



Front



Back

DTAD.01.A.50

## Specification

Patent Pending

<b>Part No.</b>	<b>DTAD.01.A.50</b>
<b>Product Name</b>	Compact Evaluation Boards for Evolution DTA.01.A Digital Tunable Antenna for 3G and 4G Cellular Applications
<b>Feature</b>	<ul style="list-style-type: none"> <li>Complete Reference Design</li> <li>Increases antenna efficiency from ~7% to ~28%</li> <li>Perfect for smaller ground plane sizes down to 50x45 mm</li> <li>Enables better transmission and reception for 3G and 4G</li> <li>USB interface</li> <li>SMA(F) Connector for Antenna Measurement</li> <li>RoHS Compliant</li> </ul>

## 1. Introduction

The DTAD.01.A.50 is an evaluation board for Taoglas new patent pending series of Evolution DTA tunable antennas.

DTA antennas deliver higher efficiency on smaller ground-plane than traditional passive antennas, enabling a new miniaturized generation of high performance wireless devices.

Typical applications would be 3G On Board Diagnostic (OBDII) Devices in automotive, medical telemetry devices, 4G dongles, access points and routers.

The board contains a surface-mount ceramic antenna DTA.01, a tunable capacitor PE64102 DuNET™ (32 state capacitance) from Peregrine Semiconductor and a matching circuit. Via a USB connection to the board, the antenna frequency response is shifted via a command from a PC with Peregrine supplied software and driver.

The antenna parameters itself can be measured via the on-board SMA connector.

A new generation of M2M devices with as little as a 50mm ground-plane in length can now achieve wide frequency coverage and higher data rates with bandwidth beating any passive antenna in the market with the same footprint and volume.

The DTAD.01.A.50 board (60.50x45mm) with ground plane size of 50x45 mm can perform efficiently at a bandwidth from 698-960 MHz and from 1710-2170 MHz, covering all worldwide cellular 3G/4G bands in a tiny form factor. In combination with your device's microprocessor it has the ability to dynamically improve the efficiency of a given antenna band in real time.

Using a combination of the DTA.01 and the PE64102 we can cover the entire

bandwidth for 3G and 4G cellular bands. Using the State 03 (2.58 pF) we can cover the 700/850/1800/1900 and 2100 MHz Band only and with the State 13 (6.52) pF we can cover a penta-band solution 850/900/1800/1900 and 2100 MHz.

The optimal states will change depending on the ground-plane, device's board and mechanical environment.

Please download the Peregrine's full set of support information. See our full links in the appendix at the end of the document.

The DTAD01 board with a ground plane of 50x45 mm has not been designed with the intention of passing the cellular carrier's minimum requirements. The integration is to achieve the maximum performance possible in the smallest form factor.

## 2. Specification

### Electrical

State	State 03 (2.58pF)			State 13 (6.52pF)		
	700	850	900	1800	1900	2100
<b>Band (MHz)</b>	700	850	900	1800	1900	2100
<b>Return Loss (dB)</b>	-7	-11	-11	-13	-14	-8
<b>Efficiency (%)</b>	26	28	27	60	55	48
<b>Average Gain (dB)</b>	-5.5	-5.3	-5.4	-2.2	-2.8	-2.9
<b>Peak Gain (dBi)</b>	1.3	1.8	1.8	2.5	2.5	2.2
<b>Impedance</b>	50Ω					
<b>Ground Size</b>	50x45 mm					
<b>Board Size</b>	60.50x45 mm					
<b>Radiation Pattern</b>	Omni-Directional					
<b>Input Power</b>	26 dBm max					

### Mechanical

<b>Antenna Dimension</b>	40x6x5 mm
<b>Board Dimension</b>	60.50x45x1.57 mm
<b>Weight</b>	20 g
<b>Connector</b>	SMA-Female

\* Based 50x45 mm ground plane size, on State 03 and State 13 respectively.

