TITLE

2.4GHZ MID SMT ANTENNA

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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

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)

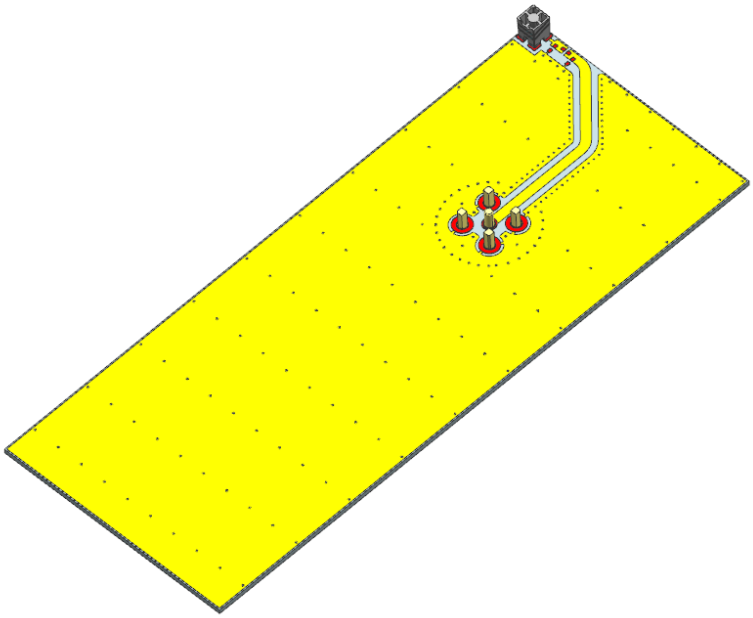


FIGURE4.1.1 REFERENCE ANTENNA LOCATION

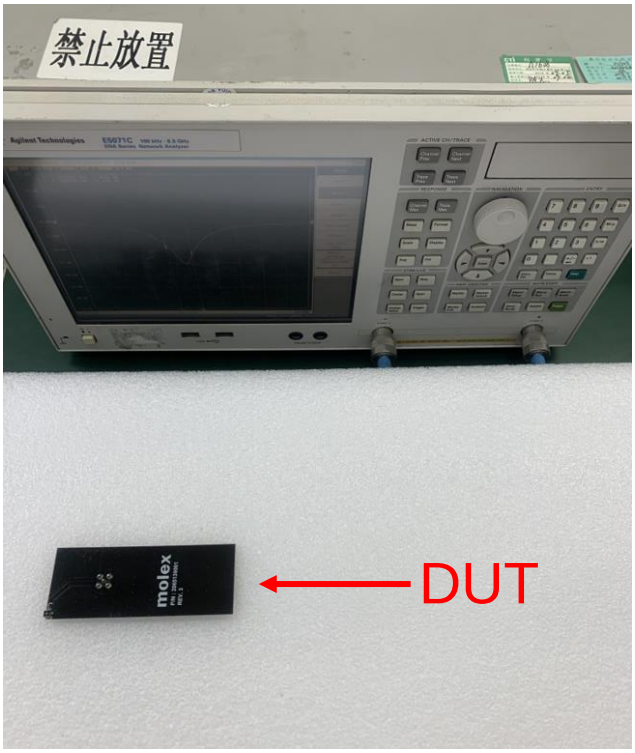


FIGURE4.1.2 ANTENNA IN FREE SPACE WITH VNA AGILENT E5071C

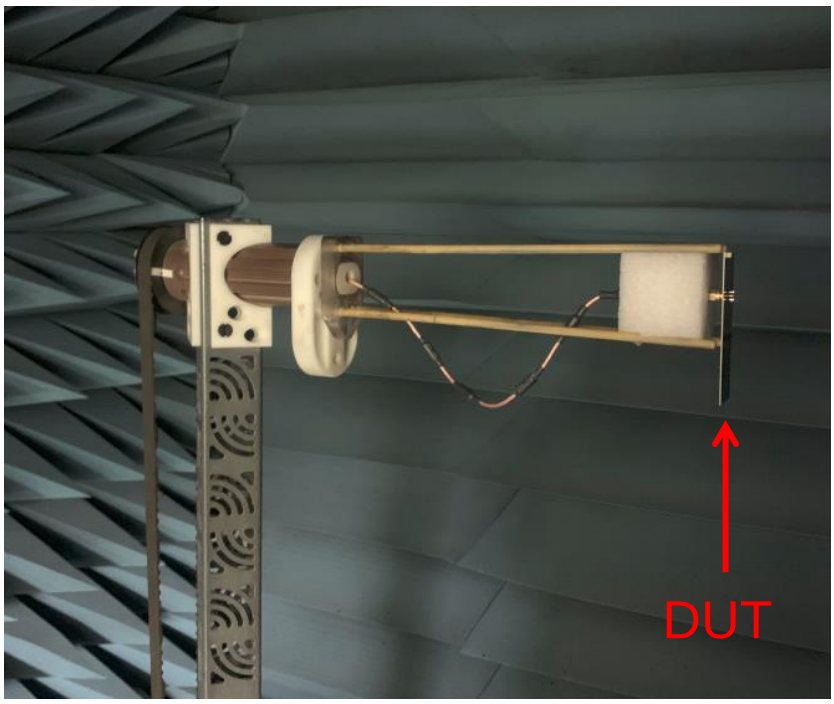


FIGURE4.1.3 ANTENNA IN FREE SPACE WITH OTA CHAMBER

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	3.7dBi
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.

