



# APPLICATION SPECIFICATION

## TITLE

## 2.4GHZ MID SMT ANTENNA

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| REVISION:           | ECR/ECN INFORMATION:              | TITLE:  | SHEET No.      |
| <b>G</b>            | EC No: 738181<br>DATE: 2023/02/15 | <b>2.4GHz MID SMT Antenna Application Specification</b> | <b>1 of 17</b> |
| DOCUMENT NUMBER:    | CREATED / REVISED BY:             | CHECKED BY:   | APPROVED BY:   |
| <b>AS-479480001</b> | Liu Hai                           | Cheng Kang  | Andy Zhang     |

## 2.4GHZ MID SMT ANTENNA

### 1.0 SCOPE

This specification describes the antenna application and recommended PCB layout for the Molex 2.4GHz SMD 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 MID SMT Antenna  
Series Number: 479480001

#### 2.2 DESCRIPTION

This is a high-performance antenna implemented using SMD option to meet the customer needs. It has low profile as the size of this antenna. It is designed to cover the frequency 2.4GHz-2.5GHz.

#### 2.3 PRODUCT STRUCTURE INFORMATION

Please refer to PS-479480001 for full information.



**FIGURE 2.3 DIMENSION OF THE 2.4GHZ SMD ANTENNA**

|   |   |   |                             |
|---|---|---|-----------------------------|
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| DOCUMENT NUMBER:<br><b>AS-479480001</b> | CREATED / REVISED BY:<br>Liu Hai                          | CHECKED BY:<br>Cheng Kang   | APPROVED BY:<br>Andy Zhang  |

## 3.0 APPLICABLE DOCUMENTS

| DOCUMENT                   | NUMBER       | DESCRIPTION                         |
|----------------------------|--------------|-------------------------------------|
| Sale Drawing (SD)          | SD-479480001 | Mechanical Dimension of the product |
| Product Specification (PS) | PS-479480001 | Product Specification               |
| Packing Drawing (PK)       | PK-479480001 | Product packaging specifications    |

## 4.0 ANTENNA PERFORMANCE

### 4.1 RF TEST CONDITIONS

The reference design is based on a recommended double side PCB size of 100 mm\*40 mm\*0.8 mm. There are one feeding pad and three fixing pads.(PCB molex p/n:479489001)

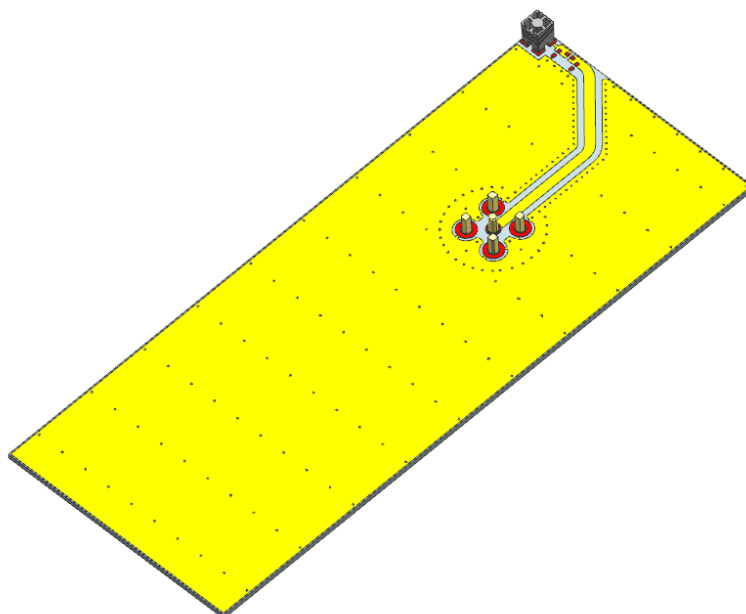
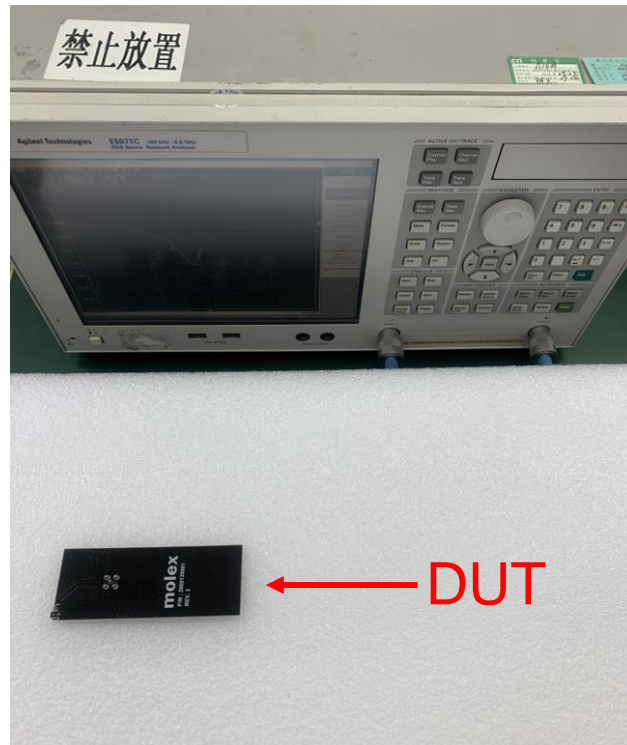
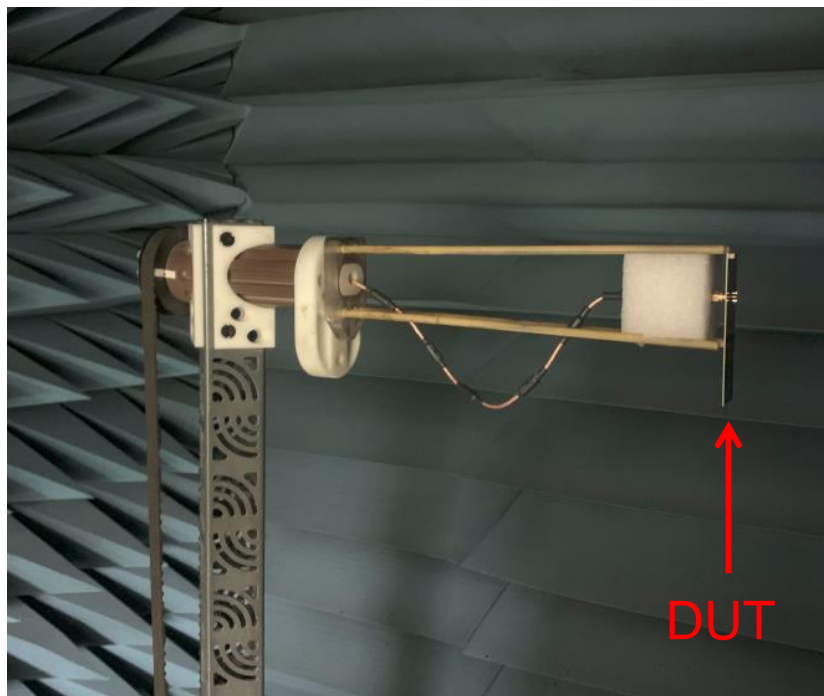


