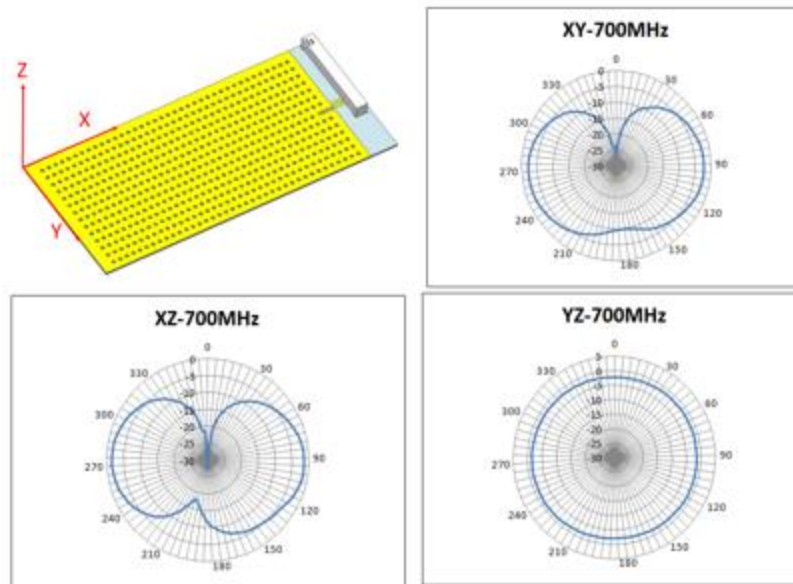


FIGURE 6.1 RADIATION PATTERN OF ANTENNA AT 700MHZ IN FREE SPACE

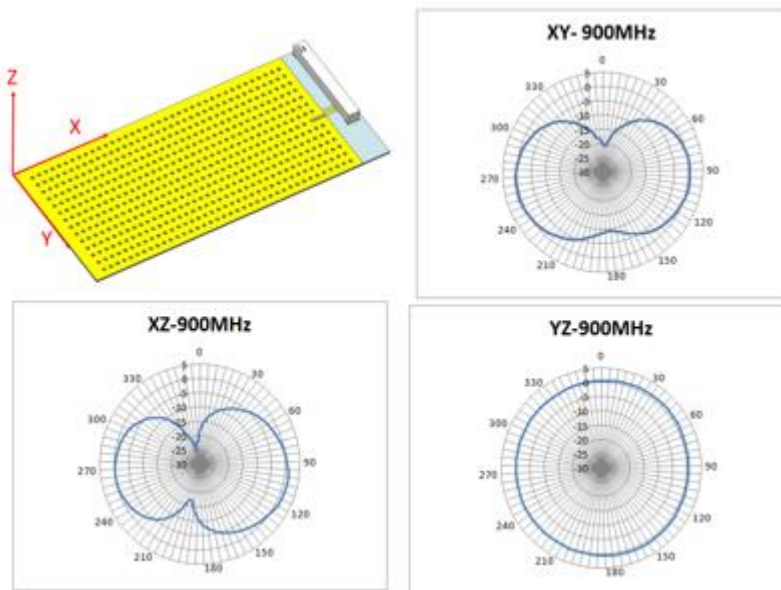


FIGURE 6.2 RADIATION PATTERN OF ANTENNA AT 900MHZ IN FREE SPACE

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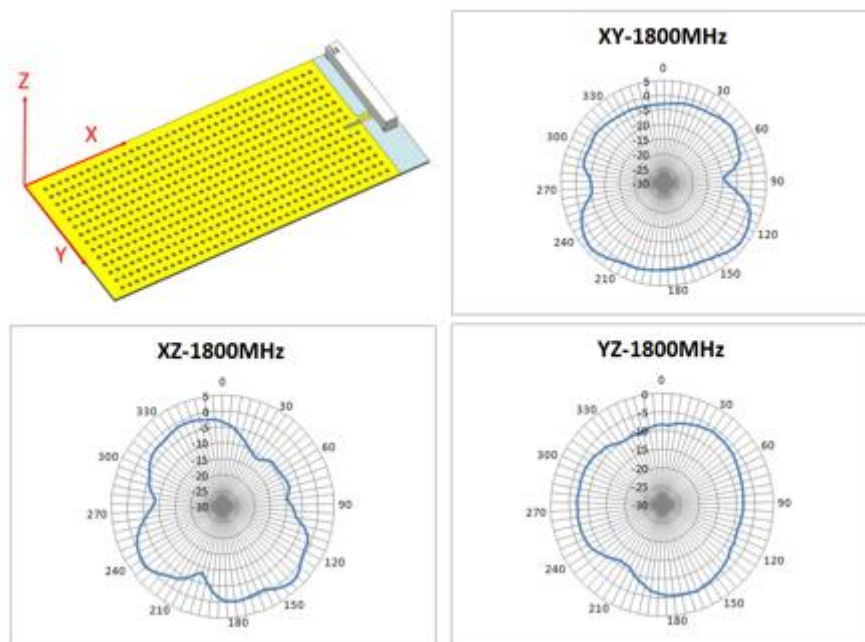


