

# FlexPIFA 6E

## Installation Application Note

*v1.0*

### OVERVIEW

The Laird Connectivity Wi-Fi 6E FlexPIFA is a flexible PCB antenna that supports three bands of WLAN applications, including the 6 to 7.125 GHz band enabling Wi-Fi 6E. These small flexible printed circuit antennas can be embedded in space-sensitive applications. They offer excellent efficiency over all three Wi-Fi bands. The antennas are specifically designed to be embedded inside various IoT devices for aesthetically pleasing integration. Utilizing PIFA type antenna elements, all products in the FlexPIFA™ family of antennas deliver strong performance in challenging environments, offering less detuning and impact from nearby metallic objects or human body tissue.

This application note displays performance data for the FlexPIFA 6E antenna when integrated into different device configurations. When placed in dense environments with nearby metallic and non-metallic objects, antenna performance can be degraded or worse yet, detuned out of the desired frequency band. This is especially true of typical dipole type peel-and-stick antennas. However, you will find that the unique FlexPIFA peel-and-stick antenna family is more immune to many of those integration challenges. This application note provides a series of comparative data to enhance and speed the wireless design engineer's efforts to integrate this antenna into the end device.



This application note provides the following:

- Best-practice guidelines for installation into customer end devices. Consideration is given to the impact of nearby objects.
  - Antenna attachment to various thicknesses of plastic.
  - Metallic objects in perpendicular and parallel planes, at varying thicknesses
  - Effects of length of exposed cable
- Antenna RF comparisons of efficiency and gain over frequency
- Packaging and ordering details

### Configuration

PART NUMBER	EXPOSED CABLE LENGTH	CONNECTOR
EFB2471A3S-10MHF1	100 mm	MHF1

### INSTALLATION GUIDELINE SUMMARY

**Important:** Broad-banded antennas in small-factors such as these are susceptible to many influences. These include the following:

- Material type and thickness onto which the antenna is placed.
- The proximity of nearby items. Both plastic and, to a much greater extent, metal objects greatly affect antenna performance. These objects can include device housings, PCB ground planes, batteries, metal device structures, connector bodies, and large magnetic components.

### SPECIFICATIONS

ELECTRICAL SPECIFICATIONS			
Laird Connectivity Part Number	EMF2471A3S-10MHF1		
Number of Ports	1		
Operating Frequency (MHz)	2400-2500	4900-6000	6000-7125
VSWR – Avg	1.4:1	1.9:1	1.6:1
VSWR – Max	< 2.5:1	< 3.0:1	< 3.0:1
Peak Gain – (dBi) *	2.1	3.2	3.3
Efficiency – Avg (%)	59	60	60
Efficiency – Avg (dB)	-2.3	-2.2	-2.2
Nominal Impedance (Ohms)	50		

**ELECTRICAL SPECIFICATIONS**

Max Power - Ambient 25°C (W)	5
Polarization	Linear
Azimuth Beamwidth	360°, Omnidirectional

**Note:** Measured on a 100 mm x 100 mm x 1.7 mm thick polycarbonate sheet.

\* Actual peak gain values can be influenced by test chamber variation, part variation and other uncertainties.

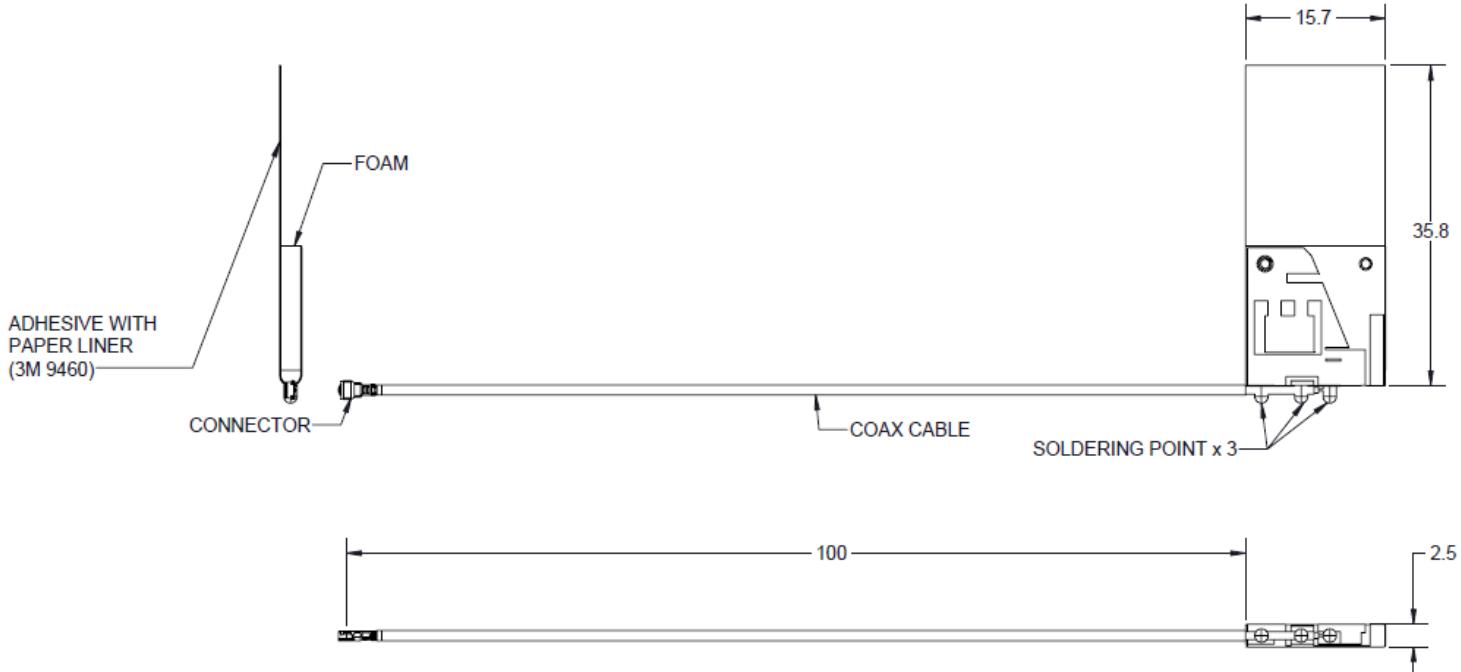
**MECHANICAL SPECIFICATIONS**

Dimensions – length x width x height – mm (inches)	16 x 36 x 2.5 (0.62 x 1.41 x .098)
Weight – g (oz.)	0.6
Adhesive	3M 467MP

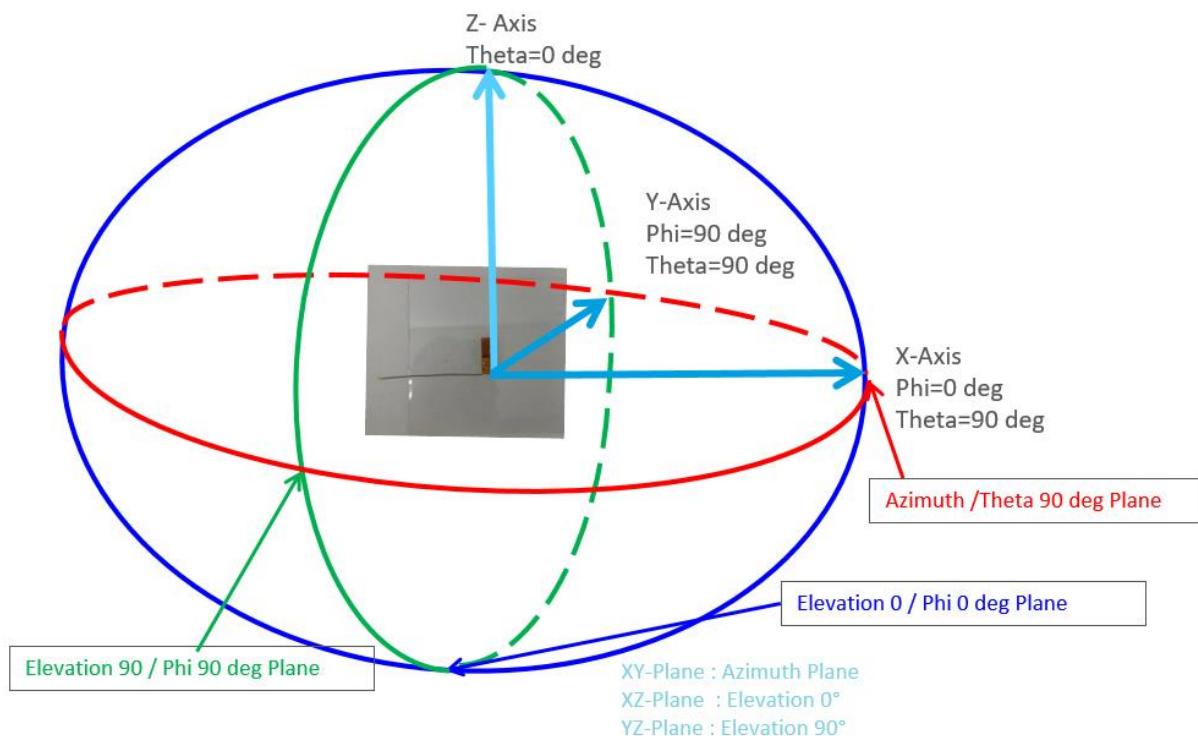
**ENVIRONMENTAL SPECIFICATIONS**

Operating Temperature – °C (°F)	-40 to +85°C (-40 to +185°F)
Storage Temperature – °C (°F)	-40 to +85°C (-40 to +185°F)
Material Substance Compliance	RoHS 3

