



## Application Notes: 2372112-X Antennas

### Product Description

- Flexible cable antenna
- Dipole antenna type (Dimension 65.0 x 15.0 x 0.2mm)
- Ground plane independent
- FPC with double-side adhesive for peel and stick
- Mini coax cable and connector
- Cable length: 150mm, 100mm
- Covers LTE/Cellular, GSM, ISM, UMTS, and ZigBee
- Antenna performance optimized to 150mm cable length

### OVERVIEW

This application note describes the RF performance of the 2372112-X (698-2700 MHz) antenna series in free space, and how the RF performance is impacted by some common factors when the antennas are integrated into a device. -X in the part number represents antennas with differing cable lengths i.e., 2372112-1: 150mm 2372112-2: 100mm etc..

The common factors discussed in this document include the angle of the FPC antenna bending curve, the size and the shape of the ground plane, the antenna cable routing directions, and the clearance distance to some large metallic structures nearby the antennas. The large metallic structures can be the representative of a different PCB ground plane, metallic enclosure of the device, a display, or any large metallic part inside the device.

This document covers many common installation scenarios. If you have a scenario that is not covered in this document, please contact us to discuss your design-in requirements.

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## 1. BASIC ANTENNA SPECIFICATIONS

### 1 a. Electrical, Mechanical & Environmental Performance\*

Electrical		
Frequency Range (MHz)	698-960	1710-2700
VSWR	<3.1:1	<2.6:1
Average Efficiency	20 %	48 %
Peak Gain	-1.12 dBi	4.36 dBi
Power Handling	10 Watt cw	
Polarization	Linear	
Mechanical		
Size mm (in.)	65.0 x 15.0 x 0.2 mm (2.56 x 0.59 x 0.008 in.)	
Weight g (oz.)	<2 g (<0.07 oz.)	
Mounting	Adhesive Tape	
Mating Connectors	MHF and MHF4L type	
Cable	1.13mm Dia.	
Environmental		
Operating Temperature	-40 to +85°C	
Storage Temperature	-40 to +85°C	

\* Electrical, Mechanical & Environmental Performance in this table is for the 2372112-1 antenna. For full 2372112-X datasheet, drawing, CAD files and specifications please visit [product landing page](#).

## 1 b. Frequency Bands

This antenna covers CDMA 1900, CDMA 850, LTE/Cellular, GSM, ISM, UMTS, and ZigBee (698 - 2700 MHz)

Band	Up Link (MHz)		Down Link (MHz)		Support	Band	Up Link (MHz)		Down Link (MHz)		Support
Band 1	1920	1980	2110	2170	✓	Band 50	1432		1517		✗
Band 2	1850	1910	1930	1990	✓	Band 51	1427		1432		✗
Band 3	1710	1785	1805	1880	✓	Band 53	2483.5		2495		✓
Band 4	1710	1755	2110	2155	✓	Band 65	1920	2010	2110	2200	✓
Band 5	824	849	869	894	✓	Band 66	1710	1780	2110	2200	✓
Band 7	2500	2570	2620	2690	✓	Band 67	N/A		738	758	✓
Band 8	880	915	925	960	✓	Band 68	698	728	753	783	✓
Band 12	699	716	729	746	✓	Band 69	N/A		2570	2620	✓
Band 13	777	787	746	756	✓	Band 70	1695	1710	1995	2020	✓
Band 14	788	798	758	768	✓	Band 71	663	698	617	652	✗
Band 18	815	830	960	875	✓	Band 74	1427	1470	1475	1518	✗
Band 20	832	862	791	821	✓	Band 75	N/A		1432	1517	✗
Band 21	1447.9	1462.9	1495.5	1510.9	✗	Band 76	N/A		1427	1432	✗
Band 22	3410	3500	3510	3600	✗	Band 77	3300		4200		✗
Band 23	2000	2020	2180	2200	✓	Band 78	3300		3800		✗
Band 24	1626.5	1660.5	1525	1559	✗	Band 79	4400		5000		✗
Band 25	1850	1915	1930	1995	✓	Band 80	1710	1785	N/A		✓
Band 26	814	849	859	894	✓	Band 81	880	915	N/A		✓
Band 28	703	748	758	803	✓	Band 82	832	862	N/A		✓
Band 29	N/A		717	728	✓	Band 83	703	748	N/A		✓
Band 30	2305	2315	2350	2360	✓	Band 84	1920	1980	N/A		✓
Band 31	452.5	457.5	462.5	467.5	✗	Band 86	1710	1780	N/A		✓
Band 32	N/A		1452	1496	✗	Band 89	824	849	N/A		✓
Band 34	2010		2025		✓	Band 90	2496		2690		✓
Band 38	2570		2620		✓	Band 91	832	862	1427	1432	✓
Band 39	1880		1920		✓	Band 92	832	862	1432	1517	✓
Band 40	2300		2400		✓	Band 93	880	915	1427	1432	✓
Band 41	2496		2690		✓	Band 94	880	915	1432	1517	✓
Band 42	3400		3600		✗	Band 95	2010	2025	N/A		✓
Band 43	3600		3800		✗	Band 96	5925		7125		✗
Band 44	703		803		✓	Band 97	2300	2400	N/A		✓
Band 46	5150		5925		✗	Band 98	1880	1920	N/A		✓
Band 47	5855		5925		✗	Band 99	1626.5	1660.5	N/A		✗
Band 48	3550		3700		✗						

### GNSS, BT and Wi-Fi Bands Coverage

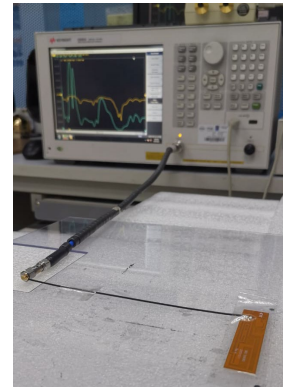
GNSS System	Band	Frequency (MHz)	Fc (MHz)	Support	GNSS System	Band	Frequency (MHz)	Fc (MHz)	Support	BT/ Wi-Fi Band	Frequency (MHz)	Fc (MHz)	Support				
GPS	L1	1565 - 1586	1575.42	✗	QZSS	L1	1565 - 1586	1575.42	✗	2.4 GHz	2400 - 2485	2443	✓				
	L2	1217 - 1238	1248.06	✗		L2C	1217 - 1238	1227.6	✗					5 GHz	5125 - 5875	5513	✗
	L5	1164 - 1189	1176.45	✗		L5	1164 - 1189	1176.45	✗								
BeiDou	B1	1559 - 1592	1575.42	✗	L6(LEX)	1258 - 1300	1278.75	✗	Other								
	B2a	1164 - 1189	1176.45	✗	L5	1164 - 1189	1176.45	✗									
	B2b	1186 - 1217	1207.14	✗	G1	1596 - 1610	1602	✗									
	B3	1258 - 1280	1268.52	✗	G2	1241 - 1255	1248.06	✗									
Galileo	E1	1563 - 1588	1575.42	✗	G3	1189 - 1212	1207.14	✗									
	E5a	1164 - 1189	1176.45	✗													
	E5b	1186 - 1217	1207.17	✗													
	E6	1258 - 1300	1278.75	✗													

## 2. RF PERFORMANCE IN FREE SPACE

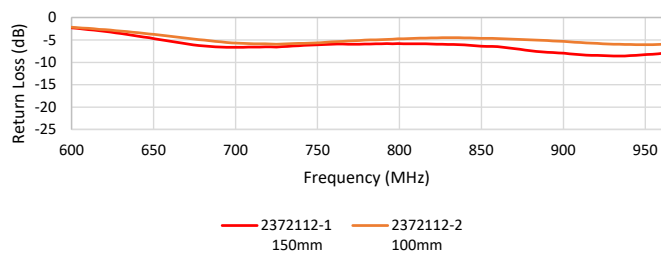
### 2 a. Return Loss

#### Test Setup

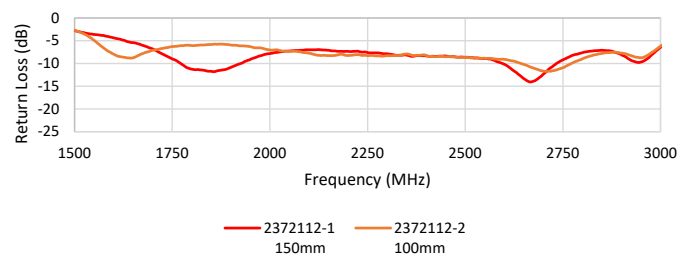
- VNA (9kHz-8.5GHz)
- The antenna is placed on a PC plastic sheet in the size of 350m x 420mm x 2mm



Return Loss for Antenna at 600-960MHz Band in Free Space



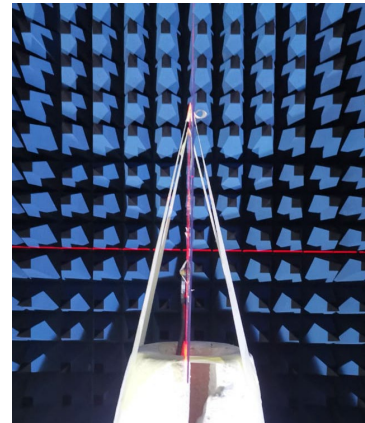
Return Loss for Antenna at 1.5-3GHz Band in Free Space