FIGURE4.1.1 REFERENCE ANTENNA LOCATION

|   |   |   |                             |
|---|---|---|-----------------------------|
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**FIGURE4.1.2 ANTENNA IN FREE SPACE WITH VNA AGILENT E5071C**



**FIGURE4.1.3 ANTENNA IN FREE SPACE WITH OTA CHAMBER**

|                     |                                   |   |                |
|---------------------|-----------------------------------|---|----------------|
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# APPLICATION SPECIFICATION

## 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 | 3.7dBi      |
| Average Total Efficiency | OTA Chamber | >70%        |
| 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.

|                     |                                   |   |                |
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## 4.3 RETURN LOSS PLOT

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

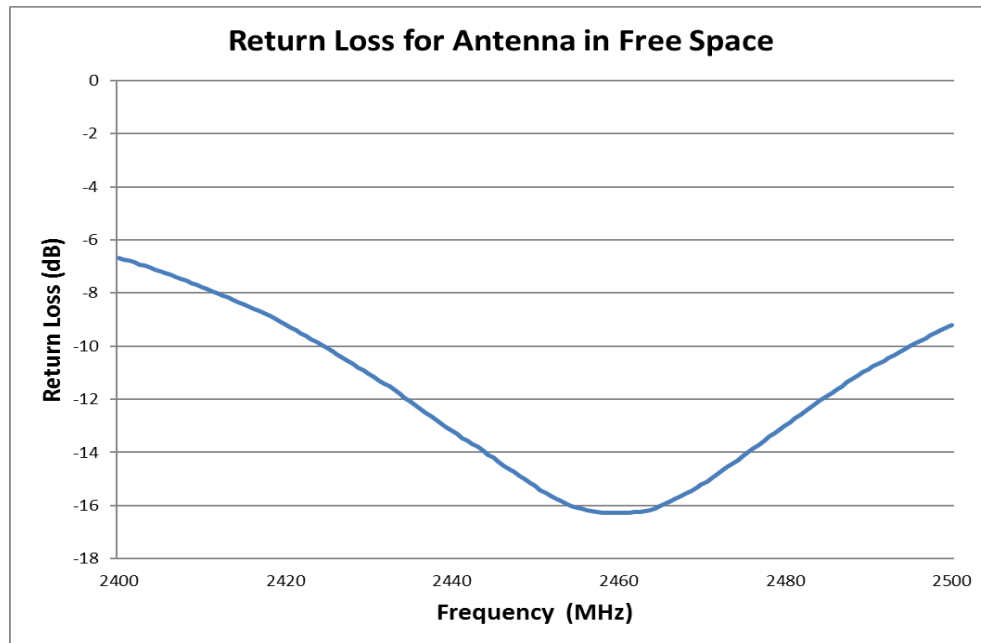


FIGURE 4.3 RETURN LOSS OF ANTENNA IN FREE SPACE

## 4.4 EFFICIENCY PLOT

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

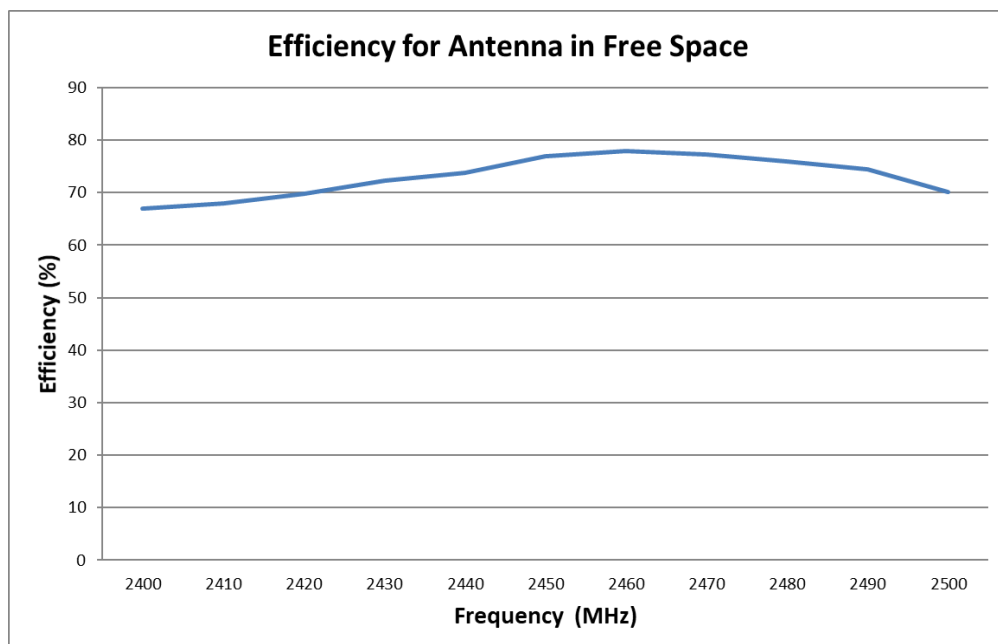


FIGURE 4.4 EFFICIENCY OF ANTENNA IN FREE SPACE

|   |   |   |                             |
|---|---|---|-----------------------------|
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## 4.5 RADIATION PATTERN

