



APPLICATION SPECIFICATION

2.4GHZ/5GHZ CERAMIC SMT ANTENNA

1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Molex 2.4GHz/5GHz Ceramic SMT Antenna. This antenna can be not only used only at 2.4GHz band but also used at 2.4GHz/5GHz band. There are two kinds of PCB layout for these two configurations. The PCB layout for configuration 1 is used only at 2.4GHz band, the PCB layout for configuration 2 is used at 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 one feeding pad, two grounding pads, one alternate pad and one 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. ALTERNATE PAD

To act as a different function pad for each configuration. For configuration 1 the alternate pad is used as a grounding pad, and for configuration 2 the alternate pad is used as a feeding pad.

4. ANTENNA RADIATOR

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

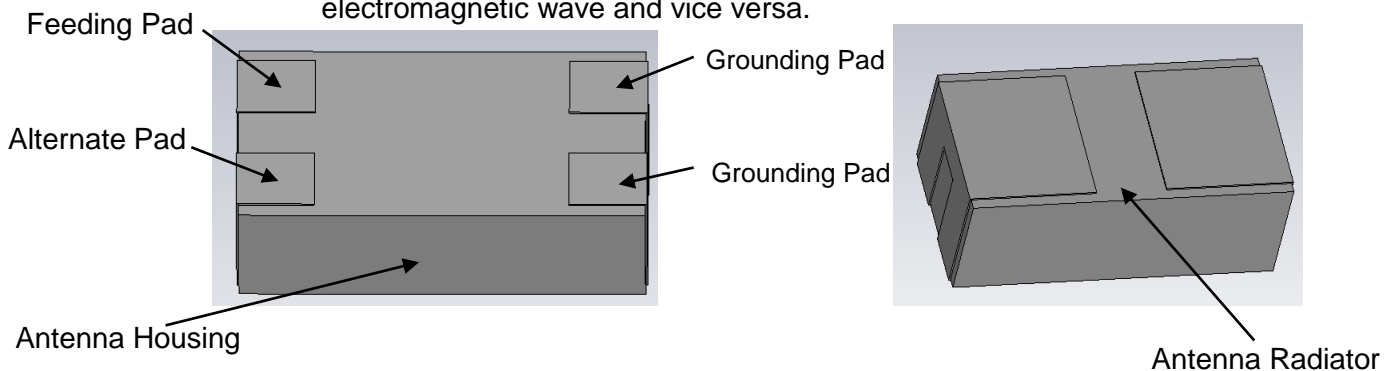


FIGURE 1. 2.4GHZ/5GHZ CERAMIC SMT ANTENNA

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B. REFERENCE IMPLEMENTATION

I. REFERENCE PCB DESCRIPTION

The size of reference PCB design is 40mm* 20mm *0.8mm, which is used for this antenna performance verification. There are two kinds of PCB layout for these two configurations. Configuration 1 is used only at 2.4GHz band and configuration 2 is used at 2.4GHz/5GHz band. The two configurations are using the same antenna. For configuration 1 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 4mm*6mm. For configuration 2 there are two feeding pads and two ground pads. Furthermore, there are two “L” type matching networks reserved close to feeding pad. The clearance size is also 4mm*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 “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

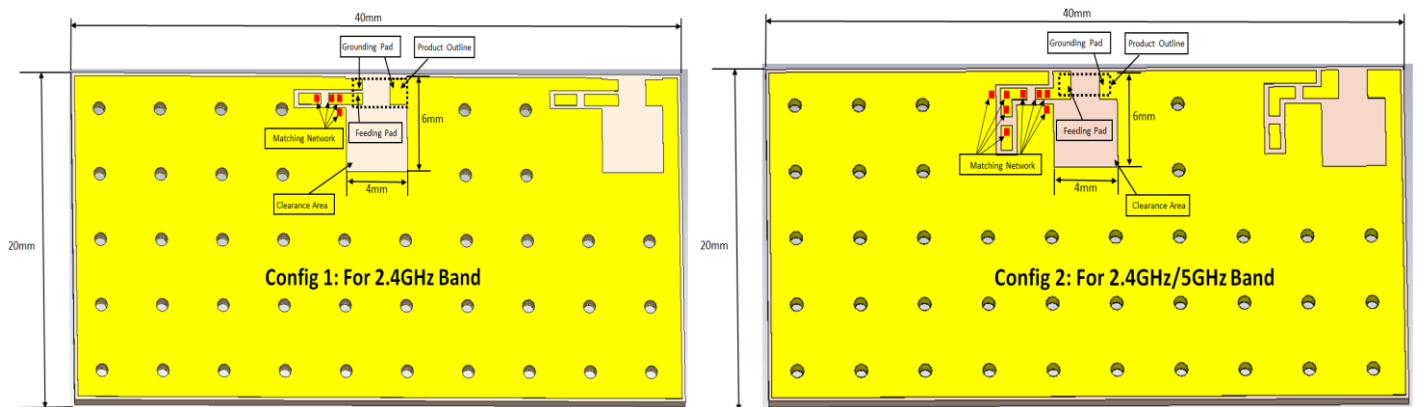


FIGURE 2: REFERENCE PCB LAYOUT FOR TWO CONFIGS

(Note: PCB Ground Size of 40 mm x 20 mm x 0.8 mm)

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III. ANTENNA PERFORMANCE AT RECOMMENDED LOCATION

The recommended antenna locations are both at the upper center of the PCB for these two configurations as shown in Figure 2.1.

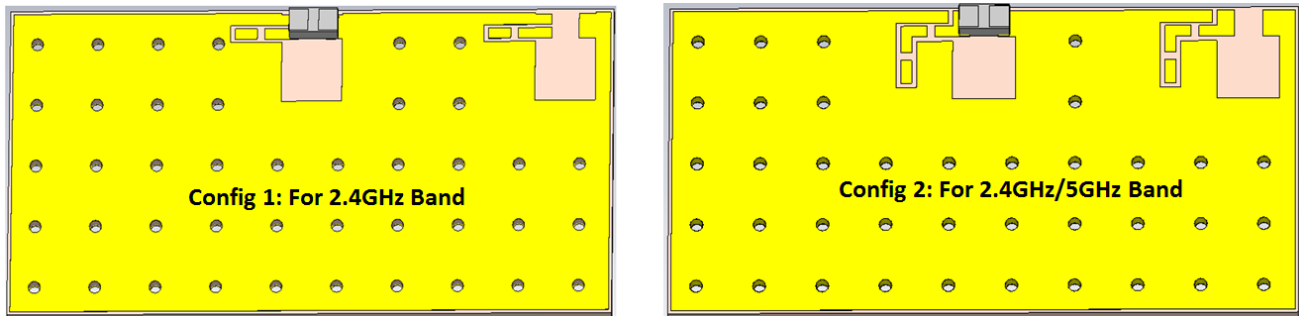


FIGURE 2.1 RECOMMENDED ANTENNA LOCATION FOR TWO CONFIGS

| DESCRIPTION | Test Condition | Requirements (For Configuration 1) | | Requirements (For Configuration 2) | |
|-----------------------|--|------------------------------------|---|------------------------------------|--------|
| | | Frequency Range | Measure antenna on recommended PCB through VNA E5071C | 2.4-2.5GHz | |
| Return Loss | Measure antenna on recommended PCB through VNA E5071C | < -10 dB | | < -5 dB | |
| Peak Gain (Max) | Measure antenna on recommended PCB through OTA chamber | 2.3dBi | | 2.1dBi | 1.5dBi |
| Avg. Total Efficiency | Measure antenna on recommended PCB through OTA chamber | >70% | | >60% | >55% |
| Polarization | Measure antenna on recommended PCB through OTA chamber | Linear | | Linear | |
| Input Impedance | Measure antenna on recommended PCB through VNA E5071C | 50Ohms | | 50Ohms | |

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2.1RF PERFORMANCE AT REFERENCE LOCATION IN FREE SPACE FOR CONFIG 1 AND CONFIG 2

