TAOGLAS

Datasheet

Universe

Part No:
PCS.50.A

Description:

Low Profile LTE/Cellular 4G/3G/2G & GNSS SMD Antenna

Features:

SMD Dielectric Antenna

LTE: 698-960MHz, 1710-2700MHz

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	3
2.	Operational Instructions of the PCSD.50.A	5
3.	Specifications	7
4.	Antenna Characteristics	9
5.	Radiation Patterns	11
6.	Mechanical Drawing	20
7.	Antenna Integration Guide	21
8.	Packaging	30
9.	Application Note	32
10.	Solder Reflow	35
	Changelog	36

Taoglas makes no warranties based on the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and product descriptions at any time without notice. Taoglas reserves all rights to this document and the information contained herein. Reproduction, use or disclosure to third parties without express permission is strictly prohibited.

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 4G cellular bands, including the most challenging 700MHz bands.

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 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.

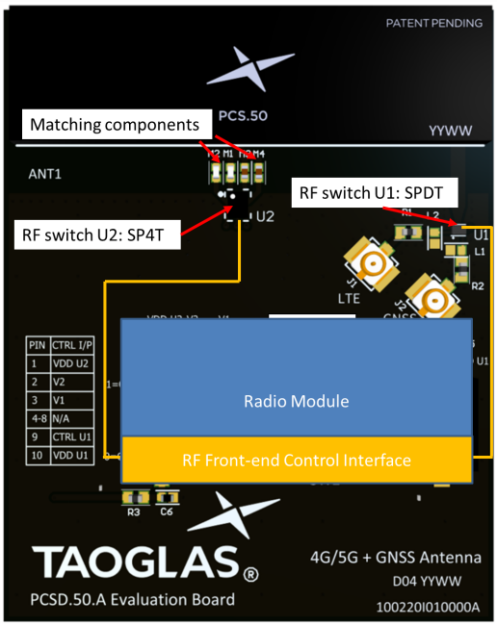
The PCS.50.A is compatible with the radio modules that support the RF front-end control interface (RFFE). The radio module controls the active RF switch to adjust the antenna resonance frequency to operate efficiently on multiple bands and increase the RF capabilities by 3dB compared with standard passive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

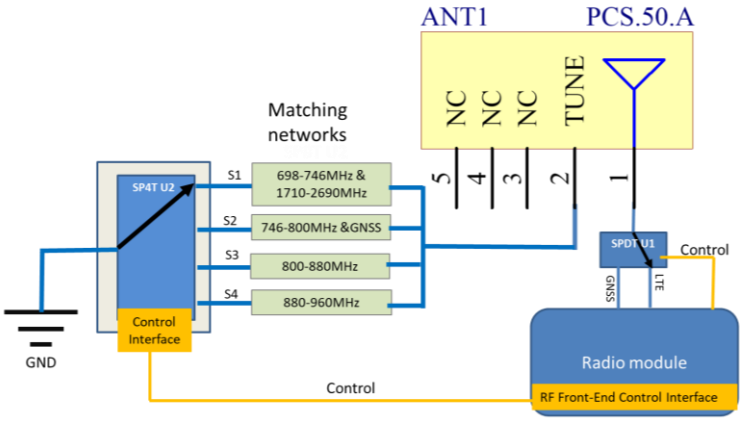
The PCS.50.A is easy to integrate using standard SMD technologies, and implementing the active solution is easy thanks to Taoglas' integration support, providing different design files depending on your requirements. The antenna can be tuned by simply selecting the best switching configuration to achieve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

Please see section 2 of this datasheet for the key operational instructions of this antenna to ensure optimum performance. Section 3, 4 and 5 of this datasheet shows the PCS.50.A antenna performance on Taoglas evaluation board PCSD.50A. Section 6 shows the mechanical drawings of the antenna. Section 7 shows how to integrate the antenna into your device, and the Application Note in Section 9 demonstrates the products used in different scenarios.

The PCS.50.A, tuned for PCBs to a size of just 40 x 50m, 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.

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.





2. Operational Instructions of the PCSD.50.A

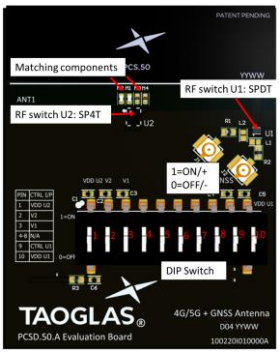
Taoglas developed an evaluation board called PCSD.50.A that includes the PCS.50.A antenna, RF switches and other components to operate this smart antenna solution. This is available to order from Taoglas.

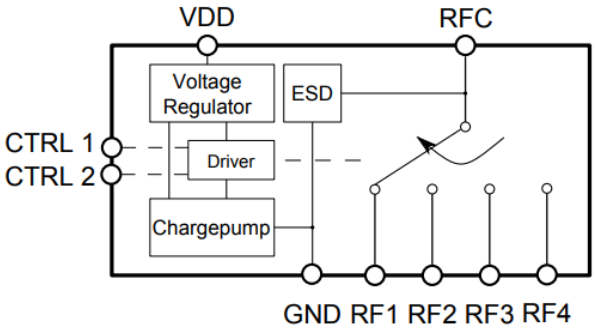
Taoglas developed this EVB to help customers in implementing this solution on their applications. The evaluation kit uses a simple RF switch SP4T to select different matching circuits and a SPDT to select GNSS or LTE radios.

The RF switches used in the evaluation kit are:

SP8T: 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.

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

- 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 9 is the control input for the SPDT, 0 = GNSS, 1 = LTE,
  - Pin 10 controls the power to SPDT.
- Pin 4, 5, 6, 7, 8 are not connected and therefore not used.

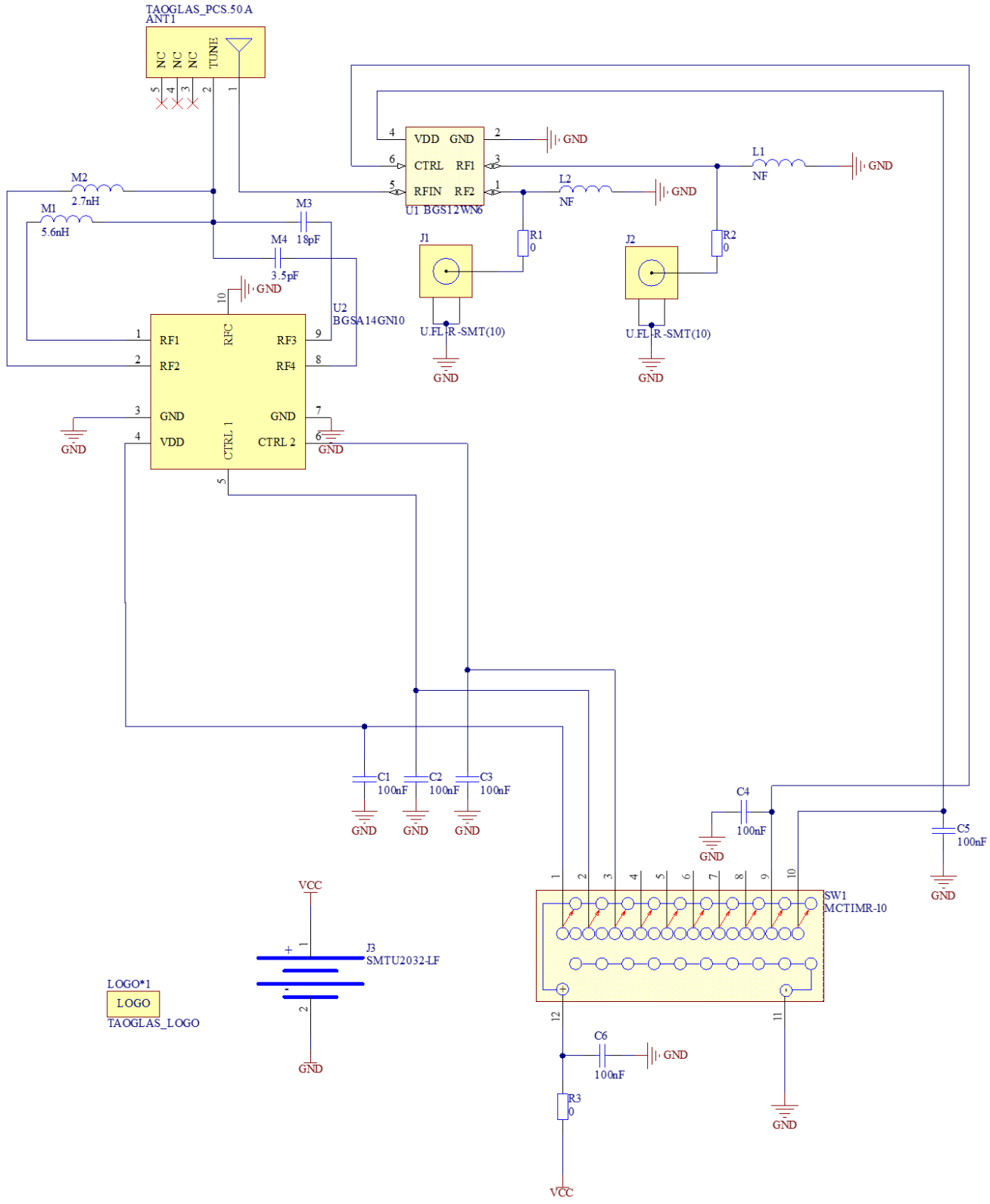
PIN 10=VDD	PIN 9=CTRL	SPDT State
1	0	GNSS-ANT
1	1	LTE-ANT

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. Specifications

Electrical									
Band	**Frequency (MHz)**	**State**	**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	
Antenna Dimensions	38mm x 10mm x 1.6mm
Material	FR4
Weight	2.5g
Soldering Type	SMD Reflow

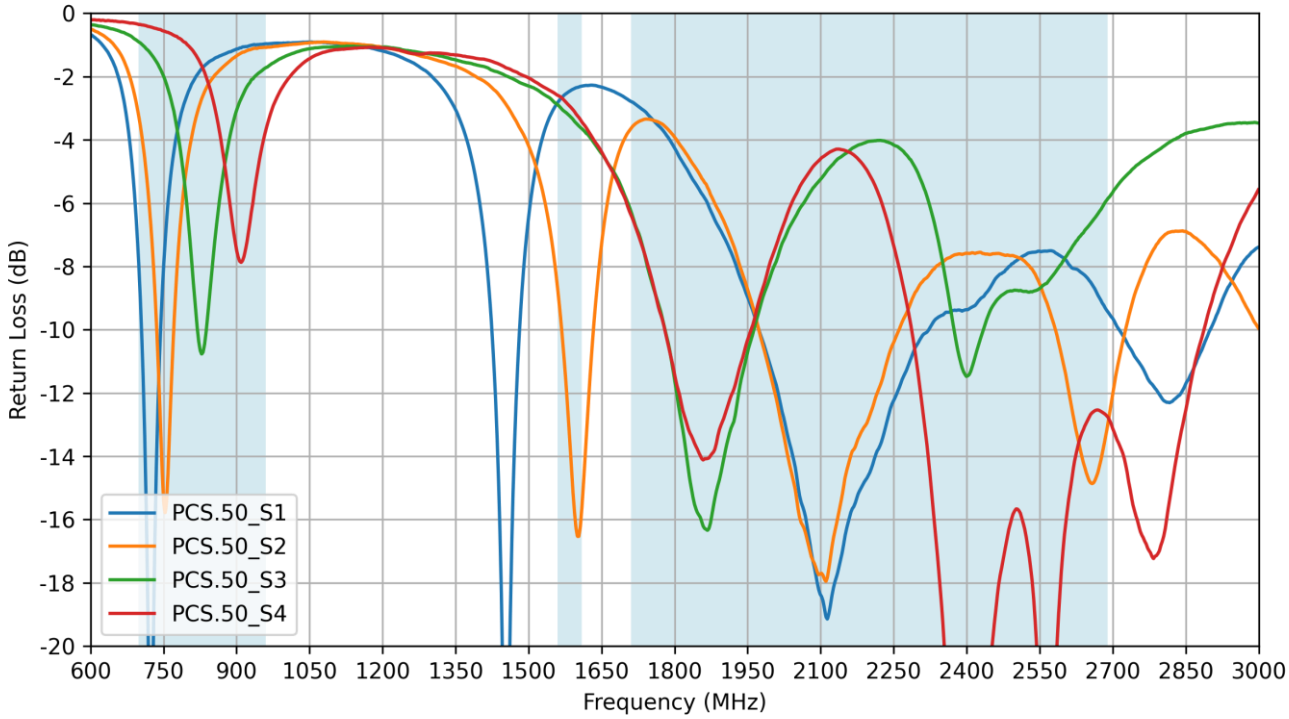
Environmental	
Operation Temperature	-40°C ~ +85°C
Storage Temperature	-40°C ~ +85°C
Moisture Sensitivity Level	3

Results are based on the Evaluation board of 40mm x 50mm with ground plane length of 35 mm. The antenna efficiency values meet operator requirement for USA markets for CATM1 cellular technology.
*Results are shown using the optimum state of the antenna on the evaluation board.

