TITLE

698-960MHZ CERAMIC ANTENNA

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698-960MHZ CERAMIC ANTENNA

1.0 SCOPE

This specification describes the antenna application and surrounding. The information in this document is for reference and benchmark purposes only.

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: 698-960MHz Ceramic Antenna

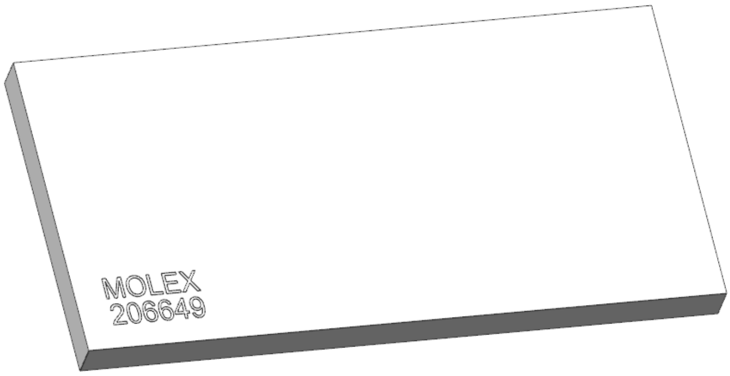
Series Number: 206649

2.2 DESCRIPTION

206649 is specifically designed for Low Power Wireless applications including NB-IoT, LoRa… With different matching and keep-out on PCB main board, it offers 4 different frequency band applications: 698 – 869 MHz; 791 – 862 MHz; 824 – 960 MHz; 698 – 960 MHz;

2.3 PRODUCT STRUCTURE INFORMATION

Please refer to PS-2066490001 for full information.



Molex 2066490001 698-960MHz CERAMIC ANTENNA 3D VIEW

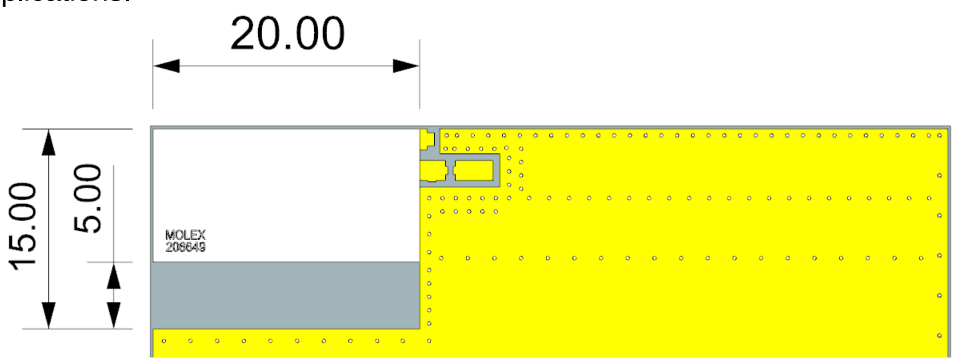
3.0 APPLICABLE DOCUMENTS

DOCUMENT	NUMBER	DESCRIPTION
Sale Drawing(SD)	SD-2066490001	Mechanical Dimension of the product
Product Specification (PS)	PS-2066490001	Product Specification
Packing Drawing(PK)	PK-2066490001	Product packaging specifications

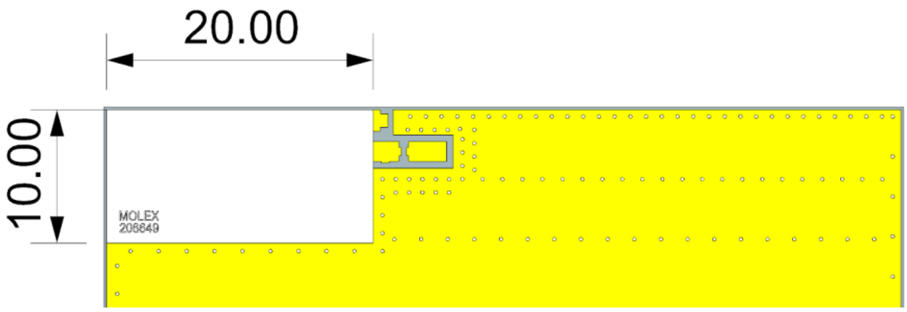
4.0 ANTENNA PERFORMANCE

4.1 RF TEST CONDITIONS

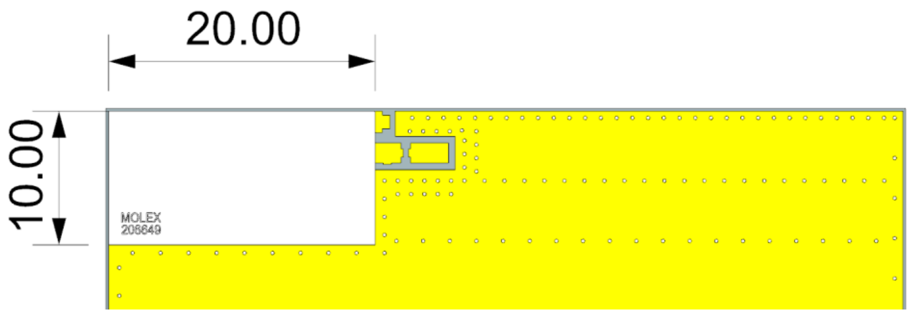
All measurements are done of the antenna mounted on a reference PCB (130*60*1mm) with VNA Agilent 5071C and Over-The-Air (OTA) chamber. There are four kinds of Applications for this antenna. The PCB sizes are the same while the clearance are different among the four Applications.



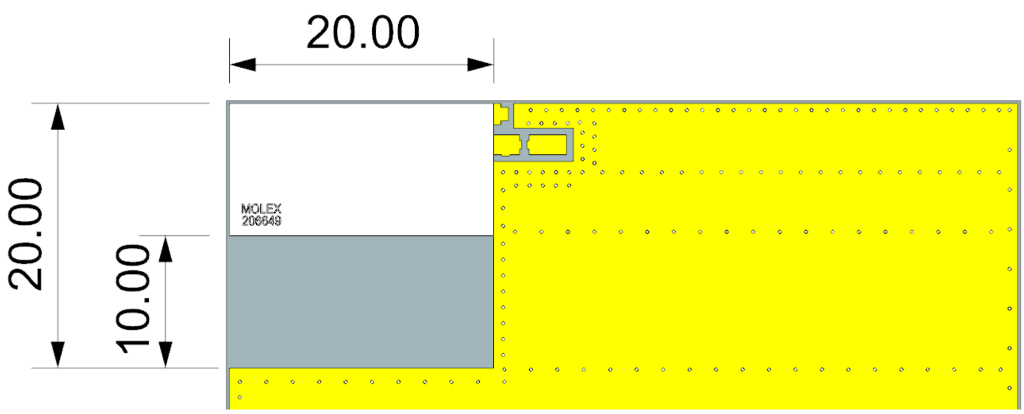
Application 1 (698-869MHz)
Recommended pcb clearance keep out area = 20x15 mm
Clearance around the perimeter of the antenna footprint = 5 mm



Application 2 (791-862MHz)
Recommended pcb clearance keep out area = 20x10 mm
Clearance around the perimeter of the antenna footprint = 0 mm



Application 3 (824-960MHz)
Recommended pcb clearance keep out area = 20x10 mm
Clearance around the perimeter of the antenna footprint = 0 mm