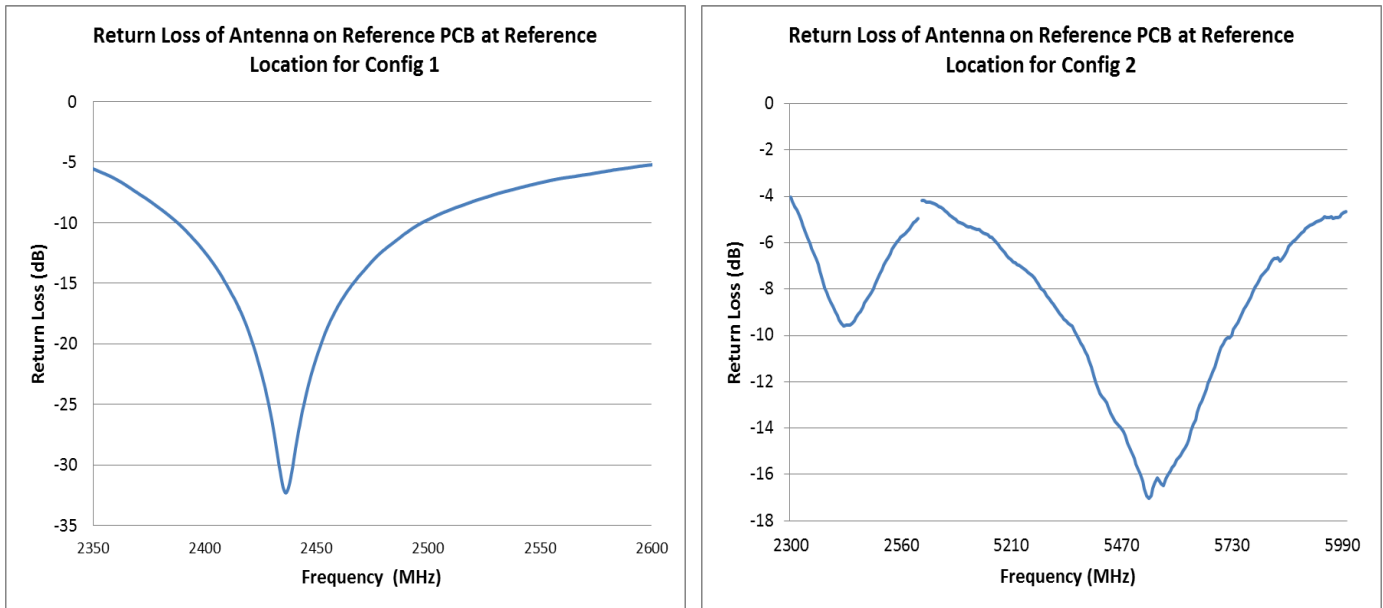


FIGURE 2.2 RETURN LOSS OF ANTENNA AT 2.4/5GHZ ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE FOR CONFIG 1 AND CONFIG 2

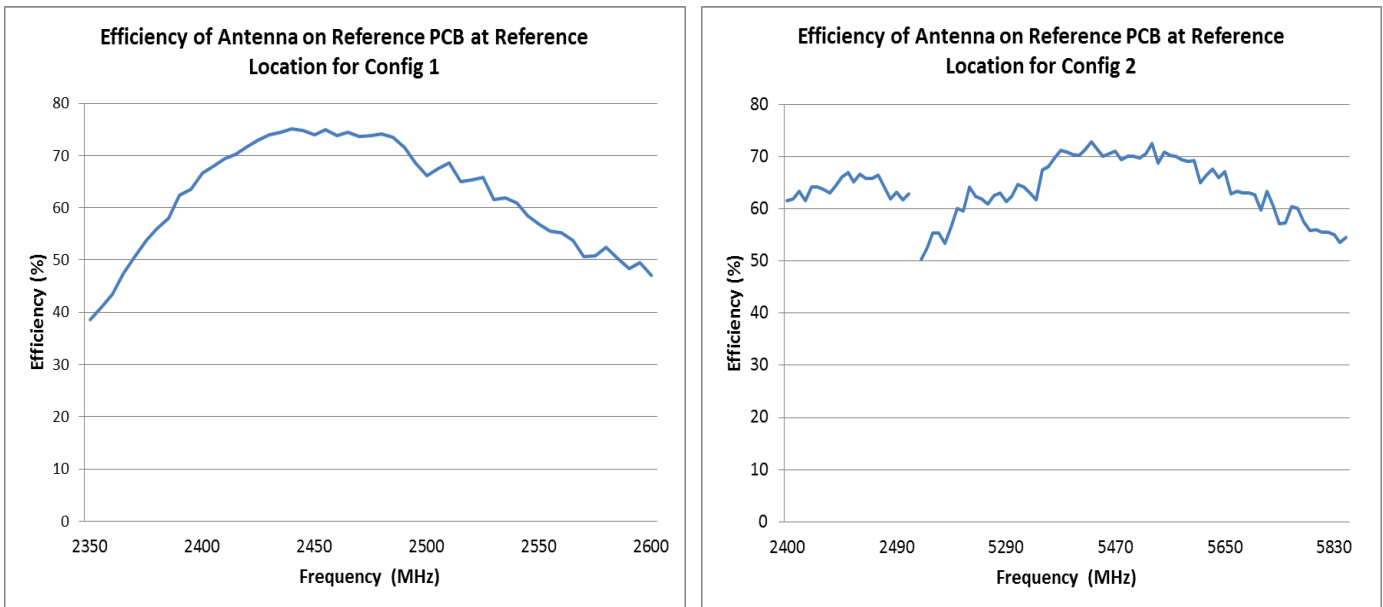


FIGURE 2.3 EFFICIENCY OF ANTENNA AT 2.4/5GHZ ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE FOR CONFIG 1 AND CONFIG 2

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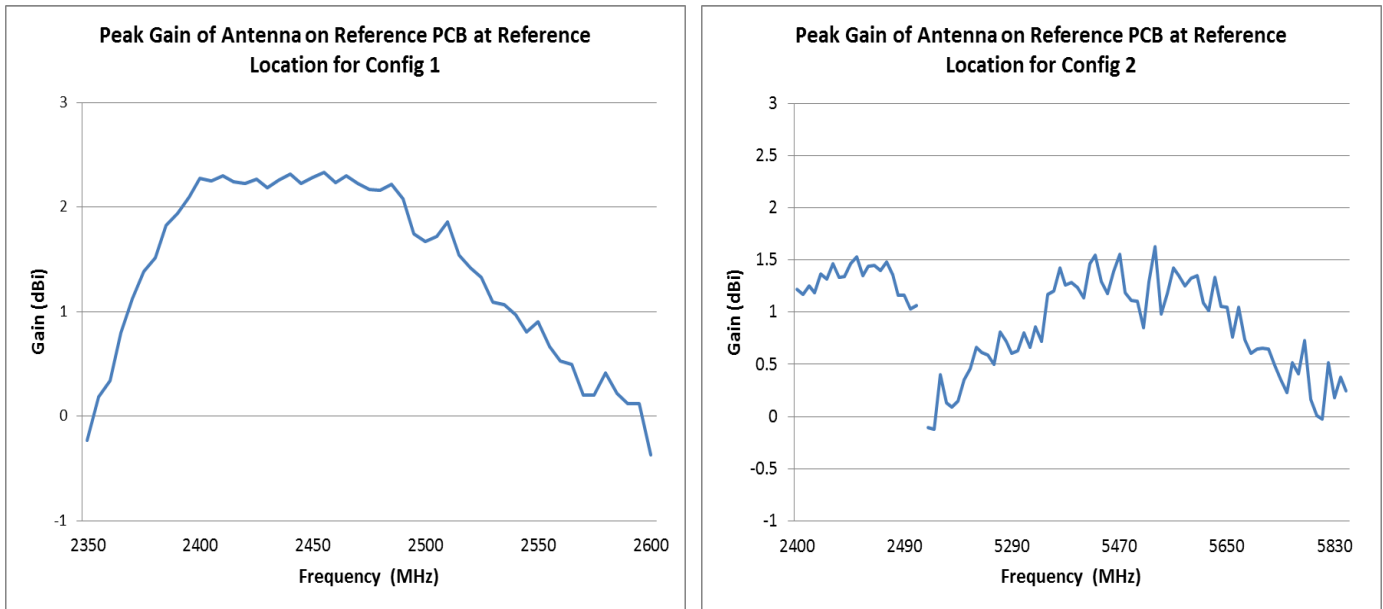


FIGURE 2.4 PEAK GAIN OF ANTENNA AT 2.4/5GHZ ON REFERENCE PCB AT REFERENCE LOCATION IN FREE SPACE FOR CONFIG 1 AND CONFIG 2

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3.0 REFERENCE DOCUMENTS

- Sales Drawing: SD-2030060001
- Product Specification: PS-2030060001
- Packaging Information – Refer to the Molex related packaging drawings.