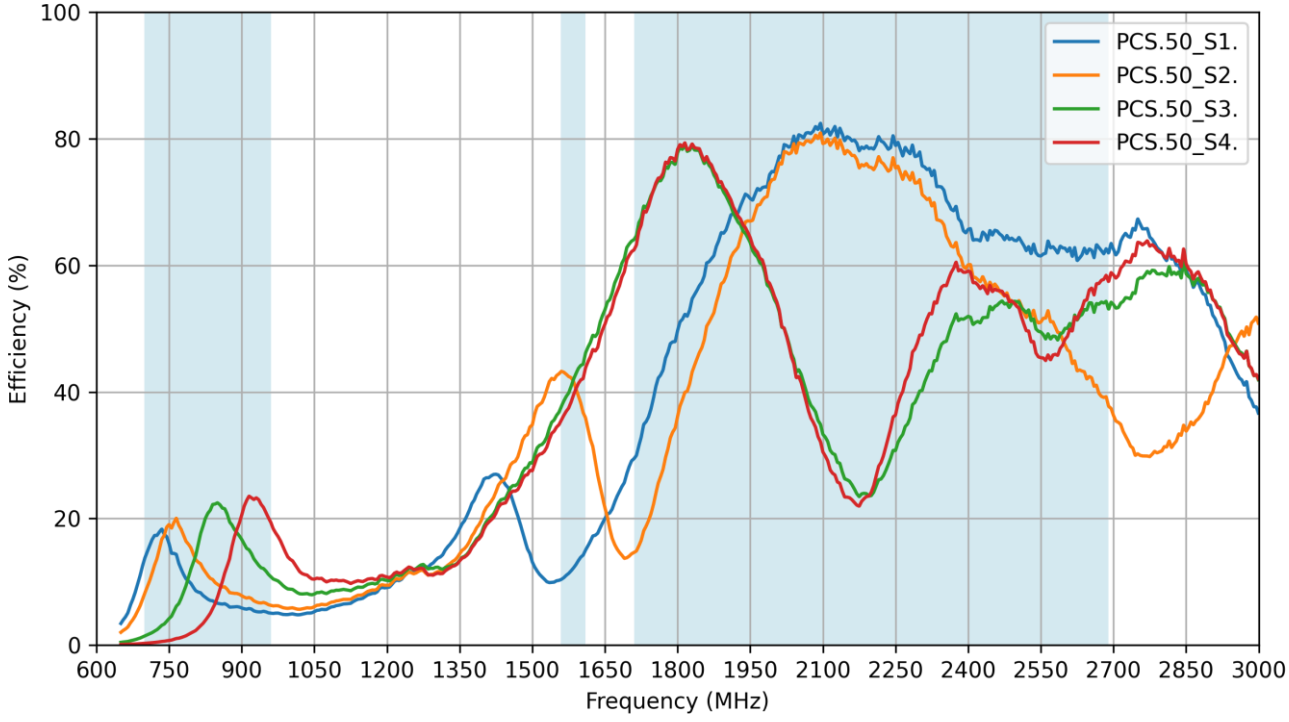
5G/4G Bands			
Band Number	5GNR / FR1 / LTE / LTE-Advanced / WCDMA / HSPA / HSPA+ / TD-SCDMA		
	Uplink	**Downlink**	**Covered**
1	UL: 1920 to 1980	DL: 2110 to 2170	✓
2	UL: 1850 to 1910	DL: 1930 to 1990	✓
3	UL: 1710 to 1785	DL: 1805 to 1880	✓
4	UL: 1710 to 1755	DL: 2110 to 2155	✓
5	UL: 824 to 849	DL: 869 to 894	✓
7	UL: 2500 to 2570	DL:2620 to 2690	✓
8	UL: 880 to 915	DL: 925 to 960	✓
9	UL: 1749.9 to 1784.9	DL: 1844.9 to 1879.9	✓
11	UL: 1427.9 to 1447.9	DL: 1475.9 to 1495.9	✗
12	UL: 699 to 716	DL: 729 to 746	✓
13	UL: 777 to 787	DL: 746 to 756	✓
14	UL: 788 to 798	DL: 758 to 768	✓
17	UL: 704 to 716	DL: 734 to 746	✓
18	UL: 815 to 830	DL: 860 to 875	✓
19	UL: 830 to 845	DL: 875 to 890	✓
20	UL: 832 to 862	DL: 791 to 821	✓
21	UL: 1447.9 to 1462.9	DL: 1495.9 to 1510.9	✗
22	UL: 3410 to 3490	DL: 3510 to 3590	✗
23	UL:2000 to 2020	DL: 2180 to 2200	✓
24	UL:1625.5 to 1660.5	DL: 1525 to 1559	✓
25	UL: 1850 to 1915	DL: 1930 to 1995	✓
26	UL: 814 to 849	DL: 859 to 894	✓
27	UL: 807 to 824	DL: 852 to 869	✓
28	UL: 703 to 748	DL: 758 to 803	✓
29	UL: -	DL: 717 to 728	✓
30	UL: 2305 to 2315	DL: 2350 to 2360	✓
31	UL: 452.5 to 457.5	DL: 462.5 to 467.5	✗
32	UL: -	DL: 1452 - 1496	✓
35	1850 to 1910		✓
38	2570 to 2620		✓
39	1880 to 1920		✓
40	2300 to 2400		✓
41	2496 to 2690		✓
42	3400 to 3600		✗
43	3600 to 3800		✗
48	3550 to 3700		✗
66	UL: 1710-1780	DL: 2110-2200	✓
71	617 to 698		✗
74/75/76	1427 to 1518		✗
78	3300 to 3800		✗
79	4400 to 5000		✗
85	698-716	728-746	✓

