TAOGLAS

Datasheet

Universe

Part No:
PCS.50.A

Description

Low Profile LTE/Cellular 5G/4G & GNSS SMD Antenna

Features:

SMD Dielectric Antenna

LTE/5G: 600-6000MHz

GPS / GLONASS / Galileo / Bei Dou (1561-1602MHz)

Adjusts the resonance frequency of the antenna to the desired frequency band

Dimensions: 38*10*1.6mm

Smart antenna solution with aperture tuning

RoHS & REACH Compliant

1. Introduction

The Taoglas Universe PCS.50.A is a patent pending active Cellular and GNSS antenna designed specifically for IoT devices with small ground planes. With an unprecedented level of integration, it combines aperture tuning and active switching technologies to provide wideband coverage for GNSS and cellular connectivity.

The PCS.50.A has an RF switch to adjust the resonance frequency of the antenna depending on the device's requirements. The aperture tuning technology allows the antenna to cover the whole spectrum of 4G LTE/5G bands by adjusting the resonant frequency of the antenna to the desired frequency band of operation. This allows the device to use the correct frequency band required by the radio module. Additionally, a second active switch can be simply added if either Cellular or GNSS needs to be selected.

The PCS.50.A is compatible with the radio modules that support the RF front-end control interface (RFFE). The radio module controls the active RF switch to adjust the antenna resonance frequency to operate efficiently on multiple bands and increase the RF capabilities by 3dB compared with standard passive solutions. This will in turn, improve the Total Radiated Power (TRP) and Total Isotropic Sensitivity (TIS).

The PCS.50.A is easy to integrate using standard SMD technologies, and implementing the active solution is easy thanks to Taoglas' integration support, providing different design files depending on your requirements. The antenna can be tuned by simply selecting the best switching configuration to achieve the optimum antenna performance.

Taoglas has developed an evaluation board PCSD.50.A to demonstrate the antenna performance for 4G/LTE applications. The PCSD.50.A is just 40 x 50mm, makes it suitable for even the smallest of IoT and CAT-M devices. Typical applications include IoT devices such as smart sensors requiring cellular and GNSS connectivity, wearables or asset tracking. The antenna itself measures just 38 x 10 x 1.6mm, and as it is manufactured from high-grade FR4 PCB, it is lightweight; yet robust, and it is supplied on tape and reel.

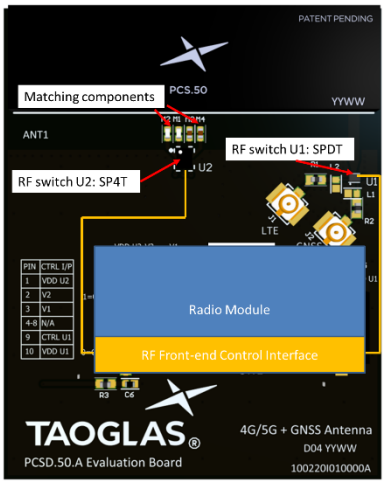
Taoglas has developed another evaluation board PCSD.50.B to demonstrate the antenna performance for 5G connectivity. The PCSD.50.B evaluation board is just 40*70mm, it covers the most challenging bands for 600MHz, making it suitable for 5G applications.

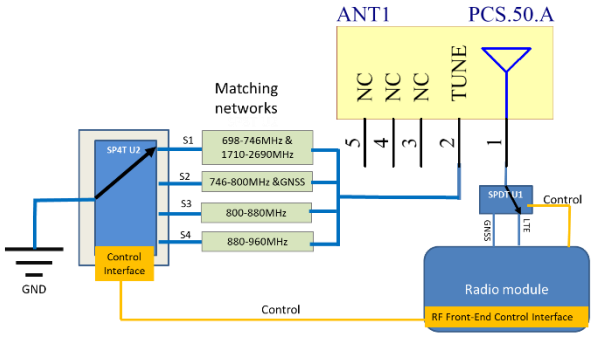
The datasheet consists of two parts mainly. The first part focuses on the 4G/LTE antenna integration and performance on the PCSD.50A evaluation board. The second part focuses on the 5G Antenna integration guidance and performance on the PCSD.50B evaluation board.

Contact your regional Taoglas customer support team for quick and professional support from our senior engineering team on integration and matching of the antenna to your device.

Part A

PCS.50.A Antenna Performance for LTE Applications 700MHz- 3GHz on PCSD.50.A





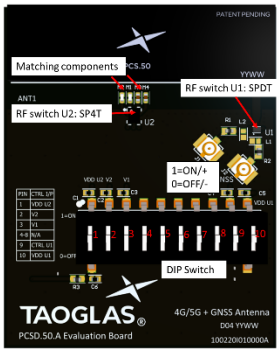
2. Operational Instructions of the PCSD.50.A

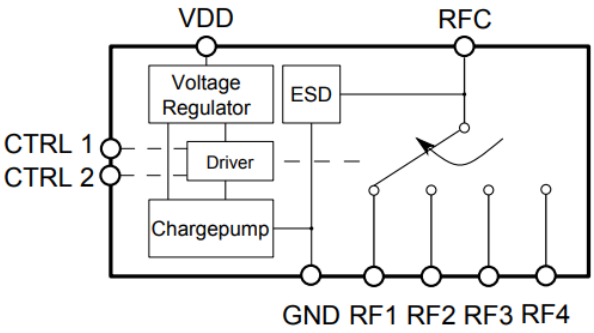
Taoglas developed an evaluation board called PCSD.50.A that includes the PCS.50.A antenna, RF switches and other components to operate this smart antenna solution. This is available to order from Taoglas.

Taoglas developed this EVB to help customers in implementing this solution on their applications. The evaluation kit uses a simple RF switch SP4T to select different matching circuits and a SPDT to select GNSS or LTE radios.

The RF switches used in the evaluation kit are:

- SP4T: Infineon BGSA14GN10
- SPDT: Infineon BGS12SN6E6327XTSA1





In the evaluation kit, both RF switches are controlled by the DIP switch, representing the control interface of the radio module. The DIP switch is connected to a 3V coin battery (CR02032).

The DIP switch has two states: 1 represents ON, 0 represents OFF.

The DIP switch is a 10 way switch, numbered 1 to 10.

Pins 1-3 are used to control the SP4T (U2):

Pin 1 controls the power to SP4T,

Pin 2 connects to the CTRL 1 on the RF switch,

Pin 3 connects to the CTRL 2 on the RF switch.

Pins 9-10 are used to control the SPDT (U1):

PIN 1=VDD	Pin 2=CTRL 1	Pin 3=CTRL 2	RF State
1	0	0	S1: M1-ANT
1	0	1	S2:M2-ANT
1	1	0	S3:M3-ANT
1	1	1	S4:M4-ANT

Pin 9 is the control input for the SPDT, 0 = GNSS, 1 = LTE,

Pin 10 controls the power to SPDT.

PIN 10=VDD	PIN 9=CTRL	SPDT State
1	0	GNSS-ANT
1	1	LTE-ANT

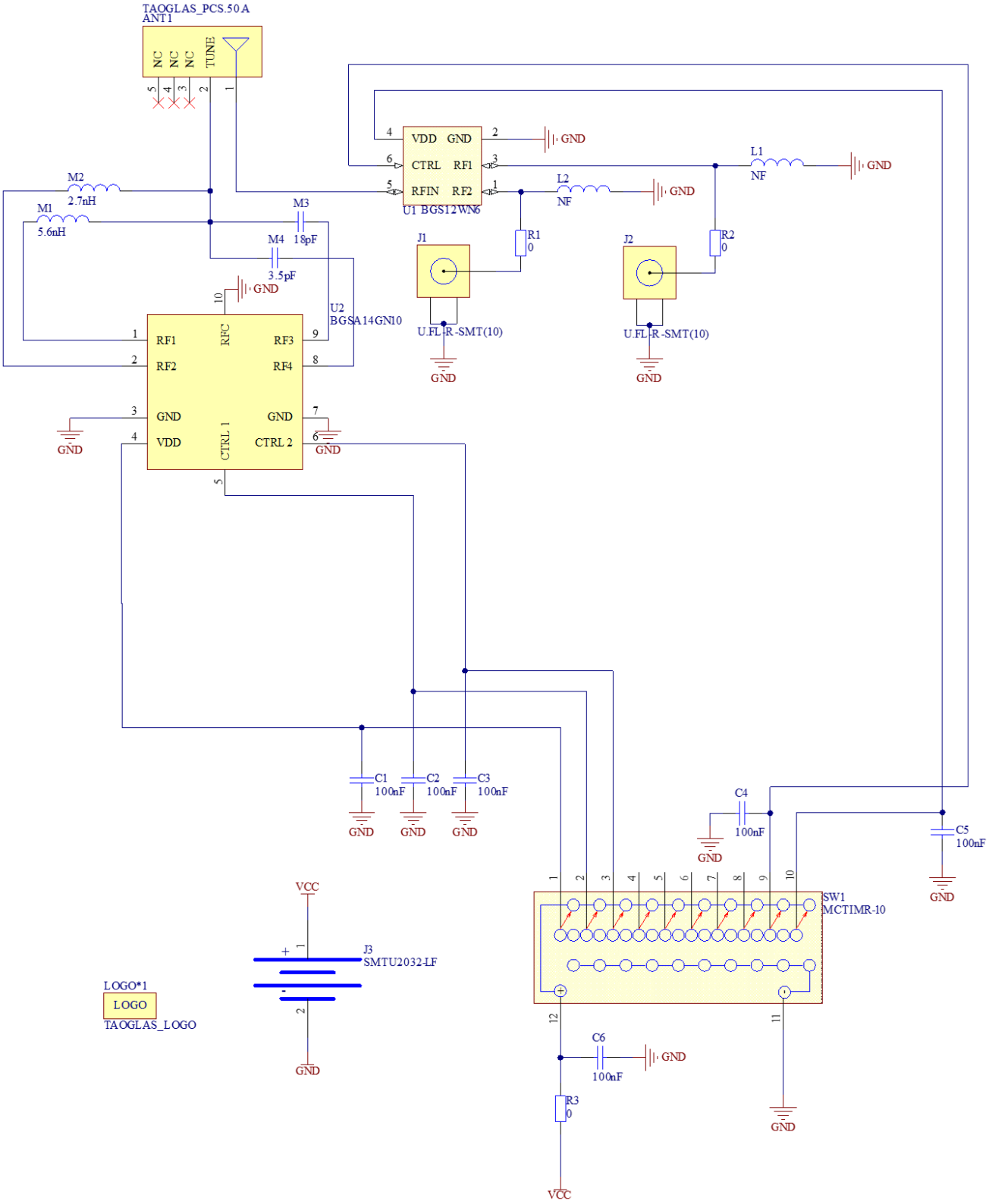
Pin 4, 5, 6, 7, 8 are not connected and therefore not used.

The pin definition and control table are shown in the tables above.

2.1 Antenna Active Tuning Circuit

Below is the Schematic of the PCSD.50.A using SP4T and SPDT.

Four sets of matching circuits are connected to the SP4T RF1-RF4. The antenna performance is tested and recorded when each of them are connected.



3. Specification for PCSD.50.A

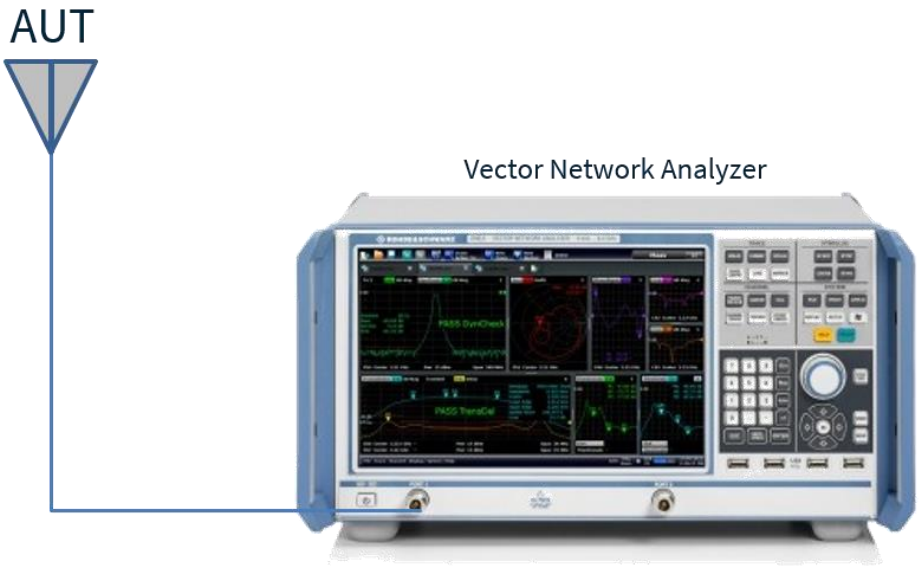
LTE Electrical									
Band	Frequency (MHz)	Measurement	Efficiency (%)	Average Gain (dB)	Peak Gain (dBi)	Impedance	Polarization	Radiation Pattern	Max. input power
5GNR/4G Band 12,17,28,29,85	698-746	S1	16.6	-7.79	-2.94	50 Ω	Linear	Omni	2W
5GNR/4G Band 13,14,20,28	746-800	S2	17.7	-7.52	-2.55				
5GNR/4G Band 5,18,19,20,26,27	800-880	S3	19.6	-7.08	-2.05				
5GNR/4G Band 8,19,26	880-960	S4	21.0	-6.79	-1.49				
GNSS GPS L1, GLONASS G1, Bei Dou B1, Galileo E1	1559-1610	S2	40.6	-3.92	0.62				
5GNR/4G Band 1,2,3,4,9,23,25,35,39, 66	1710-2690	S1	67.0	-1.74	3.23				

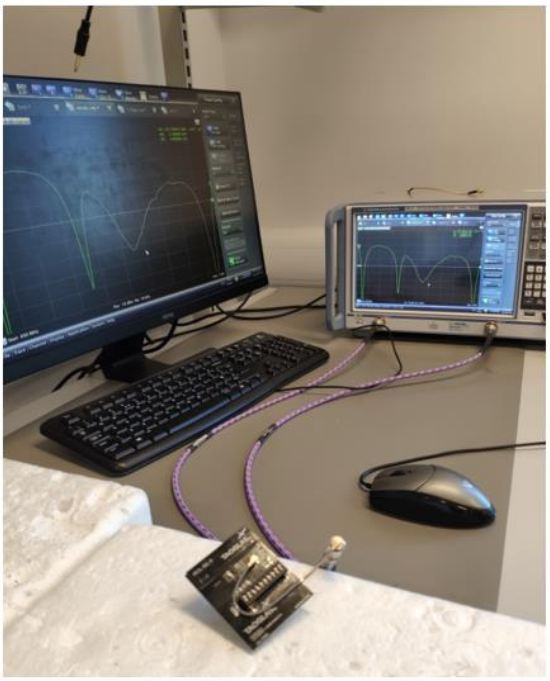
Mechanical	
Dimensions	38mm x 10mm x 1.6mm
Weight	2.5g
Material	FR4
Connector	IPEX MHF1
Cable	1.13 Mini Coaxial
Soldering Type	SMD Reflow

Environmental	
Operation Temperature	-40°C ~ +85°C
Storage Temperature	-40°C ~ +85°C
Moisture Sensitivity	3

