2.4GHZ CERAMIC ANTENNA

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1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Molex 2.4GHz 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

2.1 PRODUCT NAME AND SERIES NUMBER (S)

Product name: 2.4GHz Ceramic Antenna
Series Number: 2065130001

2.2 DESCRIPTION

206513 is 2.4GHz embedded antenna with high efficiency over 55% on all frequency bands. It's miniature SMT ceramic component, designed to be mounted directly at the corner of main device PCB, it requires very small PCB keep-out area 4x4mm totally.

2.3 PRODUCT STRUCTURE INFORMATION

Please refer to PS-2065130001 for full information.

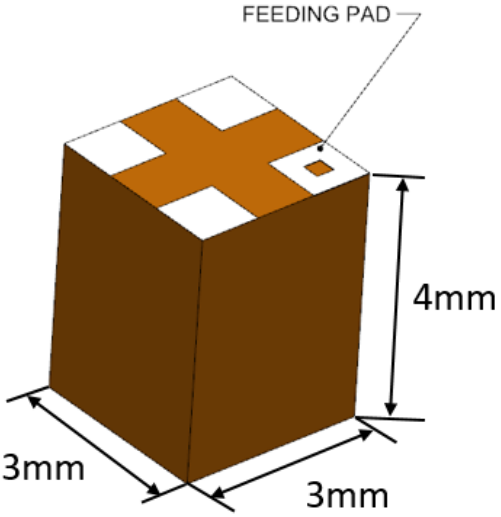


FIGURE 2.3.1 DIMENSION OF THE 2.4GHZ CERAMIC ANTENNA

3.0 APPLICABLE DOCUMENTS

DOCUMENT	NUMBER	DESCRIPTION
Sale Drawing(SD)	SD-2065130001	Mechanical Dimension of the product
Product Specification (PS)	PS-2065130001	Product Specification
Packing Drawing(PK)	PK-2065130001	Product packaging specifications

4.0 ANTENNA PERFORMANCE

4.1 RF TEST CONDITIONS

The reference design is based on a recommended double sided PCB size of 100 mm*40 mm*0.8 mm. There are one feeding pad and three fixing pads.