### 3. Antenna Setup



Figure 1. Impedance Test

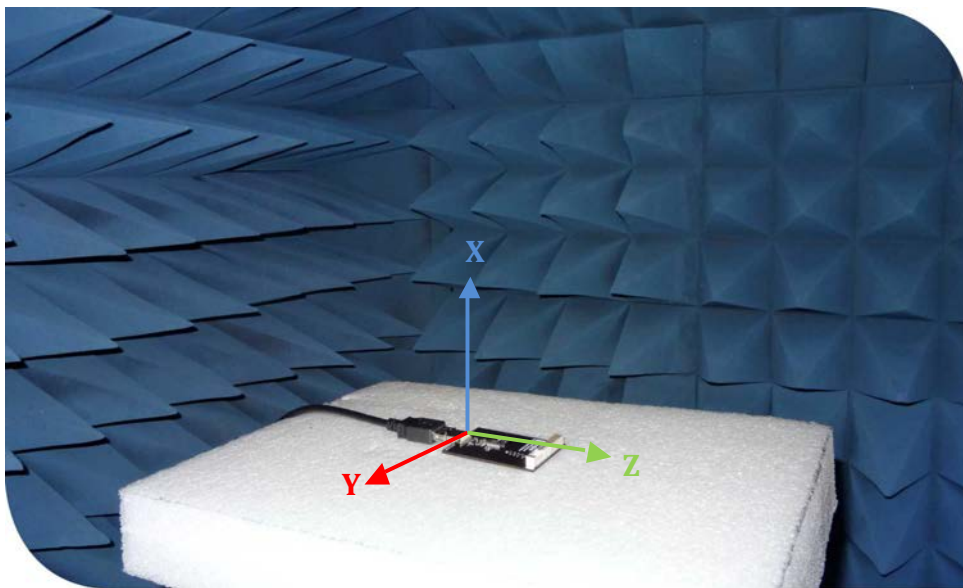


Figure 2. Over the air test

## 4. Antenna Parameters

### 4.1 Return Loss



Figure 3. Return Loss of DTA.01

### 4.2 Efficiency

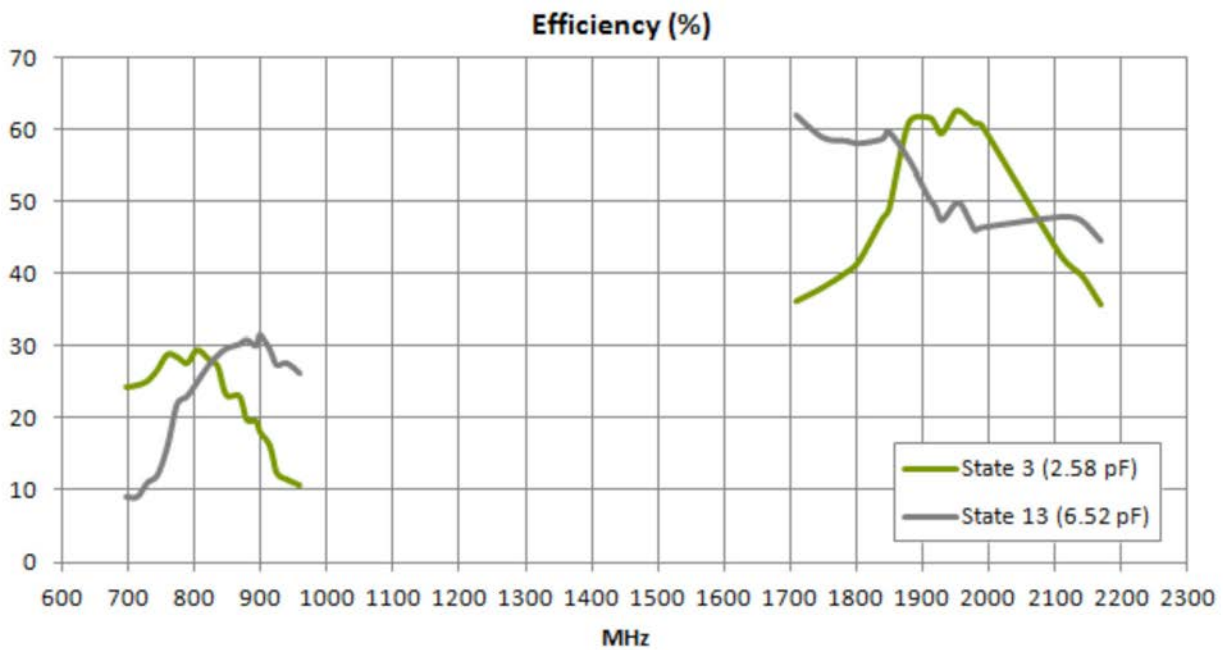


Figure 4. Efficiency of the DTA.01 Antenna

### 4.3 Peak Gain

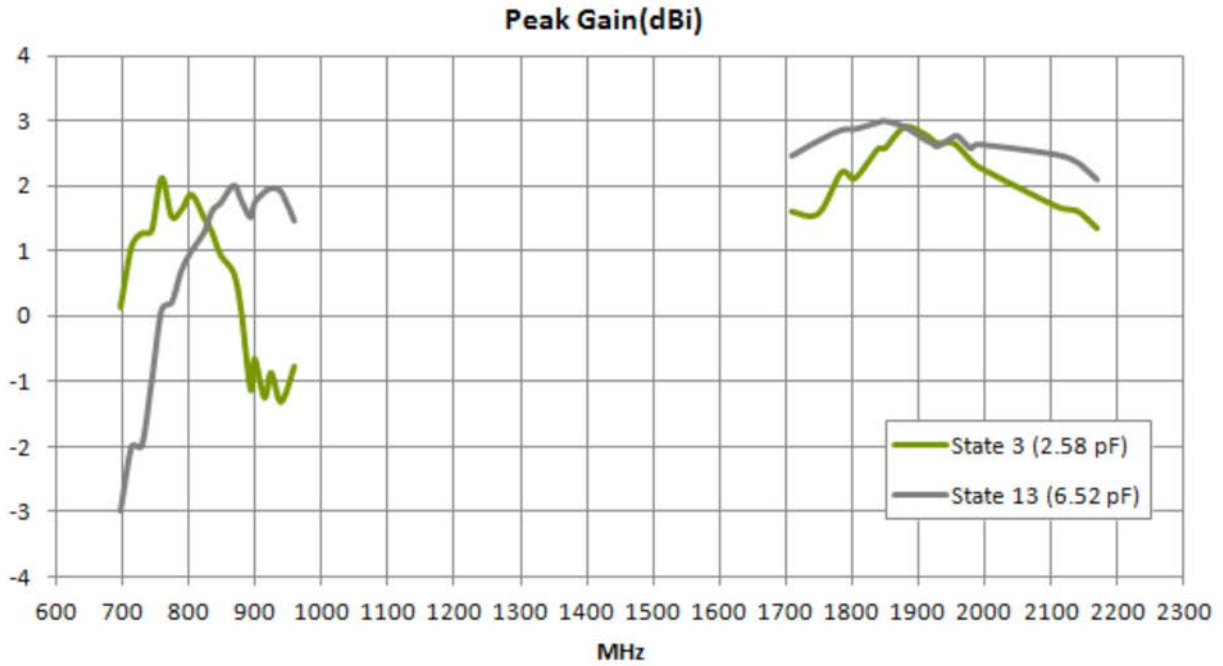


Figure 5. Peak Gain of DTA.01 Antenna

### 4.4 Average Gain

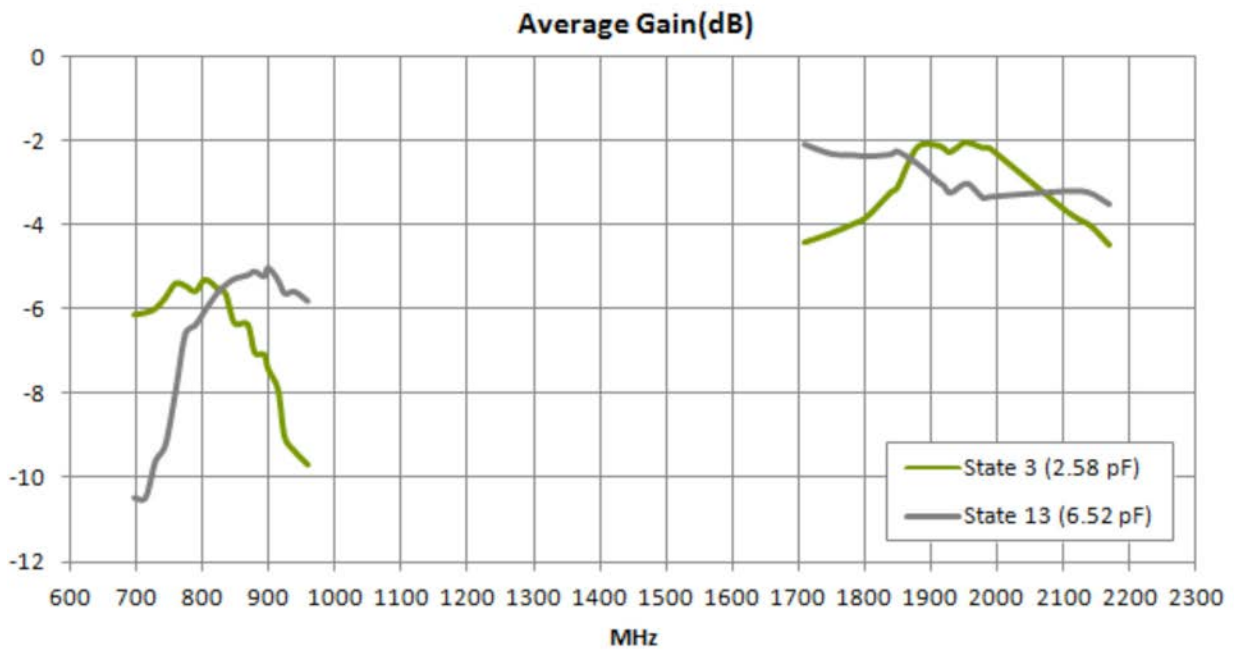