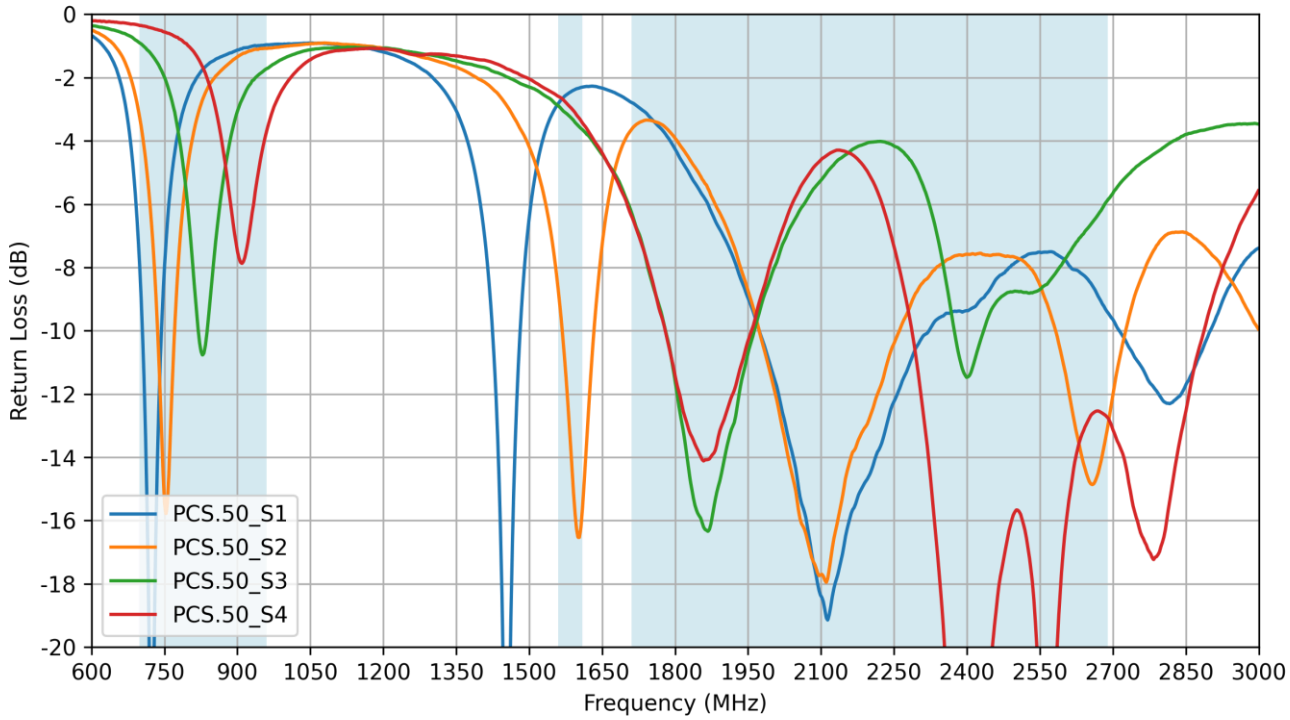
4. Antenna Characteristics

4.1 Test Setup

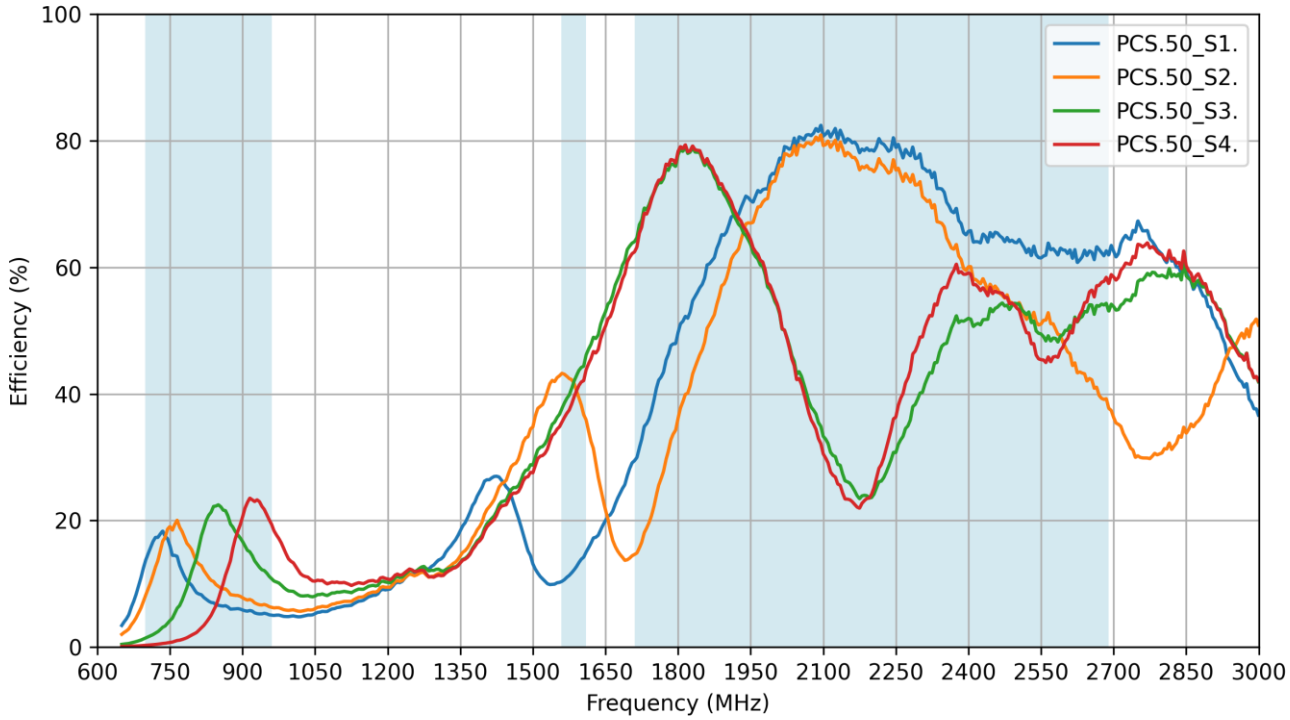




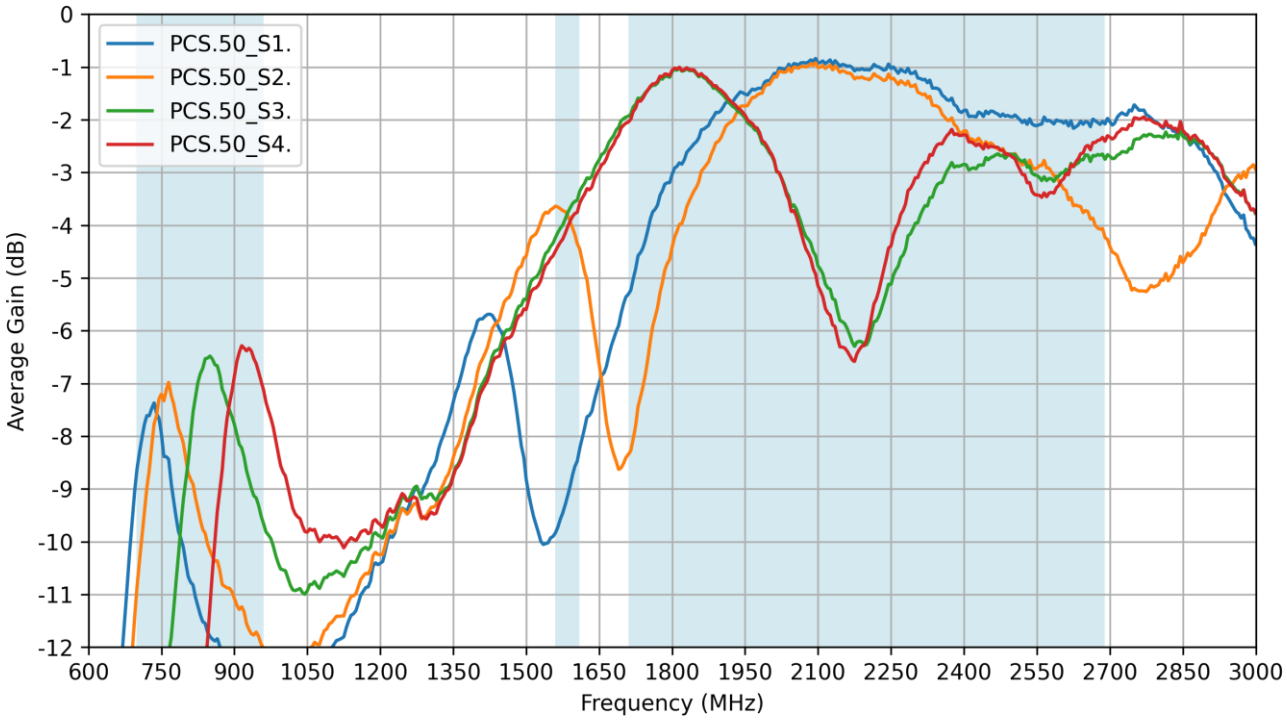
4.2 Return Loss



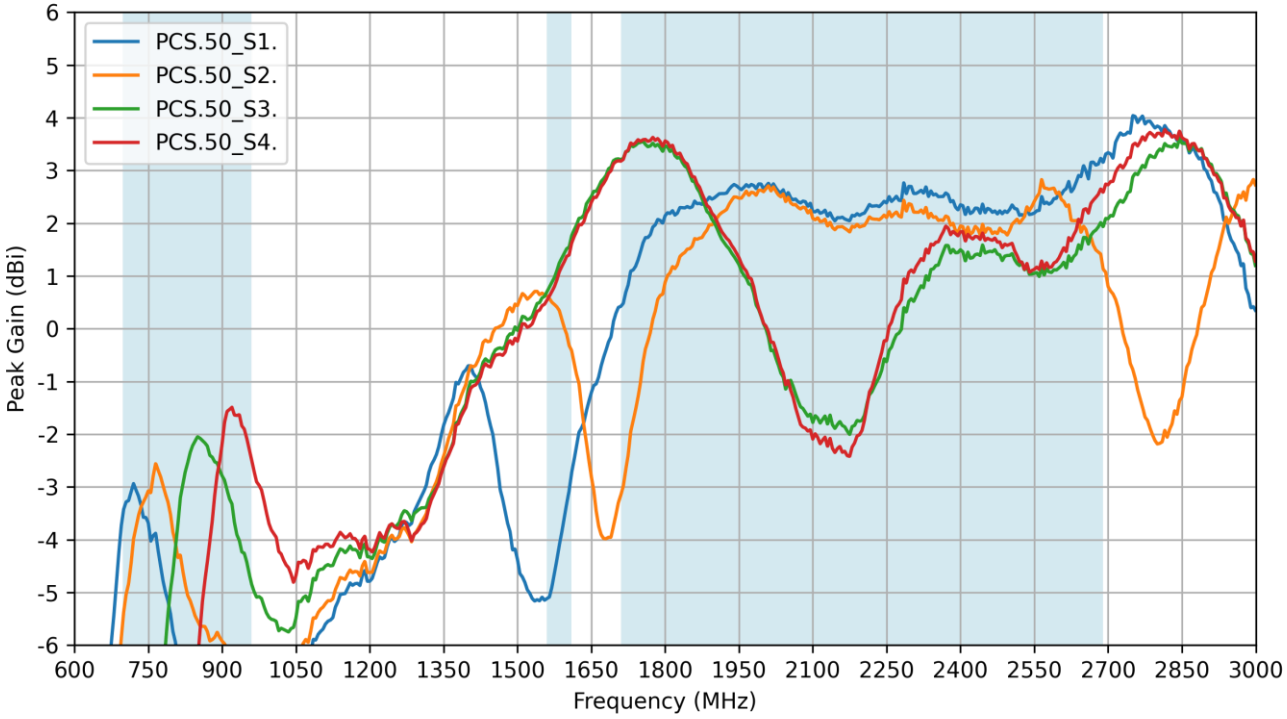
4.3 Efficiency



4.4 Average Gain

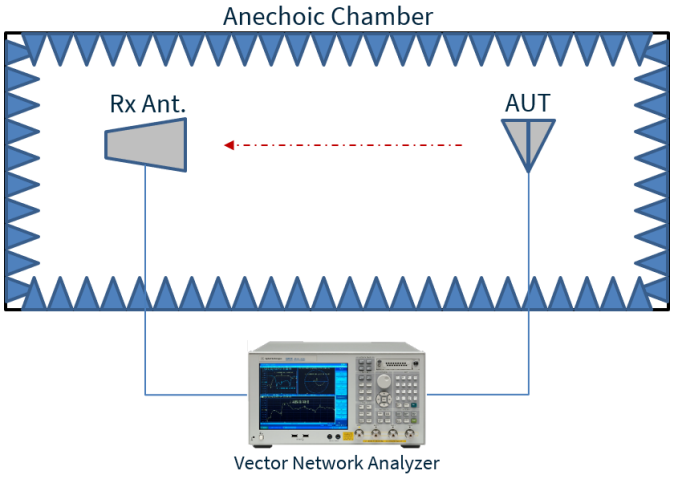


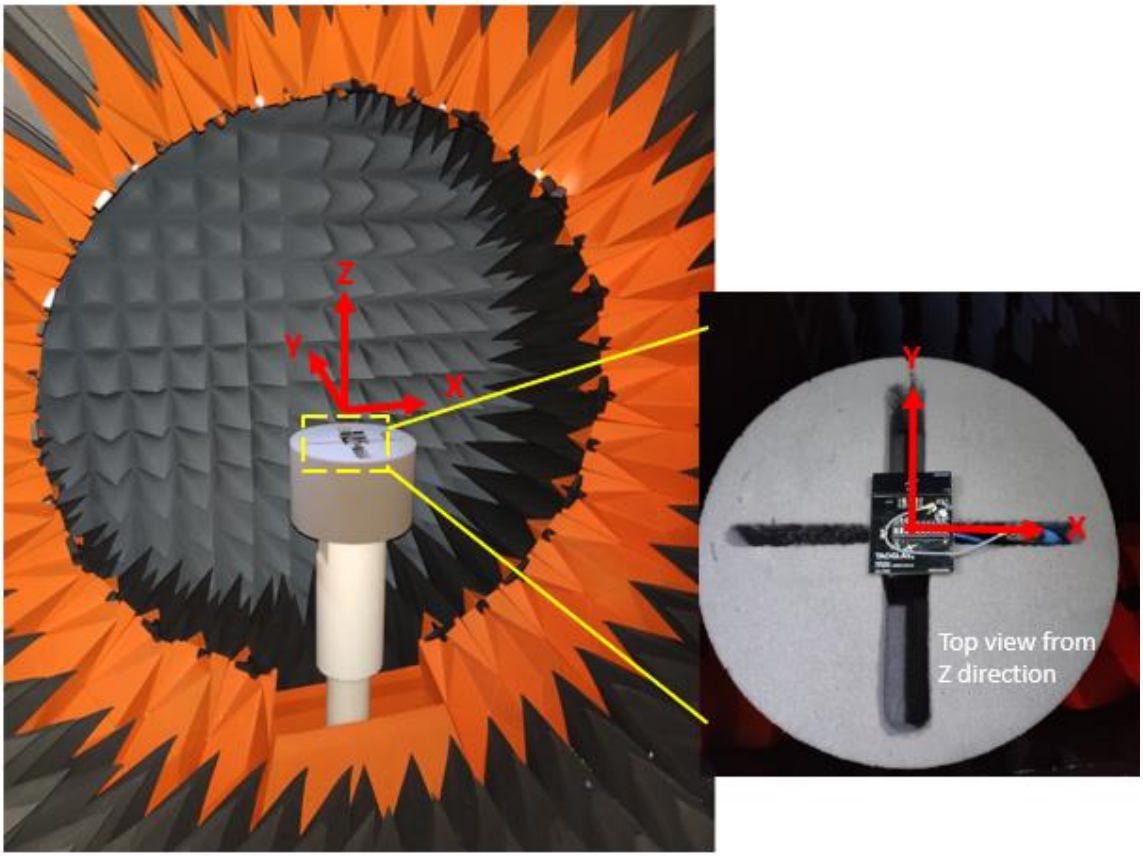
4.5 Peak Gain



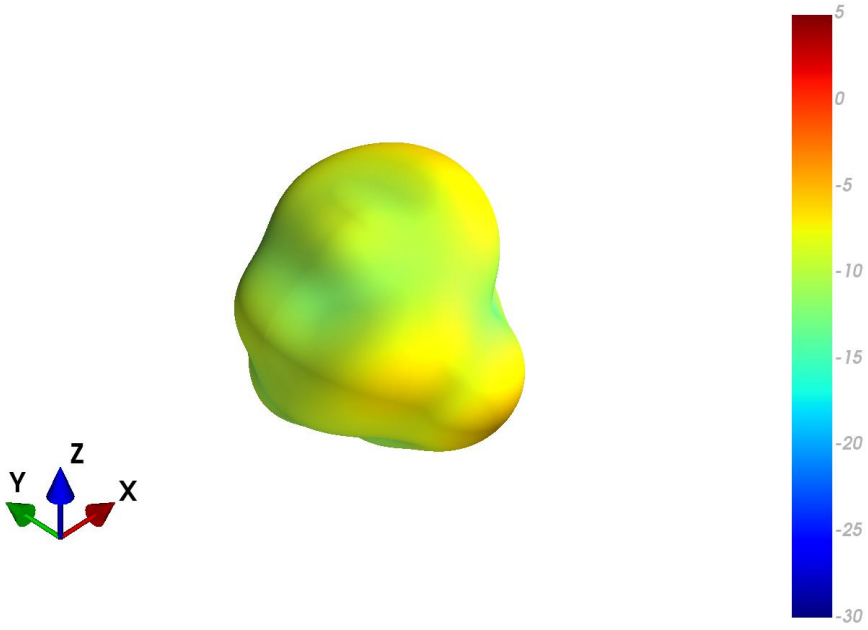
5. Radiation Patterns

5.1 Test Setup

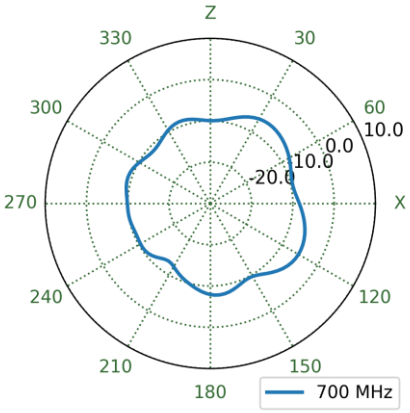


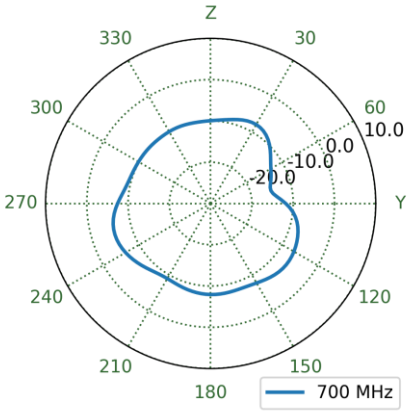


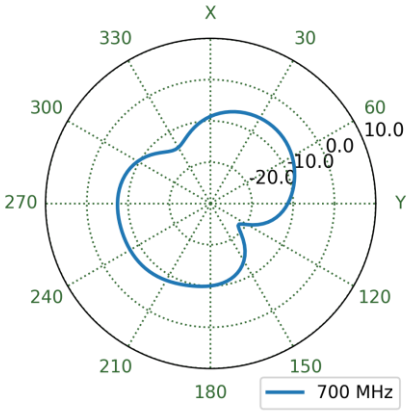
5.2 Patterns at 700 MHz



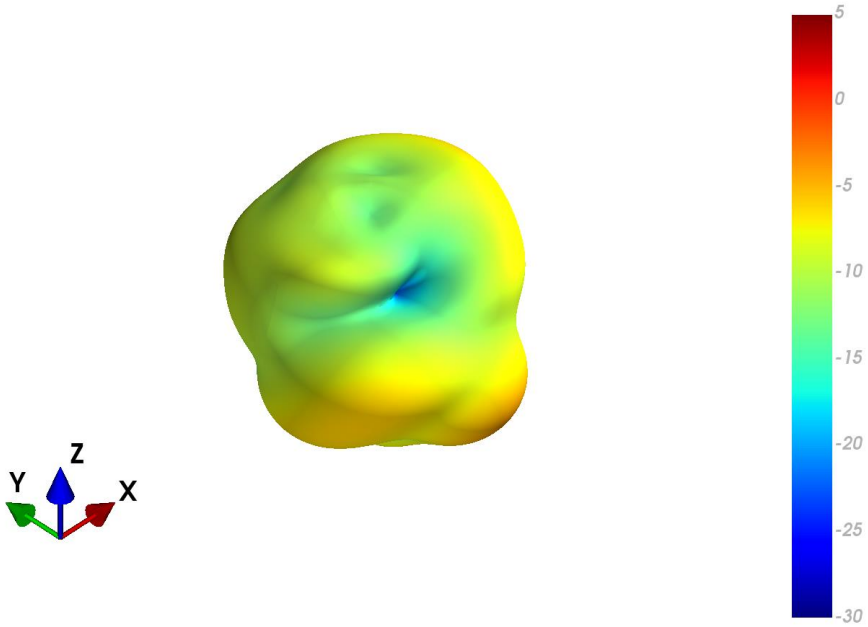
XZ Plane	YZ Plane	XY Plane



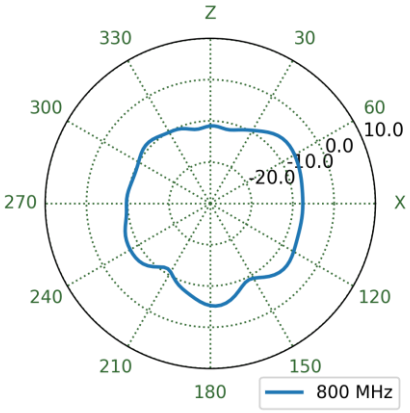


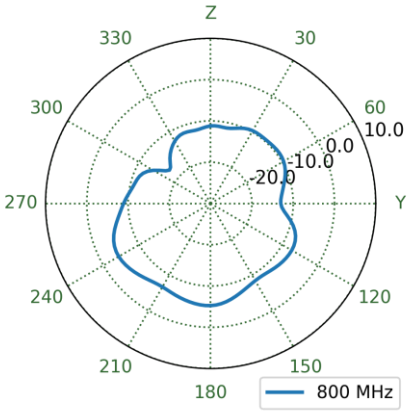


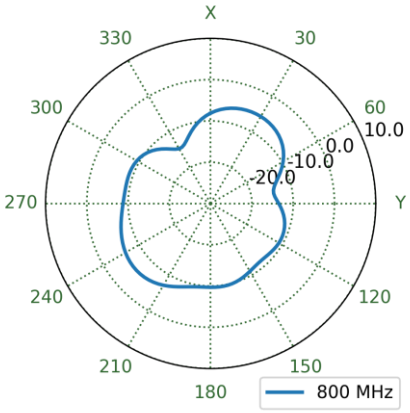
5.3 Patterns at 800 MHz



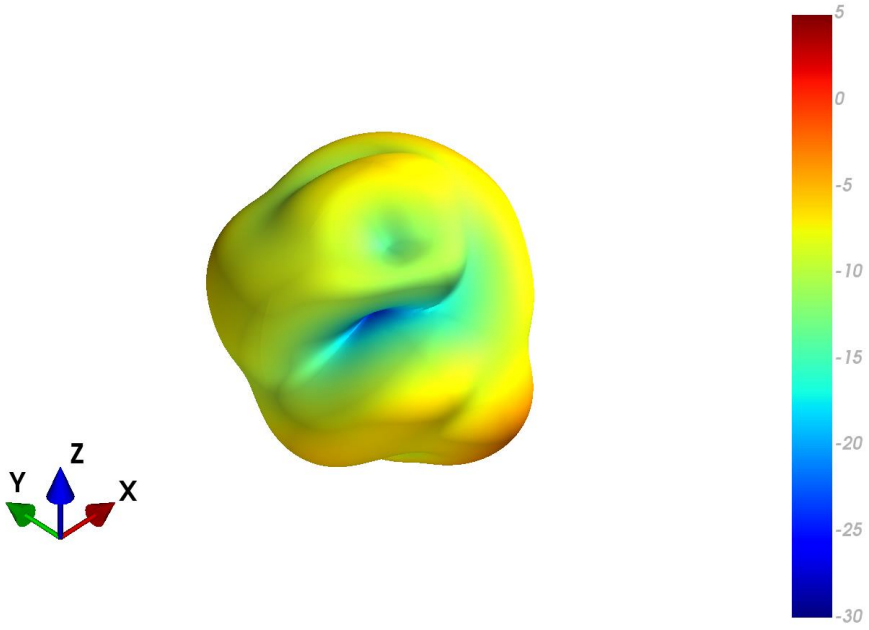
XZ Plane	YZ Plane	XY Plane



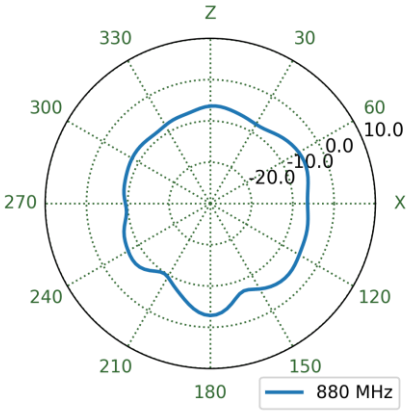


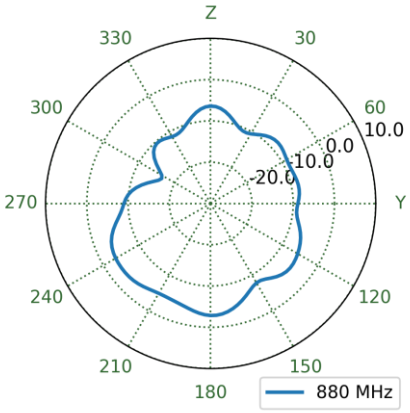


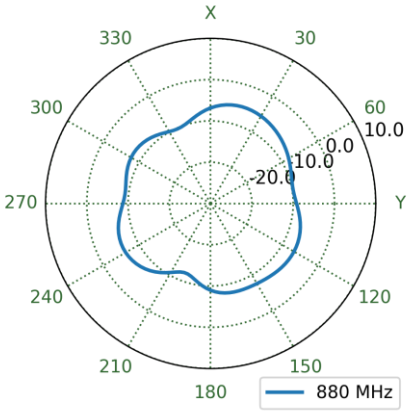
5.4 Patterns at 880 MHz



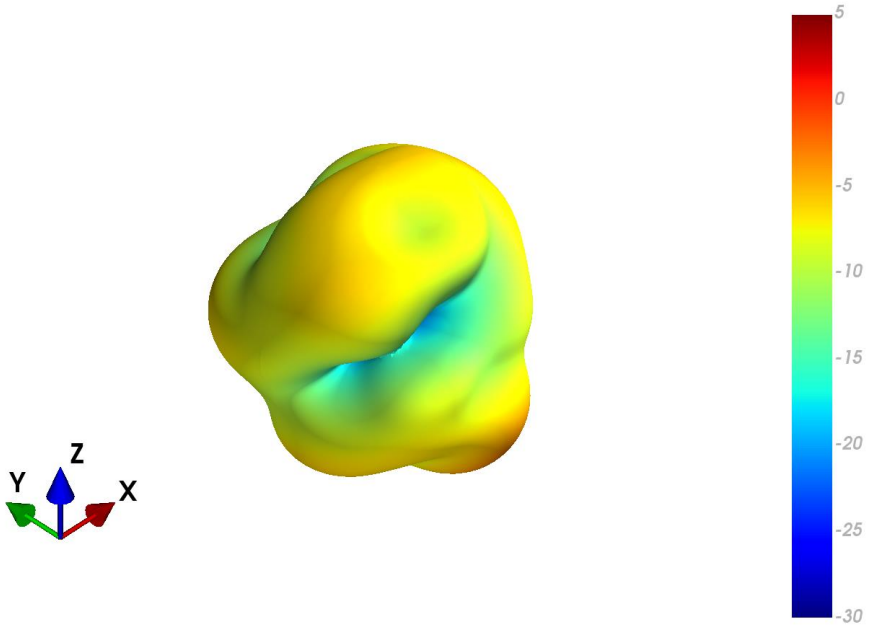
XZ Plane	YZ Plane	XY Plane



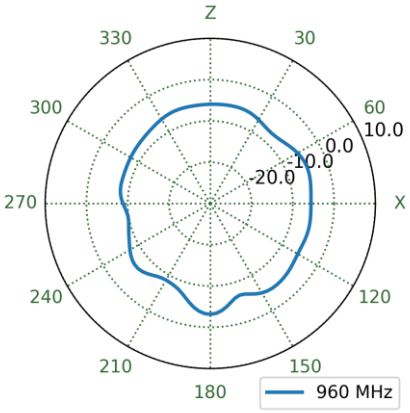


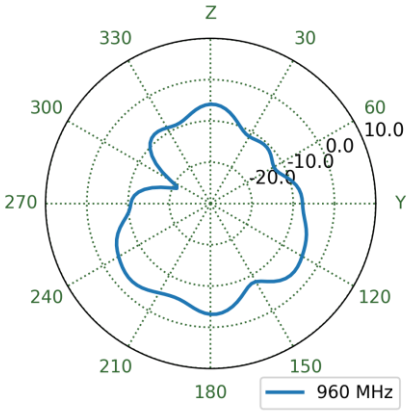


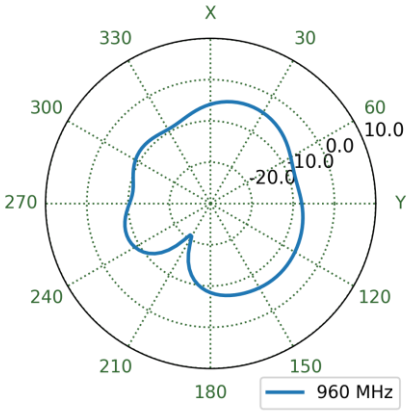
5.5 Patterns at 960 MHz



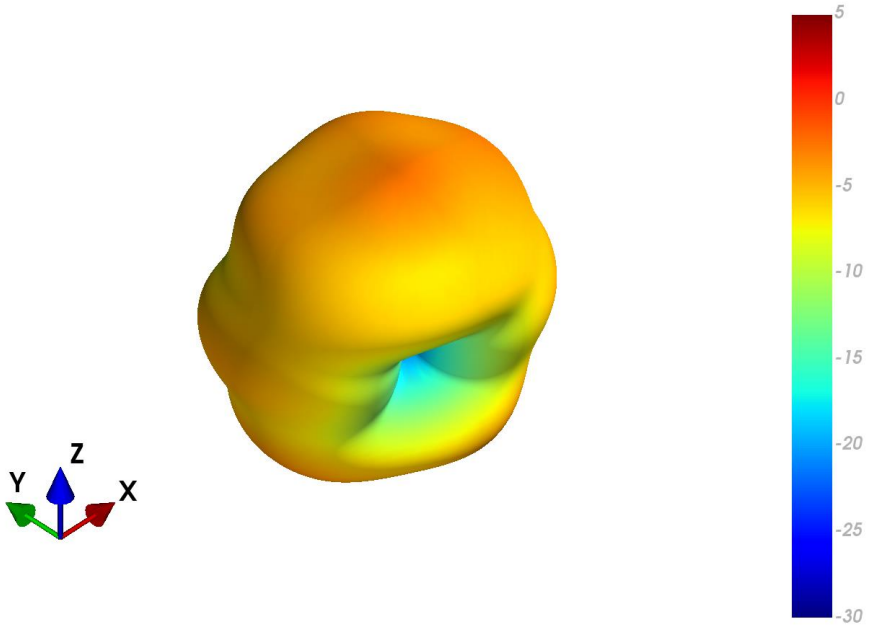
XZ Plane	YZ Plane	XY Plane



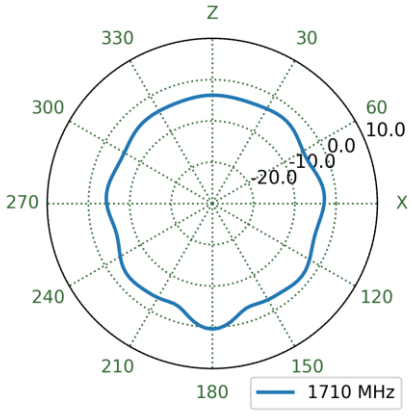


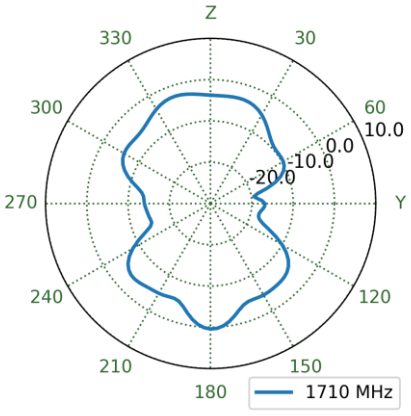