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

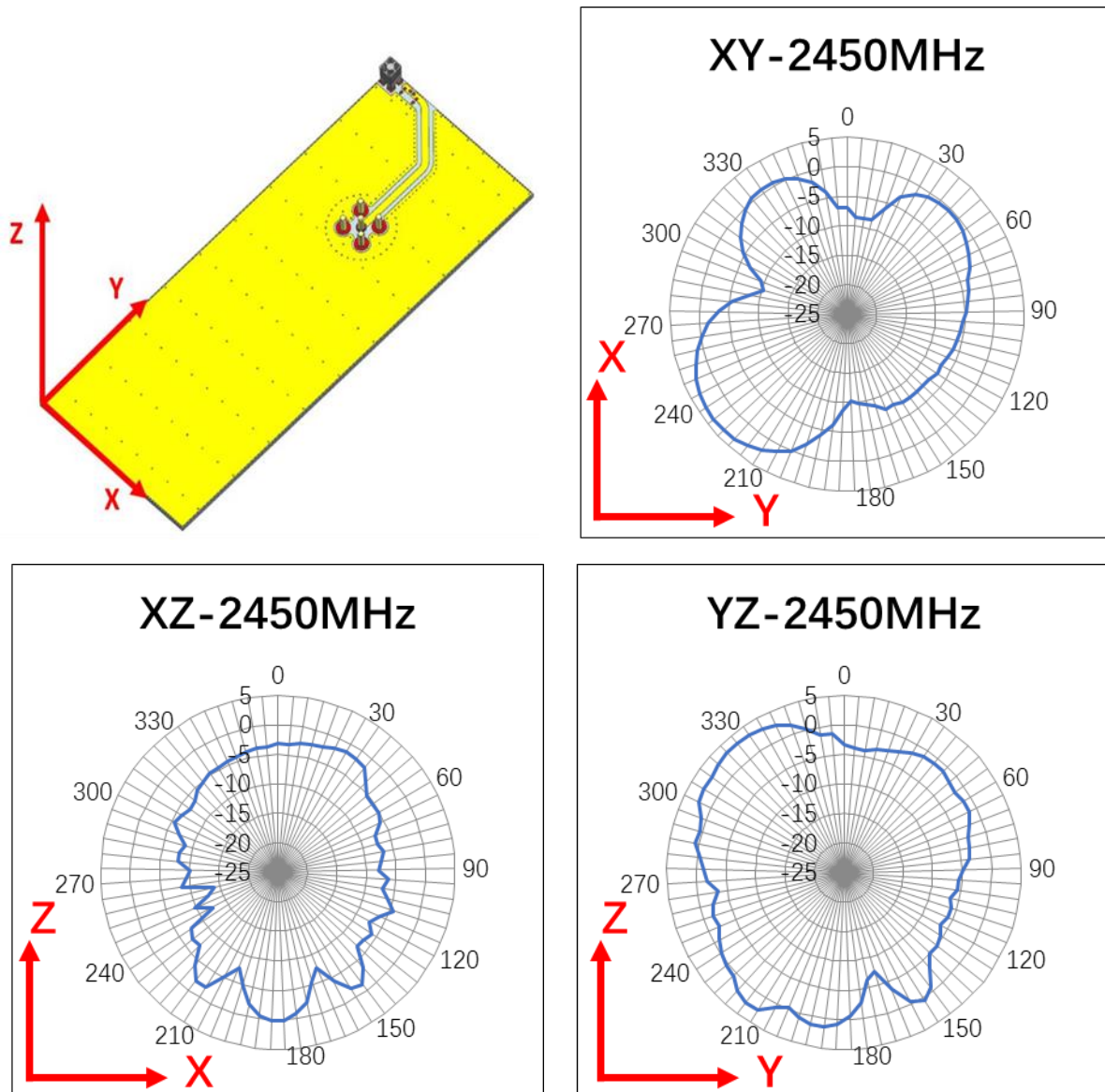
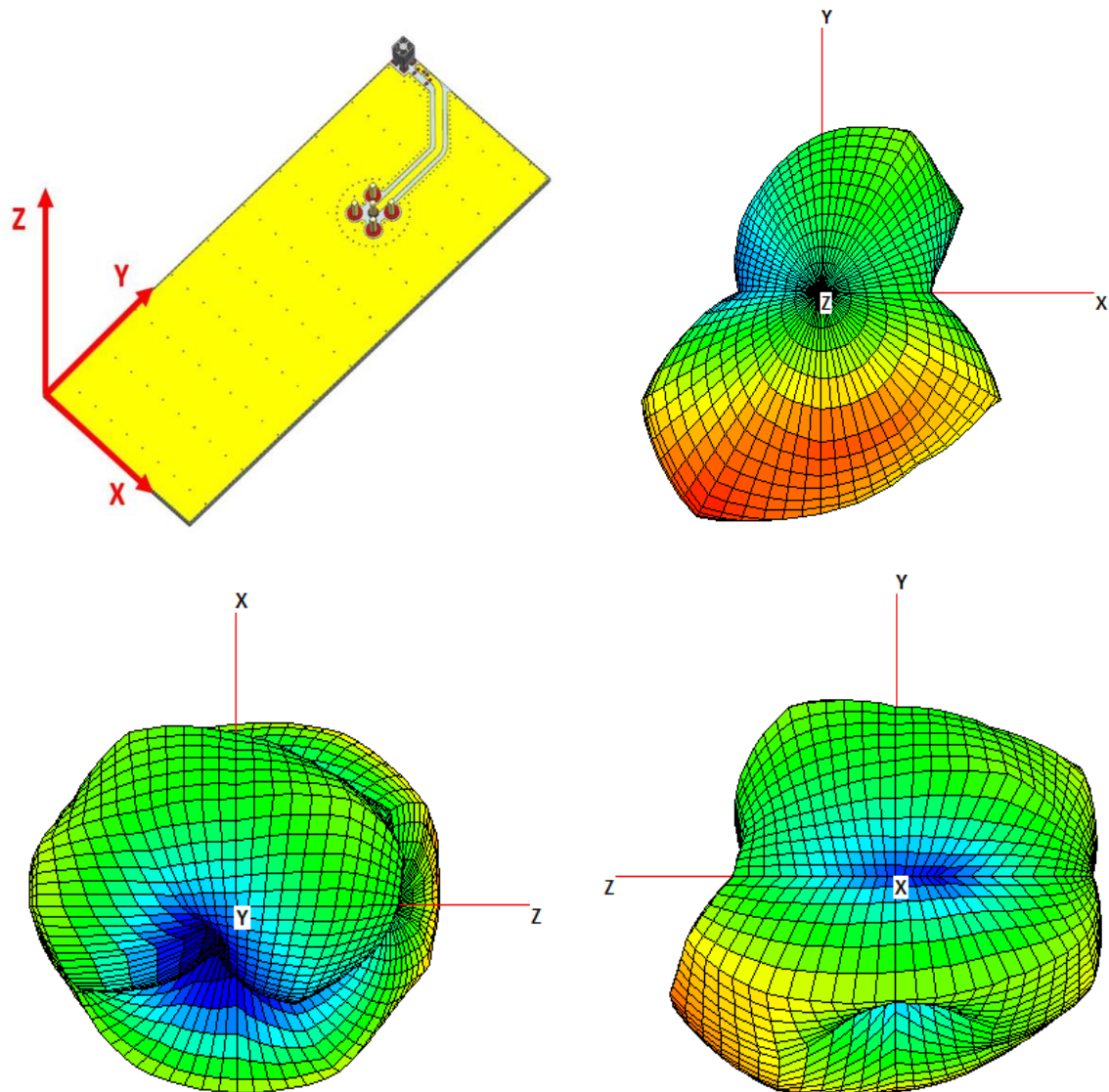