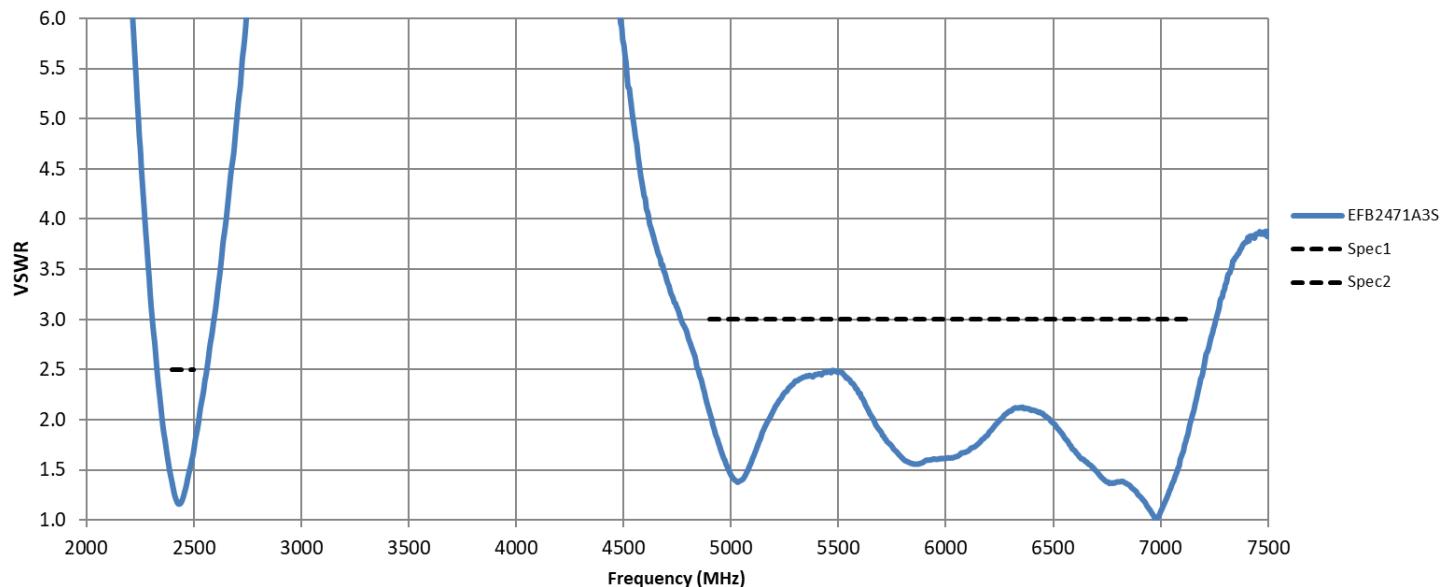
**MECHANICAL DRAWING**



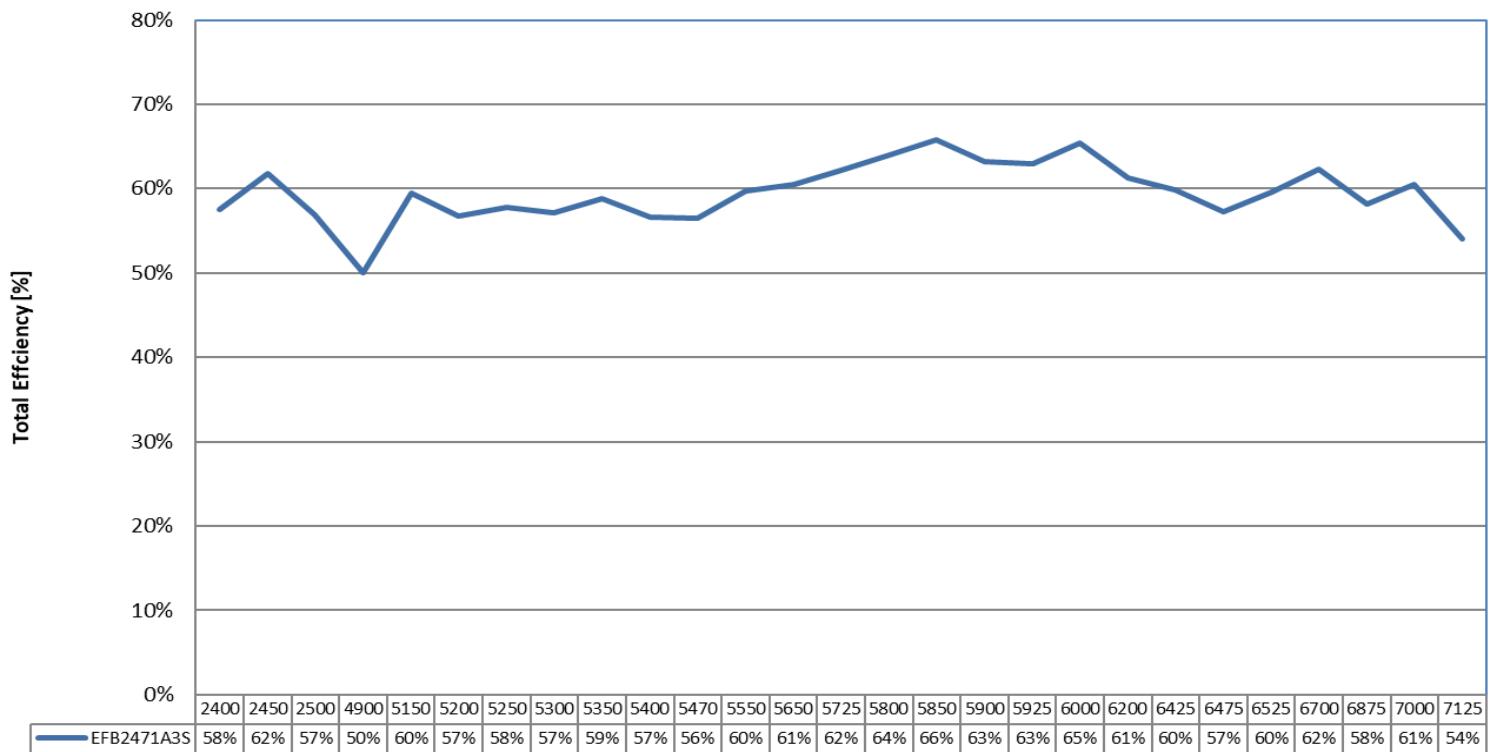
## MEASUREMENT COORDINATE SYSTEM



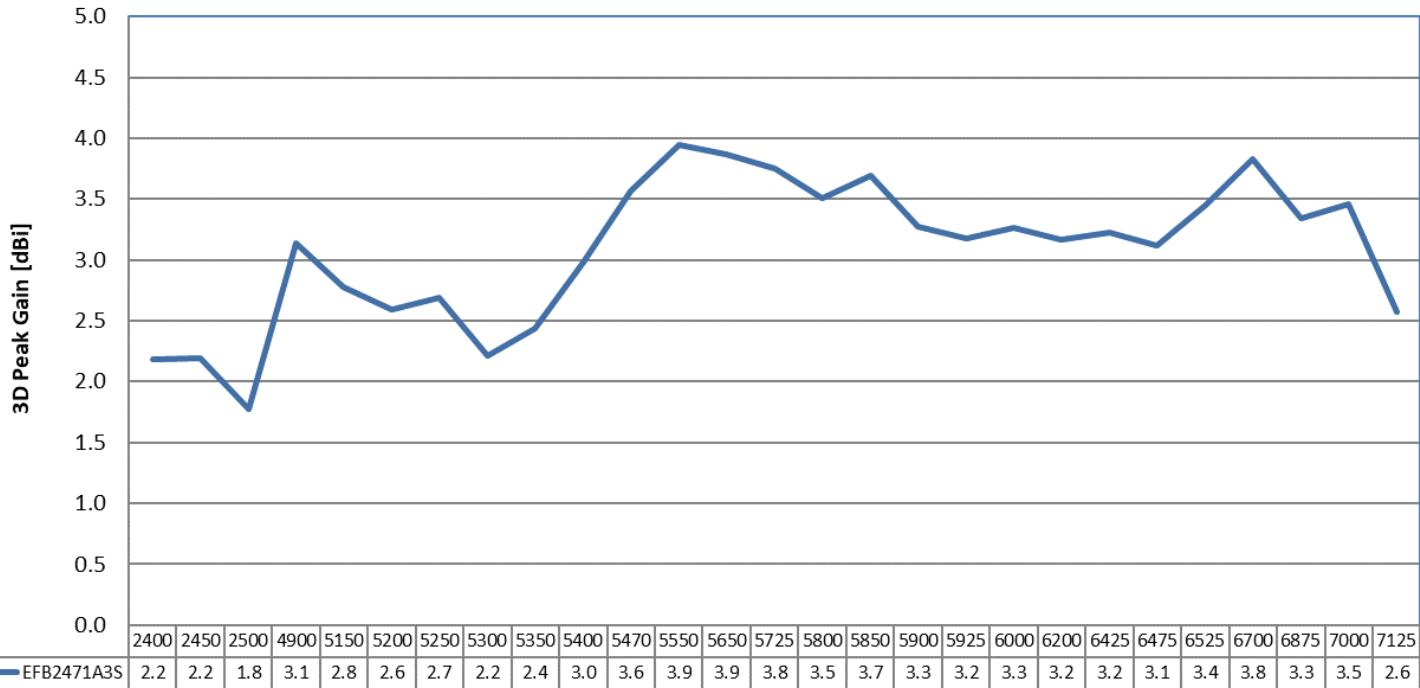
## VSWR



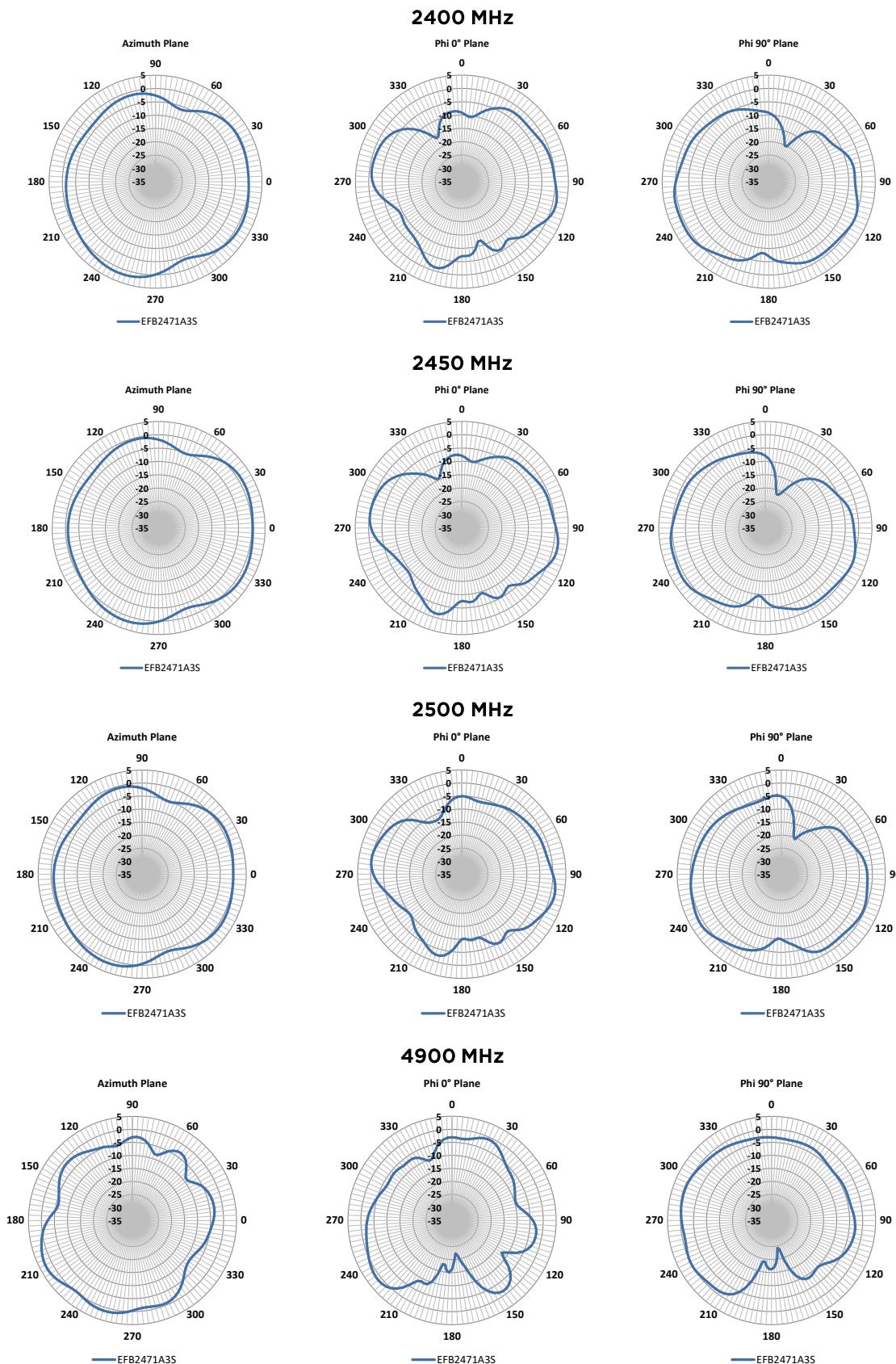