Application 4 (698-960MHz)
Recommended pcb clearance keep out area = 20x20 mm
Clearance around the perimeter of the antenna footprint = 10 mm

FIGURE4.1.1 ANTENNA LOADED ON A REFERENCE PCB IN FOUR APPLICATIONS

FIGURE4.1.2 ANTENNA LOADED WITH REFERENCE PCB TESTED WITH VNA E5071C

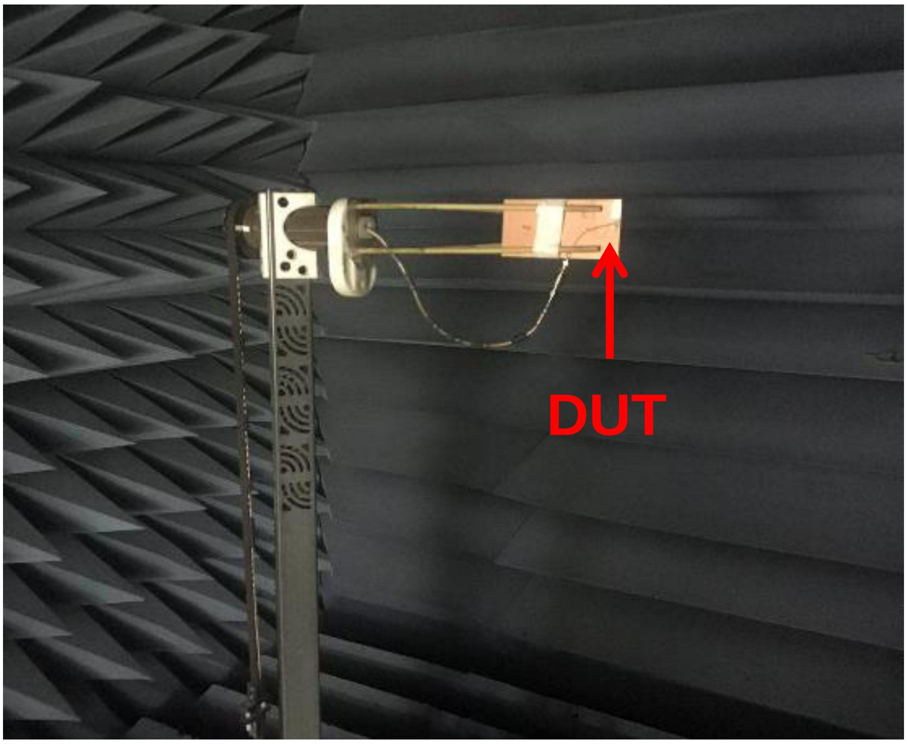


FIGURE4.1.3 ANTENNA LOADED WITH REFERENCE PCB TESTED IN OTA CHAMBER

4.2 ANTENNA PERFORMANCE

DESCRIPTION	EQUIPMENT	REQUIREMENT			
Frequency Range	VNA E5071C	Application 1	Application 2	Application 3	Application 4
		698-869MHz	791-862MHz	824-960MHz	698-960MHz
Return Loss	VNA E5071C	< -4 dB	< -6 dB	< -7 dB	< -5 dB
Peak Gain (Max)	OTA Chamber	0.5dBi	0.8dBi	1.1dBi	0.9dBi
Average Total Efficiency	OTA Chamber	50%	50%	55%	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 reference 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 on a reference PCB in four Applications.

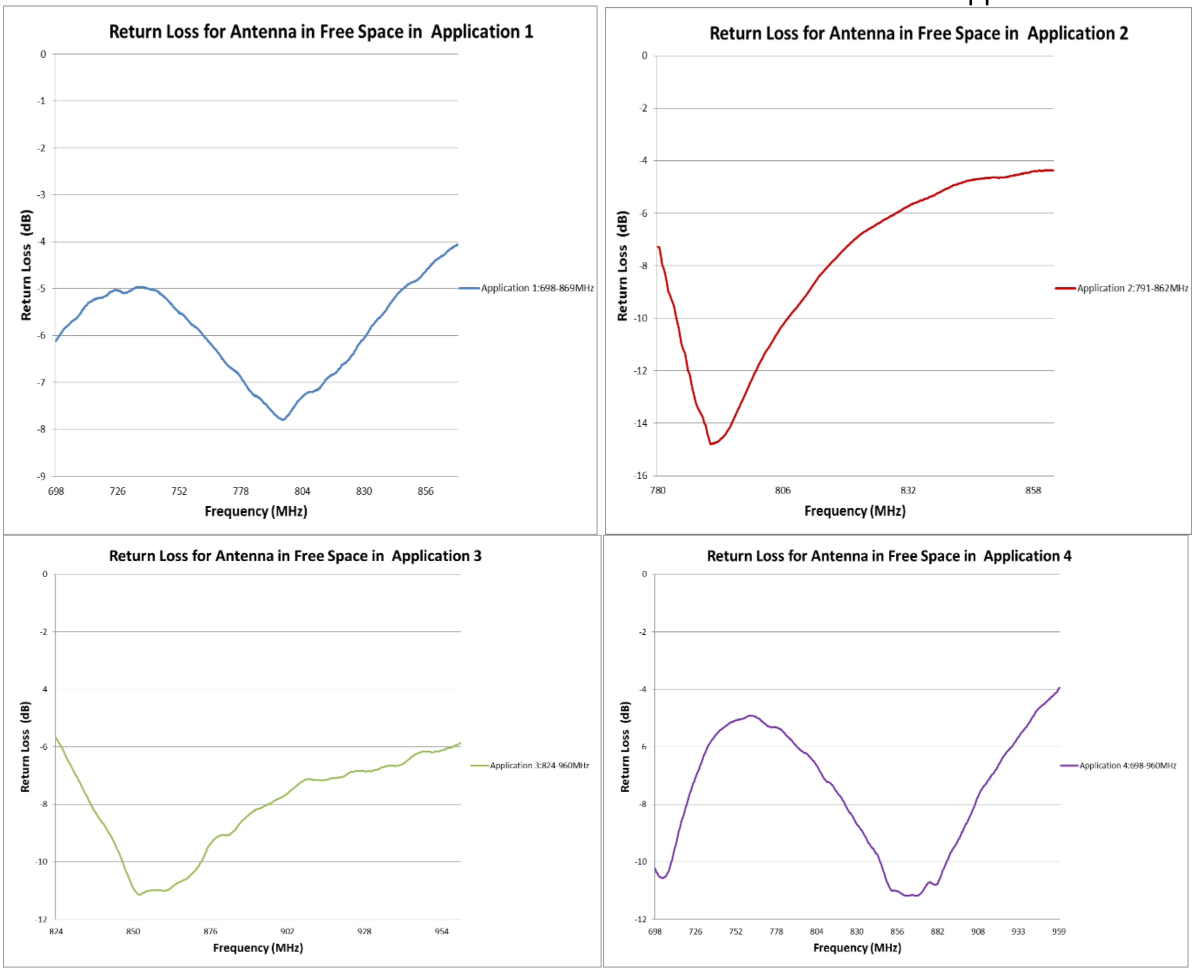


FIGURE 4.3.1 RETURN LOSS OF ANTENNA IN FREE SPACE IN FOUR APPLICATIONS

4.4 EFFICIENCY PLOT

All measurements in this document are done on a reference PCB in four Applications.