4. Antenna Characteristics

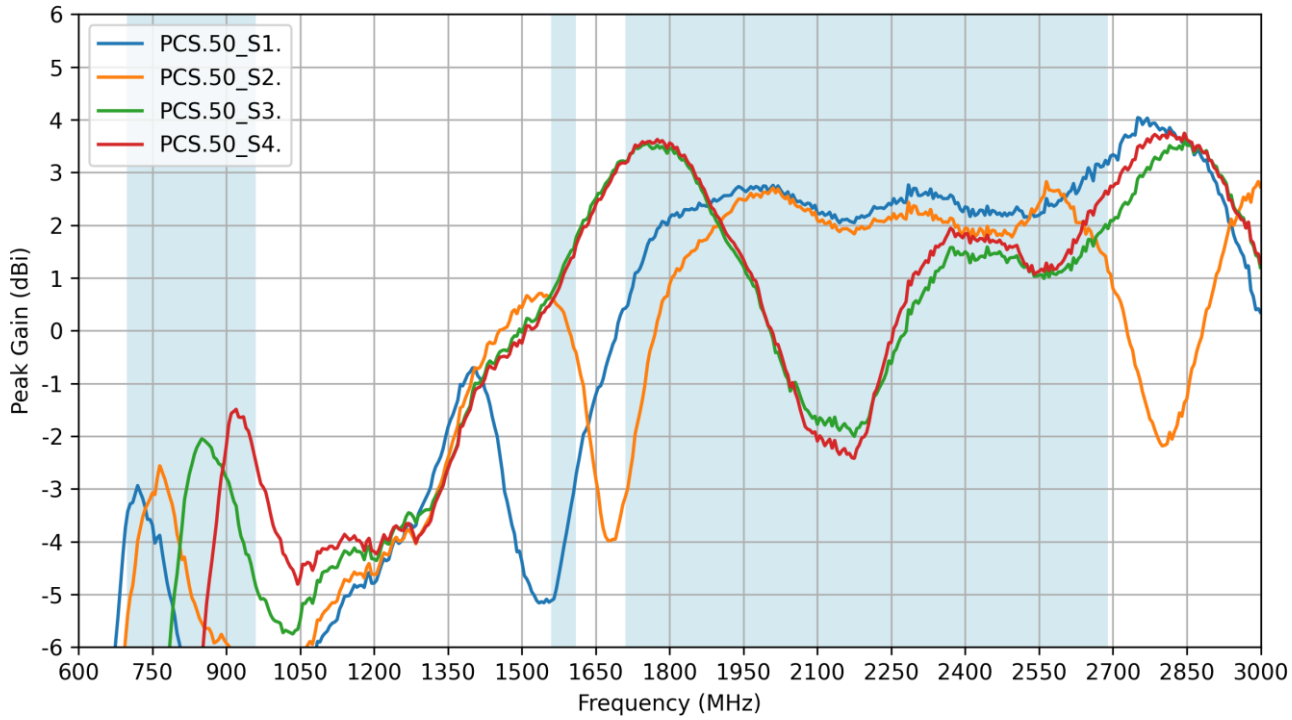
4.1 Return Loss



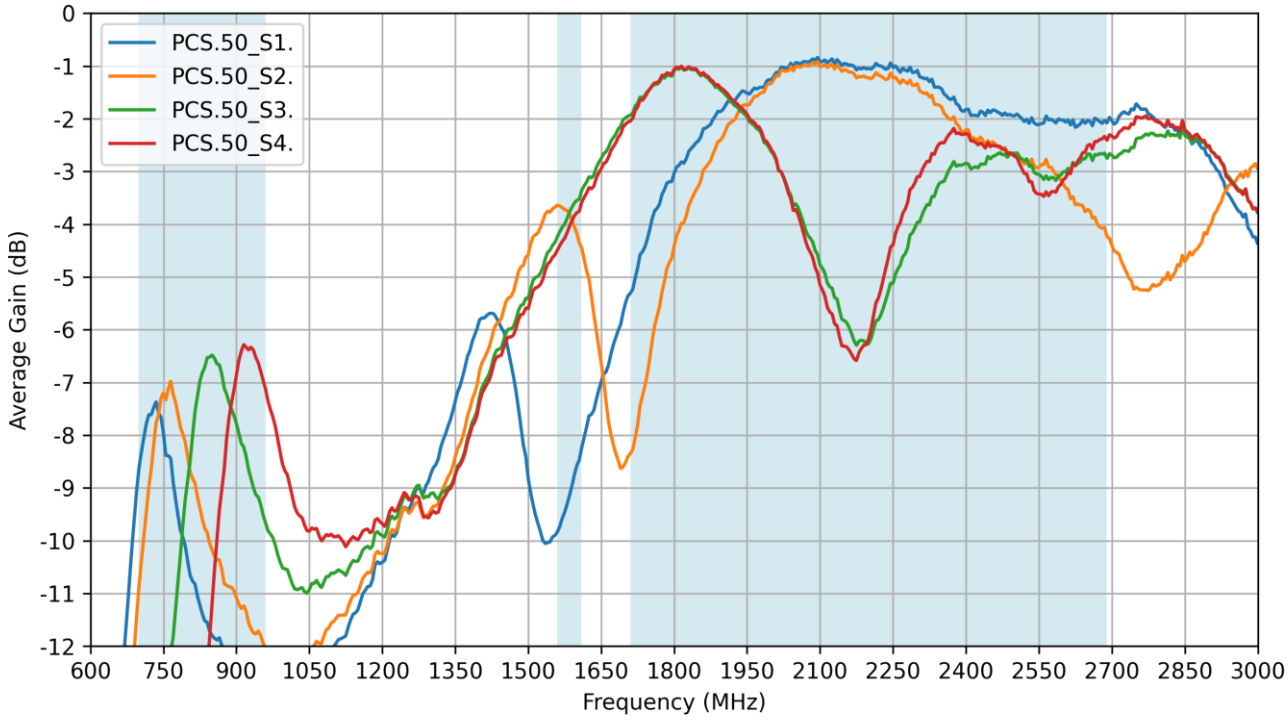
4.2 Efficiency



4.3 Peak Gain



4.4 Average Gain



5. Radiation Patterns

5.1 Test Setup

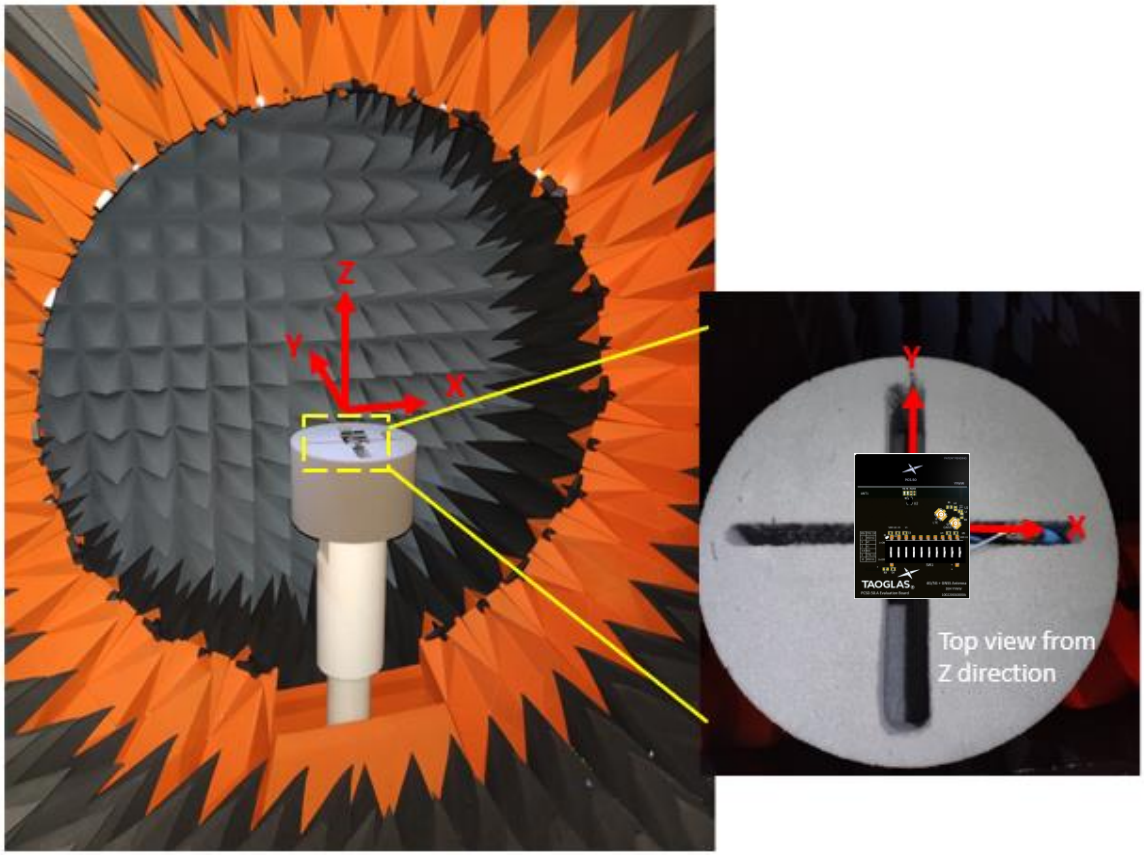
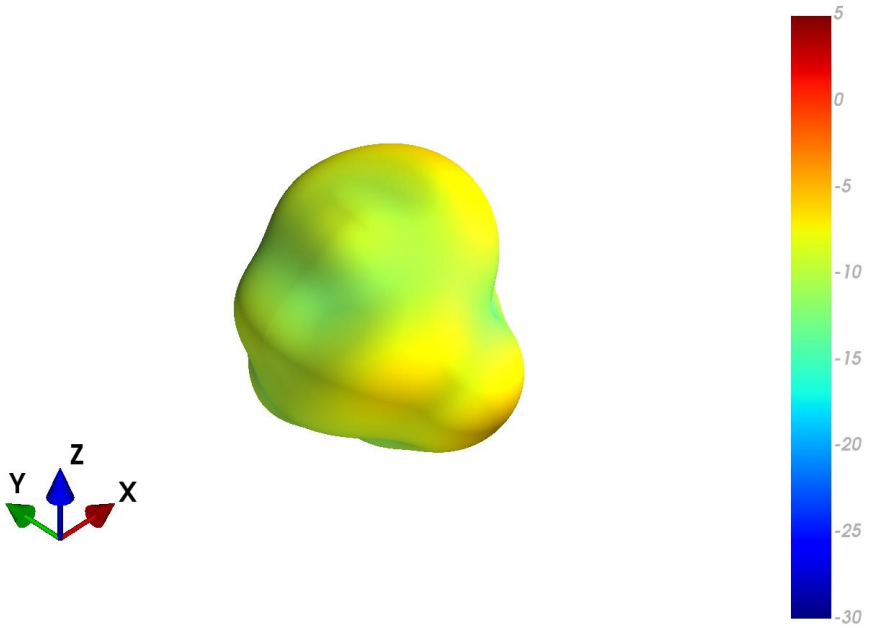
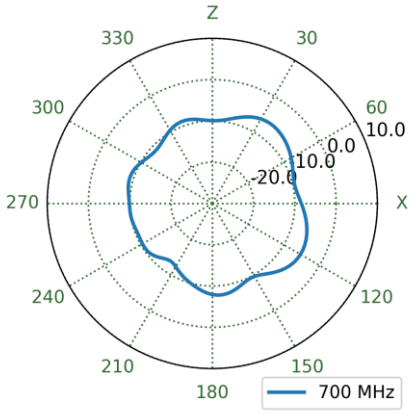
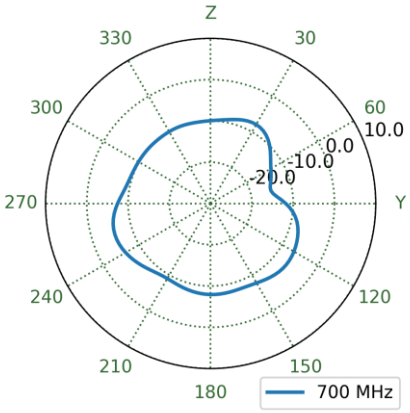
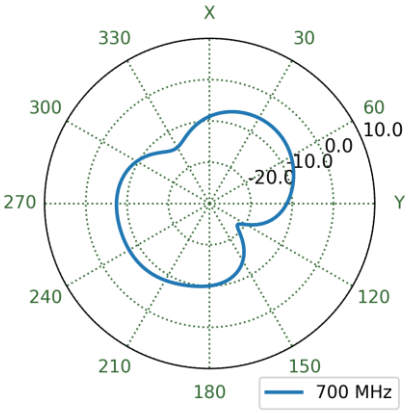


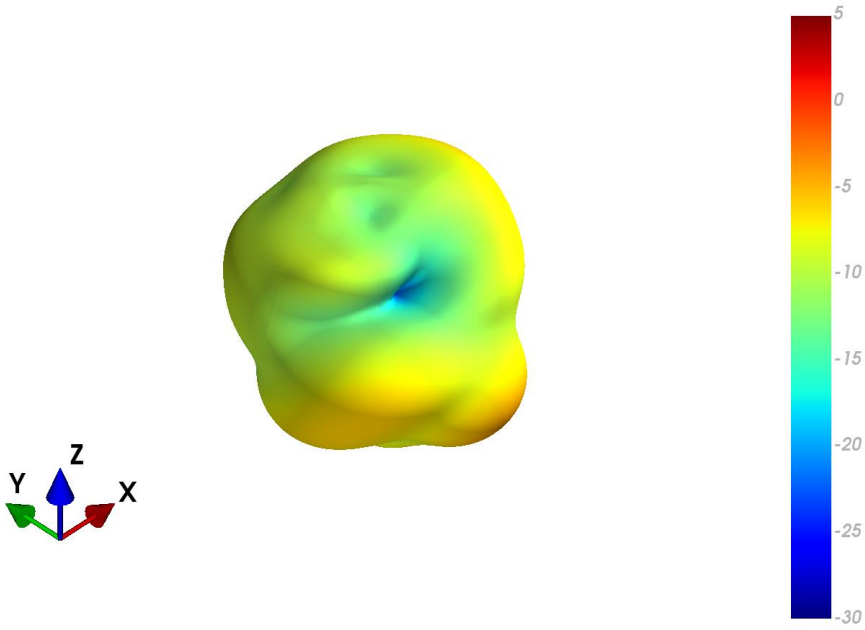
Figure 1 Chamber Setup

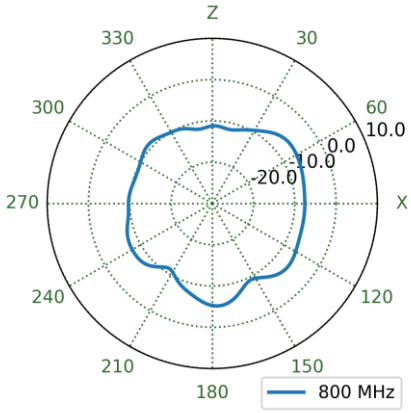
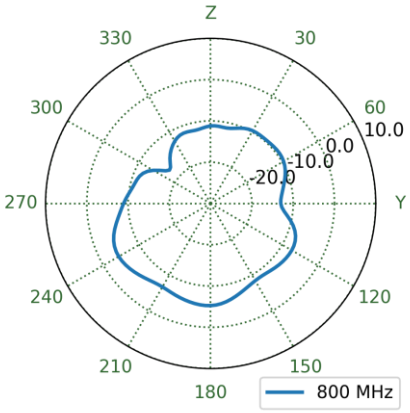
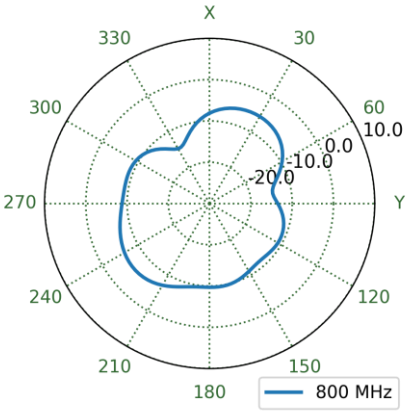
5.2 700MHz 3D and 2D Radiation Patterns