FIGURE 6.3 RADIATION PATTERN OF ATNENNA AT 1800MHZ IN FREE SPACE

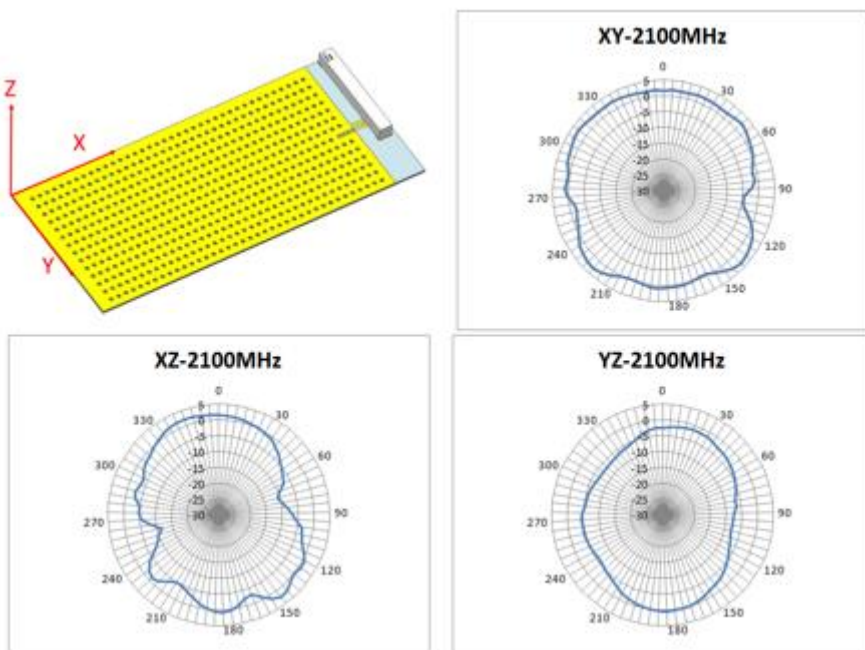


FIGURE 6.4 RADIATION PATTERN OF ATNENNA AT 2100MHZ IN FREE SPACE

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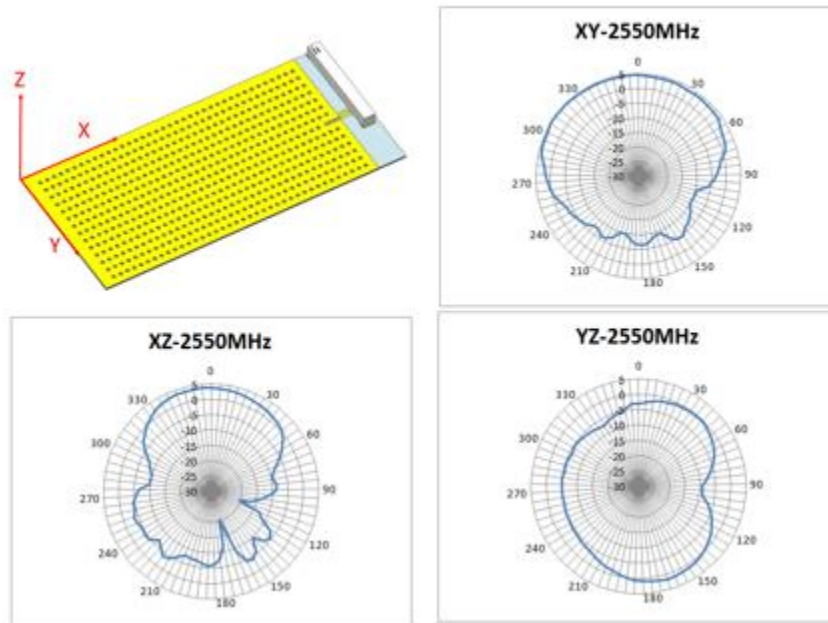


FIGURE 6.5 RADIATION PATTERN OF ANTENNA AT 2550MHz IN FREE SPACE

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APPLICATION SPECIFICATION

7. LTE MIMO ANTENNA APPLICATION

These two individual Full LTE antenna also can be integrated with high performance as Full LTE MIMO application. The recommend placement and location of these two parts are given in the following pages. As antenna performance will impact by location and space, therefore, other placements performance will need to re-tune to get the optimal performance