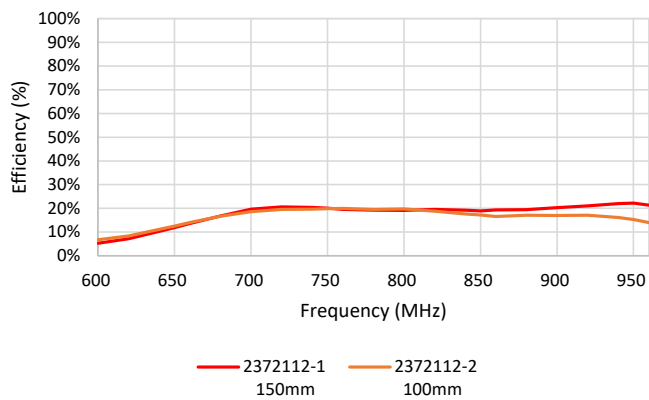
## 2 b. Total Efficiency

### Test Setup

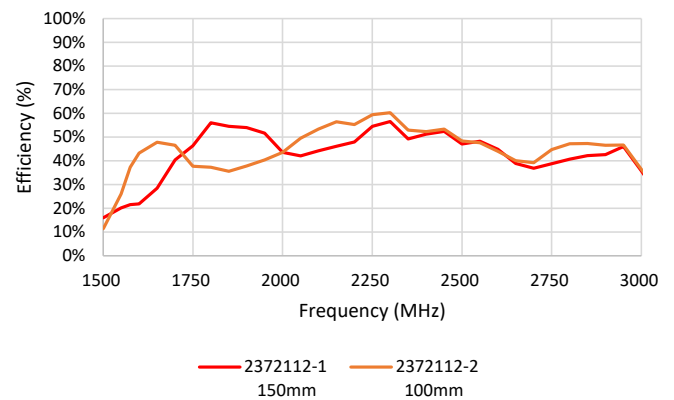
- Antenna Anechoic Chamber (400MHz-6GHz)
- The antenna is placed on a PC plastic sheet in the size of 350mm x 420mm x 2mm



Efficiency (PN:2372112-X)

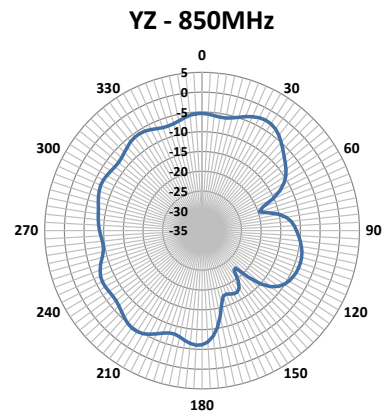
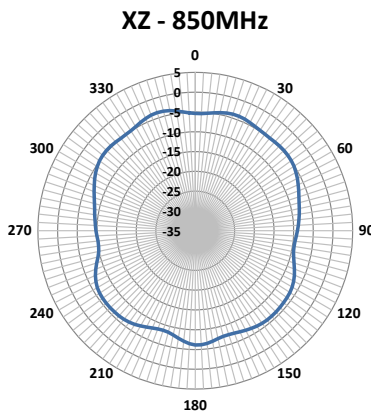
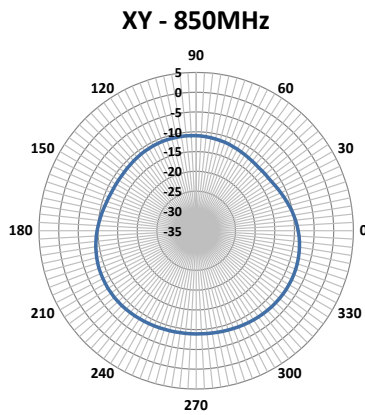
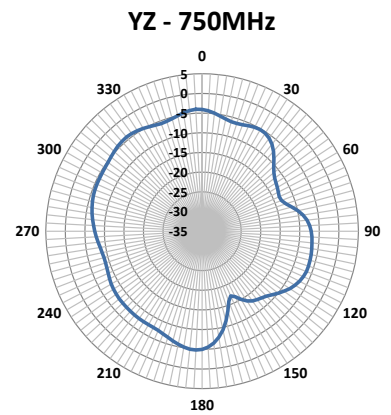
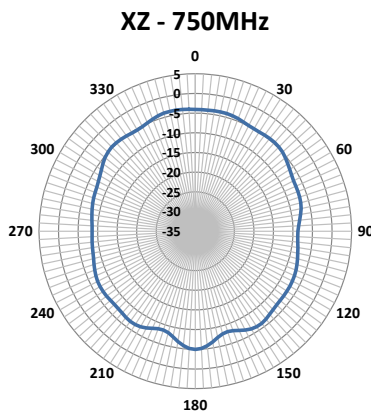
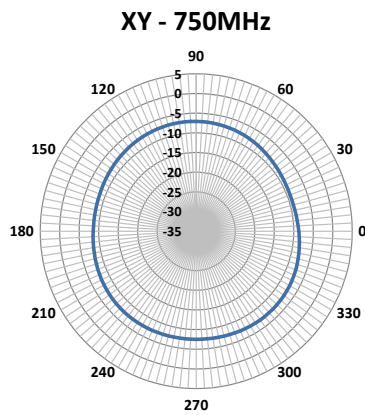
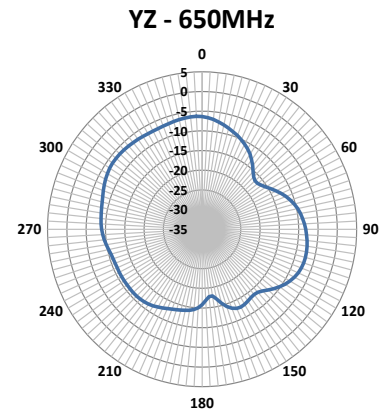
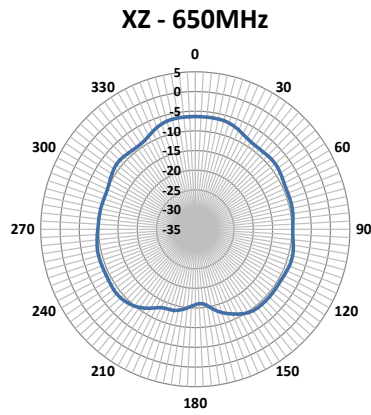
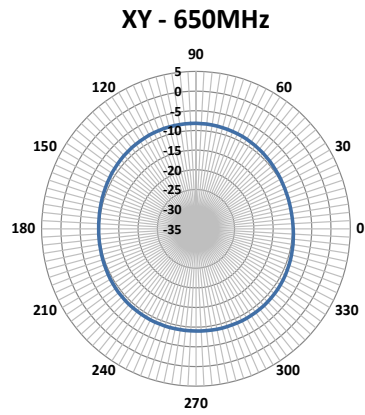
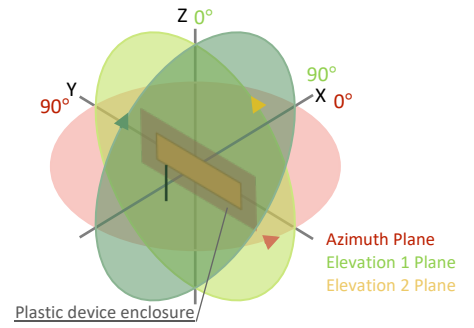


Efficiency (PN:2372112-X)

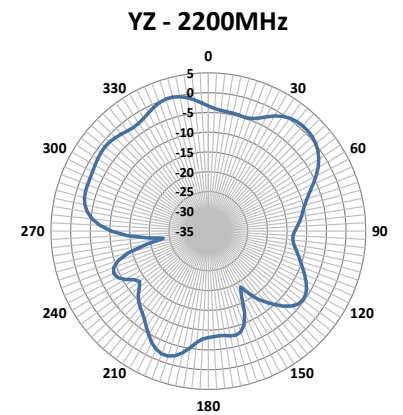
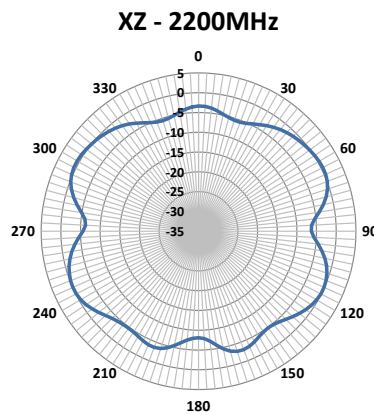
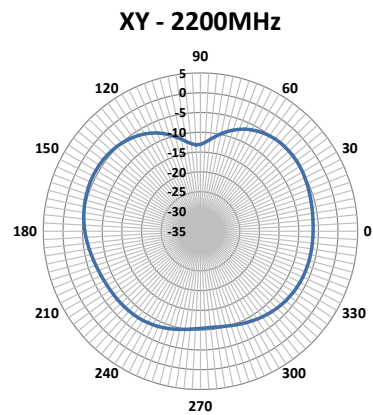
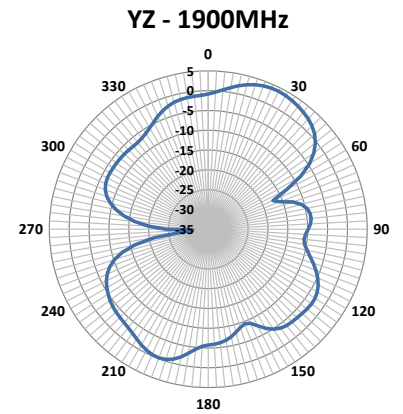
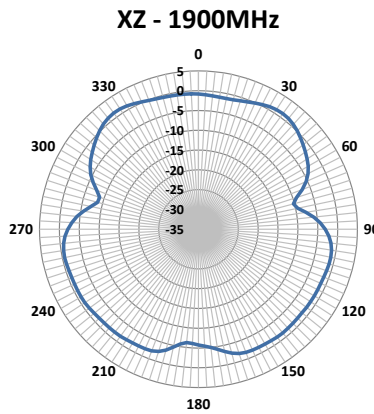
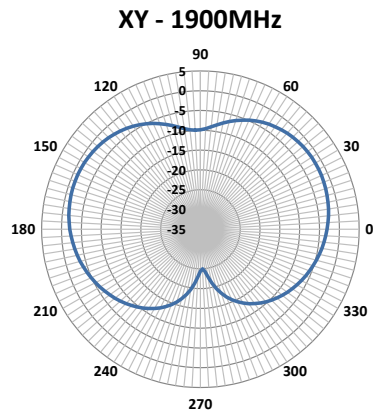
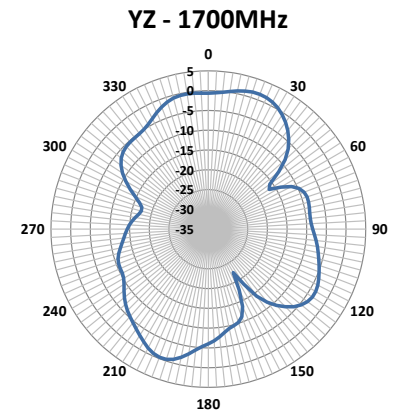
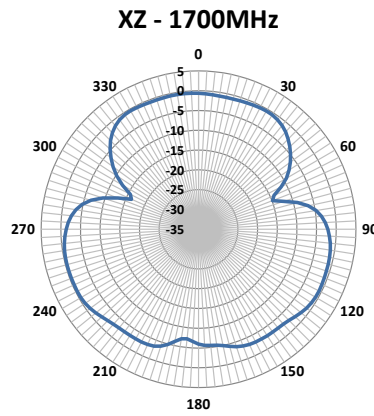
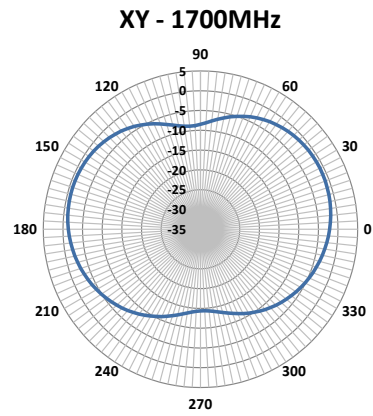
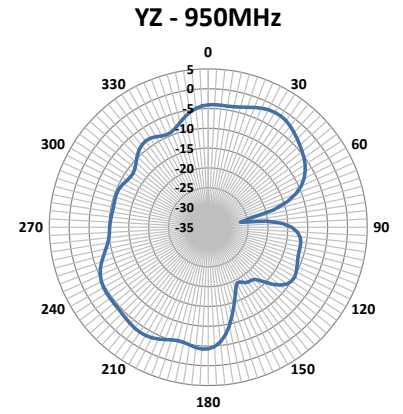
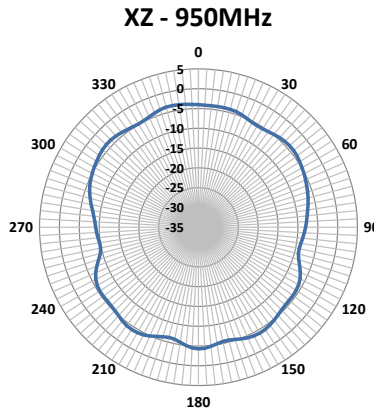
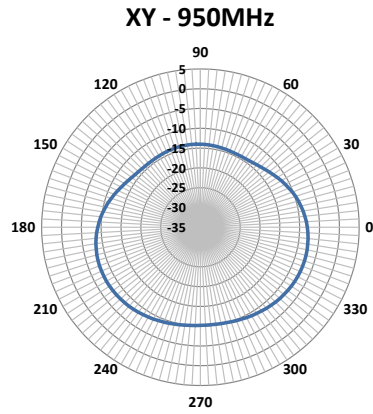