Figure 6. Average Gain of DTA.01 Antenna

## 5. Comparison Performance

### 5.1 Return Loss (dB)

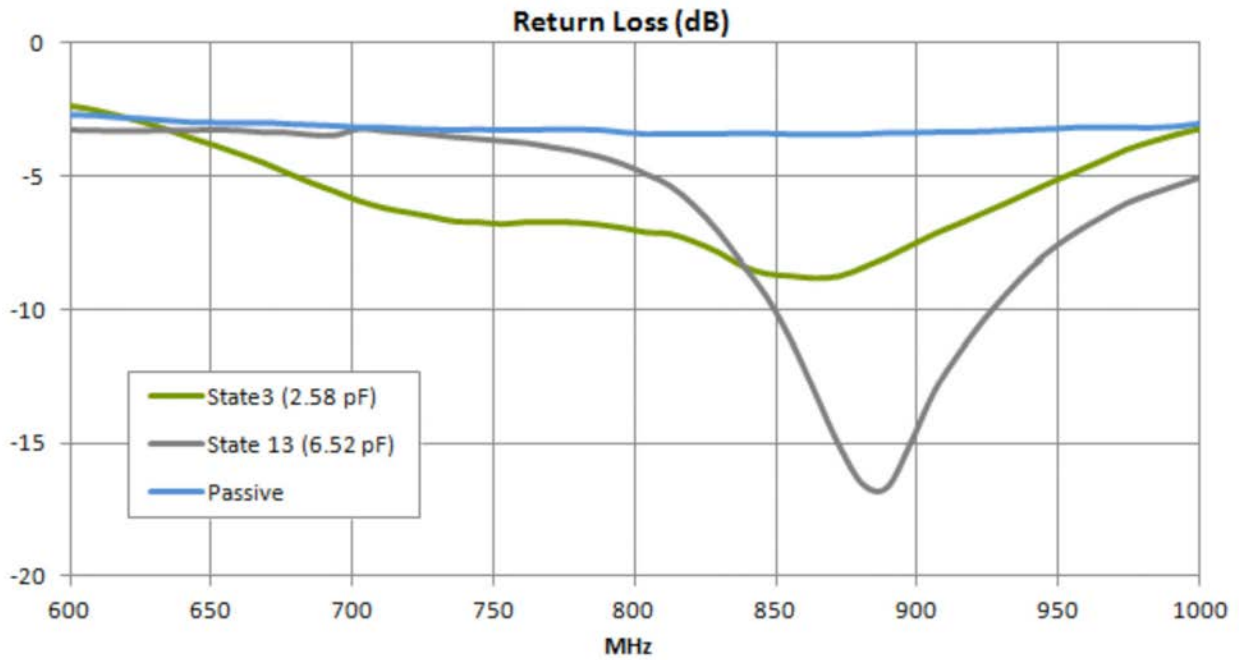


Figure 7. Return Loss Comparison of DTA.01 vs. PA.710 Antenna

### 5.2 Efficiency (%)

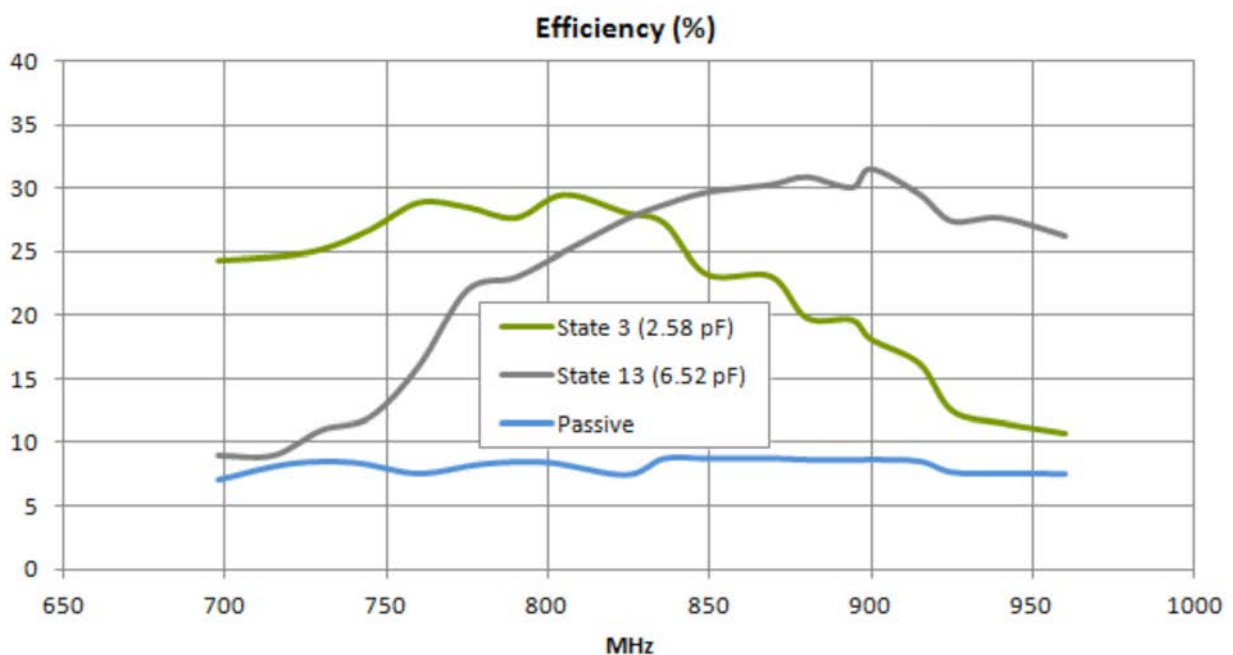


Figure 8. Return Loss Comparison of DTA.01 vs. PA.710 Antenna

## 6. Antenna Radiation Patterns

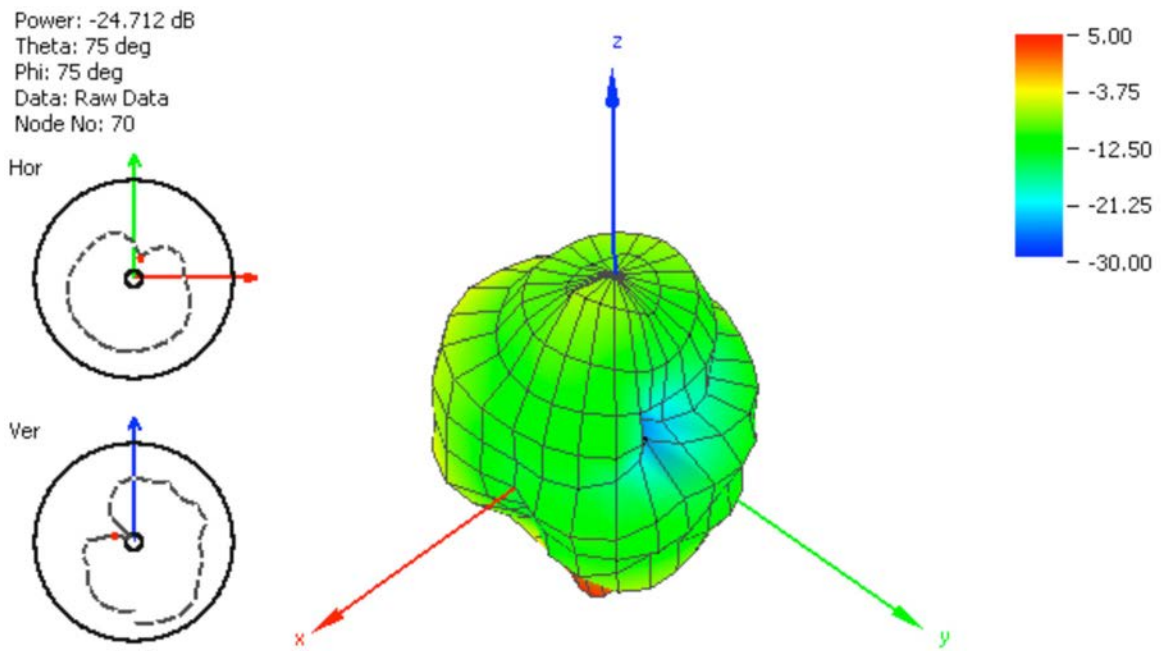


Figure 9. Radiation Pattern at 750 MHz, State 3.