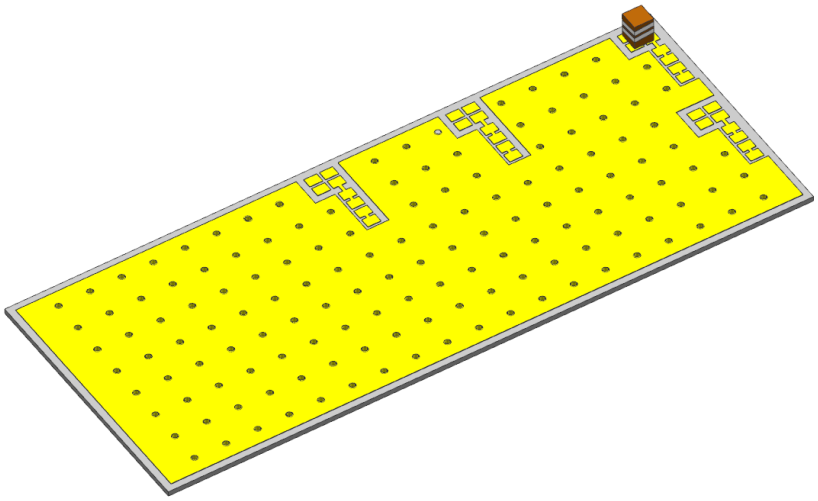


FIGURE4.1.1 REFERENCE ANTENNA LOCATION

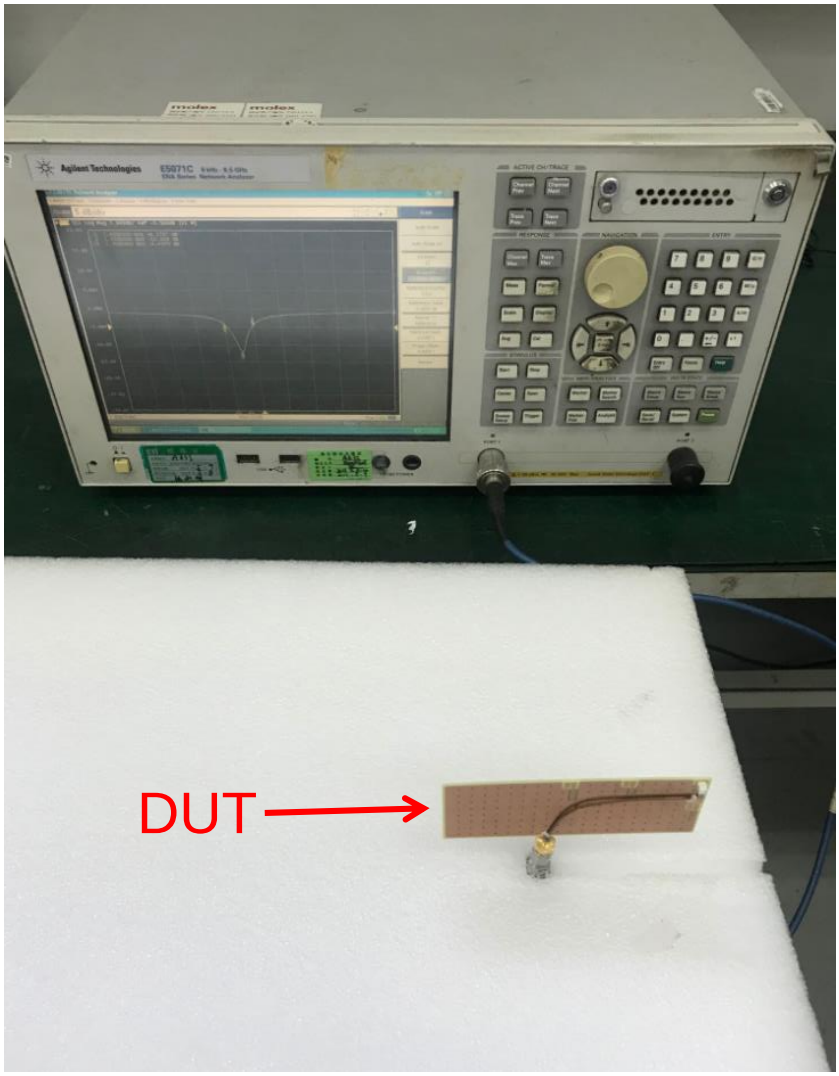


FIGURE4.1.2 ANTENNA LOADED WITH VNA

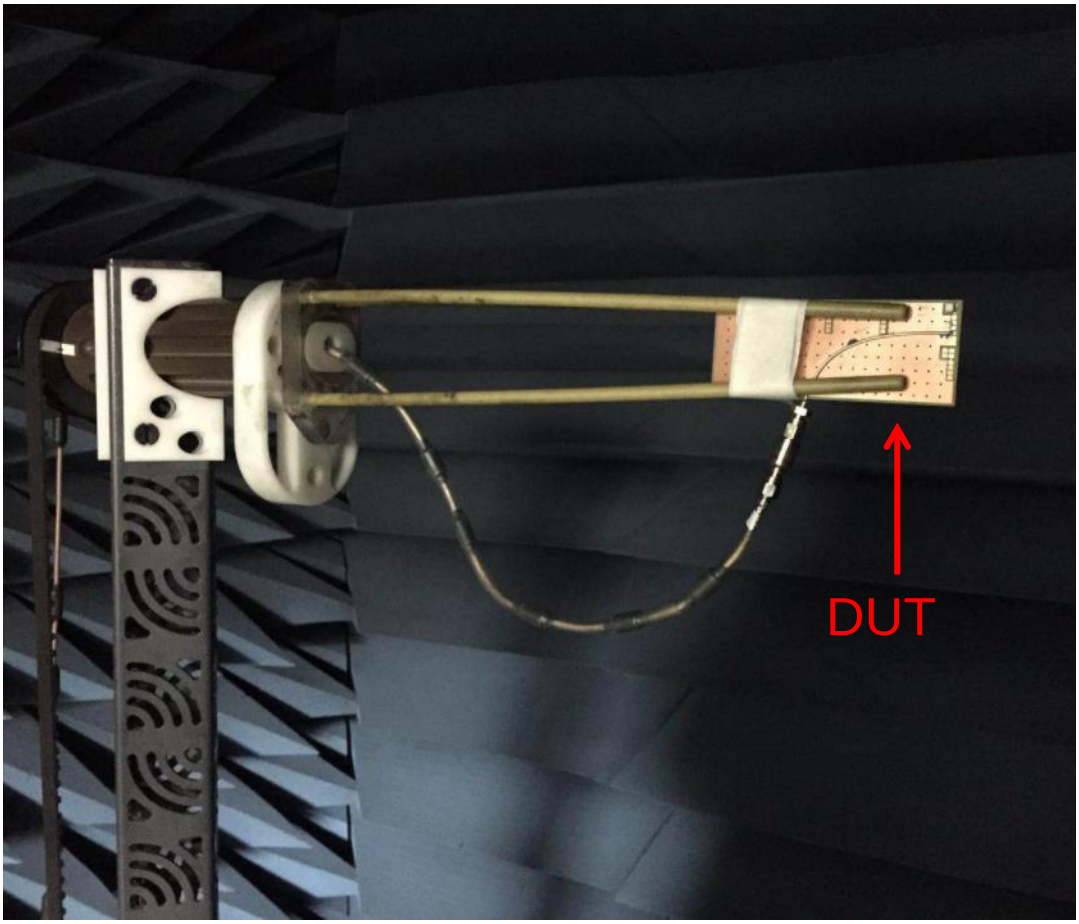


FIGURE4.1.3 ANTENNA LOADED WITH OTA CHAMBER

4.2 ANTENNA PERFORMANCE

DESCRIPTION	EQUIPMENT	REQUIREMENT
Frequency Range	VNA E5071C	2.4~2.5GHz
Return Loss	VNA E5071C	< -6 dB
Peak Gain (Max)	OTA Chamber	3.6dBi
Average Total Efficiency	OTA Chamber	>55%
Polarization	OTA Chamber	Linear
Input Impedance	VNA E5071C	50 Ohms

Note that the above antenna performance is measured with just the antenna mounted on a recommended PCB to similar a free-space condition. When implement into the system, the frequency resonant might be off-tune due to the loading of surrounding components especially metal plane. This off-tune can be compensated through matching. Although module manufacturers specify a peak gain limit, it is based on free-space conditions. The peak gain will be degraded by 1 to 2dBi in the actual implementation as the radiation pattern will change due to the surround components. As such, during selection of antenna, you can select one with high peak gain to compensate for the loss. Molex can offer assistant to choose the best location and best tuning in-order to meet this peak gain requirement.

4.3 RETURN LOSS PLOT

All measurements in this document are done of the antenna mounted on the recommended PCB.

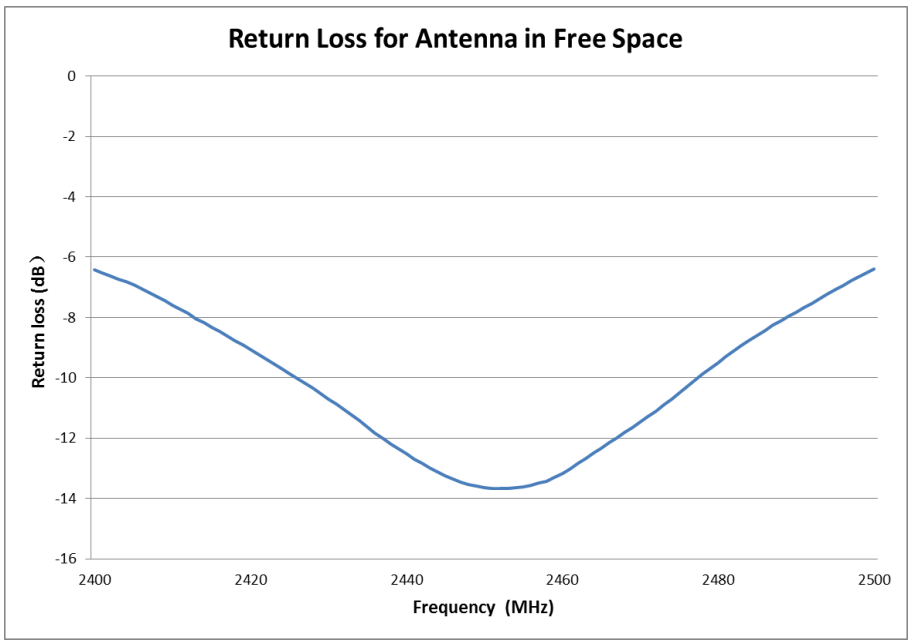


FIGURE 4.3.1 RETURN LOSS OF ANTENNA AT 2.4GHZ BAND IN FREE SPACE

4.4 EFFICIENCY PLOT

All measurements in this document are done of the antenna mounted on the recommended PCB.