7.1 RETURN LOSS

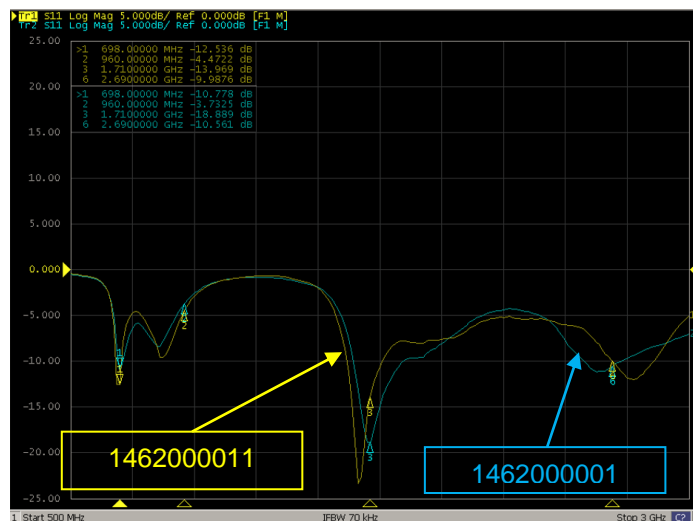


FIGURE 7.1 RETURN LOSS OF 1462000001 AND 1462000011 ANTENNAS

7.2 EFFICIENCY

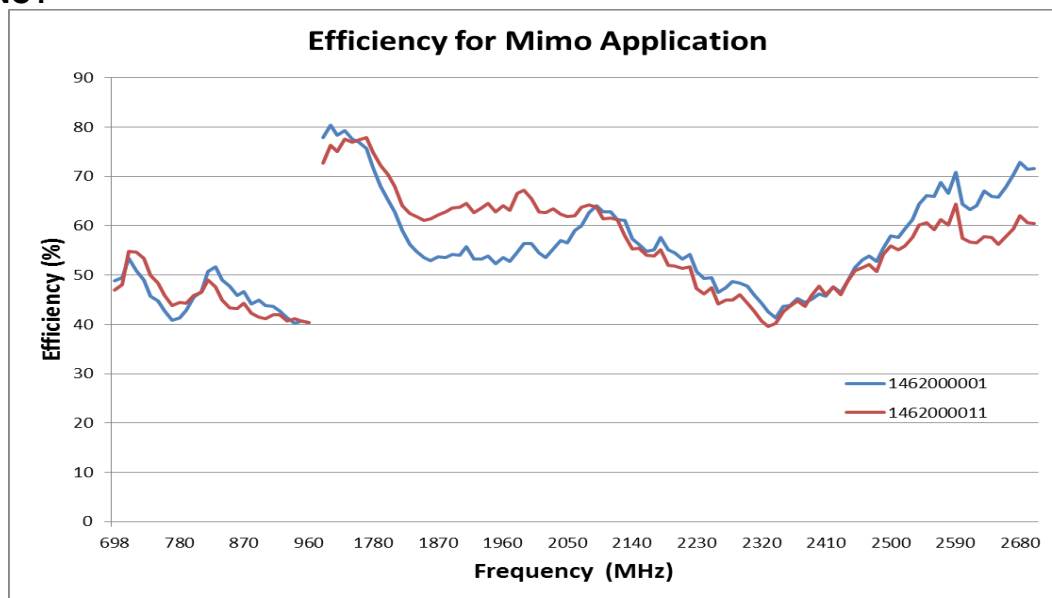


FIGURE 7.2 EFFICIENCY OF 1462000001 AND 1462000011 ANTENNAS

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7.3 PEAK GAIN

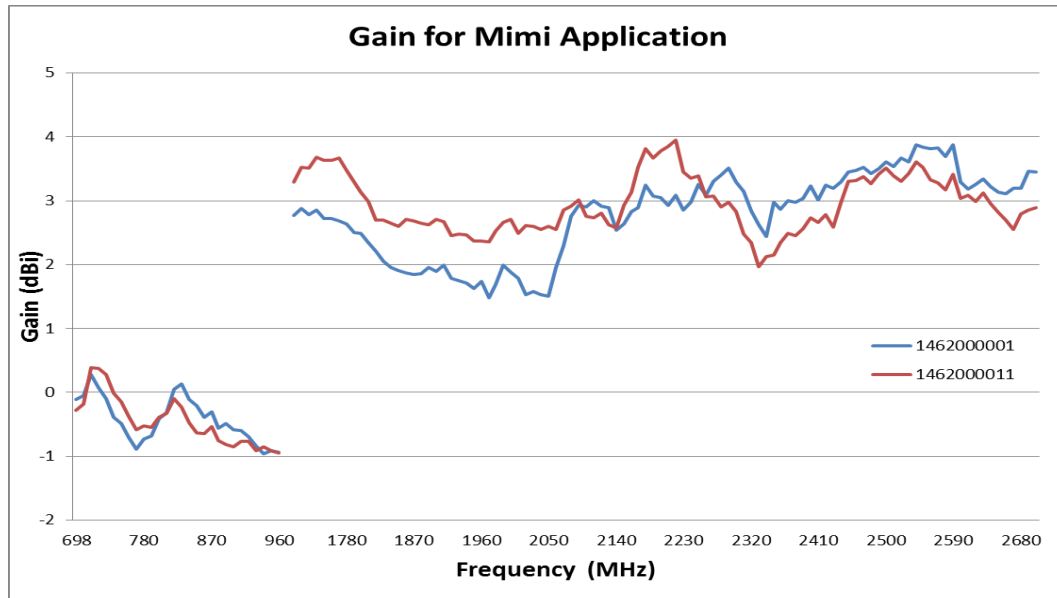


FIGURE 7.3 PEAK GAIN OF 1462000001 AND 1462000011 ANTENNAS

7.4 ISOLATION

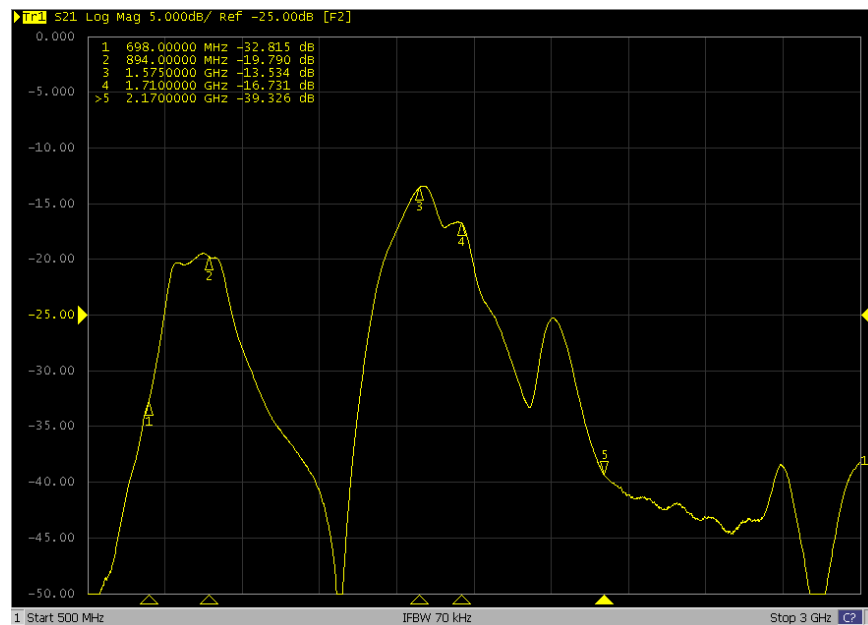


FIGURE 7.4 ISOLATION OF 1462000001 AND 1462000011 ANTENNAS