FIGURE 4.5.1 2D RADIATION PATTERN OF ANTENNA AT 2.45GHZ IN FREE SPACE

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

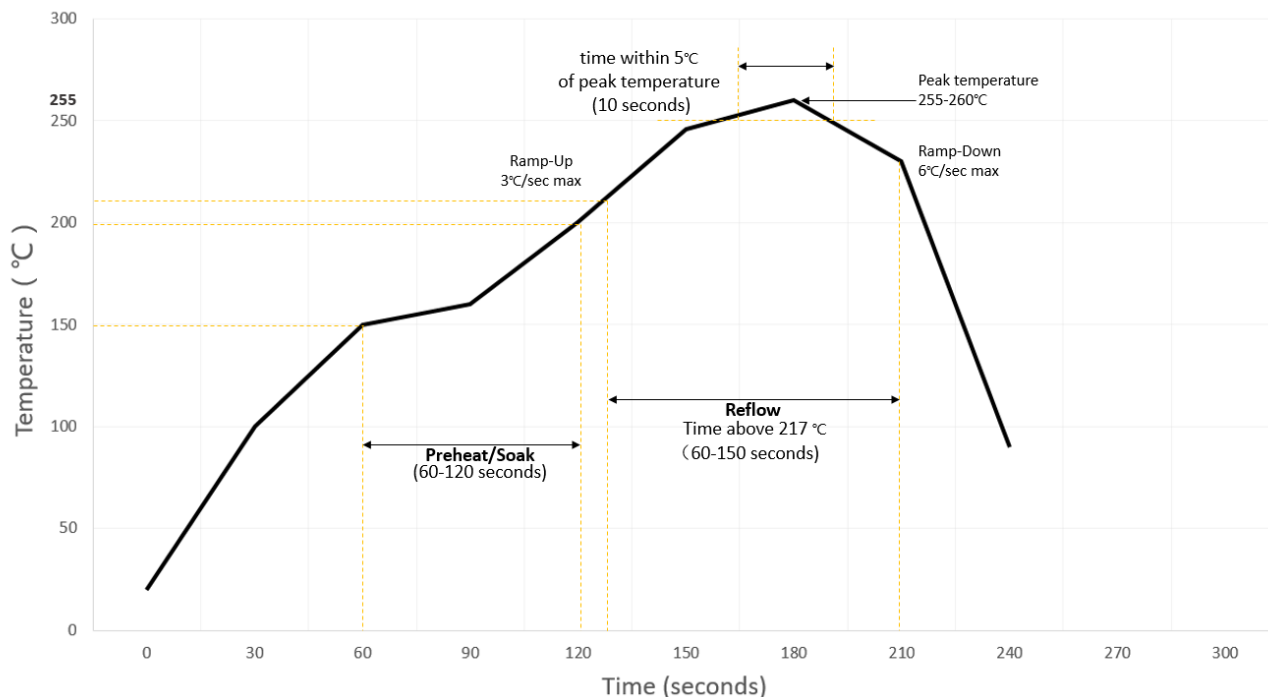
|                     |                      |   |             |                |
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# APPLICATION SPECIFICATION

## 5.0 RECOMMENDED REFLOW CONDITION



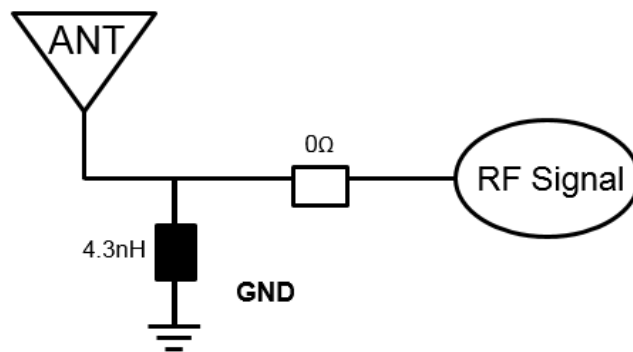
Recommended solder paste: ALPHA CAP-390 SAC305

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.