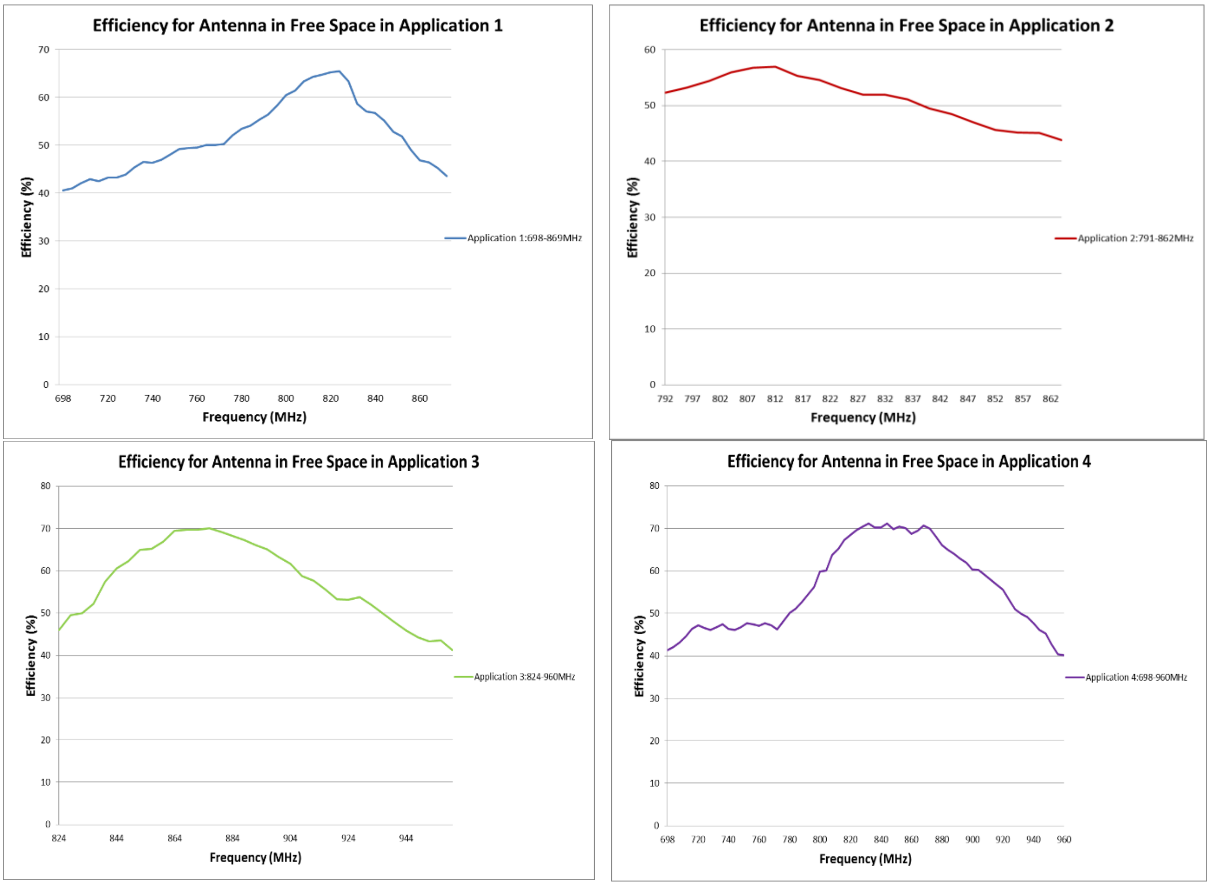


FIGURE 4.4.1 EFFICIENCY OF ANTENNA IN FREE SPACE IN FOUR APPLICATIONS

4.5 2D RADIATION PATTERN

All measurements in this document are done on a reference PCB in four Applications, we will use Application 4 as an example to test the radiation pattern.

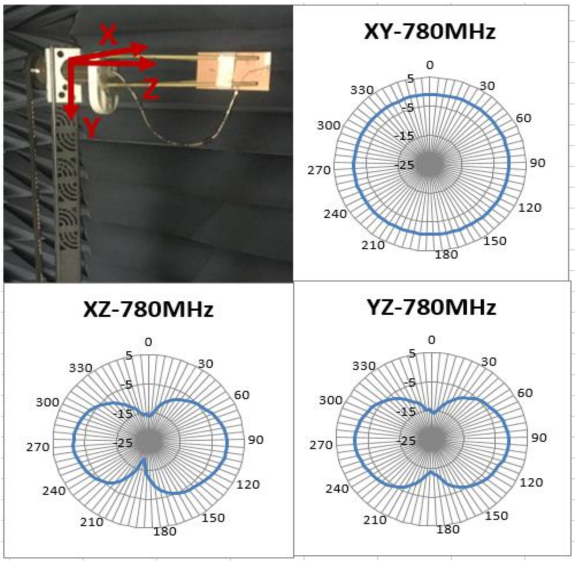


FIGURE 4.5.1 2D RADIATION PATTERN OF ANTENNA AT 780MHZ IN FREE SPACE ON A REFERENCE PCB

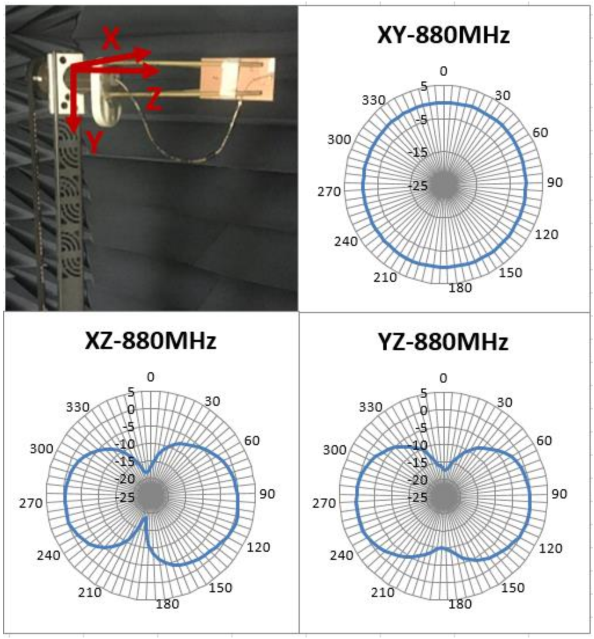


FIGURE 4.5.2 2D RADIATION PATTERN OF ANTENNA AT 880MHZ IN FREE SPACE ON A REFERENCE PCB

4.6 3D RADIATION PATTERN

All measurements in this document are done on a reference PCB in four Applications, we will use Application 4 as an example to test the radiation pattern.