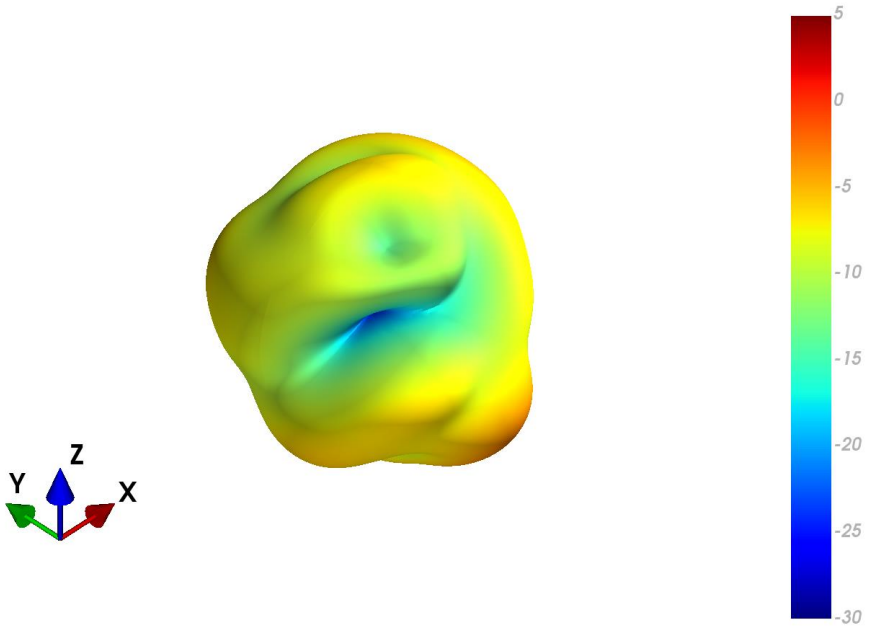
XZ Plane	YZ Plane	XY Plane
		

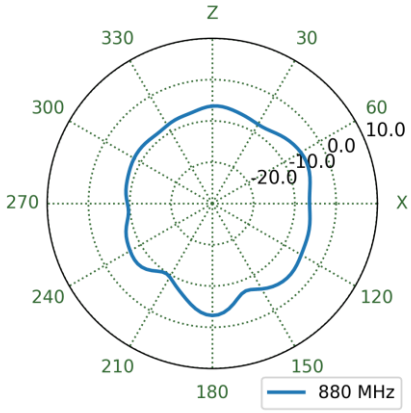
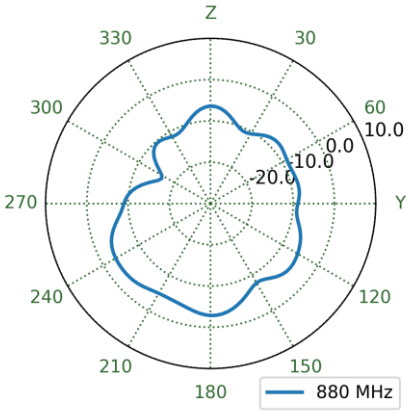
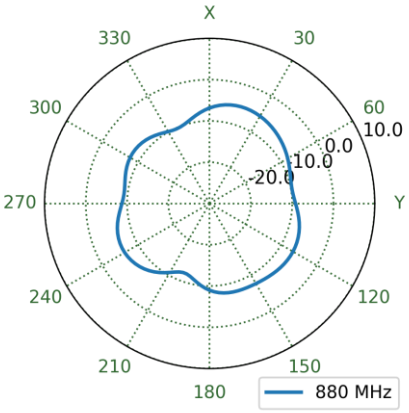
5.3 800MHz 3D and 2D Radiation Patterns



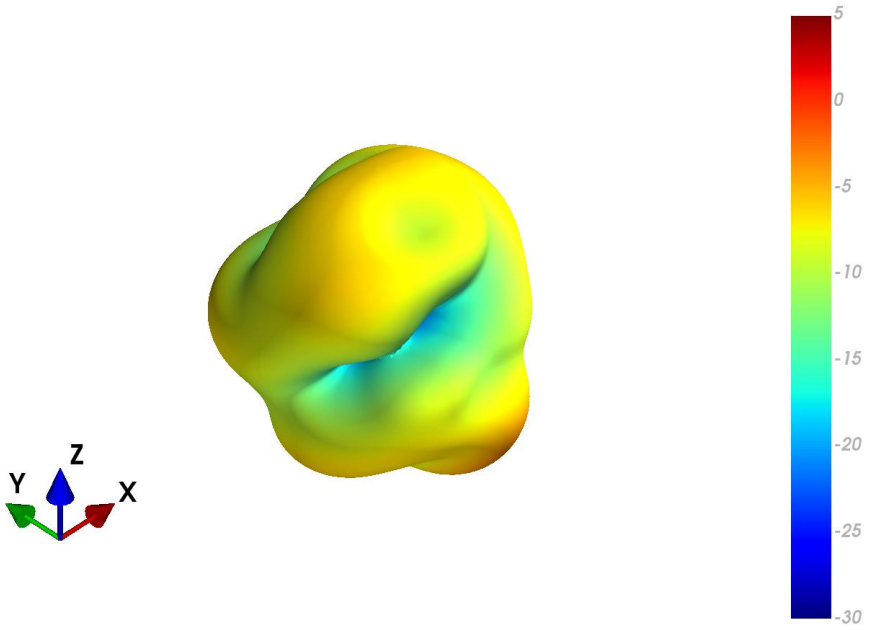
XZ Plane	YZ Plane	XY Plane
		

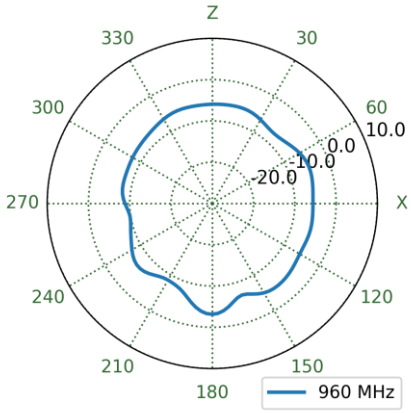
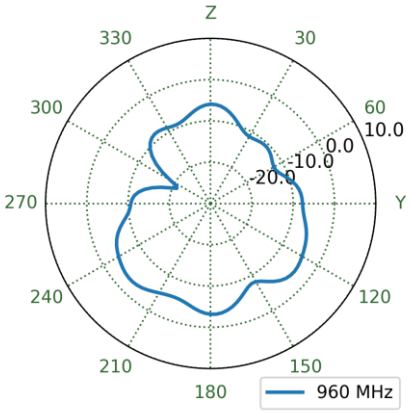
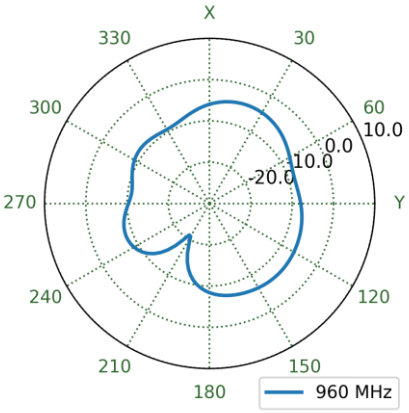
5.4 880MHz 3D and 2D Radiation Patterns



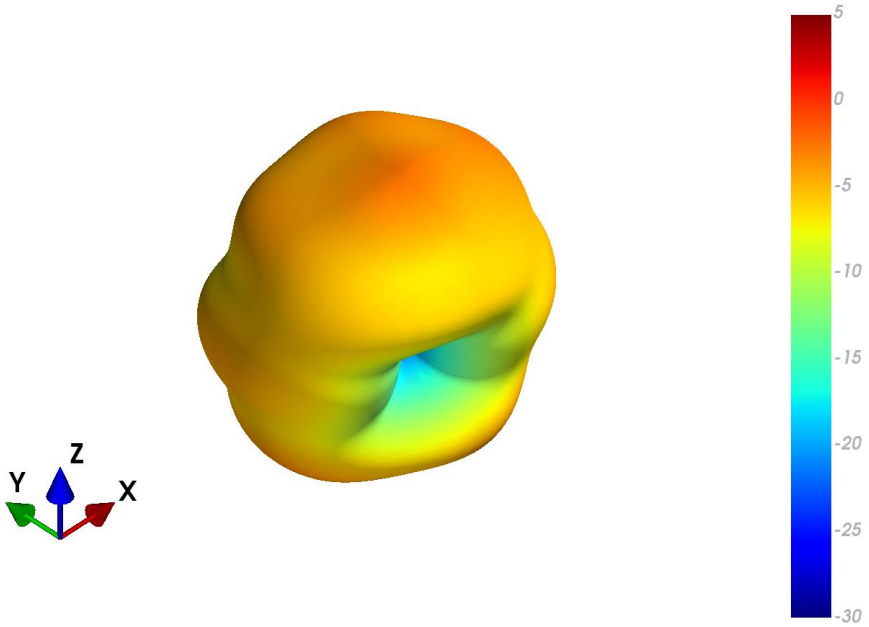
XZ Plane	YZ Plane	XY Plane
		

5.5 960MHz 3D and 2D Radiation Patterns

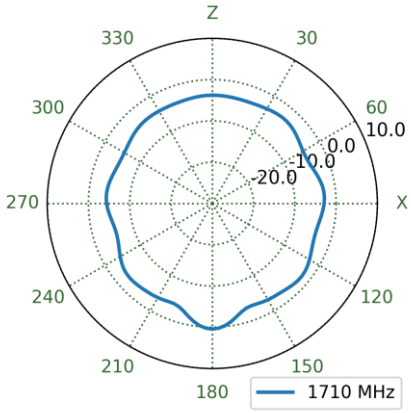


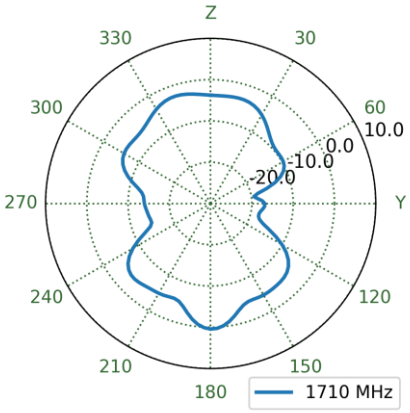
XZ Plane	YZ Plane	XY Plane
		

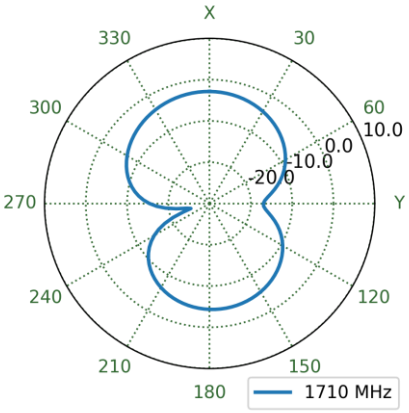
5.6 1710MHz 3D and 2D Radiation Patterns



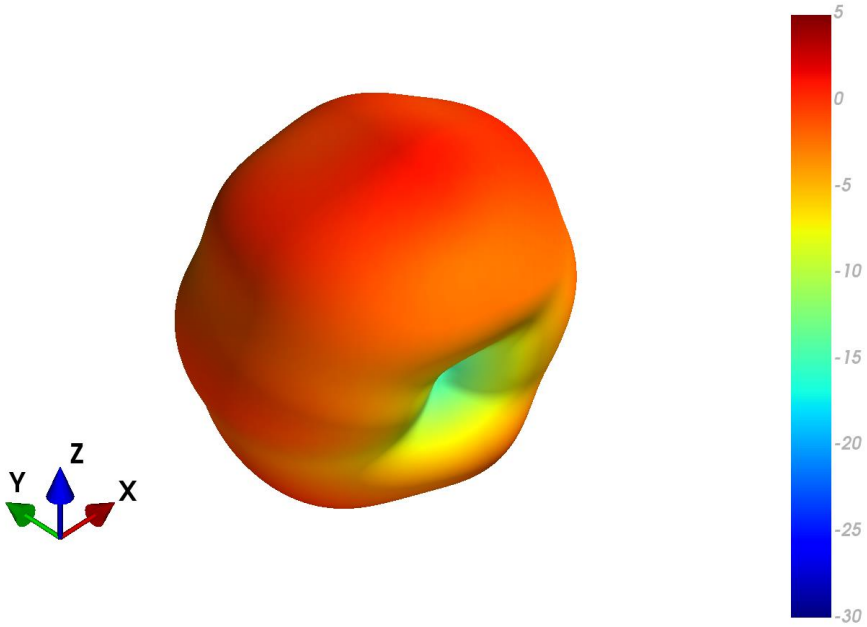
XZ Plane	YZ Plane	XY Plane



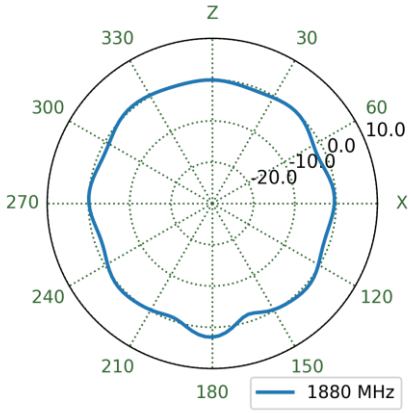


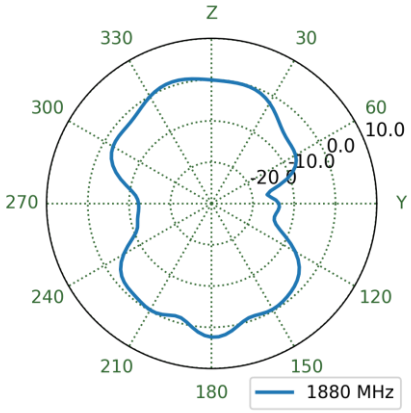


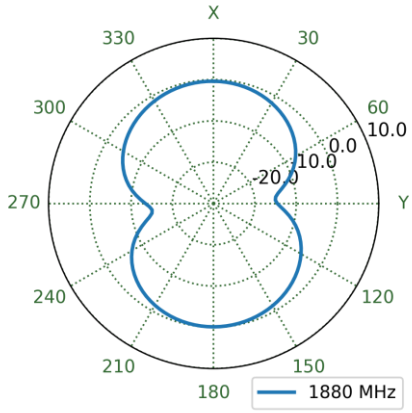
5.7 1880MHz 3D and 2D Radiation Patterns