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

7.5 ECC (ENVELOPE CORRELATION COEFFICIENT)

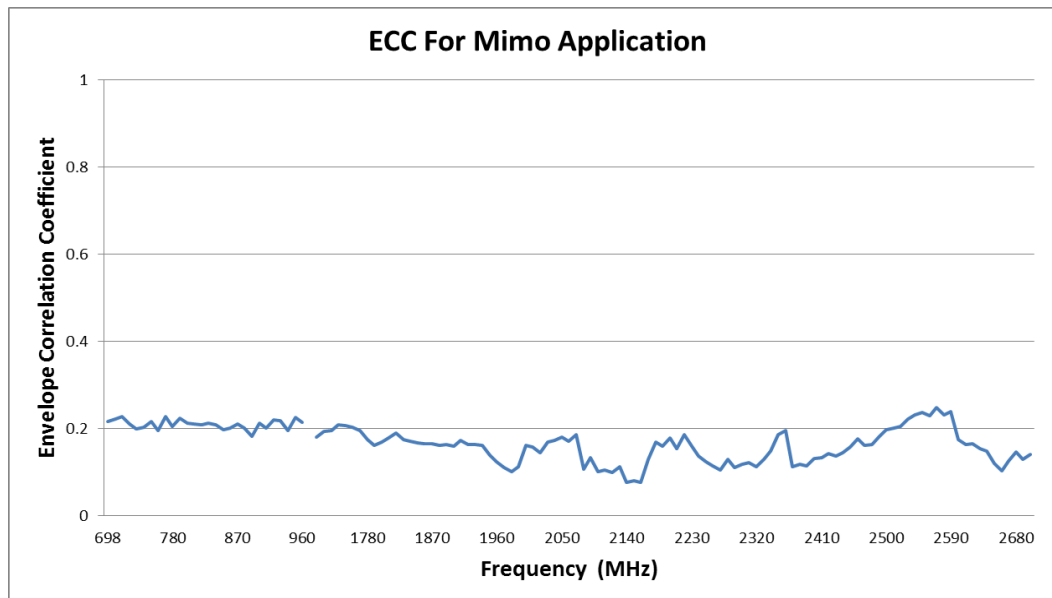


FIGURE 7.5 ECC OF 1462000001 AND 1462000011 ANTENNAS

7.6 3D RADIATION PATTERN (MEASURED ON 130*120MM EVB)

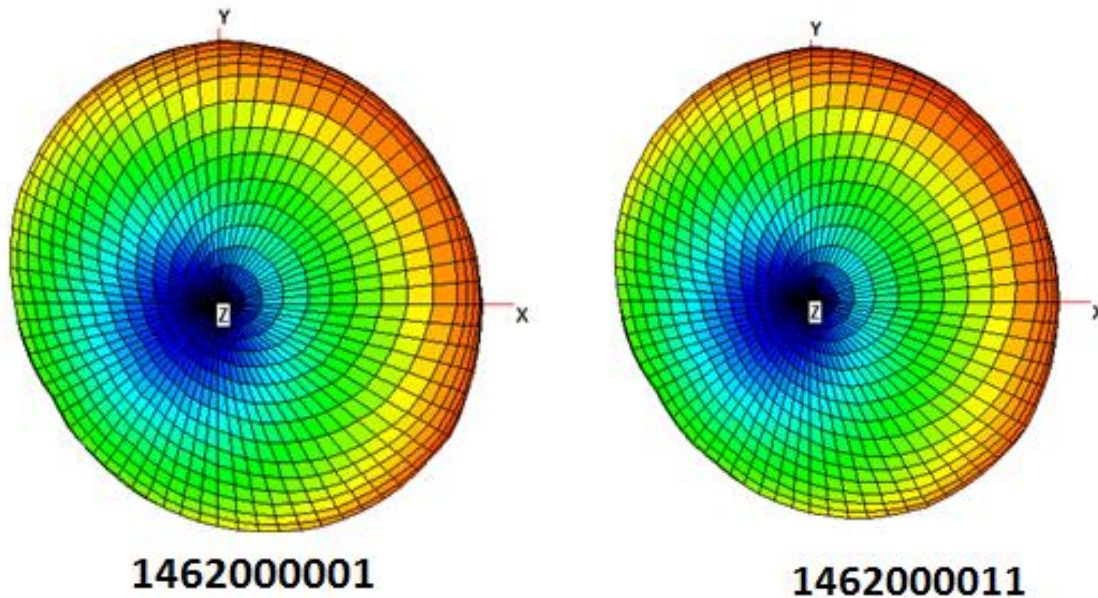
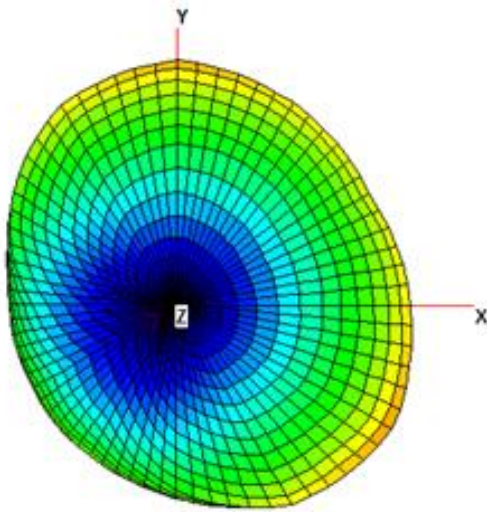
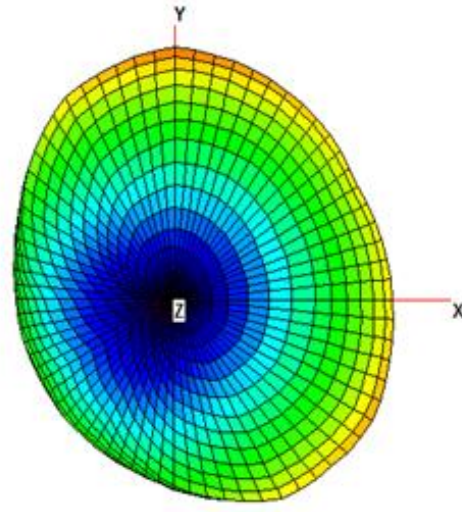


FIGURE 7.6.1 3D RADIATION PATTERN AT 700MHZ OF 1462000001 AND 1462000011 ANTENNAS

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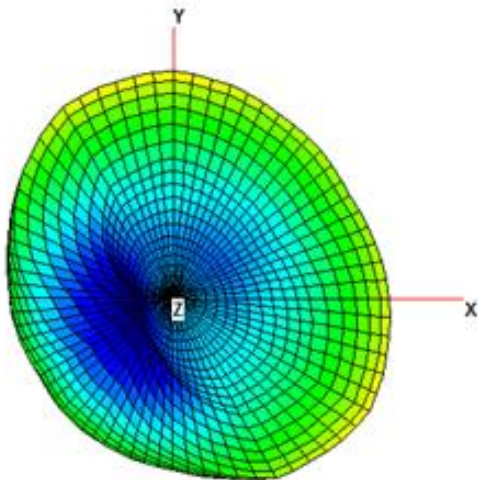