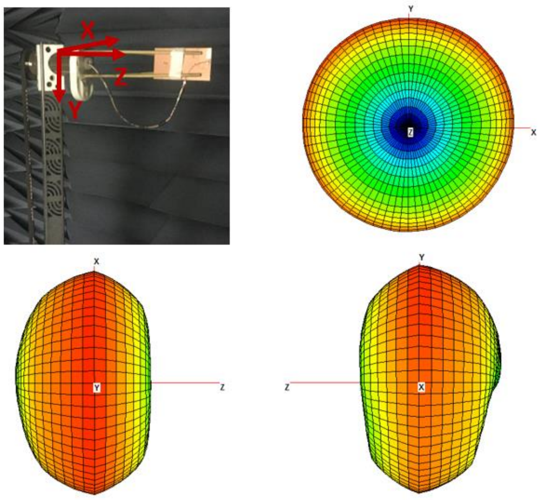


FIGURE 4.6.1 3D RADIATION PATTERN OF ANTENNA AT 780MHZ IN FREE SPACE ON A REFERENCE PCB

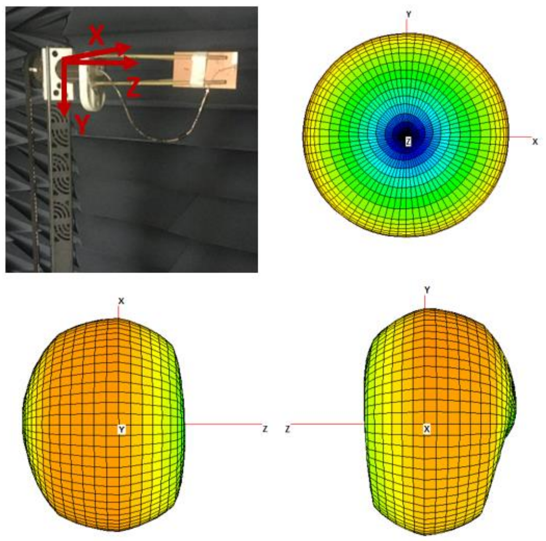


FIGURE 4.6.2 3D RADIATION PATTERN OF ANTENNA AT 880MHZ IN FREE SPACE ON A REFERENCE PCB

5.0 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 parallel element and series element depends on the resistance of antenna in smith chart shows in Figure 5.1.

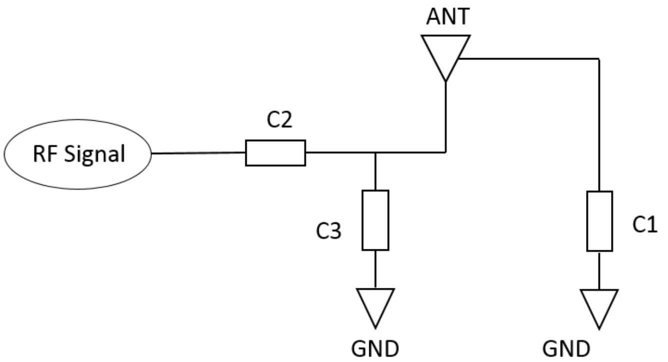
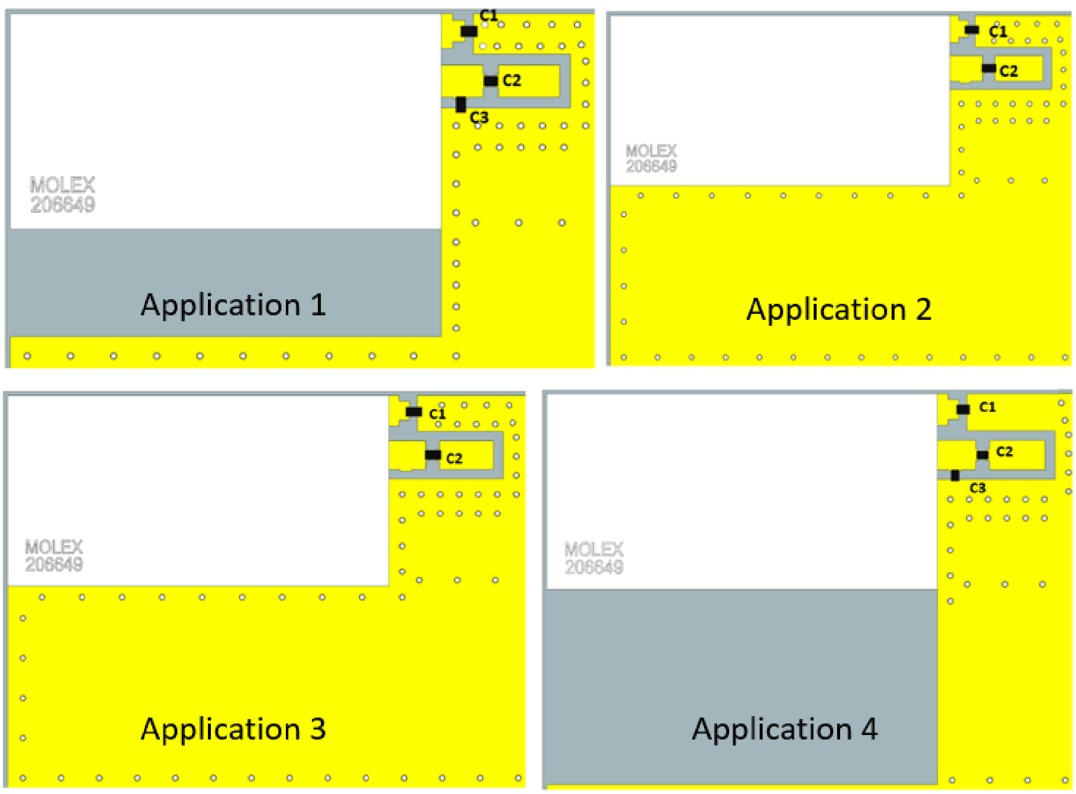