4.3 RETURN LOSS PLOT

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

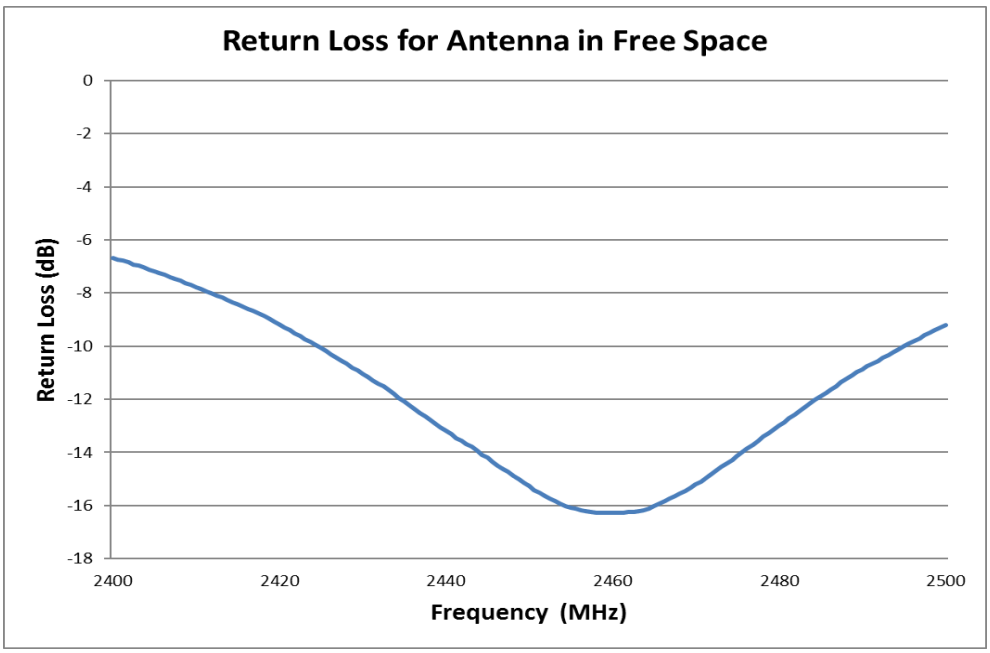


FIGURE 4.3 RETURN LOSS OF ANTENNA IN FREE SPACE

4.4 EFFICIENCY PLOT

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

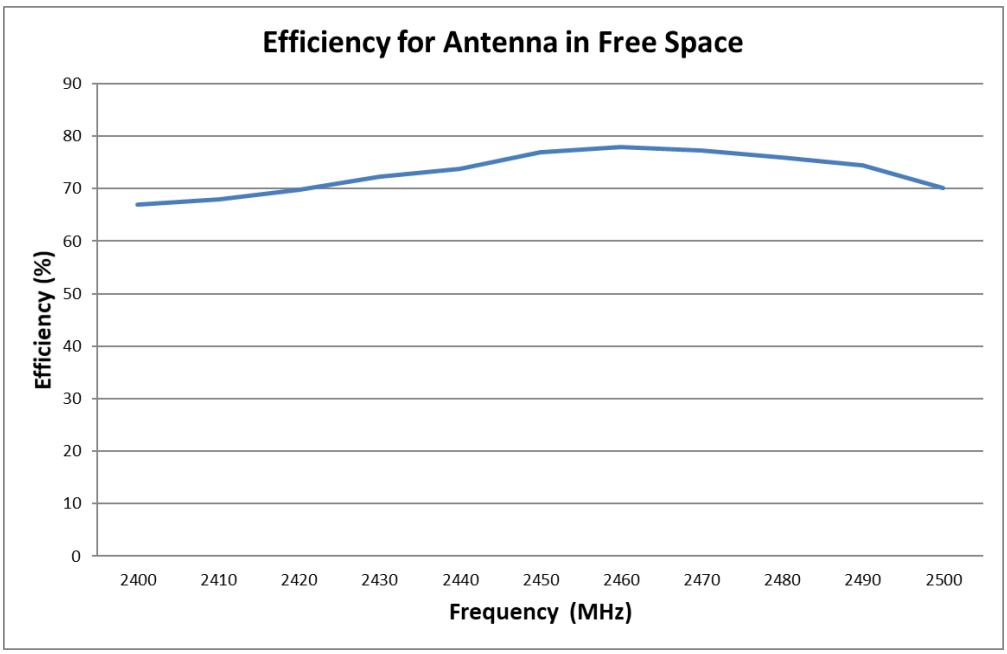
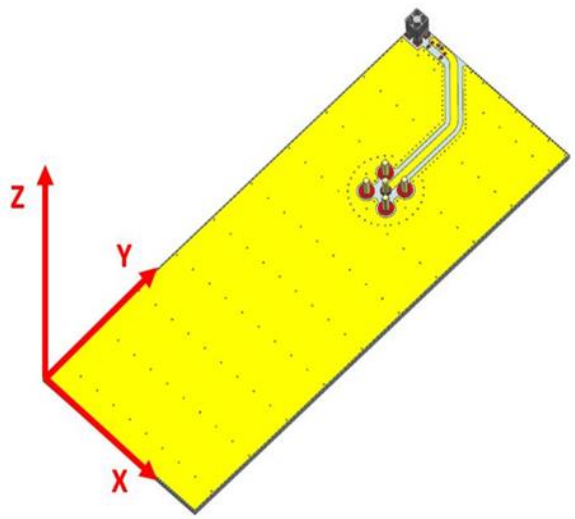
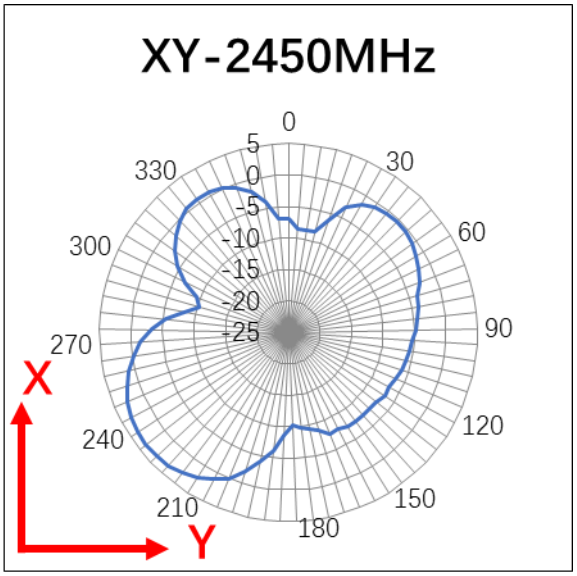


