



APPLICATION SPECIFICATION

2.4/5GHz SMT CHIP ANTENNA

1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Molex 2.4/5 GHz SMT Chip 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 3mm* 5mm*4mm (Width*Length*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.

5. PICK AND PLACE FEATURE

To enable the antenna to be picked up by SMT machine pick up nozzle.

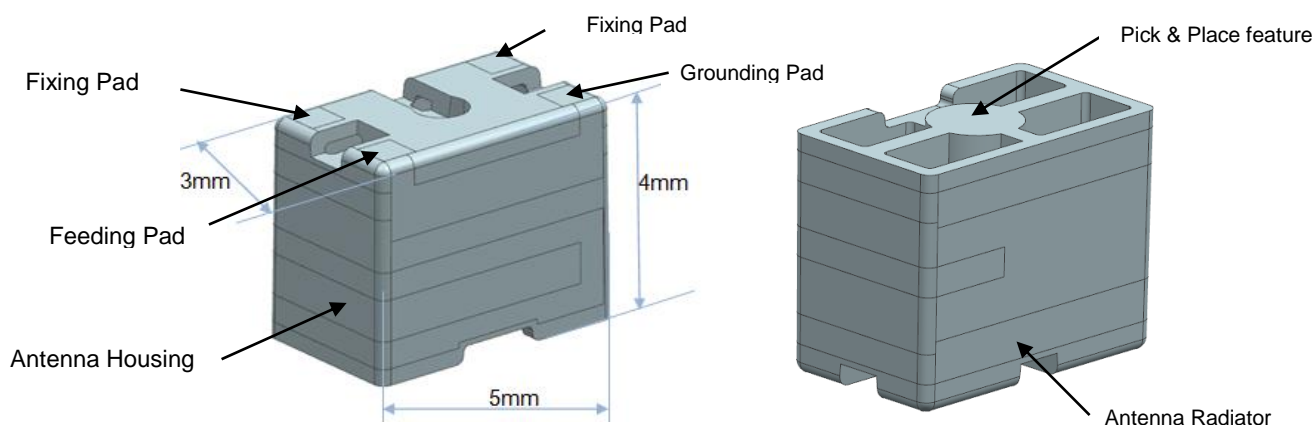


FIGURE 1. 2.4/5GHz SMT CHIP ANTENNA

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AS-146175-001	Benson Liu	Hai Liu	Chris Zhong

B. REFERENCE IMPLEMENTATION

I. REFERENCE PCB DESCRIPTION

The reference design is based on a recommended double sided PCB size of 100 mm * 40 mm * 1 mm. There are one feeding pad, one grounding pad and two fixing pads.

Furthermore there is a “ π ” type matching network reserved close to feeding pad. The PCB ground should be at least 1mm far away from antenna pads. See figure 2 and 3.1.

1. FEEDING PAD

The signal from 50ohm 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

Recommended to reserve PCB space for a “ π ” type matching circuit in case it should be necessary to adjust the return loss due to loading by the device housing and surrounding components.

II. REFERENCE PCB LAYOUT

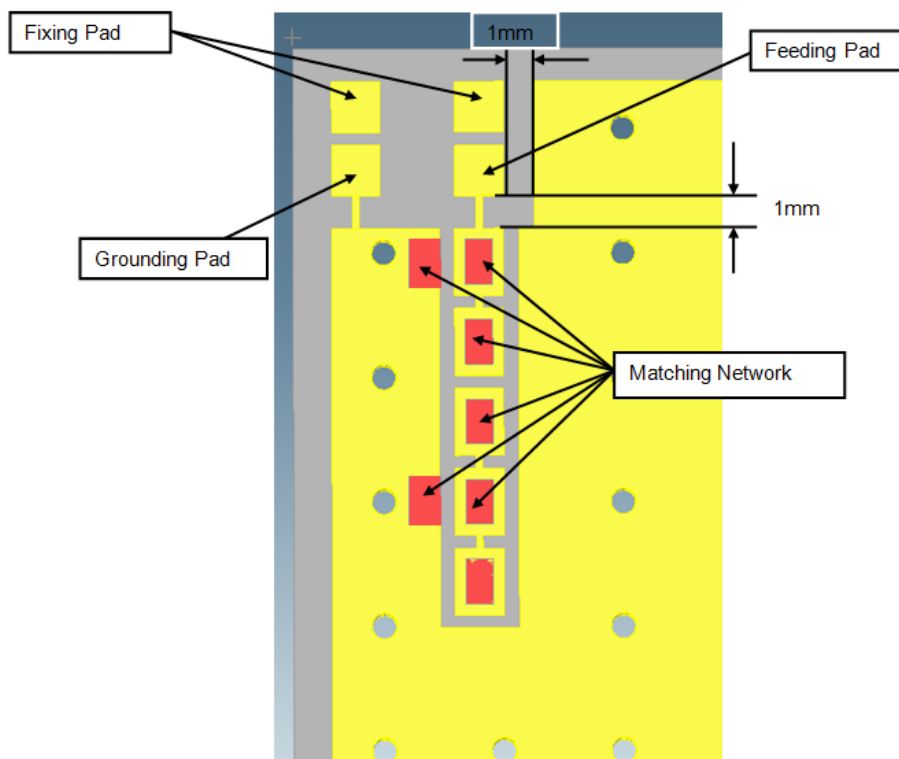


FIGURE 2: RECOMMENDED PCB LAYOUT
FIXED DO NOT GROUND
 (Note: PCB size of 100 mm x 40 mm)

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III. PERFORMANCE AT REFERENCE ANTENNA LOCATION

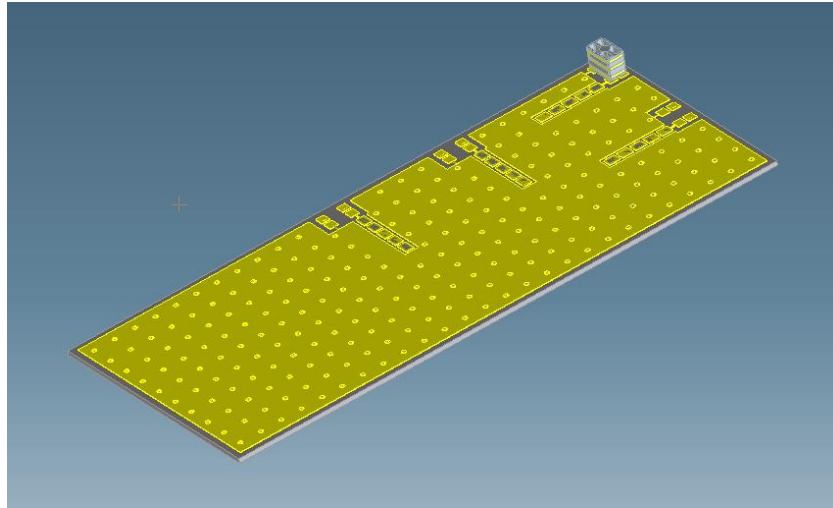


Figure 3.1 REFERENCE ANTENNA LOCATION

The reference antenna location is at the corner of the PCB as shown in Figure 3.1.

DESCRIPTION	TEST CONDITION	REQUIREMENTS	
Frequency Range	Measure antenna on recommended PCB through VNA E5071C	2.4~2.5GHz	5.15~5.85GHz
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	3dBi	4.2dBi
Total Efficiency	Measure antenna on recommended PCB through OTA chamber	>70%	>70%
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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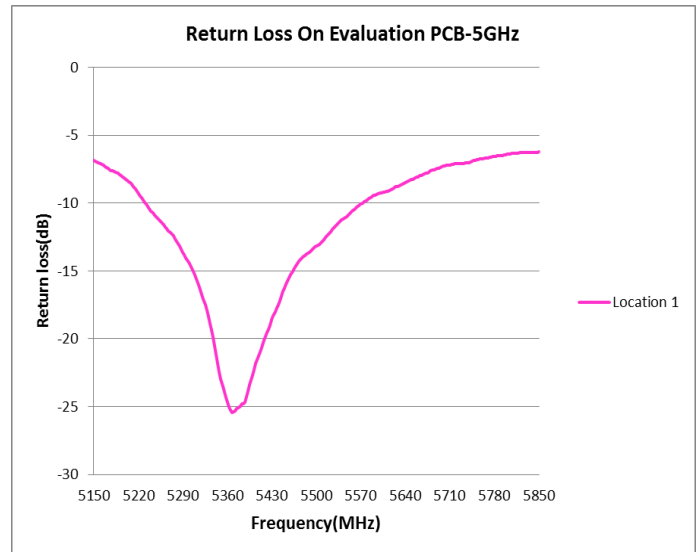
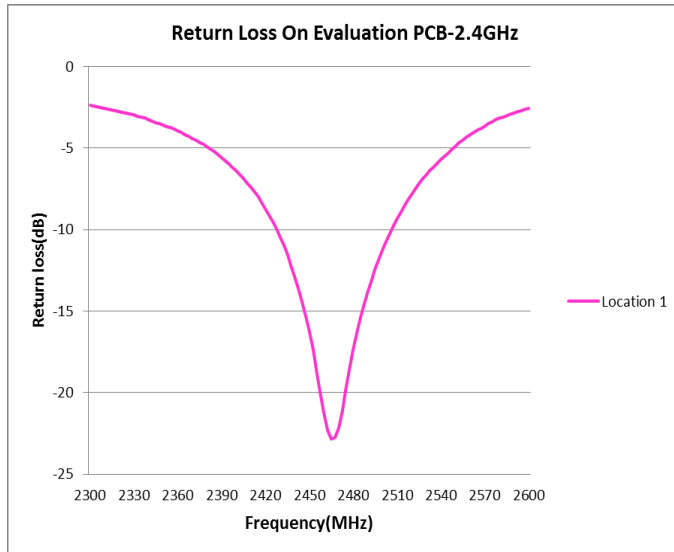