FIGURE 5.1 CONFIGURE 1 FOR MATCHING CIRCUIT

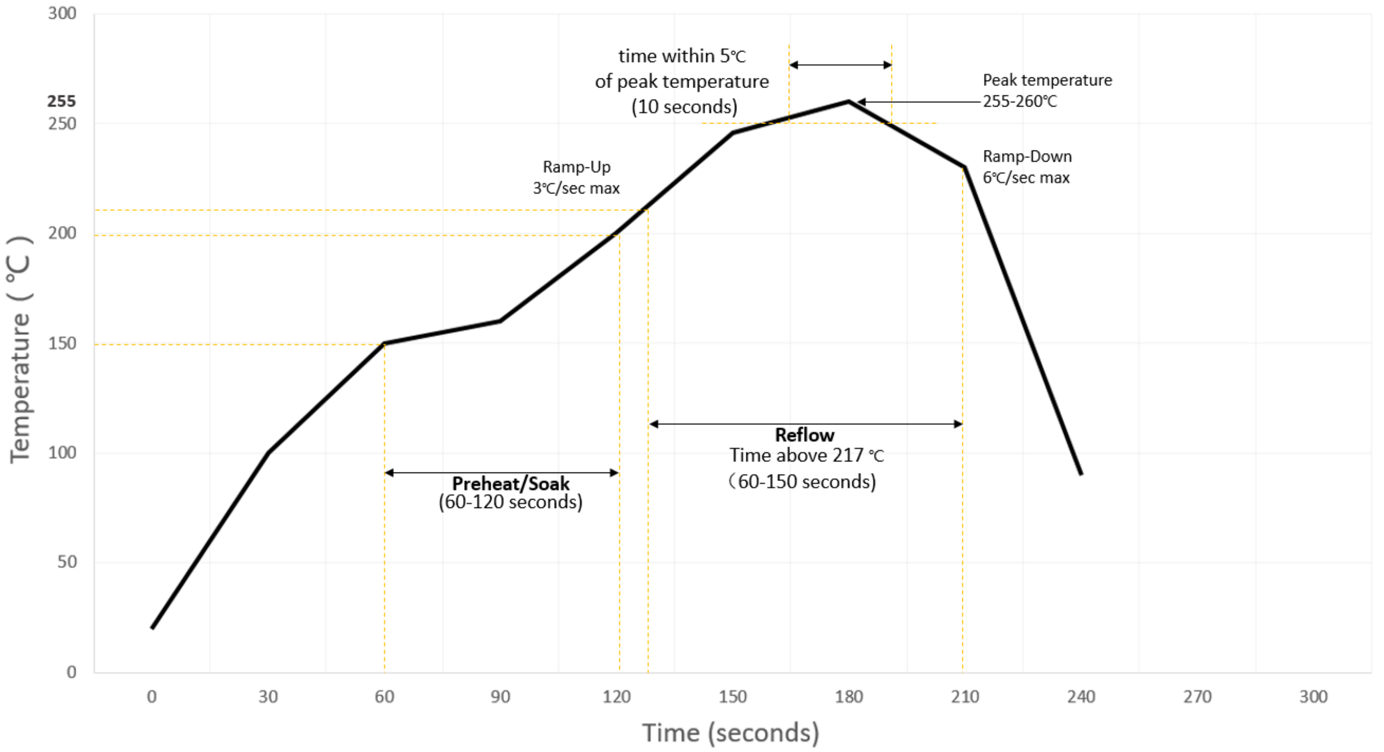


COMPONENT	Application 1	Application 2	Application 3	Application 4
C1	Value:22nH	Value:5.6nH	Value:4.1nH	Value:18nH
	(PN:LQW15AN22 NG00)	(PN:LQP02HQ5N6 H02)	(PN:LQP02HQ4N1 B02)	(PN:LQW15AN18N G00)
C2	Value:1.8pF	Value:30nH	Value:30nH	Value:1.5pF
	(PN:GCQ1555C1 H1R8WB01)	(PN:LQW15AN30N G00)	(PN:LQW15AN30N G00)	(PN:GRM1554C1E 1R5WA01)
C3	Value:18nH	NC	NC	Value:18nH
	(PN:LQW15AN18 NG00)			(PN:LQW15AN18N G00)

Note: The supplier of all the above components is Murata.

FIGURE 5.2 MATCHING CIRCUIT IN FOUR APPLICATIONS

6.0 RECOMMENDED REFLOW CONDITION



Recommended solder paste: ALPHA CAP-390 SAC305

For mechanically challenging applications Molex recommends using surface mount glue (e.g. Loctite 3611) before reflow soldering process, to ensure increased mechanical retention on the PCB.

7.0 RF PERFORMANCE AS A FUNCTION OF IMPLEMENTATION

All measurements in this document are done on a reference PCB in four Applications, we will use Application 4 as an example to test RF performance in below items.

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 80mm*40mm and we move the plane ground to four locations for each test. The antenna performance is better with larger distance between antenna and parallel plane ground at high band. The minimum distance between antenna and plane ground is recommended to be 15mm to achieve acceptable RF performance.

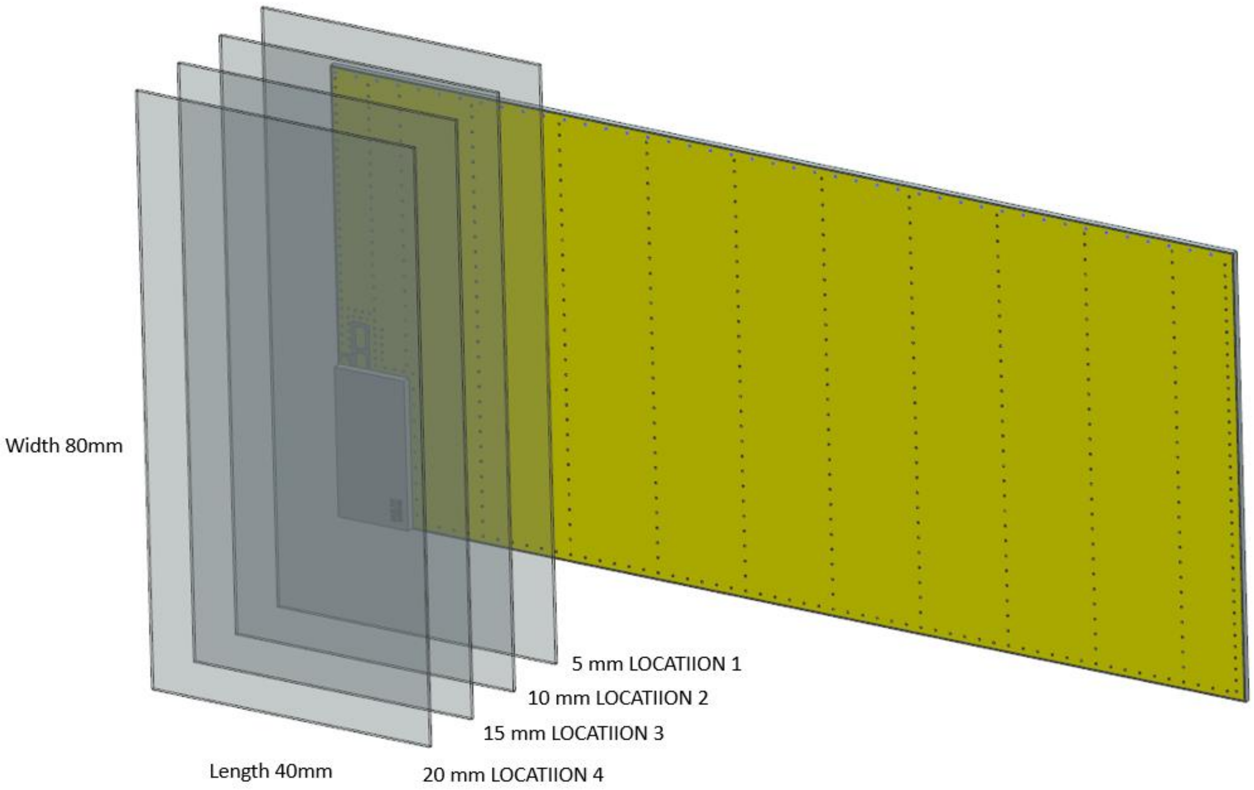


FIGURE 7.1 FOUR LOCATIONS WITH PARALLEL PLANE GROUND

Ground Size: 40mm*80mm;
Location 1: Distance between antenna and plane ground is about 5mm;
Location 2: Distance between antenna and plane ground is about 10mm;
Location 3: Distance between antenna and plane ground is about 15mm;
Location 4: Distance between antenna and plane ground is about 20mm.