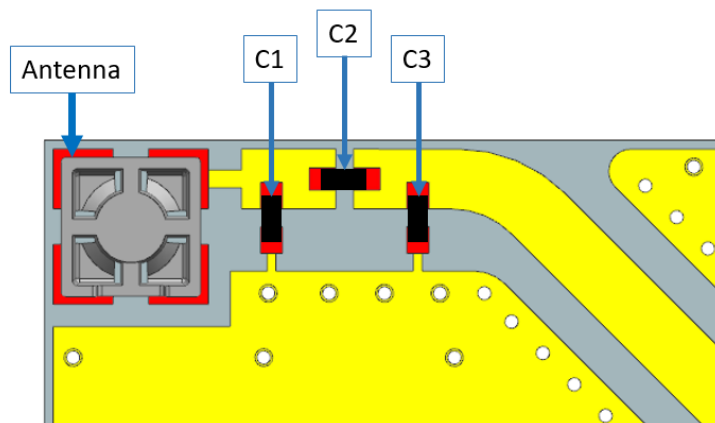
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## 6.0 MATCHING NETWORK DESCRIPTION

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. (PCB molex p/n:479489001)



**FIGURE 6.1 RECOMMENDED MATCHING CIRCUIT FOR 2.4GHZ BAND**



| Component |                            |
|-----------|----------------------------|
| C1        | 4.3nH                      |
|           | Murata (PN: LQG15HS4N3B02) |
| C2        | 0 Ω                        |
| C3        | NA                         |

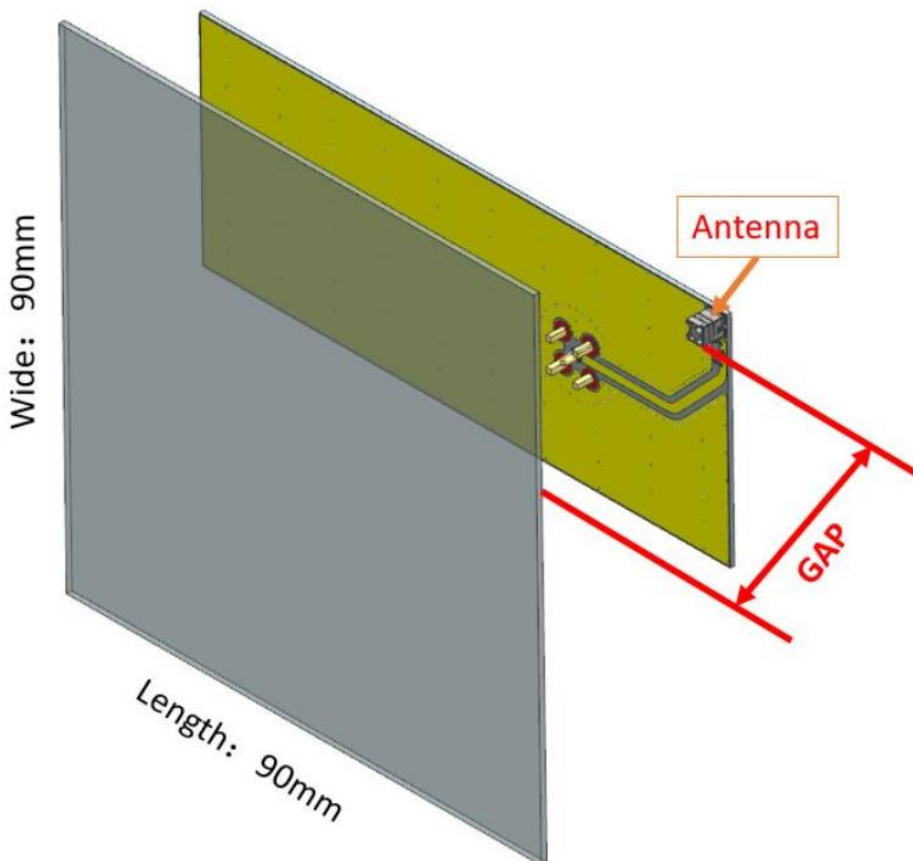
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## 7.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

### 7.1 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH PARALLEL PLANE GROUND

Four locations with parallel plane ground have been evaluated and these locations are shown in figure 7.1. The plane ground size is 90mm\*90mm and we move the plane ground to four locations for each test.

The distance between antenna and parallel plane ground affect the antenna performance slightly. We still suggest the minimum distance between antenna and plane ground is recommended to be 5mm.



**FIGURE 7.1 FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

Ground Size: 90mm\*90mm;

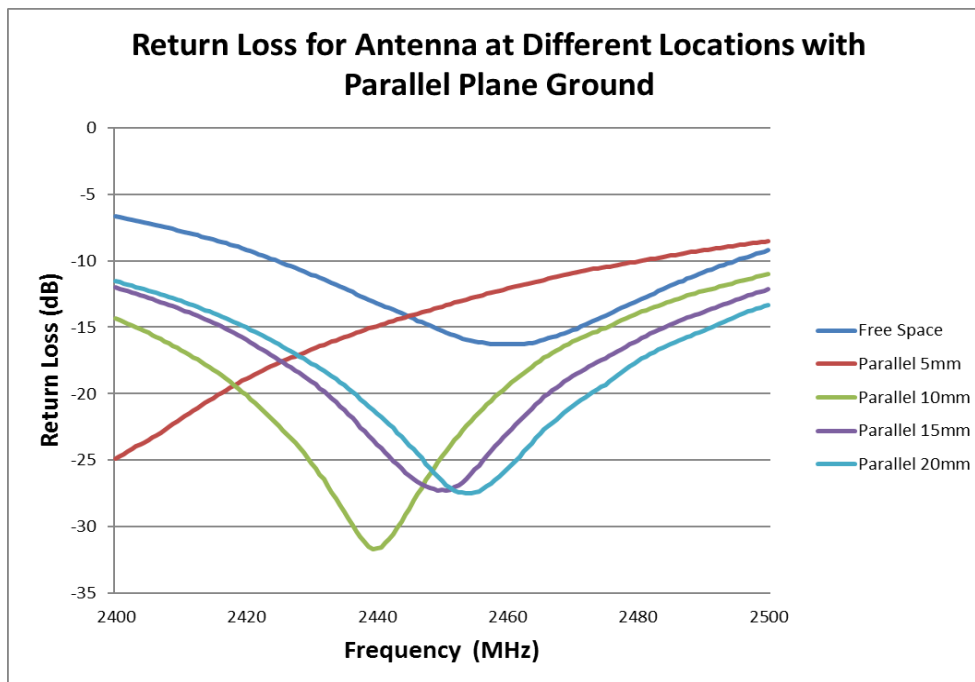
Location 1: Distance between antenna and plane ground (GAP) is about 5mm;