FIGURE 3.2 RETURN LOSS OF ANTENNA AT 2.4/5GHZ BAND AT REFERENCE LOCATION

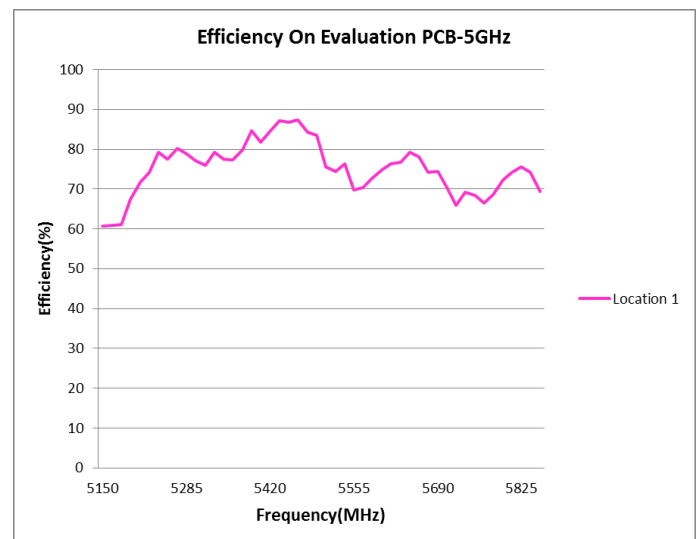
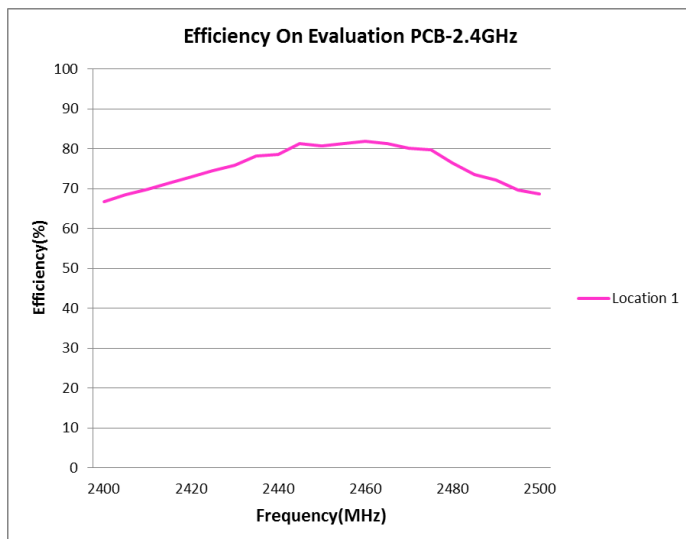


FIGURE 3.3 EFFICIENCY OF ANTENNA AT 2.4/5GHZ BAND AT REFERENCE LOCATION

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3.0 REFERENCE DOCUMENTS

- Engineering Drawing :AS-146175-001
- Product Specification: PS-146175-001
- 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 LOCATION ON THE PCB

RF performance of antenna at four locations has been evaluated and these locations are shown in figure 4.1. Figure 4.2 and Figure 4.3 comparatively present the return loss and efficiency at 2.4GHz band while Figure 4.4 and Figure 4.5 comparatively show the return loss and efficiency at 5GHz band at four locations. The entire tests are without any matching network.

The location which gives the best RF performance is location 1. Location 1 (corner location) is the recommended location for the antenna.

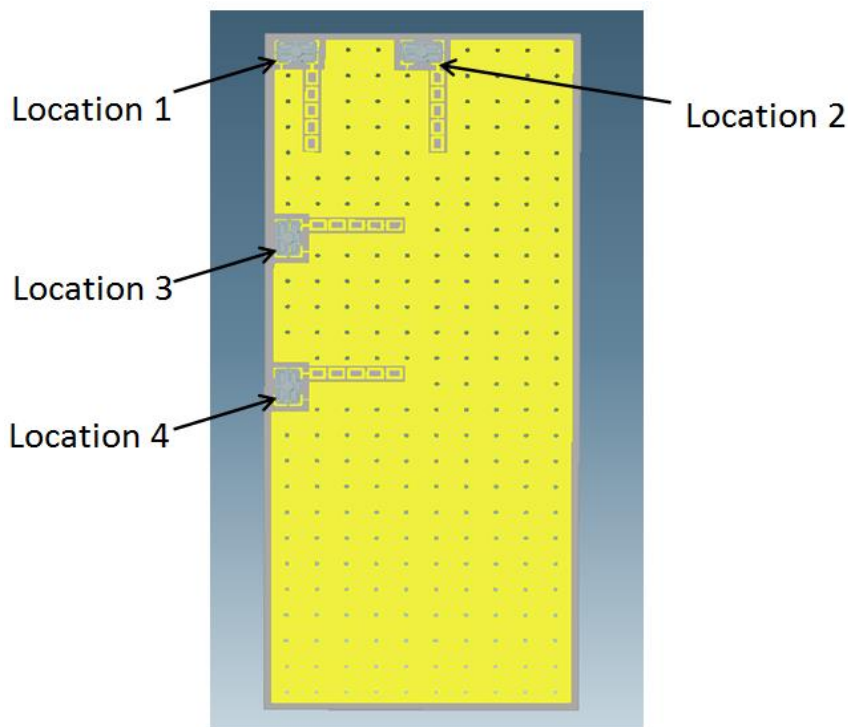


FIGURE 4.1 FOUR LOCATIONS ON REFERENCE PCB

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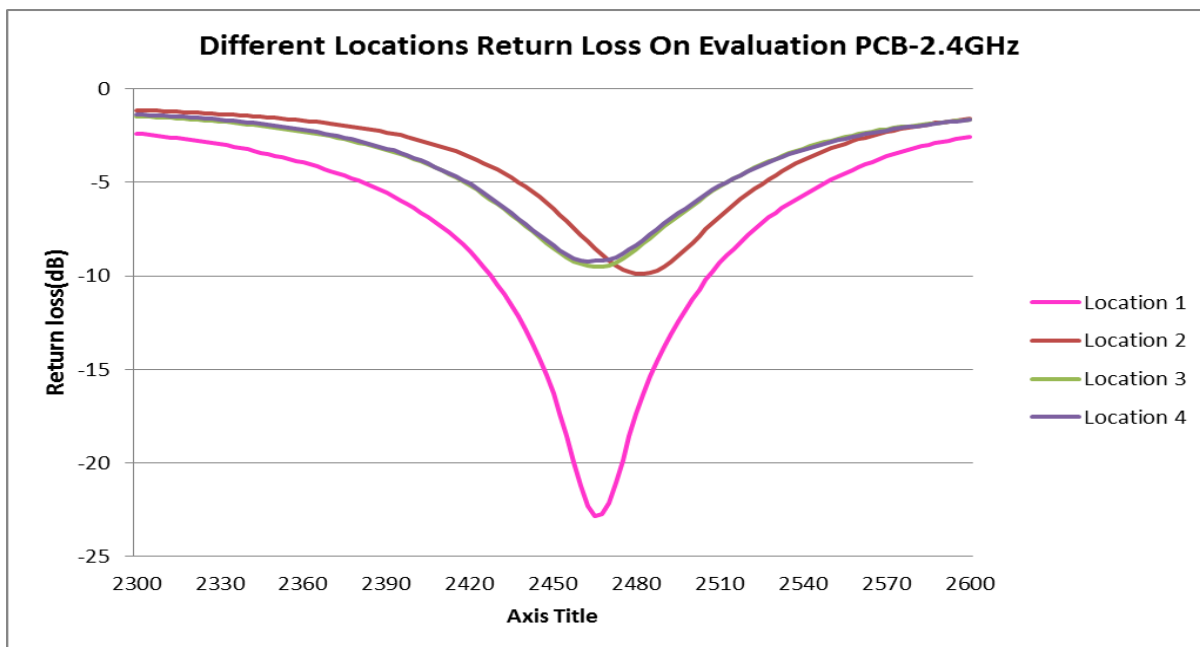