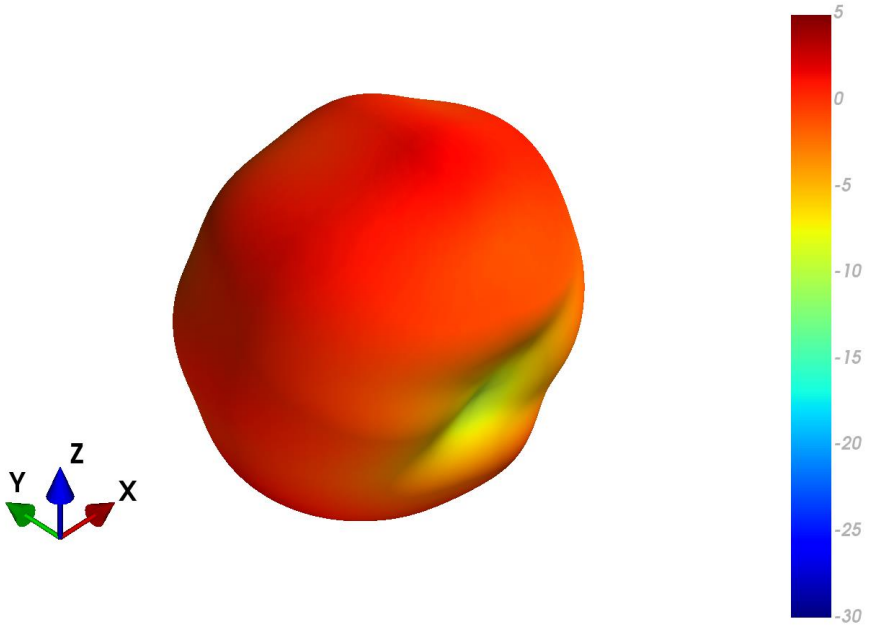
XZ Plane	YZ Plane	XY Plane

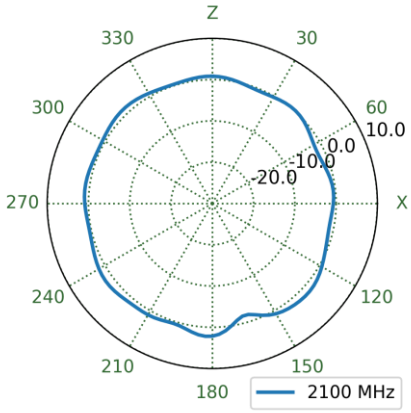
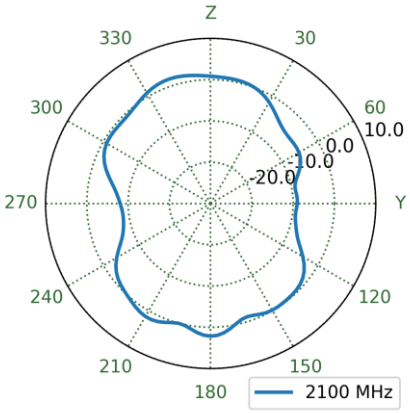
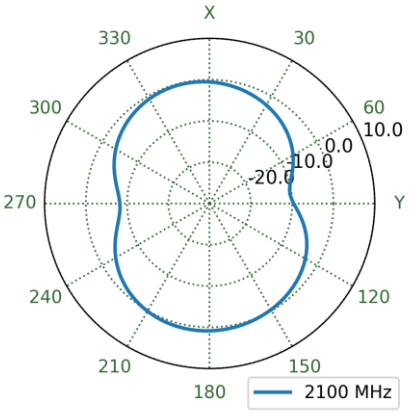




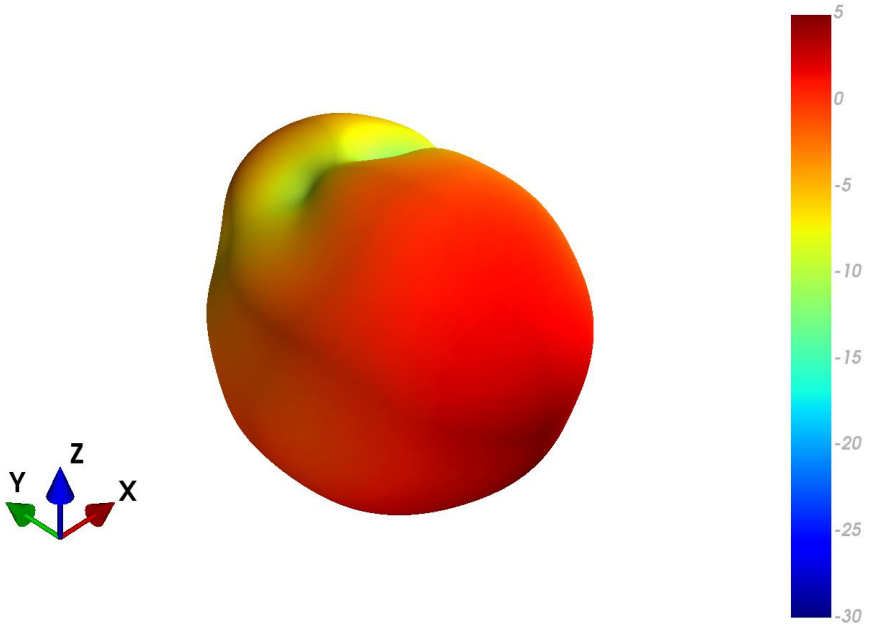


5.8 2100MHz 3D and 2D Radiation Patterns

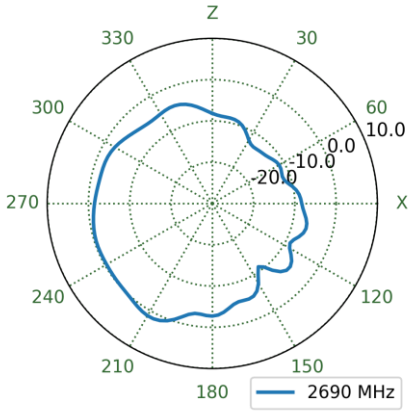


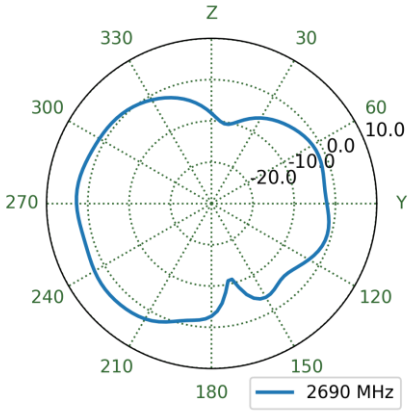
XZ Plane	YZ Plane	XY Plane
		

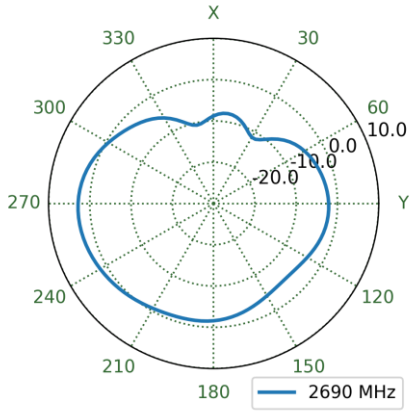
5.9 2690MHz 3D and 2D Radiation Patterns