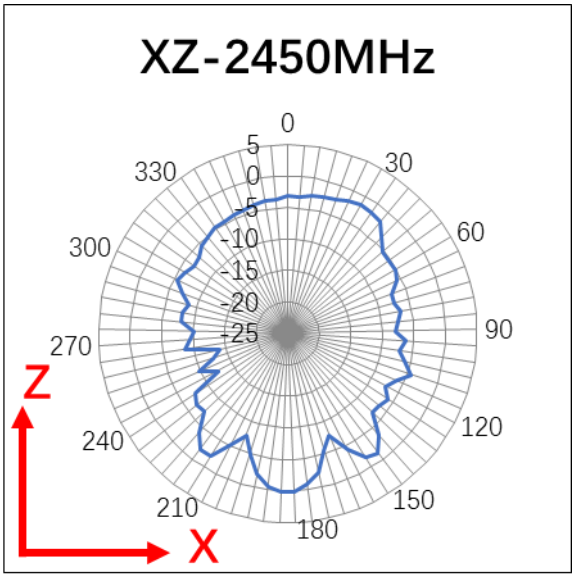
FIGURE 4.4 EFFICIENCY OF ANTENNA IN FREE SPACE

4.5 RADIATION PATTERN

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







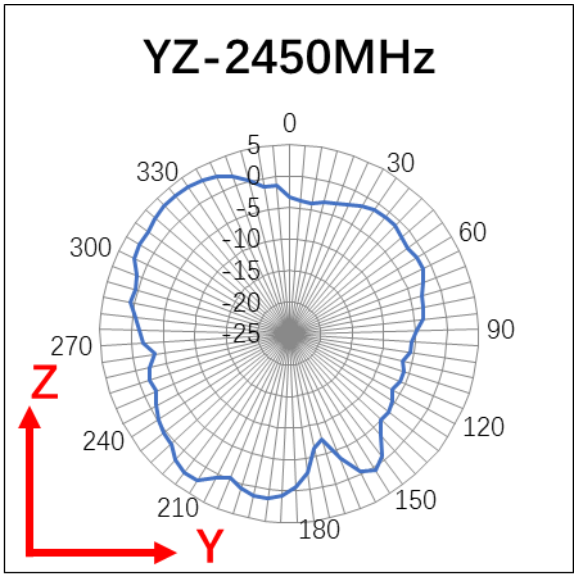


FIGURE 4.5.1 2D RADIATION PATTERN OF ANTENNA AT 2.45GHZ IN FREE SPACE

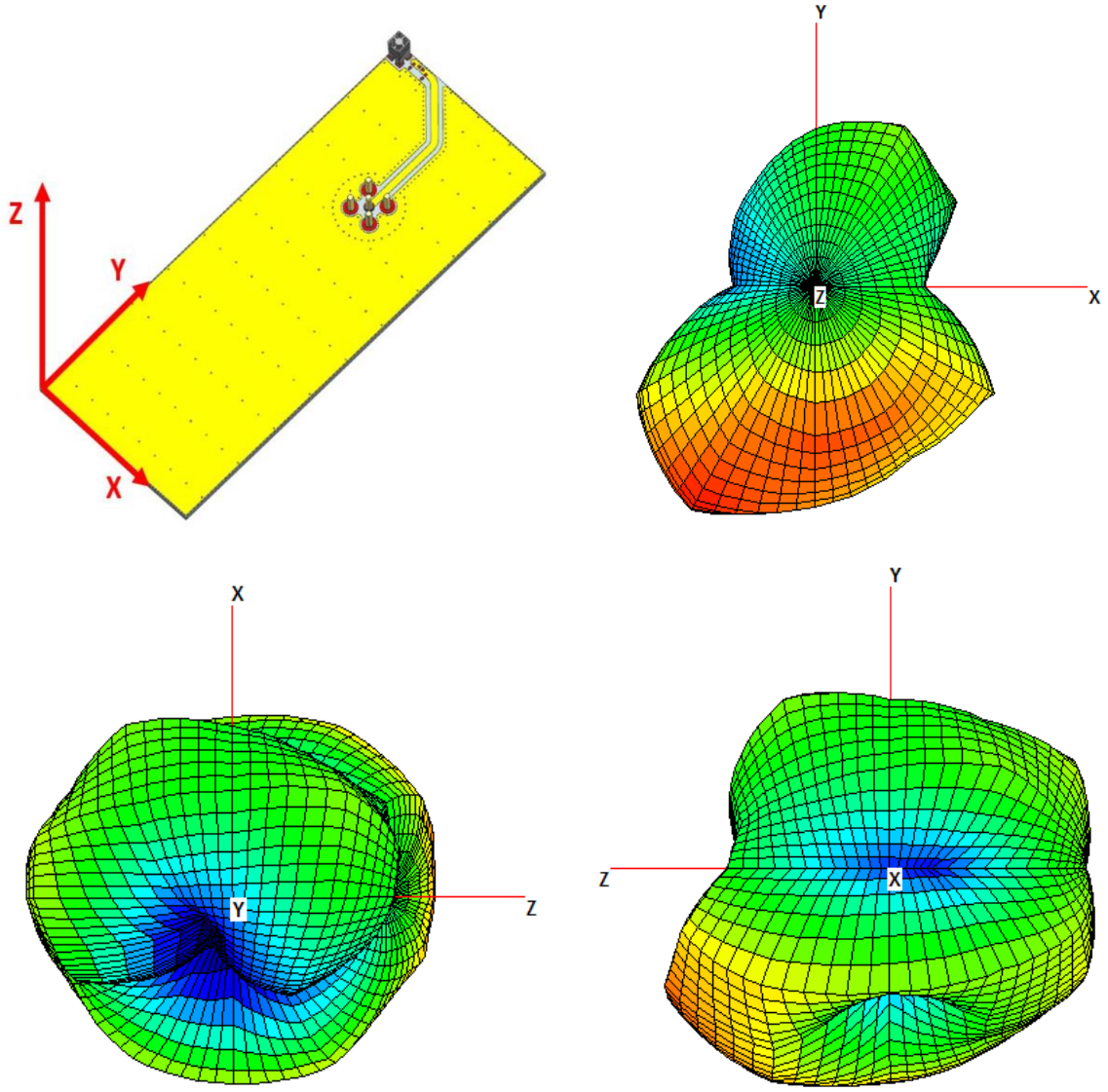
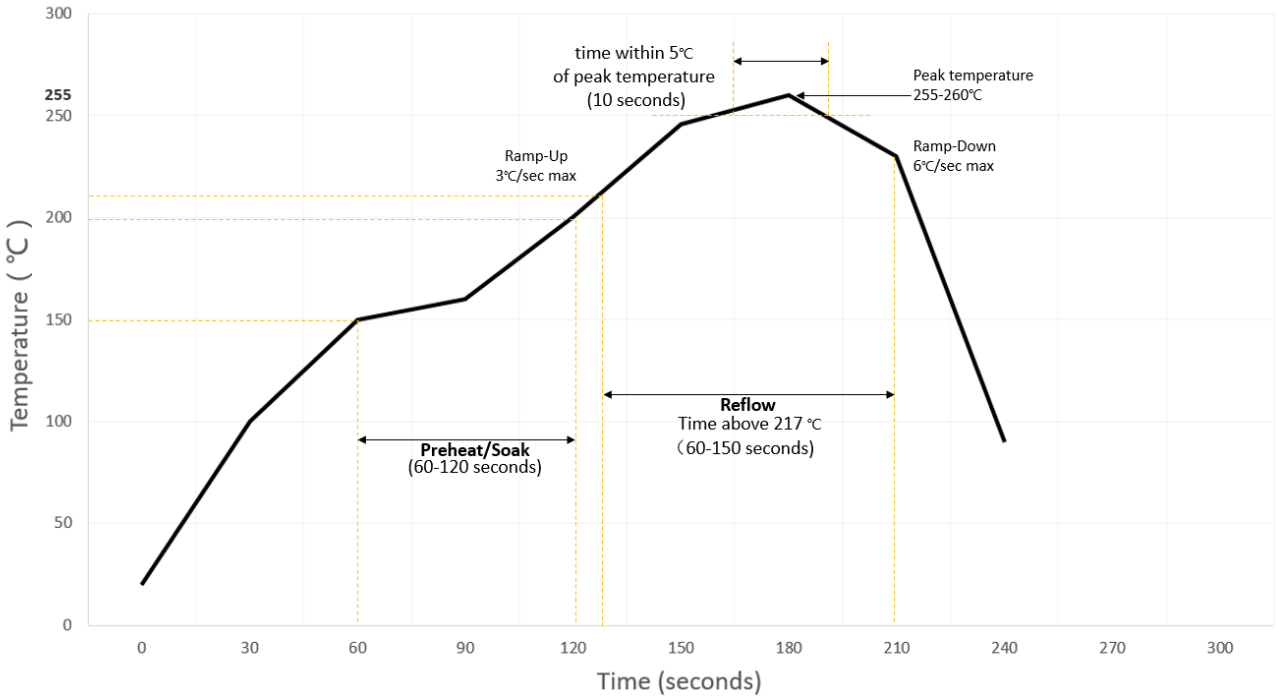


FIGURE 4.5.2 3D RADIATION PATTERN OF ANTENNA AT 2.45GHZ IN FREE SPACE

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. (PCB molex p/n:479489001)

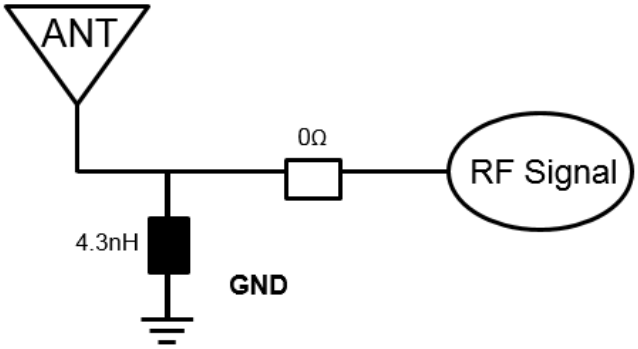
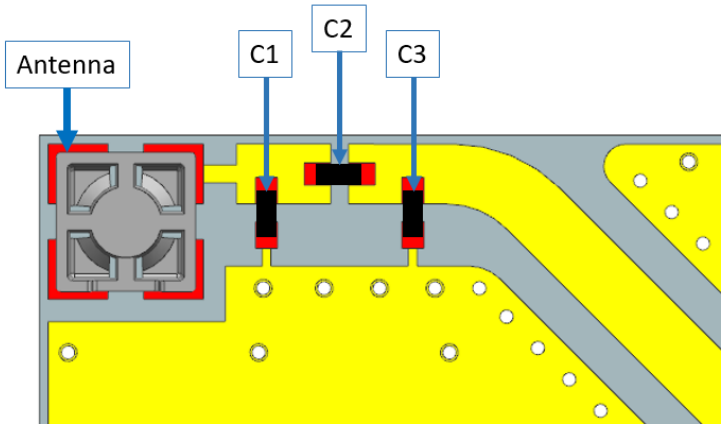


FIGURE 6.1 RECOMMENDED MATCHING CIRCUIT FOR 2.4GHZ BAND



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

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.