1462000001

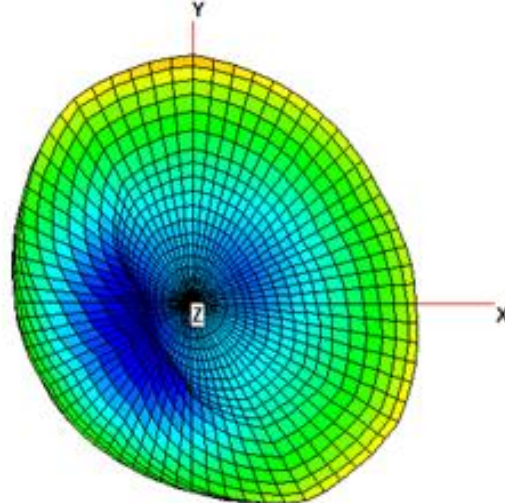


1462000011

FIGURE 7.6.2 3D RADIATION PATTERN AT 820MHZ OF 1462000001 AND 1462000011 ANTENNAS



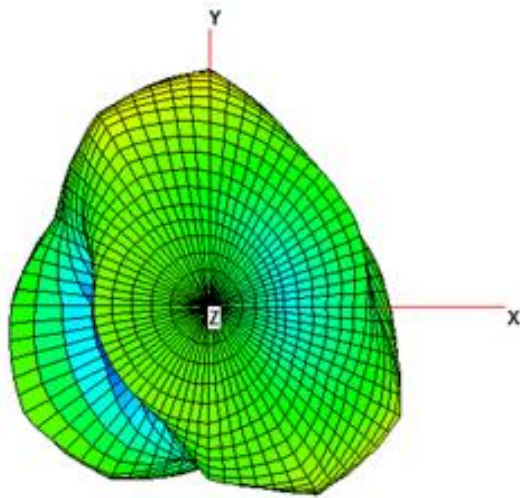
1462000001



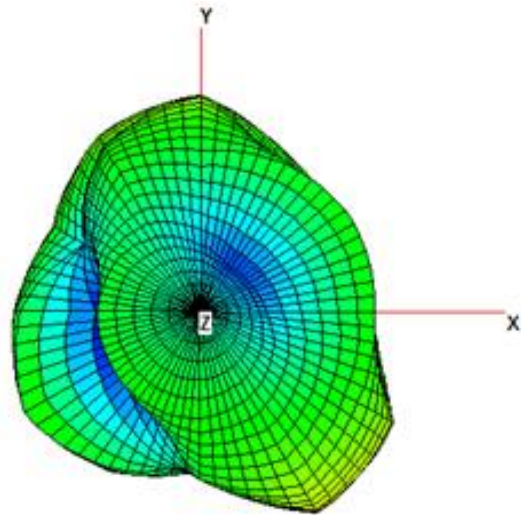
1462000011

FIGURE 7.6.3 3D RADIATION PATTERN AT 960MHZ OF 1462000001 AND 1462000011 ANTENNAS

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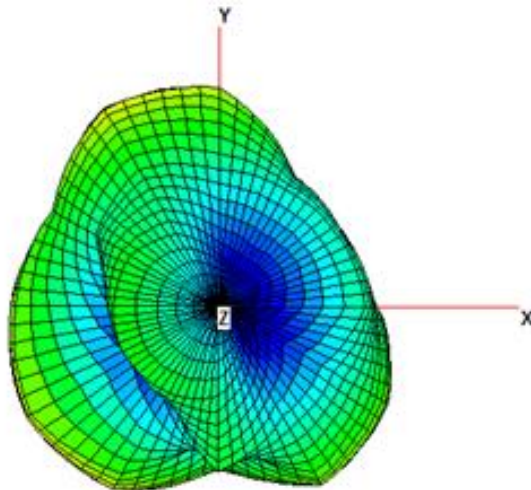