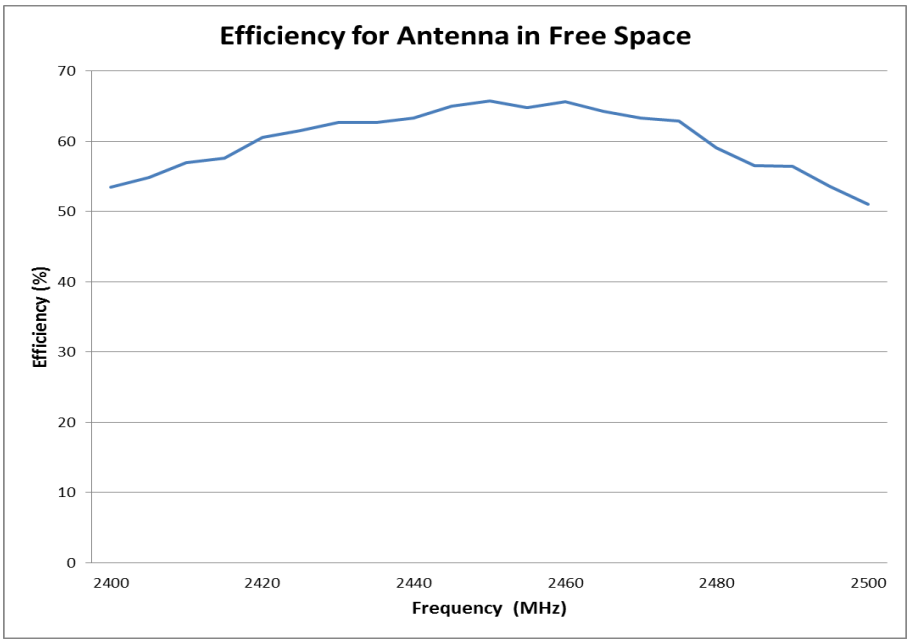


FIGURE 4.4.1 EFFICIENCY OF ANTENNA AT 2.4GHZ BAND IN FREE SPACE

4.5 RADIATION PATTERN

All measurements in this document are done of the antenna mounted on the recommended PCB.