## TOTAL EFFICIENCY



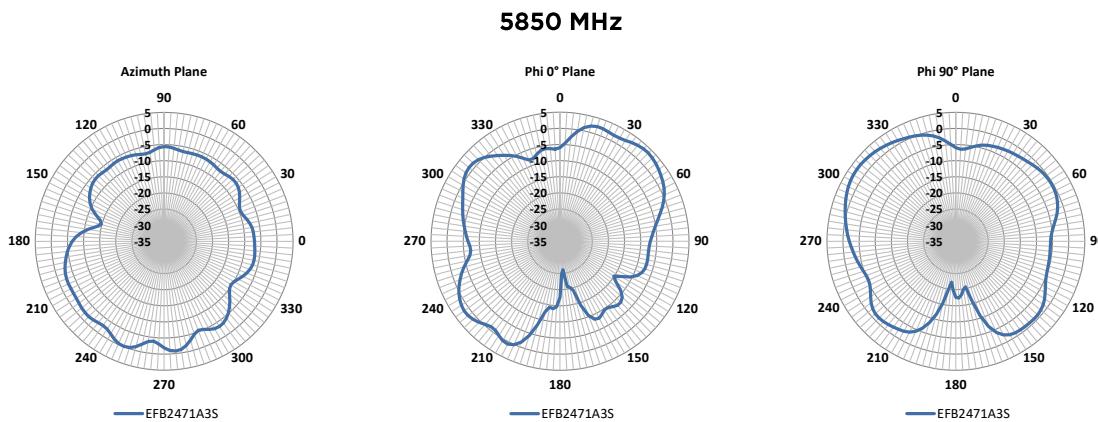
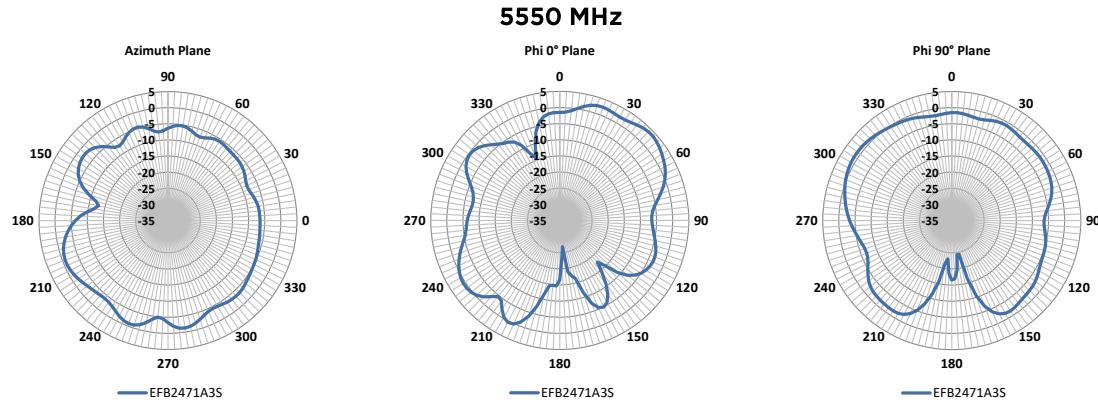
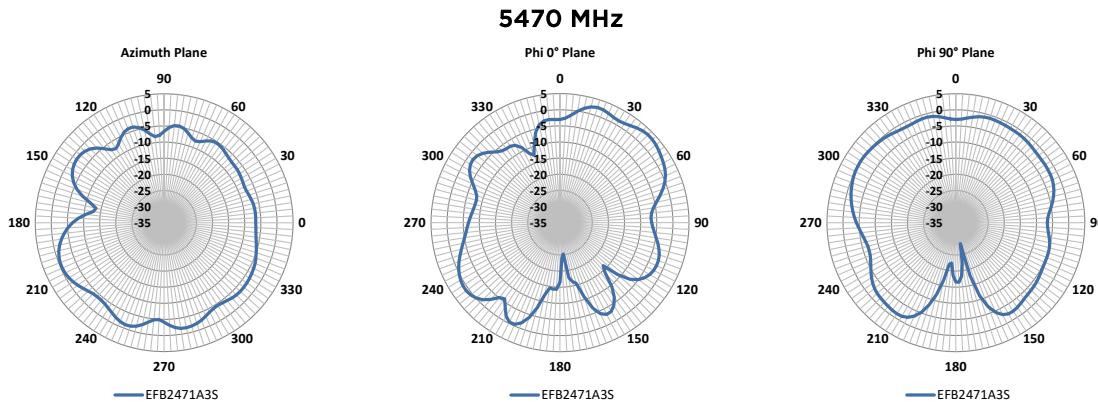
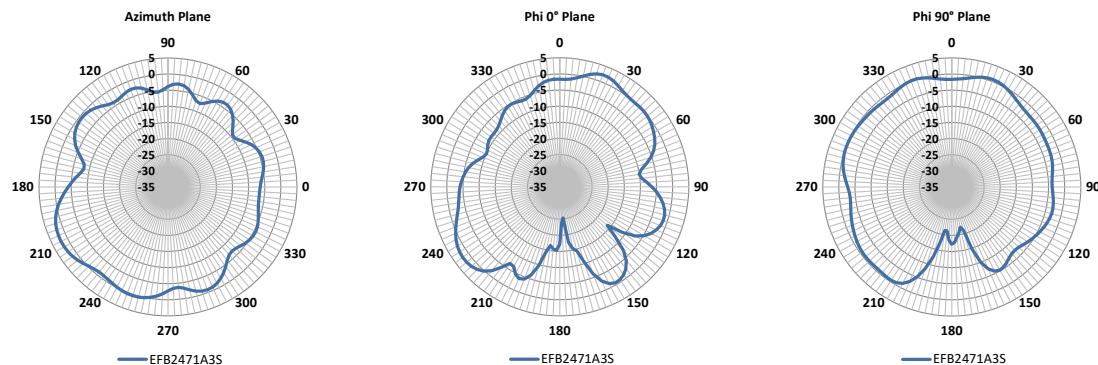
## PEAK GAIN