Location 2: Distance between antenna and plane ground (GAP) is about 10mm;

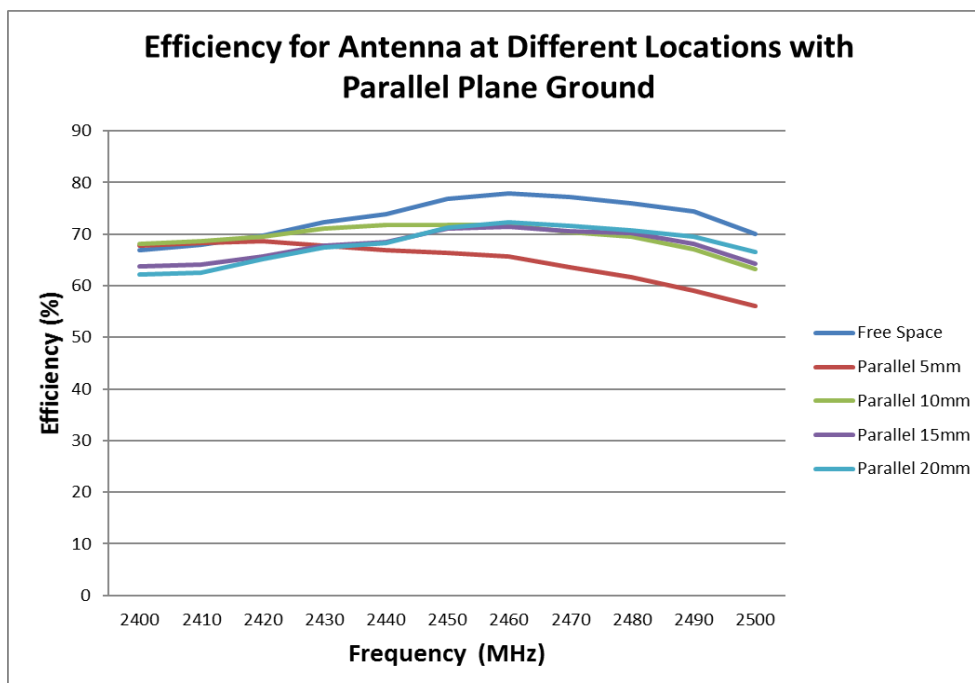
Location 3: Distance between antenna and plane ground (GAP) is about 15mm;

Location 4: Distance between antenna and plane ground (GAP) is about 20mm

|                     |                                   |   |                 |
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**FIGURE 7.1.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**



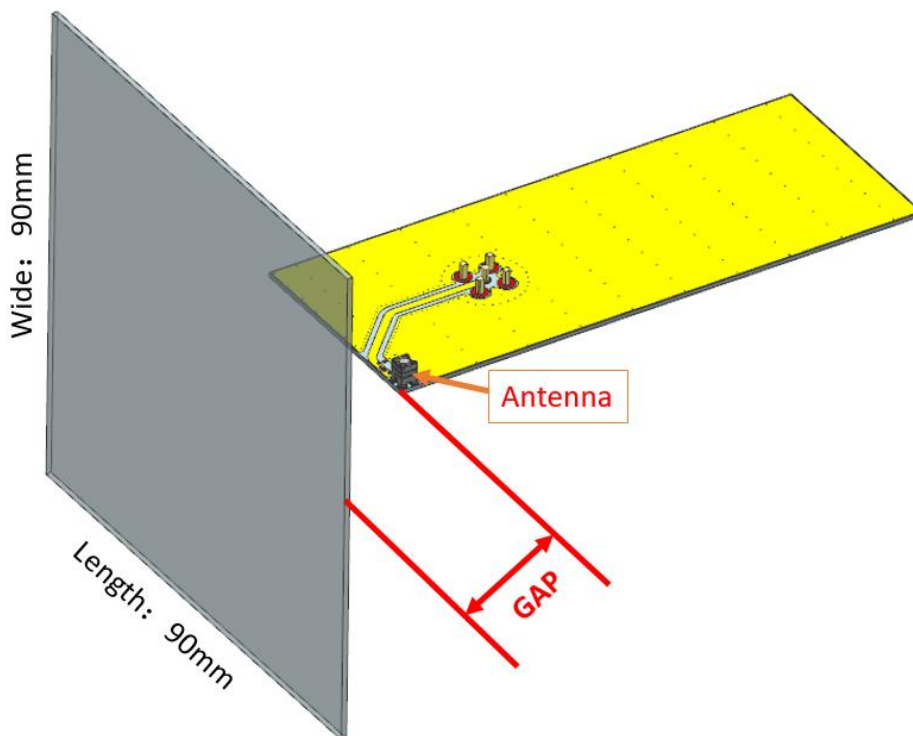
**FIGURE 7.1.2 EFFICIENCY OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

|                     |                                   |   |                 |
|---------------------|-----------------------------------|---|-----------------|
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## 7.2 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH VERTICAL PLANE GROUND

Four locations with vertical plane ground have been evaluated and these locations are shown in figure 7.2. The plane ground size is 90mm\*90mm and we move the plane ground to four locations for each test.

The distance between antenna and vertical plane ground affect the antenna performance slightly. We still suggest the minimum distance between antenna and plane ground is recommended to be 5mm.