## 2 c. Gain Radiation Patterns 2D

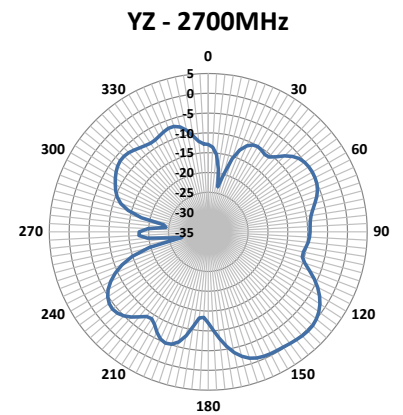
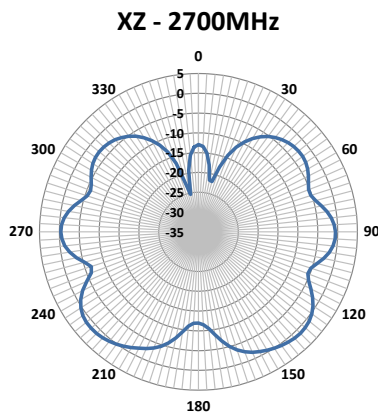
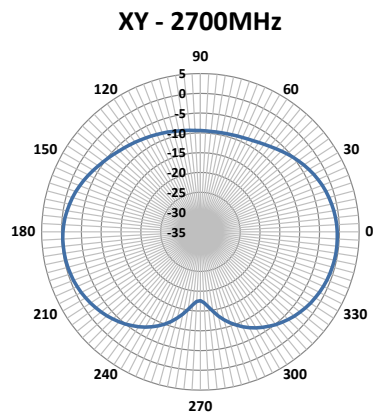
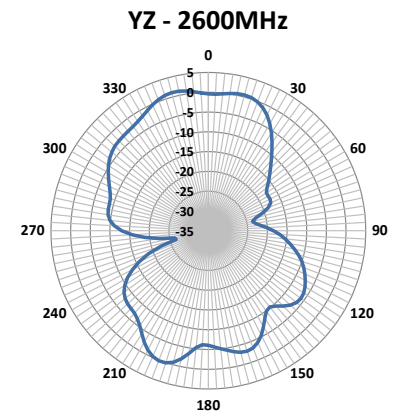
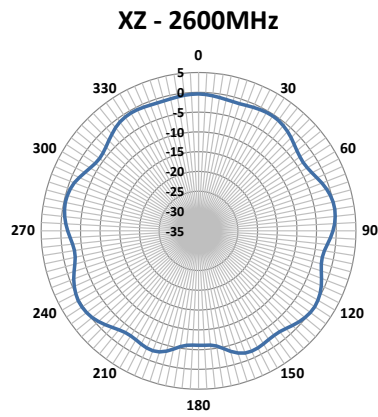
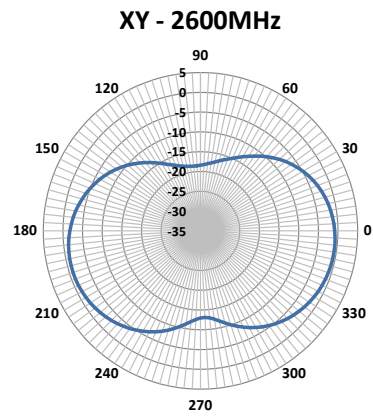
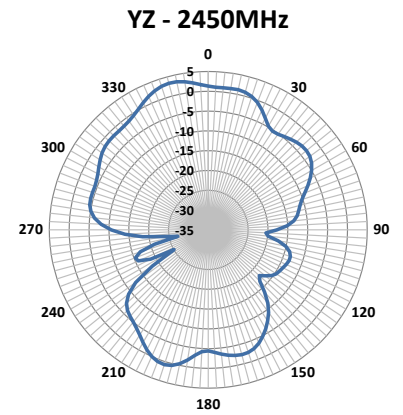
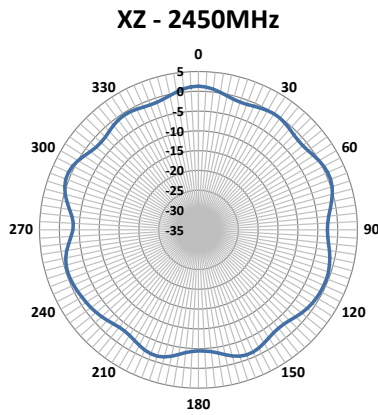
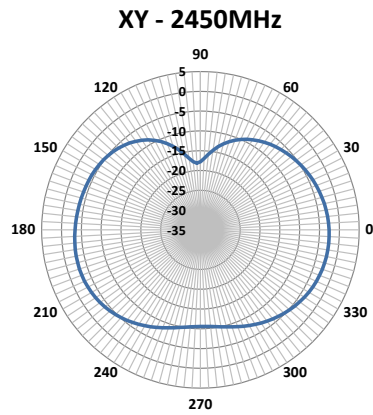
Total Gain Radiation Patterns (2D) of the Antenna with 150mm Cable Length (PN: 2372112-1)