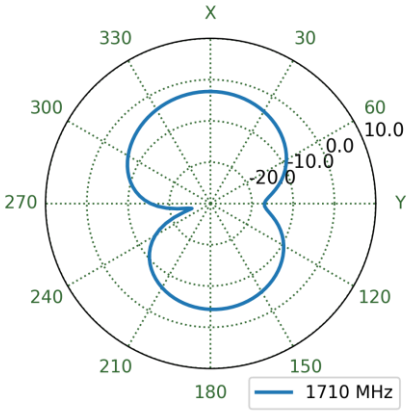
5.6 Patterns at 1710 MHz



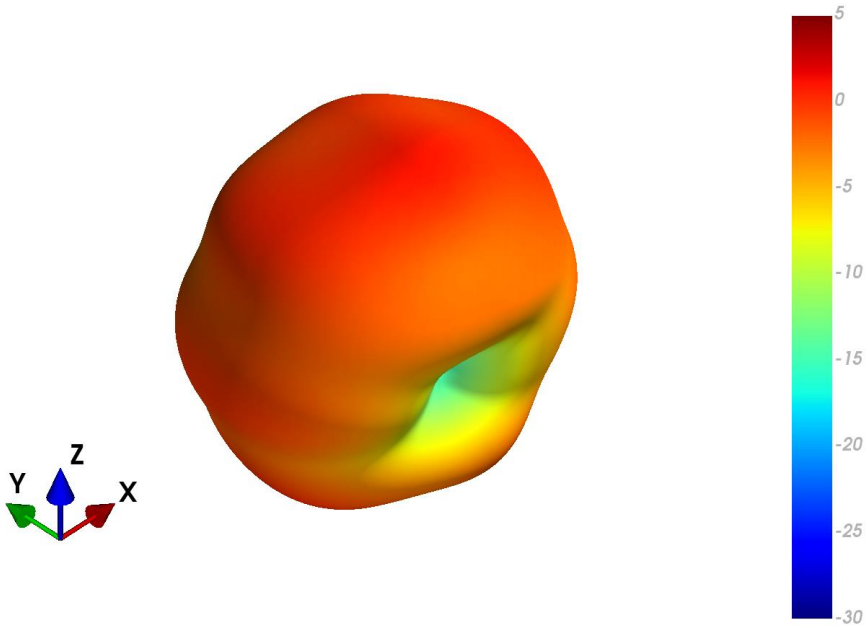
XZ Plane	YZ Plane	XY Plane

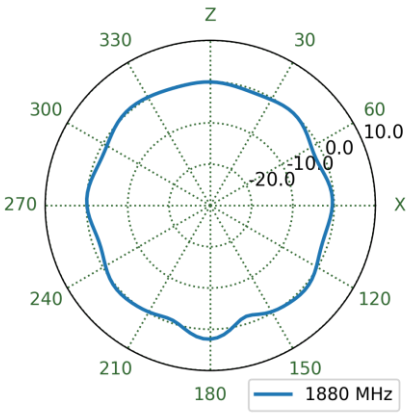
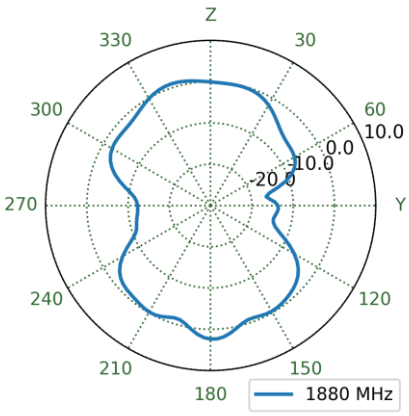
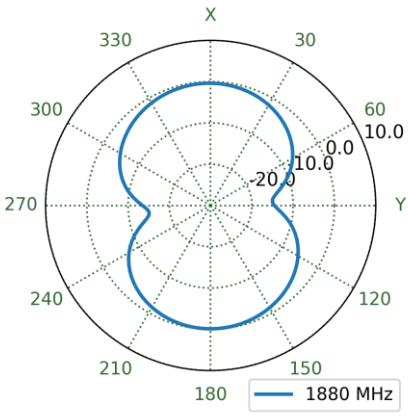




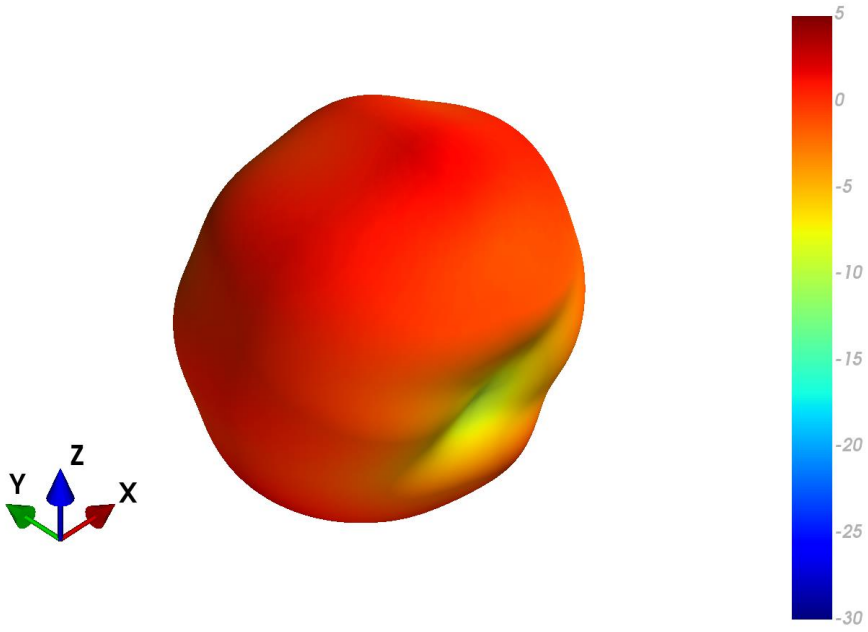


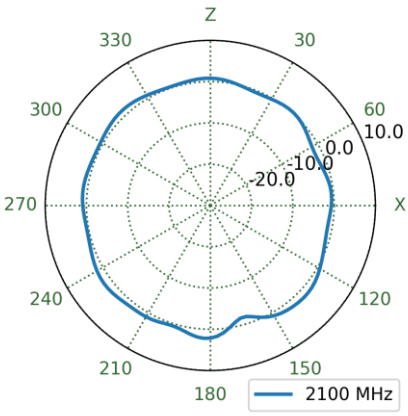
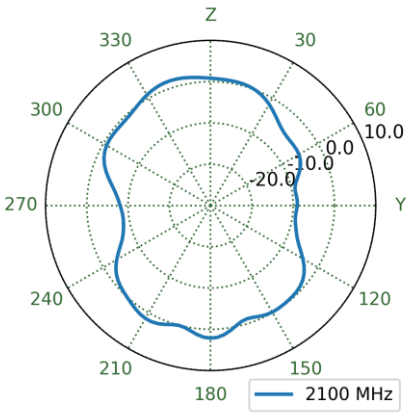
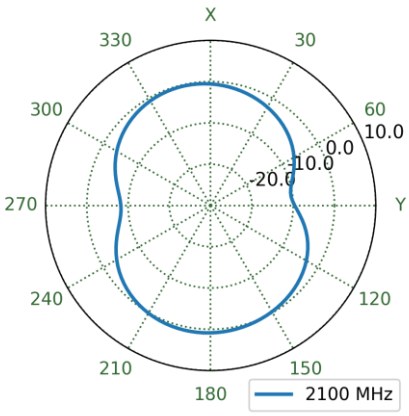
5.7 Patterns at 1880 MHz



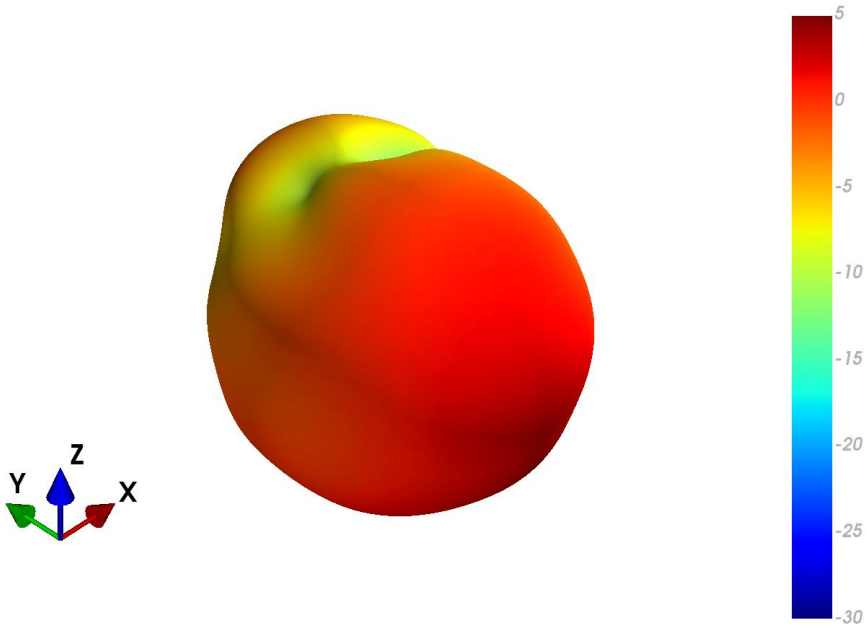
XZ Plane	YZ Plane	XY Plane
		

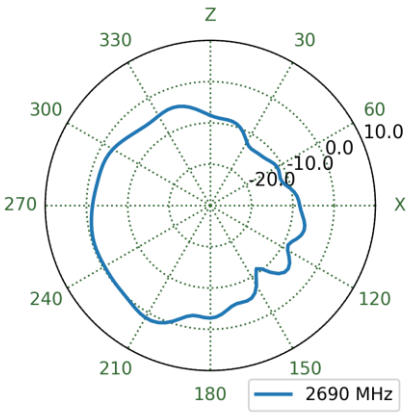
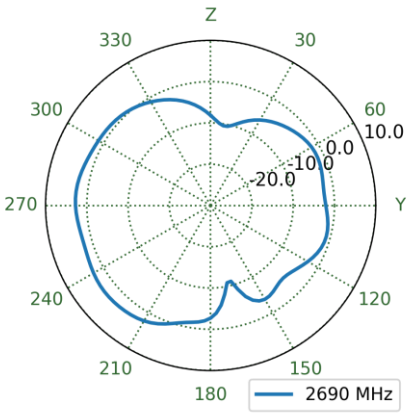
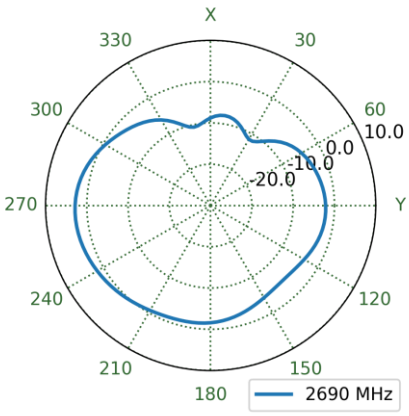
5.8 Patterns at 2100 MHz



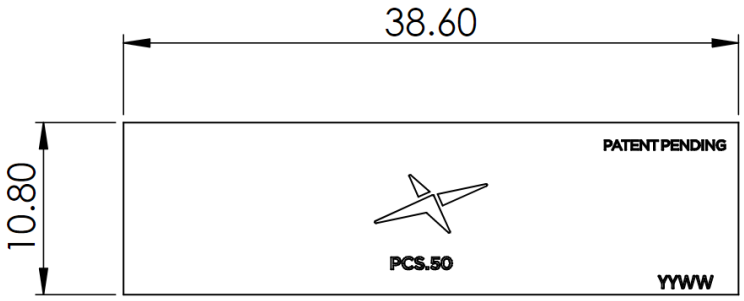
XZ Plane	YZ Plane	XY Plane
		

5.9 Patterns at 2690 MHz



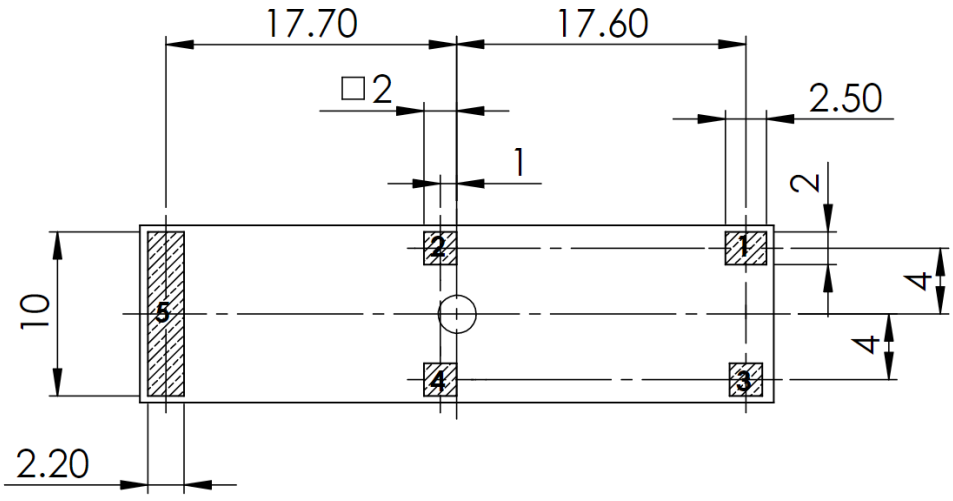
XZ Plane	YZ Plane	XY Plane
		

6. Mechanical Drawing - Antenna



TOP VIEW

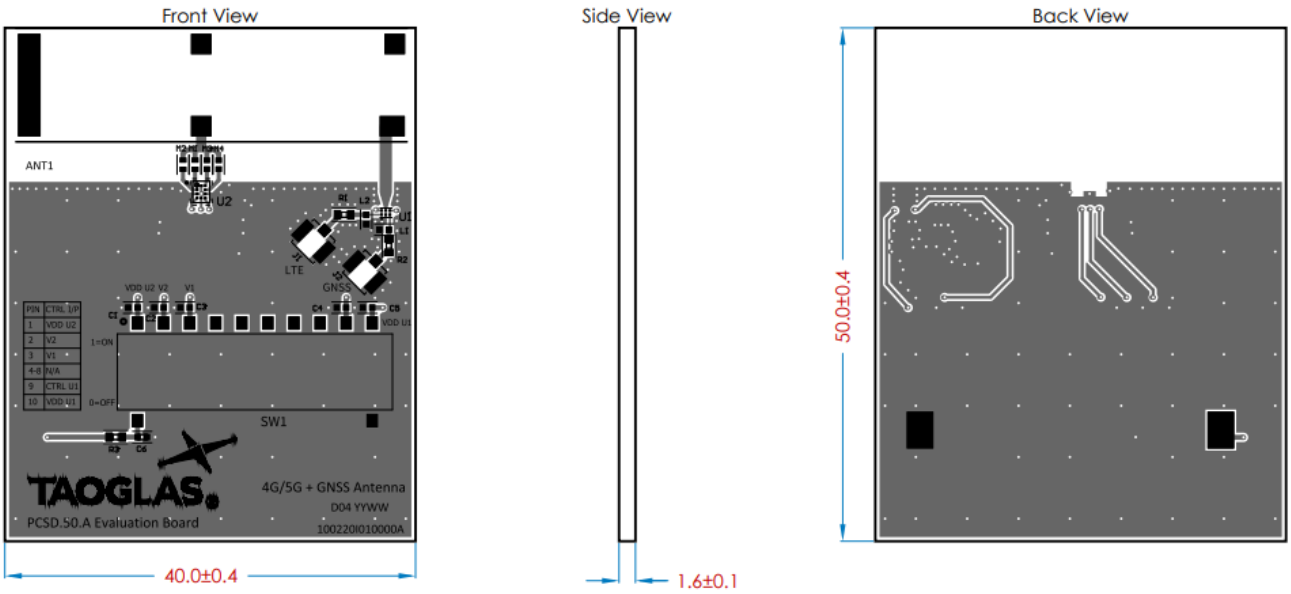
FRONT VIEW



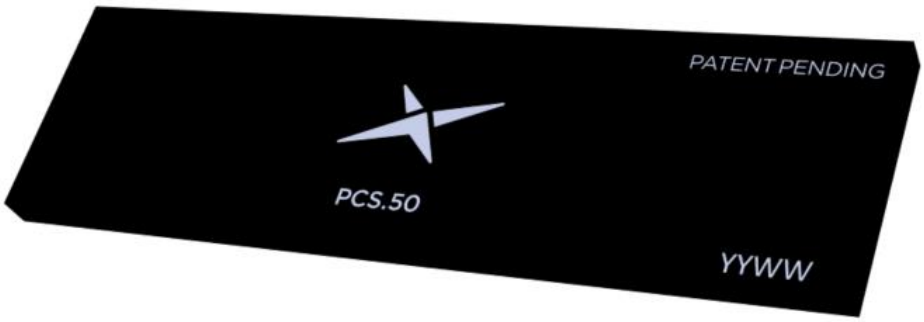
PADS 2,3,4 THE SAME SIZE

BOTTOM VIEW

7. Mechanical Drawing – Eval Board PCSD.50.A



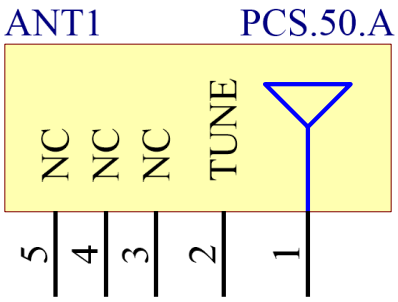
8. Antenna Integration Guide



8.1 Schematic and Symbol Definition

The circuit symbol for the antenna is shown below. The antenna has 5 pins with only two pins functional (Pin 1 and Pin 2). Pins 3, 4 and 5 are not connected and are only used for mechanical integration only.