4.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION FOR TWO CONFIGS

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 for these two configurations. 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 for these two configurations. When the distance is less than 5mm, the antenna performance will be significantly degraded. Refer to figure 4.1.1-4.1.3

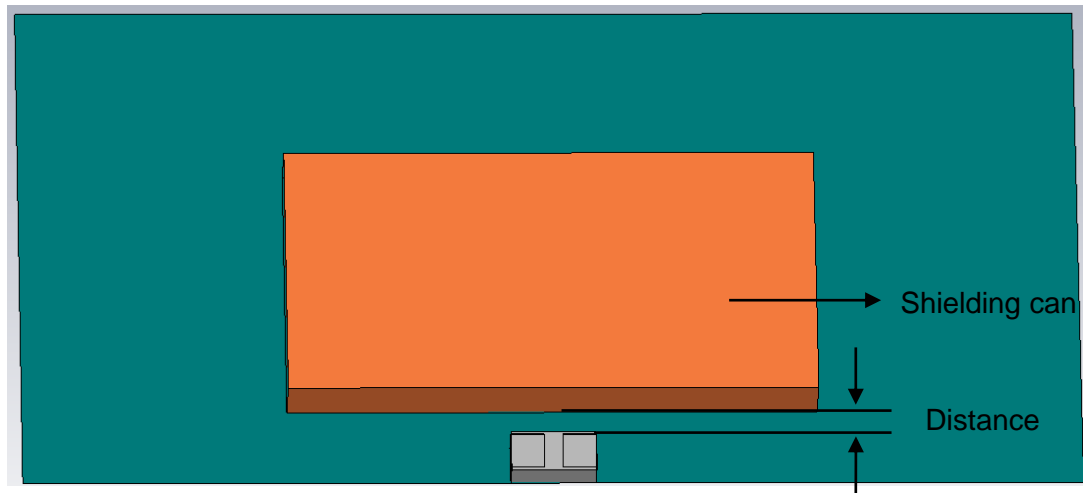


FIGURE 4.1 SHIELDING CAN FIXED ON REFERENCE PCB FOR TWO CONFIGS

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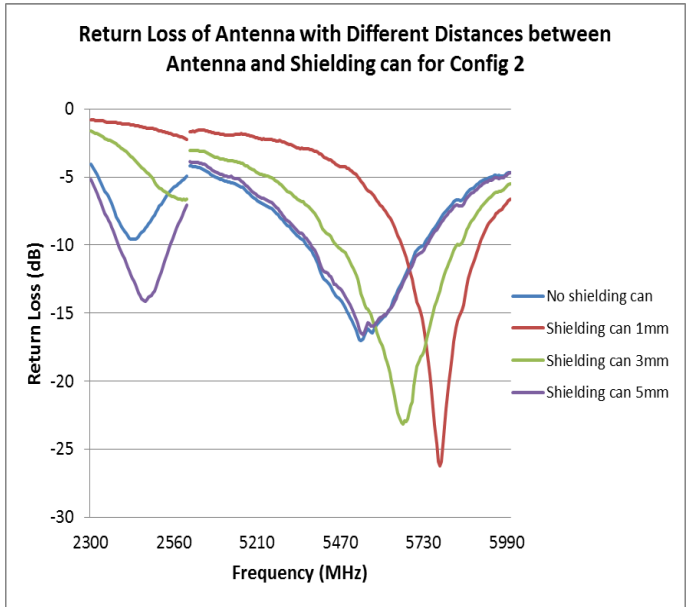
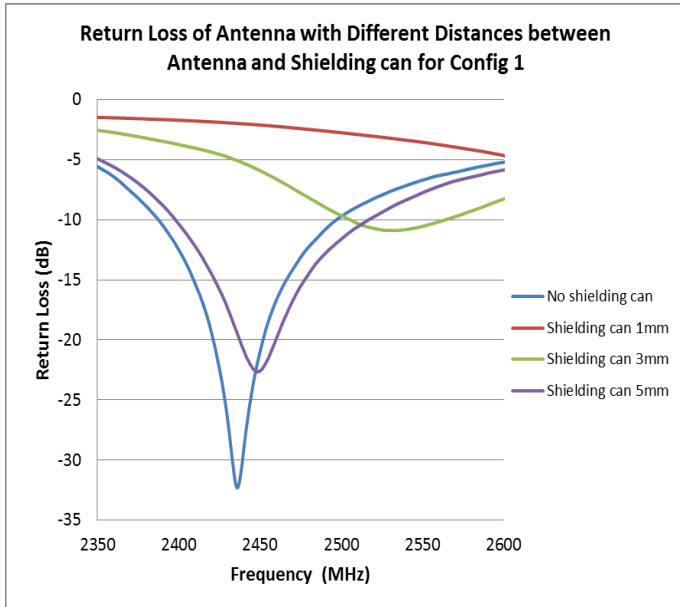


FIGURE 4.1.1 RETURN LOSS COMPARISON AT 2.4/5GHZ OF SHIELDING CAN DISTANCE FROM ANTENNA FOR CONFIG 1 AND CONFIG 2

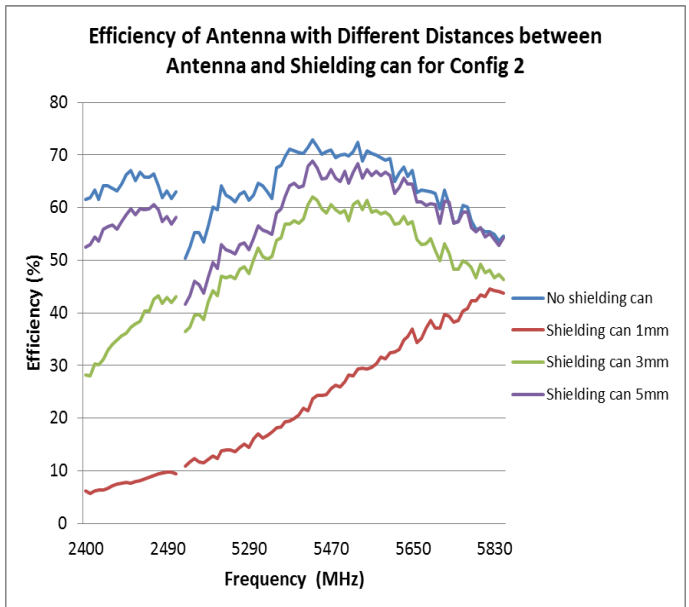
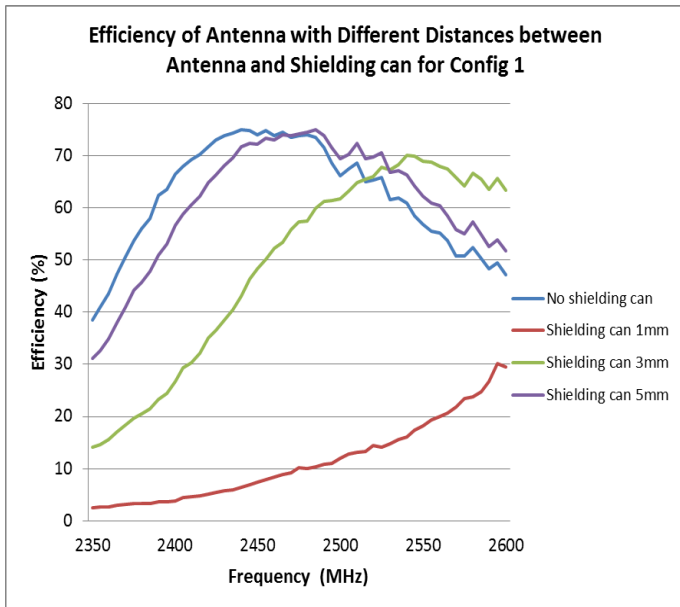


FIGURE 4.1.2 EFFICIENCY COMPARISON AT 2.4/5GHZ OF SHIELDING CAN DISTANCE FROM ANTENNA FOR CONFIG 1 AND CONFIG 2

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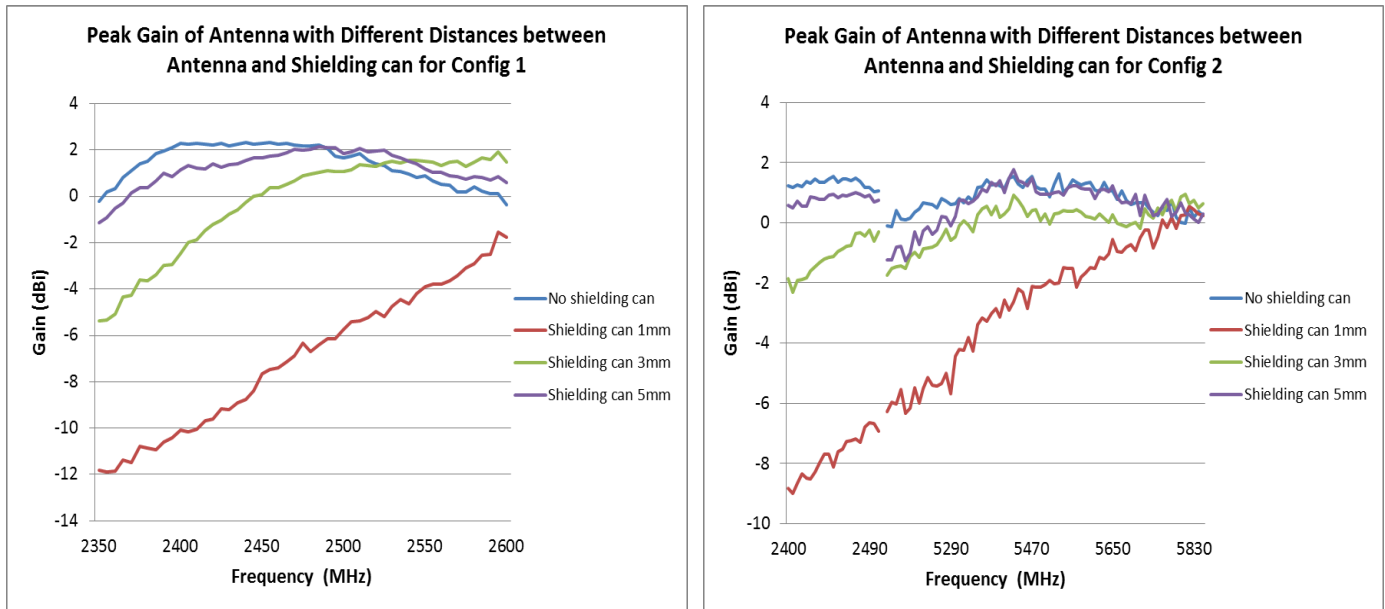


FIGURE 4.1.3 PEAK GAIN COMPARISON AT 2.4/5GHZ OF SHIELDING CAN DISTANCE FROM ANTENNA FOR CONFIG 1 AND CONFIG 2

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4.2 RF PERFORMANCE AS AN EFFECT OF PCB GROUND SIZE

Three kinds of PCB ground sizes have been evaluated and these configurations are shown in figure 4.2. Figure 4.2.1-4.2.3 comparatively shows the return loss, the efficiency, and the peak gain of this antenna with three kinds of PCB for these two configurations.