## 2 c. Gain Radiation Patterns 2D Contd.

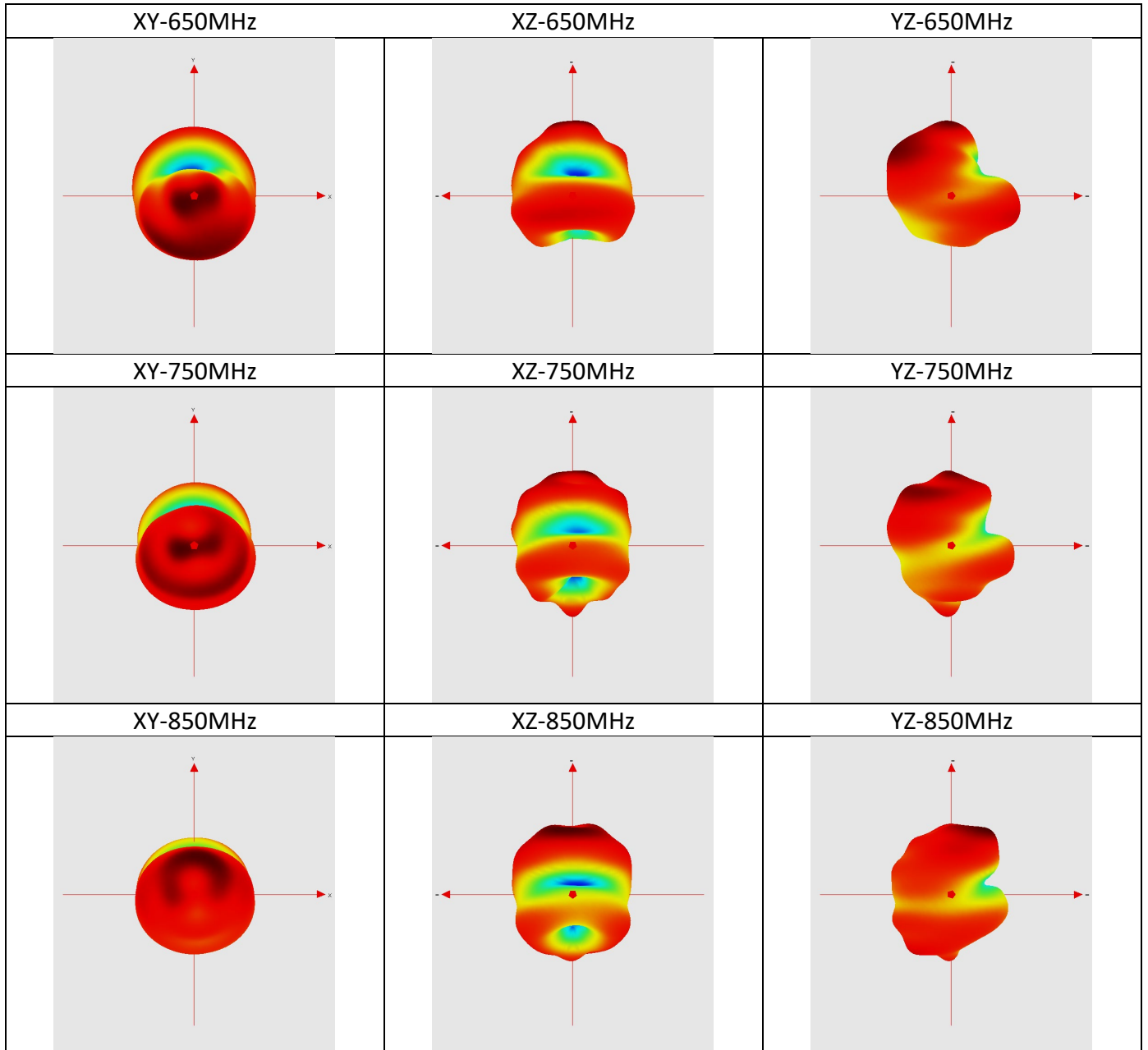
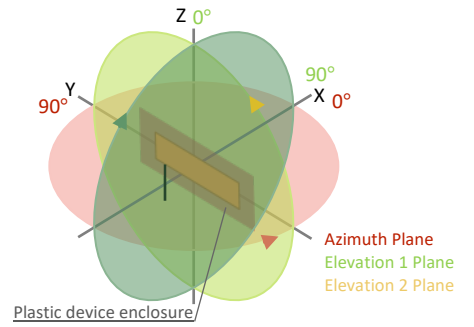


## 2 c. Gain Radiation Patterns 2D Contd.

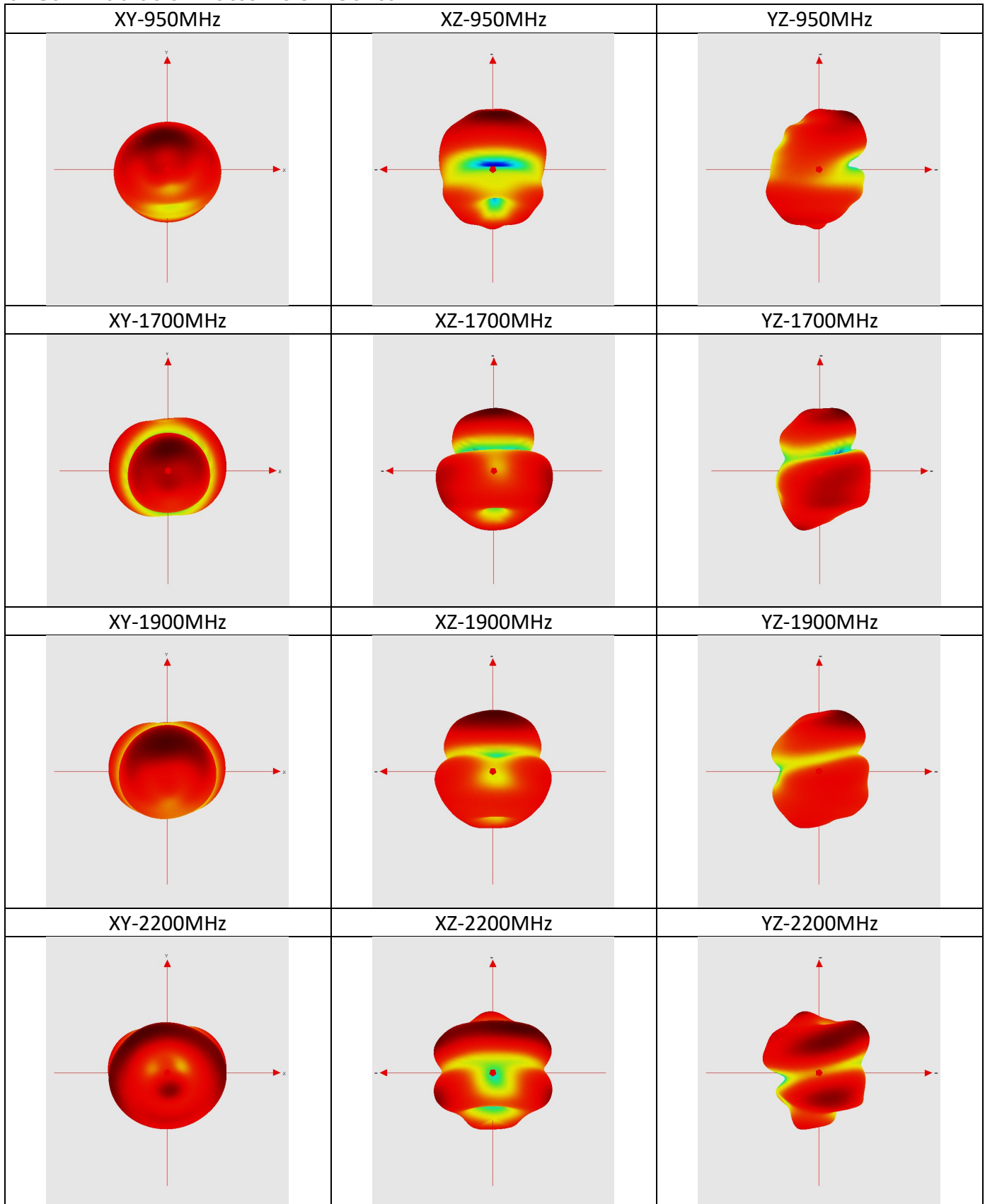


## 2 d. Gain Radiation Patterns 3D

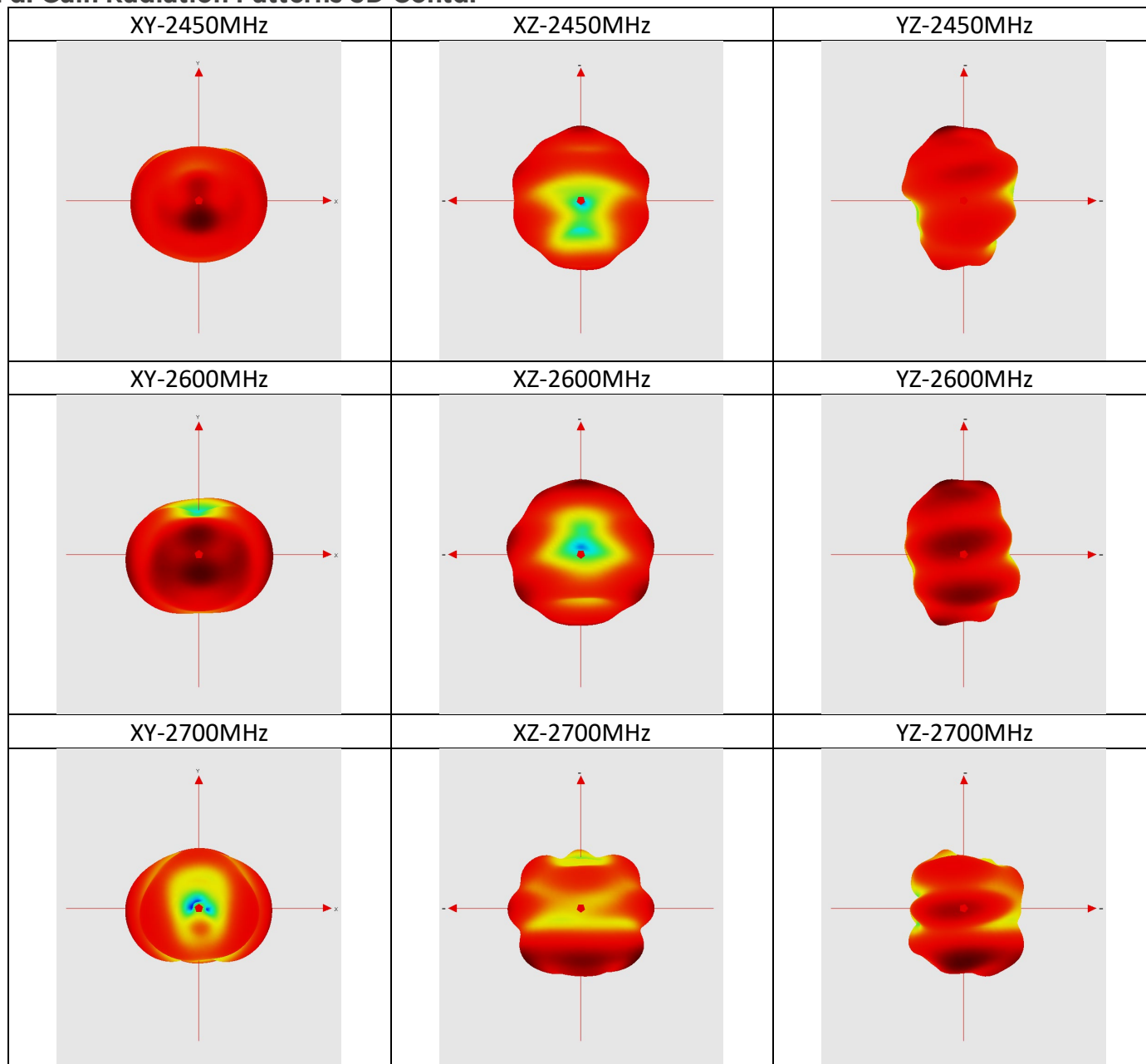
Total Gain Radiation Patterns (3D) of the Antenna with 150mm Cable Length (PN: 2372112-1)



## 2 d. Gain Radiation Patterns 3D Contd.



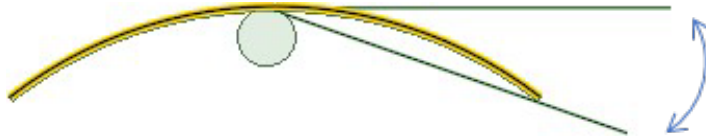
## 2 d. Gain Radiation Patterns 3D Contd.