## RADIATION PATTERNS

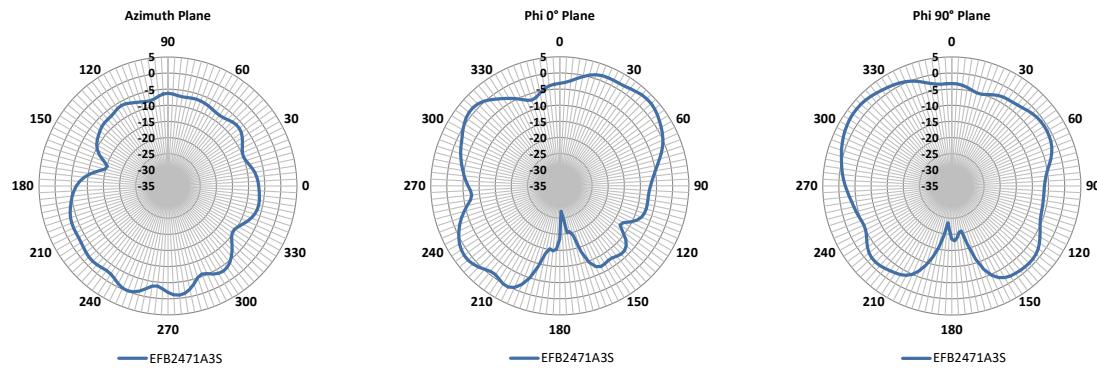


## RADIATION PATTERNS

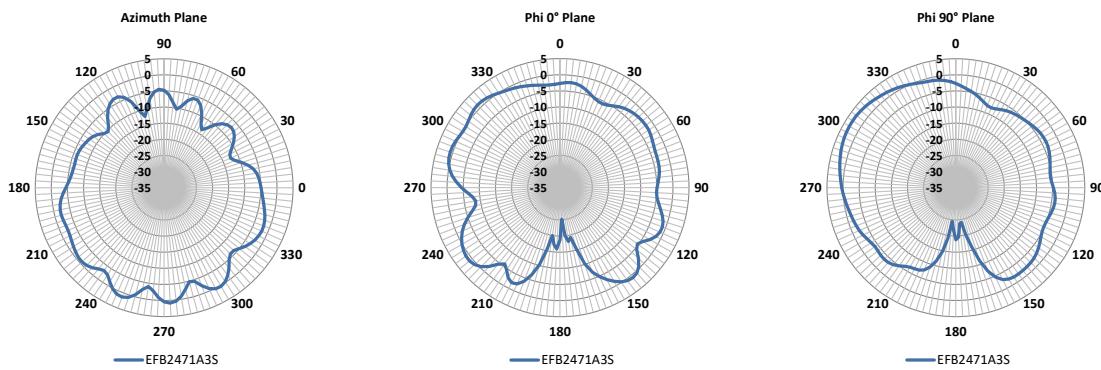


## RADIATION PATTERNS

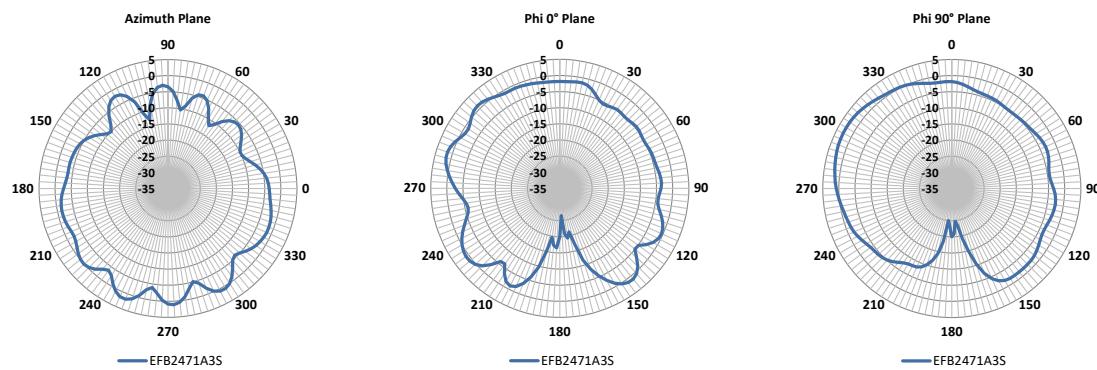
**5925 MHz**



**6425 MHz**

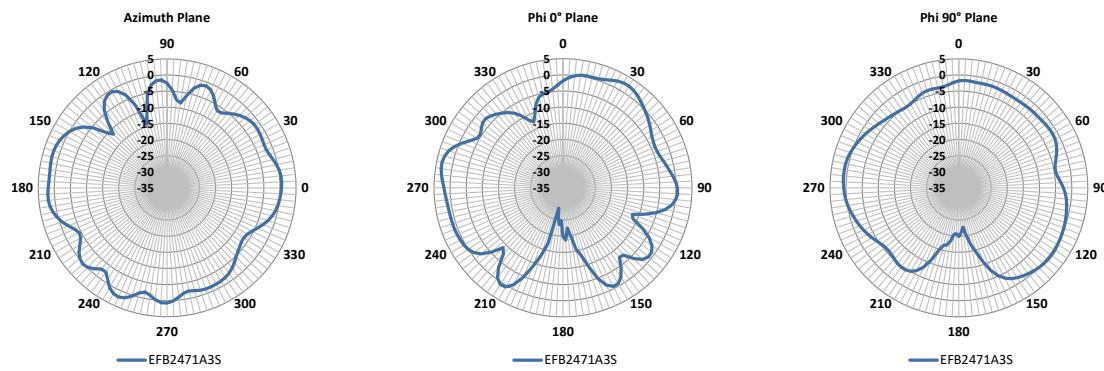


**6525 MHz**

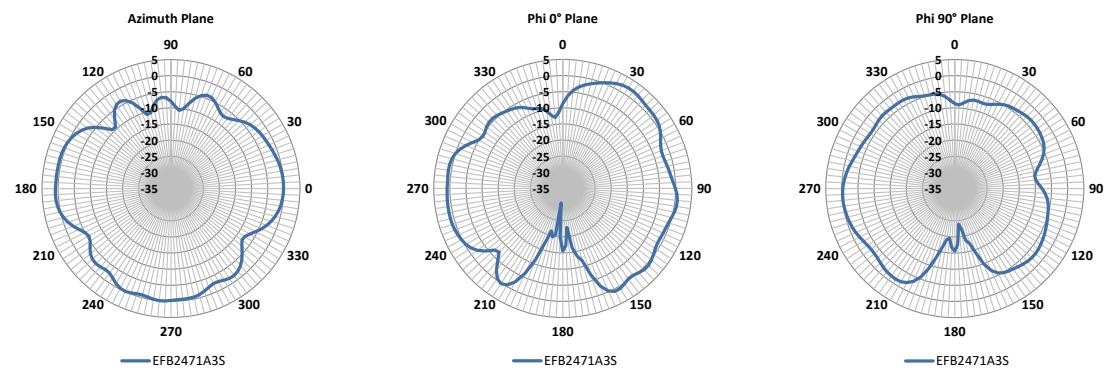


## RADIATION PATTERNS

**6875 MHz**



**7125 MHz**



## INSTALLATION GUIDELINE SUMMARY

The following examples show antenna performance for a variety of design-in scenarios. The goal is to provide performance data that a design engineer can expect to achieve when utilizing the FlexPIFA 7GHz antenna in devices that utilize similar spacing or materials for their applications. The following sections demonstrate the following:

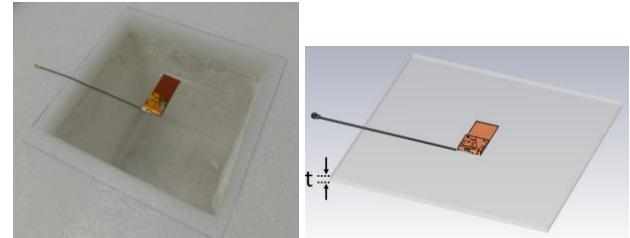
- Impact on Antenna VSWR when Placed on Plastic of Different Thicknesses
- Impact on Antenna VSWR of Exposed Cable Length
- Impact on Antenna VSWR of Placement on Plastic, Corner Bend
- Impact on Antenna VSWR of Placement Above Metal Ground Plane
- Impact on Antenna VSWR of Parallel Placement to Right Side of Metal Ground Plane

- Impact on Antenna VSWR of Parallel Placement to Left Side of Metal Ground Plane