40mm*20mm is the recommended minimum PCB ground size for this antenna for these two configurations. When the ground size is less than 40mm*20mm, the performance will be significantly decreased.

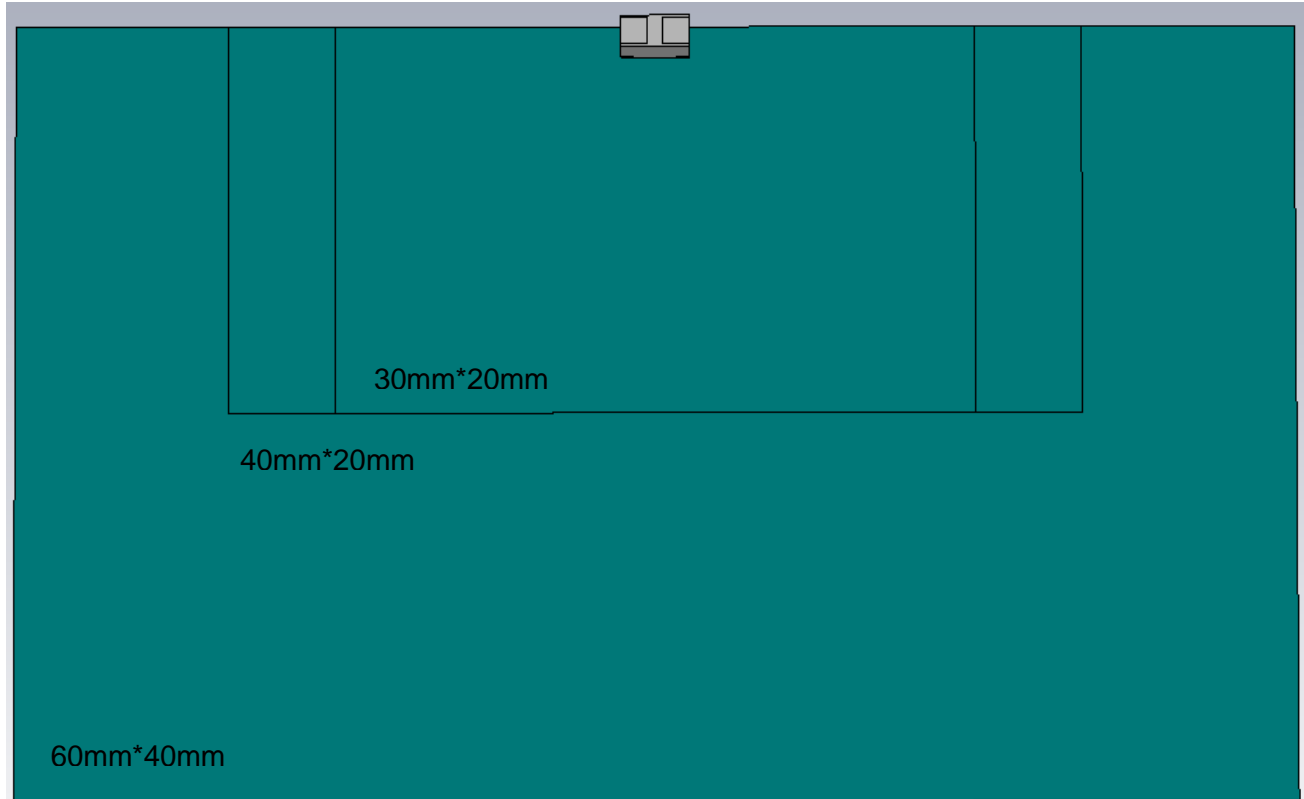


FIGURE 4.2 DIFFERENT GROUND PCB SIZE FOR TWO CONFIGS

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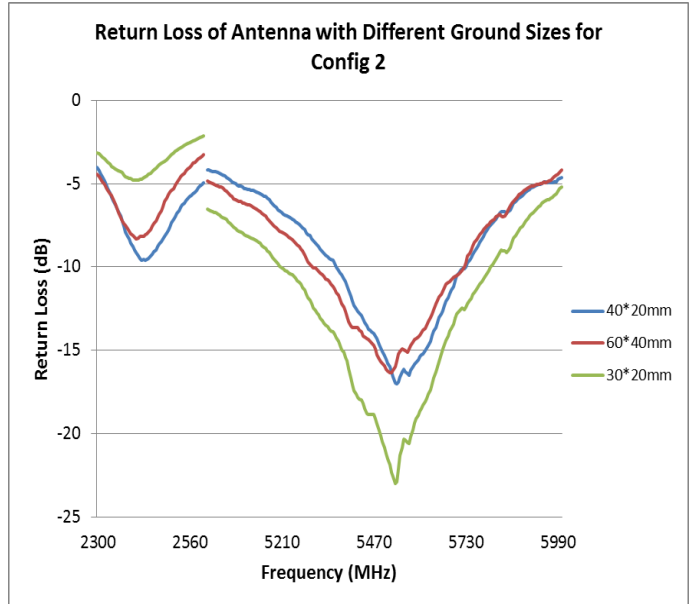
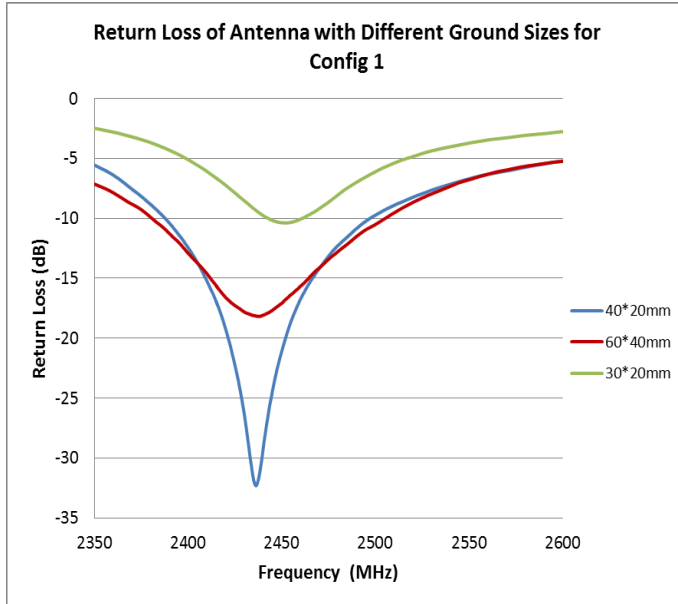
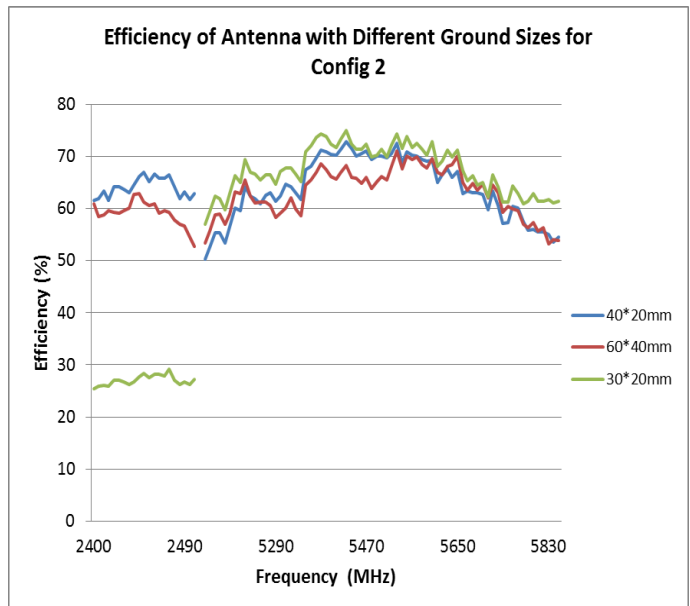
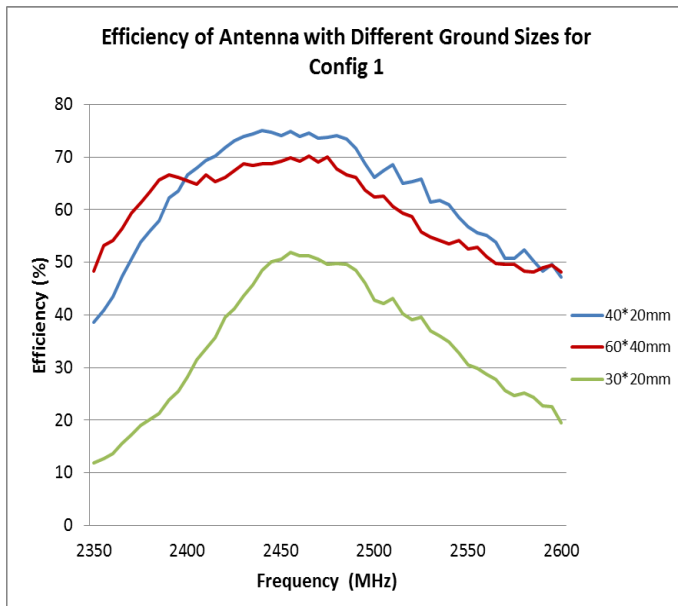