1462000001

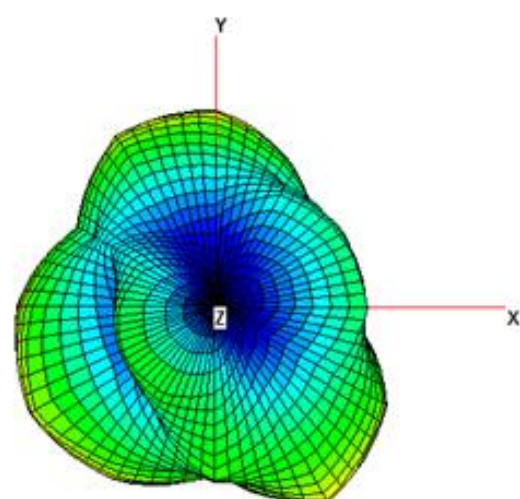


1462000011

FIGURE 7.6.4 3D RADIATION PATTERN AT 1710MHZ OF 1462000001 AND 1462000011 ANTENNAS



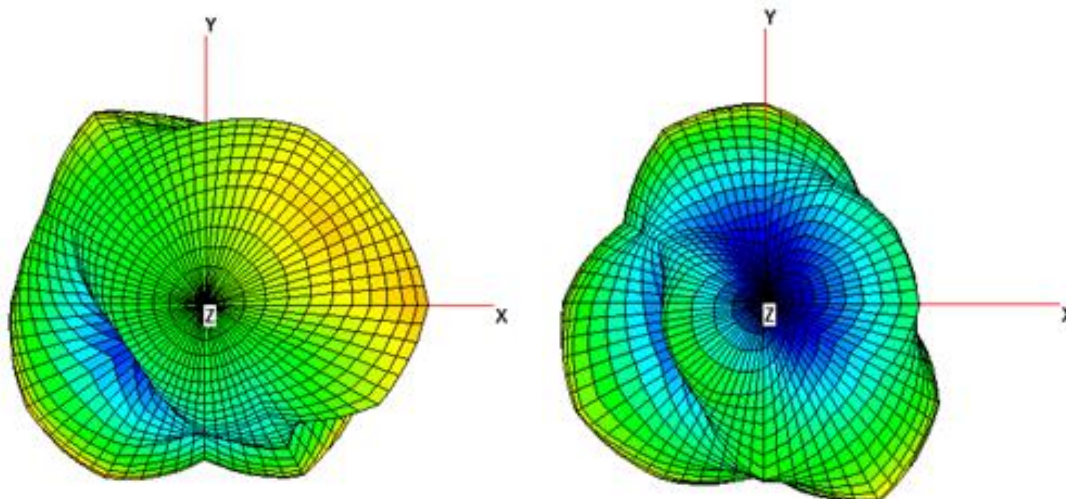
1462000001



1462000011

FIGURE 7.6.5 3D RADIATION PATTERN AT 1850MHZ OF 1462000001 AND 1462000011 ANTENNAS

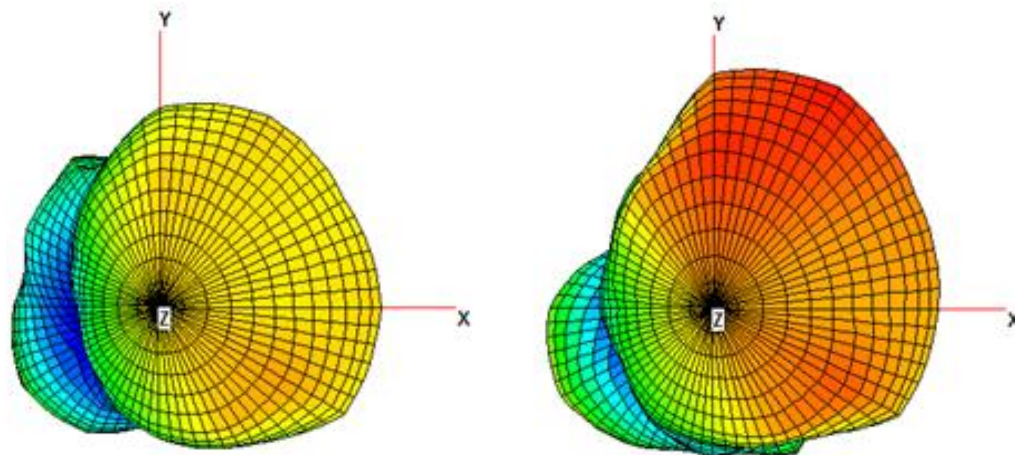
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1462000001

1462000011

FIGURE 7.6.6 3D RADIATION PATTERN AT 1990MHZ OF 1462000001 AND 1462000011 ANTENNAS

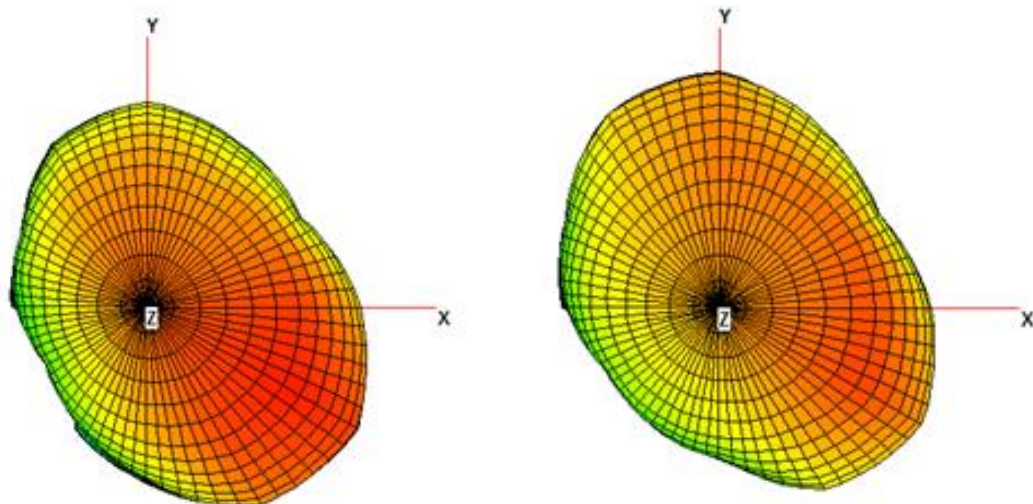


1462000001

1462000011

FIGURE 7.6.7 3D RADIATION PATTERN AT 2170MHZ OF 1462000001 AND 1462000011 ANTENNAS

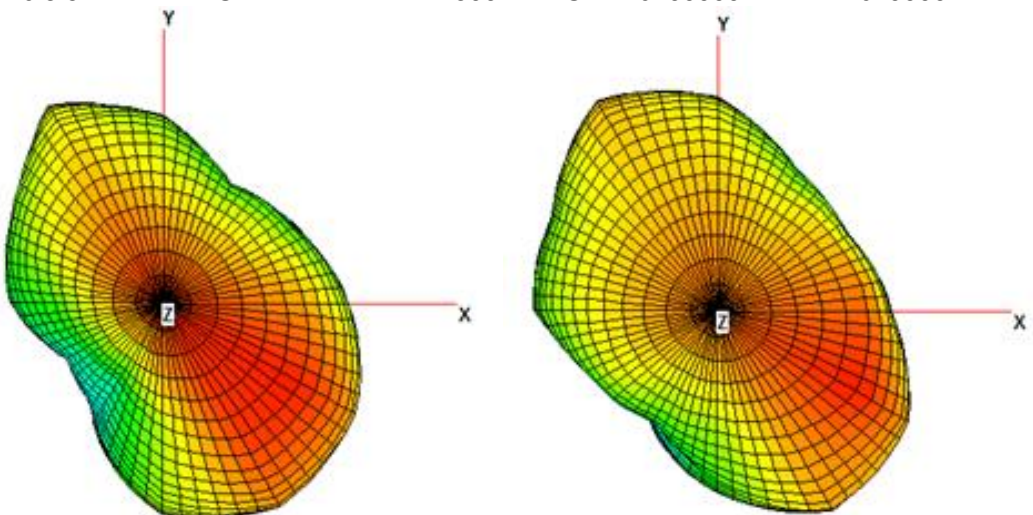
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1462000001