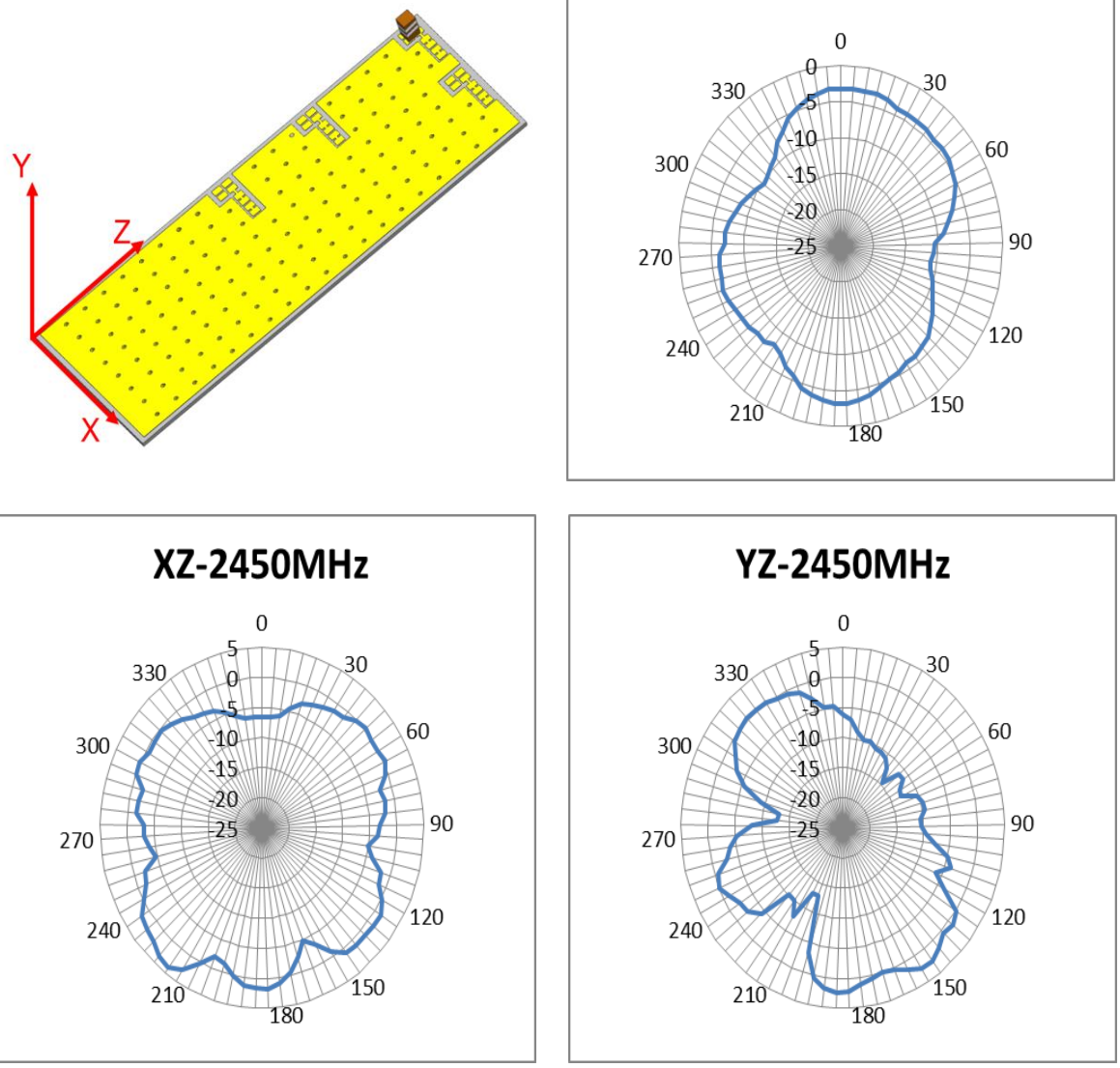


FIGURE 4.5.1 2D RADIATION PATTERN OF ANTENNA AT 2.45GHZ IN FREE SPACE

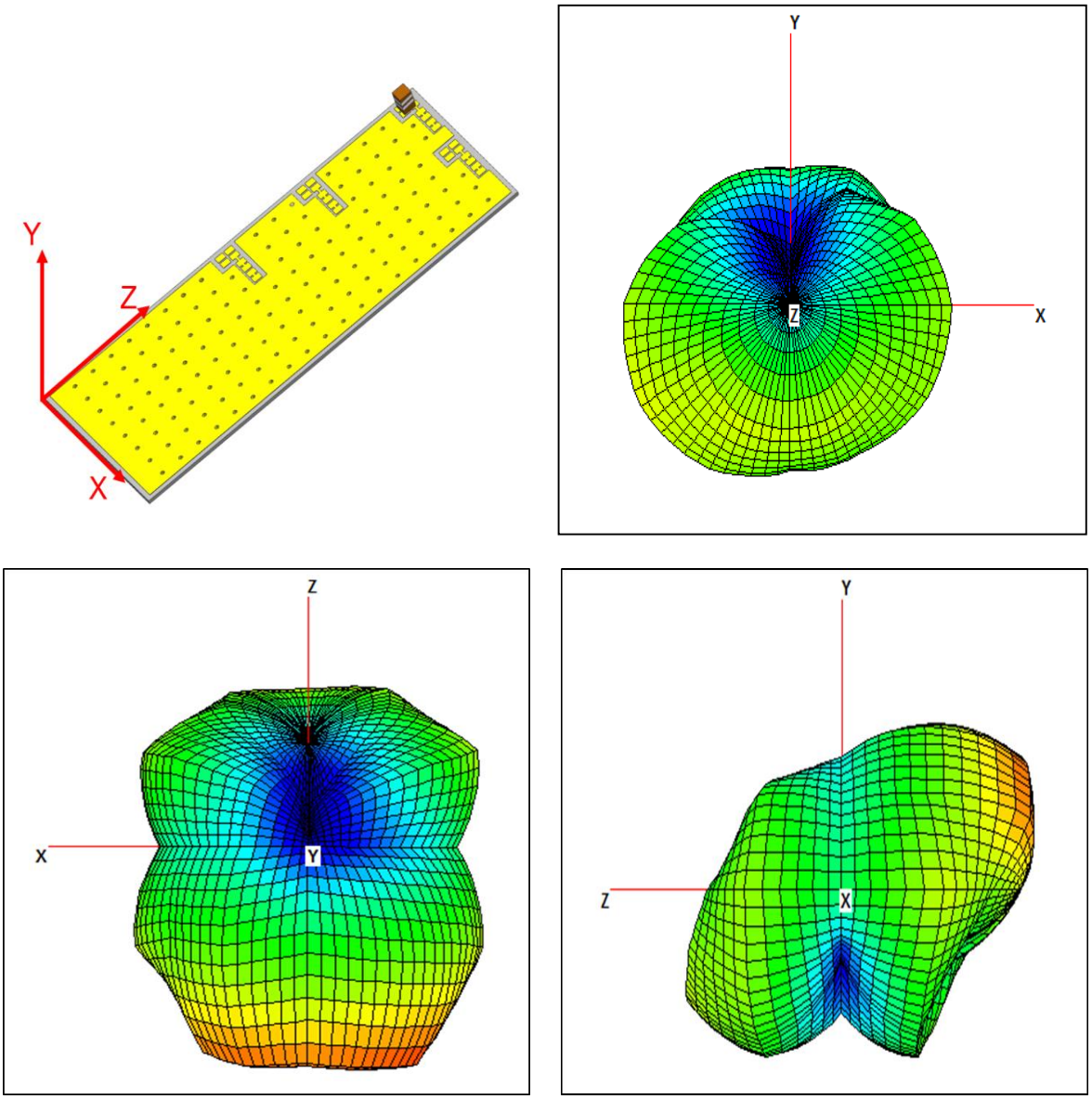
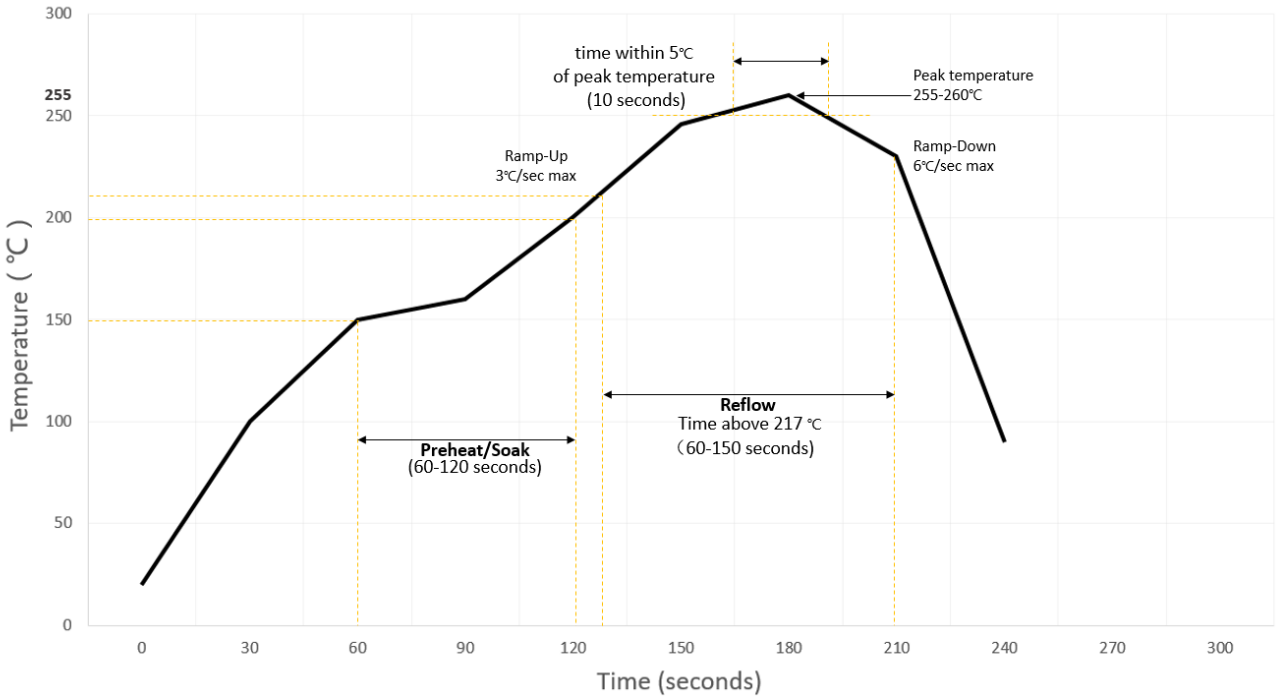