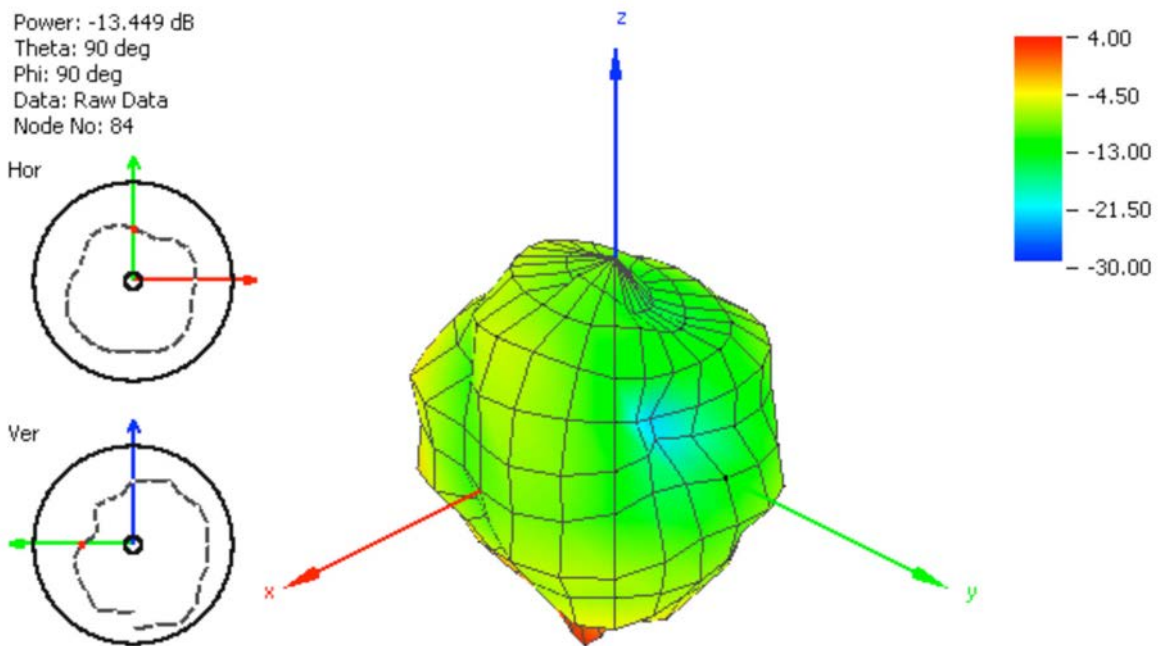


Figure 10. Radiation Pattern at 849 MHz, State 13.



## 6. Antenna Radiation Patterns

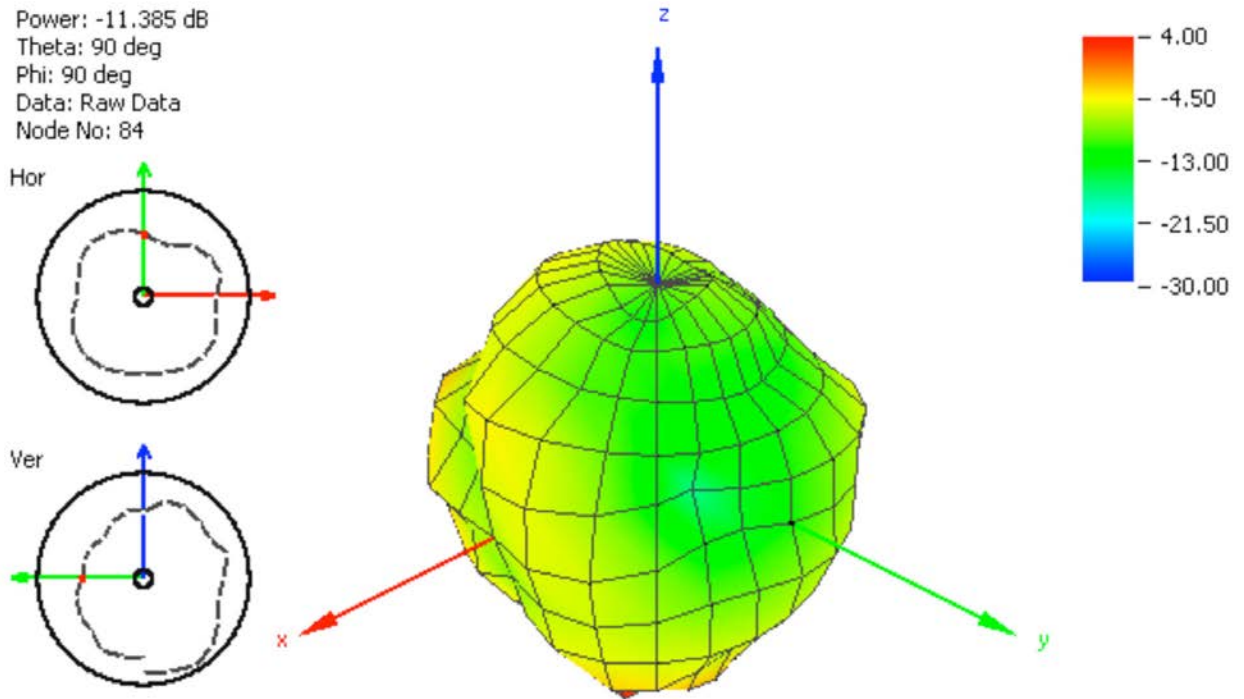


Figure 11. Radiation Pattern at 915 MHz, State 13.

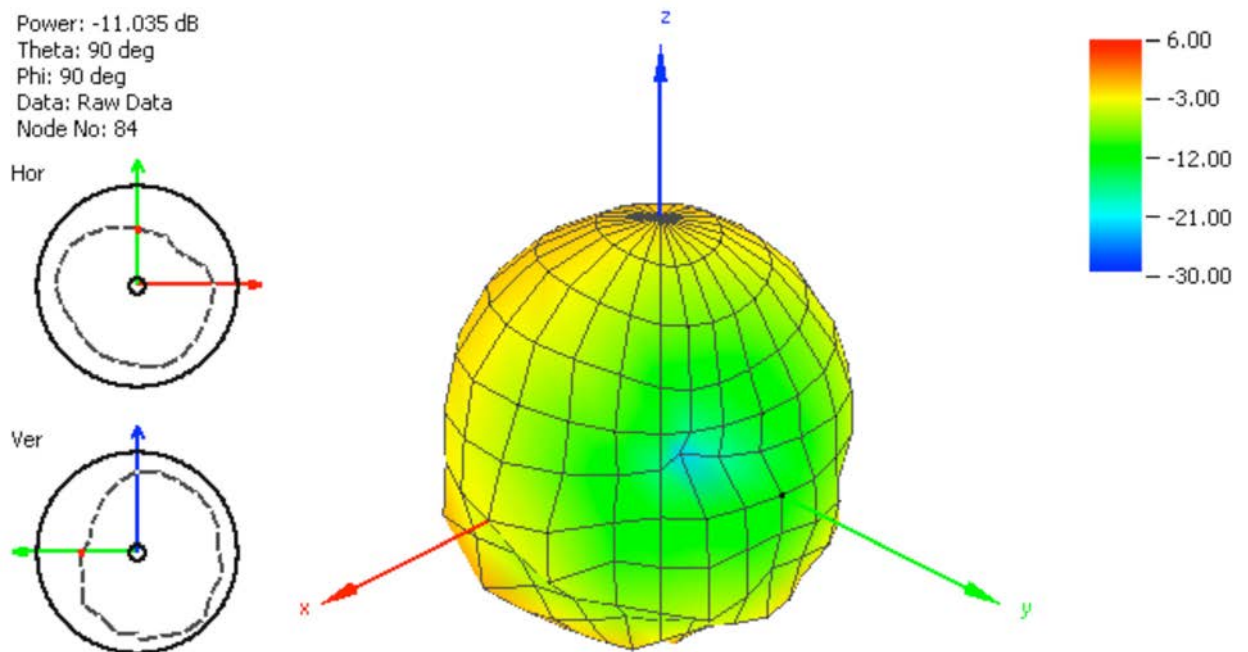


Figure 12. Radiation Pattern at 1850 MHz, State 13.