Pin	Description
1	RF Feed
2	Tuning
3, 4, 5	Not Connected



8.2 Antenna Integration

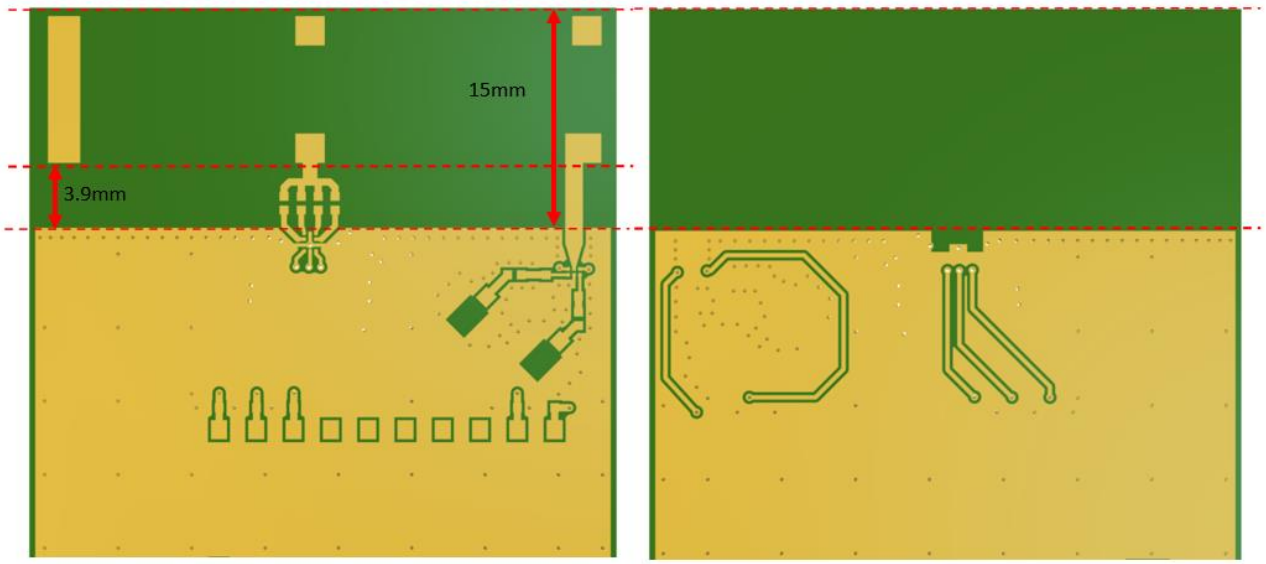
Depending on the size of the PCB, the antenna should ideally be placed on the PCB's shorter side, this will allow the antenna to take advantage of a longer ground plane.

With Top Solder Mask

Without Top Solder Mask

8.3 PCB Layout

The footprint and clearance on the PCB must meet the antenna specification. Below shows the antenna footprint and clearance through ALL the layers of the PCB. Only the antenna pads and connections to RF Feed and TUNE are present within this clearance area (marked RED). The clearance area extends 3.9mm from the antenna mechanical pads to the ground area. This clearance area includes the bottom side and ALL internal layers of the PCB.

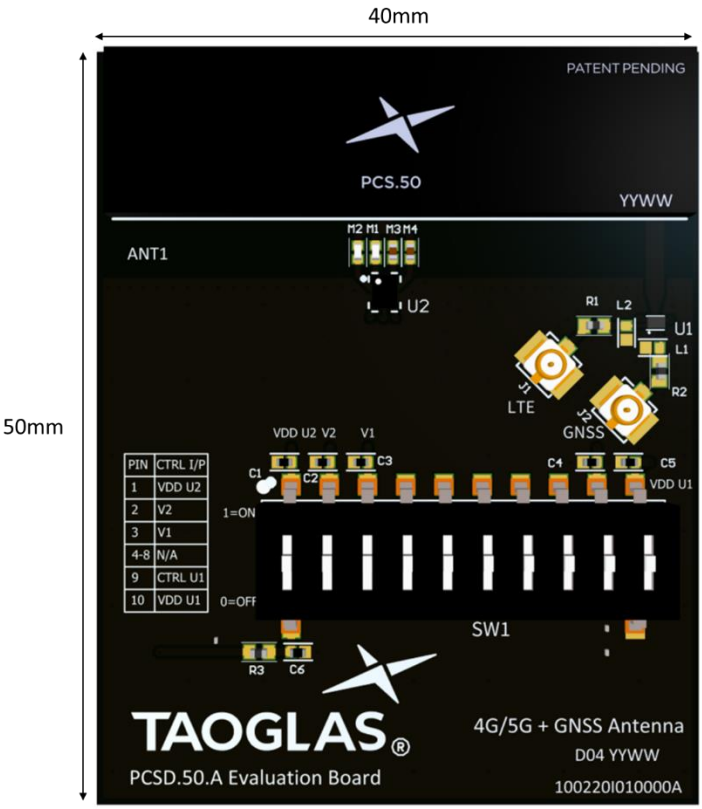


Top Side

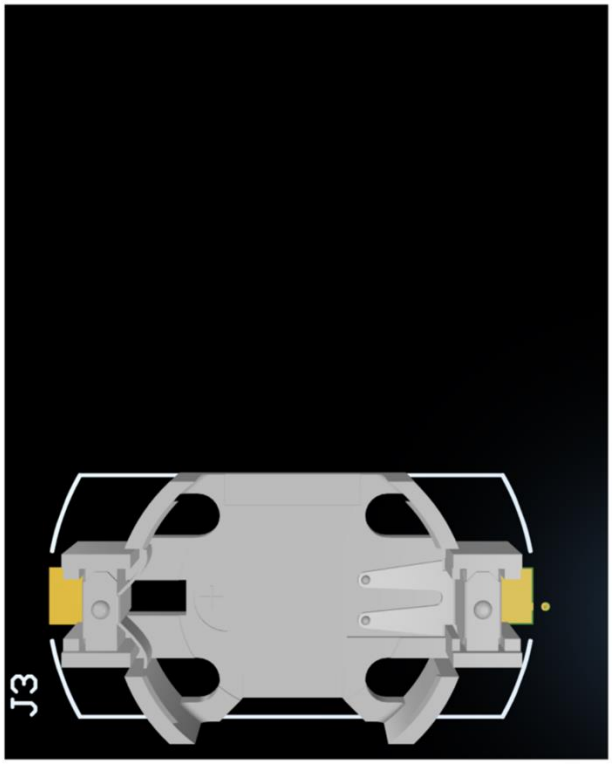
Bottom Side

8.4 Evaluation Board

Shown below are images of the evaluation PCB used to measure the antenna and generate the results shown in this document.



Top Side

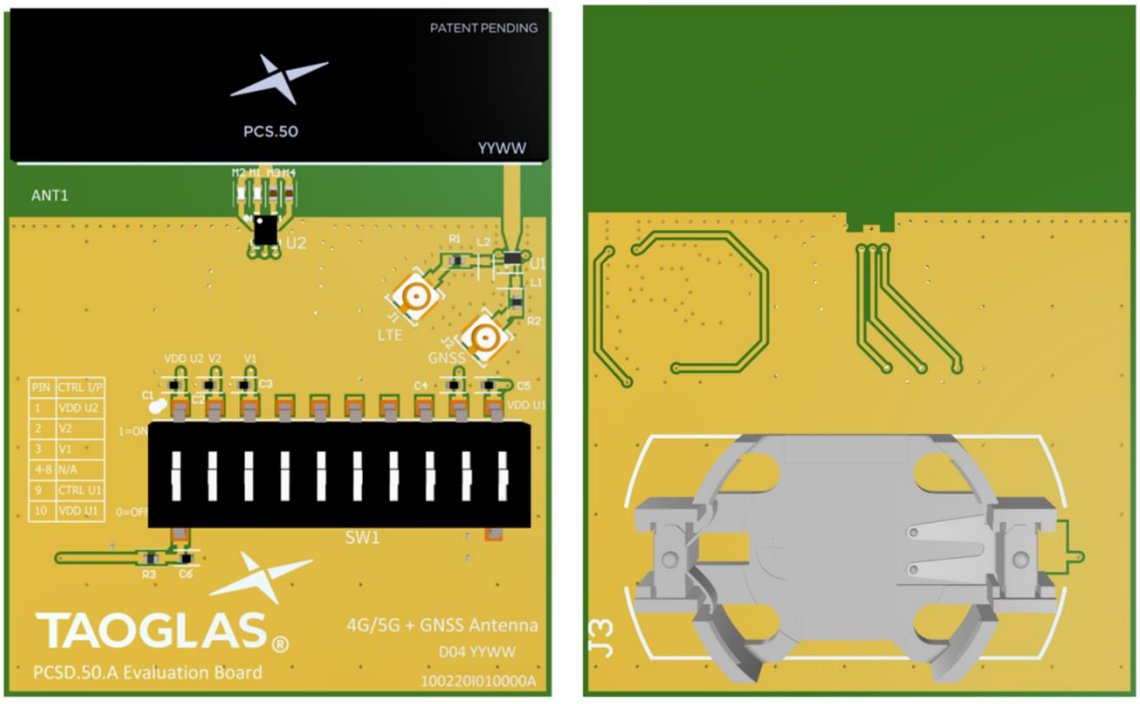


Bottom Side

8.5 Evaluation Board Ground Plane Length

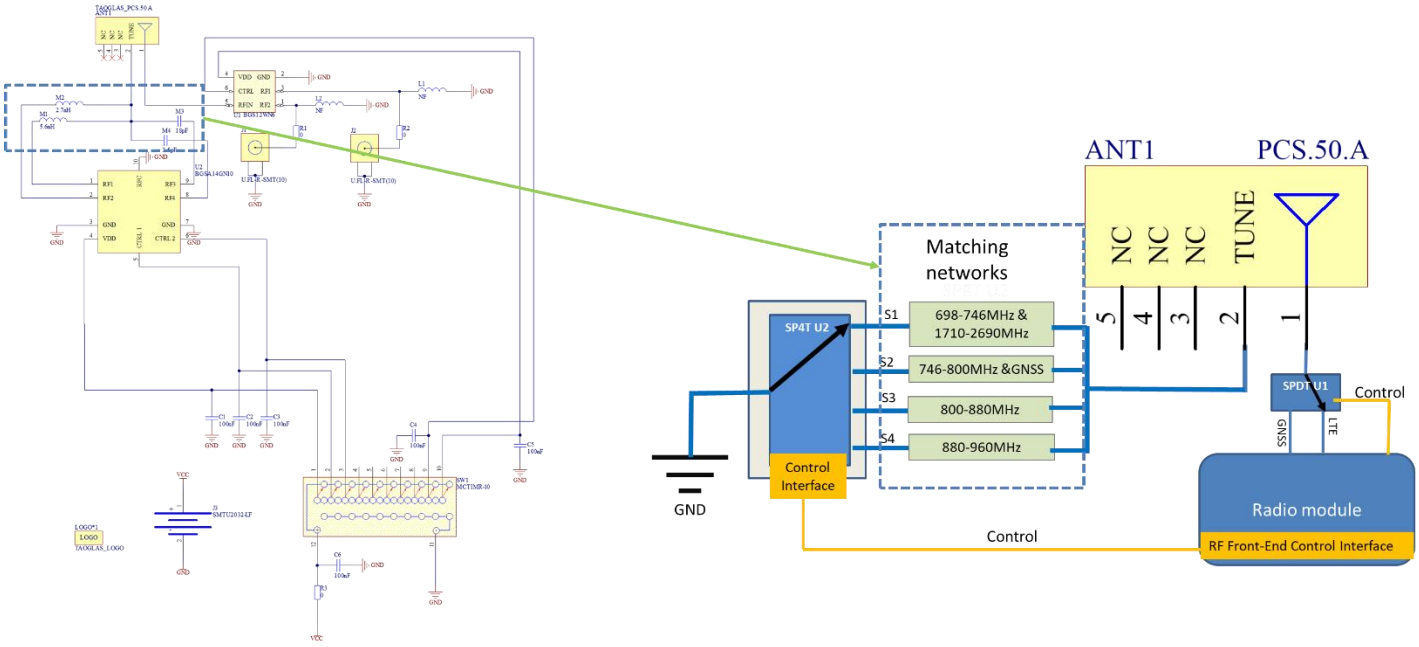
Shown below is the PCSD.50.A with solder mask removed to highlight the PCB ground plane length.

Ground Plane Length 35mm



8.6 Evaluation Board Matching Circuit PCSD.50.A

The matching components M1-M4 are connected to the SP4T switch. These are used to tune the antenna resonances. The values for these components are shown in the mapping table below.

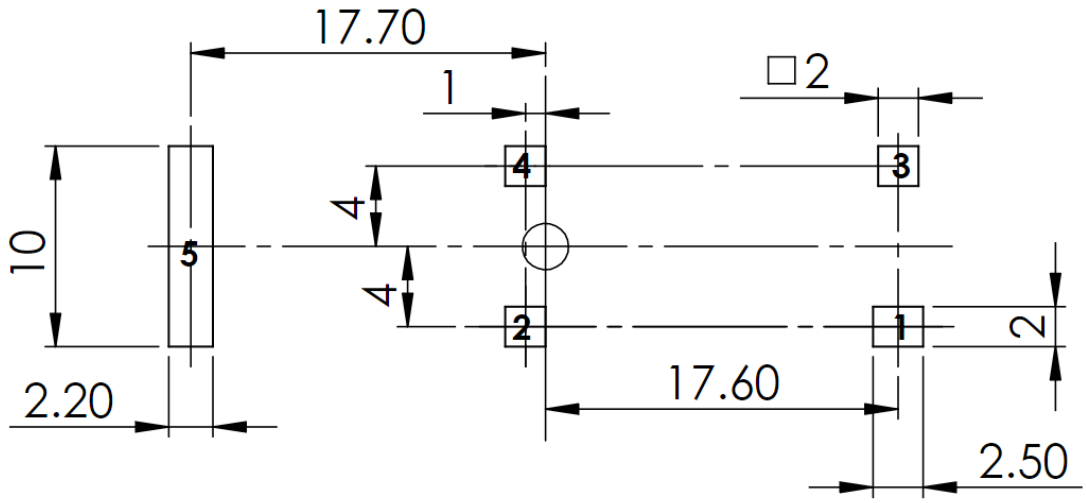


CTRL1=PIN2	CTRL2=PIN3	SP4T State	Matching Components	Frequency coverage
0	0	S1:M1-ANT	5.6nH, MLK1005S5N6ST000	698-746MHz &1710-2690MHz
0	1	S2:M2-ANT	2.7nH MLK1005S2N7ST000	746-800MHz &GNSS
1	0	S3:M3-ANT	18pF GRM1555C1H180JA01D	800-880MHz
1	1	S4:M4-ANT	3.5pF GJM1555C1H3R5BB01D	880-960MHz

An additional matching circuit at the antenna feed side may be necessary for some applications to provide additional tuning options. Taoglas recommend incorporating extra component footprints, to form an ‘‘L’’ or “Pi” matching network between the antenna feed and the radio module. On the PCSD.50.A evaluation board, an L network is reserved but it is not used as there is a zero Ω link fitted in this case.

8.7 Footprint

Below shows the antenna mounting footprint this displays recommended size and layout of the pads on the PCB. These pads are numbered to correspond with the pads on the antenna.

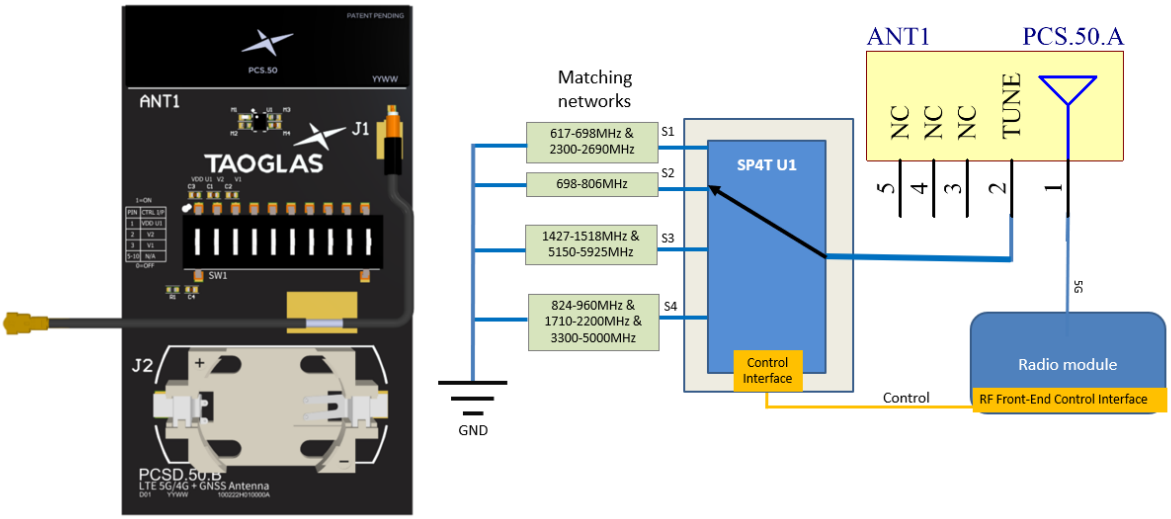


PADS 2,3,4 THE SAME SIZE

PCB FOOTPRINT

Part B

PCS.50.A Antenna Performance for 5G Applications 600MHz- 6GHz on PCSD.50.B



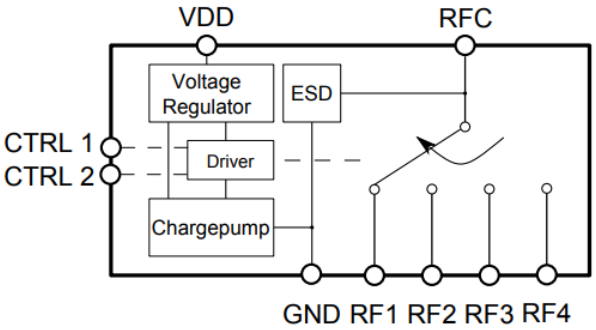
9. Operational Instructions of the PCSD.50.B

Taoglas developed an evaluation board called PCSD.50.B that includes the PCS.50.A antenna, RF switches and other components to operate this smart antenna solution for 5G connectivity.

Taoglas developed this EVB to help customers in implementing this solution on their applications. The evaluation kit uses a simple RF switch SP4T to select different matching circuits.

The RF switches used in the evaluation kit are:

- SP4T: Infineon BGSA14GN10



In the evaluation kit, the RF switch is controlled by the DIP switch, representing the control interface of the radio module. The DIP switch is connected to a 3V coin battery (CR02032).

The DIP switch has two states: 1 represents ON, 0 represents OFF.

The DIP switch is a 10 way switch, numbered 1 to 10.

- Pins 1-3 are used to control the SP4T (U1):

  Pin 1 controls the power to SP4T,

  Pin 2 connects to the CTRL 1 on the RF switch,

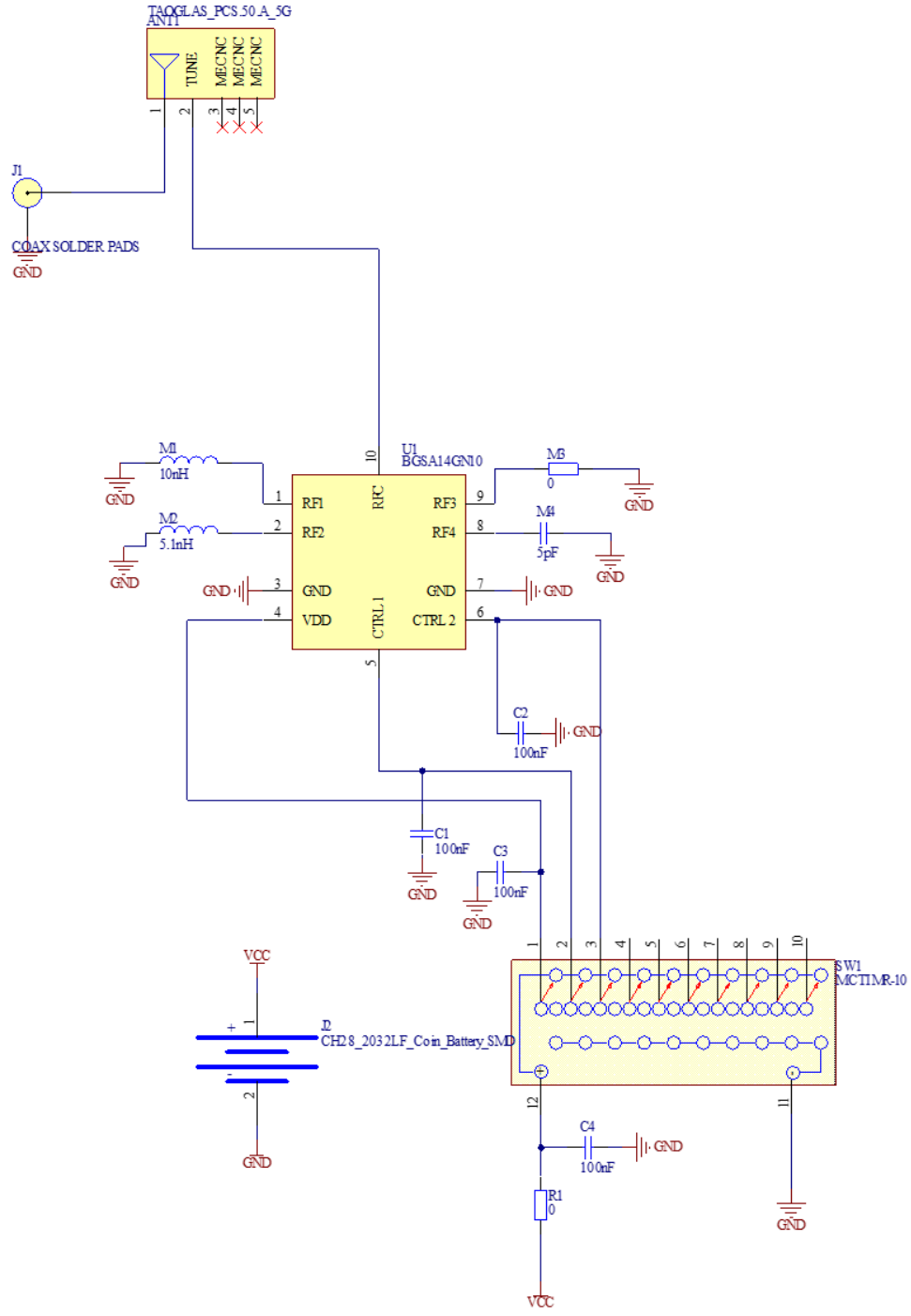
  Pin 3 connects to the CTRL 2 on the RF switch.
- Pin 4 to 10 are not connected and therefore not used.

PIN 1=VDD	Pin 2=CTRL 1	Pin 3=CTRL 2	RF State
1	0	0	S1: M1-ANT
1	0	1	S2:M2-ANT
1	1	0	S3:M3-ANT
1	1	1	S4:M4-ANT

The pin definition and control table is shown above.

Below is the Schematic of the PCSD.50.B using SP4T.

Four sets of matching circuits are connected to the SP4T RF1-RF4. The antenna performance is tested and recorded when each of them are connected.