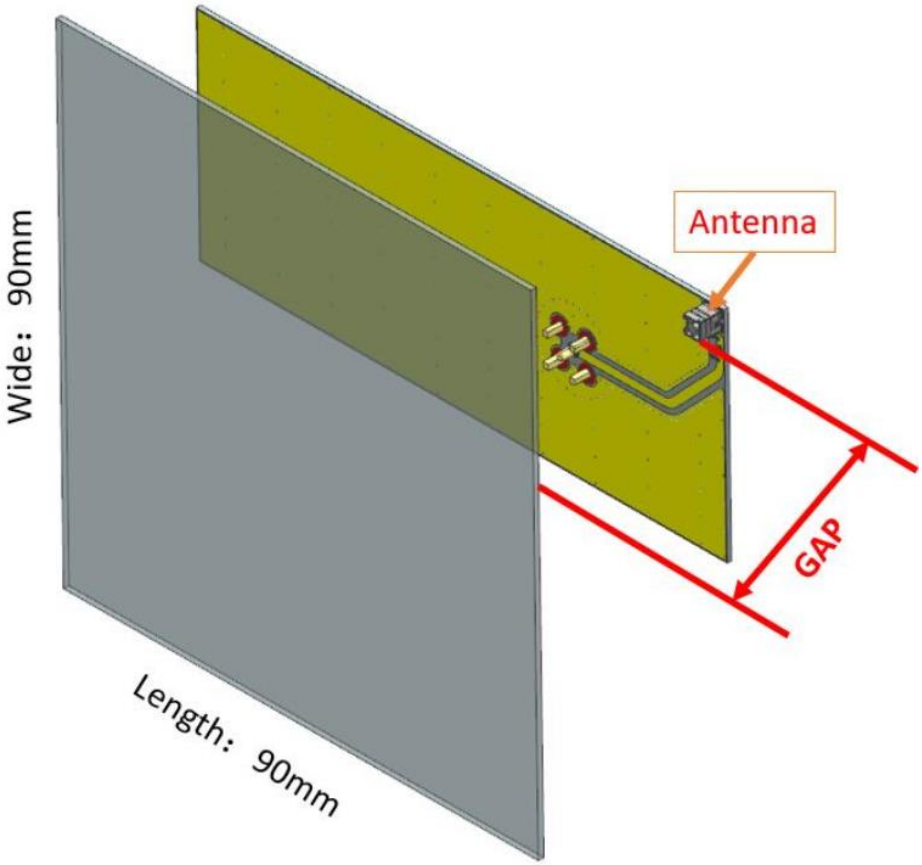


FIGURE 7.1 FOUR LOCATIONS WITH PARALLEL PLANE GROUND

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

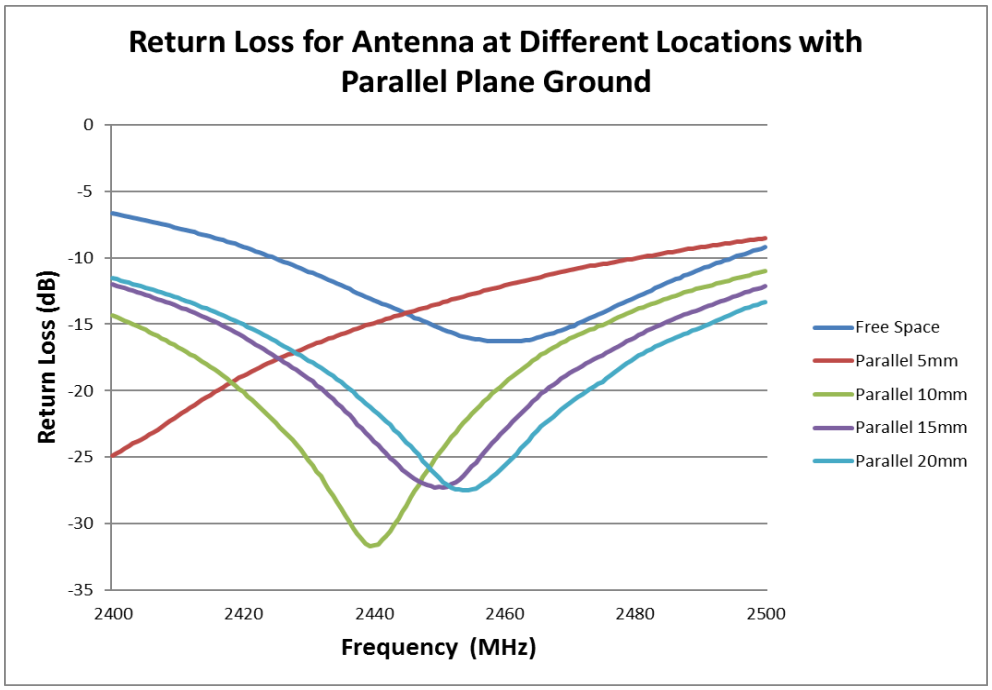


FIGURE 7.1.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

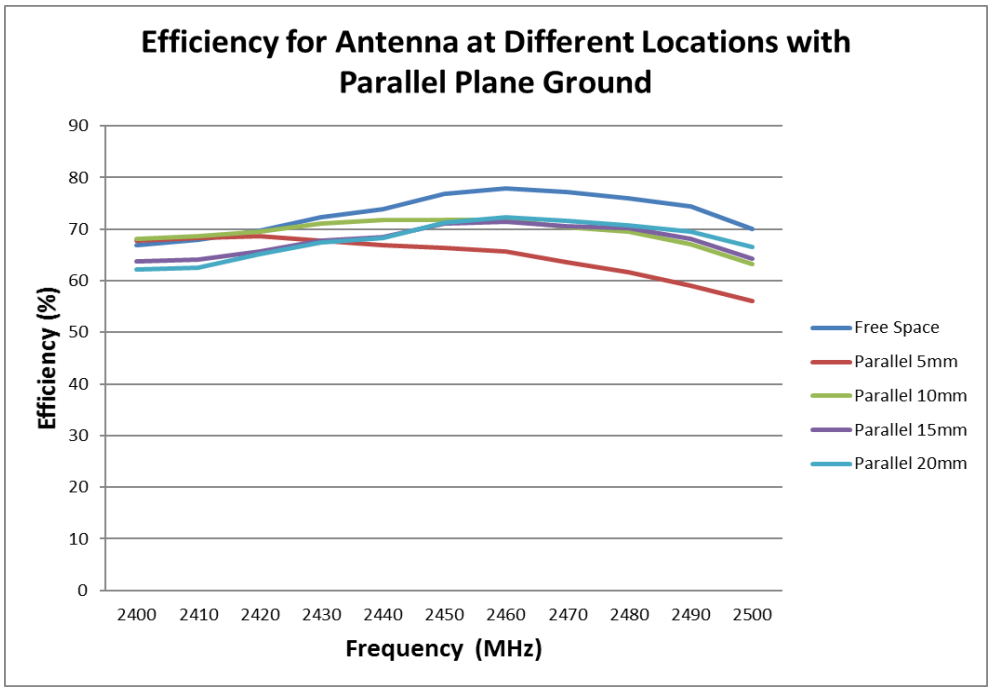


FIGURE 7.1.2 EFFICIENCY OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

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.

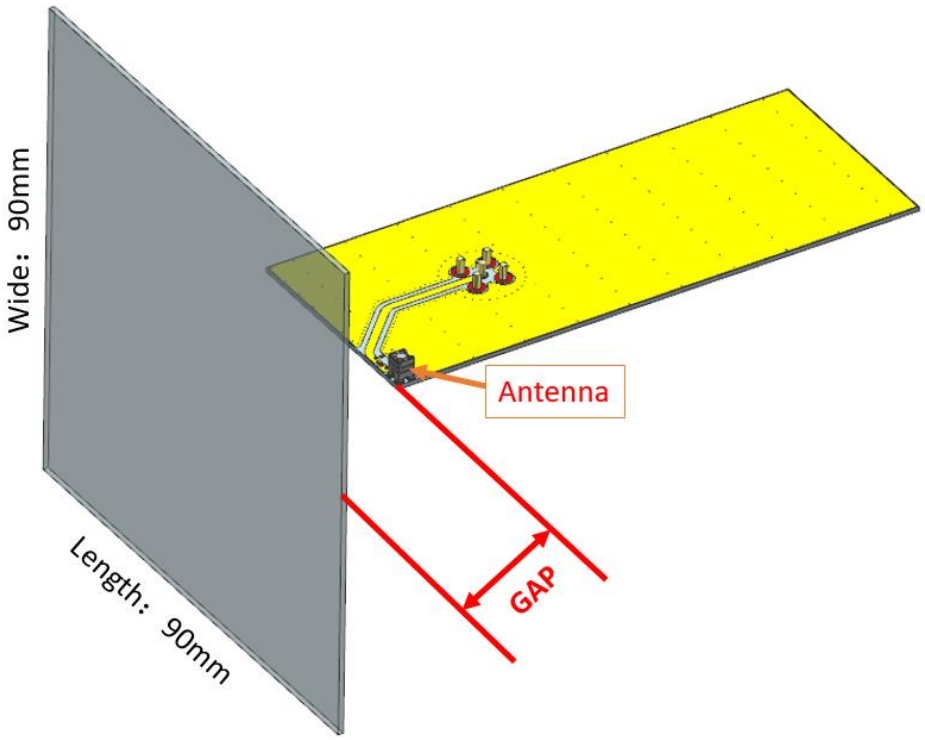


FIGURE 7.2 FOUR LOCATIONS WITH VERTICAL PLANE GROUND

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.