FIGURE 4.2.1 RETURN LOSS COMPARISON AT 2.4/5GHZ OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZES FOR CONFIG 1 AND CONFIG 2



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FIGURE 4.2.2 EFFICIENCY COMPARISON AT 2.4/5GHZ OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZES FOR CONFIG 1 AND CONFIG 2

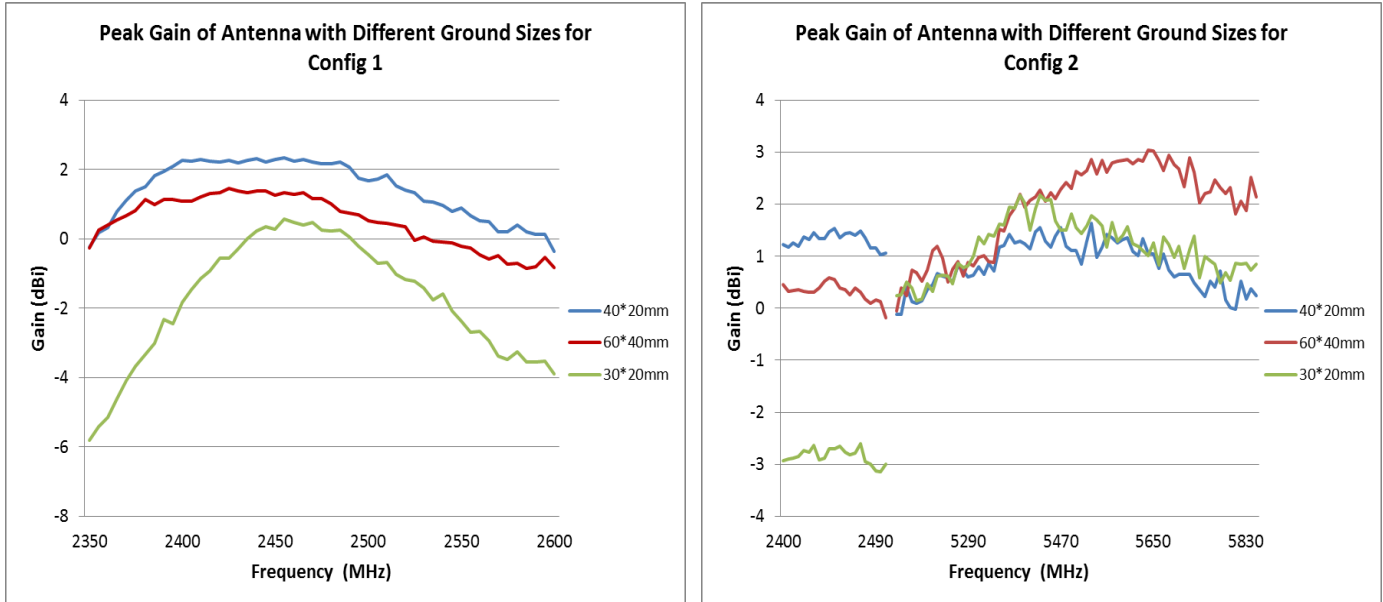


FIGURE 4.2.3 PEAK GAIN COMPARISON AT 2.4/5GHZ OF AN ANTENNA MOUNTED ON DIFFERENT GROUND SIZES FOR CONFIG 1 AND CONFIG 2

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4.3RF PERFORMANCE AS A FUNCTION OF LOCATIONS ON REFERENCE PCB

Two locations for these two configurations 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 performance of the antenna at the two locations have been optimized with matching circuits for these two configurations.

The performances of location 1 are both much better than location 2 for these two configurations. So location 1 (upper center location) is the recommended location for this antenna for these two configurations.

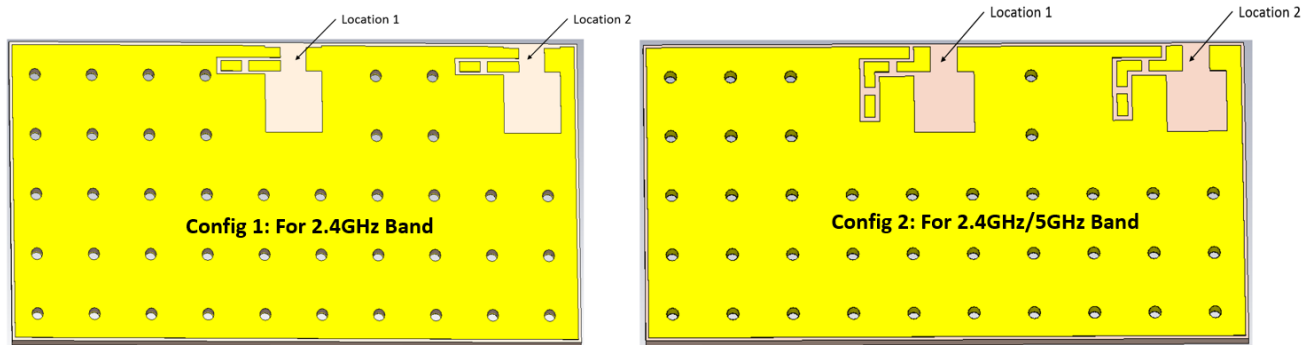


FIGURE 4.3 TWO LOCATIONS ON REFERENCE PCB FOR TWO CONFIGS

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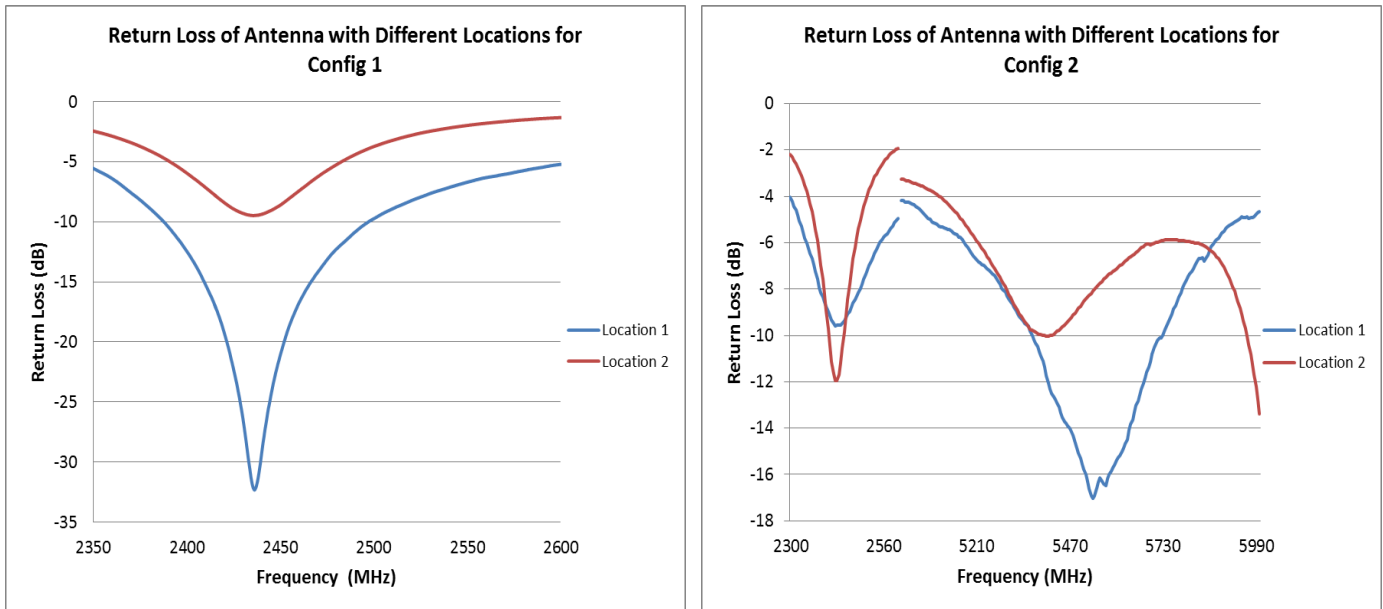