Figure 4.2 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS

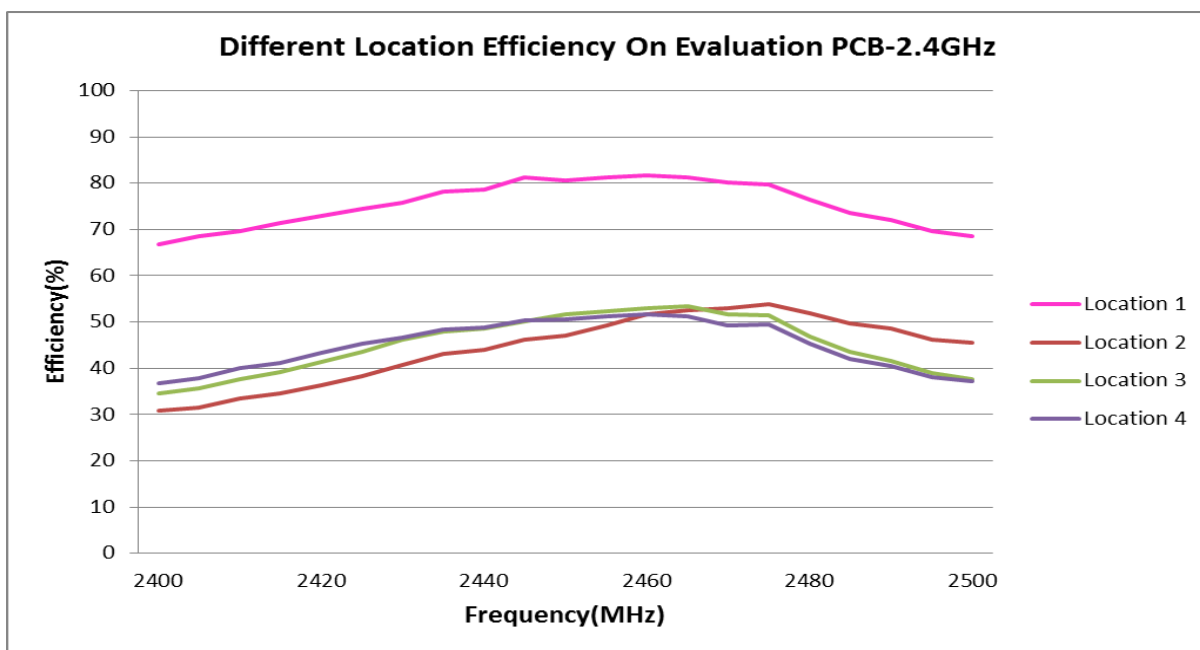


Figure 4.3 EFFICIENCY OF ANTENNA AT 2.4GHZ BAND AT FOUR LOCATIONS

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



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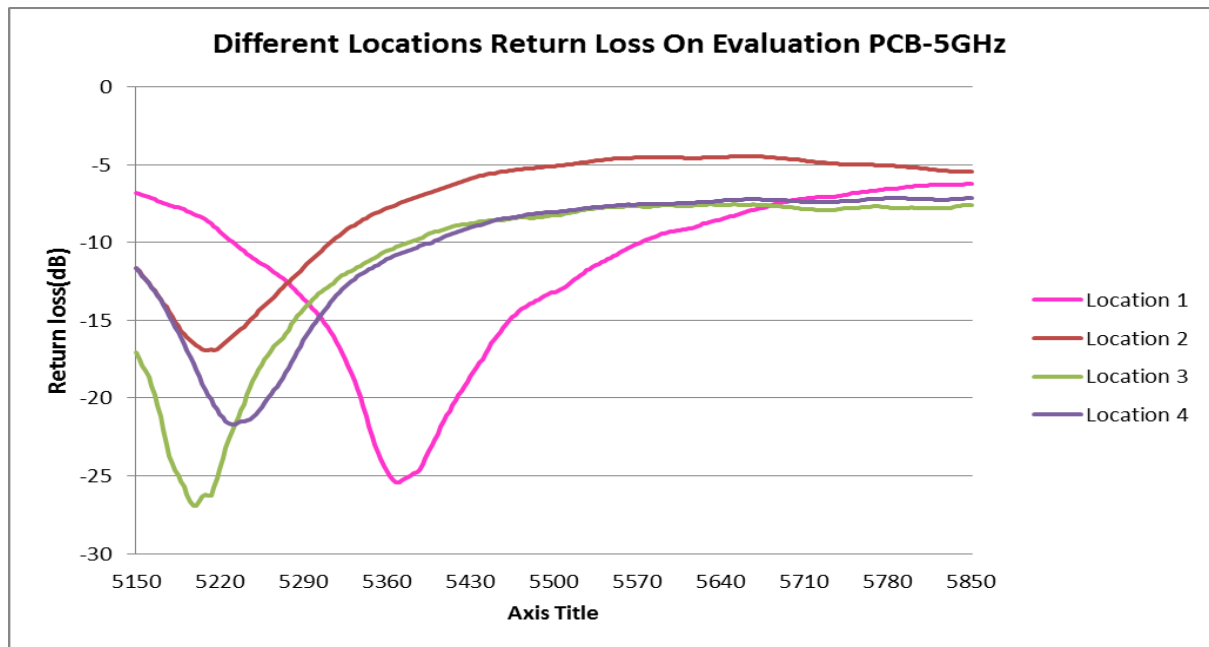


Figure 4.4 RETURN LOSS OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS

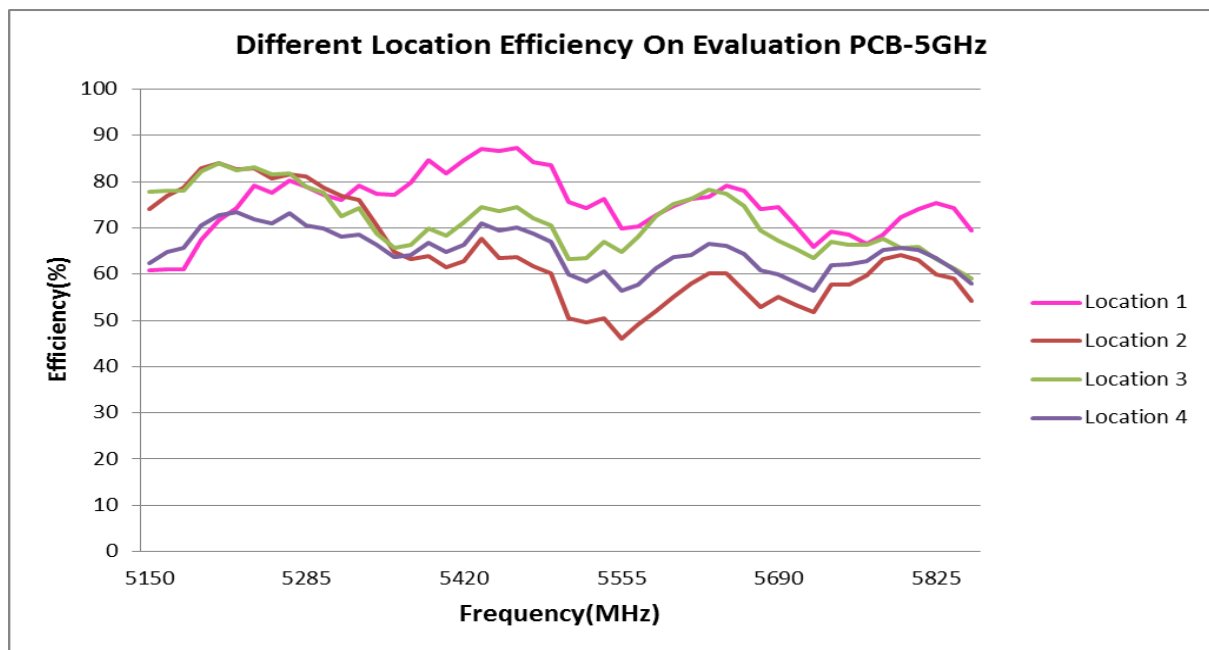


Figure 4.5 EFFICIENCY OF ANTENNA AT 5GHZ BAND AT FOUR LOCATIONS

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4.0.2 ANTENNA RF PERFORMANCE INFLUENCED BY NEARBY SHIELDING CAN

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

From the study, we can say that a shielding can (30mm x 30mm x 2mm) 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 4.7- 4.10.