## 6. Antenna Radiation Patterns

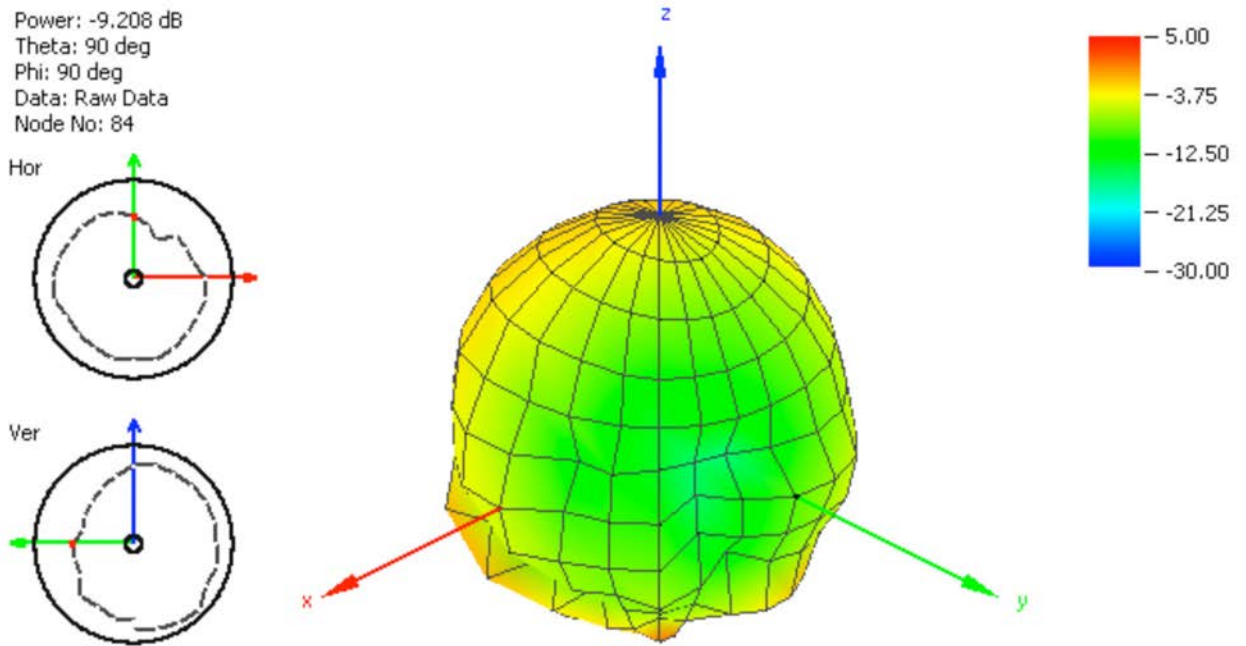


Figure 13. Radiation Pattern at 1950 MHz, State 13.

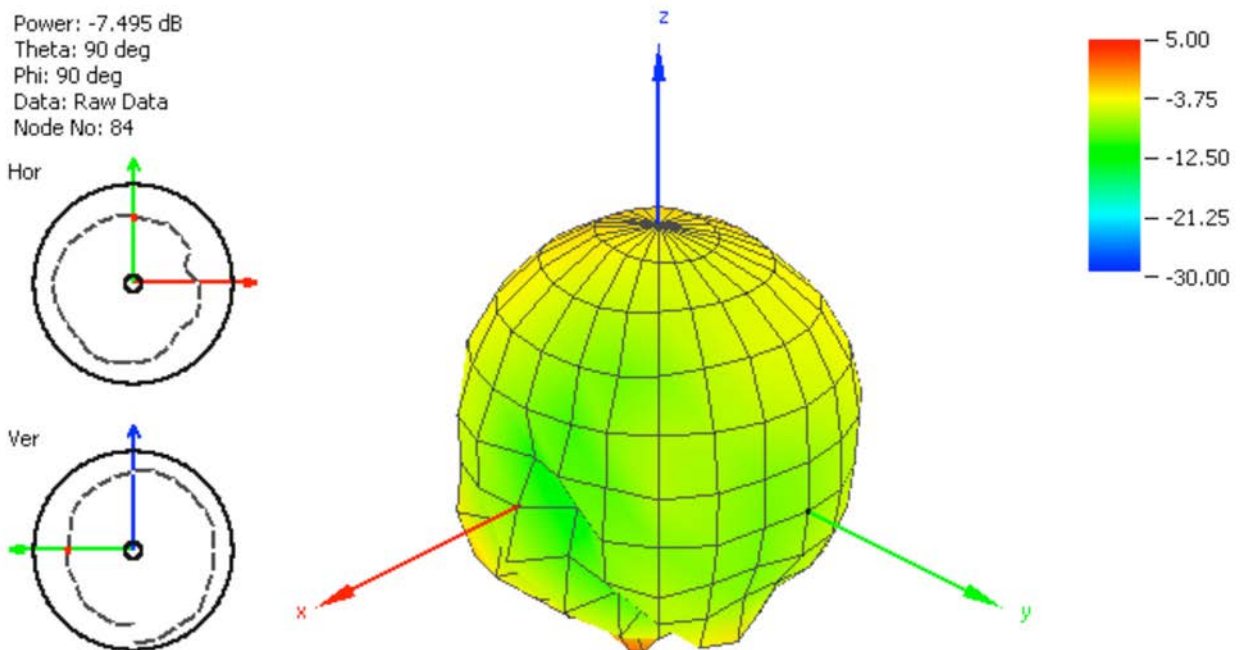


Figure 14. Radiation Pattern at 2140 MHz, State 13.