**FIGURE 7.2 FOUR LOCATIONS WITH VERTICAL PLANE GROUND**

Ground Size: 90mm\*90mm;

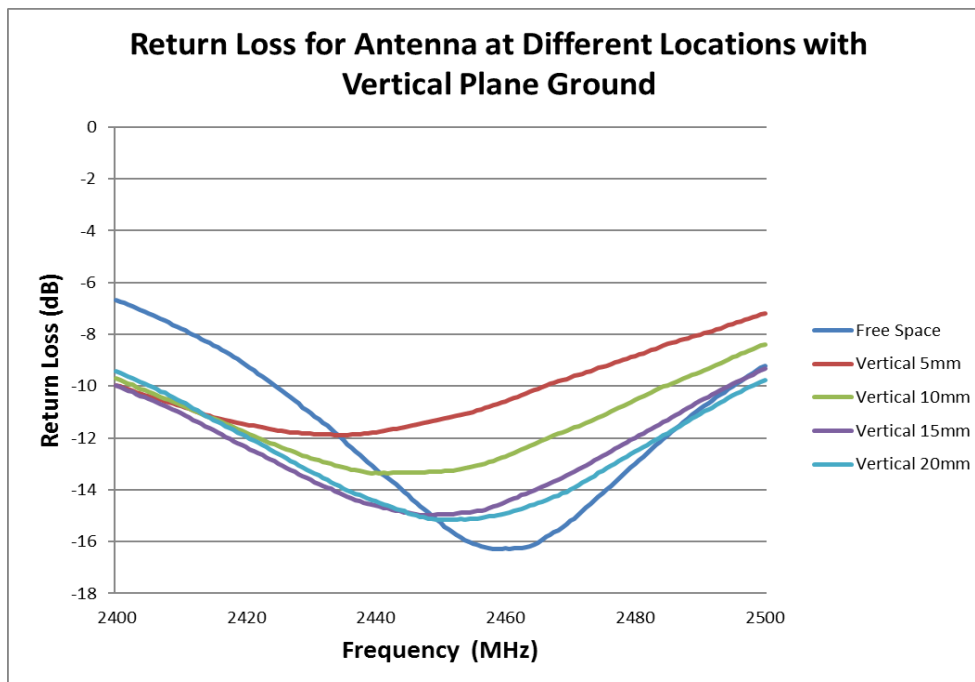
Location 1: Distance between antenna and plane ground (GAP) is about 5mm;

Location 2: Distance between antenna and plane ground (GAP) is about 10mm;

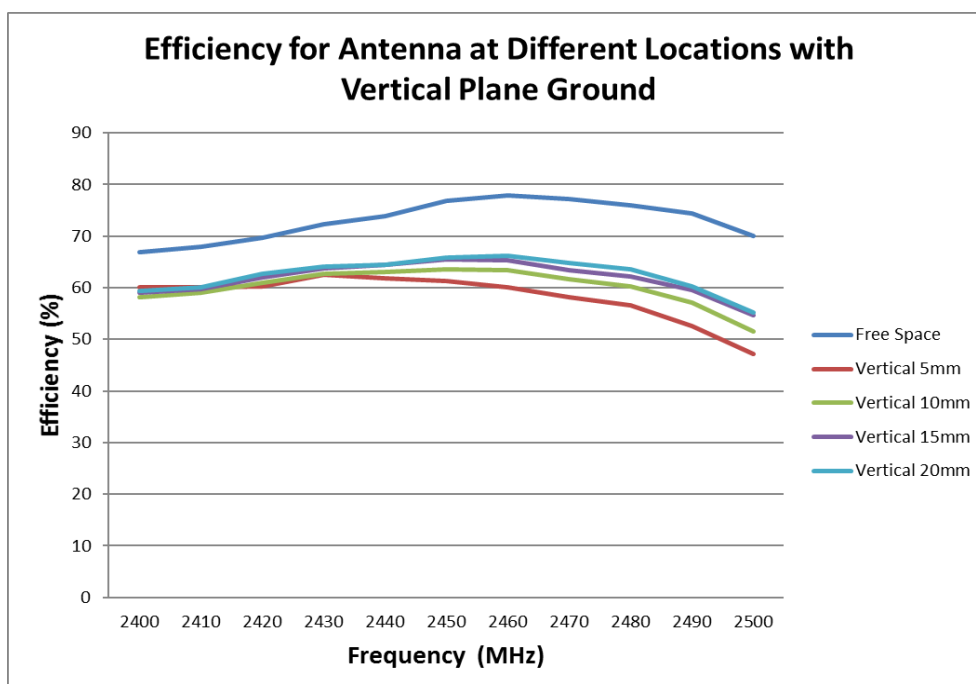
Location 3: Distance between antenna and plane ground (GAP) is about 15mm;

Location 4: Distance between antenna and plane ground (GAP) is about 20mm.

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**FIGURE 7.2.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND**



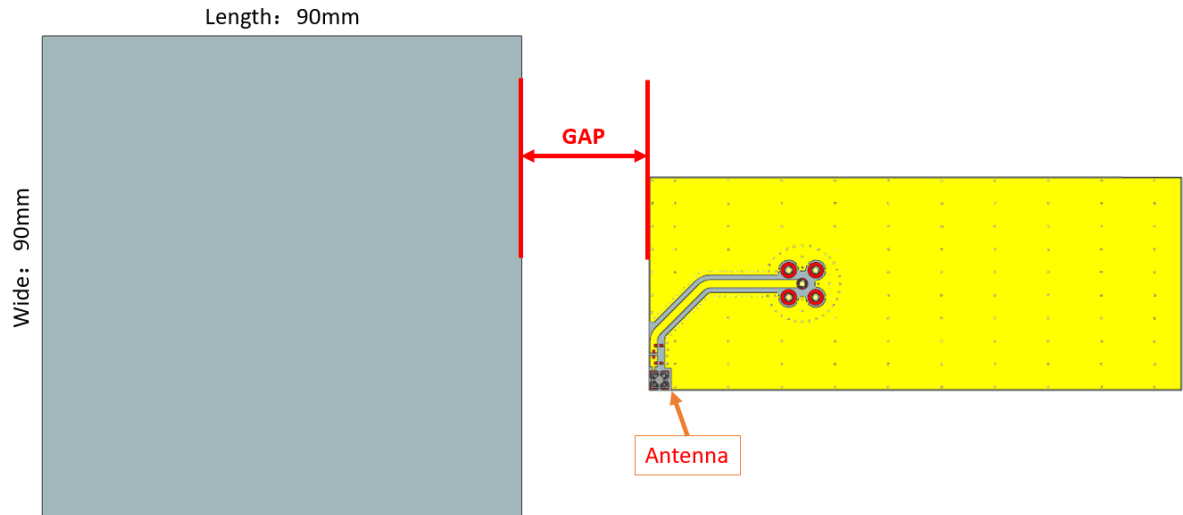
**FIGURE 7.2.2 EFFICIENCY OF ANTENNA AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND**

|                     |                                   |   |                 |
|---------------------|-----------------------------------|---|-----------------|
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## 7.3 ANTENNA RF PERFORMANCE AS A FUNCTION OF DIFFERENT LOCATIONS WITH PARALLEL PLANE GROUND

Four locations with parallel plane ground have been evaluated and these locations are shown in figure 7.3. The plane ground size is 90mm\*90mm and we move the plane ground to four locations for each test.