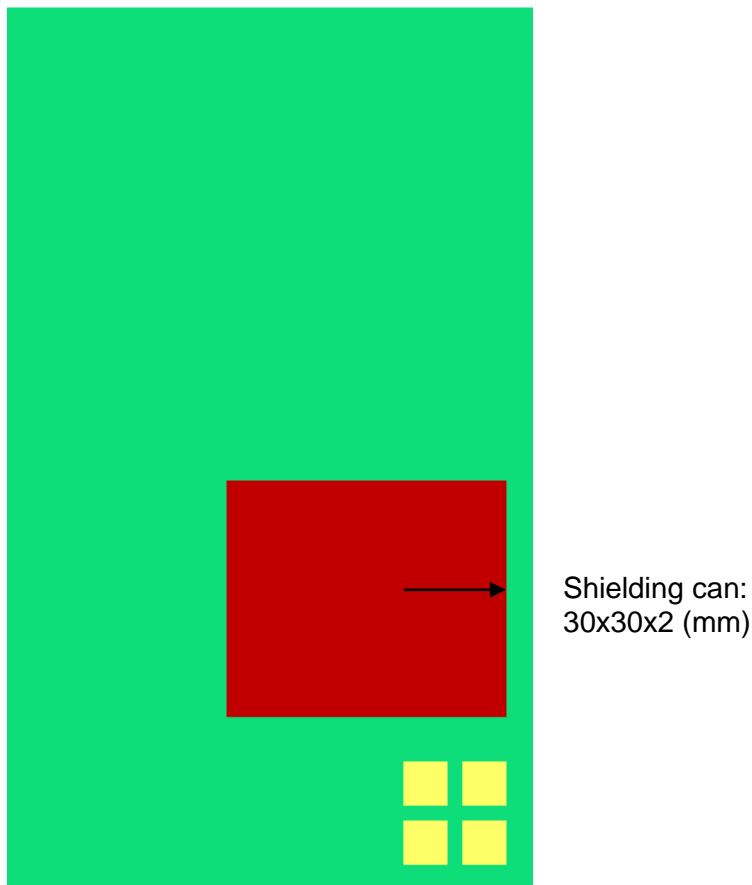


Figure 4.6 SHIELDING CAN FIXED ON REFERENCE PCB

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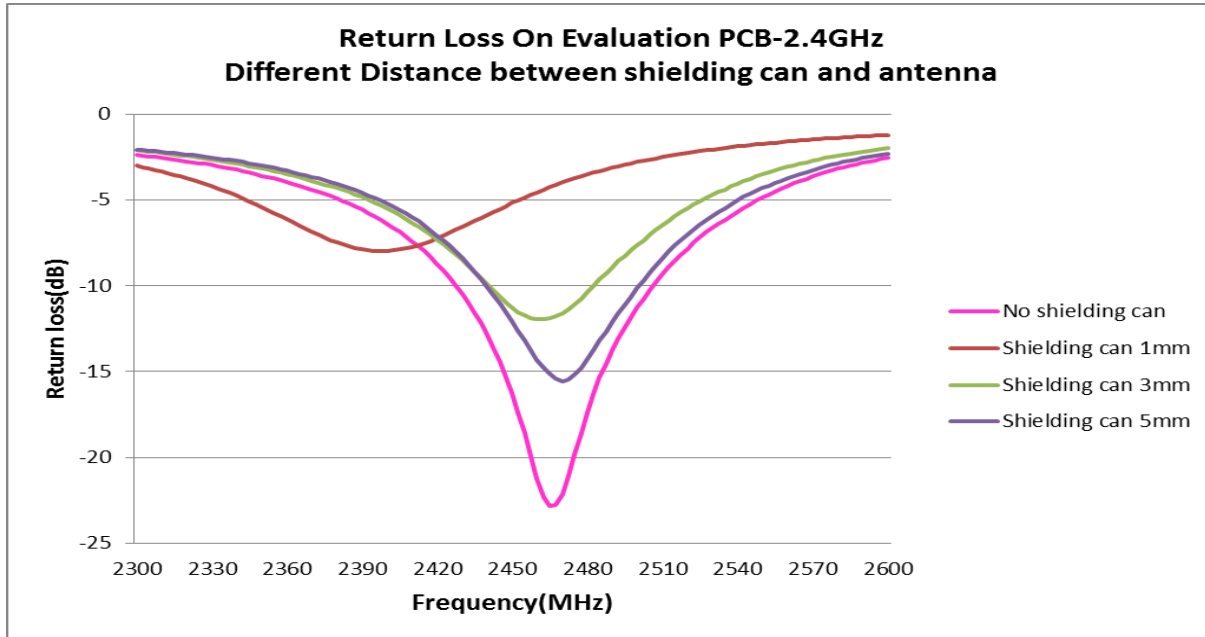


FIGURE 4.7 RETURN LOSS COMPARISON AT 2.4 GHZ BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

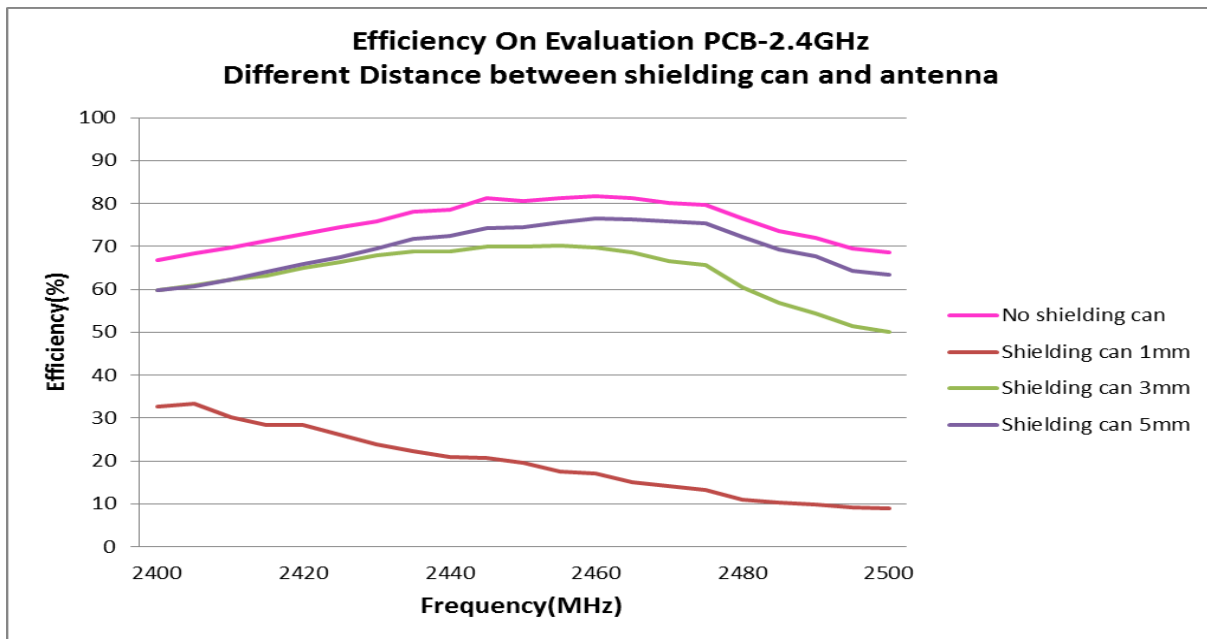


FIGURE 4.8 EFFICIENCY COMPARISON AT 2.4 GHZ BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

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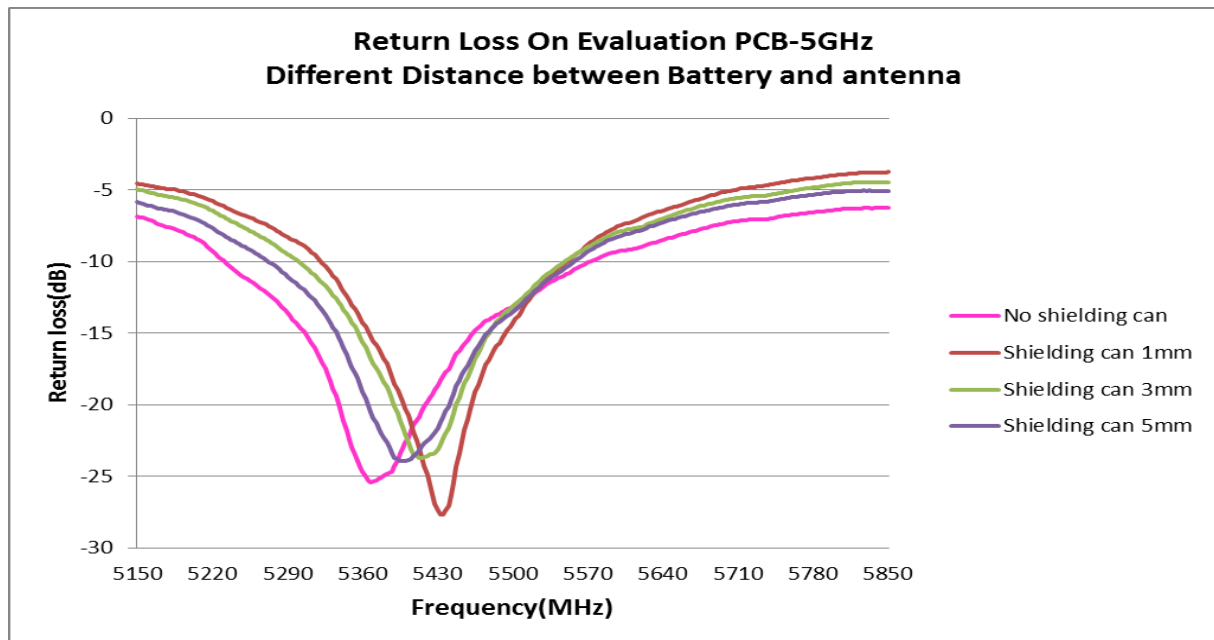


FIGURE 4.9 RETURN LOSS COMPARISON AT 5 GHZ BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

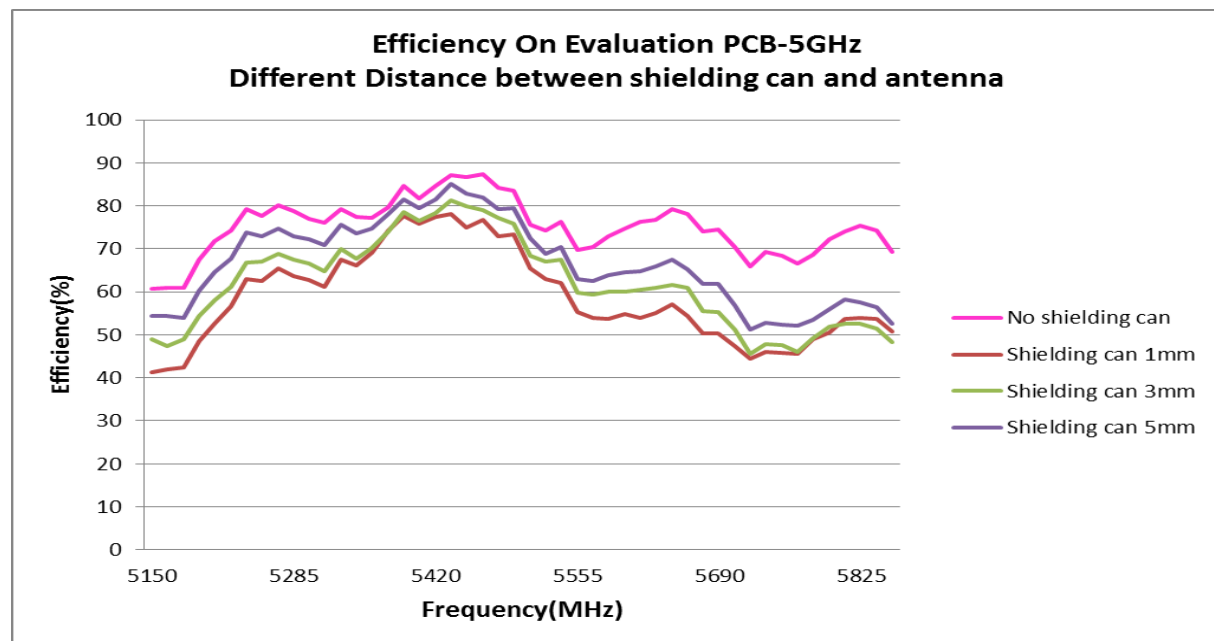


FIGURE 4.10 RETURN LOSS COMPARISON AT 5 GHZ BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

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4.0.3 RF PERFORMANCE INFLUENCED BY NEARBY BATTERY

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

From the study, we can say that a battery (30mm x 60mm x 3mm) 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 4.12-4.15.