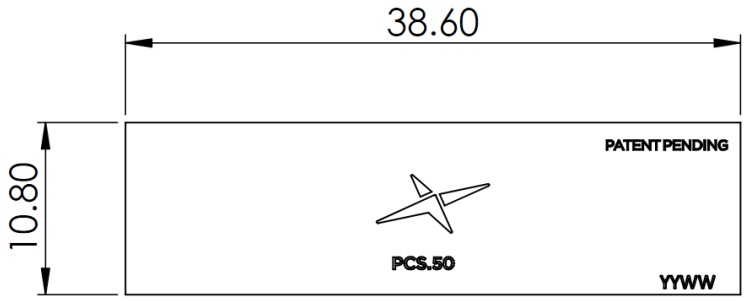
XZ Plane	YZ Plane	XY Plane



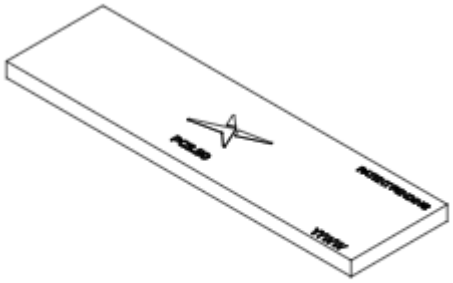




6. Mechanical Drawing (Units: mm)

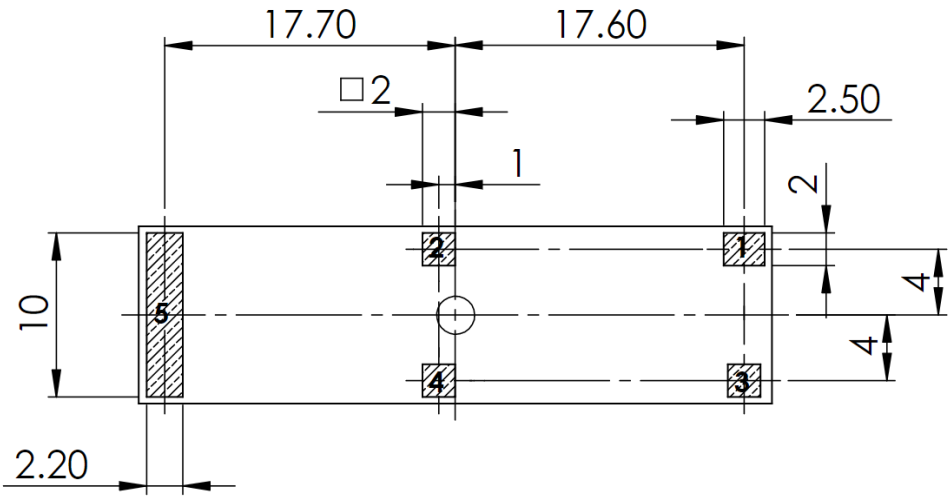


TOP VIEW



ISOMETRIC VIEW

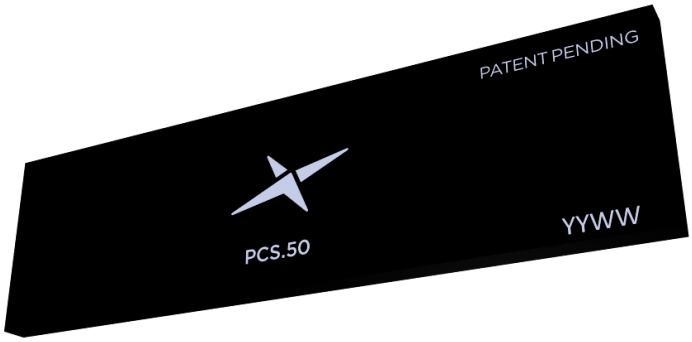
FRONT VIEW



PADS 2,3,4 THE SAME SIZE

BOTTOM VIEW

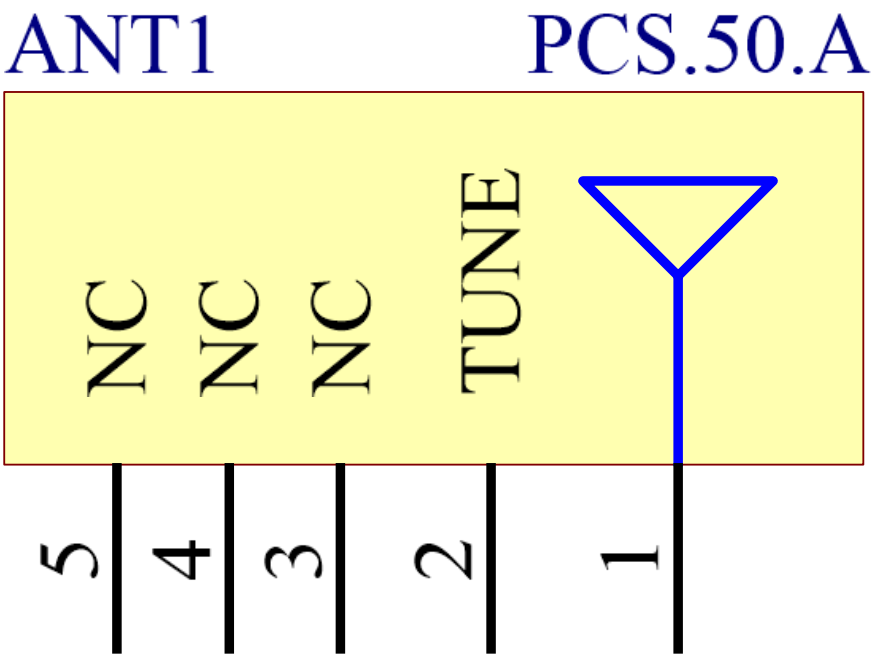
7. Antenna Integration Guide



7.1 Schematic Symbol and Pin 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



Please note you can download the design files, 3D model from the website here:

https://www.taoglas.com/product/universe-pcs-50-designed-for-iot-devices/

7.2 Antenna Integration

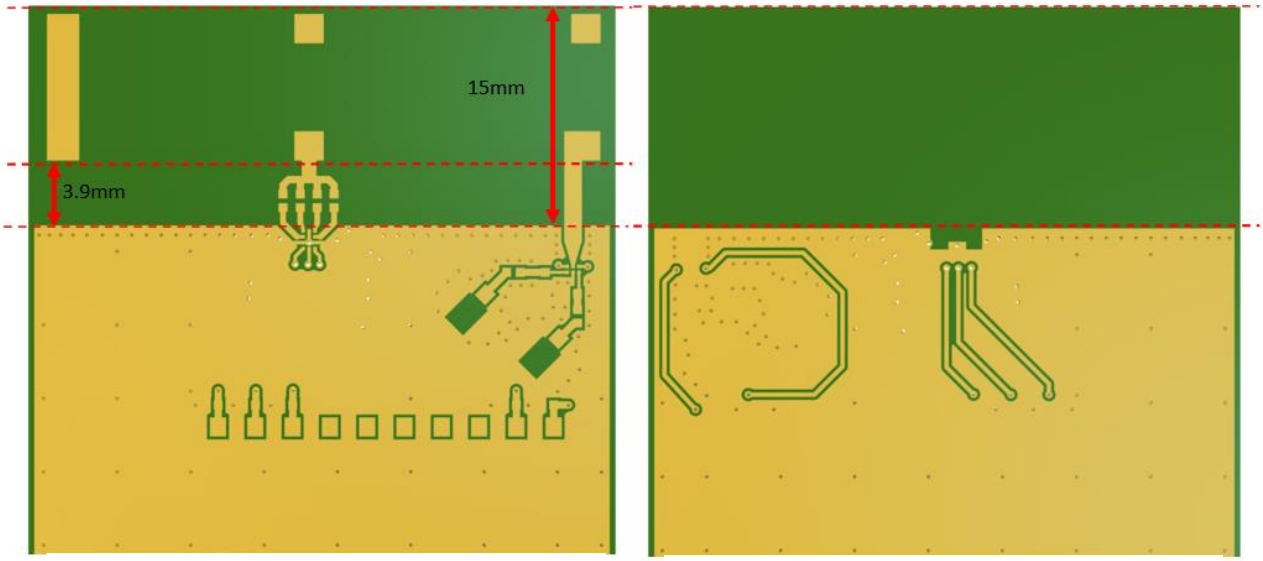
Depending on the size of the PCB, the antenna should ideally be placed on the PCB's shorter side, this will allow the antenna to take advantage of a longer ground plane.

PCSD.50.A with Solder Mask

PCSD.50.A without Solder Mask

7.3 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.