- Impact on Antenna VSWR of Placement Beside Metal Plate (90 degree, Right-2)
- Impact on Antenna VSWR of Placement Beside Metal Plate (90 degree, Left-2)
- Impact on Antenna VSWR on a Curved Surface (Inside and Outside PVC Tube)

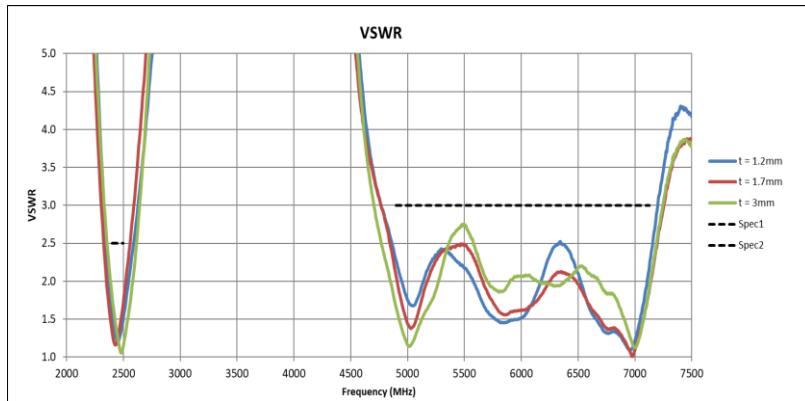
### Impact on Antenna VSWR when Placed on Plastic of Different Thicknesses

#### General Test Conditions:

- Tested on piece of polycarbonate of size 150 X 150 mm with varying thickness
- Antenna with exposed cable length of 100 mm



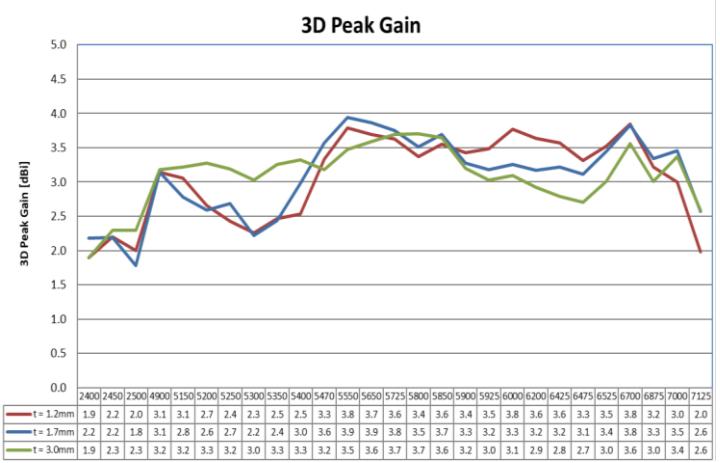
#### VSWR On Various Plastic Thicknesses



Frequency (MHz)	VSWR (Max) @ t Thickness		
	T = 1.2 mm	T = 1.7 mm	T = 3.0 mm
2400 – 2500	1.63	1.72	1.81
4900 – 6000	2.43	2.49	2.75
6000 – 7125	2.53	2.13	2.20

#### VSWR vs Frequency for placement on 3 tested plastic thicknesses

#### Total Efficiency & Max Gain on Various Plastic Thicknesses



Frequency (MHz)	3D Total Efficiency – Average (%)		
	T = 1.2 mm	T = 1.7 mm	T = 3.0 mm
2400-2500	59%	59%	60%
4900-6000	60%	60%	57%
6000-7125	59%	60%	56%

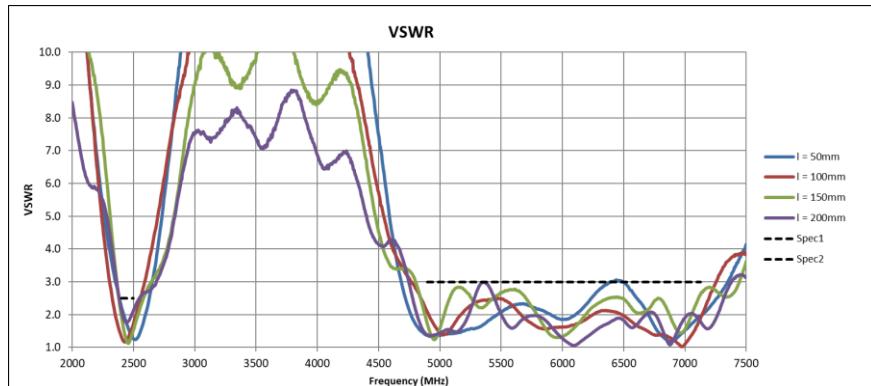
Frequency (MHz)	3D Max Gain (dBi)		
	T = 1.2 mm	T = 1.7 mm	T = 3.0 mm
2400-2500	2.2	2.2	2.3
4900-6000	3.8	3.9	3.7
6000-7125	3.8	3.8	3.6