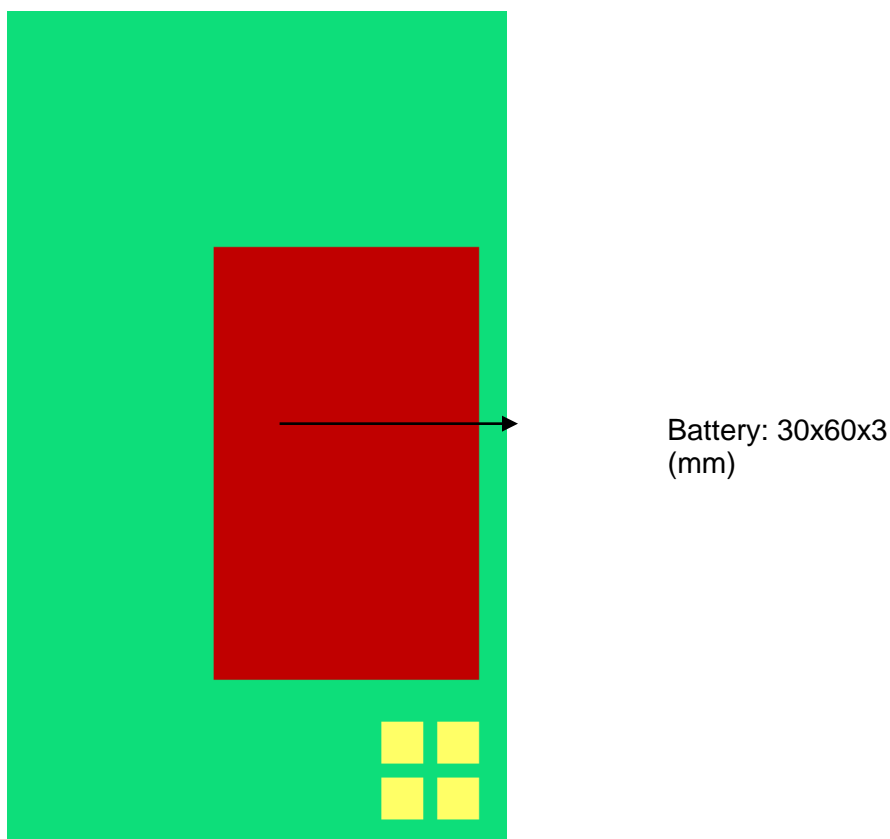


FIGURE 4.11 BATTERY FIXED ON REFERENCE PCB

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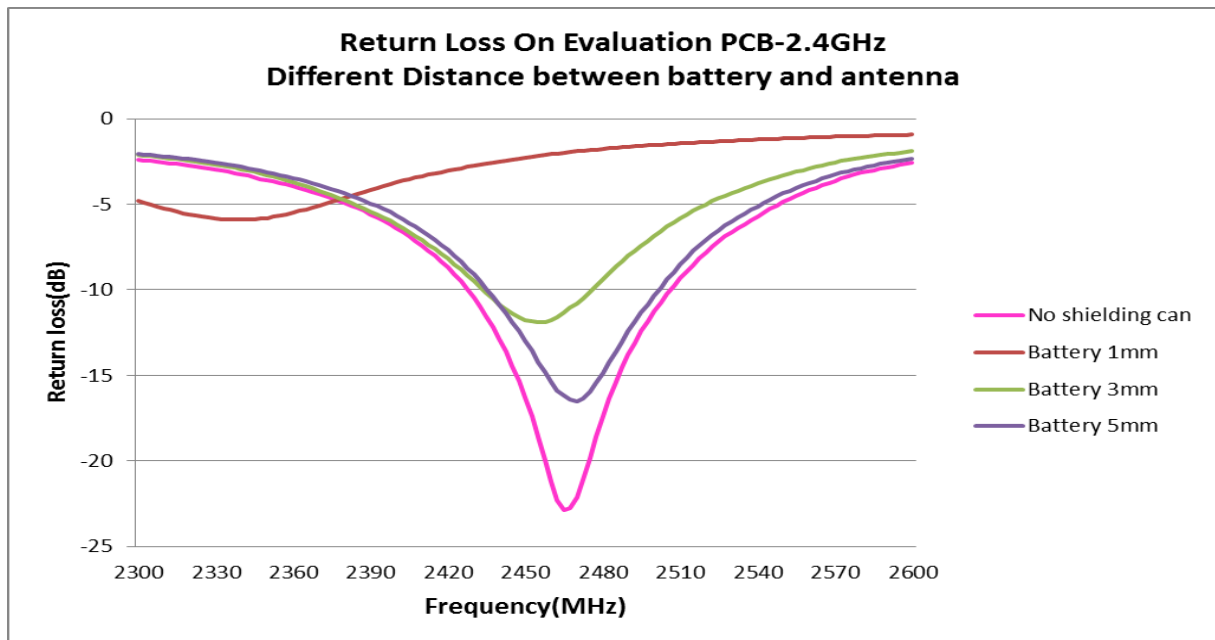