Figure 4.3.1 RETURN LOSS OF ANTENNA AT 2.4GHZ/5GHZ AT TWO DIFFERENT LOCATIONS FOR CONFIG 1 AND CONFIG 2

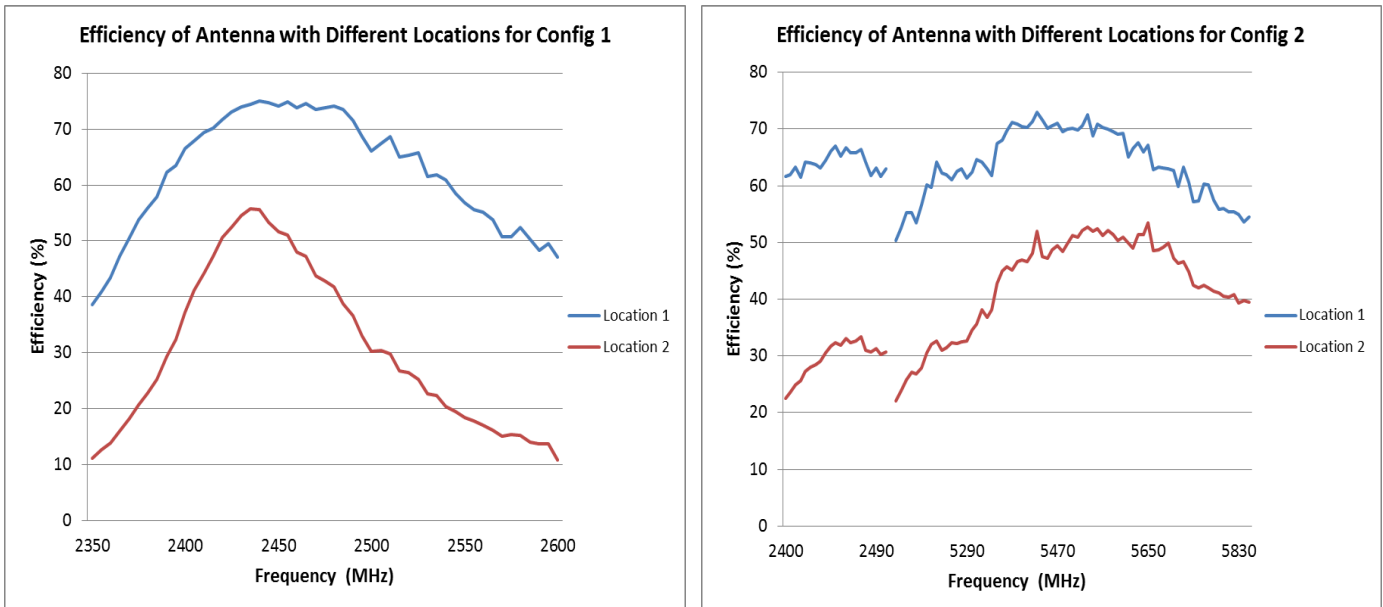


Figure 4.3.2 EFFICIENCY OF ANTENNA AT 2.4GHZ/5GHZ AT TWO DIFFERENT LOCATIONS FOR CONFIG 1 AND CONFIG 2

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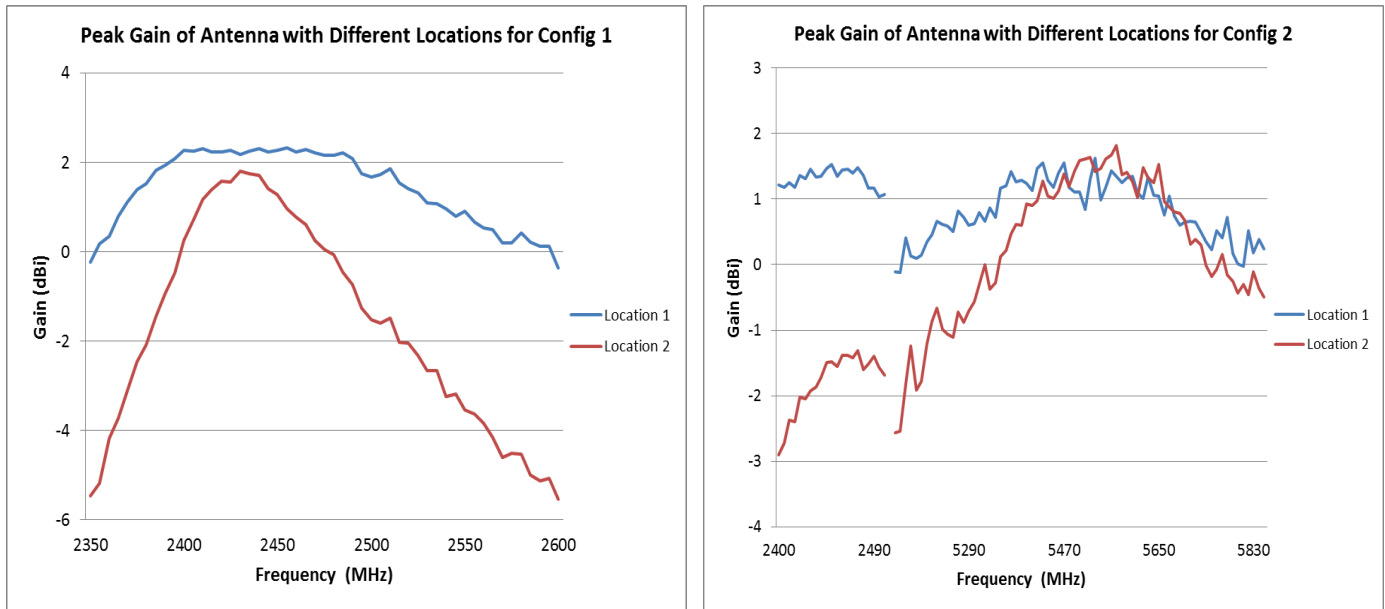


Figure 4.3.3 PEAK GAIN OF ANTENNA AT 2.4GHZ/5GHZ AT TWO DIFFERENT LOCATIONS FOR CONFIG 1 AND CONFIG 2

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5.0 MATCHING NETWORK

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

5.1 MATCHING NETWORK DESCRIPTION FOR CONFIG 1

The “L” type matching circuit is recommended to be applied for this antenna at the recommended position on reference PCB for configuration 1. The sequence of parallel element and series element depends on the resistance of antenna in smith chart shows in Figure 5.1.1. Figure 5.1.2 shows the matching network for this antenna at 2.4GHz at the recommended position on reference PCB. The figure 5.1.3 is the smith chart comparison without and with the matching network for the antenna at 2.4GHz on reference PCB ground size and at reference location. The two red arrows show the smith chart travelling route after using the matching component.

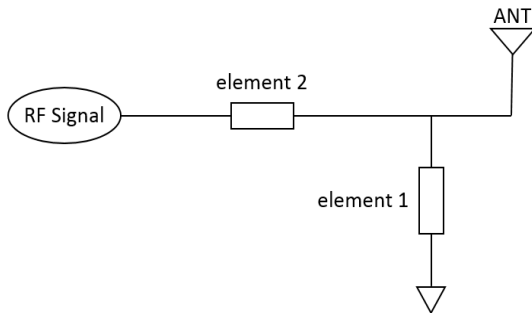


FIGURE 5.1.1 MATCHING CIRCUIT

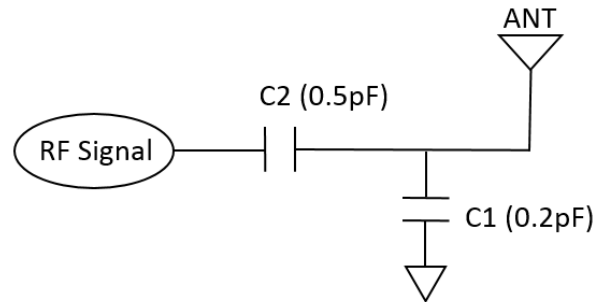


FIGURE 5.1.2 MATCHING COMPONENT FOR CONFIG 1

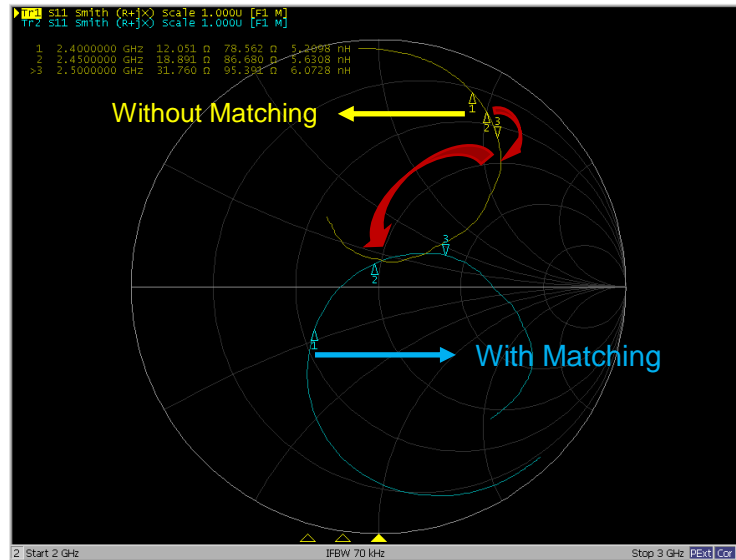


FIGURE 5.1.3 SMITH CHART OF ANTENNA WITHOUT AND WITH MATCHING ON REFERENCE PCB GROUND SIZE AT REFERENCE LOCATION FOR CONFIG 1