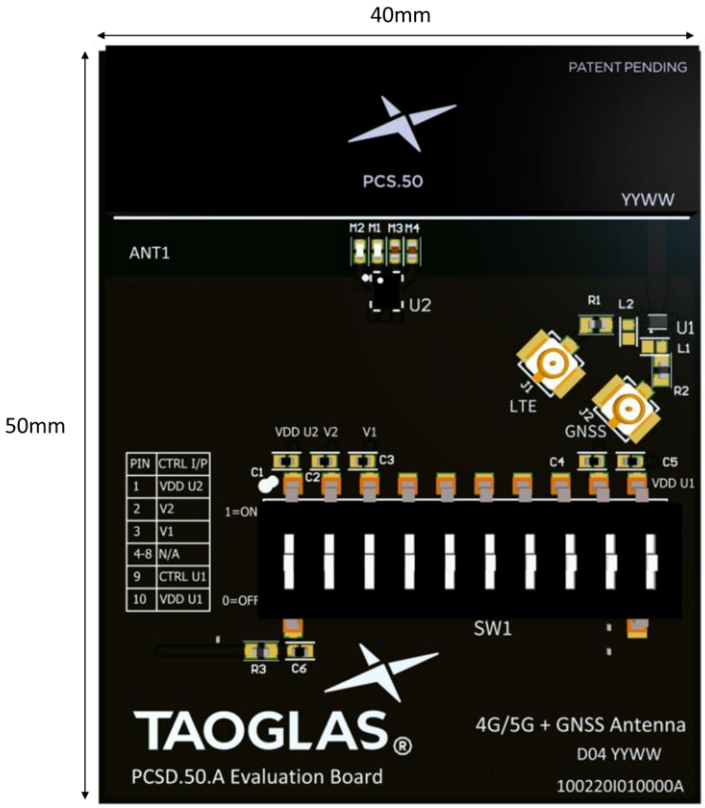


Top Side

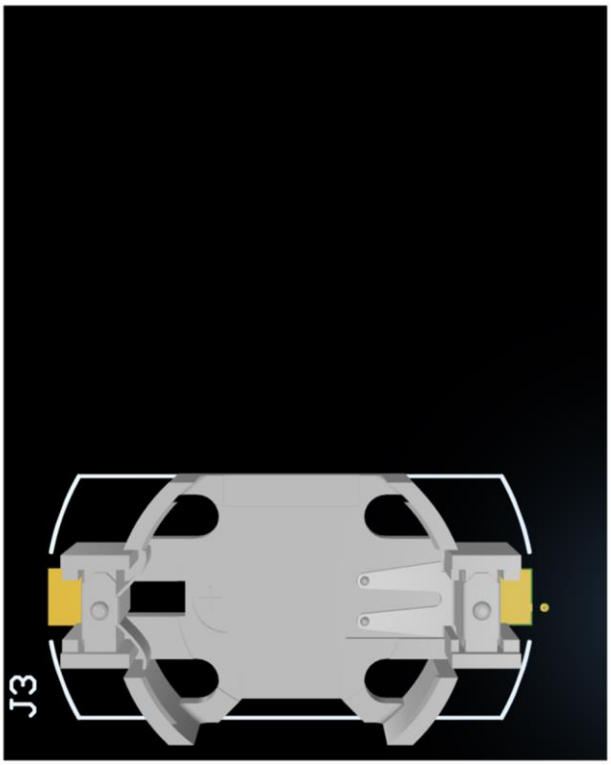
Bottom Side

7.4 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

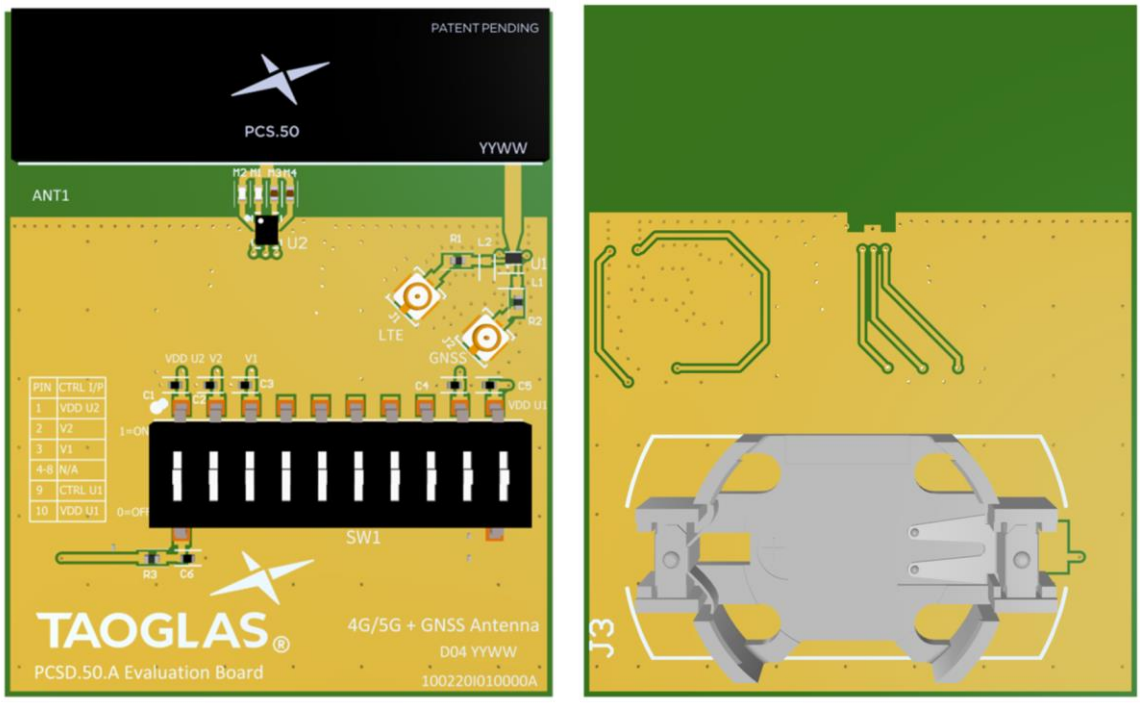


Bottom Side

7.6 Evaluation PCB Ground Plane Length

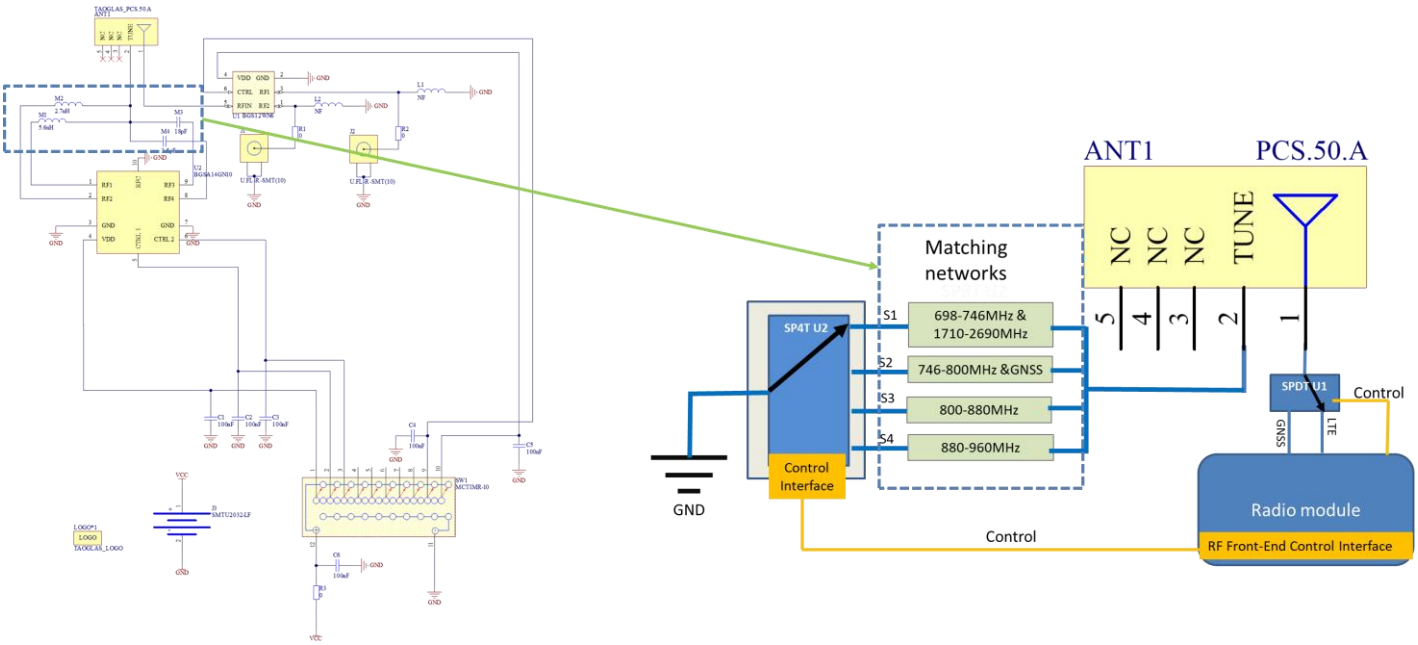
Shown below is the PCSD.50.A with solder mask removed to highlight the PCB ground plane length.

Ground Plane Length 35mm



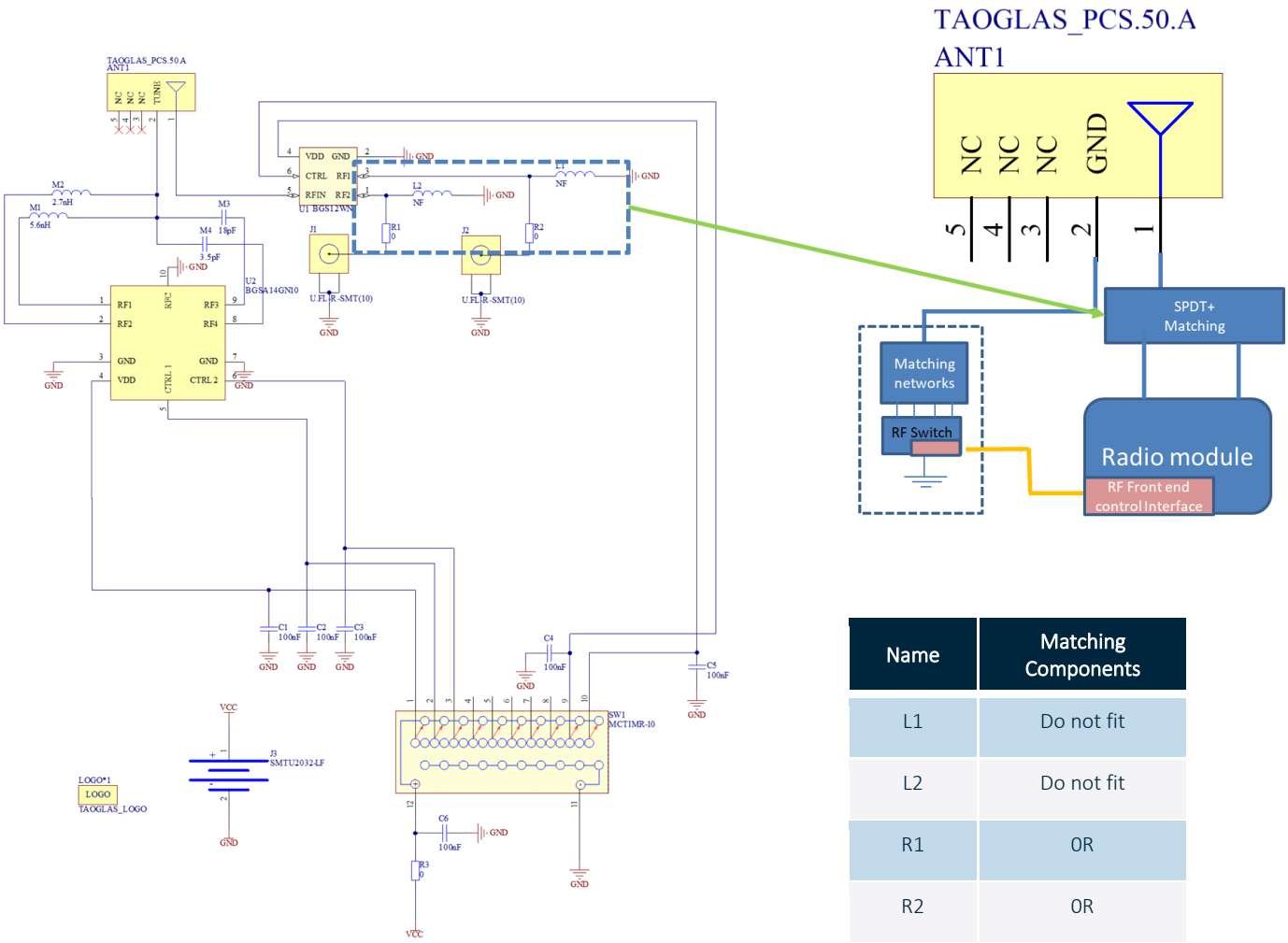
7.7 Antenna Matching Circuit (SP4T RF switch configuration)

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

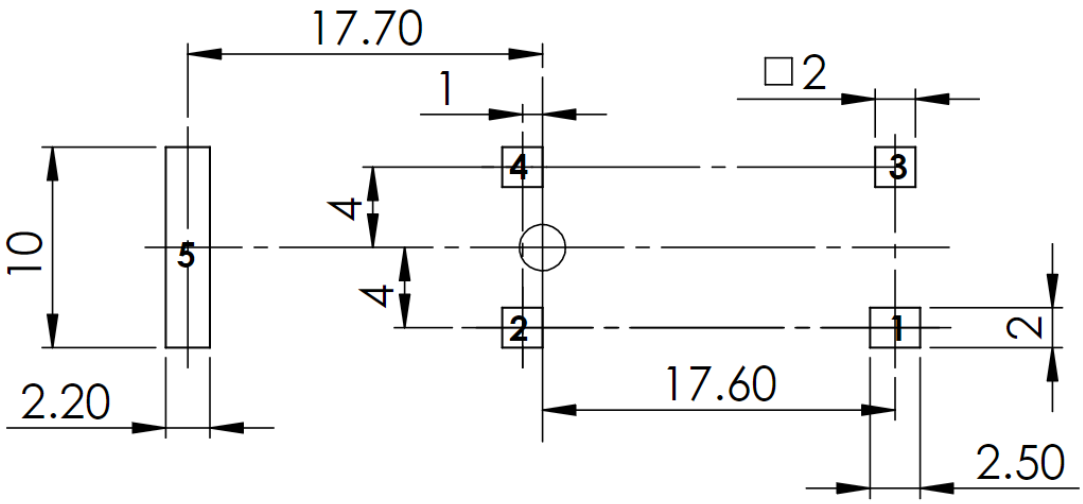
An additional matching circuit at the antenna feed side may be necessary for some applications to provide additional tuning options. Taoglas recommend incorporating extra component footprints, to form an ‘‘L’’ or “Pi” matching network between the antenna feed and the radio module. On the PCSD.50.A evaluation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



Name	Matching Components
L1	Do not fit
L2	Do not fit
R1	0R
R2	0R

7.8 PCS.50.A 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.



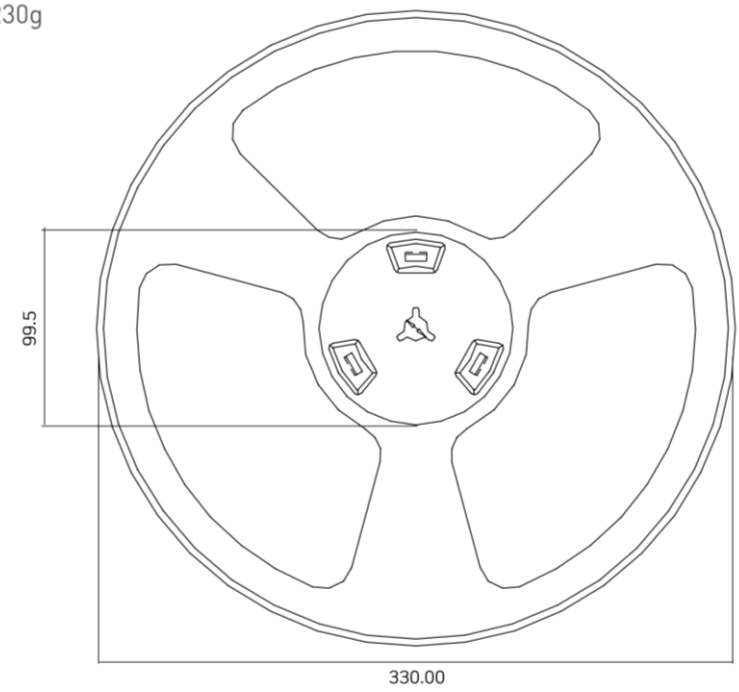
PADS 2,3,4 THE SAME SIZE

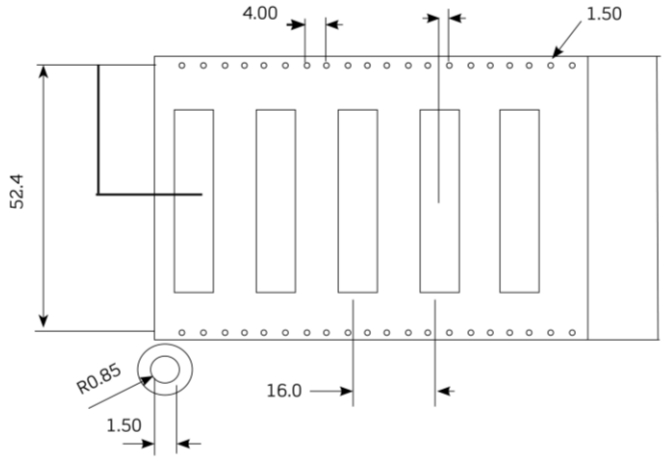
PCB FOOTPRINT

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

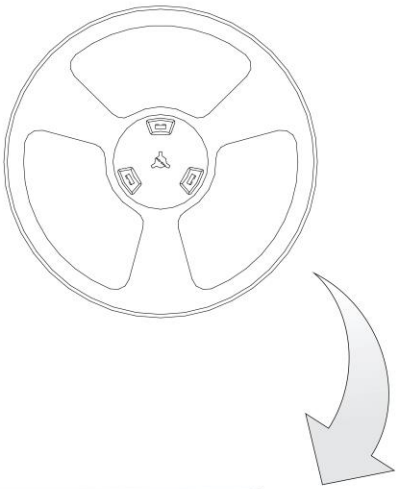
8. Packaging

1000 pc PCS.50.A per reel
Dimensions - Ø330*60mm
Weight - 3230g

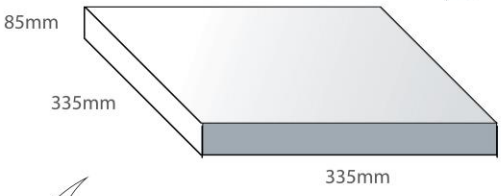




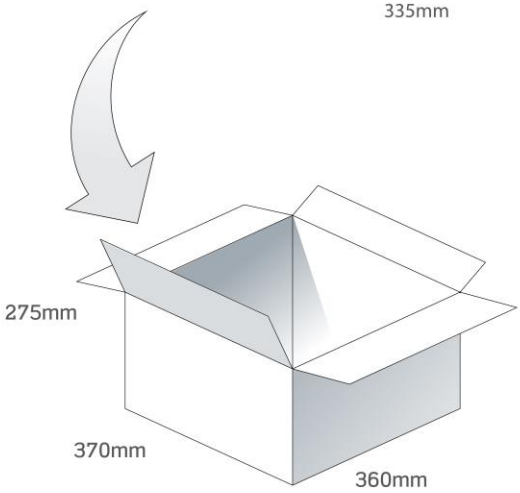
1000 pcs PCS.50.A reel
Dimensions - 330*330*60mm
Weight -3230g