FIGURE 4.5.2 3D RADIATION PATTERN OF ANTENNA AT 2.45GHZ IN FREE SPACE

5.0 RECOMMENDED REFLOW CONDITION



Recommended solder paste: ALPHA CAP-390 SAC305
For mechanically challenging applications Molex recommends using surface mount adhesive (e.g. Loctite 3611) before reflow soldering process, to ensure increased mechanical retention on the PCB.

6.0 MATCHING NETWORK DESRICPTION

The “L” type matching circuit is recommended to be applied for this antenna at the recommended position on reference PCB. The sequence of series element and parallel element depends on the impedance of antenna in smith chart. Figure 6.1 shows the matching network for this antenna at 2.4GHz at the recommended position on reference PCB.

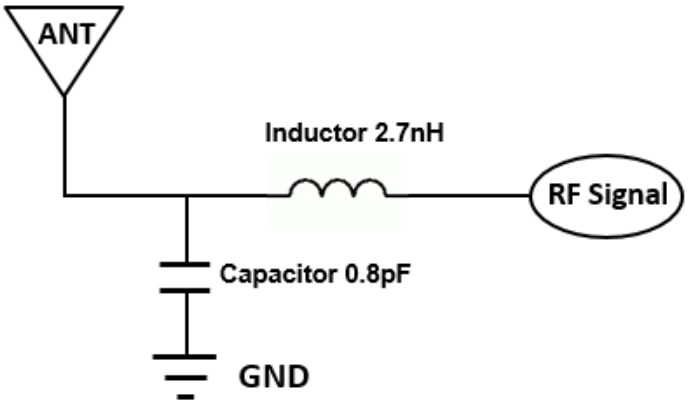


FIGURE 6.1 RECOMMENDED MATCHING CIRCUIT FOR 2.4GHZ BAND

The following plot figure 6.2 shows the return loss chart comparison with and without the matching network for the antenna at 2.4GHz on reference PCB ground size and at reference location.

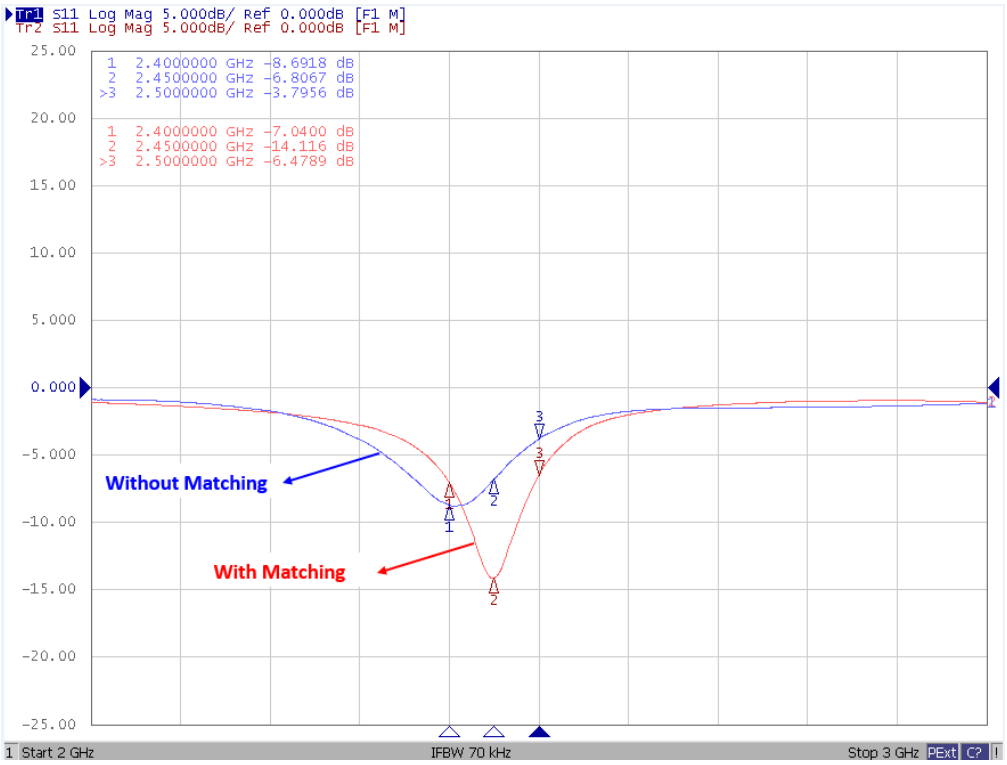


FIGURE 6.2 RETURN LOSS COMPARISON WITH AND WITHOUT MATCHING ON REFERENCE PCB GROUND SIZE AT REFERENCE LOCATION

7.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

7.1 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 as figure 7.1.1. 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 7.1.2- 7.1.3.