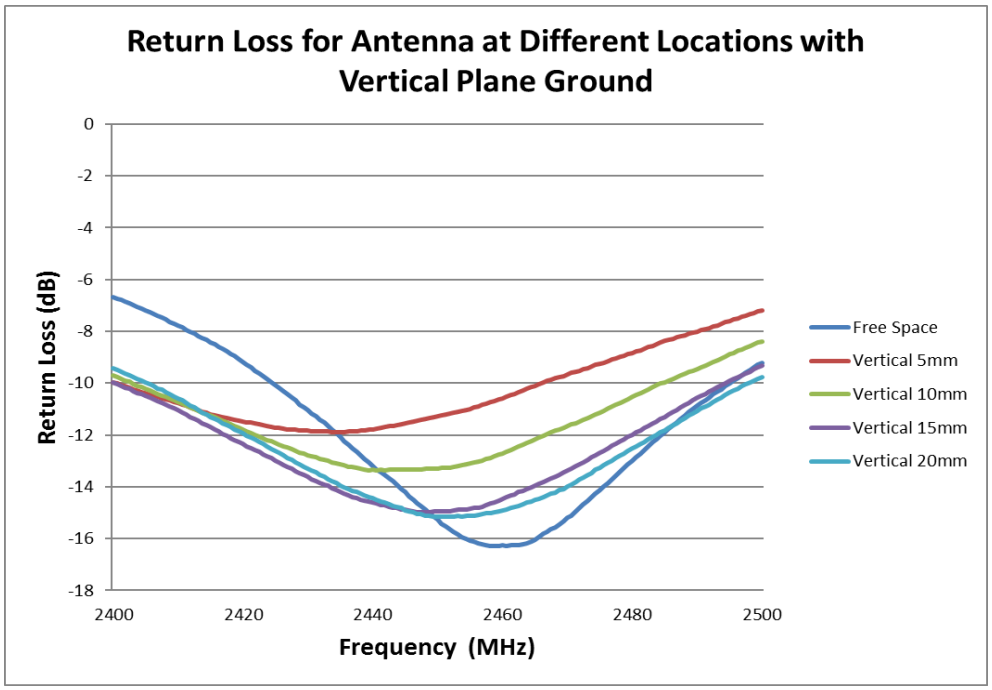


FIGURE 7.2.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND

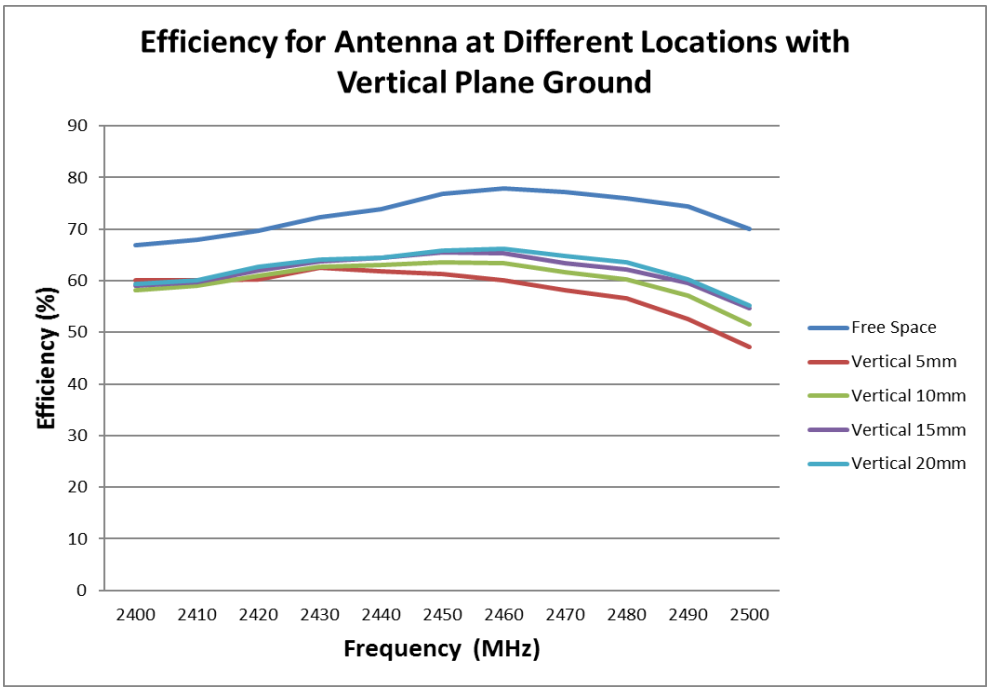


FIGURE 7.2.2 EFFICIENCY OF ANTENNA AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND

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.

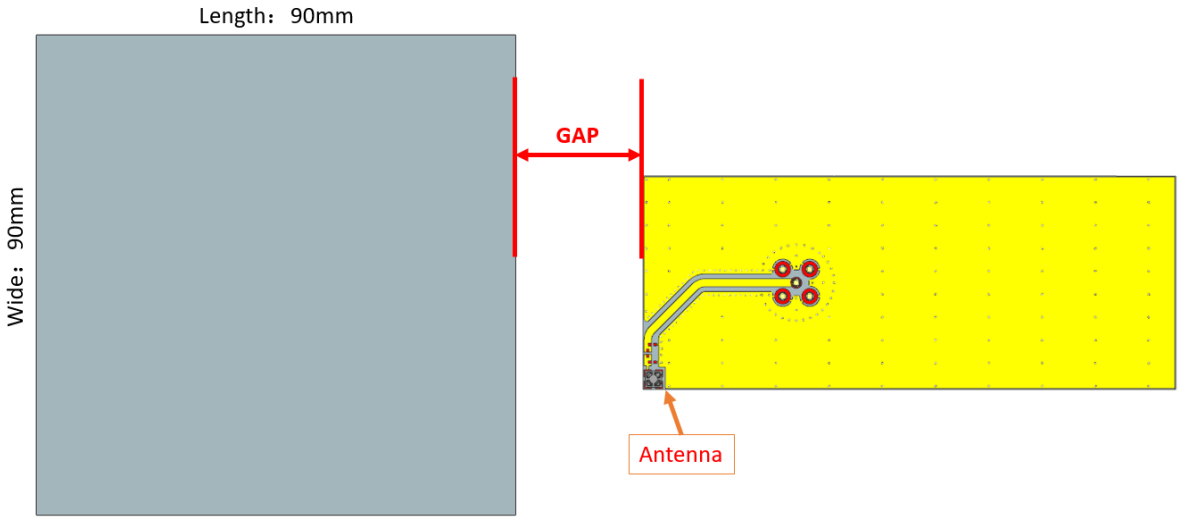


FIGURE 7.3 FOUR LOCATIONS WITH VERTICAL PLANE GROUND

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.