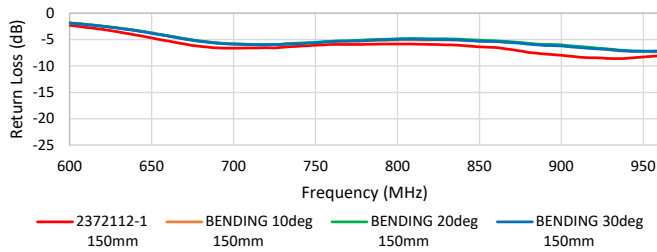
### 3. ANTENNA PERFORMANCE VARIATION WITH DIFFERENT ANTENNA DESIGN-IN IMPLEMENTATION

#### 3 a. Performance Variation with FPC Bending Curve

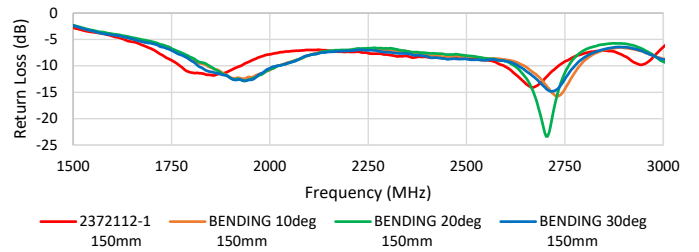
This section shows the effect on return loss of bending the antenna by 10°, 20° and 30° vs a flat position. The effect on return loss is shown in the plots below at various frequencies. This test was conducted on an antenna with a cable length of 150mm (PN: 2372112-1).



Return Loss for Antenna at 600-960MHz Band in Free Space

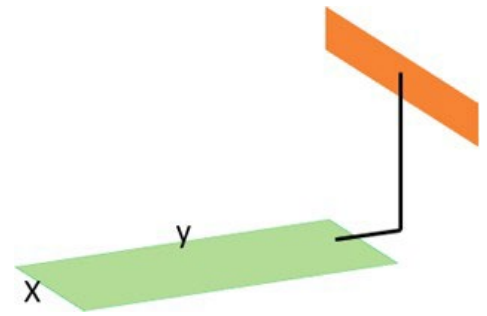


Return Loss for Antenna at 1.5-3GHz Band in Free Space



### 3 b. Performance Variation with Orthogonal Ground Plane

This section shows the effect on return loss of positioning the antenna in the vicinity of various sizes of orthogonally placed ground planes. The antenna is fed from the mini coax connector at the edge of the PCB ground plane. Ensure the cable bending curve doesn't violate the minimum bending radius (especially for 50 mm cable).

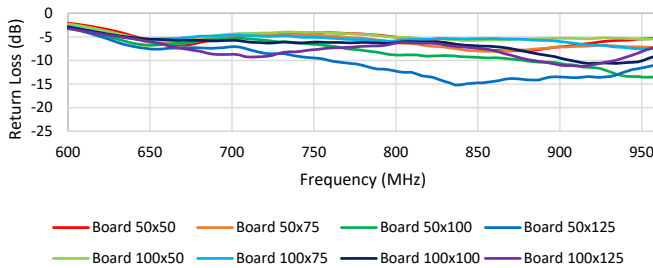


Variables:

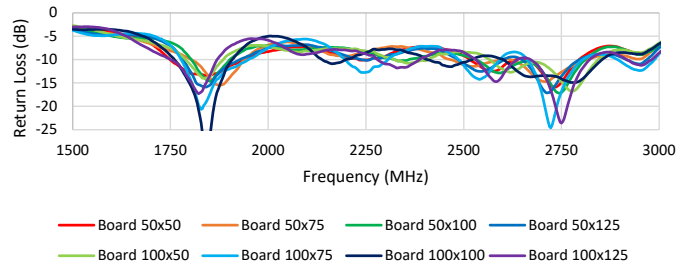
Board Size (mm)	X	Y
Board 50x50	50mm	50mm
Board 50x75	50mm	75mm
Board 50x100	50mm	100mm
Board 50x125	50mm	125mm
Board 100x50	100mm	50mm
Board 100x75	100mm	75mm
Board 100x100	100mm	100mm
Board 100x125	100mm	125mm

#### 150mm Cable

Return Loss for 2372112-1 (150mm) in Orthogonal Ground Plane Distance

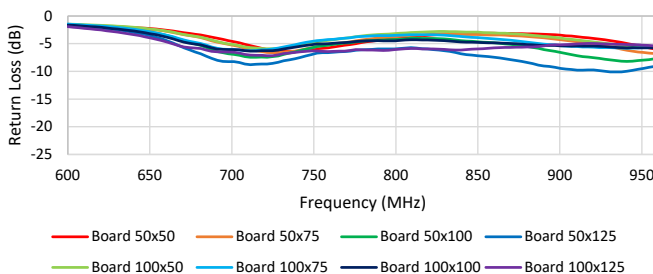


Return Loss for 2372112-1 (150mm) in Orthogonal Ground Plane Distance

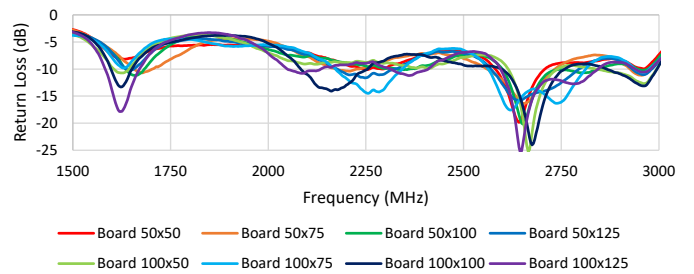


#### 100mm Cable

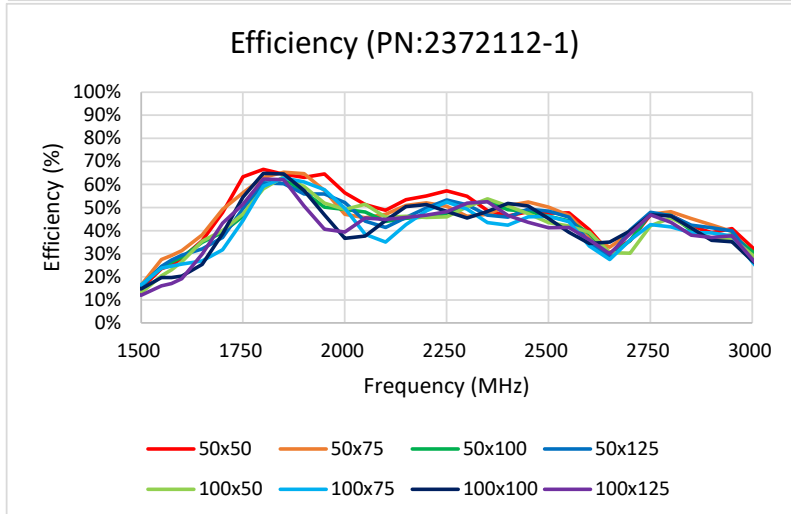
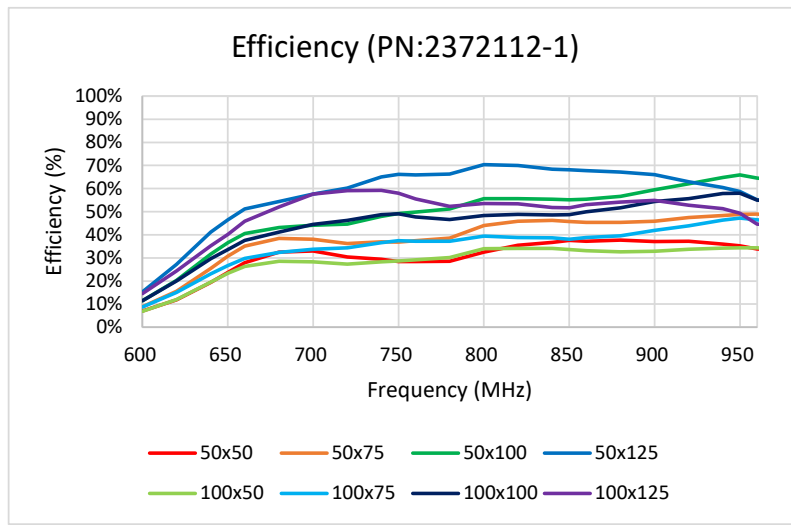
Return Loss for 2372112-2 (100mm) in Orthogonal Ground Plane Distance