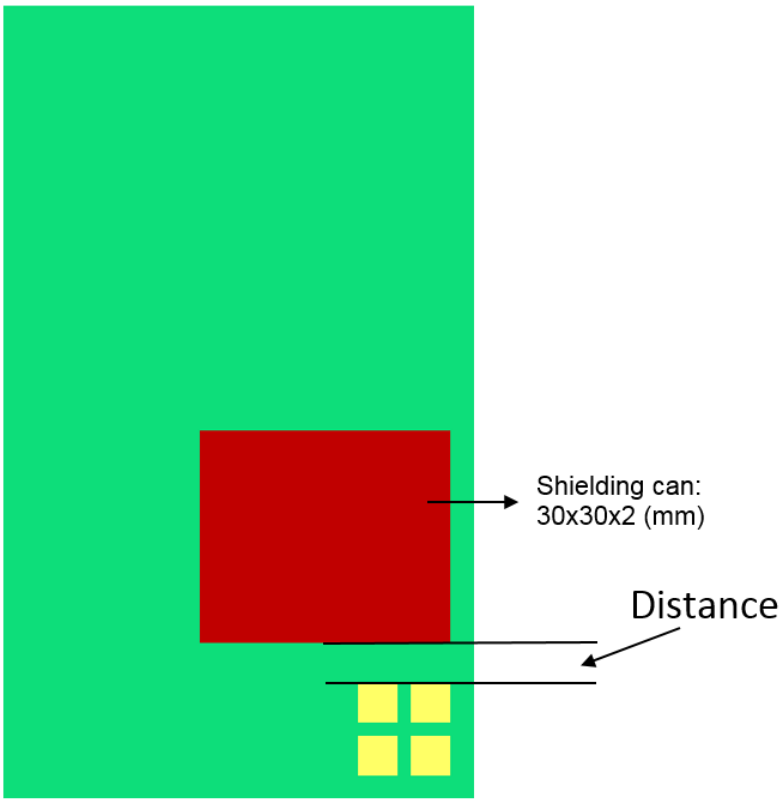


FIGURE 7.1.1 SHIELDING CAN FIXED ON REFERENCE PCB

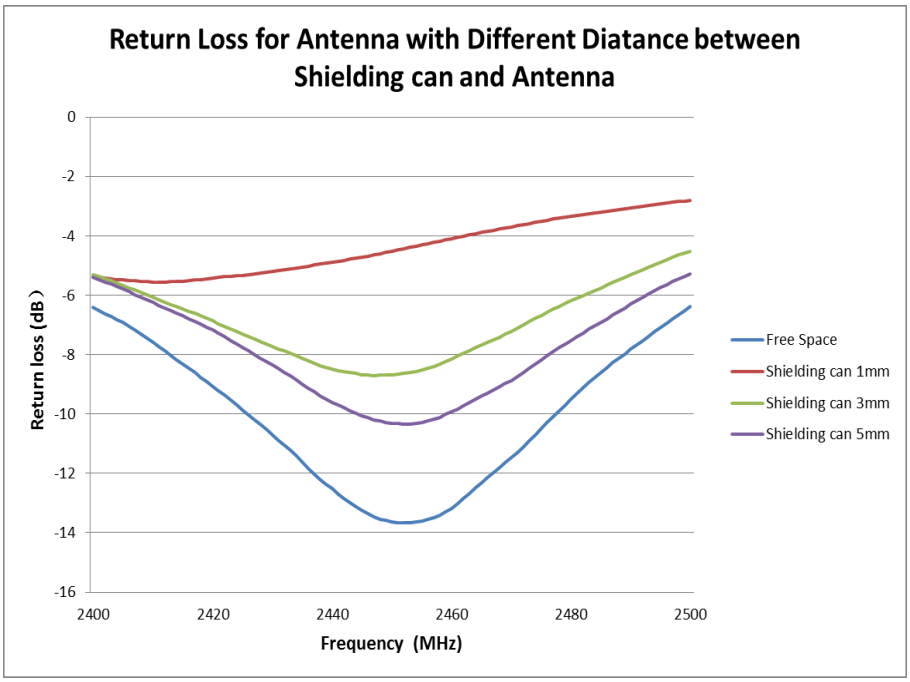


FIGURE 7.1.2 RETURN LOSS COMPARISON AT 2.4 GHZ BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

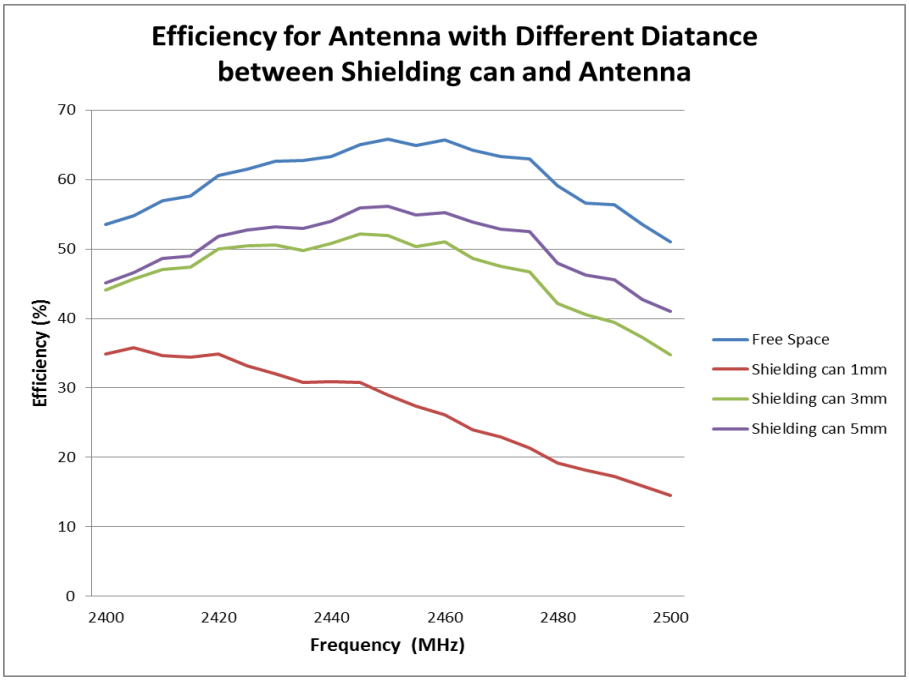


FIGURE 7.1.3 EFFICIENCY COMPARISON AT 2.4 GHZ BAND OF SHIELDING CAN DISTANCE FROM ANTENNA

7.2 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 as figure 7.2.1. 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 7.2.2-7.2.3.