## Impact on Antenna VSWR of Exposed Cable Length

### General Test Conditions:

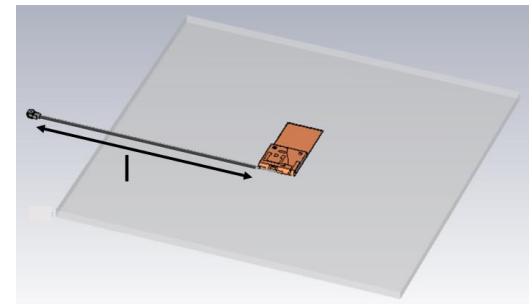
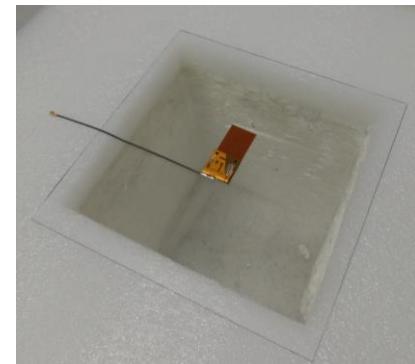
- Tested on a PC of size 150 X 150 mm and thickness of 1.7 mm.
- Antenna with exposed cable length L

### VSWR Maximum @ Various Exposed Cable Lengths



VSWR vs Frequency for each of 4 exposed cable lengths

Frequency (MHz)	VSWR (Max)			
	50 mm	100 mm	150 mm	200 mm
2400 – 2500	2.28	1.72	2.00	2.17
4900 – 6000	2.34	2.49	2.84	3.00
6000 – 7125	3.07	2.13	2.59	2.08

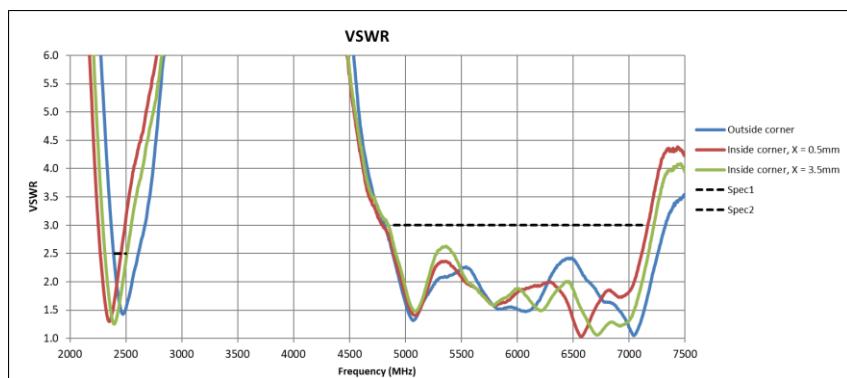


## Impact on Antenna VSWR of Placement on Plastic, Corner Bend

### General Test Conditions:

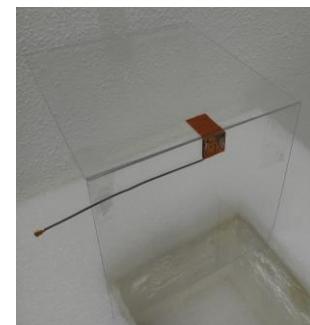
- Tested on a corner made of two polycarbonate pieces of size 150 X 150 mm and thickness of 1.7 mm
- For the case of inside the corner, a distance X between edge of foam and bent flex is adjusted to achieve different VSWR
- Antenna with exposed cable length of 100 mm

### VSWR Maximum @ Max Bend Length

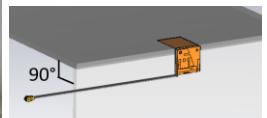


VSWR vs Frequency with maximum bend vs. straight

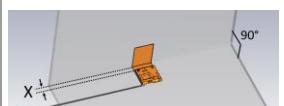
Frequency (MHz)	VSWR (Max)		
	Outside Corner	Inside Corner, X=0.5 mm	Inside Corner, X=3.5 mm
2400 – 2500	2.24	3.16	2.4
4900 – 6000	2.39	2.44	2.63
6000 – 7125	2.42	2.58	2.06



Outside corner



Inside corner

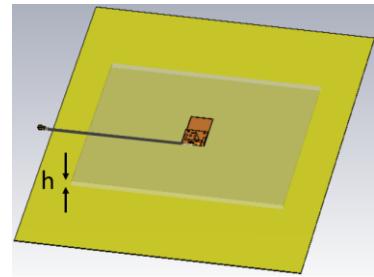
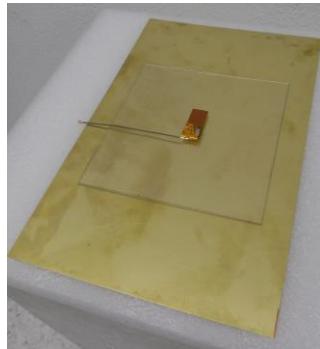


## Impact on Antenna VSWR of Placement Above Metal Ground Plane

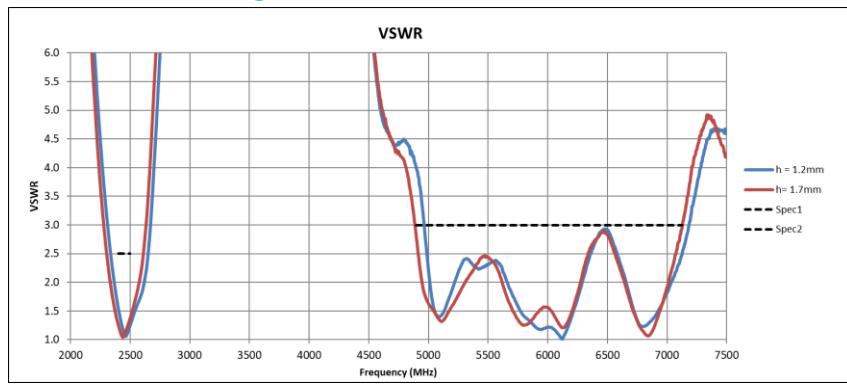
### General Test Conditions:

- Tested above a metal plate of size 300 X 210 mm
- Antenna separated from the metal plate by a PC piece of size 150 X 150 mm and thickness  $h$
- Antenna with exposed cable length of 100 mm

**Note:** The ground of the antenna can be placed as close as 1.7 mm to a metal plate while maintaining good VSWR.



### VSWR Maximum @ Various Distances from Ground Plane



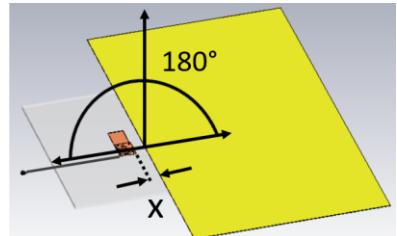
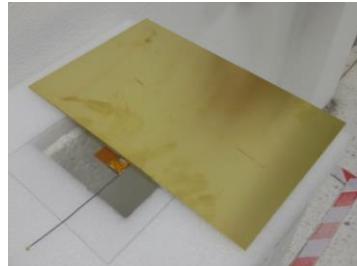
Frequency (MHz)	VSWR (Max) @ plastic thickness, $H$	
	$H = 1.2\text{ mm}$	$H = 1.7\text{ mm}$
2400 – 2500	1.56	1.37
4900 – 6000	3.99	2.78
6000 – 7125	2.93	2.93

## Impact on Antenna VSWR of Parallel Placement to Right Side of Metal Ground Plane (180 degree, Right-1)

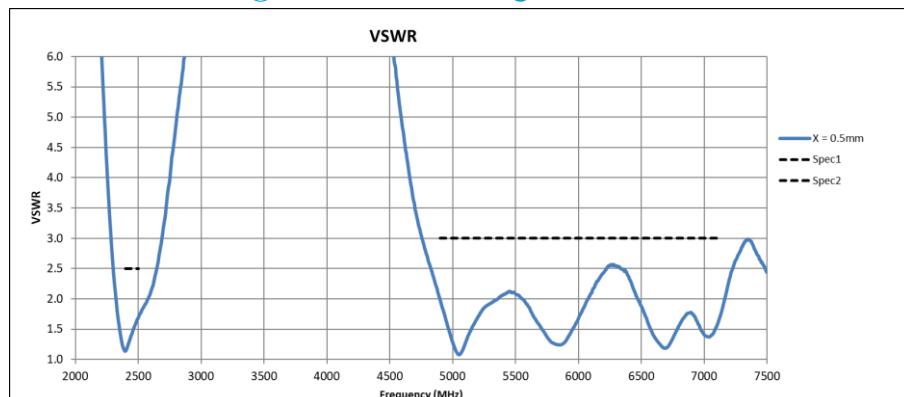
### General Test Conditions:

- Metal plate of size 300 X 210 mm placed 2 mm above the radiator surface and a distance  $X$  from the right of its edge
- Antenna stucked to a PC of thickness 1.7 mm and size 150 X 150 mm
- Antenna with exposed cable length of 100 mm

**Note:** The antenna can be placed as close as 0.5 mm to a metal plate parallel to its right edge while maintaining good VSWR.