FIGURE 4.12 RETURN LOSS COMPARISON AT 2.4 GHZ BAND OF BATTERY DISTANCE FROM ANTENNA

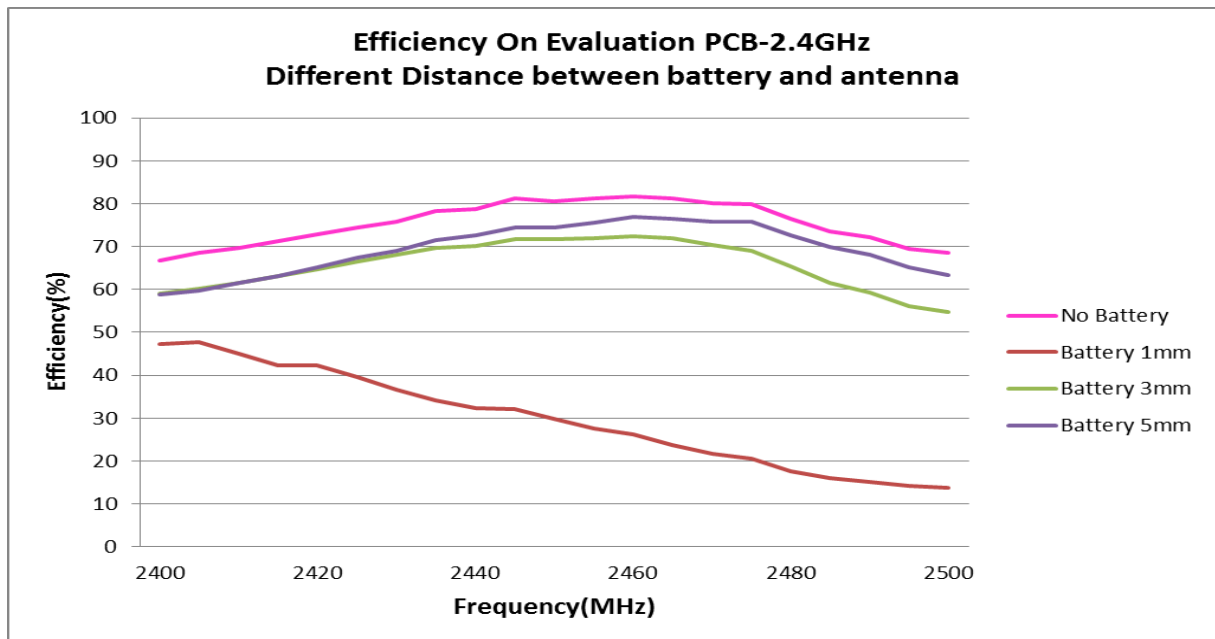


FIGURE 4.13 EFFICIENCY COMPARISON AT 2.4 GHZ BAND OF BATTERY DISTANCE FROM ANTENNA

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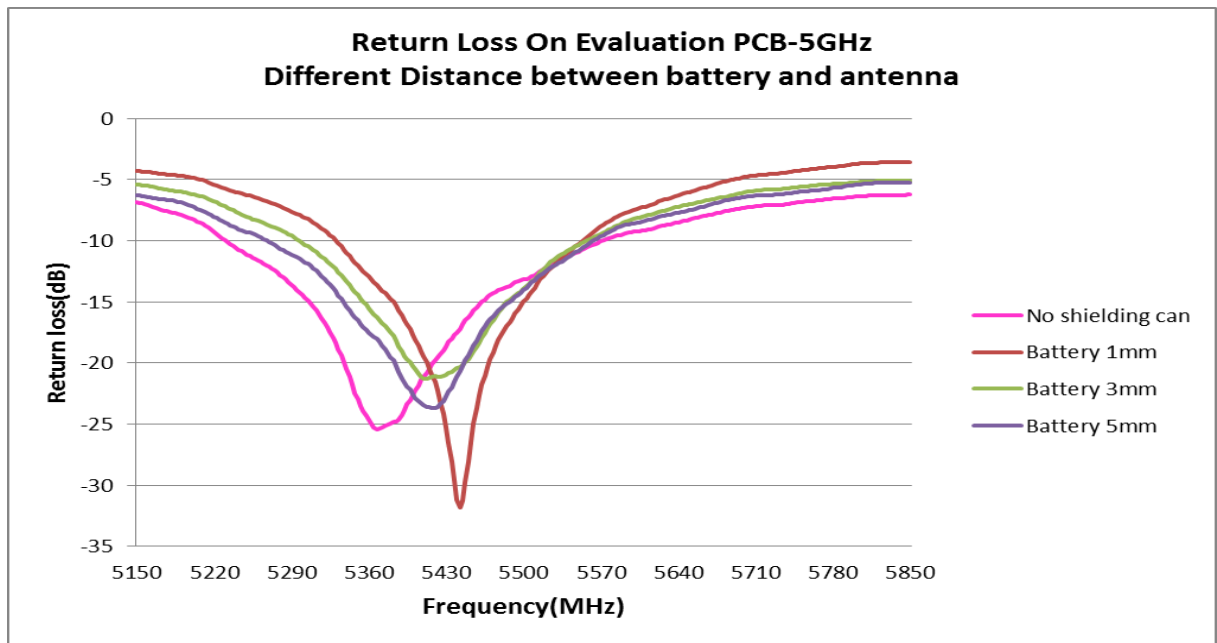


FIGURE 4.14 RETURN LOSS COMPARISON AT 5 GHZ BAND OF BATTERY DISTANCE FROM ANTENNA

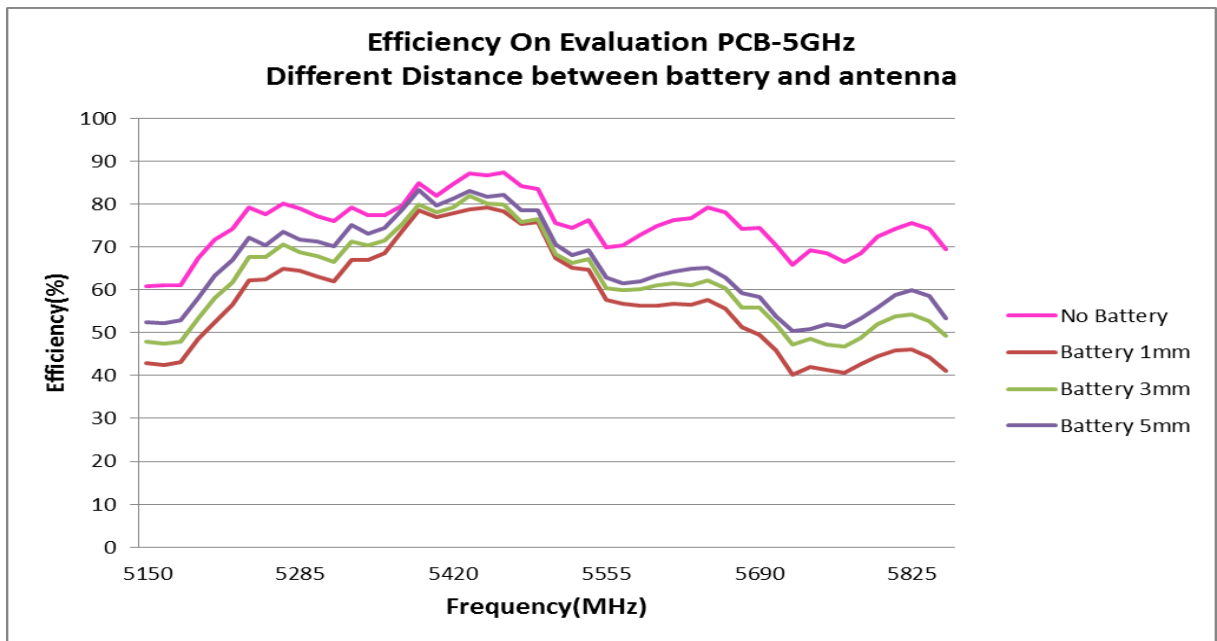


FIGURE 4.15 EFFICIENCY COMPARISON AT 5 GHZ BAND OF BATTERY DISTANCE FROM ANTENNA

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5.0 MATCHING NETWORK DESCRIPTION

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 5.1 and Figure 5.2 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 5.3.

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 5.3.

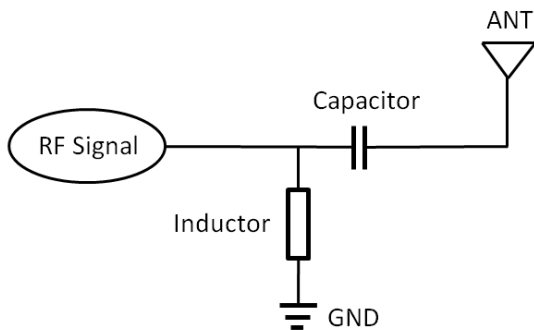


FIGURE 5.1 CONFIG 1 FOR 2.4GHZ BAND

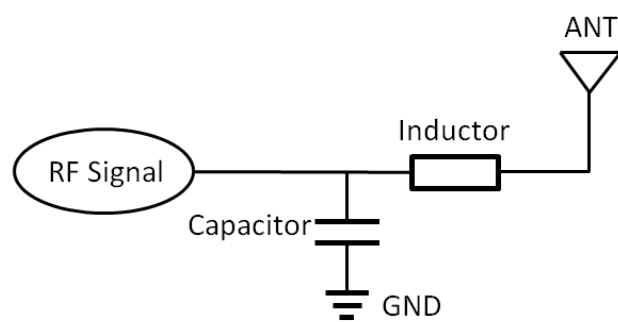


FIGURE 5.2 CONFIG 2

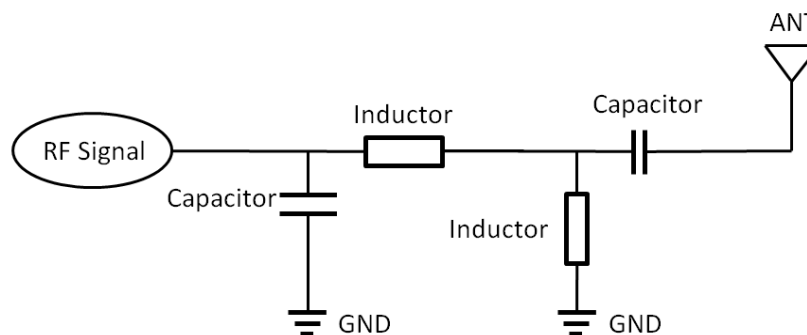


FIGURE 5.3 MATCHING TOPOLOGY FOR BOTH 2.4 GHZ AND 5 GHZ BAND

The following two examples are used for better understanding of the matching network.

Case 1 is applied for explaining 2.4GHz band matching. Figure 5.4 and Figure 5.5 comparatively show the return loss and smith chart of this antenna with and without matching. The matching network is a series capacitor, whose value is 3.3pF. After matching, the performance at 2.4GHz band becomes better than before while there is no obvious influence on 5GHz band.

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Case 2 is applied for explaining 5GHz band matching. Figure 5.6 and Figure 5.7 comparatively show the return loss and smith chart of this antenna with and without matching. The matching network is a series inductor, whose value is 1.2nH. After matching, the performance at 5GHz band becomes better than before while there is no obvious influence on 2.4GHz band.