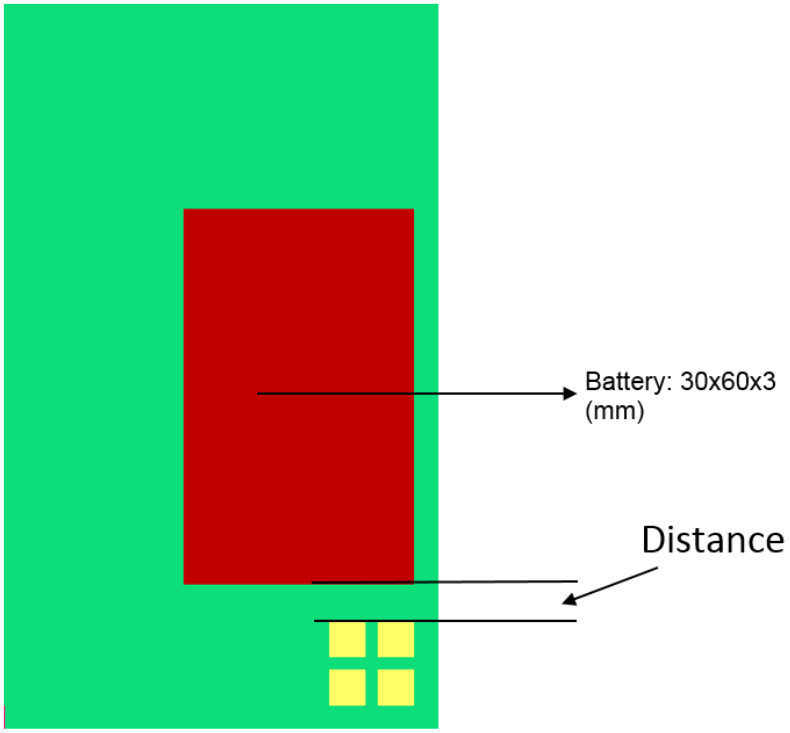


FIGURE 7.2.1 BATTERY FIXED ON REFERENCE PCB

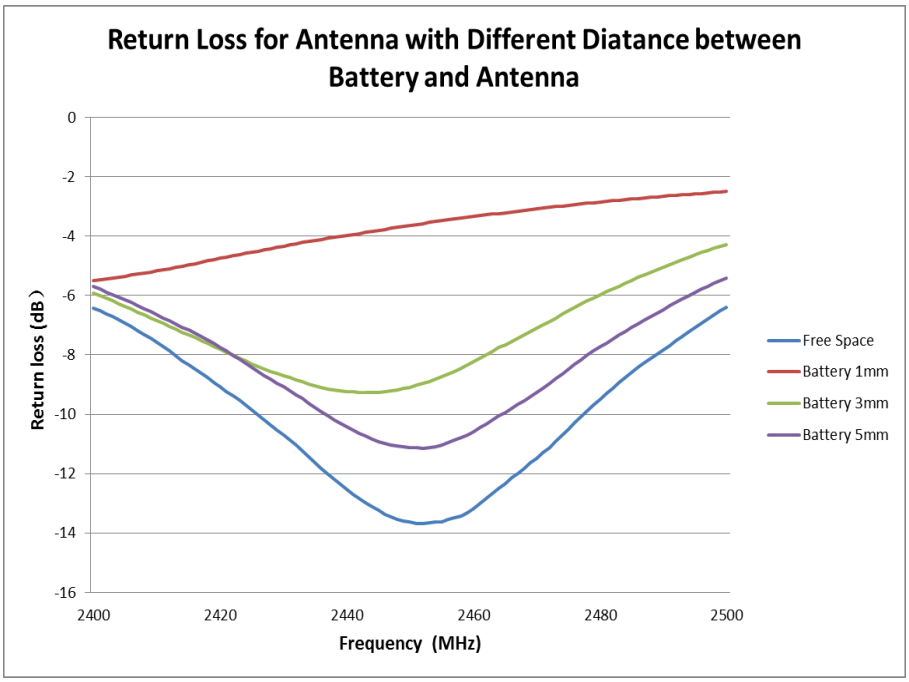


FIGURE 7.2.2 RETURN LOSS COMPARISON AT 2.4 GHZ BAND OF BATTERY DISTANCE FROM ANTENNA

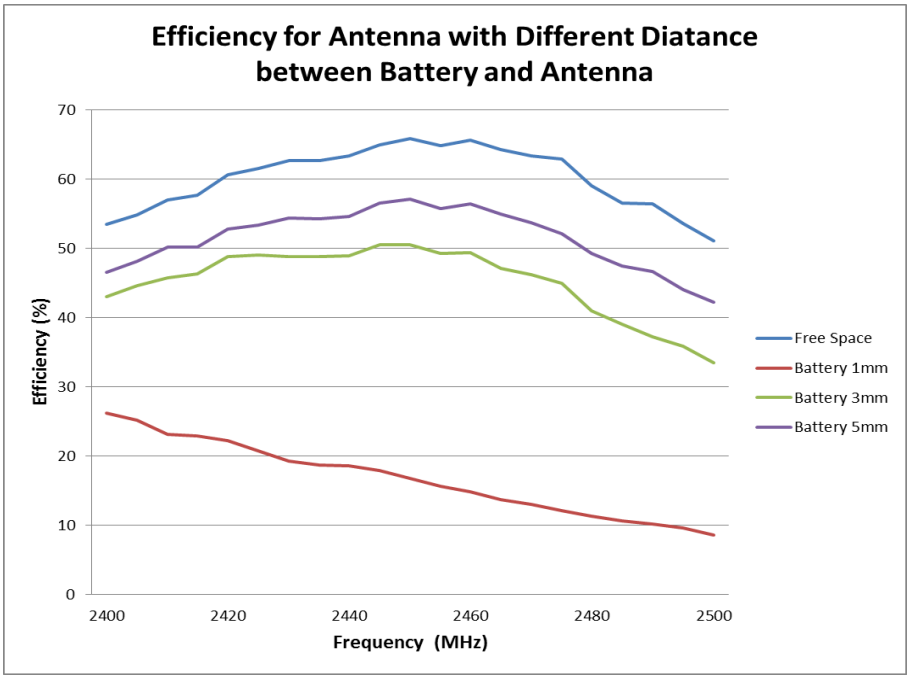


FIGURE 7.2.3 EFFICIENCY COMPARISON AT 2.4 GHZ BAND OF BATTERY DISTANCE FROM ANTENNA

7.3 ANTENNA RF PERFORMANCE AS A FUNCTION OF LOCATION ON THE PCB

Four locations have been evaluated RF performance and these locations are shown in figure 7.3.1. Figure 7.3.2 and Figure 7.3.3 comparatively present the return loss and efficiency at 2.4GHz band at four locations. The location which gives the best RF performance is location 1. Location 1 (corner location) is the recommended location for the antenna.