### VSWR Maximum @ 0.5 mm to the Right of Ground Plane



Frequency (MHz)	VSWR (Max) @ 0.5 mm from Ground Plane	
	Spec1	Spec2
2400 – 2500	1.70	
4900 – 6000	2.13	
6000 – 7125	2.57	

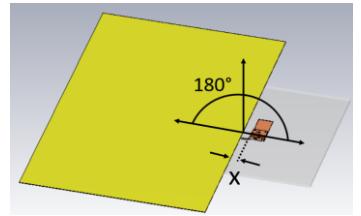
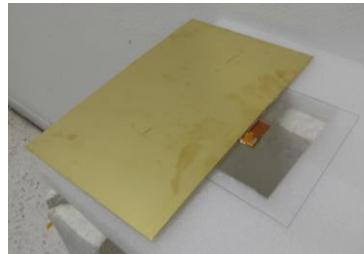
VSWR vs Frequency for 0.5 mm to right of ground plane

## Impact on Antenna VSWR of Parallel Placement to Left Side of Metal Ground Plane (180 degree, Left-1)

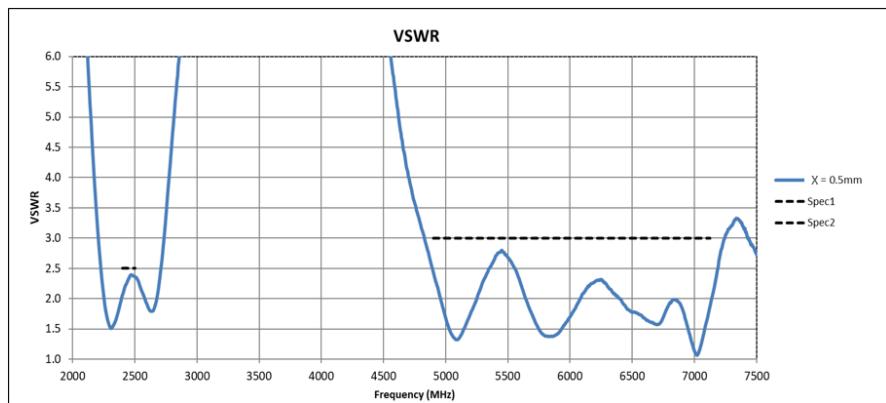
### General Test Conditions:

- Metal plate of size 300 X 210 mm placed 2 mm above the radiator surface and a distance X from the left of its edge
- Antenna stucked to a PC of thickness 1.7 mm and size 150 X 150 mm
- Antenna with exposed cable length of 100 mm

**Note:** The ground of the antenna can be placed as close as 0.5 mm to a metal plate while maintaining good VSWR.



### VSWR Maximum @ 0.5 mm to the Left of Ground Plane



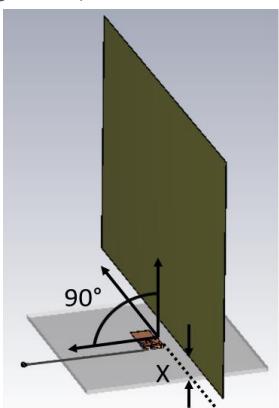
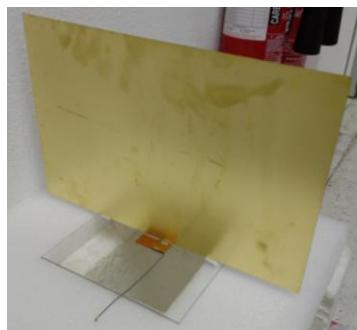
Frequency (MHz)	VSWR (Max) @ Left of Ground Plane 0.5 mm
2400 – 2500	2.40
4900 – 6000	2.80
6000 – 7125	2.32

## Impact on Antenna VSWR of Placement Beside Metal Plate (90 degree, Right-2)

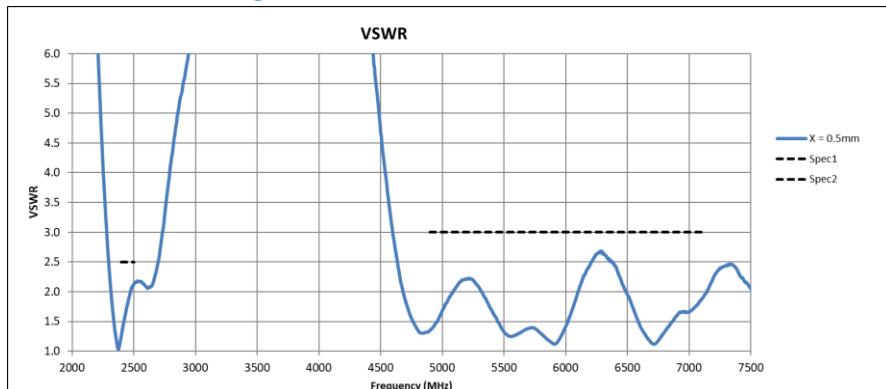
### General Test Conditions:

- Metal plate of size 300 X 210 mm placed at a distance, X right above the right edge of the radiator
- Antenna stucked to a PC of thickness 1.7 mm and size 150 X 150 mm
- Antenna with exposed cable length of 100 mm

**Note:** The antenna can be placed as close as 0.5 mm to a metal plate perpendicular and right above its right edge while maintaining good VSWR.



### VSWR Maximum @ Various Distances from Ground Plane



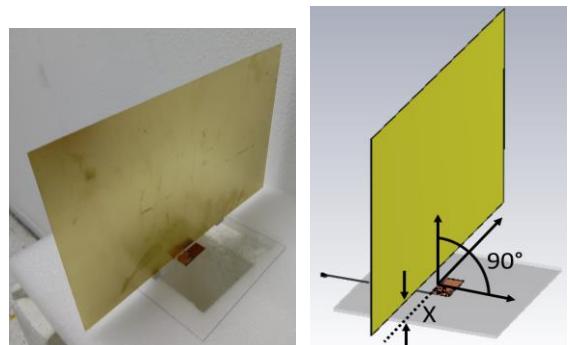
Frequency (MHz)	VSWR (Max) @ Distances from Ground 0.5 mm
2400 – 2500	2.13
4900 – 6000	2.23
6000 – 7125	2.68

VSWR vs Frequency for each of 3 tested distances from ground plane

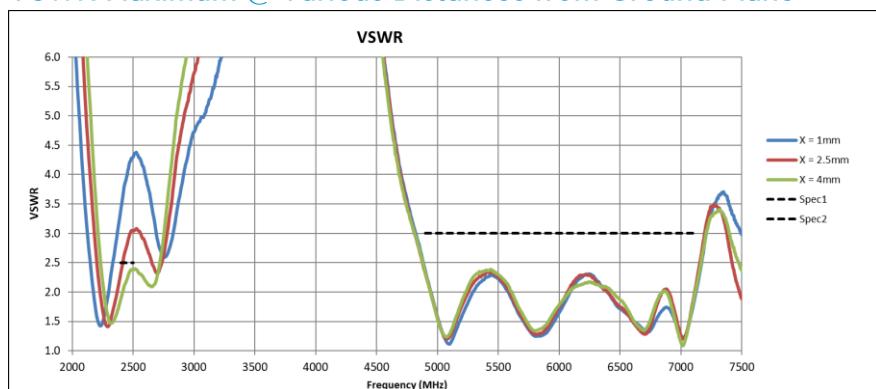
## Impact on Antenna VSWR of Placement Beside Metal Plate (90 degree, Left-2)

### General Test Conditions:

- Metal plate of size 300 X 210 mm placed at a distance, X right above the left of the edge of the radiator.
- Antenna stucked to a PC of thickness 1.7 mm and size 150 X 150 mm.
- Antenna with exposed cable length of 100 mm