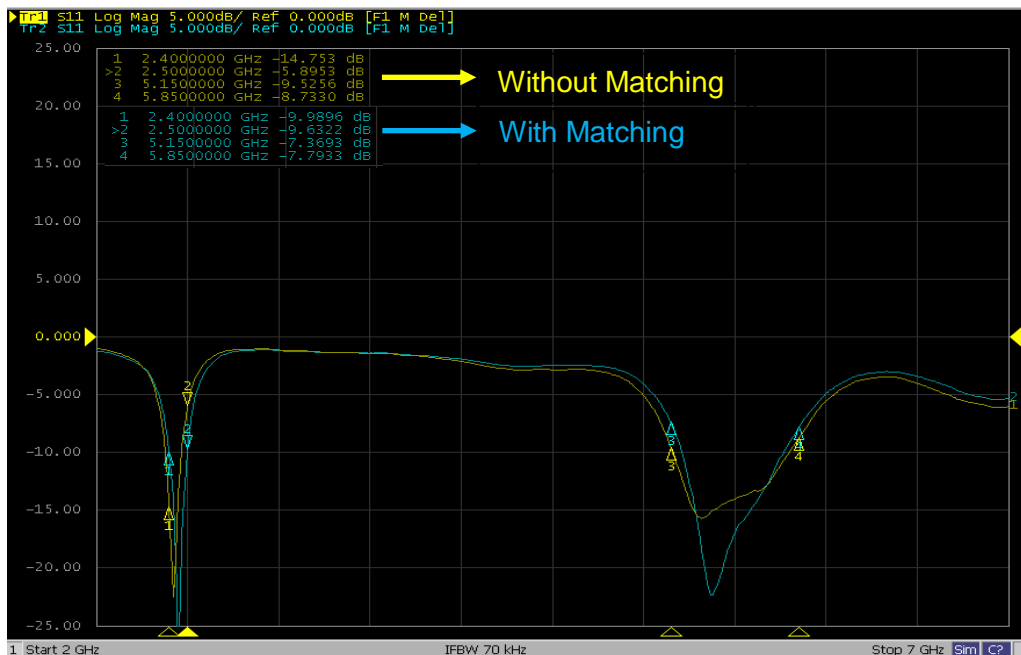


FIGURE 5.4 CASE1 – RETURN LOSS OF ANTENNA WITH AND WITHOUT MATCHING

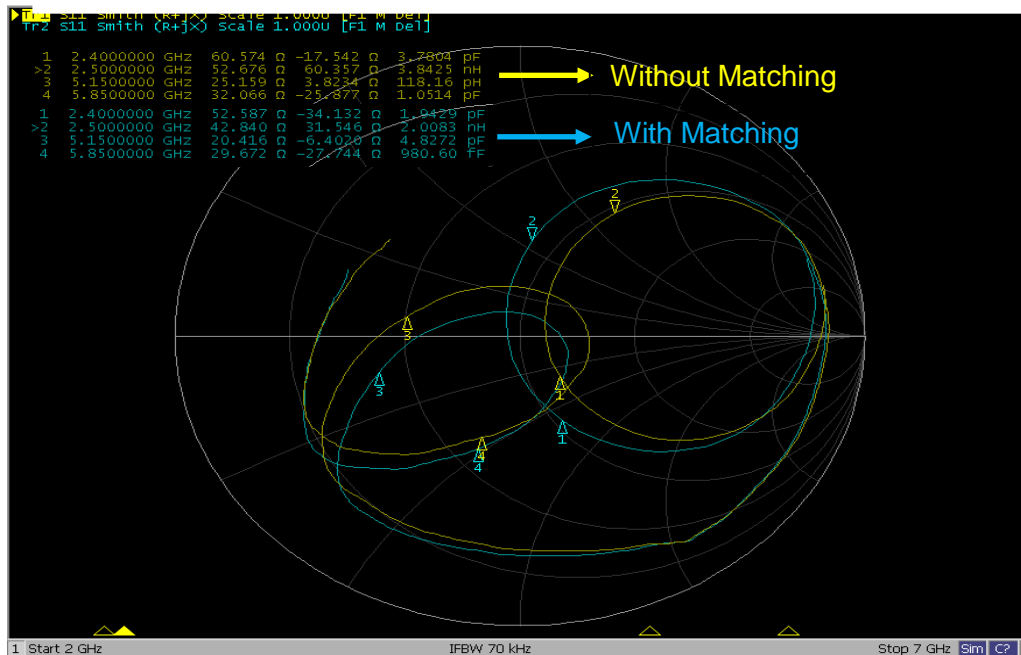


FIGURE 5.5 CASE1 – SMITH CHART OF ANTENNA WITH AND WITHOUT MATCHING

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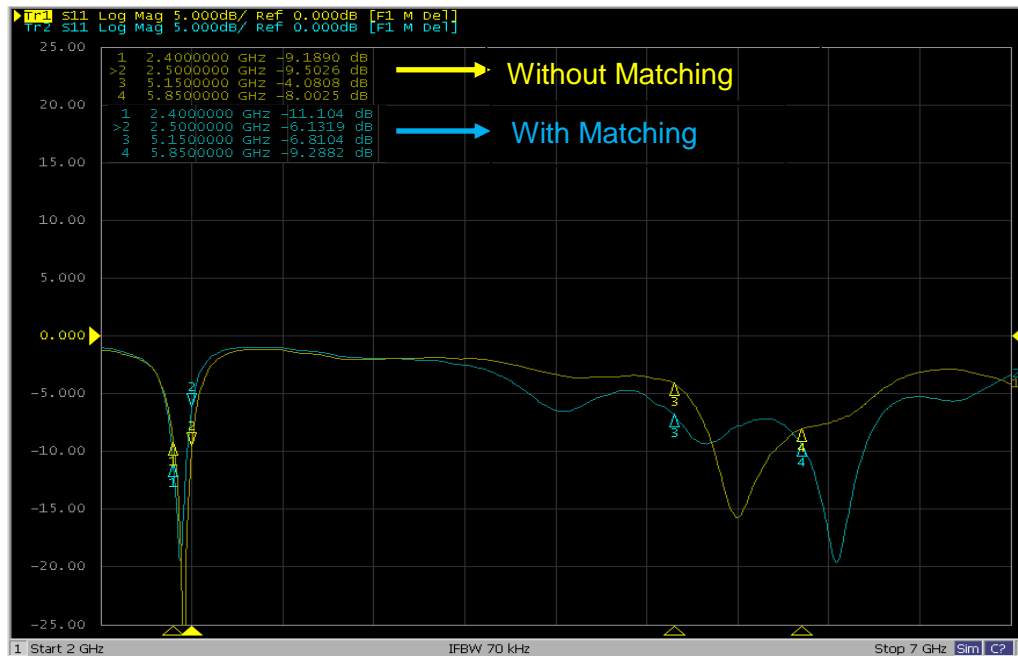