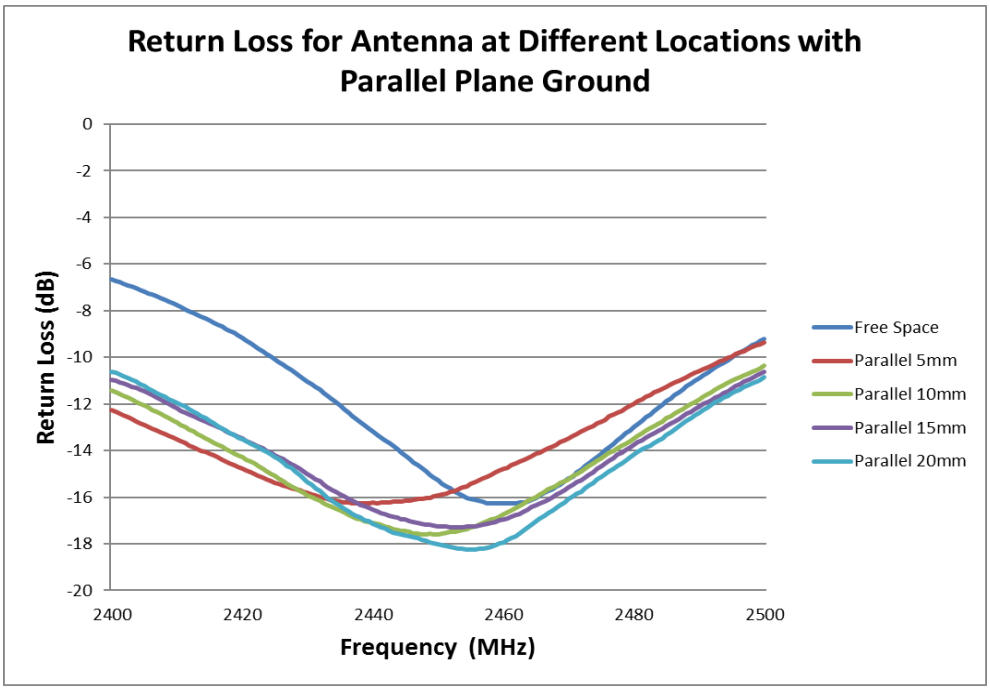


FIGURE 7.3.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

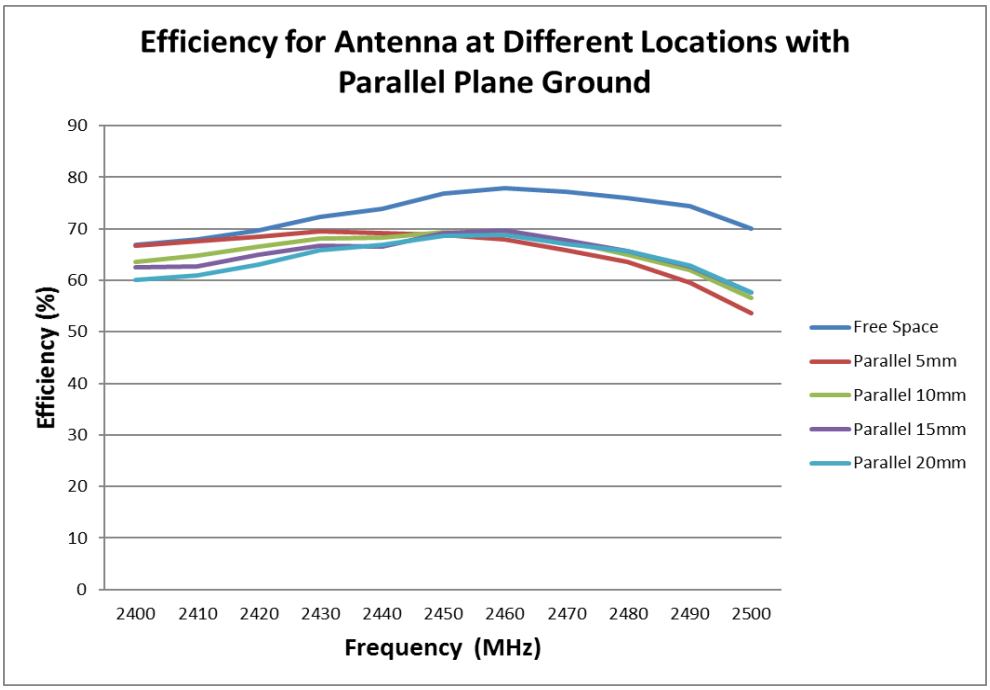


FIGURE 7.3.2 EFFICIENCY OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND

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

TITLE

2.4GHZ MID SMT ANTENNA

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8.0 RECOMMENDED REFLOW CONDITION

9.0 RECOMMENDED FOOTPRINT ON PCB FOR SOLDERING

10.0 PACKING

11.0 OTHER MOLEX ANTENNA PRODUCTS

12.0 CHANGED HISTORY

2.4GHZ MID SMT ANTENNA

1.0 SCOPE

This product specification covers the mechanical, electrical and environmental performances specification for 2.4GHz MID SMT antenna.

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.

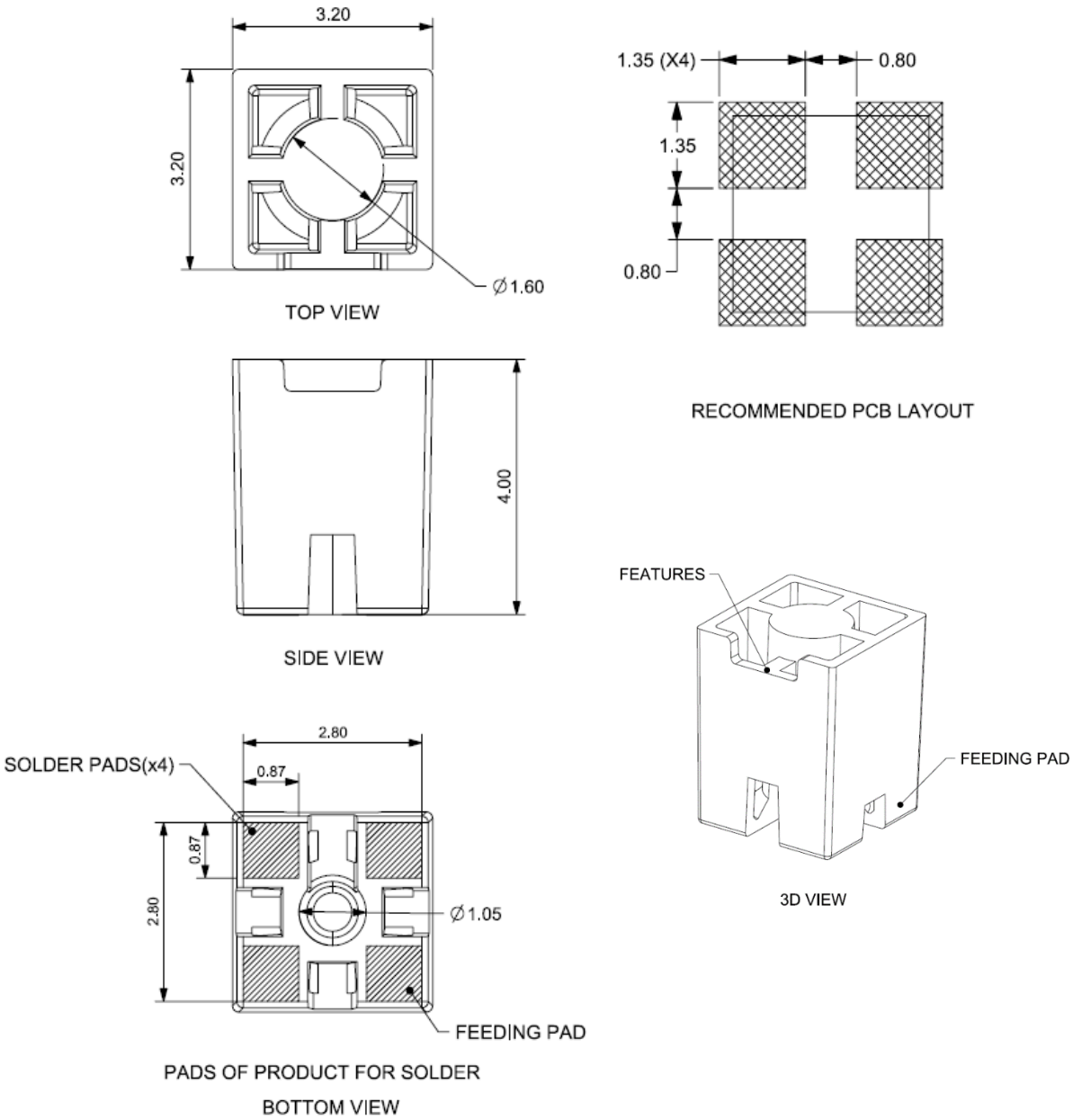
2.3 FEATURES

- 2.4GHz, monopole,
- SMT embedded, PCB corner mounting
- High efficiency over 70% on 2.4-2.5GHz
- Antenna size 3x3x4mm
- RoHS Compliant

ANTENNA PICTURE

2.4 PRODUCT STRUCTURE INFORMATION

P/N	479480001



MECHANICAL STRUCTURE INFORMATION FOR 479480001

3.0 APPLICABLE DOCUMENTS

DOCUMENT	NUMBER	DESCRIPTION
Sale Drawing (SD)	SD-479480001	Mechanical Dimension of the product
Application Guide (AS)	AS-479480001	Antenna Application and surrounding
Packing Drawing (PK)	PK-479480001	Product packaging specifications

4.0 GENERAL SPECIFICATION

PRODUCT NAME	2.4GHZ MID SMT antenna
PART NUMBER	479480001
FREQUENCY RANGE(+/-3MHz)	2.4~2.5GHz
POLARIZATION	Linear
IMPEDANCE WITH MATCHING	50 Ohms
OPERATION TEMPERATURE	-40℃ to 85℃
STORAGE TEMPERATURE	-40℃ to 85℃
AVERAGE TOTAL EFFICIENCY	>70%
RF POWER	2 Watts
NET WEIGHT	0.042g/PCS
ANTENNA TYPE	Plastics

*If you plan to re-use the products that be taken out from packaging. Suggest to repacked them within 48 hours by re-seal to prevent oxidation!