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5.2 MATCHING NETWORK DESCRIPTION FOR CONFIG 2

The two “L” type matching circuits are recommended to be applied for this antenna at the recommended position on reference PCB for configuration 2. The combination of these two matching circuits can be applied for both of the two bands(2.4GHz/5GHz) matching at the same time and the sequence of parallel element and series element depends on the resistance of antenna in smith chart shows in Figure 5.2.1. Figure 5.2.2 shows the matching network for this antenna at 2.4GHz/5GHz at the recommended position on reference PCB. The figure 5.2.3 is the 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. The two red arrows show the smith chart travelling route after using the matching component for the two bands (2.4GHz/5GHz).

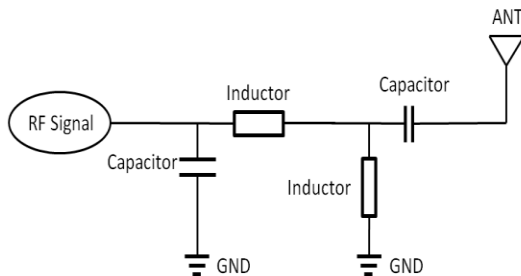


FIGURE 5.2.1 MATCHING CIRCUIT

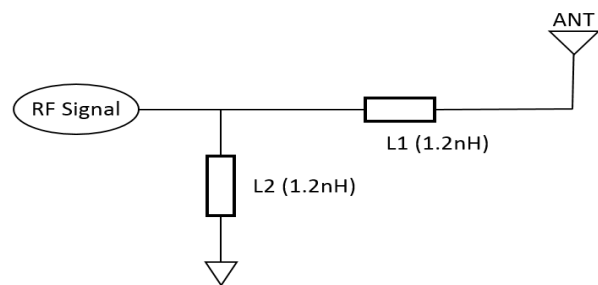


FIGURE 5.2.2 MATCHING COMPONENT FOR CONFIG 2

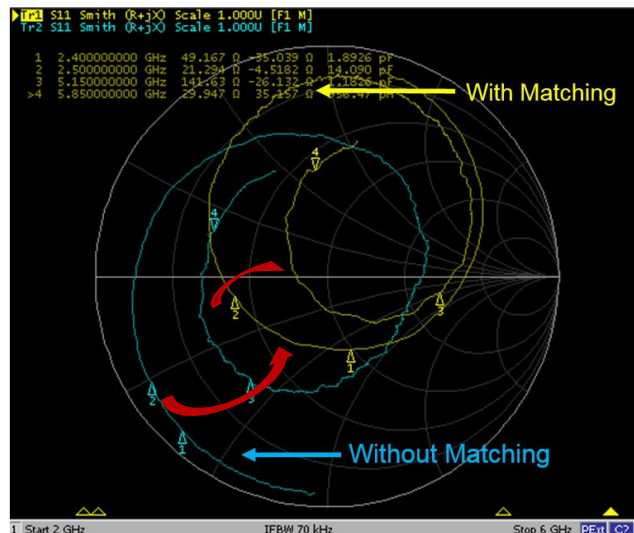


FIGURE 5.2.3 SMITH CHART OF ANTENNA WITHOUT AND WITH MATCHING ON REFERENCE PCB GROUND SIZE AT REFERENCE LOCATION FOR CONFIG 2

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6.0 RADIATION PATTERN

6.1 RADIATION PATTERN FOR CONFIG 1

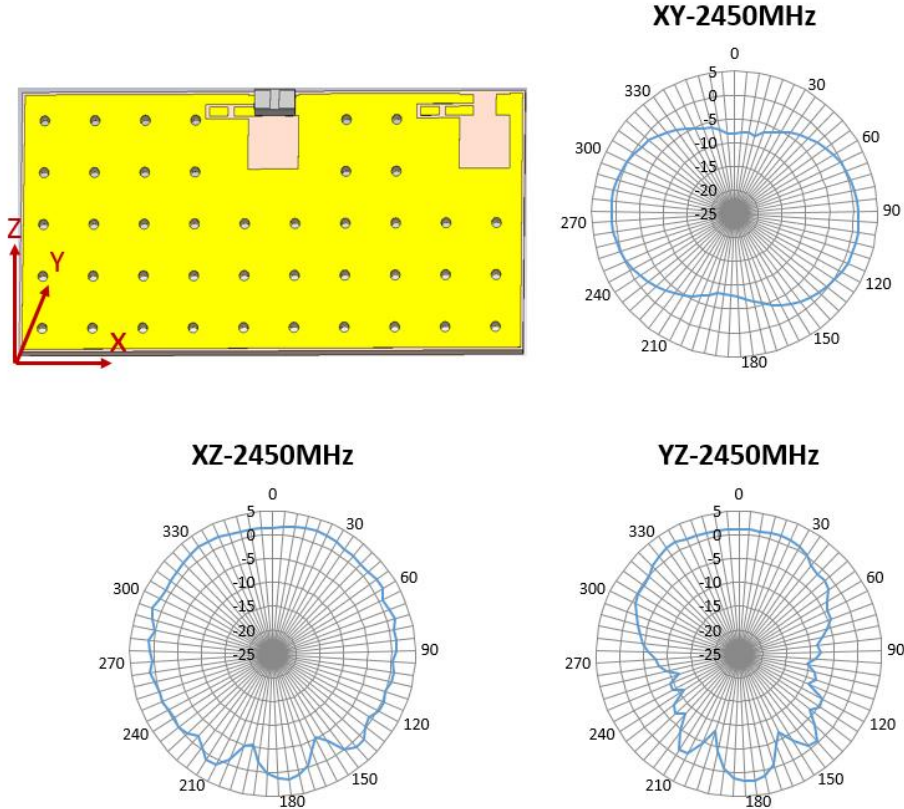


FIGURE 6.1 RADIATION PATTERN OF ANTENNA AT 2.45GHZ AT RECOMMENDED LOCATION FOR CONFIG 1

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6.2 RADIATION PATTERN FOR CONFIG 2