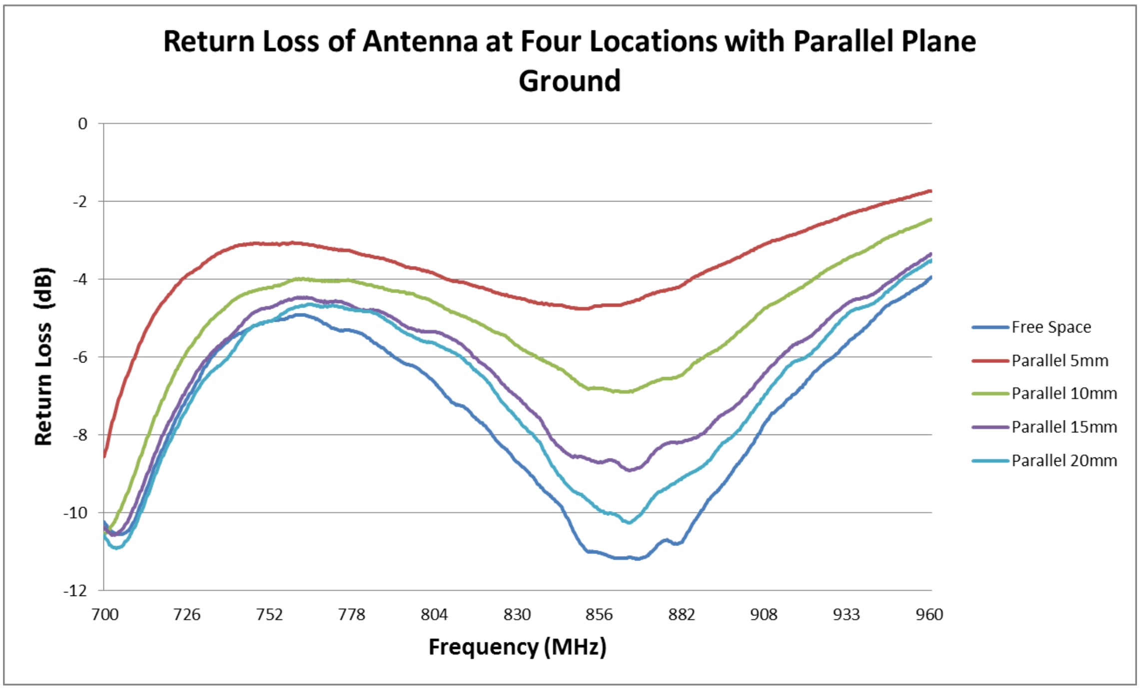


FIGURE 7.1.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND ON A REFERENCE PCB

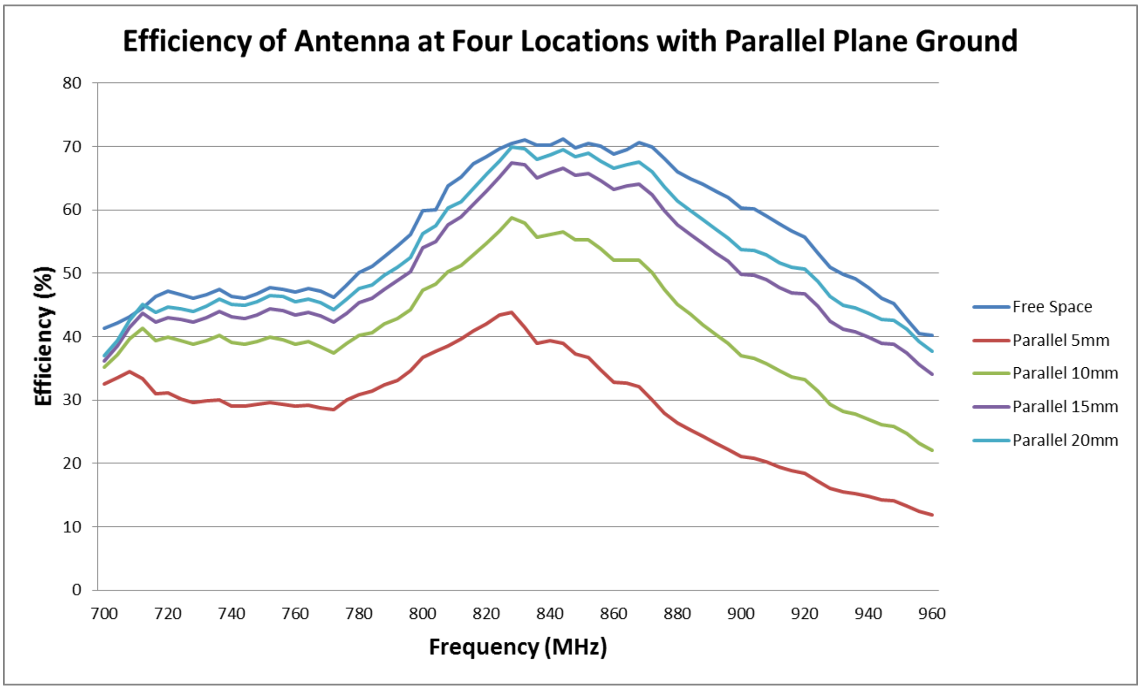


FIGURE 7.1.2 EFFICIENCY OF ANTENNA AT FOUR LOCATIONS WITH PARALLEL PLANE GROUND ON A REFERENCE PCB

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 80mm*40mm 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 3mm.

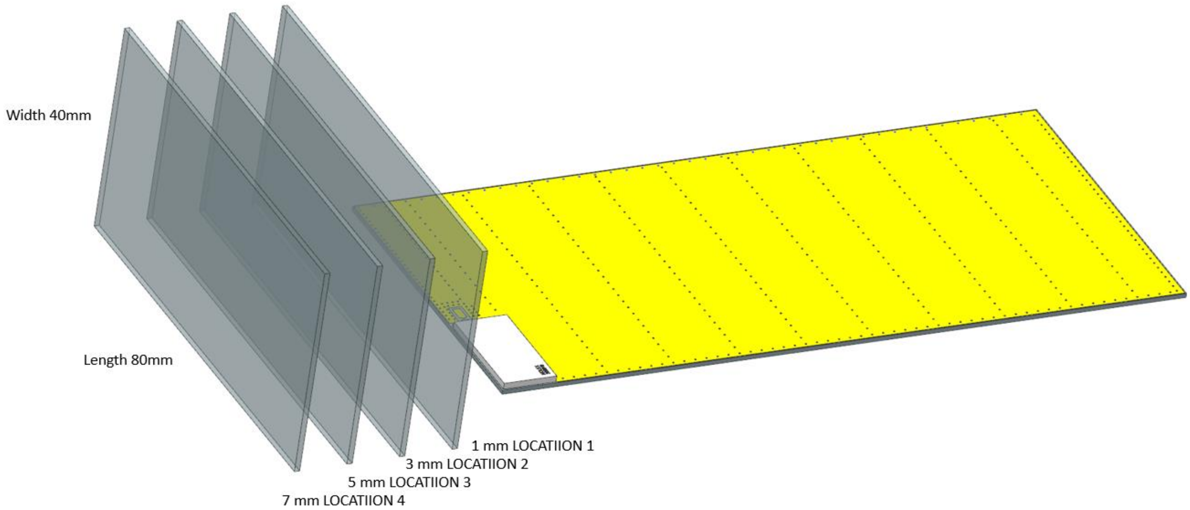


FIGURE 7.2 FOUR LOCATIONS WITH VERTICAL PLANE GROUND

Ground Size: 40mm*80mm;
Location 1: Distance between antenna and plane ground is about 1mm;
Location 2: Distance between antenna and plane ground is about 3mm;
Location 3: Distance between antenna and plane ground is about 5mm;
Location 4: Distance between antenna and plane ground is about 7mm.