10. Specification for PCSD.50.B

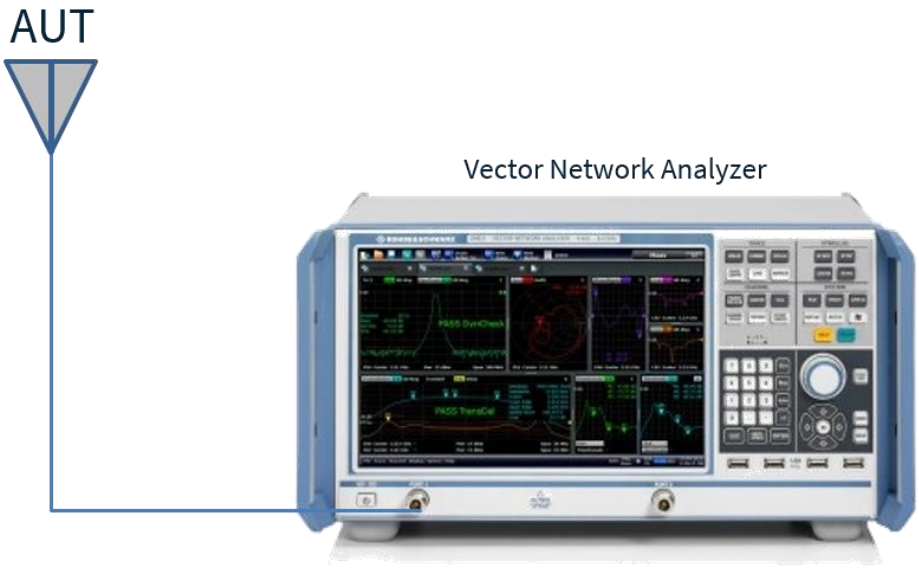
LTE Electrical									
Band	Frequency (MHz)	Measurement	Efficiency (%)	Average Gain (dB)	Peak Gain (dBi)	Impedance	Polarization	Radiation Pattern	Max. input power
5GNR/4G Band71	617-698	S1	15.3	-8.15	-3.59	50 Ω	Linear	Omni	2W
4G/3G Band 12,13,14,17,28,29	698-806	S2	17.3	-7.62	-2.87				
4G/3G/NB-IoT/Cat M Band 5,8,18,19,20,26,27	824-960	S4	20.3	-6.91	-1.88				
5GNR/4G Band 21,32,74,75,76	1427-1518	S3	49.3	-3.07	0.67				
4G/3G Band 1,2,3,4,9,23,25,35,39, 66	1710-2200	S4	57.4	-2.41	3.14				
4G/3G Band 7,30,38,40,41	2300-2690	S1	63.6	-1.96	4.52				
5GNR/4G Band 22,42,48,77,78,79	3300-5000	S4	63.5	-1.97	5.21				
LTE5200/Wi-Fi5800	5150-5925	S3	64.1	-1.93	4.09				

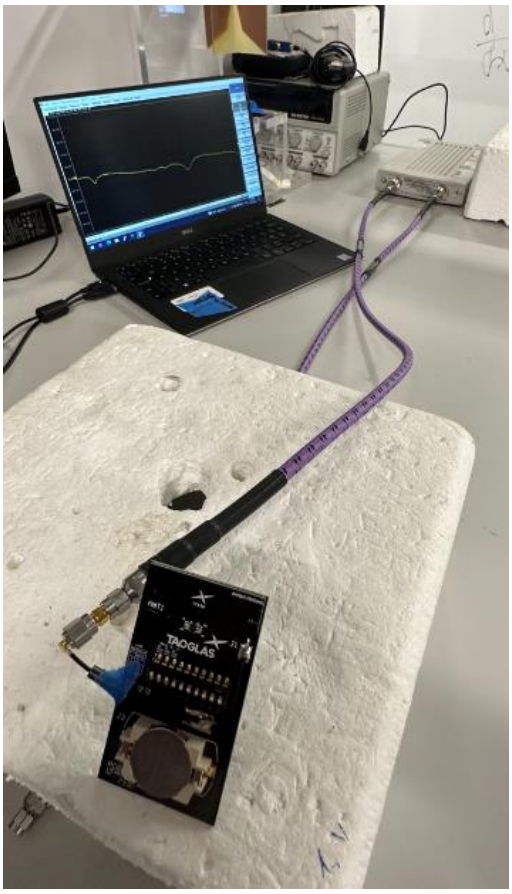
Mechanical	
Dimensions	38mm x 10mm x 1.6mm
Weight	2.5g
Material	FR4
Connector	IPEX MHF1
Cable	1.13 Mini Coaxial
Soldering Type	SMD Reflow

Environmental	
Operation Temperature	-40°C ~ +85°C
Storage Temperature	-40°C ~ +85°C
Moisture Sensitivity	3

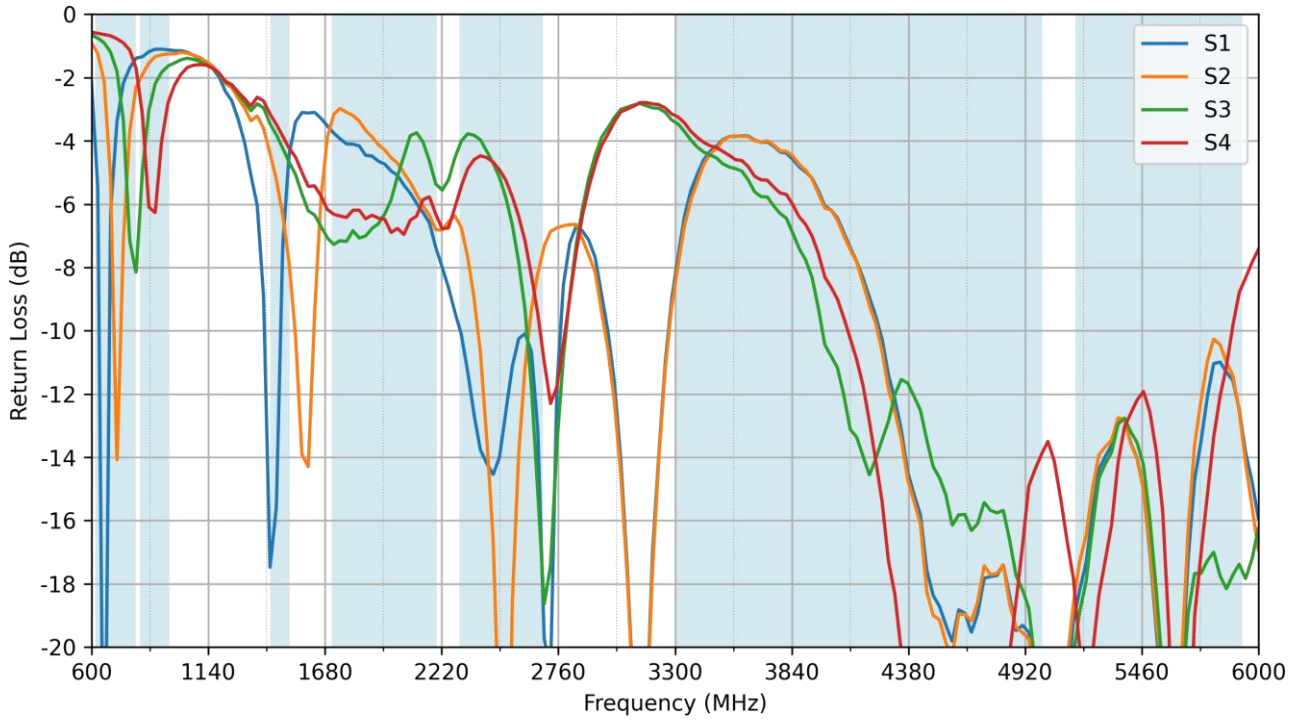
11. Antenna Characteristics for PCSD.50.B

11.1 Test Setup

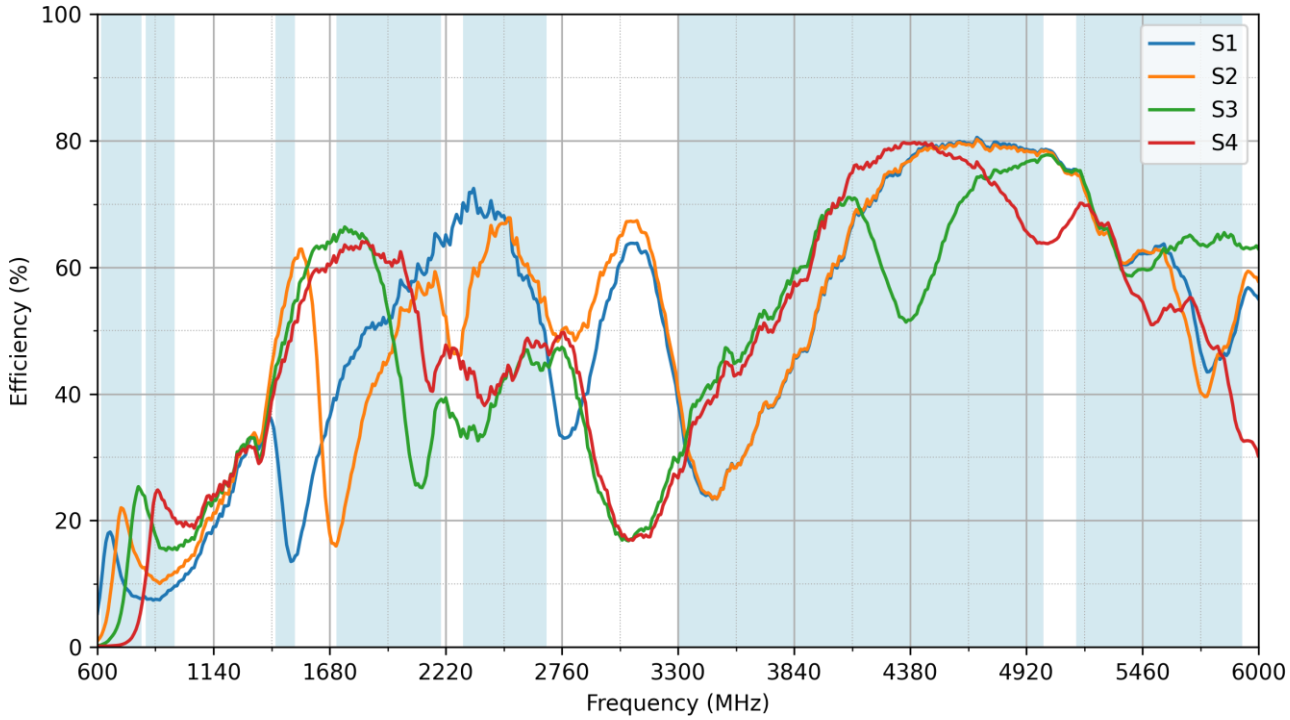




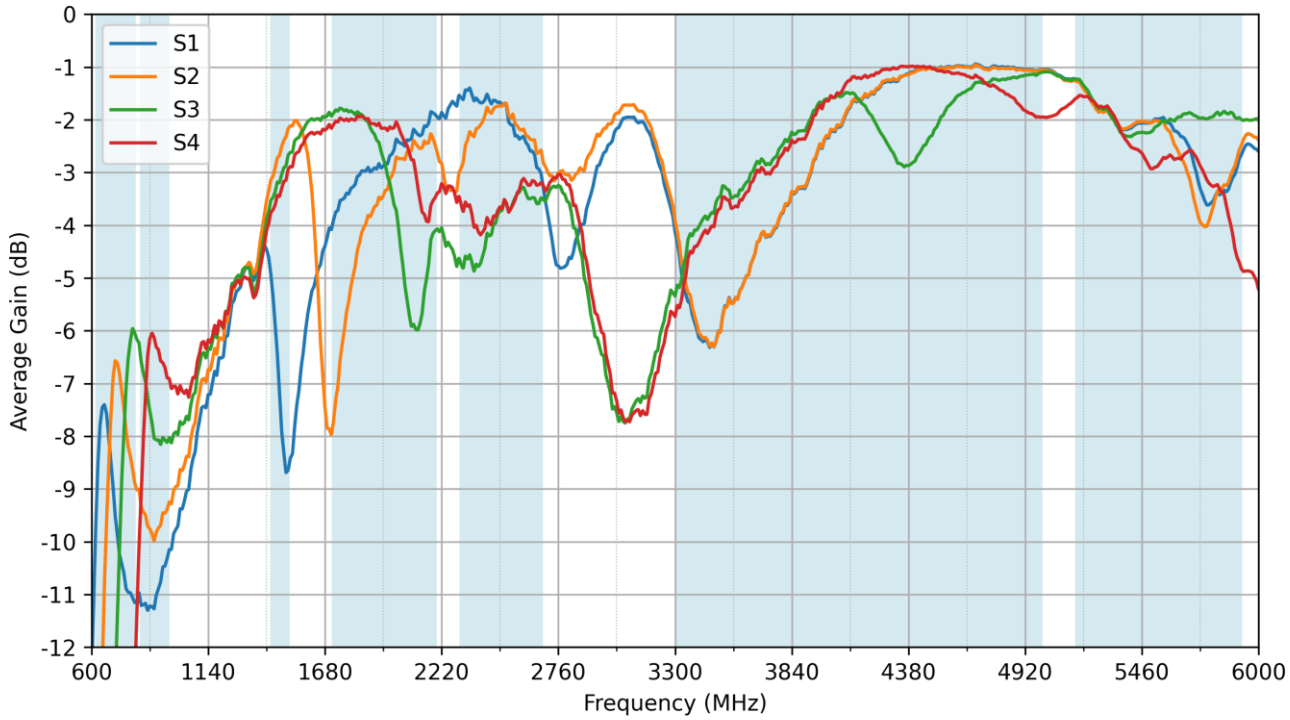
11.2 Return Loss



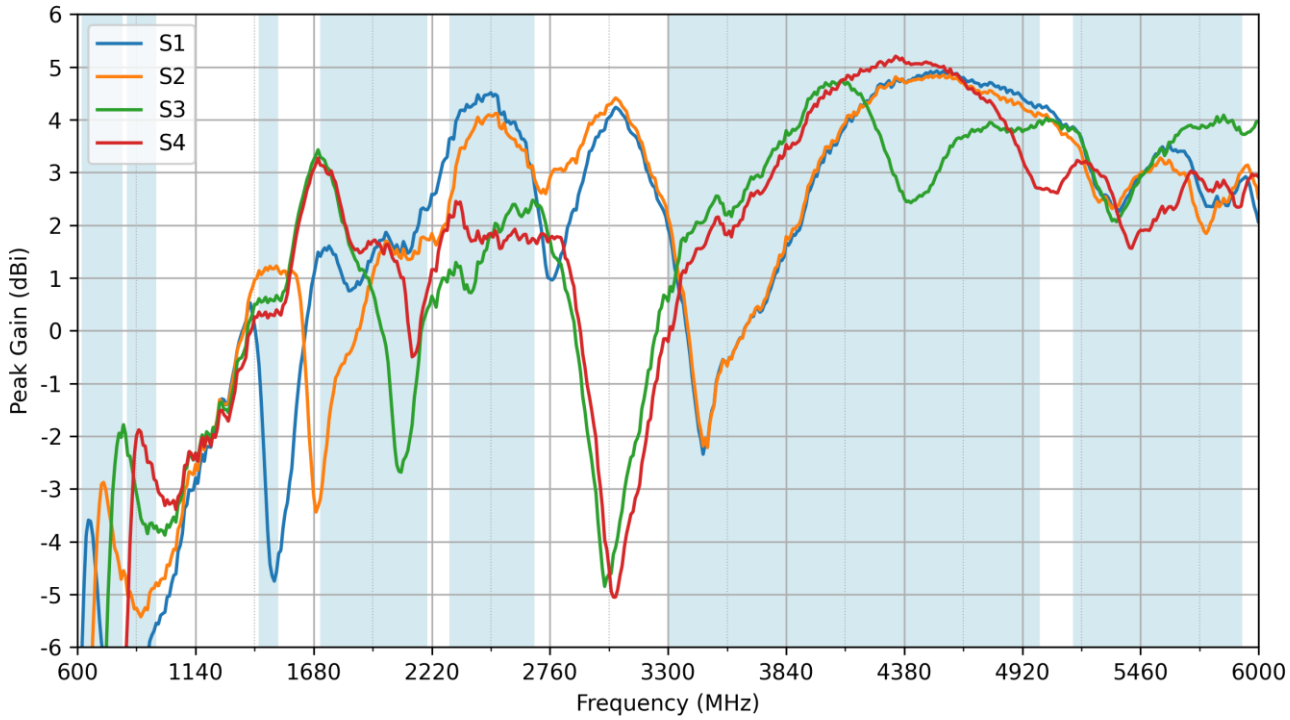
11.3 Efficiency



11.4 Average Gain

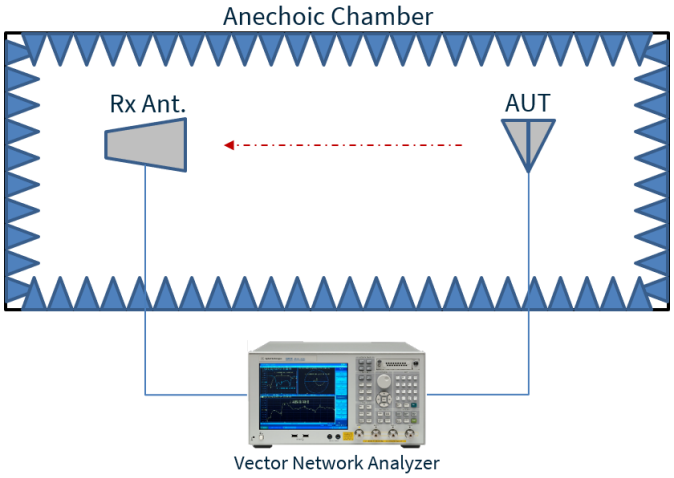


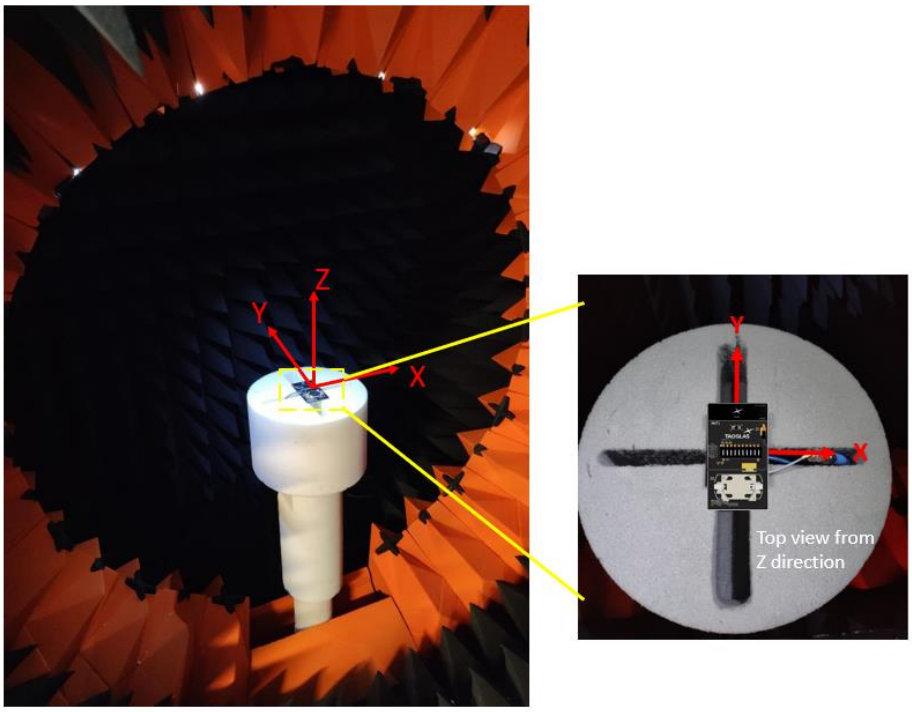
11.5 Peak Gain



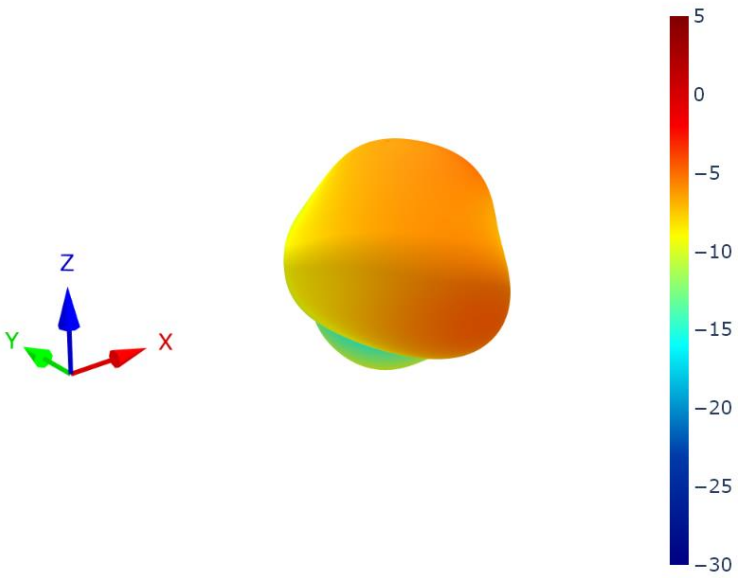
12. Radiation Patterns

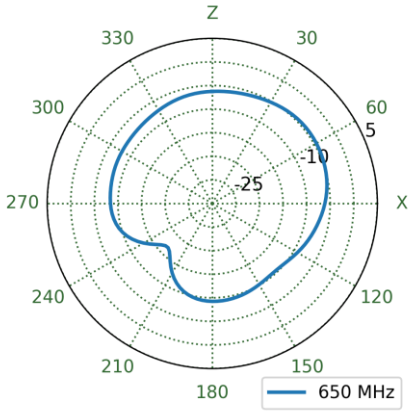
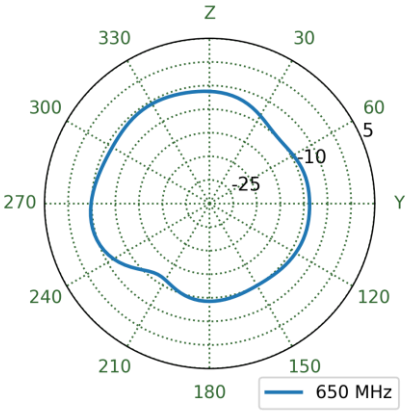
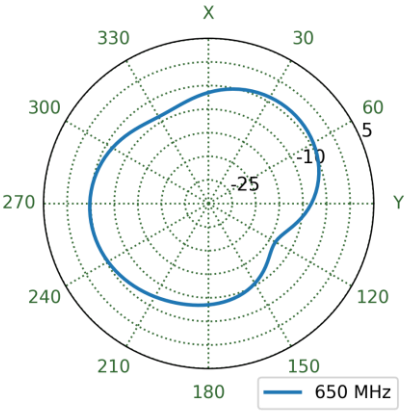
12.1 Test Setup