## 7. Matching Circuit

The antenna matching for a ground plane of 50x50 mm is a combination of capacitors and inductors as follows;

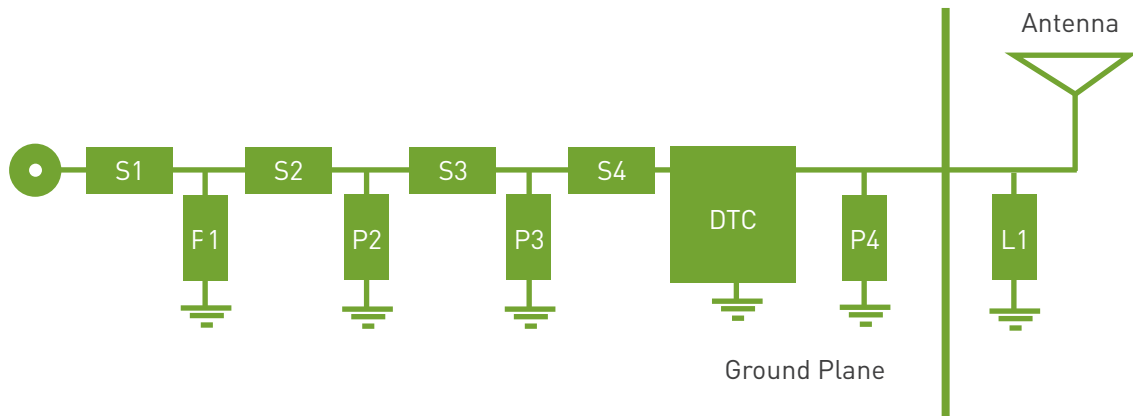


Figure 15. Antenna Matching

### Inductor Outside of Ground Plane

L1= reserved for later use if required

#### Series Elements

S1 = 0 Ohm, S2 = 10 pF, S3 = 0.5 nH, S4 = 0.5 nH,

#### Parallel Elements

P1 = 47 nH, P2 = 6.2 nH, P3 = 1 pF, P4 = 3.9nH

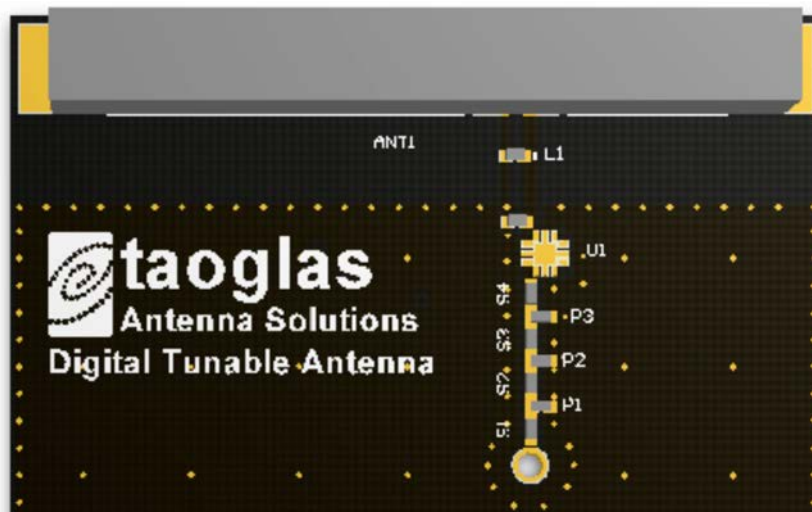
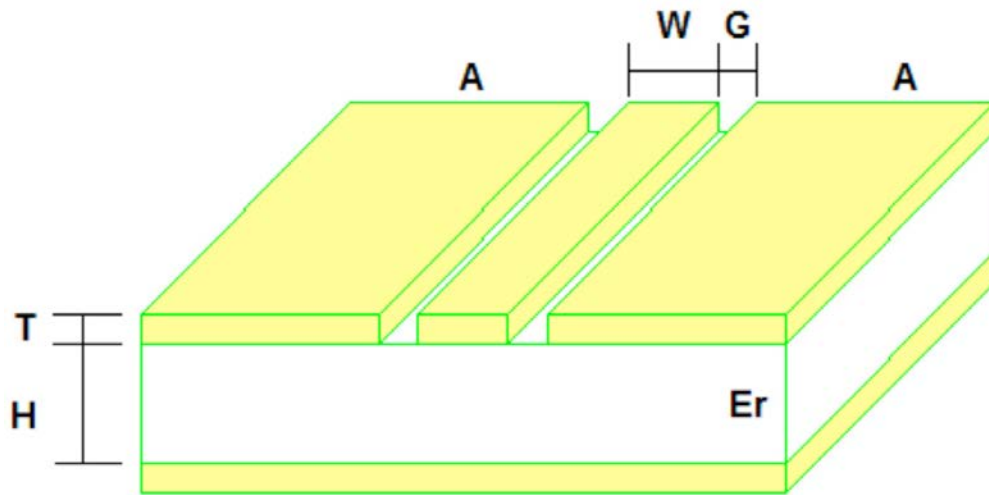


Figure 16. Lumped Component Spaces

## 8. Transmission Line



**Figure 17.** Co-Planar Waveguide

Follow the below transmission line dimensions for optimal performance.

### Dimensions

**W** = 0.8 mm, **G** = 0.3 mm, **H** = 21 mils, **T** = 0.36 mm

### Dielectric Constant

**Er** = 4.4

The dimension of the ground aside of the signal track (A), must be at least 3 times the width (W). For those cases where the transmission line have to be curved, bent or close to the board's edge, the 3xW relation

to each side of the signal track needs to be followed.

In order to maintain the proposed Co-Planar Waveguide (CPW) design,

the height from first middle layer (ground) to the top layer, must be 21 mils +/- 10%.

The computation of the above values gives an impedance of 49.83 ohms.