The distance between antenna and parallel plane ground affect the antenna performance slightly. We still suggest the minimum distance between antenna and plane ground is recommended to be 5mm.



**FIGURE 7.3 FOUR LOCATIONS WITH VERTICAL PLANE GROUND**

Ground Size: 90mm\*90mm;

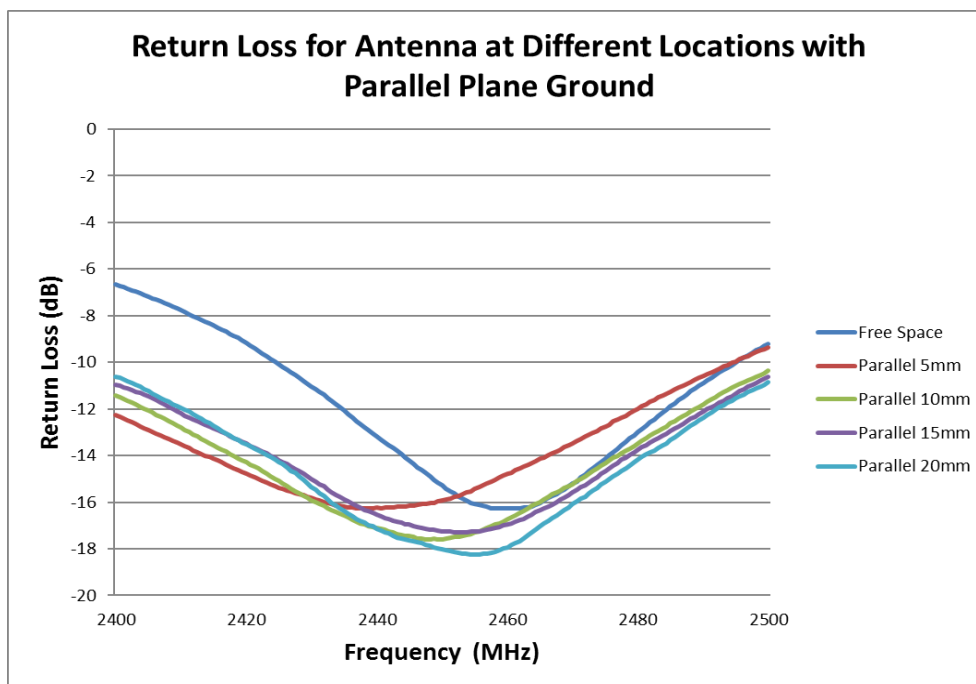
Location 1: Distance between antenna and plane (GAP) ground is about 5mm;

Location 2: Distance between antenna and plane (GAP) ground is about 10mm;

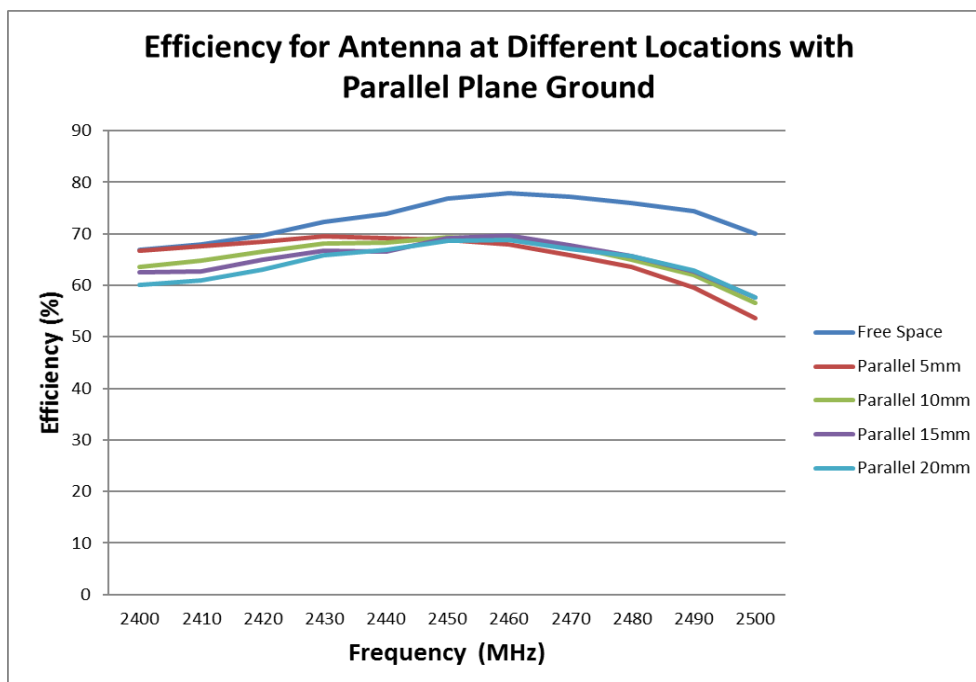
Location 3: Distance between antenna and plane (GAP) ground is about 15mm;

Location 4: Distance between antenna and plane (GAP) ground is about 20mm.

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**FIGURE 7.3.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**



**FIGURE 7.3.2 EFFICIENCY OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND**

|                     |                                   |   |                 |
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# APPLICATION SPECIFICATION

## 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 | DATA       | DESCRIPTION                          |
|-----|------------|--------------------------------------|
| F   | 2020/05/11 | Update document template             |
| G   | 2023/02/10 | Add 8.0 other molex antenna products |
|     |            |                                      |
|     |            |                                      |

|                     |                                   |   |                 |
|---------------------|-----------------------------------|---|-----------------|
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