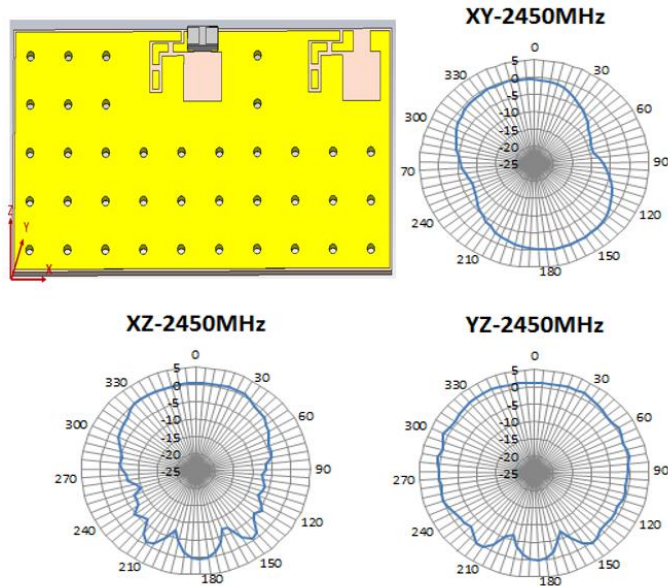


FIGURE 6.2.1 RADIATION PATTERN OF ANTENNA AT 2.45GHZ AT RECOMMENDED LOCATION FOR CONFIG 2

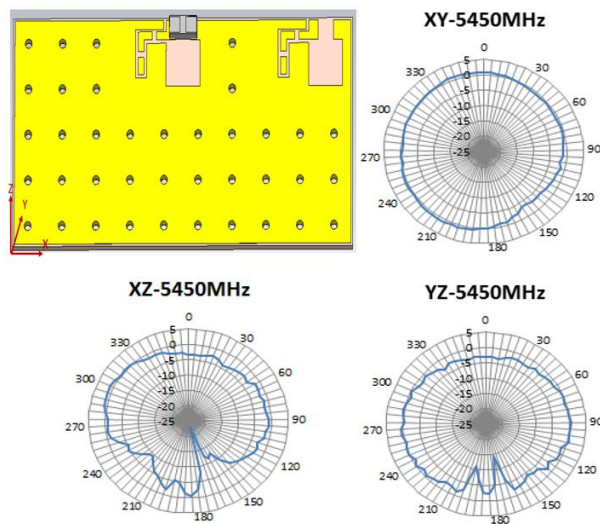


FIGURE 6.2.2 RADIATION PATTERN OF ANTENNA AT 5.45GHZ AT RECOMMENDED LOCATION FOR CONFIG 2

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7.0 ASSEMBLY INSTRUCTIONS

A. RECOMMENDED SMT REFLOW PROFILE

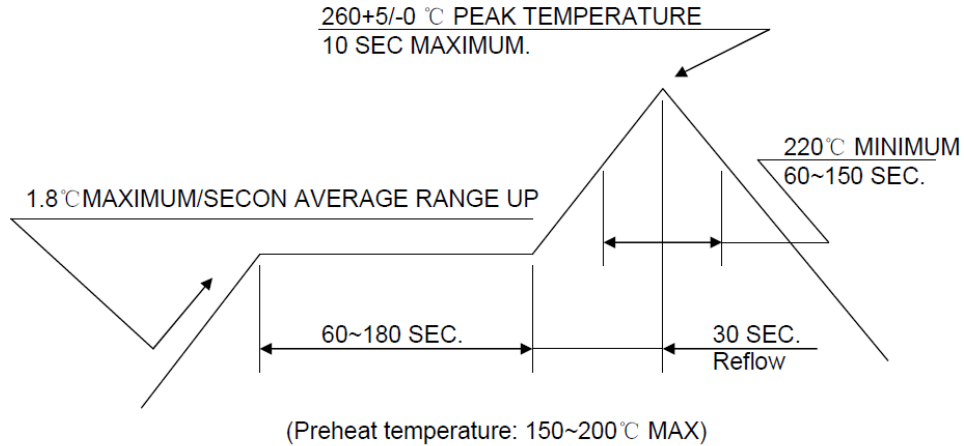


FIGURE 7.1 RECOMMENDED SMT REFLOW PROFILE

B. MECHANICAL INTERFACE

I. GENERAL DESCRIPTION

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

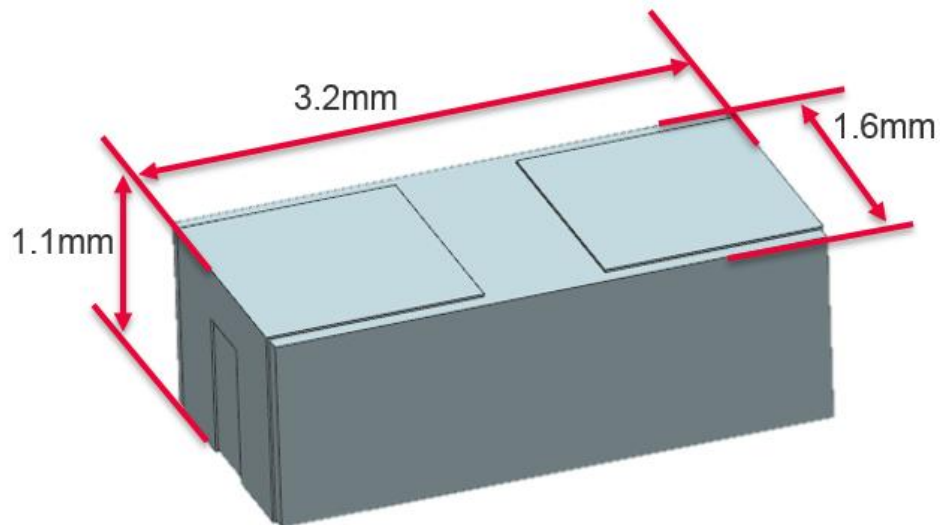


FIGURE 7.2 OVERALL ANTENNA SIZE

| | | | |
|--|---|--|--|
| REVISION: B | ECR/ECN INFORMATION: EC No: 115005 DATE: 2017/07/13 | TITLE: 2.4GHz/5GHz Ceramic SMT Antenna Application Specification | SHEET No. 19 of 20 |
| DOCUMENT NUMBER: AS-2030060001 | CREATED / REVISED BY: Benson Liu 2017/07/13 | CHECKED BY: Chris Zhong 2017/07/13 | APPROVED BY: Welson Tan 2017/07/13 |

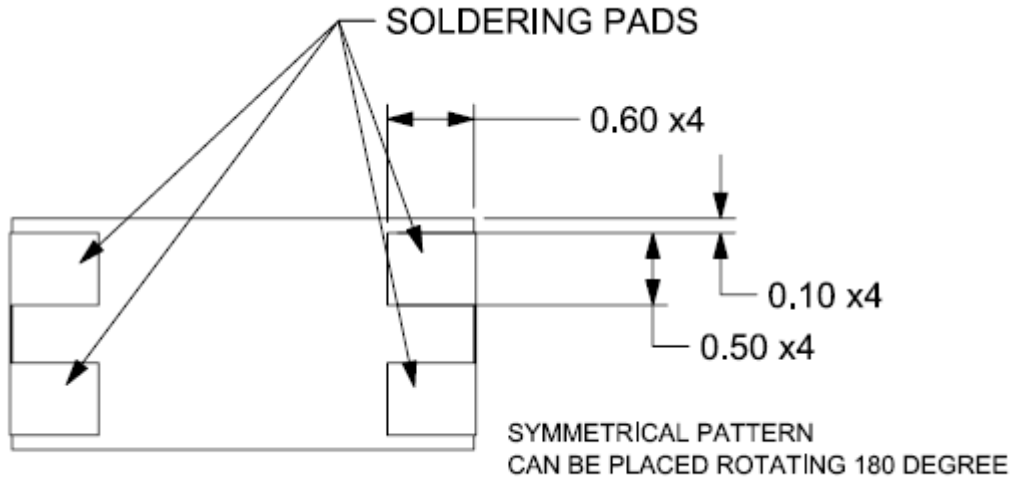


FIGURE 7.3 PADS OF PRODUCT FOR SOLDERING

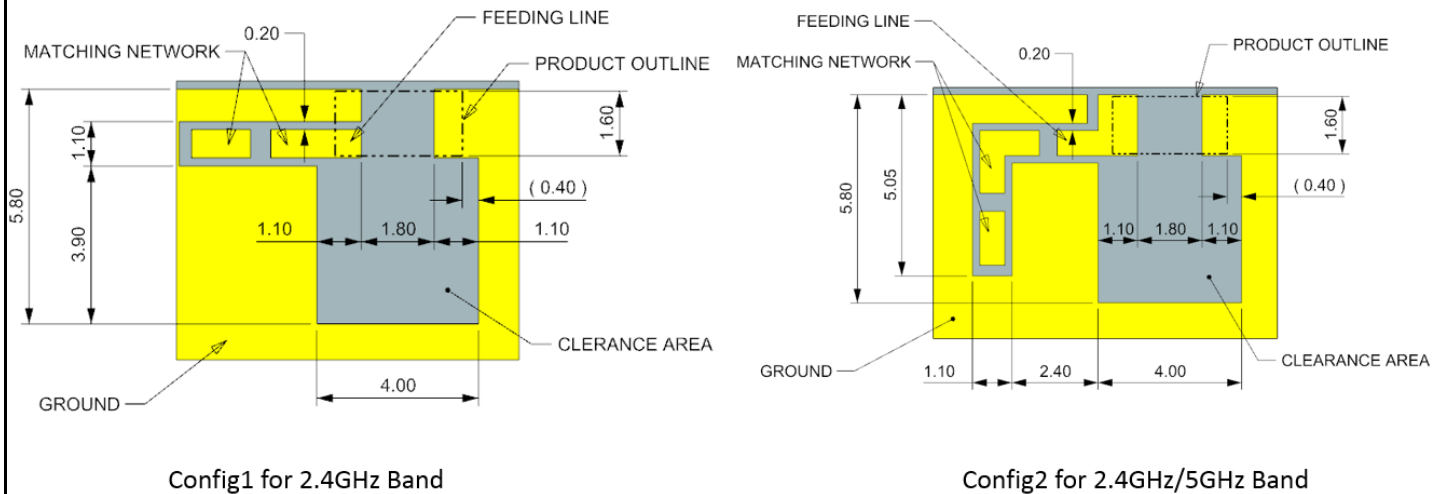


FIGURE 7.4 RECOMMENDED FOOTPRINT ON PCB FOR SOLDERING

| | | | |
|---|---|--|--|
| REVISION: B | ECR/ECN INFORMATION: EC No: 115005 DATE: 2017/07/13 | TITLE: 2.4GHz/5GHz Ceramic SMT Antenna Application Specification | SHEET No. 20 of 20 |
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| <small>TEMPLATE FILENAME: APPLICATION_SPEC[SIZE_A](V.1).DOC</small> | | | |