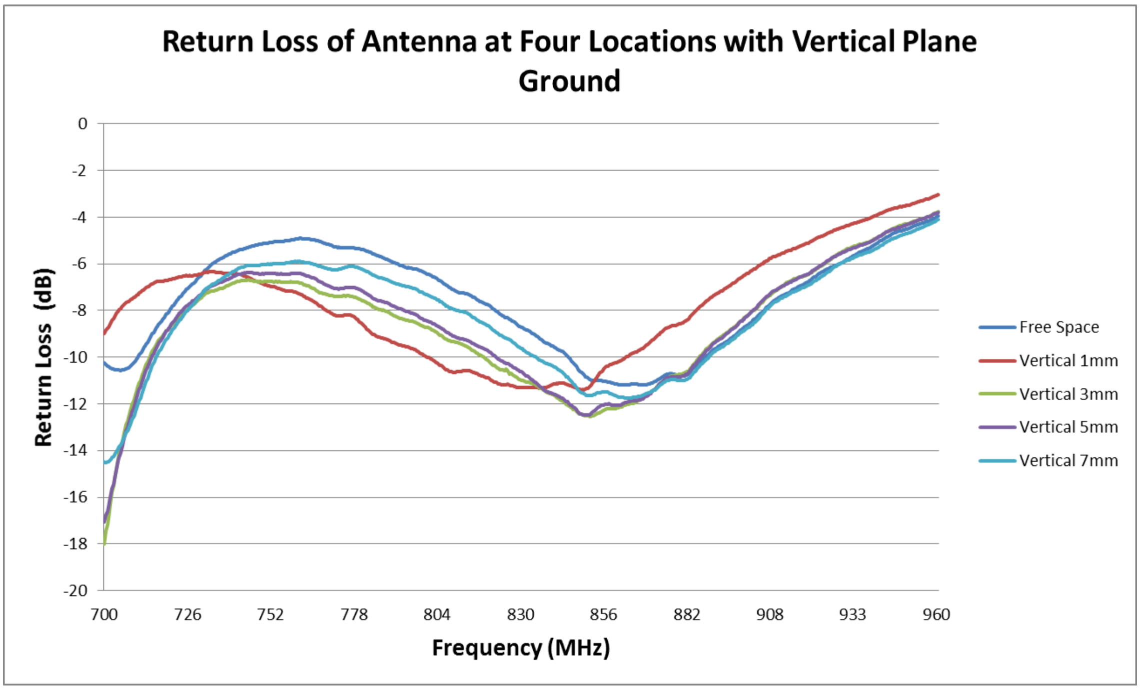


FIGURE 7.2.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND ON A REFERENCE PCB

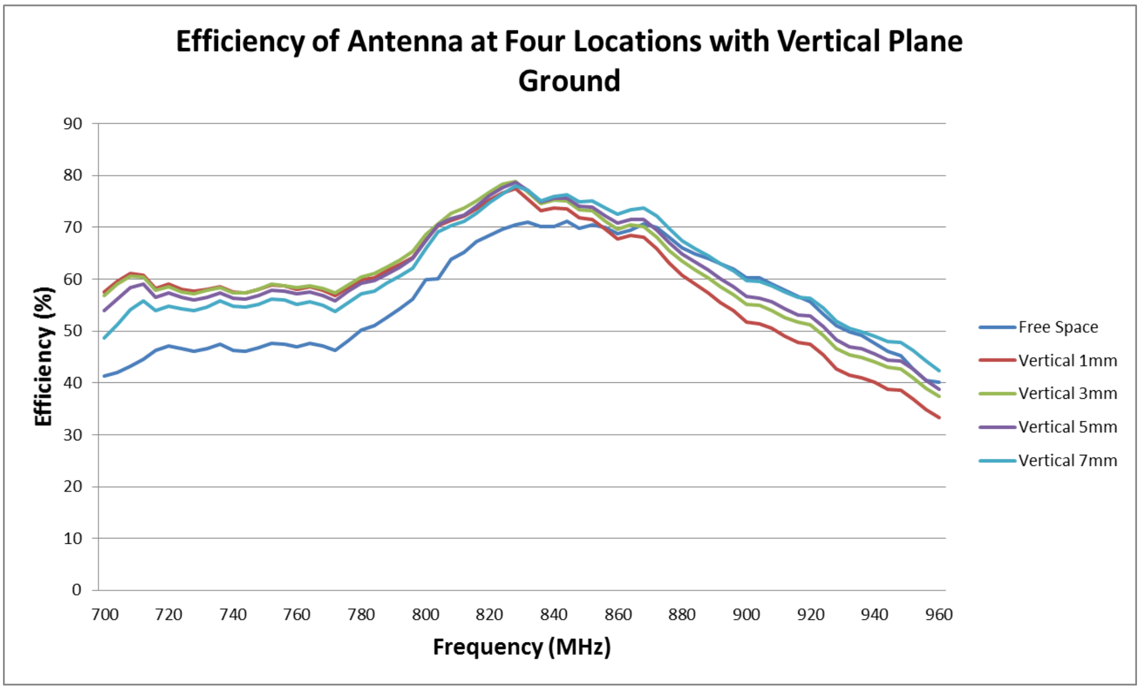


FIGURE 7.2.1 RETURN LOSS OF ANTENNA AT FOUR LOCATIONS WITH VERTICAL PLANE GROUND ON A REFERENCE PCB

7.3 RF PERFORMANCE AS A FUNCTION ON DIFFERENT SIZE GROUD

Three kinds of ground plane size were used for this study, which were 80mm*45mm, 130mm*60mm (Reference PCB), 150*100mm. When customers apply different PCB size ground, new matching network should be used for return loss and efficiency improvement. From the test result we can see, the antenna performance is the best using reference PCB size.