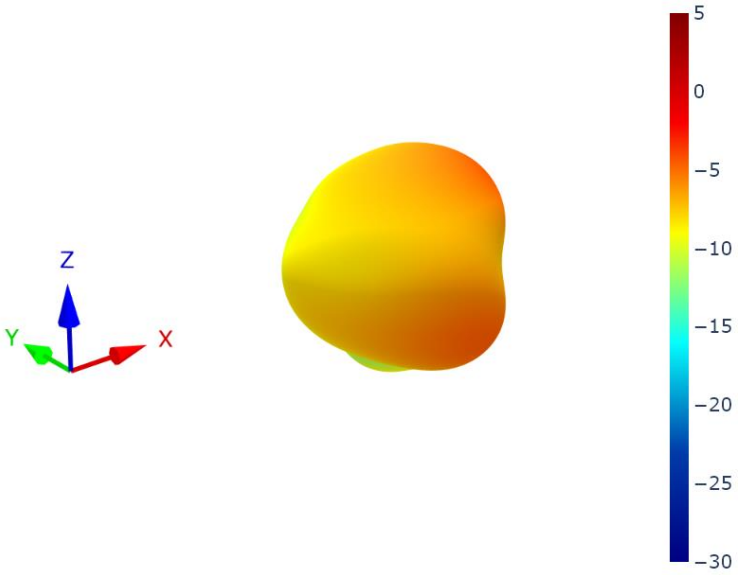


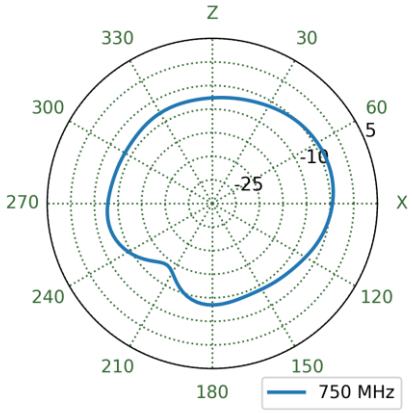
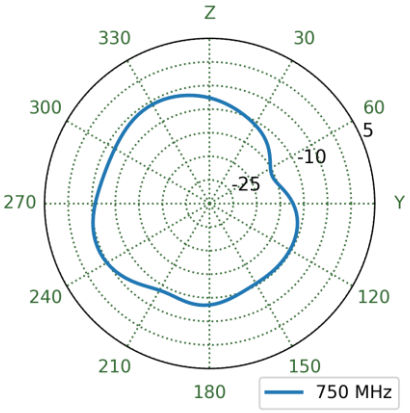
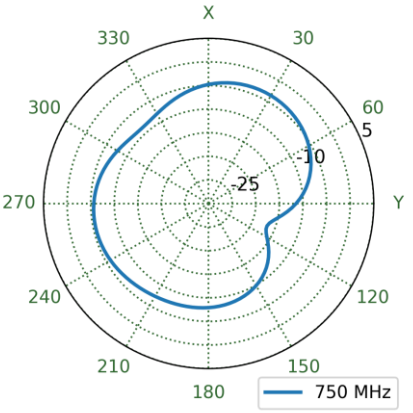
12.2 Patterns at 650 MHz



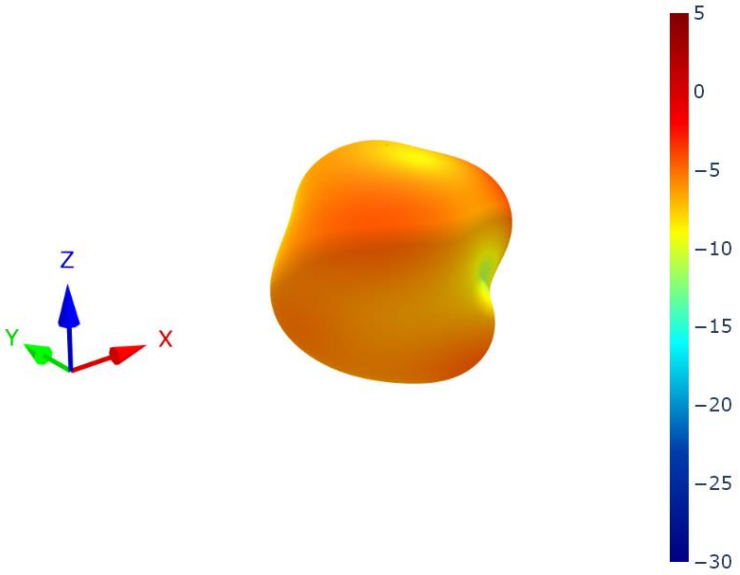
XZ Plane	YZ Plane	XY Plane
		

12.3 Patterns at 750 MHz

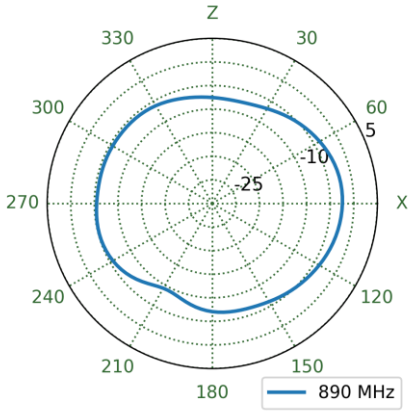


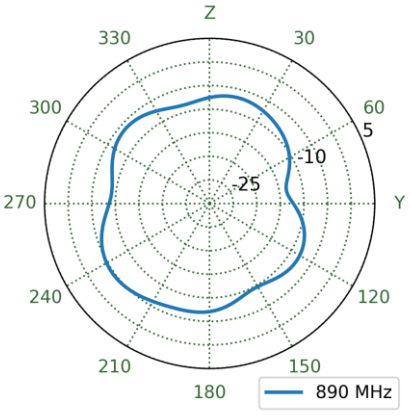
XZ Plane	YZ Plane	XY Plane
		

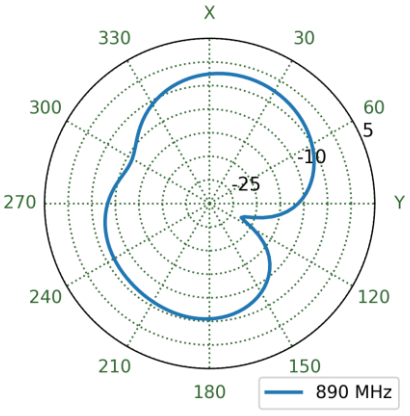
12.4 Patterns at 890 MHz



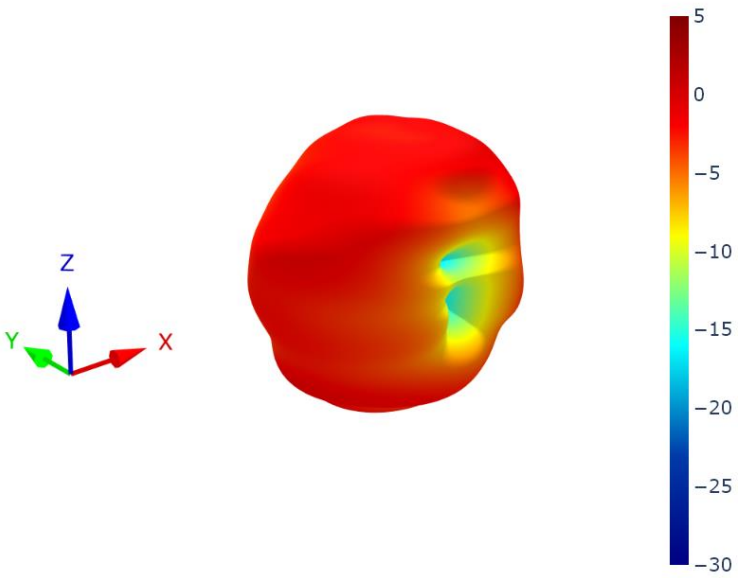
XZ Plane	YZ Plane	XY Plane

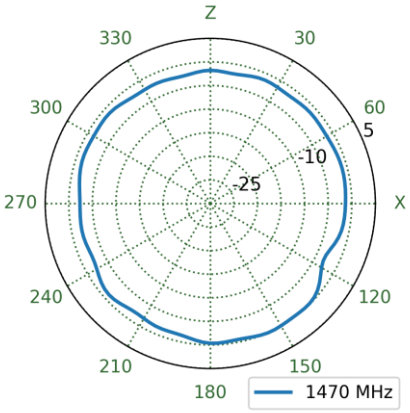
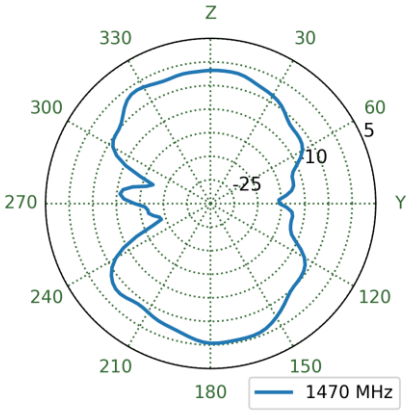
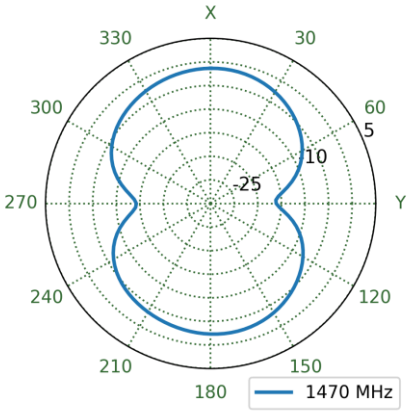




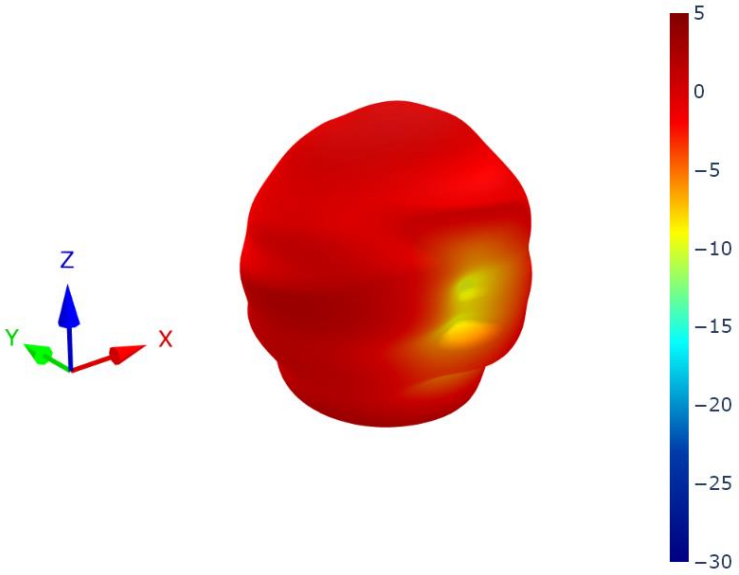


12.5 Patterns at 1475 MHz

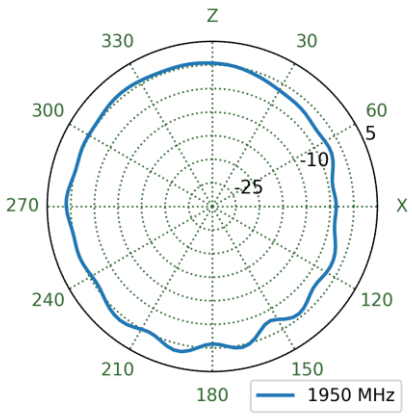


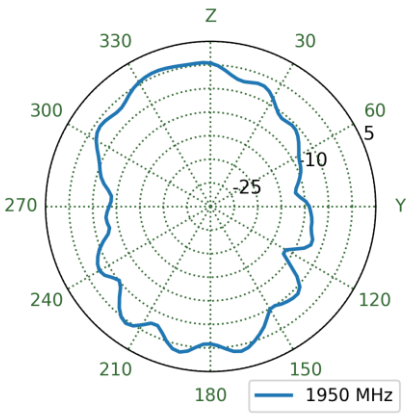
XZ Plane	YZ Plane	XY Plane
		

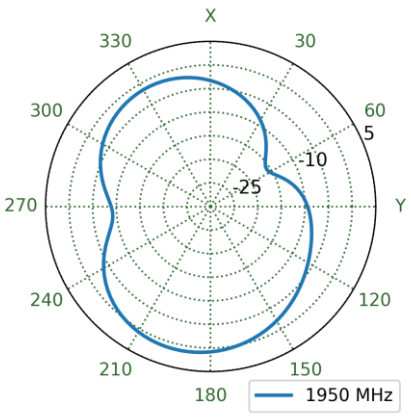
12.6 Patterns at 1955 MHz



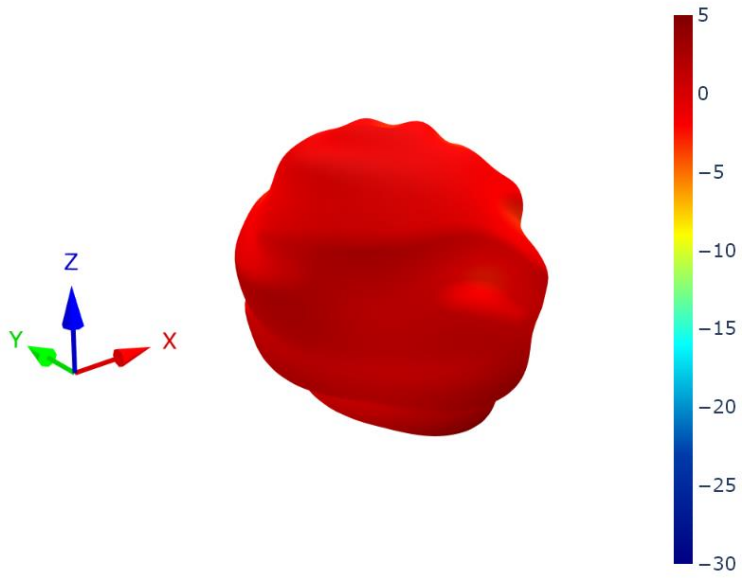
XZ Plane	YZ Plane	XY Plane

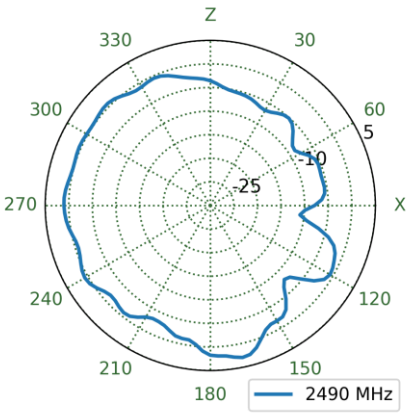
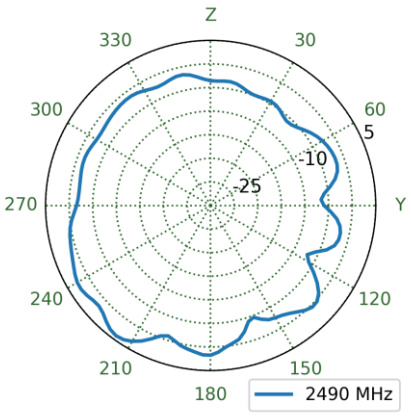
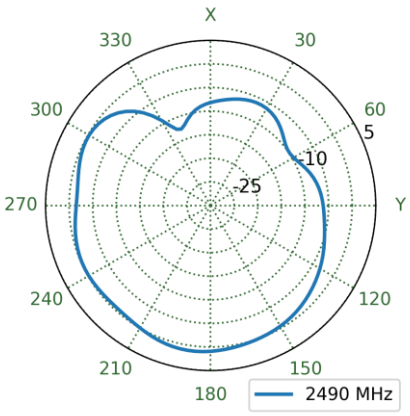




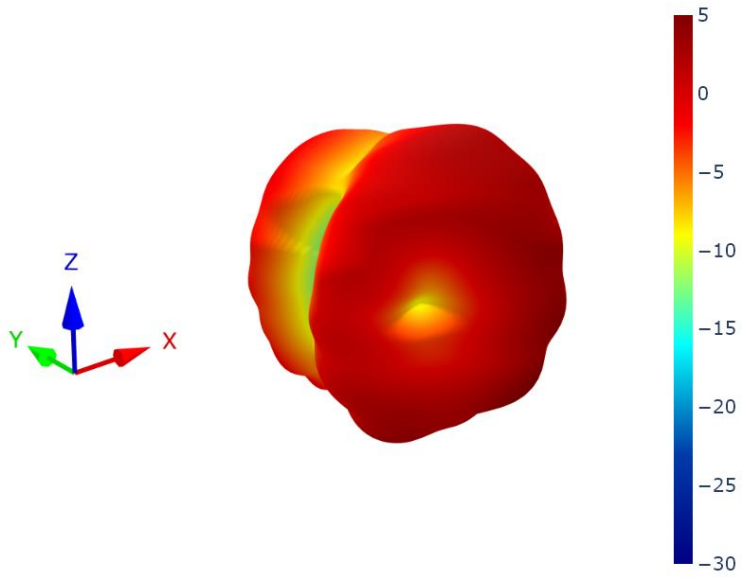


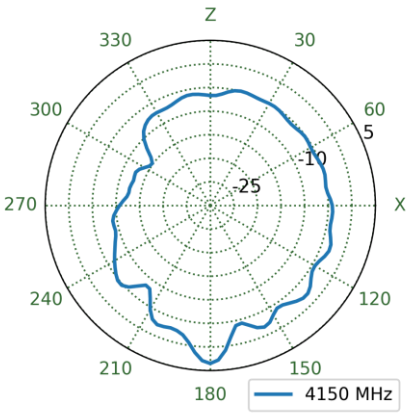
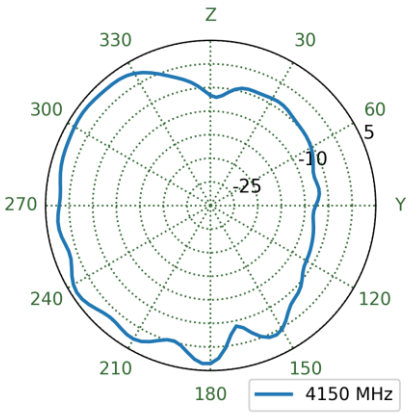
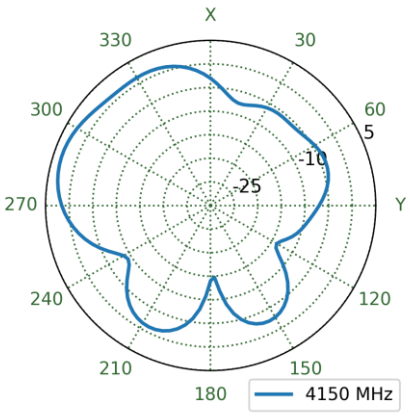
12.7 Patterns at 2495 MHz



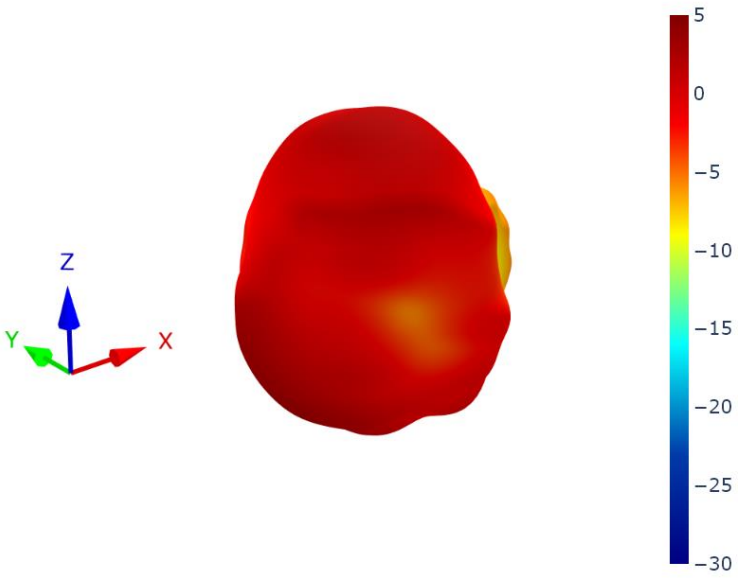
XZ Plane	YZ Plane	XY Plane
		

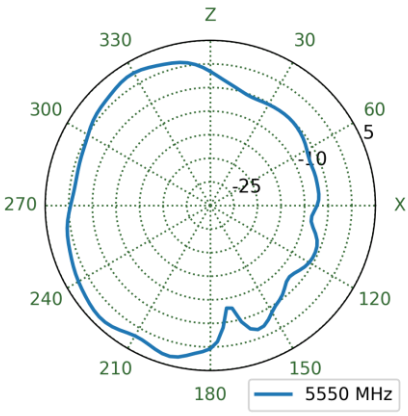
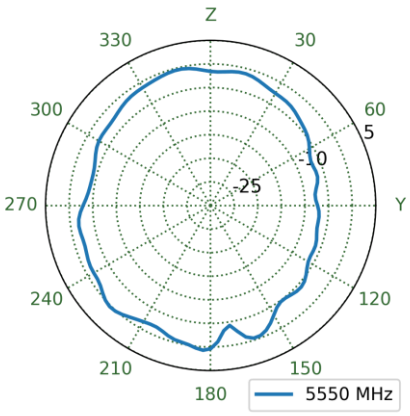
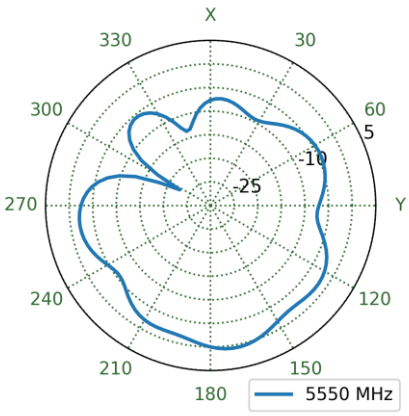
12.8 Patterns at 4150 MHz