## 9. Drawings

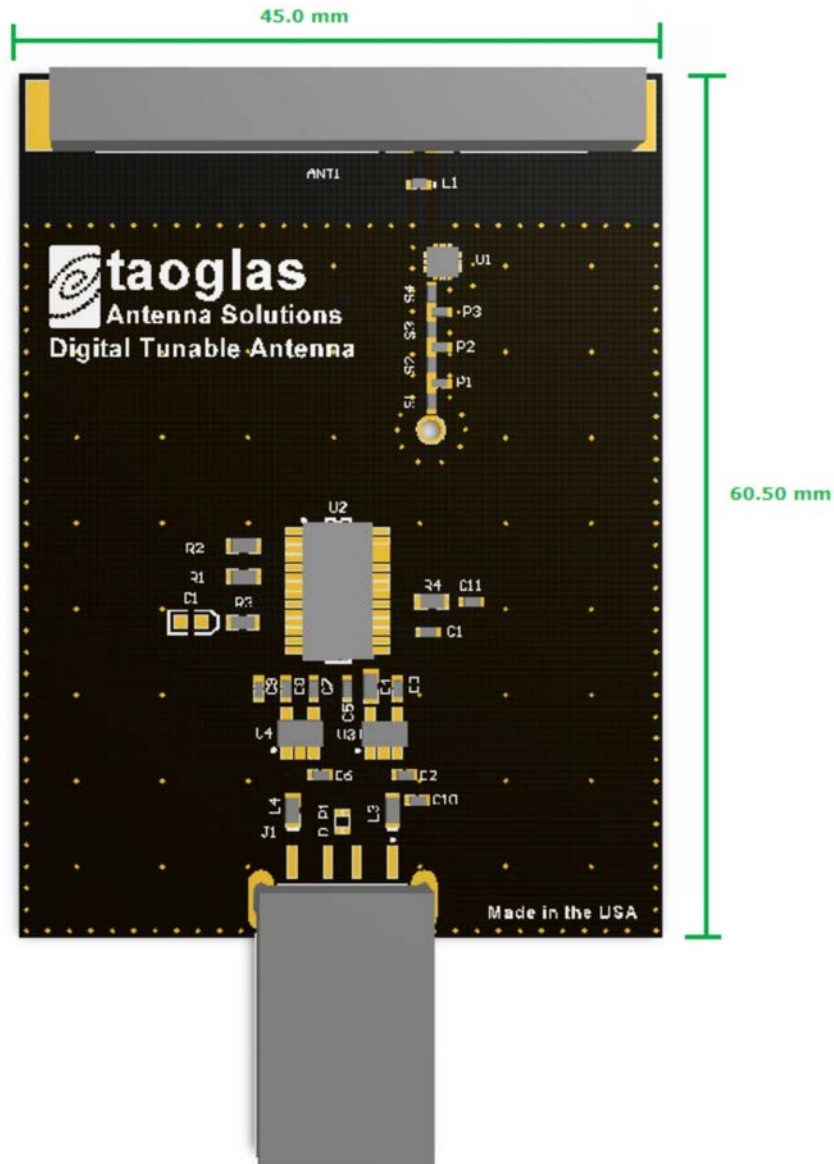


Figure 18. Board Size

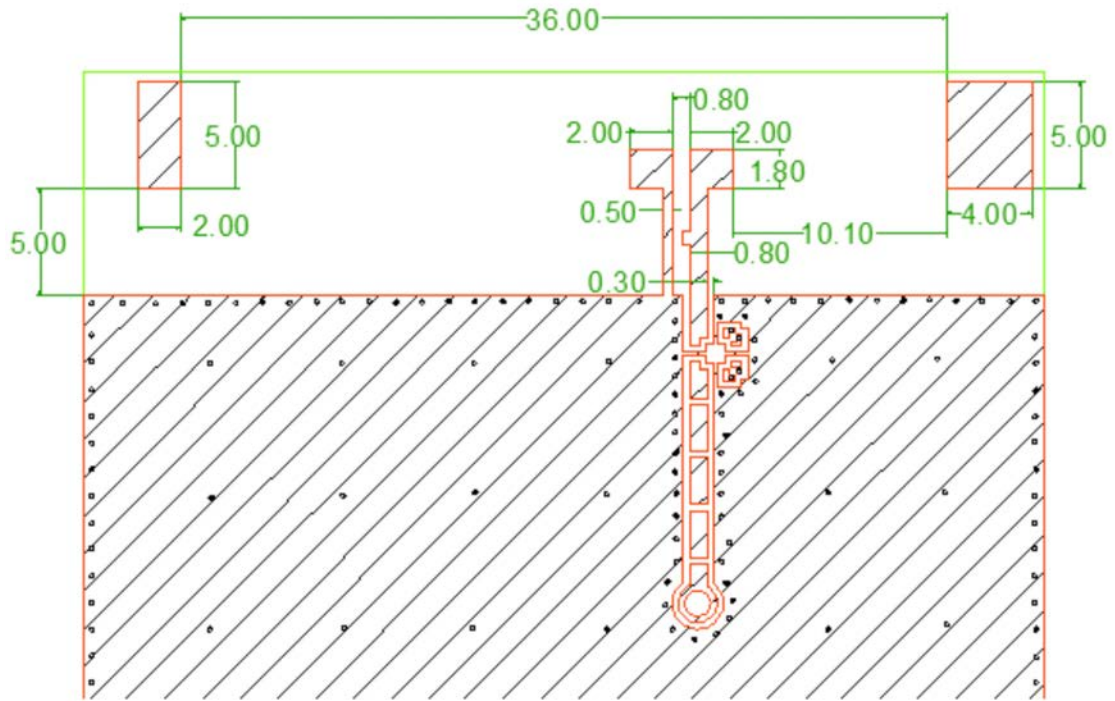


Figure 19. Antenna Layout

Top View

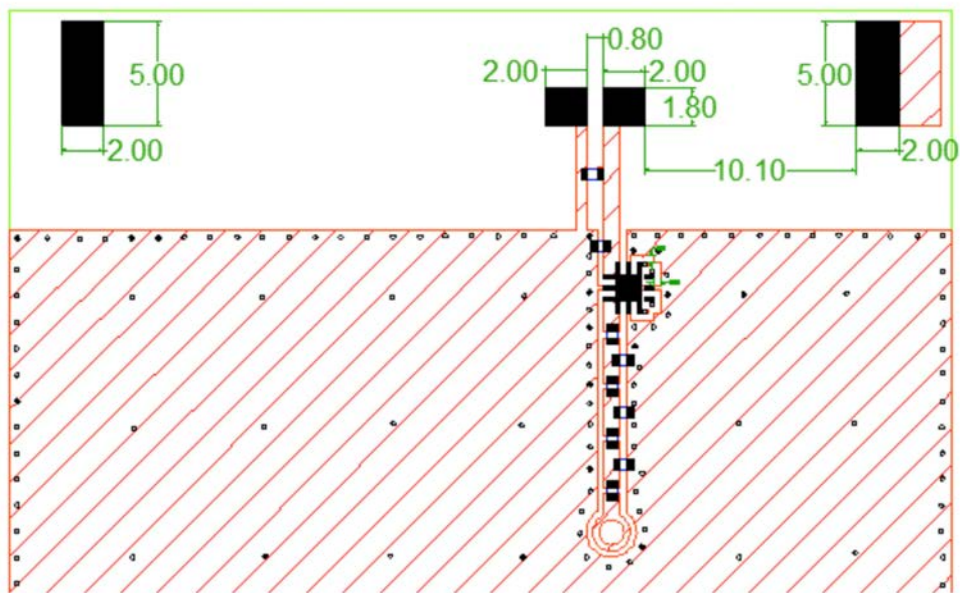
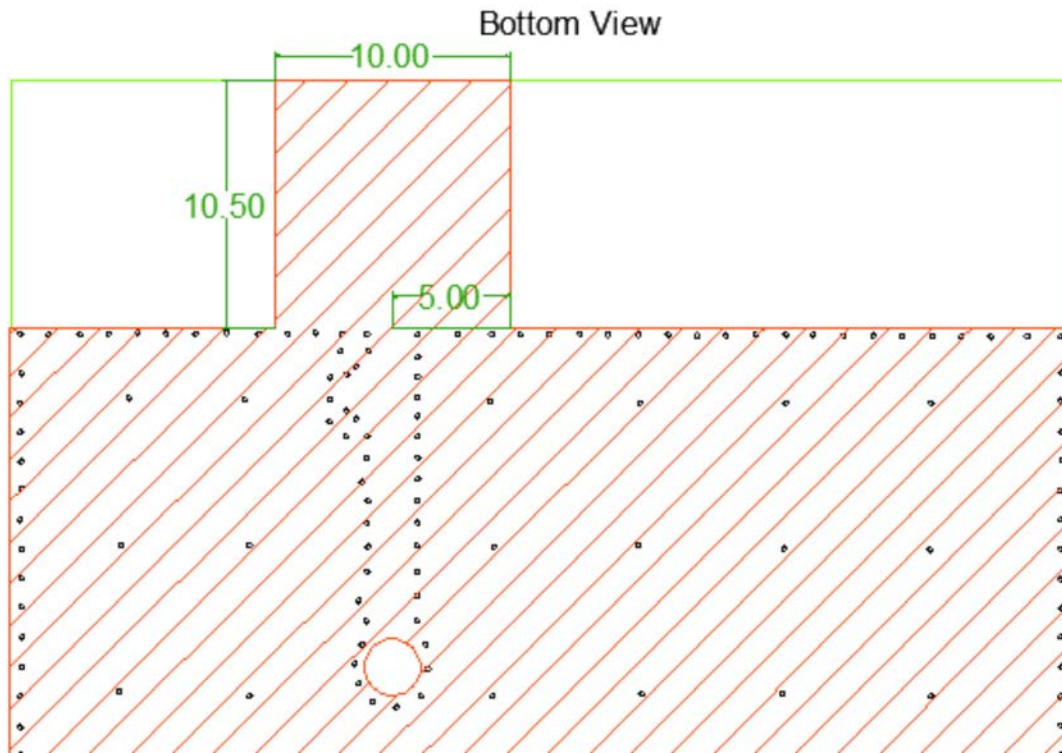
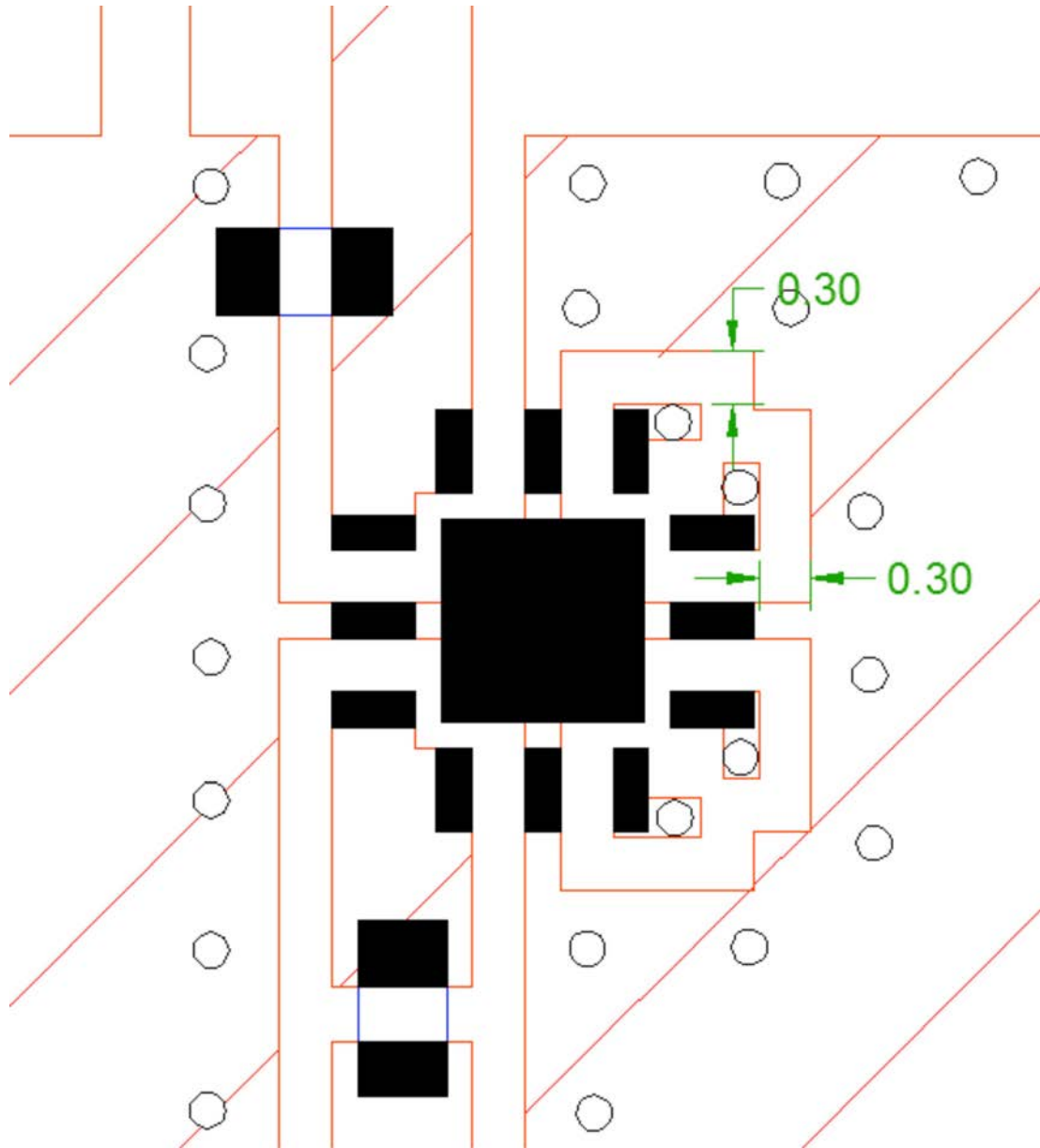


Figure 20. Solder area for the antenna



**Figure 21.** Bottom Layout

At the bottom layer we need to add a portion of ground plane underneath the antenna, this portion measures 10x10.5 mm and