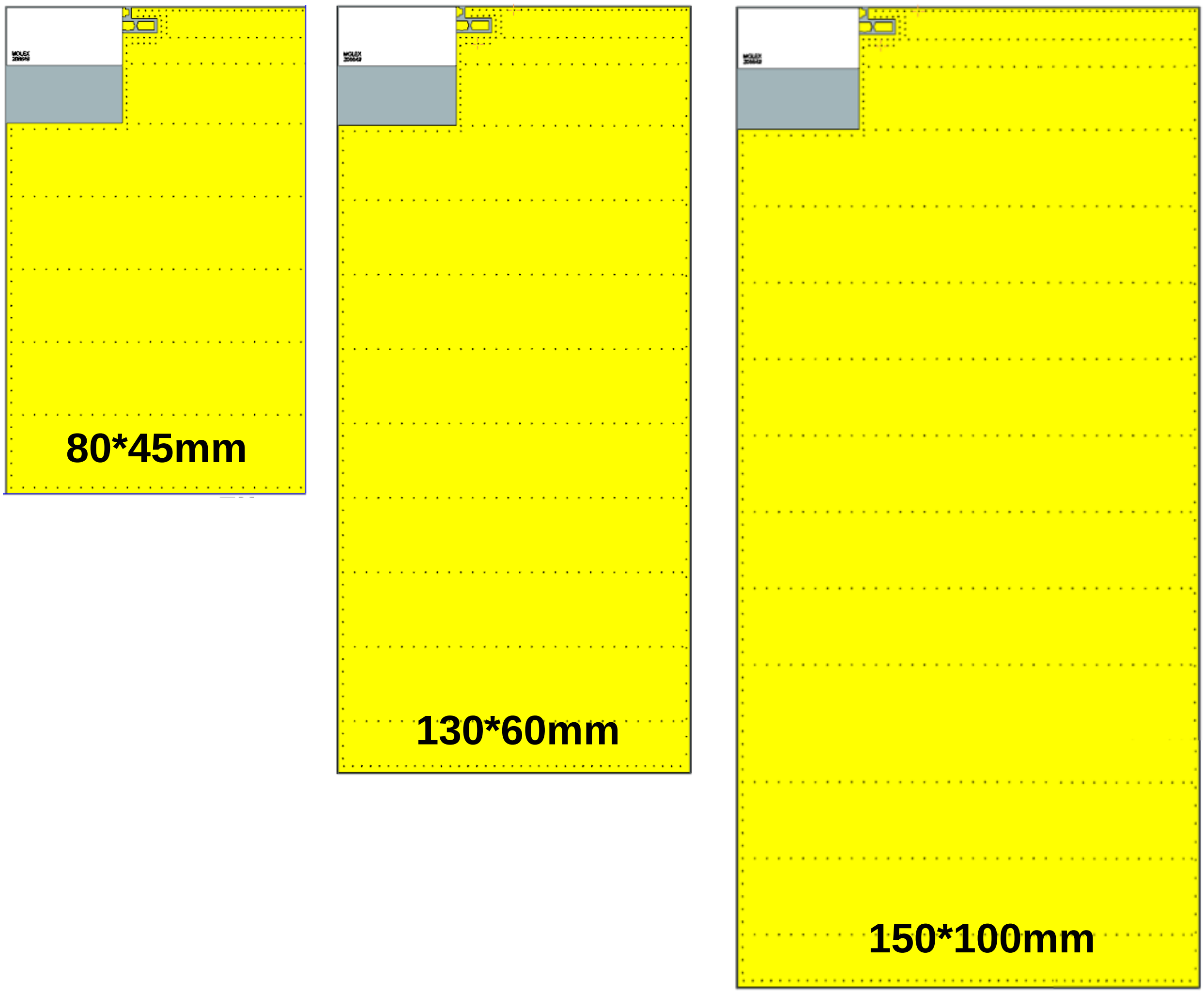


FIGURE 7.3 ANTENNA WITH DIFFERENT PLANE GROUNDS

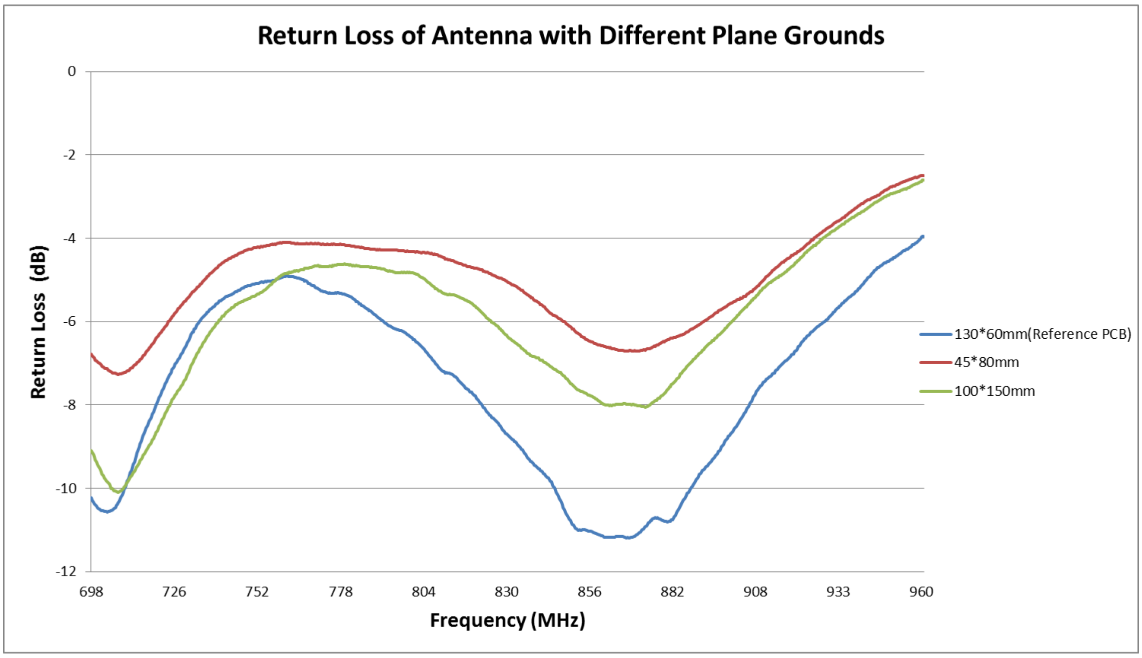


FIGURE 7.3.1 RETURN LOSS OF ANTENNA WITH DIFFERENT PLANE GROUNDS

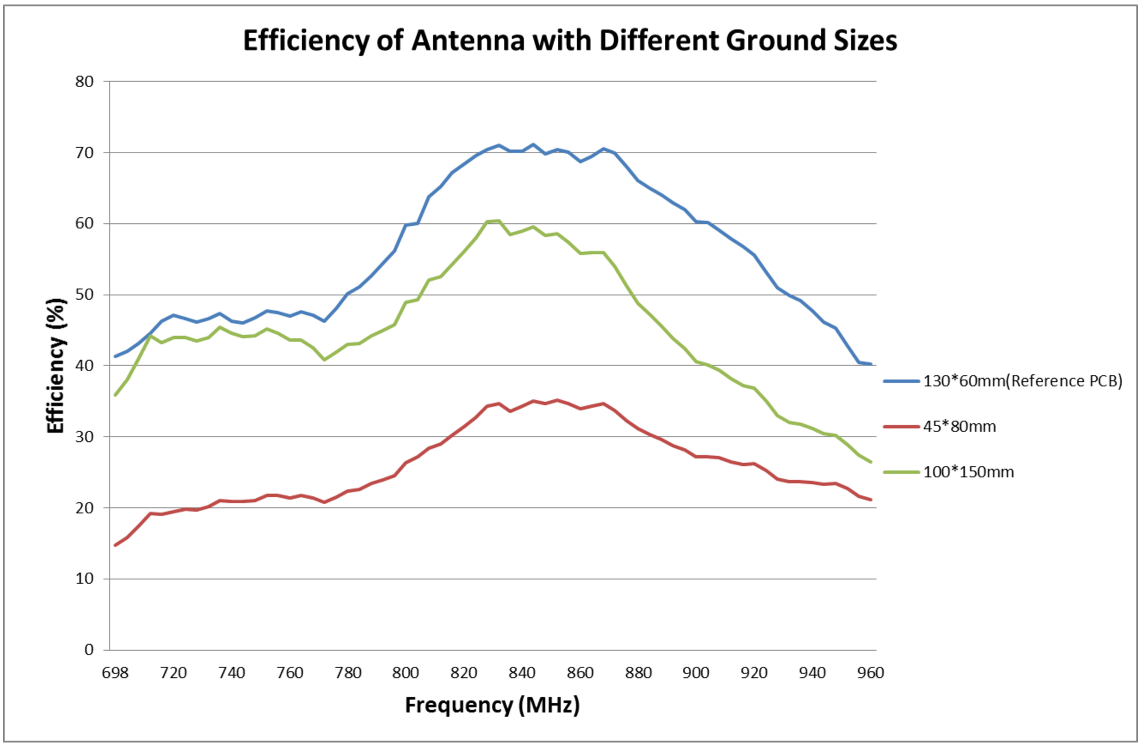


FIGURE 7.3.2 EFFICIENCY OF ANTENNA WITH DIFFERENT PLANE GROUNDS