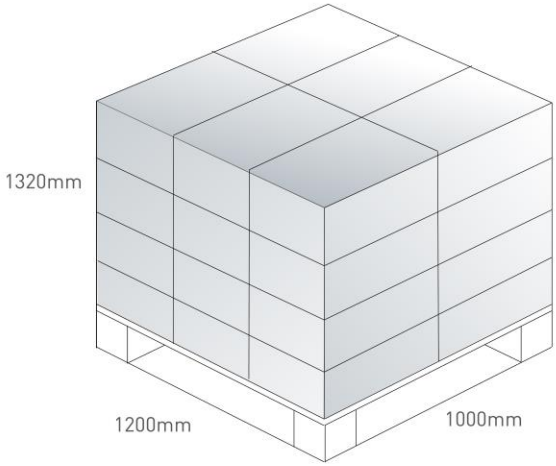
1000 pcs PCS.50.A / 1 Reel in small box
Dimensions - 335*335*85mm
Weight -3.5Kg



3 reels, 3000 pcs in one carton
Carton Dimensions - 370*360*275mm
Weight -11.3Kg



Pallet Dimensions 1200*1000*1320mm
24 Cartons per Pallet
6 Cartons per layer
4 Layers



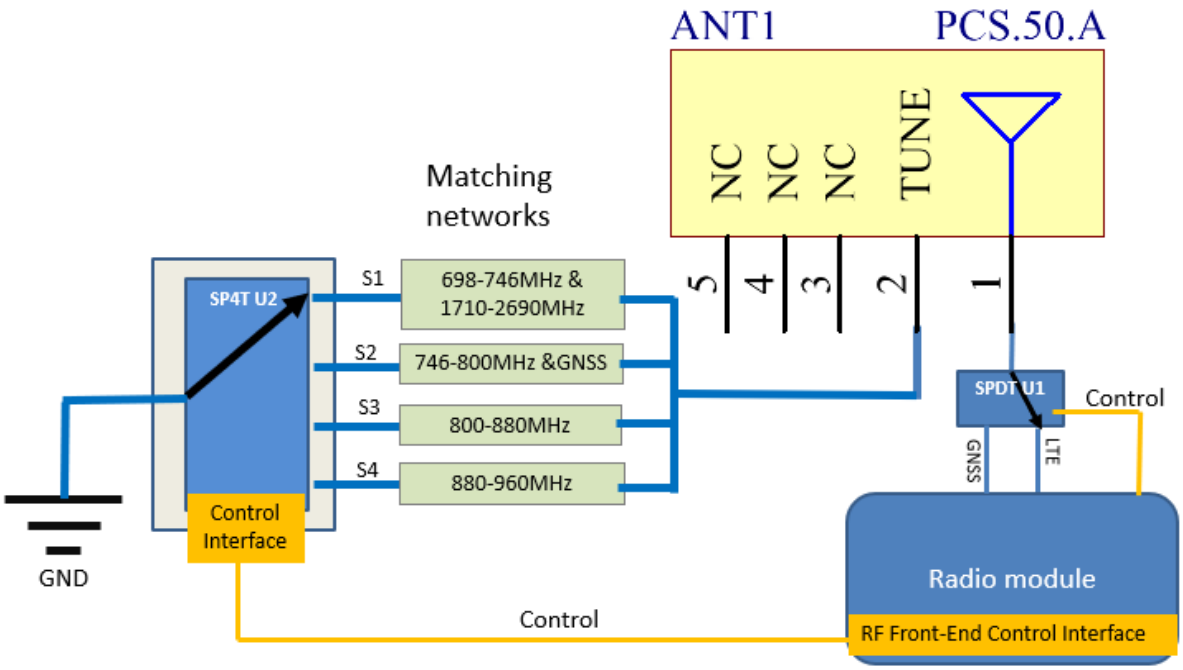
9. Application Note

9.1 Radio Module Selection for PCS.50.A

PCS.50.A is an active antenna solution that works together with a radio module creating a whole RF system. When using the PCS.50.A antenna as part of a design, a suitable radio module will need to be selected that can control a tuneable antenna solution. Typically, there are two types of radio modules that operate with a tuneable antenna solution:

- Radio module with GPIO interface
- Radio module with MIPI interface

Depending on the radio module selected the RF switch should also have the same interface. As an example, a radio module with a GPIO interface requires an RF switch with a GPIO interface.



9.2 PCS.50.A Integration Service

Taoglas offer integration services for this device please contact customer services or local sales for more support.

A mapping table will be generated during the integration service. The mapping table links the matching circuits with the frequency bands and RF states (one example is shown below). The mapping table will be programmed within the interface of the radio module. When the radio module selects the frequency band, it uses the RF switch to select the best matching circuits for that frequency corresponding to the mapping table.

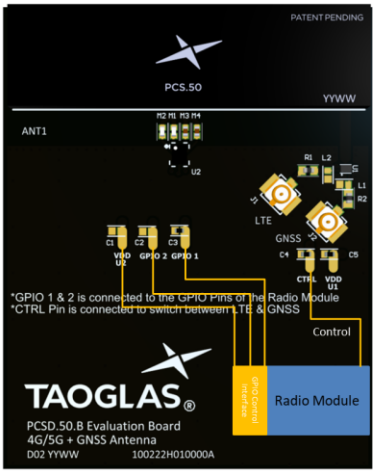
CTRL1=PIN2	CTRL2=PIN3	SP4T State	Matching Components	Frequency coverage
0	0	S1:M1-ANT	5.6nH, MLK1005S5N6ST000	698-746MHz &1710-2690MHz
0	1	S2:M2-ANT	2.7nH MLK1005S2N7ST000	746-800MHz &GNSS
1	0	S3:M3-ANT	18pF GRM1555C1H180JA01D	800-880MHz
1	1	S4:M4-ANT	3.5pF GJM1555C1H3R5BB01D	880-960MHz

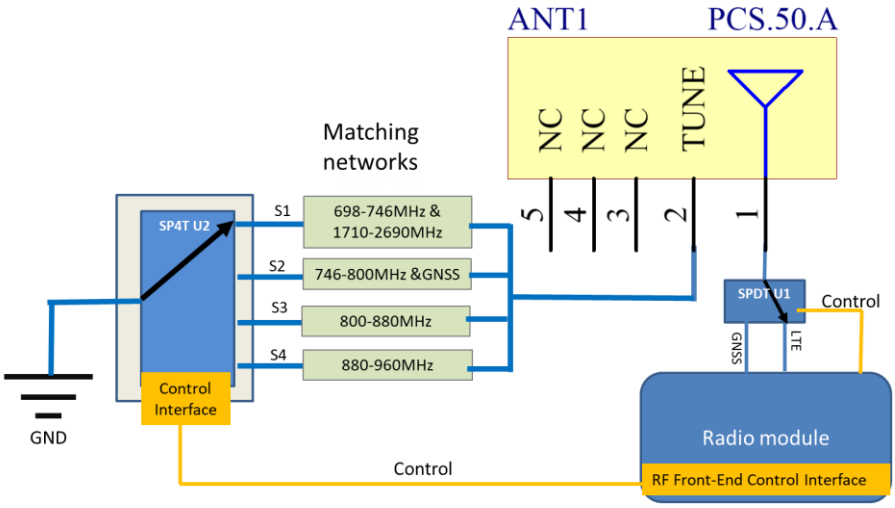
PCS.50.A covers both LTE and GNSS. An SPDT is used to choose between LTE and GNSS, if the customer only requires LTE, the SPDT can be removed from the circuit.

9.3 Antenna Integration PCB Template for PCS.50.A

Taoglas has pre designed an antenna integration PCB template to help with the PCS.50.A integration into our customers PCB which you can download from product page here.

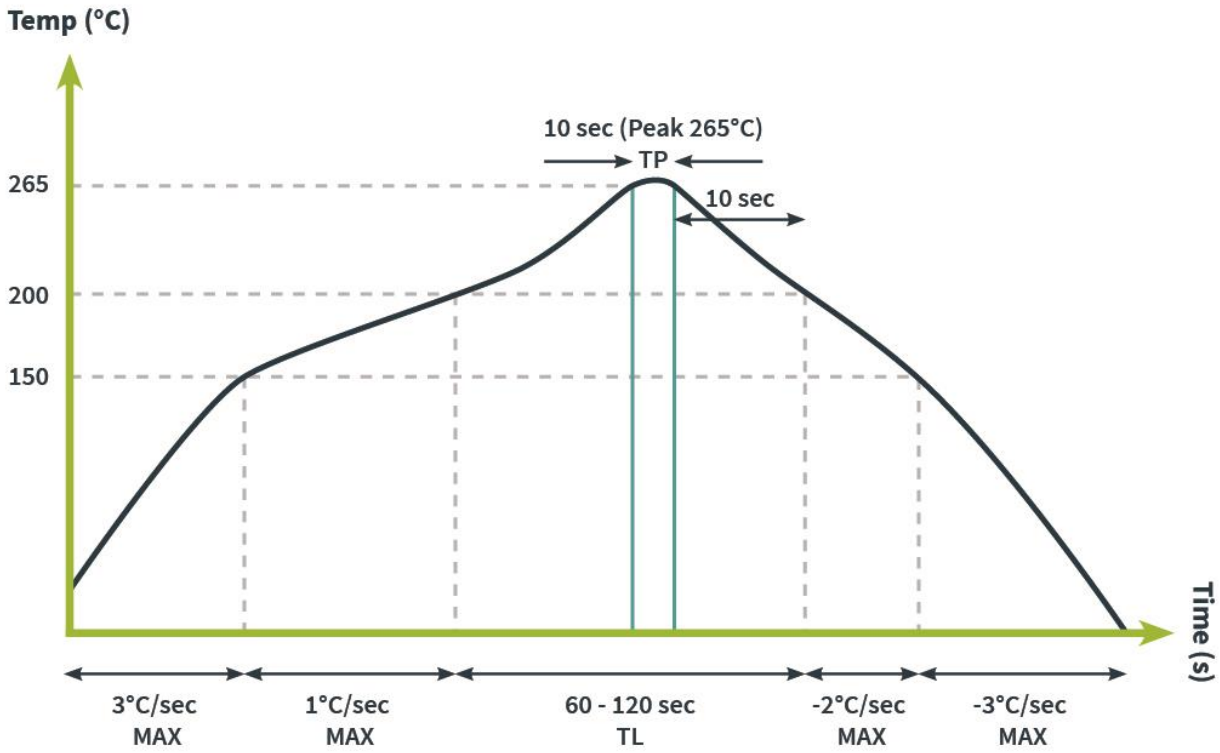
In the PCB template, The Antenna, foot print, RF switches are present. Customers just need to bring their design to the same PCB, and link up the VDD, GPIOs, RF port to the radio module and design the surrounding circuits. Customers are free to change the shape and dimensions of the ground plane (excluding the antenna clearance area) according to their application. The SPDT RF switch can be removed from the circuit if the GNSS is not required. For more information/support, please contact Taoglas customer services or local sales.





10. Solder Reflow Reccomendations

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



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

The PCS.50.A is not limited to the number of passes through the reflow process. Smaller components are typically mounted on the first pass, however, we do advise mounting the PCS.50.A when placing larger components on the board during subsequent reflows.

Changelog for the datasheet

SPE-21-8-119 – PCS.50.A

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

Previous Revisions

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