### VSWR Maximum @ Various Distances from Ground Plane



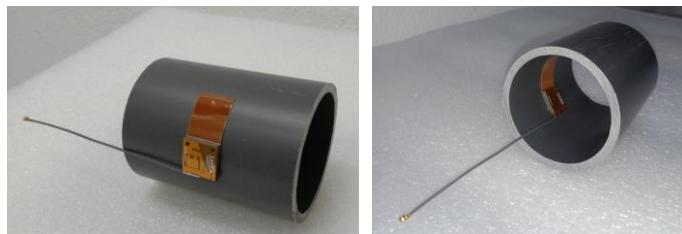
Frequency (MHz)	VSWR (Max) @ Distances from Ground		
	1 mm	2.5 mm	4 mm
2400 – 2500	4.30	3.05	2.38
4900 – 6000	2.36	2.34	2.38
6000 – 7125	2.31	2.29	2.17

VSWR vs Frequency for each of 3 tested distances from ground plane

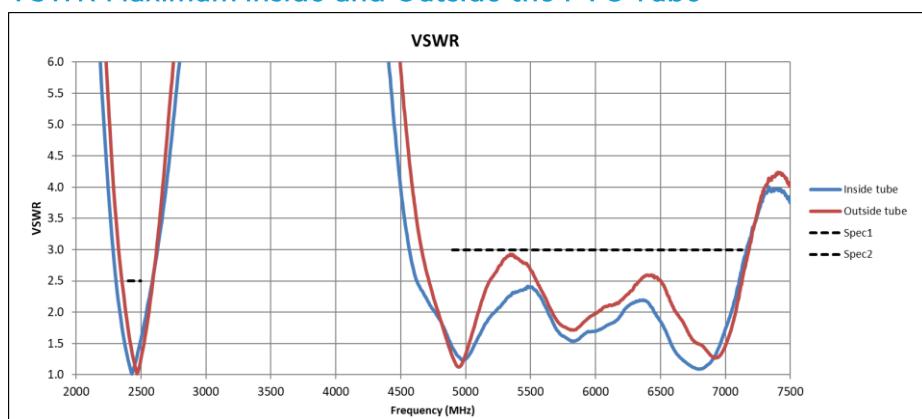
## Impact on Antenna VSWR on a Curved Surface (Inside and Outside PVC Tube)

### General Test Conditions:

- Tested inside and outside of a PVC tube of outer diameter of 60 mm, length of 80 mm, and thickness of 4 mm.
- Antenna with exposed cable length of 100 mm



### VSWR Maximum Inside and Outside the PVC Tube

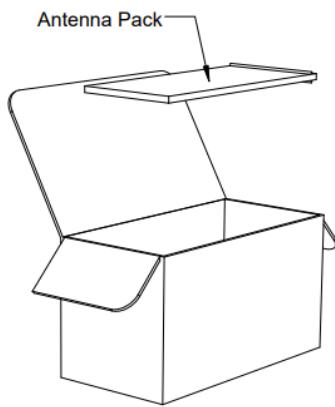


Frequency (MHz)	VSWR (Max) Inside and Outside Tube	
	Inside Tube	Outside Tube
2400 – 2500	1.57	1.75
4900 – 6000	2.42	2.93
6000 – 7125	2.65	2.59

## PACKAGING INFORMATION

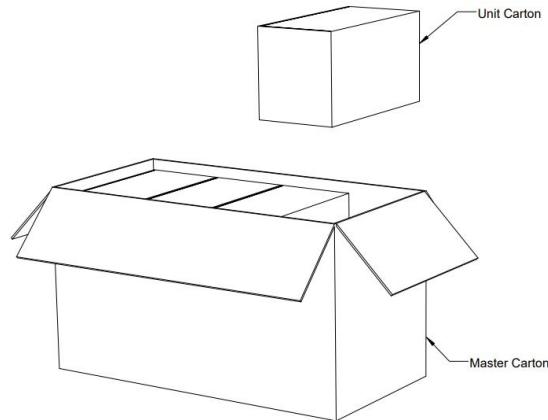
### Carton Layout

#### Unit Carton



- Dimensions: 245 mm x 120 mm x 135 mm
- Weight: 0.22 kg
- Zipper bag 152 mm x 229 mm (10 antennas per bag)
- 20x zipper bags per carton (200 antennas total)

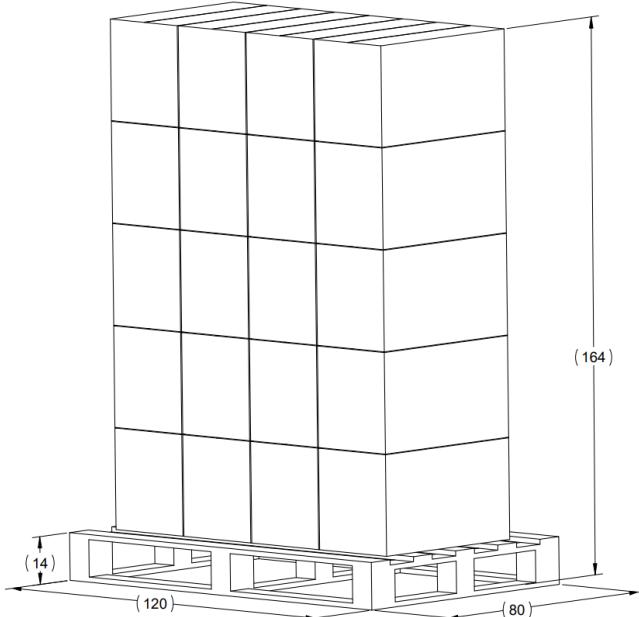
#### Master Carton



- Dimensions: 520 mm x 260 mm x 295 mm
- Weight: 2.4 kg
- Total of 8-unit cartons per master carton
- Total of 1600 antennas per master carton

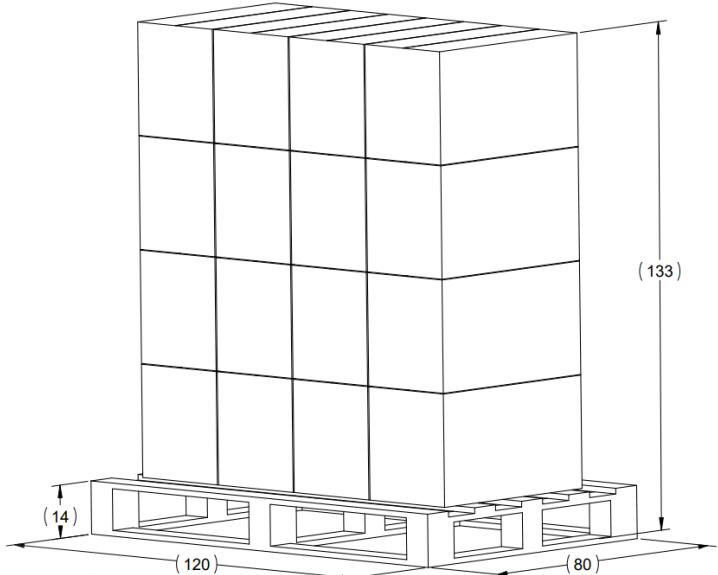
### Pallet Layout

#### Ocean Shipping Pallet



- Pallet base dimensions: 120 cm x 80 cm x 14 cm
- Full loaded dimensions: 120 cm x 80 cm x 164 cm
- 20 master cartons (4 x 5 layout), 60 kg total
- 32000 antennas per pallet

#### Air Shipping Pallet



- Pallet base dimensions: 120 cm x 80 cm x 14 cm
- Full loaded dimensions: 120 cm x 80 cm x 133 cm
- 16 master cartons (4 x 4 layout), 50.4 kg total
- 25600 antennas per pallet

## REVISION HISTORY

Version	Date	Notes	Approver
1.0	29 July 2021	Initial Release	Paul Fadlovich

### ✓ RoHS

Laird Connectivity warrants to the original end user customer of its products that its products are free from defects in material and workmanship. Subject to conditions and limitations Laird Connectivity will, at its option, either repair or replace any part of its products that prove defective because of improper workmanship or materials. This limited warranty is in force for the useful lifetime of the original end product into which the Laird Connectivity product is installed. Useful lifetime of the original end product may vary but is not to exceed five (5) years from the original date of the end product purchase.

Any information furnished by Laird Connectivity and its agents is believed to be accurate and reliable. All specifications are subject to change without notice. Responsibility for the use and application of Laird Connectivity materials rests with the end user, since Laird Connectivity and its agents cannot be aware of all potential uses. Laird Connectivity makes no warranties as to the fitness, merchantability or suitability of any Laird Connectivity materials or products for any specific or general uses. Laird Connectivity shall not be liable for incidental or consequential damages of any kind. All Laird Connectivity products are sold pursuant to the Laird Connectivity Terms and Conditions of sale in effect from time to time, a copy of which will be furnished upon request.

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