FIGURE 5.6 CASE2 – RETURN LOSS OF ANTENNA WITH AND WITHOUT MATCHING

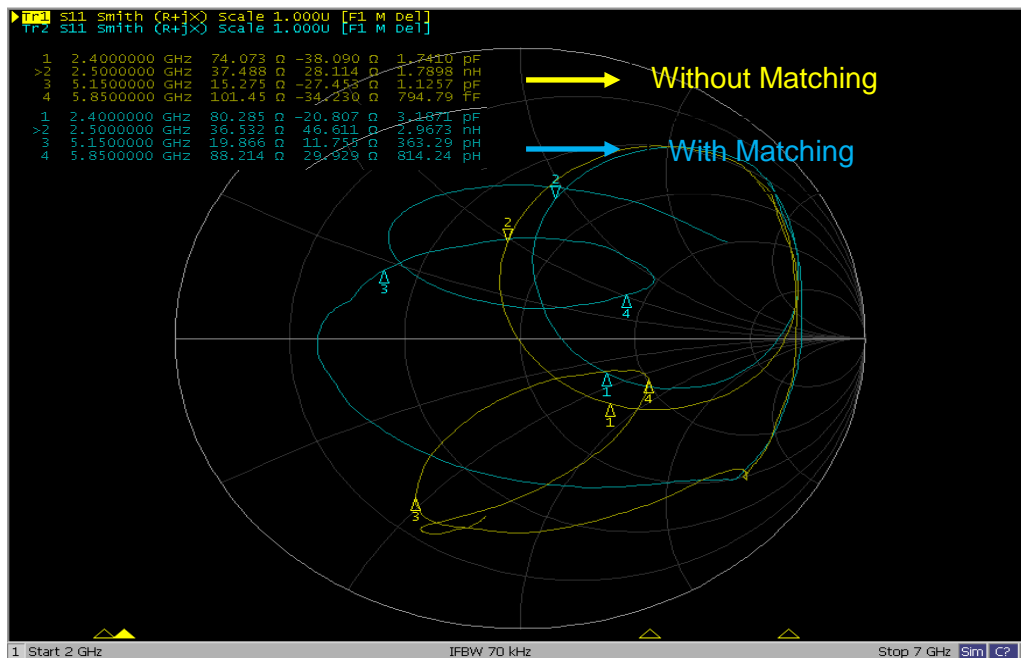


FIGURE 5.7 CASE2 – SMITH CHART OF ANTENNA WITH AND WITHOUT MATCHING

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6.0 RADIATION PATTERN

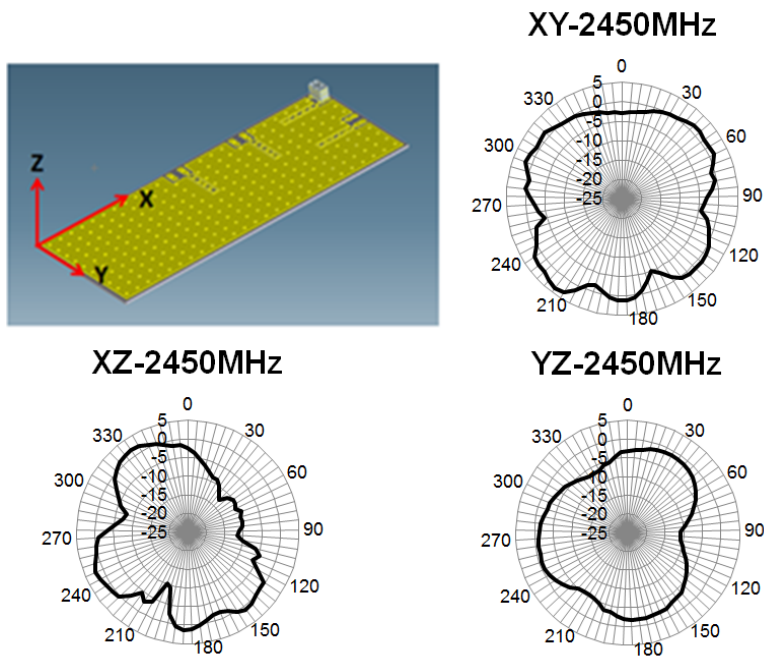


FIGURE 6.1 RADIATION PATTERN OF ATNENNA AT 2.45 GHZ AT REFERENCE LOCATION

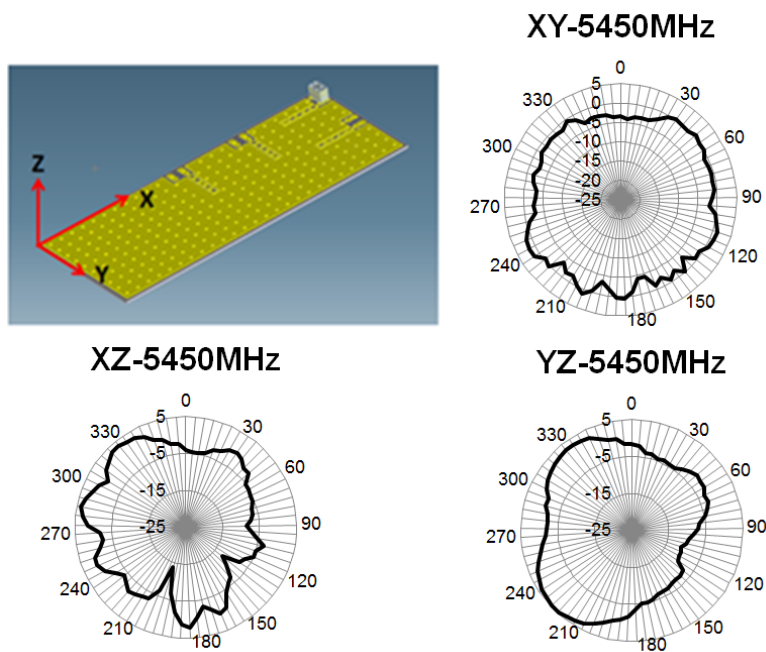


FIGURE 6.2 RADIATION PATTERN OF ATNENNA AT 5 GHZ AT REFERENCE LOCATION

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7.0 ASSEMBLY INSTRUCTIONS

A. RECOMMENDED SMT REFLOW PROFILE

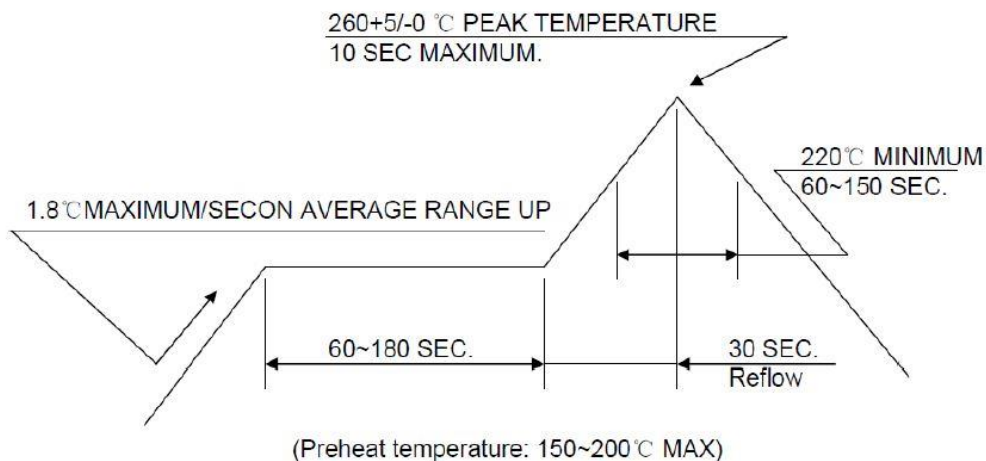


FIGURE 7.1 RECOMMENDED SMT REFLOW PROFILE

B. MECHANICAL INTERFACE

I. GENERAL DESCRIPTION

The overall antenna size is 3mm* 5mm*4mm (Width*Length*Height).

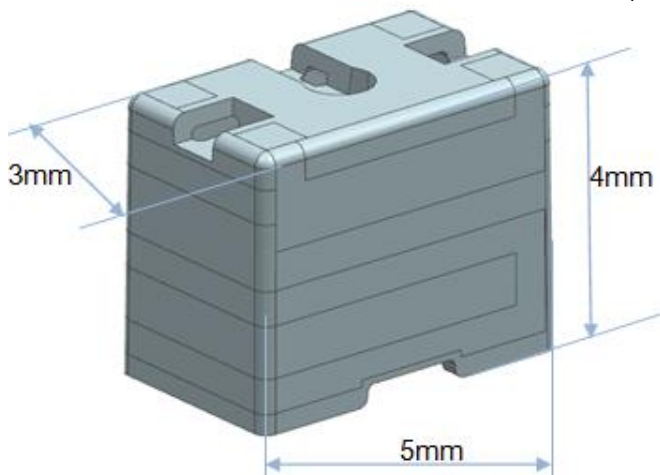


FIGURE 7.2 OVERALL ANTENNA SIZE

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II. STRUCTURE FUNCTIONAL DESCRIPTION

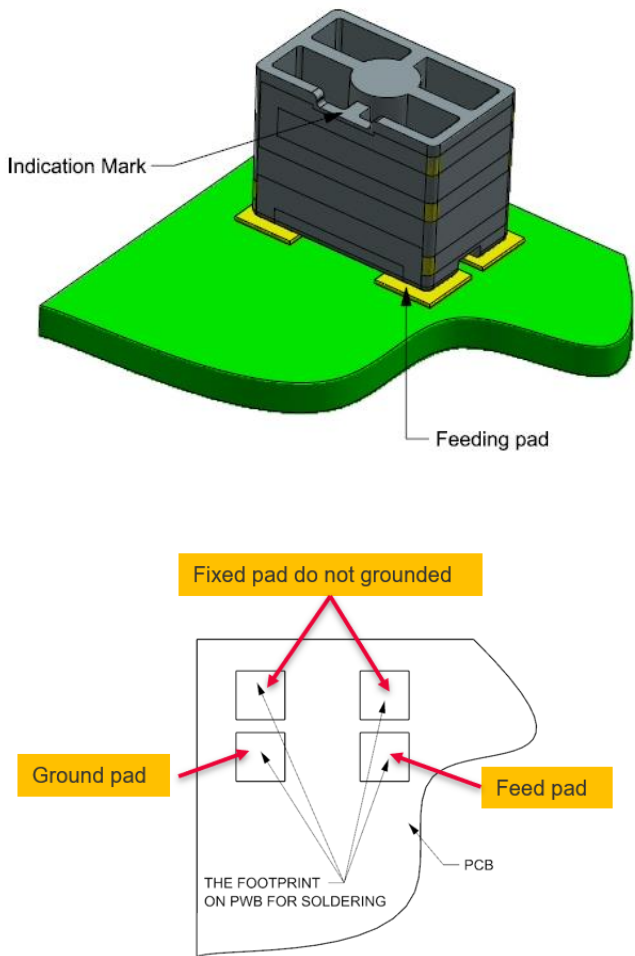


FIGURE 7.3 ANTENNA ASSEMBLY INDICATION

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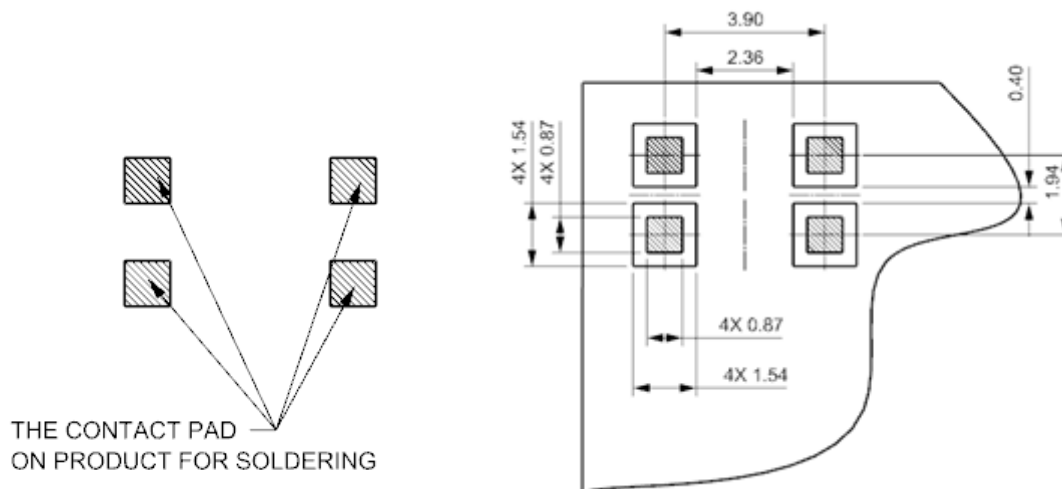


FIGURE 7.4 FOOTPRINT ON PCB FOR SOLDERING

8.0 OTHER MOLEX ANTENNA PRODUCTS

Please refer to the Antenna products in Molex home page to view all the Molex Antenna products.

<https://www.molex.com>

Molex, LLC
2222 Wellington Court
Lisle, IL 60532
USA

9.0 CHANGED HISTORY

REV	DATE	CHANGE DESCRIPTION
A	2017/09/15	First Release
B	2023/02/10	1.Update figure 7.3 antenna assembly indication 2.Add 8.0 Other molex antenna products

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