1462000011

FIGURE 7.6.8 3D RADIATION PATTERN AT 2500MHZ OF 1462000001 AND 1462000011 ANTENNAS



1462000001

1462000011

FIGURE 7.6.9 3D RADIATION PATTERN AT 2700MHZ OF 1462000001 AND 1462000011 ANTENNAS

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APPLICATION SPECIFICATION

8.0 ASSEMBLY INSTRUCTIONS

A. RECOMMENDED SMT REFLOW PROFILE

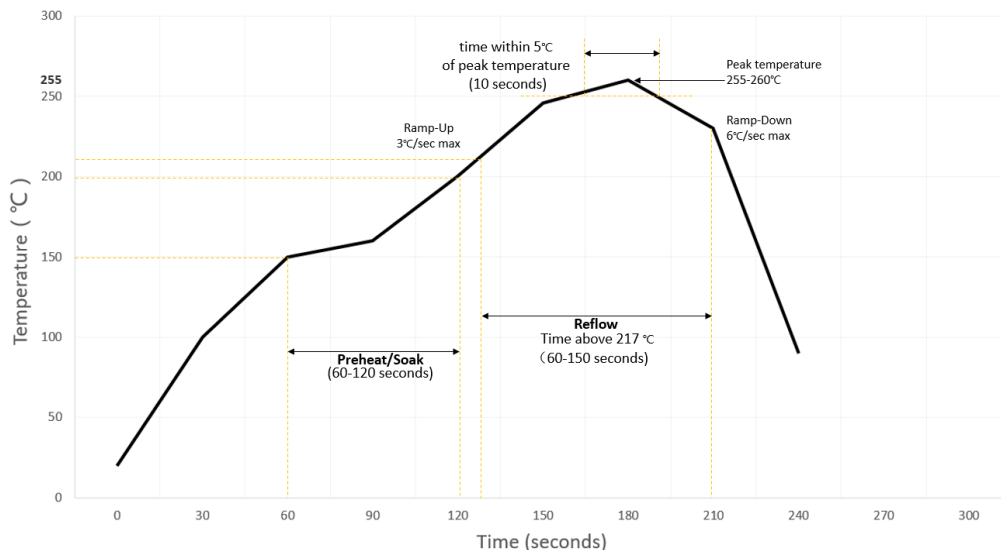


FIGURE 8.1 RECOMMENDED SMT REFLOW PROFILE

B. MECHANICAL INTERFACE

I. GENERAL DESCRIPTION

The overall antenna size is 40mm* 5mm *5mm (Length*Width*Height)

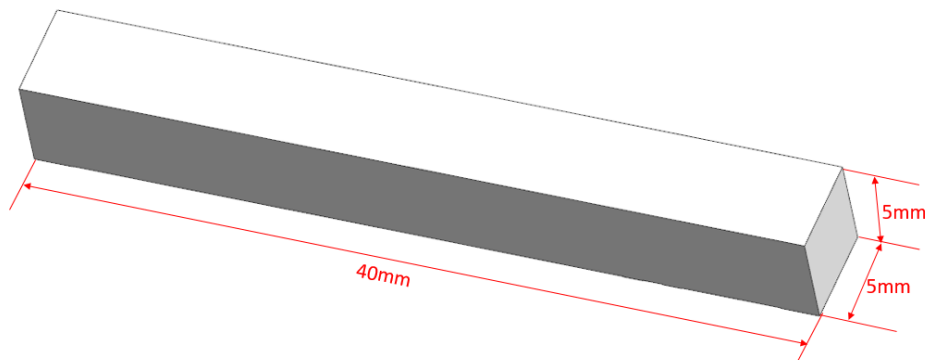


FIGURE 8.2 OVERALL ANTENNA SIZE (1462000001 and 1462000011)

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II. STRUCTURE FUNCTIONAL DESCRIPTION

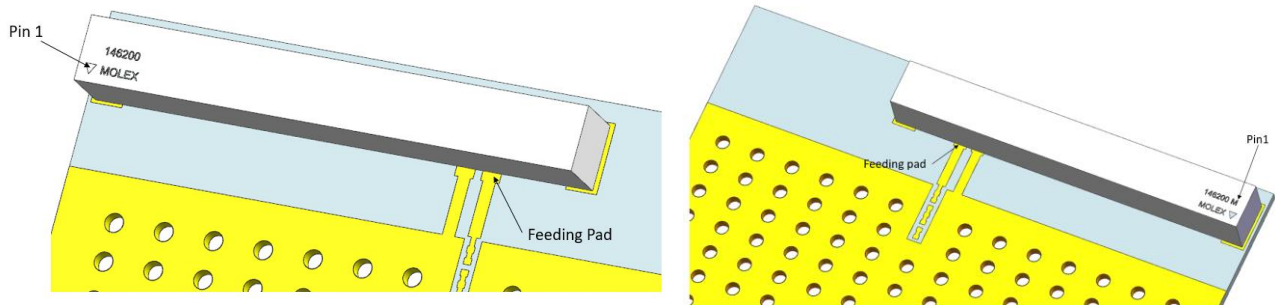
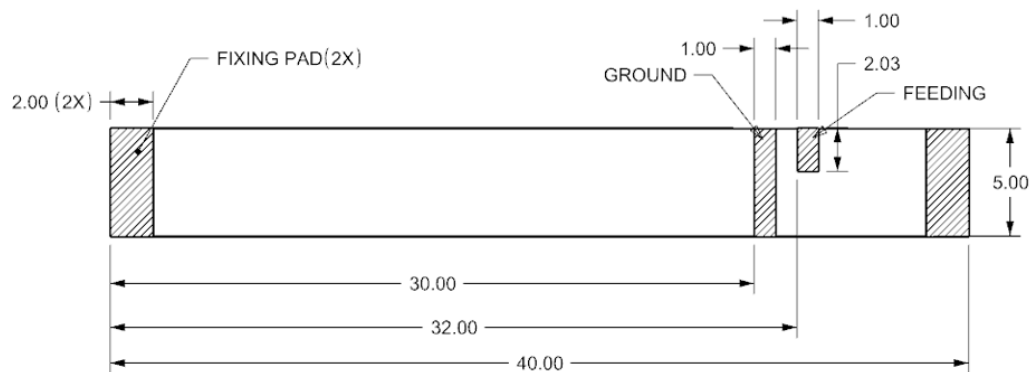
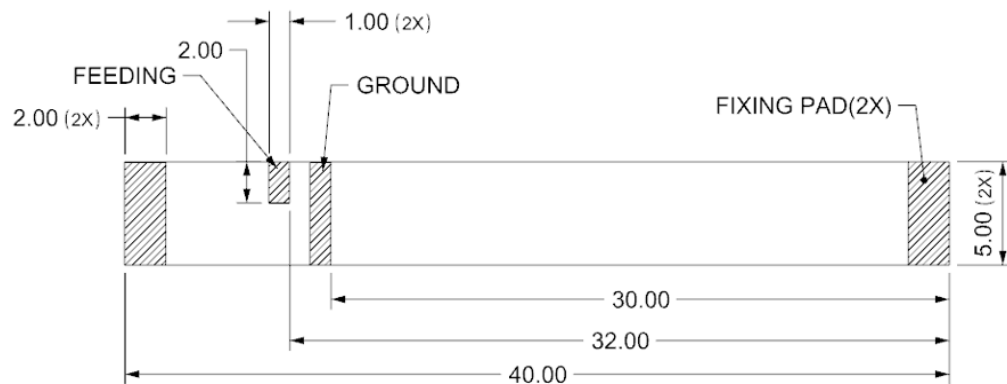