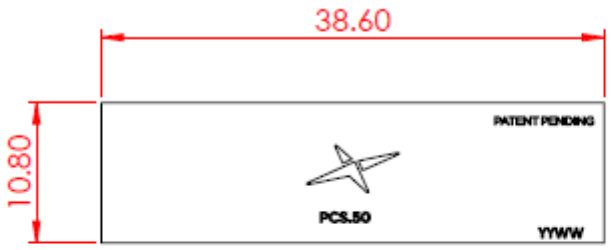
XZ Plane	YZ Plane	XY Plane
		

12.9 Patterns at 5550 MHz

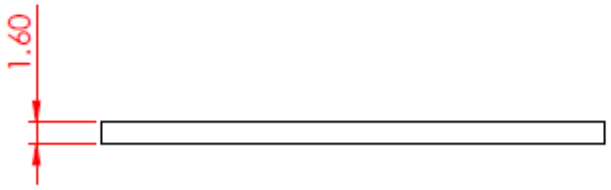


XZ Plane	YZ Plane	XY Plane
		

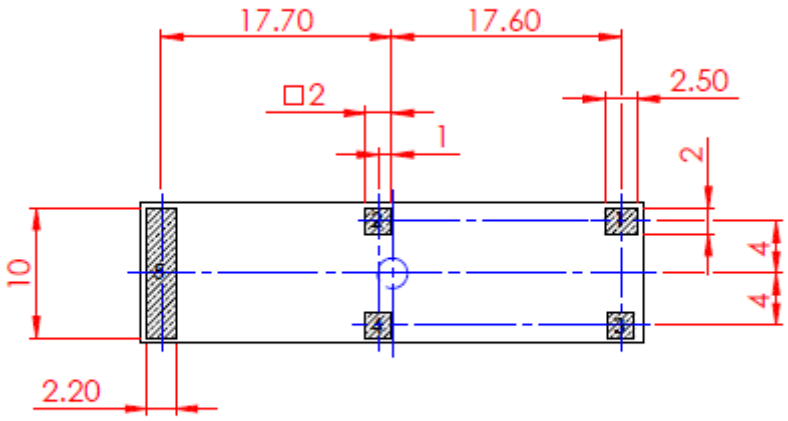
13. Mechanical Drawing - Antenna



TOP VIEW



FRONT VIEW



PADS 2,3,4 THE SAME SIZE

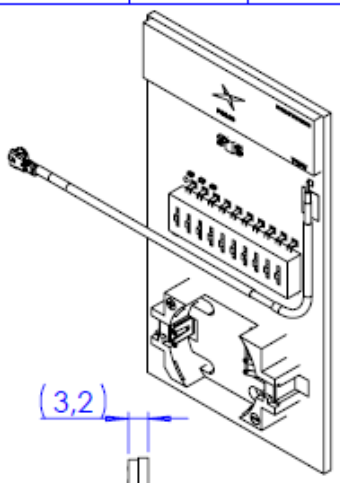
BOTTOM VIEW

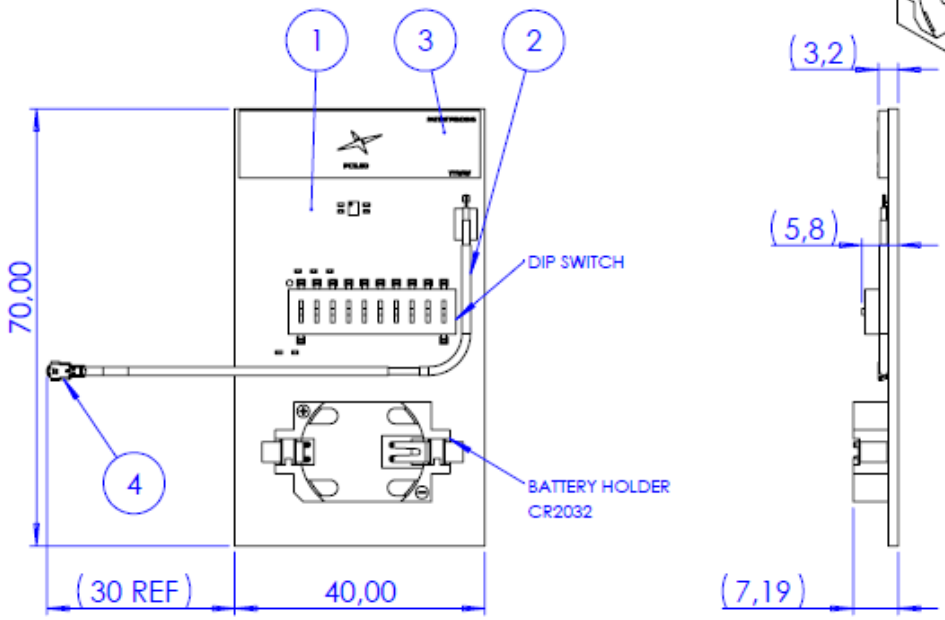
PIN:	DESCRIPTION:
1	FEED (50 OHM)
2	GND
3,4,5	NC

14. Mechanical Drawing – Eval Board

ISO NO.: EDW-23-8-0726
STATE: RELEASE
NOTES: 1.ALL MATERIAL MUST BE ROHS COMPLIANT.
2.FINISH:
3.THE CONNECTOR ORIENTATION HAS A FIXED POSITION TO THE ANTENNA AS PER DRAWING.
4.*** CRITICAL DIMENSIONS.

REV.	DESCRIPTION	DATE	APPROVED
D01	RELEASE FOR USE	01/06/2023	W.LEVINGSTONE
D02	PDF DRAWING FILE CORRECTED	08/06/2023	W.LEVINGSTONE
D03	CABLE ROUTING MODIFIED	21/09/2023	S.CARROLL

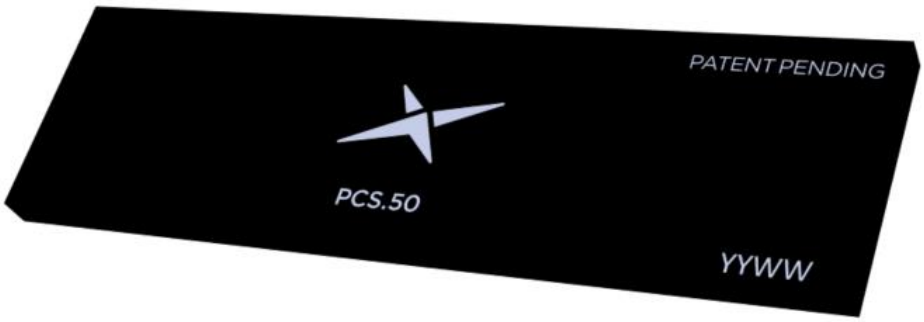


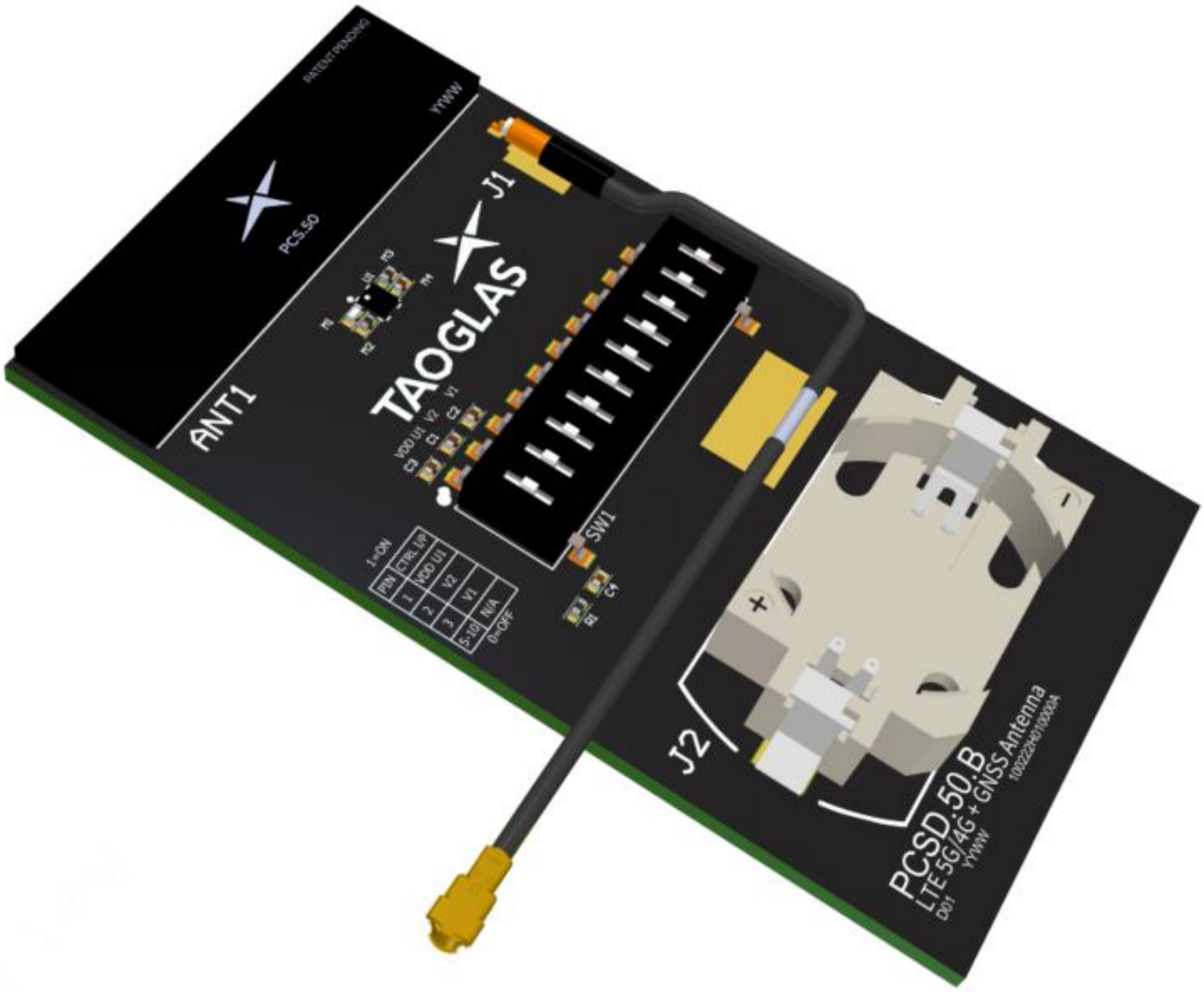


ITEM NO.	DESCRIPTION	MATERIAL	FINISH	Default/QTY.
1	PCBA PCSD.50.B	IT180 + COMPONENTS	BLACK	1
2	1.37 COAXIAL CABLE TO IPEX MHFHT 85mm	1.37 COAXIAL CABLE	BLACK	1
3	LOW PROFILE CELLULAR 5G/4G/3G & GNSS SMD ANTENNA	IT 180	BLACK	5
4	IPEX MHFHT	BRASS	GOLD	1

APPROVED BY: W.LEVINGSTONE	TAOGLAS. EMEA Design Centre				
CHECK BY: S.CARROLL					
DRAWN BY: W.LEVINGSTONE					
DATE: 31-MAY-2023	TITLE: PCS.50.A SMD MOUNT FR4 ANTENNA ON EVALUATION BOARD WIDEBAND LAYOUT				
UNLESS OTHERWISE SPECIFIED TOLERANCES ON:	PART NO.: PCSD.50.B				
THIRD ANGLE PROJECTION	UNIT: mm	SCALE: 1:1	PAGES: 1/1	REV. D03	

15. Antenna Integration Guide

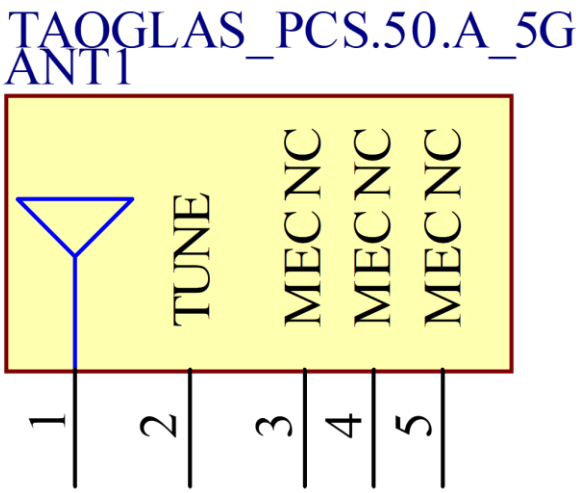




15.1 Schematic and Symbol Definition

The circuit symbol for the antenna is shown below. The antenna has 5 pins with only two pins (Pin 1 and Pin 2) as functional. Pins 3, 4 and 5 are not connected.

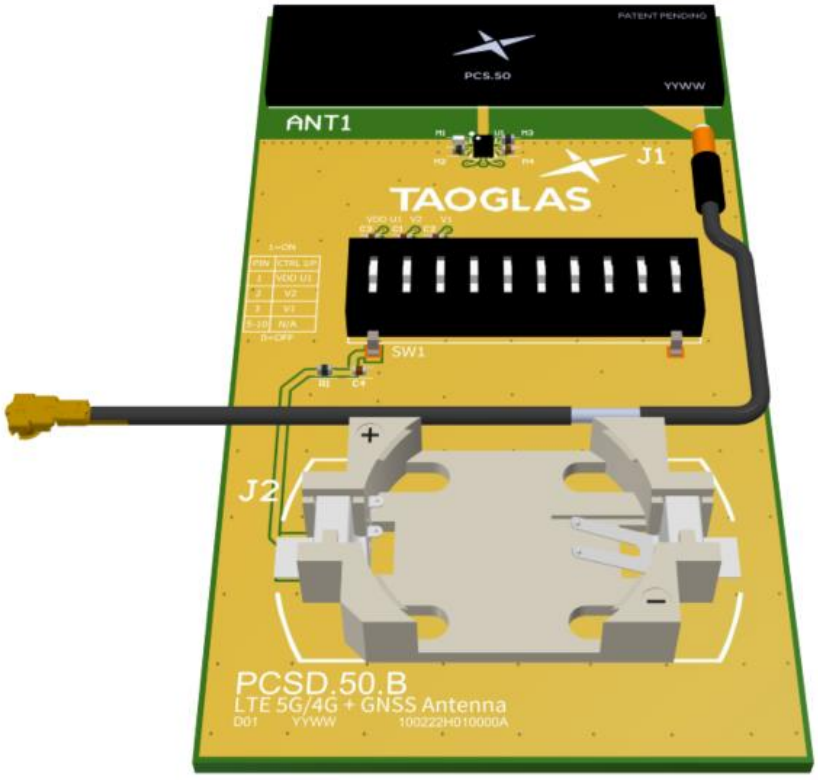
Pin	Description
1	RF Feed
2	Tuning
3, 4, 5	Not Connected



15.2 Antenna Integration

Whatever the size of the PCB, the antenna should ideally be placed on the PCB's shortest side, to take advantage of the ground plane. Optimized matching components can be placed as shown.

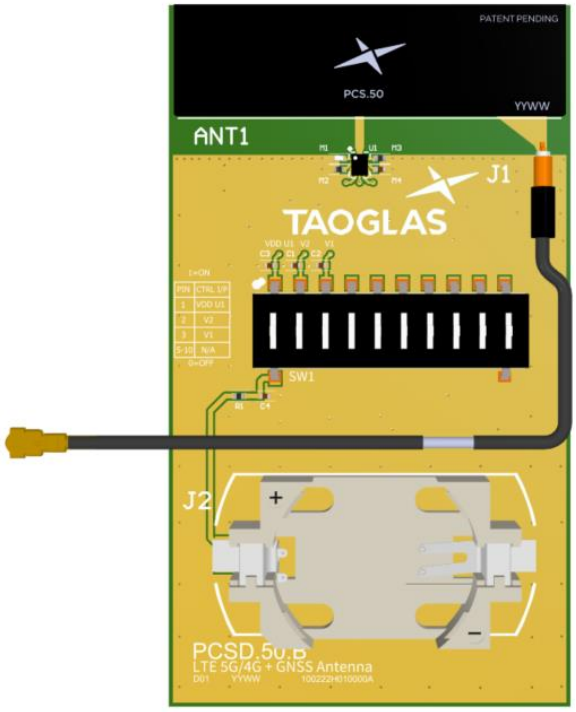
With Top Solder Mask



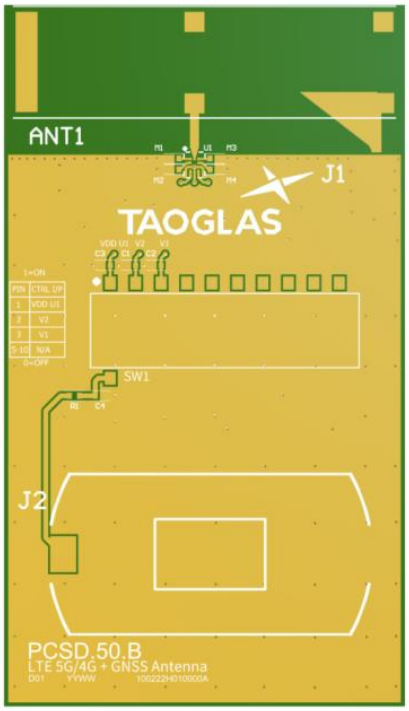
Without Top Solder Mask

15.3 PCB Layout

The footprint and clearance on the PCB must meet the antenna specification. An example of the PCB layout shows the antenna footprint with clearance.



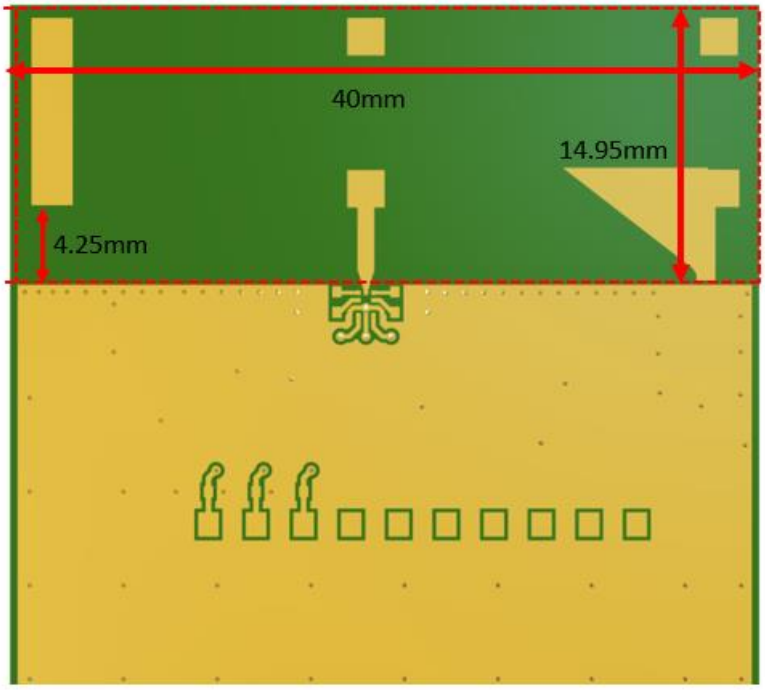
With Components



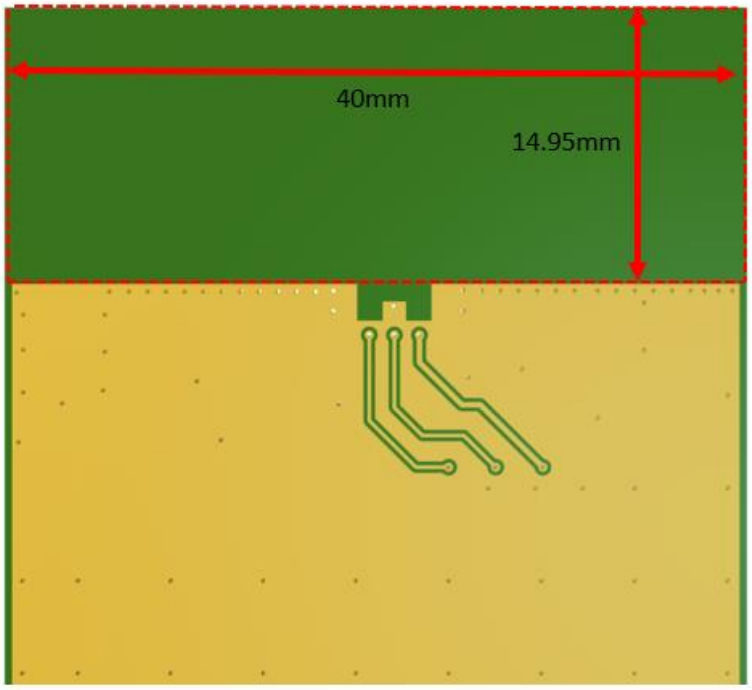
Without Components

15.4 PCB Clearance

Below shows the antenna footprint and clearance through ALL layers on the PCB. Only the antenna pads and connections to feed and GND are present within this clearance area (marked RED). The clearance area extends to 4.25mm from the antenna mechanical pads to the ground area. This clearance area includes the bottom side and ALL internal layers on the PCB.