5.0 ANTENNA SPECIFICATION

All measurements are done of the antenna mounted on reference PCB (100*40*0.8mm Molex p/n:479489001) with VNA Agilent E5071C and Over-The-Air (OTA) chamber.

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.

6.0 MECHANICAL REQUIREMENTS

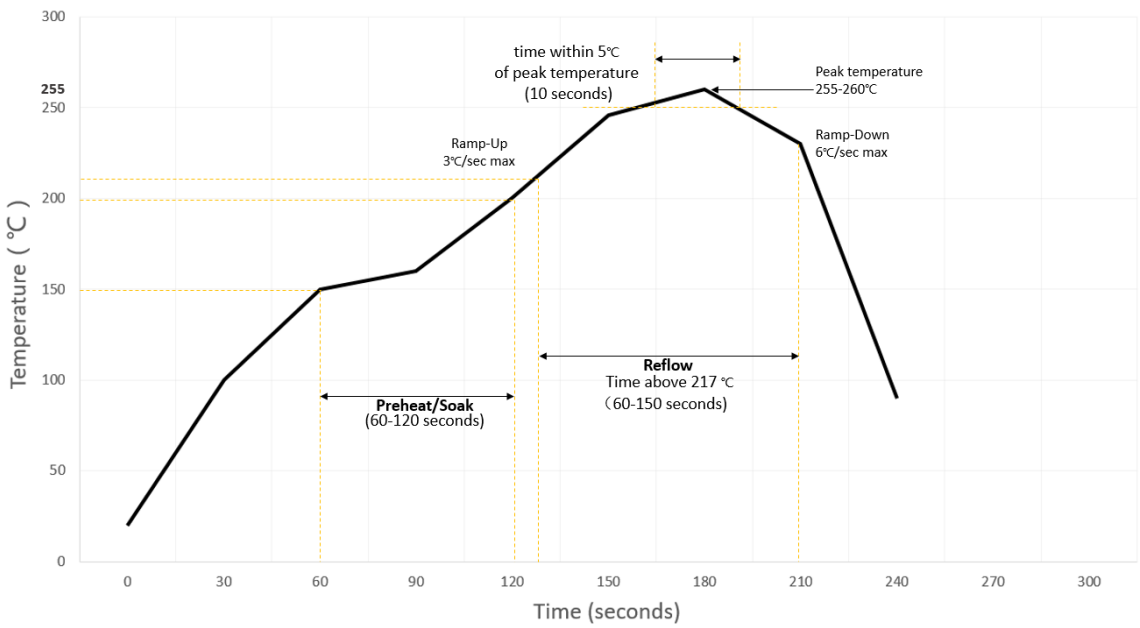
DESCRIPTION	SPECIFICATION
Shear Force	Apply three axial peeling force on parts soldered on the PCB at the speed rate of 25±3 mm/minute. Shear force:15N Min.
Solder-Ability Test	Dip solder pad in flux then immerse in solder bath at 245+/-50℃ for 4~5seconds,95% of immersed area mush show no voids

7.0 ENVIRONMENTAL SPECIFICATION

DESCRIPTION	SPECIFICATION
Temperature Cycling Test	1. The device under test is kept for 30 mins in an environment with a temperature of -40 ℃. 2. Kept for 4 Hours in an environment with a temperature of 85 degrees. 3. Kept for 2 Hours in an environment with a temperature of 125 degrees. 4. The cycle is repeated until a total of 40 cycles have been completed. Hereafter the conditions are stabilized at room temperature. 5. No cosmetic problem (No bubble issue、No plating peeling off issue、 No mechanical damage.)
Temperature Shock Test	1. The device under test at -40 ℃⇔125 ℃ by 100 cycles, Dwell of 30 mins, transition time between Dwell 30 secs (61 mins / cycle) and each item should be measured after exposing them in normal temperature and humidity for 24 h. 2. No cosmetic problem (No bubble issue、No plating peeling off issue、 No mechanical damage.)

DESCRIPTION	SPECIFICATION
High Temperature	1. Temperature:125℃, time:1008 hours. 2. There is no substantial obstruction to air flow across and around the samples, and the samples are not touching each other. 3. No visible corrosion.
Salt Mist Test	1. The device under test is exposed to a spray of a 5% (by volume) resolution of NACL in water for 2 hours. Thereafter the device under test is left for 1 week in room temperature at a relative humidity of 95%. The cycle is repeated until a total of 2 cycles have been completed. Here after the conditions are stabilized at room temperature。 2. No visible corrosion. 3. Discoloration acceptable.

8.0 RECOMMENDED REFLOW CONDITION



Recommended IR reflow times：1 time.

Recommended solder paste: ALPHA CAP-390 SAC305(Ag%≥3%)

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. (Figure 8.1)

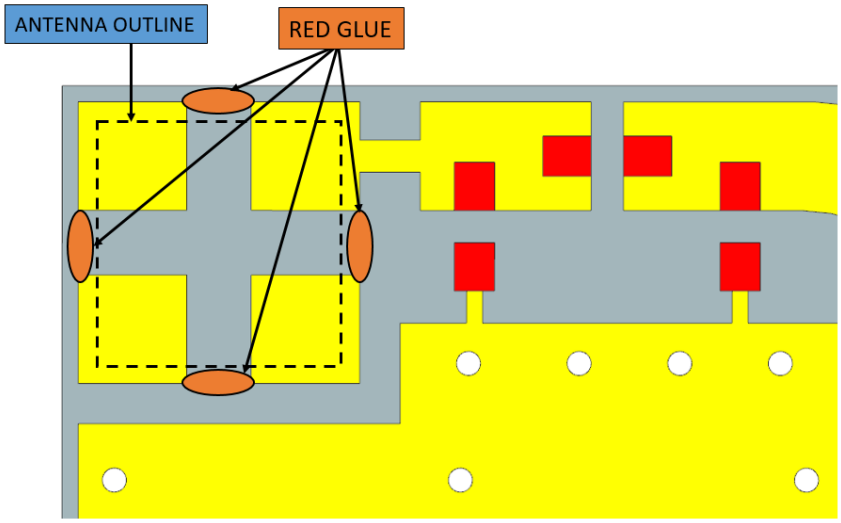
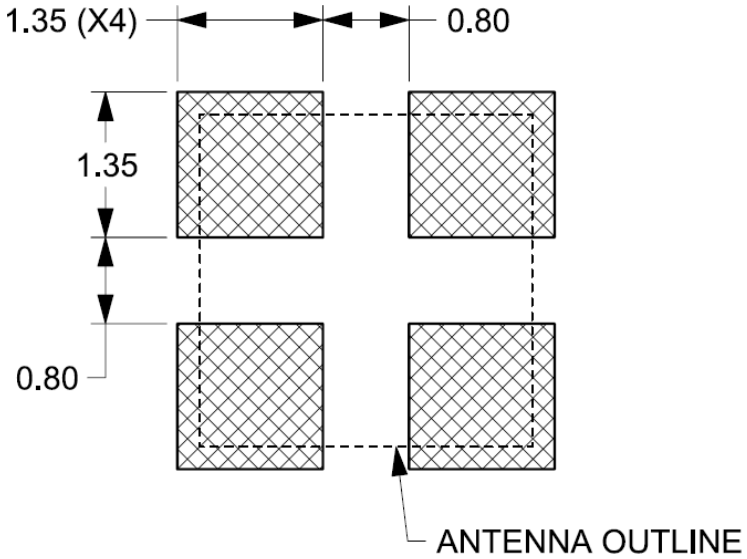