Return Loss for 2372112-2 (100mm) in Orthogonal Ground Plane Distance



### 3 b. Performance Variation with Orthogonal Ground Plane Contd.

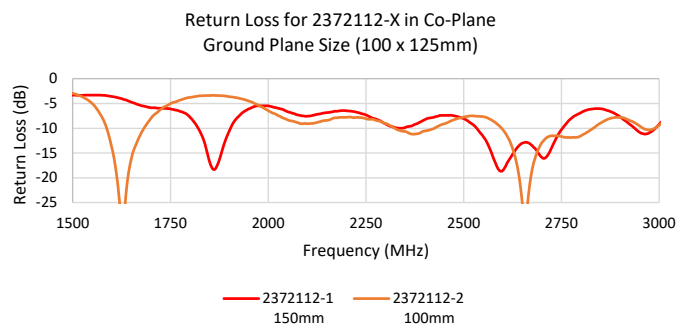
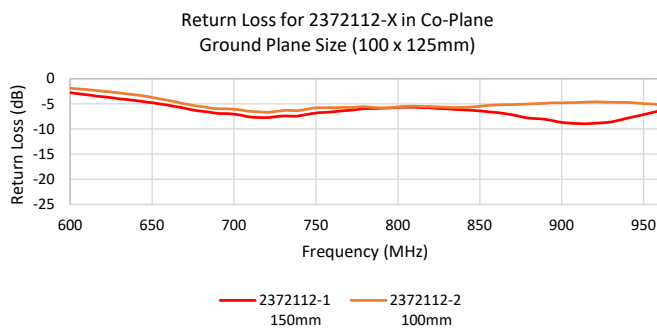
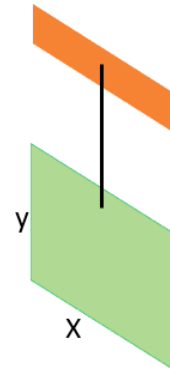


### 3 c. Performance Variation with Co-Plane Ground Plane

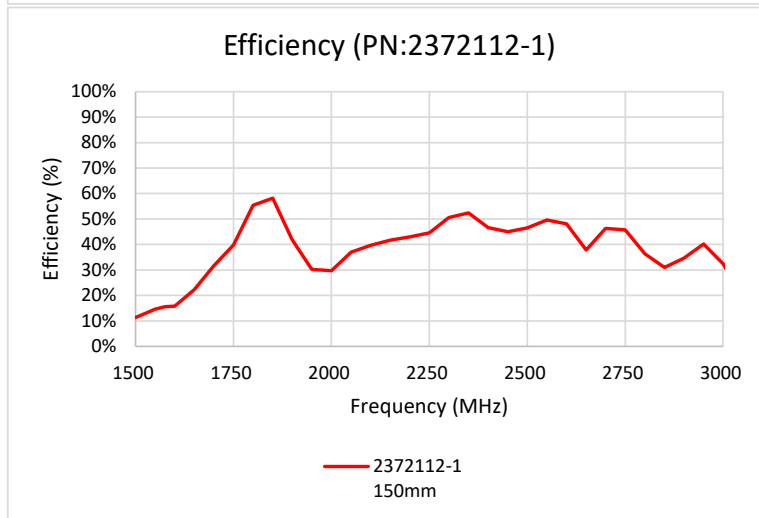
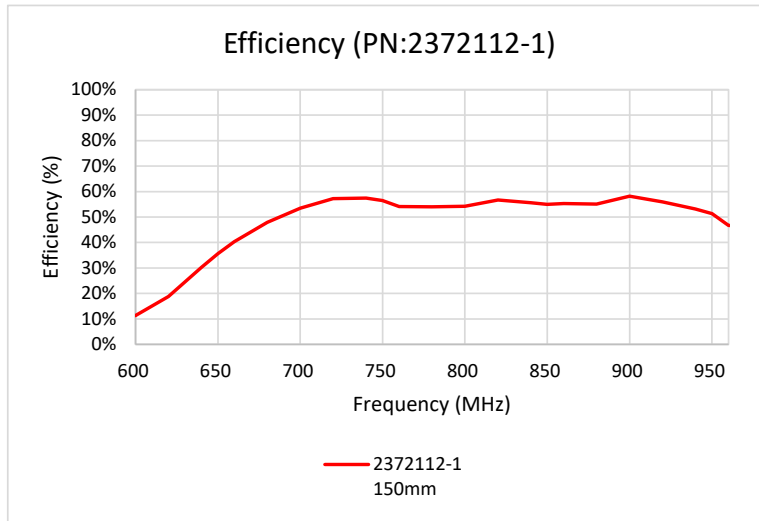
This section shows the effect on return loss of positioning the antenna in line with the ground plane (100x125mm). The antenna is fed from the mini coax connector at the edge of the PCB ground plane.

Variables:

X=100mm, Y=125mm



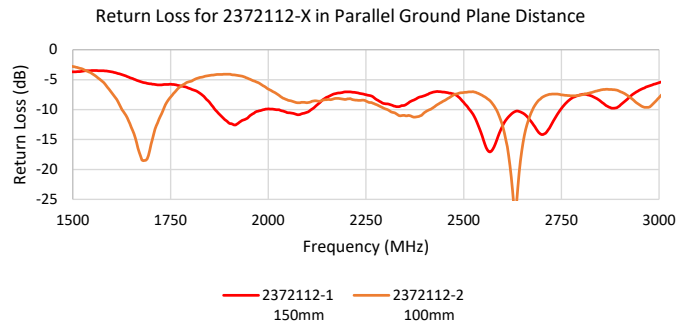
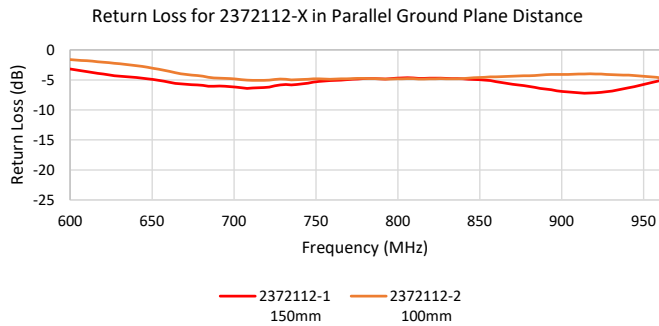
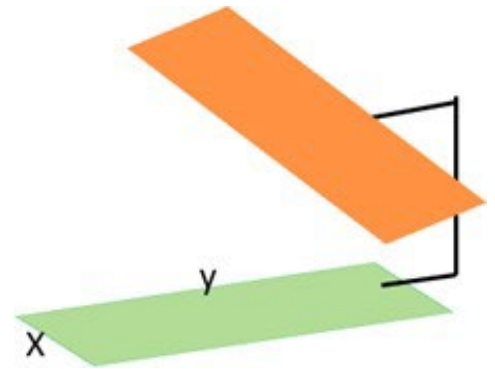
### 3 c. Performance Variation with Co-Plane Ground Plane Contd.



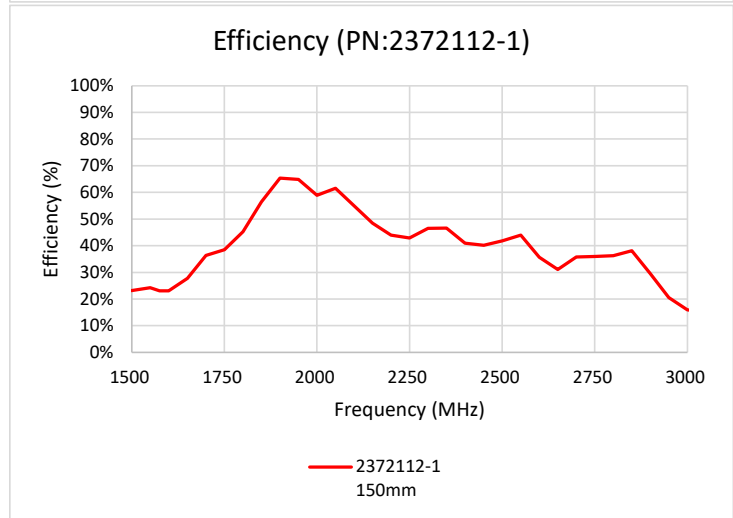
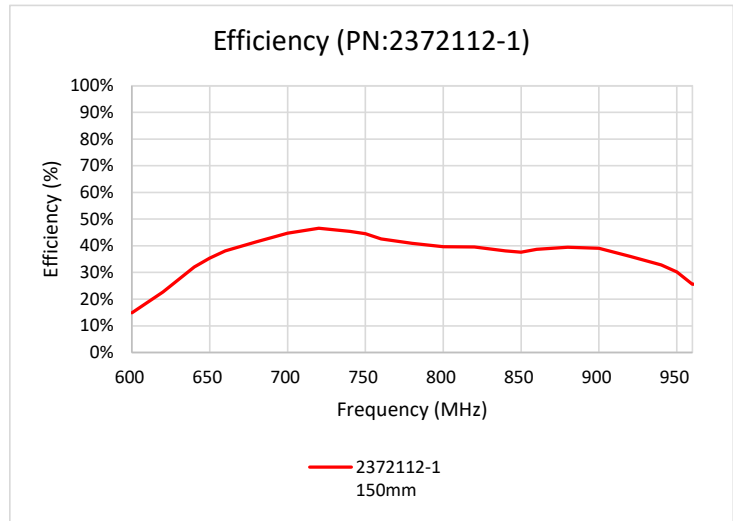
### 3 d. Performance Variation with Parallel Ground Plane

This section shows the effect on return loss of positioning the antenna parallel with the ground plane (100x125mm). The antenna is fed from the mini coax connector at the edge of the PCB ground plane.

Variables:  
100mm, Y=125mm



### 3 d. Performance Variation with Parallel Ground Plane Contd.



### 3 e. Performance Variation with Parallel Floating Metal Plate (Left Side)

This section shows the effect on return loss of positioning the antenna parallel with a floating metal plate (100x100mm), in various distances to the left of the antenna. The antenna is fed from the mini coax connector at the edge of the PCB ground plane.