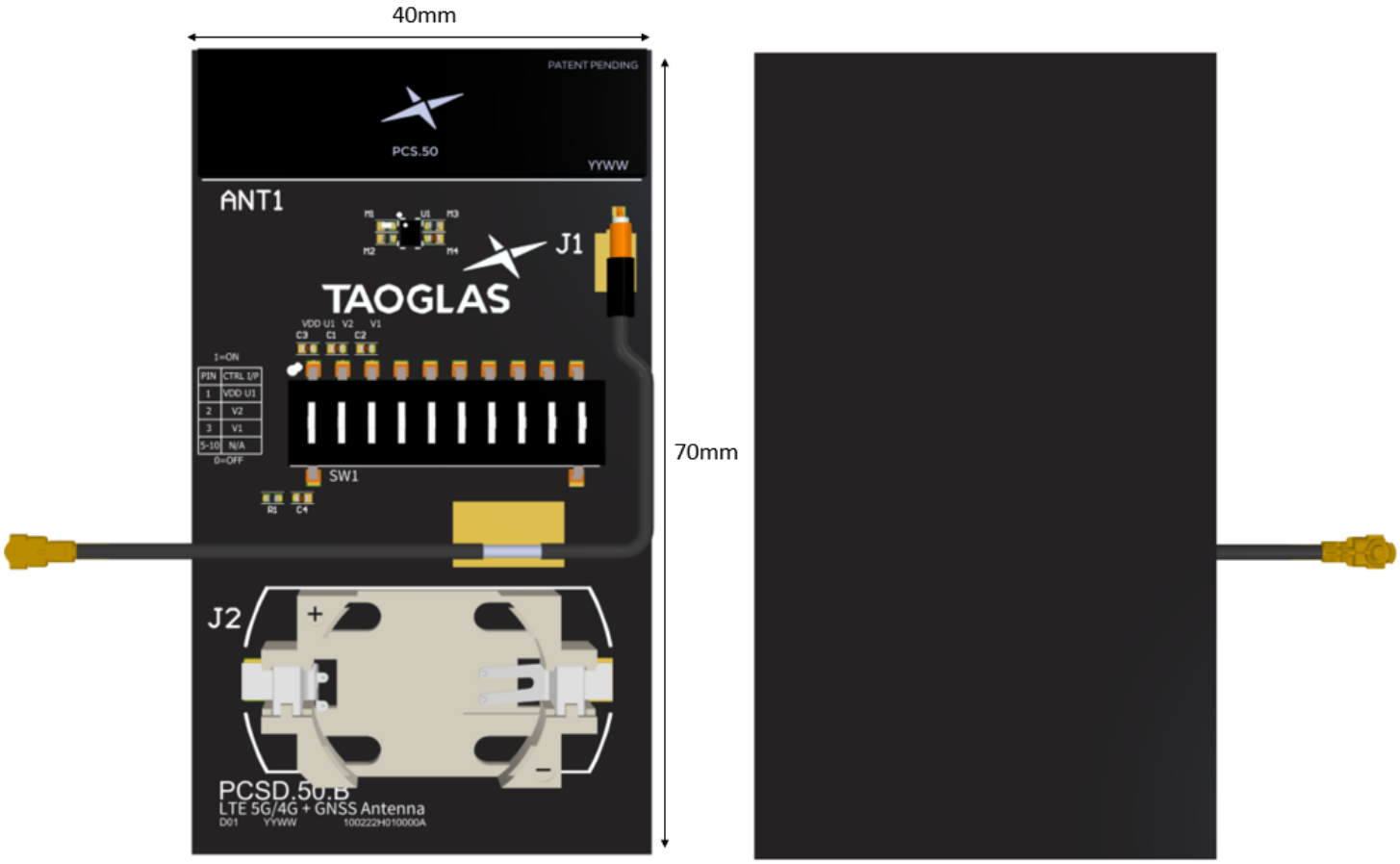


Topside

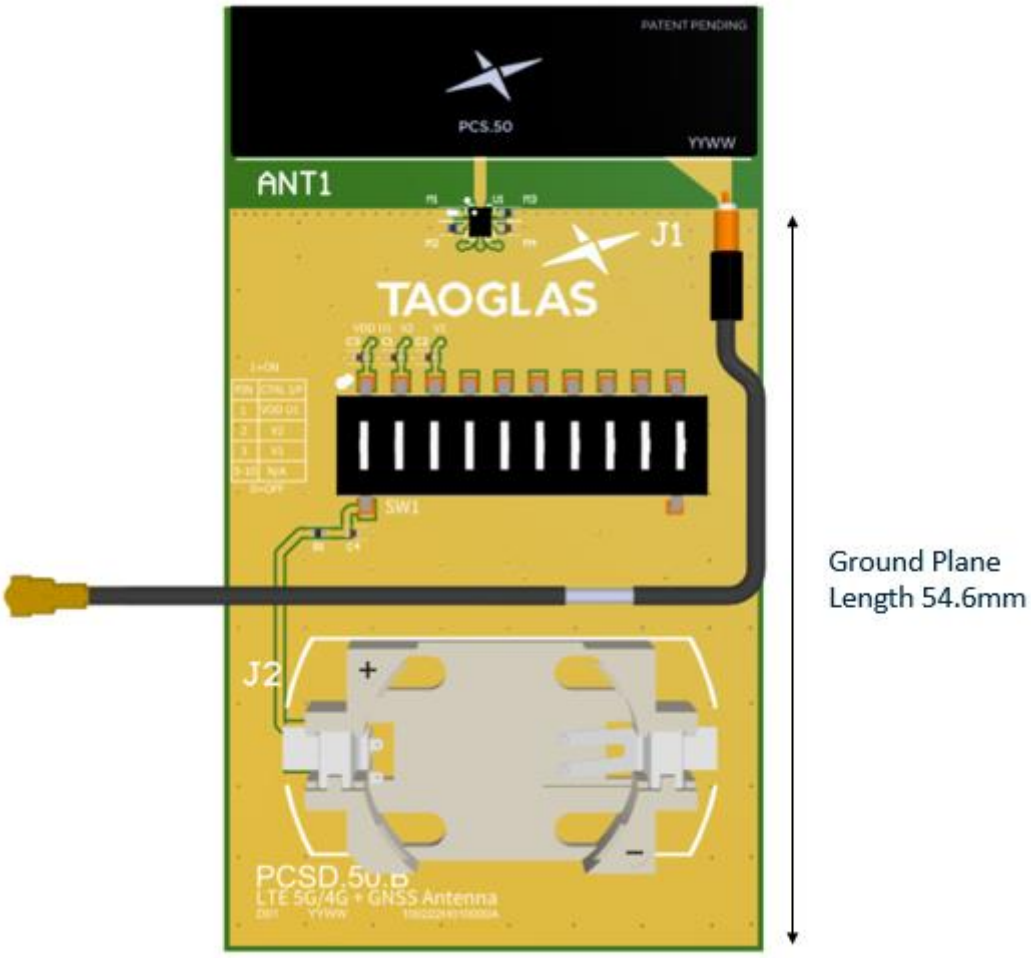


Bottom Side

15.5 Evaluation Board

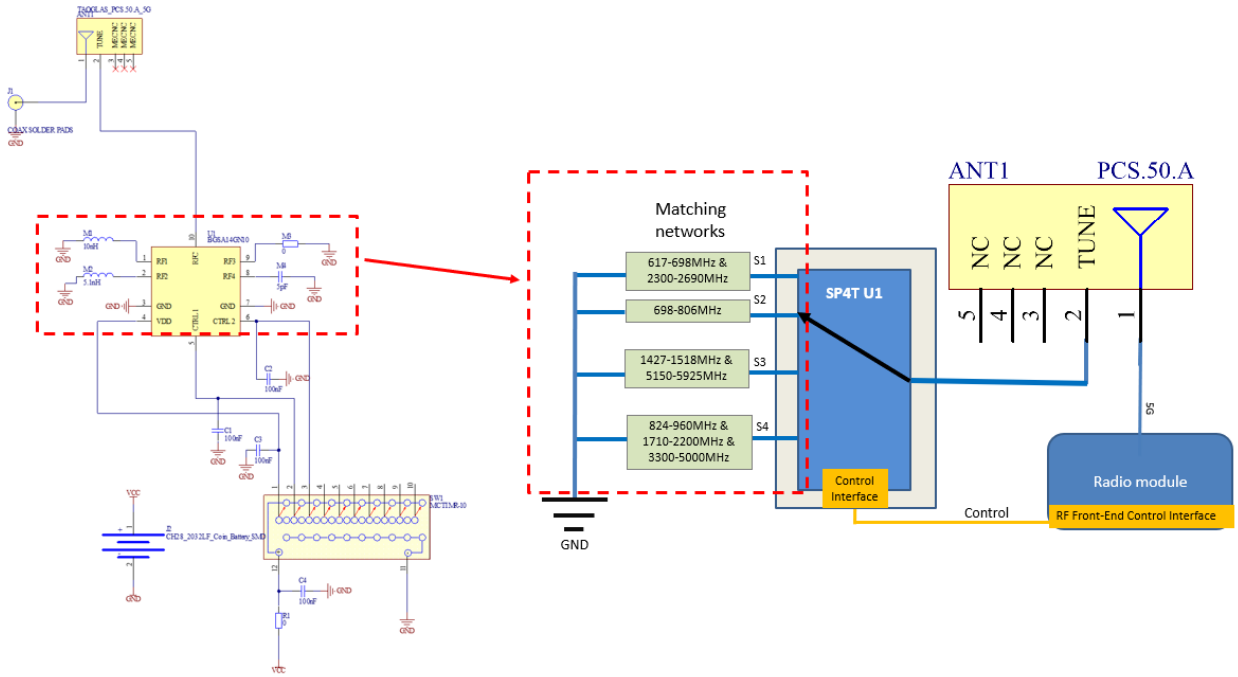


15.6 Evaluation Board Ground Plane Length



15.7 Evaluation Board Matching Circuit

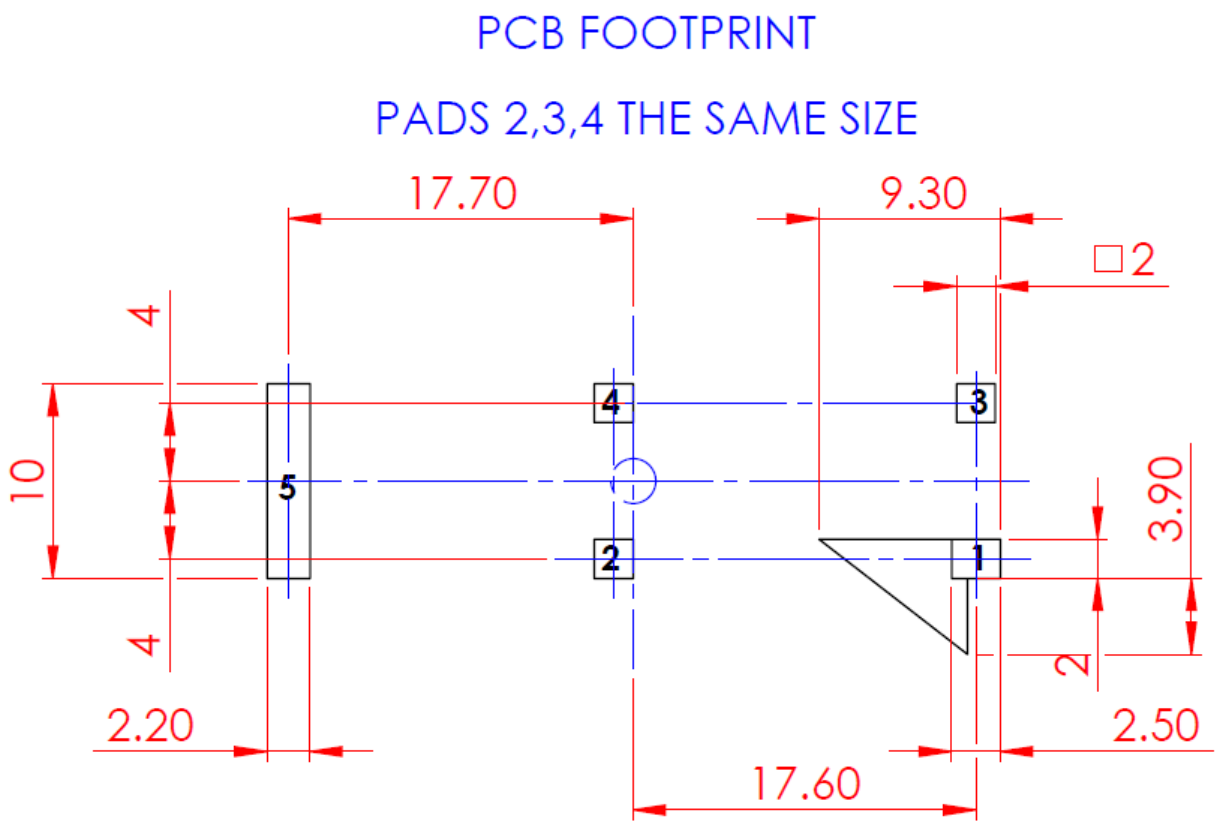
The matching components M1-M4 are connected to the SP4T switch. These are used to tune the antenna resonances. The values for these components are shown in the mapping table below.



CTRL1=PIN2	CTRL2=PIN3	SP4T State	Matching Components	Frequency coverage
0	0	S1:M1-ANT	10nH, MLK1005S10NJT000	617-698MHz & 2300-2690MHz
0	1	S2:M2-ANT	5.1nH MLK1005S5N1ST000	698-806MHz
1	0	S3:M3-ANT	0 ohms	1427-1518MHz & 5150-5925MHz
1	1	S4:M4-ANT	5pF GJM1555C1H5R0BB01D	824-960MHz & 1710-2200MHz & 3300-5000MHz

15.8 Footprint

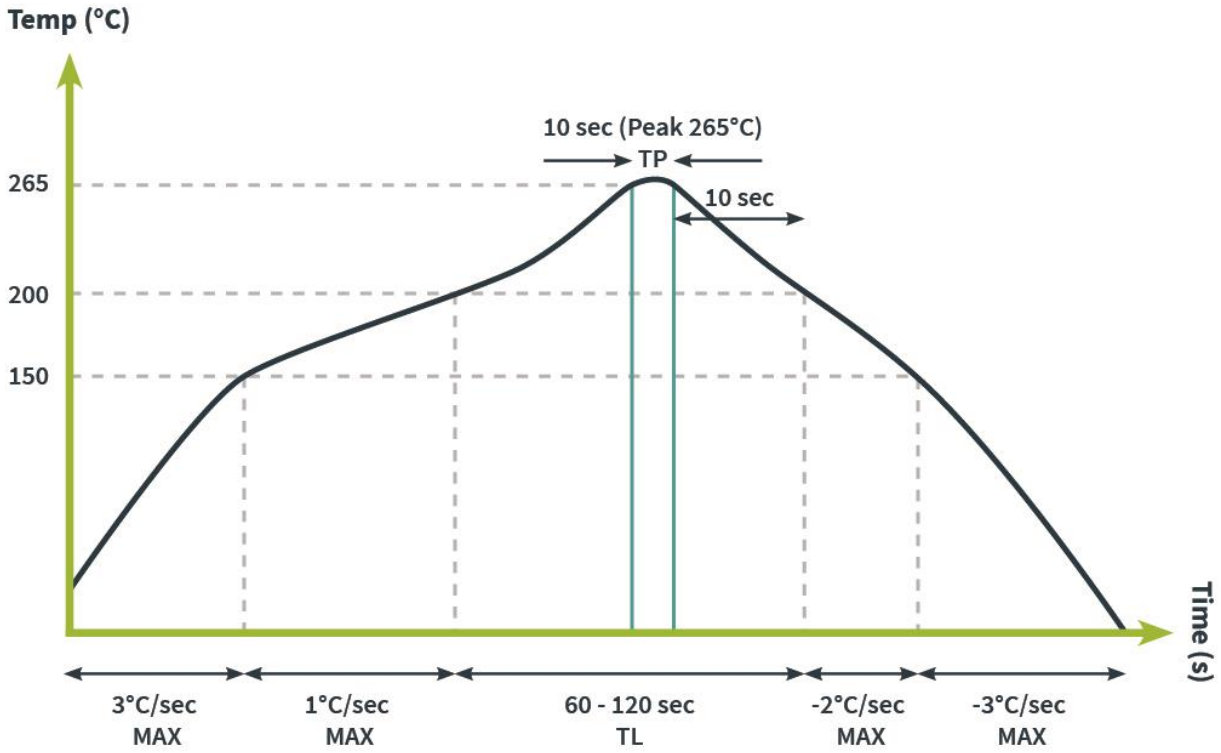
Below shows the antenna mounting footprint for 5G this displays recommended size and layout of the pads on the PCB. These pads are numbered to correspond with the pads on the antenna.



PIN:	DESCRIPTION:
1	FEED (50 OHM)
2	GND
3,4,5	NC

16. Solder Reflow Profile

The PCS.50 can be assembled by following the recommended soldering temperatures are as follows:

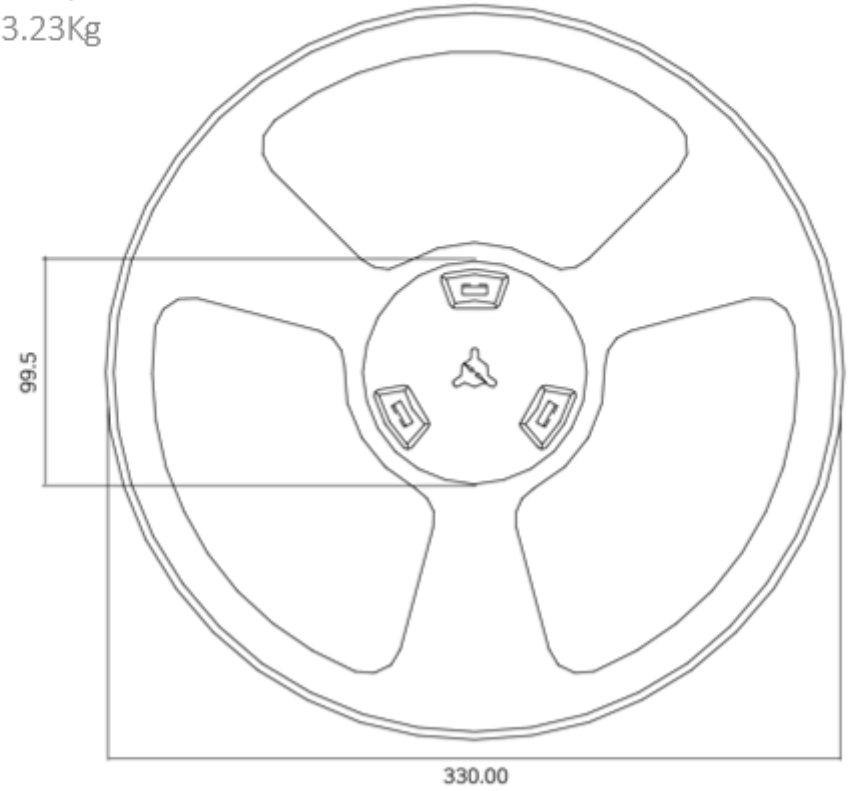


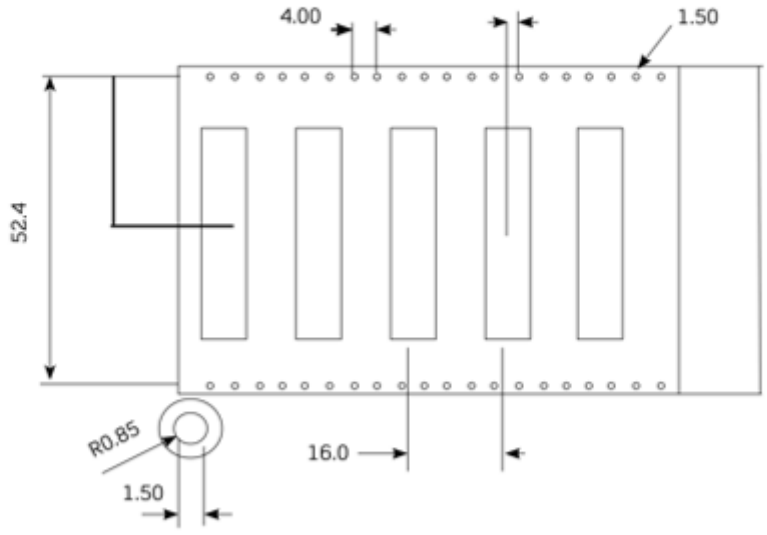
*Temperatures listed within a tolerance of +/- 10º C

Smaller components are typically mounted on the first pass, however, we do advise mounting the PCS.50 when placing larger components on the board during subsequent reflows.

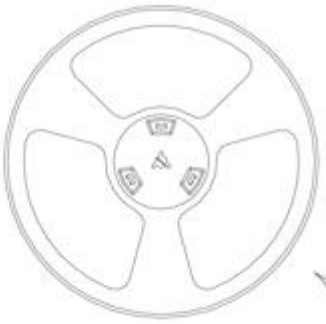
17. Packaging

1000 pcs PCS.50 per reel
Dimensions – Ø330 x 60mm
Weight – 3.23Kg

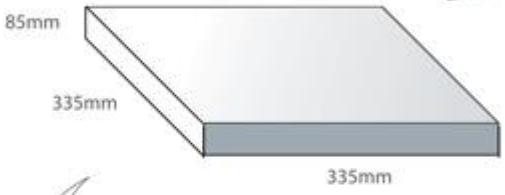




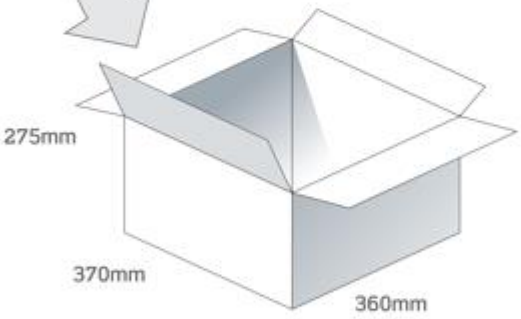
1000 pcs PCS.50 per reel
Dimensions – Ø330 x 60mm
Weight – 3.23Kg



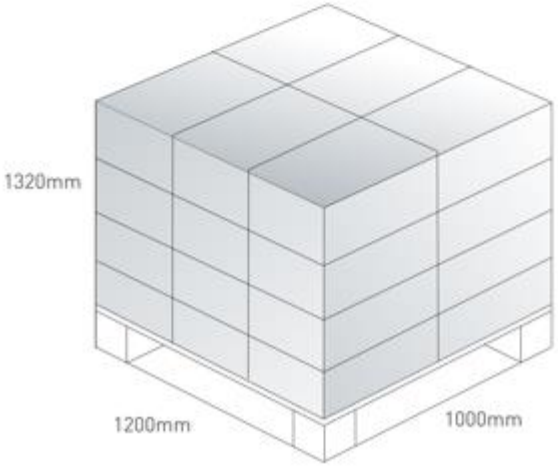
1000 pcs PCS.50 / 1 reel in small box
Dimensions – 335 x 335 x 85mm
Weight – 3.5Kg



3 reels, 3000pcs in one carton
Carton dimensions – 370 x 360 x 275mm
Weight – 11.3Kg



Pallet dimensions 1200 x 1000 x 1320mm
14 Cartons per pallet
4 Layers



Changelog for the datasheet

SPE-21-8-119 – PCS.50.A

Revision: E (Current Version)	
Date:	2023-10-18
Changes:	Full datasheet update with addition of PCSD.50.B results.
Changes Made by:	Gary West

Previous Revisions

Revision: D	
Date:	2023-01-18
Changes:	Updated PCB Layout
Changes Made by:	Gavin Mackey

Revision: C	
Date:	2023-01-12
Changes:	Updated PCB Images and Components
Changes Made by:	Gavin Mackey

Revision: B	
Date:	2022-08-30
Changes:	Updated data.
Changes Made by:	Gary West

Revision: A (First Release)	
Date:	2021-12-06
Changes:	First Release
Changes Made by:	Gary West

TAOGLAS®

www.taoglas.com