FIGURE 8.1 PCB BOARD SCHEMATIC PICTURE

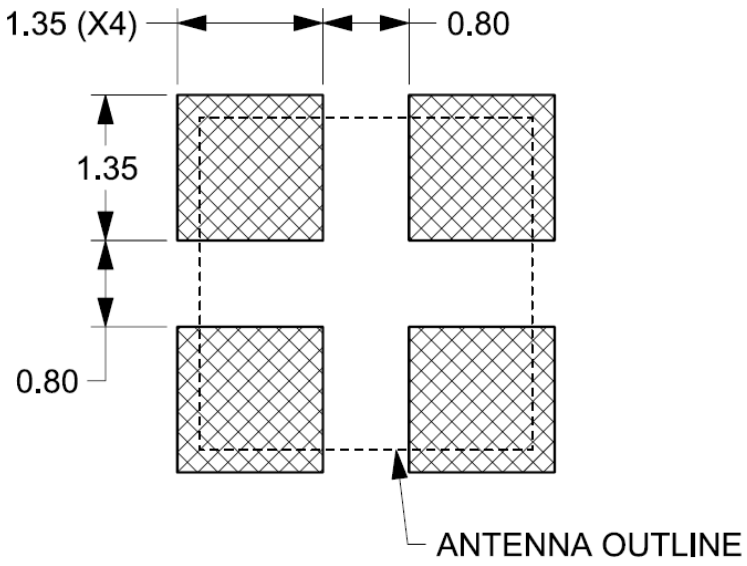
9.0 RECOMMENDED FOOTPRINT ON PCB FOR SOLDERING

9.1 RECOMMENDED PCB PADS AREA



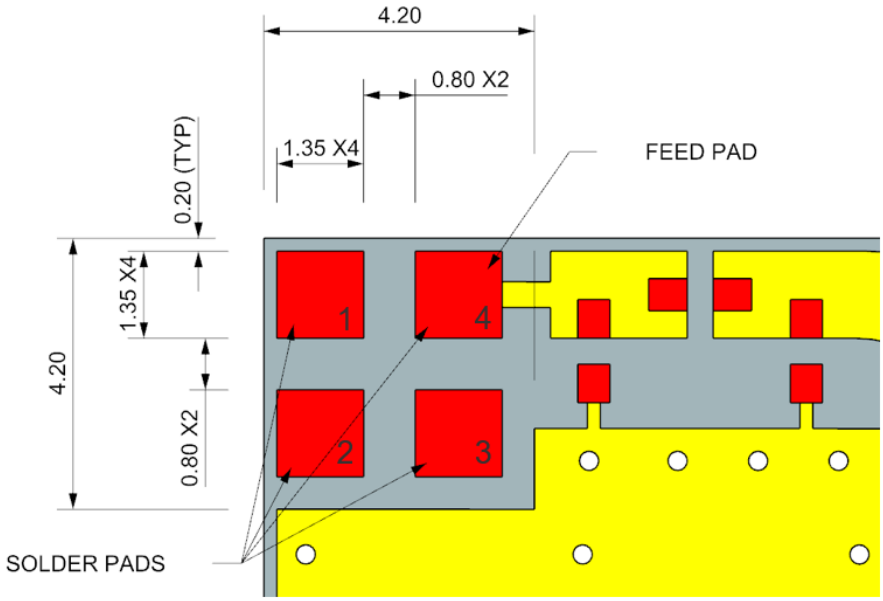
RECOMMENDED PCB LAYOUT

9.2 RECOMMENDED STENCIL OPENING DESIGN



Recommended Stencil Thickness > 0.1mm

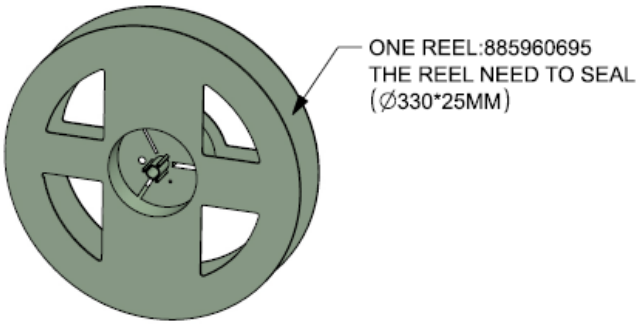
9.3 RECOMMENDED PCB CLEARANCE KEEP OUT AREA

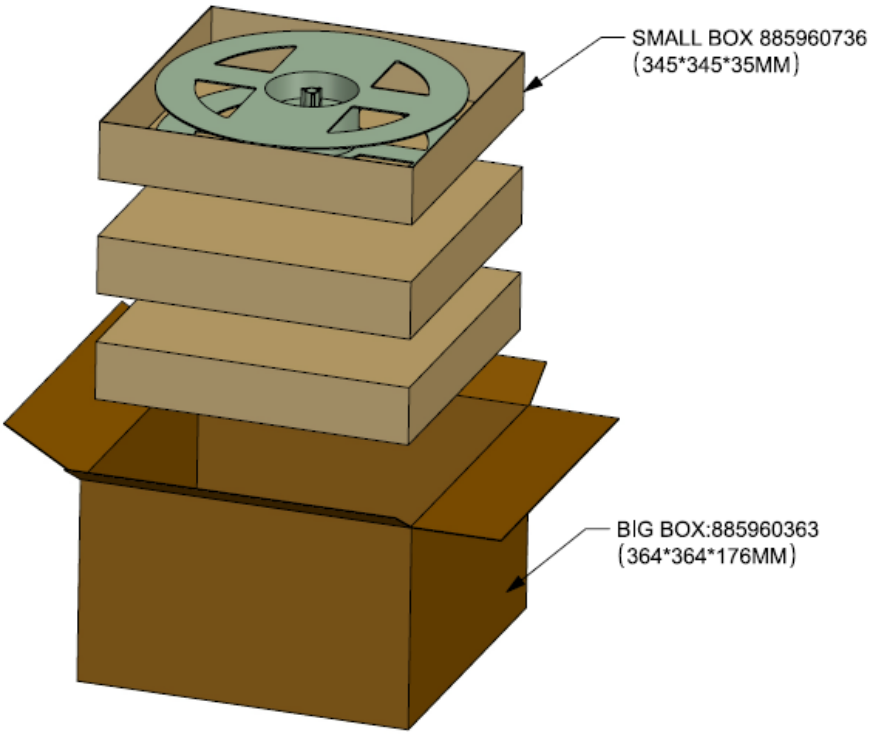


RECOMMENDED PCB CLEARANCE KEEP OUT AREA
(Pad-1 & Pad-2 & Pad-3 is Fixed pad do not grounded, Pad-4 is feed pad)

10.0 PACKING

P/N	Q'TY/REEL	REEL/SMALL BOX	SMALL BOX/BIG BOX	SPQ
479480001	1800	1	5	1800





NOTES:
1.PRODUCTS MUST BE PACKED IN CARTONS AND SEALED UP WITH TAPE.
2.STICK LABEL WITH PART NUMBER AND DATE CODE
3.STANDARD PACKAGING QUANTITY:SEE TABLE
4.THIS PACKAGINGSPECIFICATION TO BE USED FOR "2.4GHz MID SMT ANTENNA".

PACKAGING INFORMATION FOR 4794800001

11.0 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

12.0 CHANGED HISTORY

REV	DATE	DESCRIPTION
F1	2022/04/08	Update 2.3 features description
G	2023/02/10	1. Update 9.3 recommended pcb clearance keep out area 2. Add 11.0 other molex antenna products
G1	2023/09/26	1. Add Pack Reel size information