FIGURE 8.3 ANTENNA ASSEMBLY



P/N:1462000001



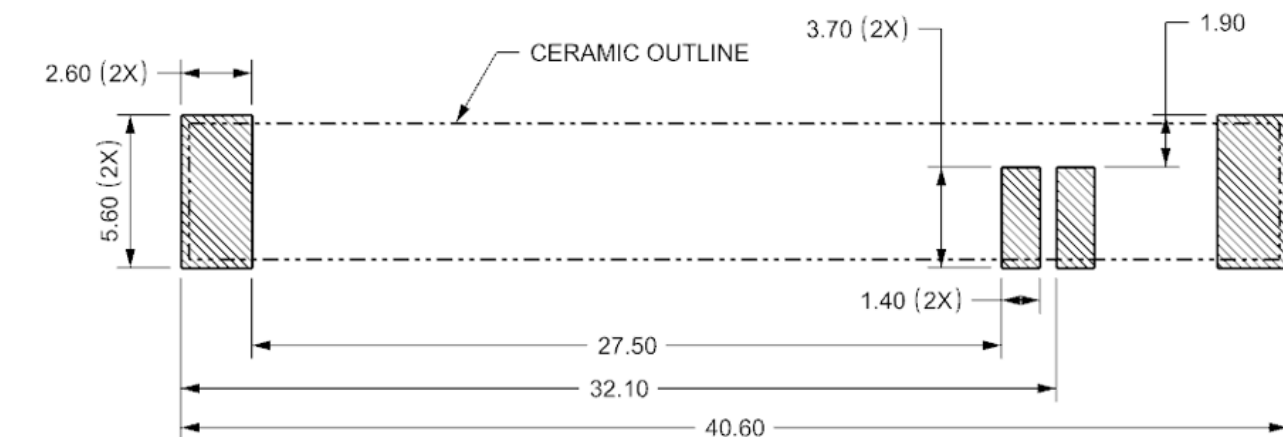
P/N:1462000011

FIGURE 8.4 PADS OF PRODUCT FOR SOLDERING

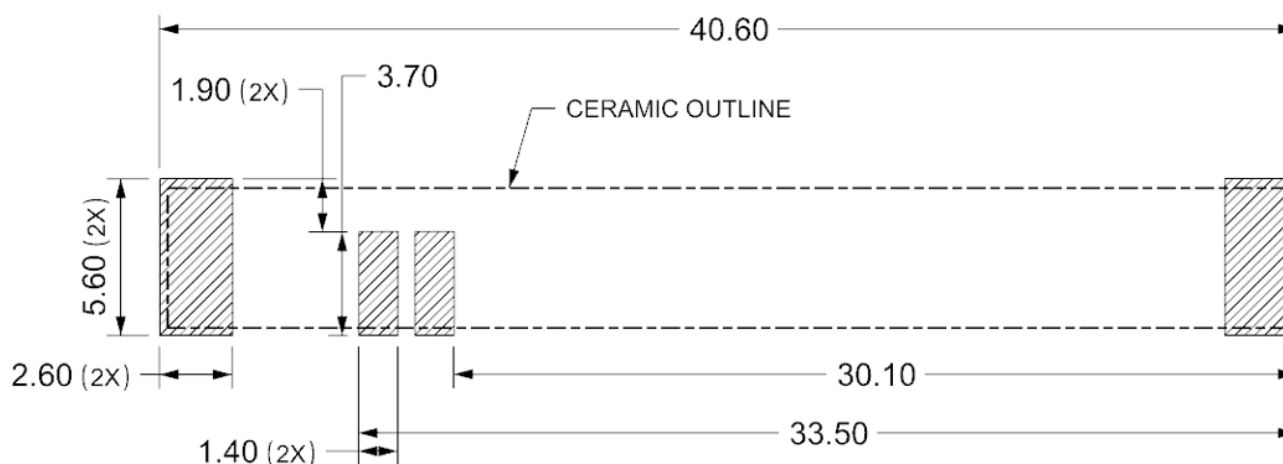
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P/N:1462000001



P/N:1462000011

FIGURE 8.5 RECOMMENDED FOOTPRINT ON PCB FOR SOLDERING

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