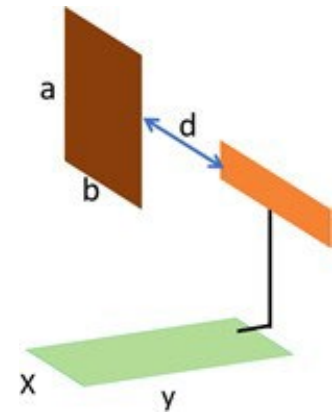
Variables:

X=100mm, Y=125mm

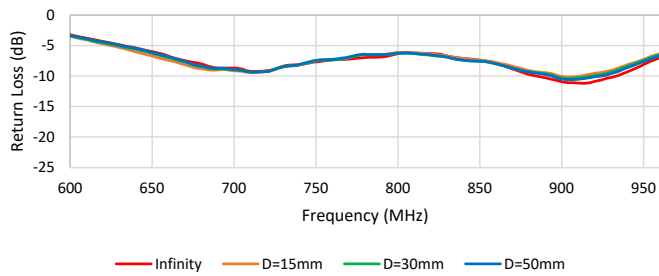
a=100mm, b=100mm

d = 15mm, 30mm, 50mm, infinity (without the floating metal plate)

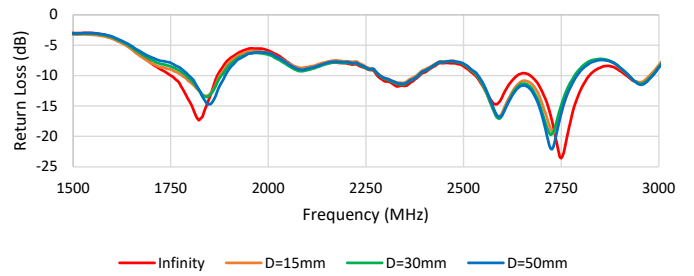
Antenna cable length = 150mm (PN: 2372112-1)



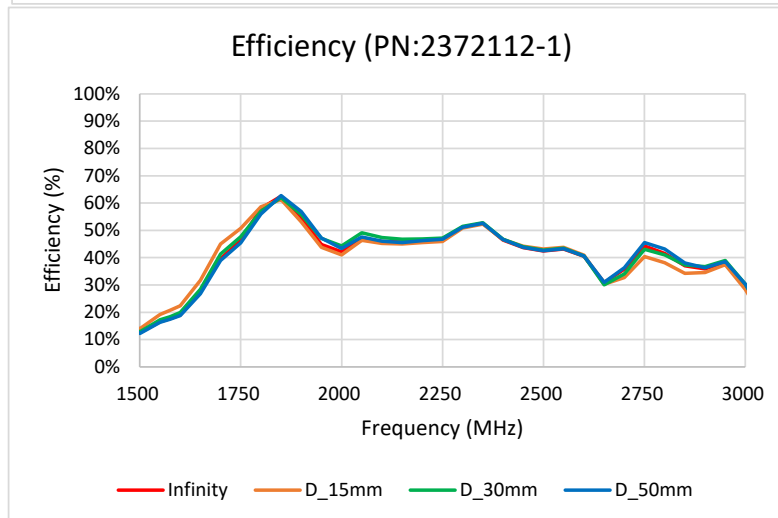
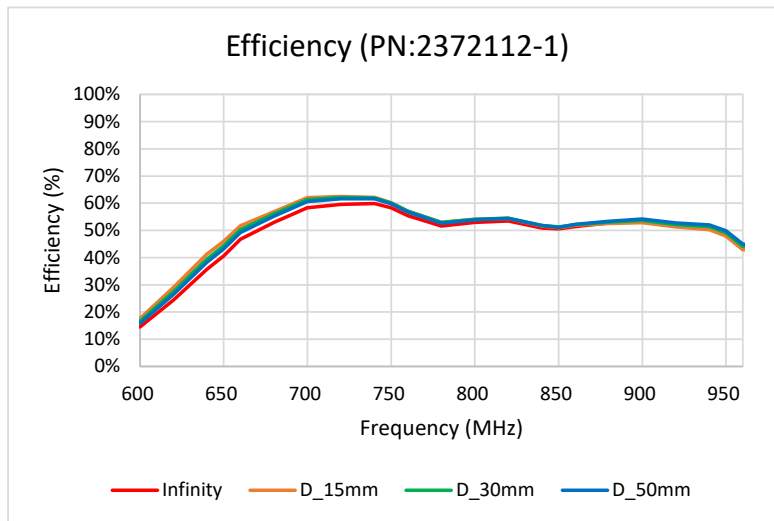
Return Loss for 2372112-1 (150mm) in Parallel Floating Metal Plate Distance (Left Side)



Return Loss for 2372112-1 (150mm) in Parallel Floating Metal Plate Distance (Left Side)



### 3 e. Performance Variation with Parallel Floating Metal Plate (Left Side) Contd.



### 3 f. Performance Variation with Parallel Floating Metal Plate (Centered)

This section shows the effect on return loss of positioning the antenna centrally with a floating metal plate in various distances. The antenna is fed from the mini coax connector at the edge of the PCB ground plane.

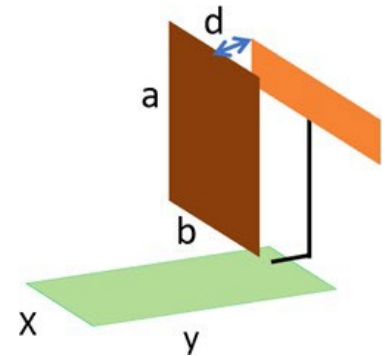
Variables:

X=100mm, Y=125mm

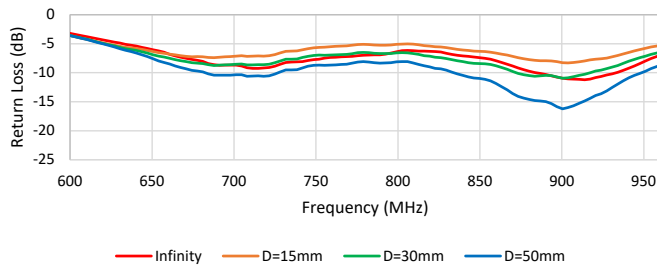
a=100mm, b=100mm

d = 15mm, 30mm, 50mm, infinity (without the floating metal plate)

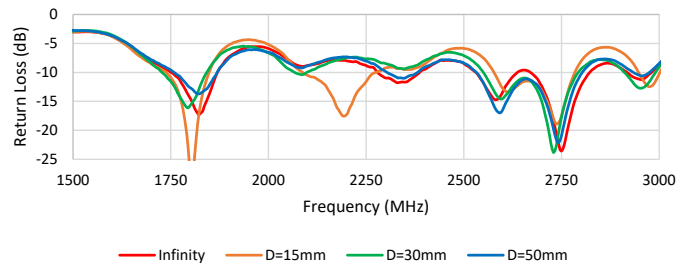
Antenna cable length = 150mm (PN: 2372112-1)



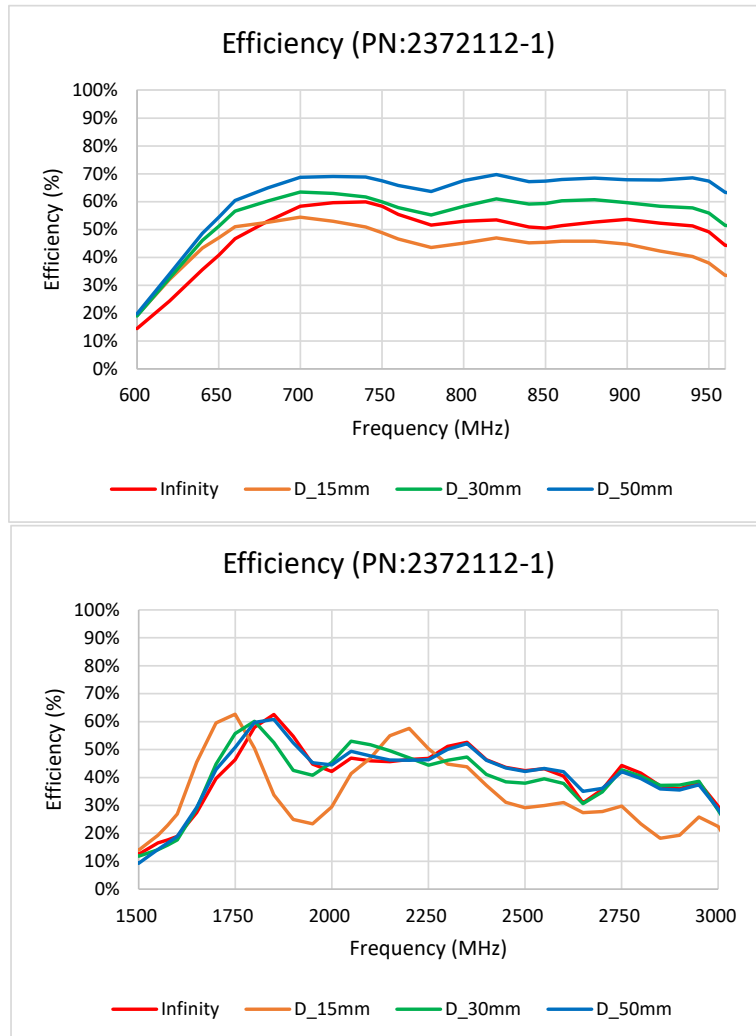
Return Loss for 2372112-1 (150mm) in Parallel Floating Metal Plate Distance (Centered)



Return Loss for 2372112-1 (150mm) in Parallel Floating Metal Plate Distance (Centered)



### 3 f. Performance Variation with Parallel Floating Metal Plate (Centered) Contd.



### 3 g. Performance Variation with Parallel Floating Metal Plate (Right Side)

This section shows the effect on return loss of positioning the antenna parallel with a floating metal plate in various distance to the right of the antenna. The antenna is fed from the mini coax connector at the edge of the PCB ground plane.