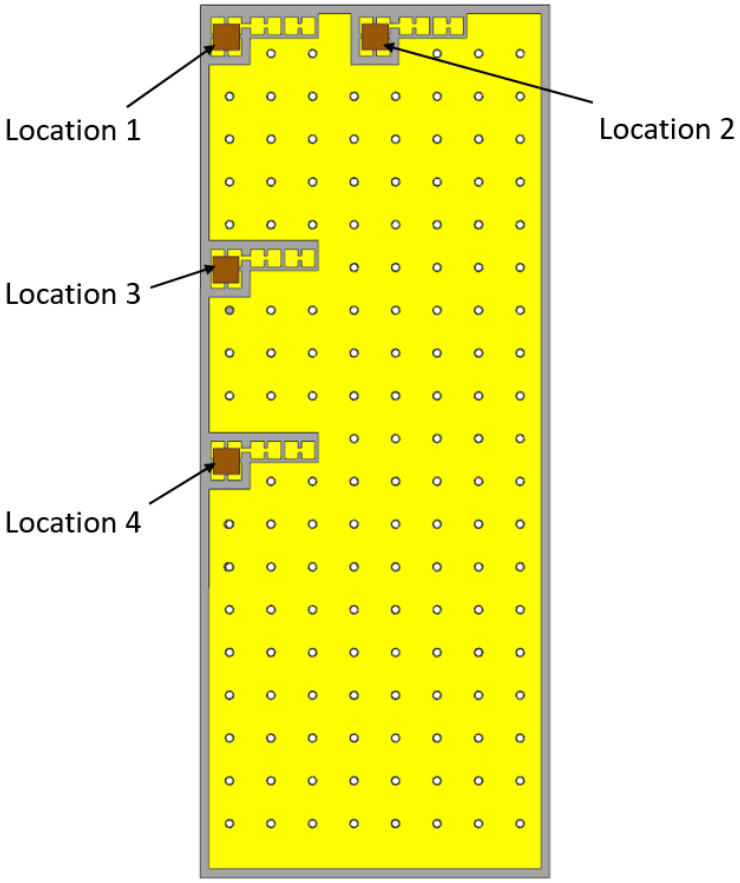


FIGURE 7.3.1 FOUR LOCATIONS ON REFERENCE PCB

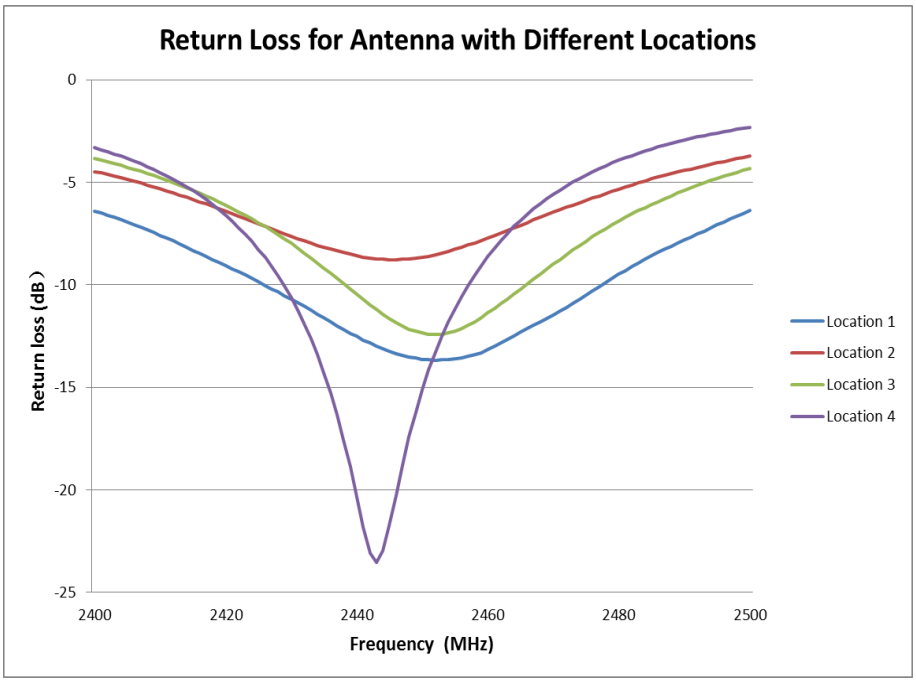


FIGURE 7.3.2 RETURN LOSS COMPARISON AT 2.4 GHZ BAND AT FOUR LOCATIONS

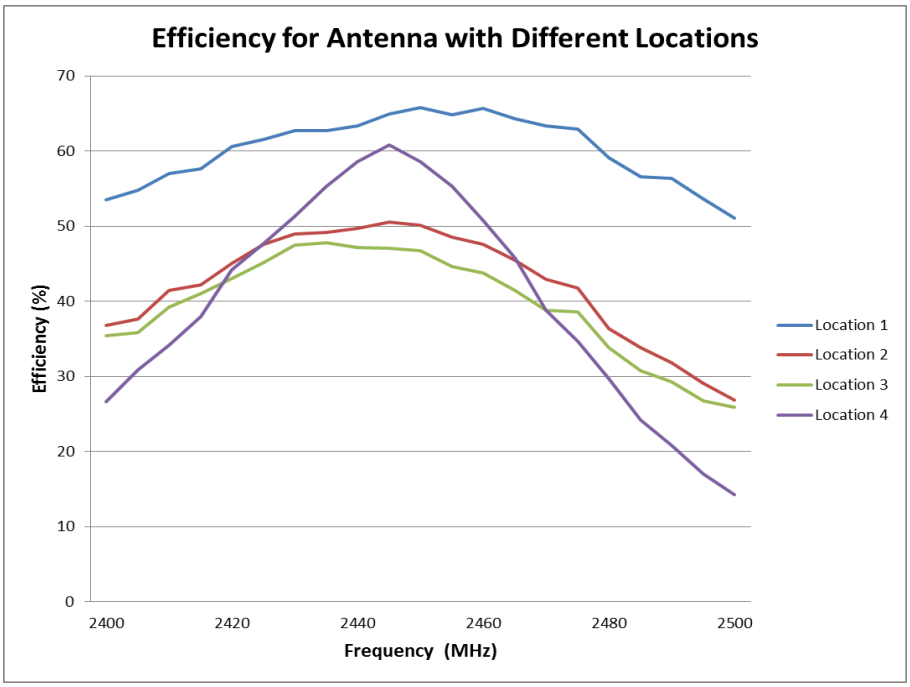


FIGURE 7.3.3 EFFICIENCY COMPARISON AT 2.4 GHZ BAND AT FOUR LOCATIONS