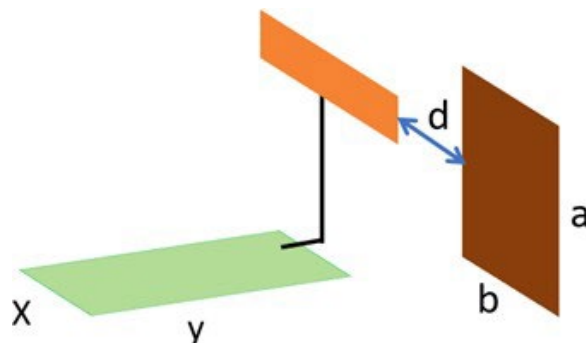
Variables:

X=100mm, Y=125mm

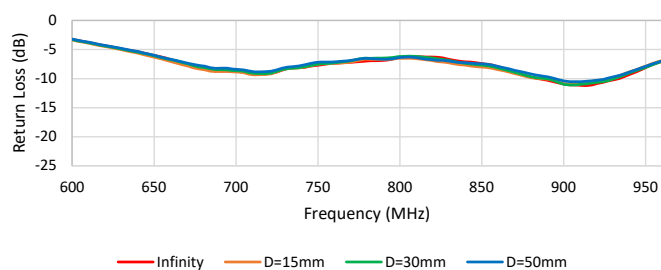
a=100mm, b=100mm,

d = 15mm, 30mm, 50mm, infinity (without the floating metal plate)

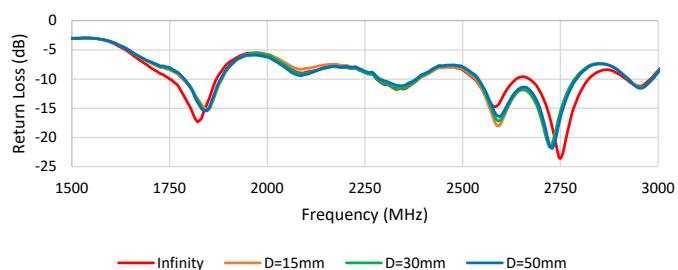
Antenna cable length = 150mm (PN: 2372112-1)



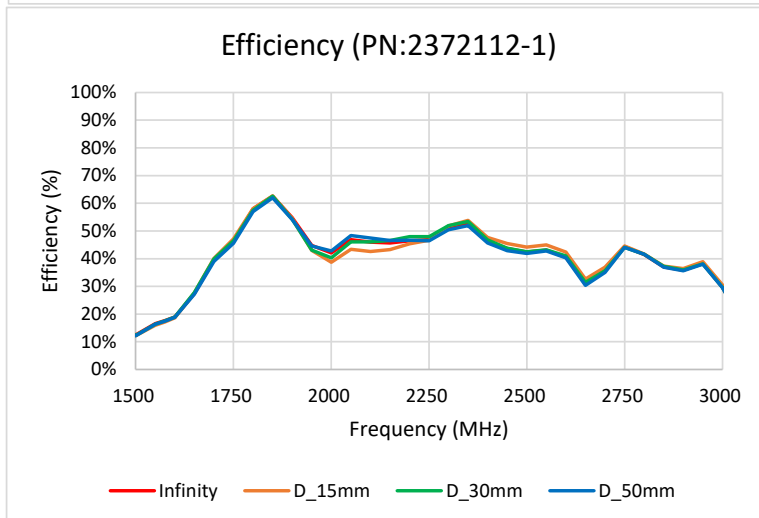
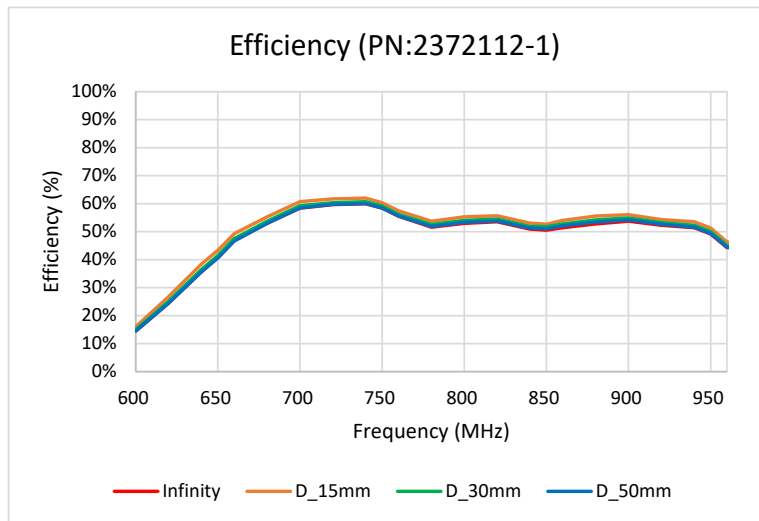
Return Loss for 2372112-1 (150mm) in Parallel Floating Metal Plate Distance (Right Side)



Return Loss for 2372112-1 (150mm) in Parallel Floating Metal Plate Distance (Right Side)



### 3 g. Performance Variation with Parallel Floating Metal Plate (Right Side) Contd.



### 3 h. Performance Variation with Orthogonal Floating Metal Plate (Centered)

This section shows the effect on return loss of positioning the antenna orthogonally with a floating metal plate at various height to the PCB ground plane. The antenna is fed from the mini coax connector at the edge of the PCB ground plane.

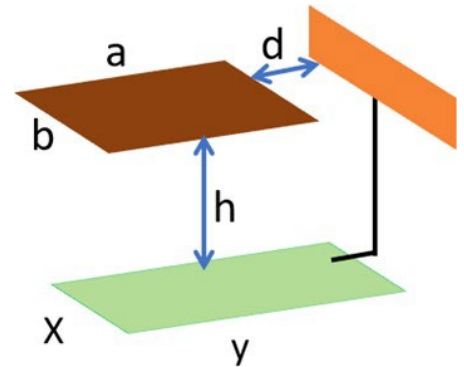
Variables:

X=100mm, Y=125mm

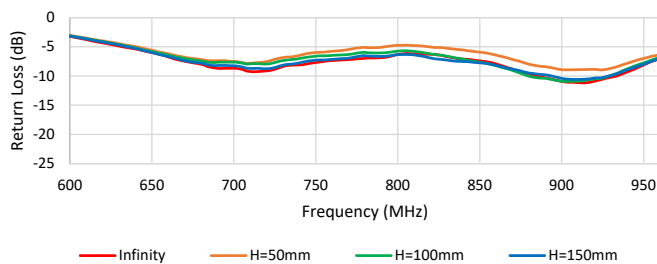
a=100mm, b=100mm, d = 50mm

h= 50mm, 100mm, 150mm, infinity (without the floating metal plate)

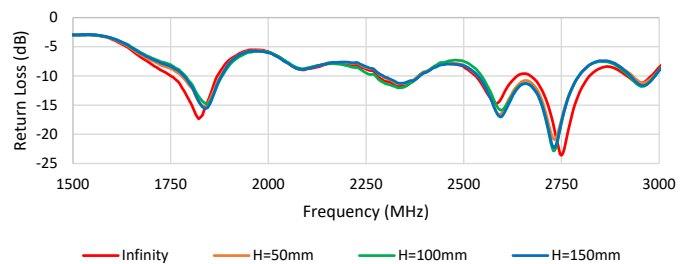
Antenna cable length = 150mm (PN: 2372112-1)



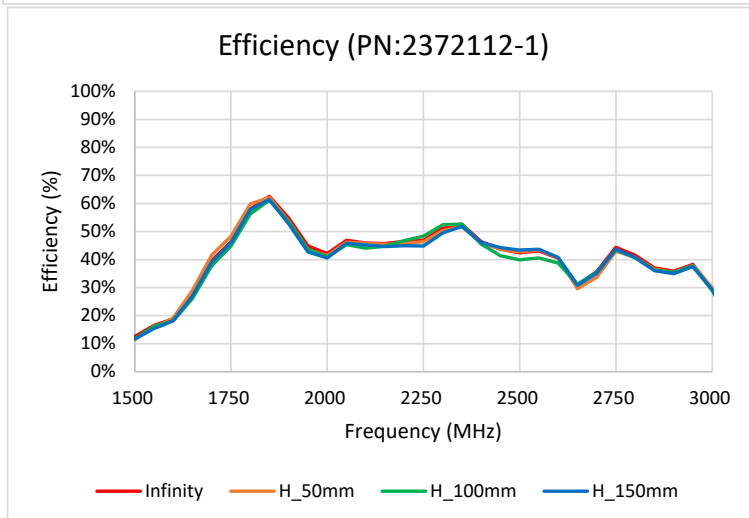
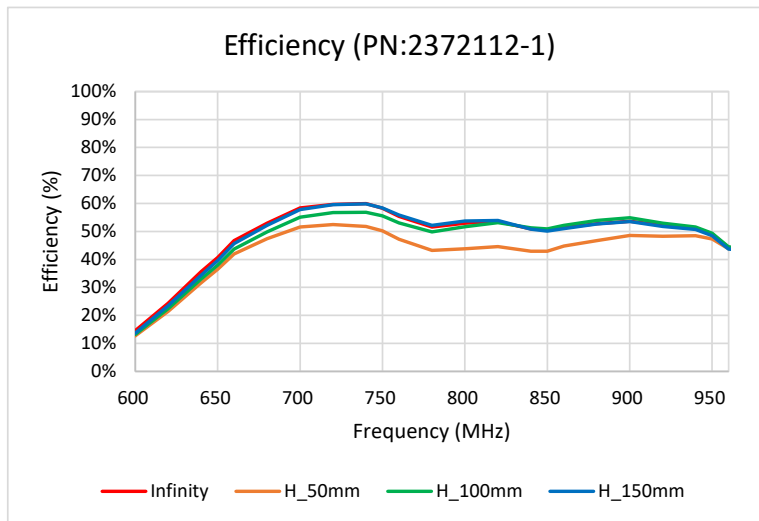
Return Loss for 2372112-1 (150mm) in Orthogonal Floating Metal Plate Distance (Centered)



Return Loss for 2372112-1 (150mm) in Orthogonal Floating Metal Plate Distance (Centered)



### 3 h. Performance Variation with Orthogonal Floating Metal Plate (Centered) Contd.



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