is centered to the signal track of the transmission line at the top layers (5 mm to each side).



**Figure 22.** Recommended layout of the PE64102

For the solder pads of the PE64102 and the lumped components please check their respective specifications.  
We recommend 0402 size parts. (see the appendix)



## 10. Schematics

### USB Interface Power Supply

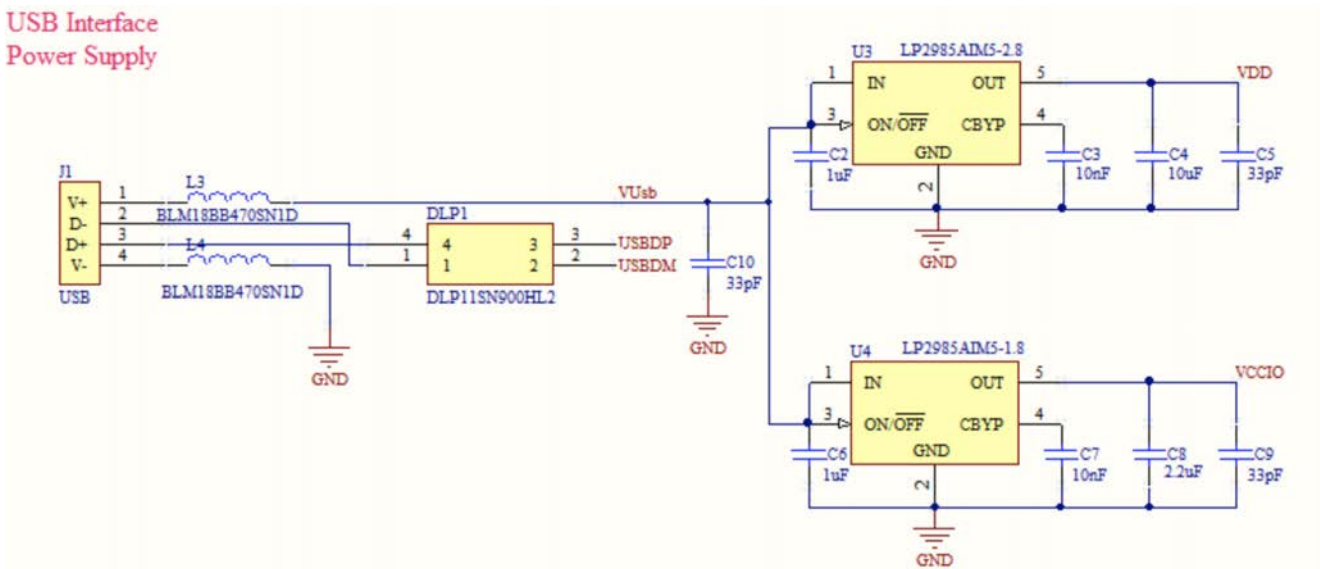


Figure 23. USB interface and power supply

### USB2SERIAL (SPI) Converter

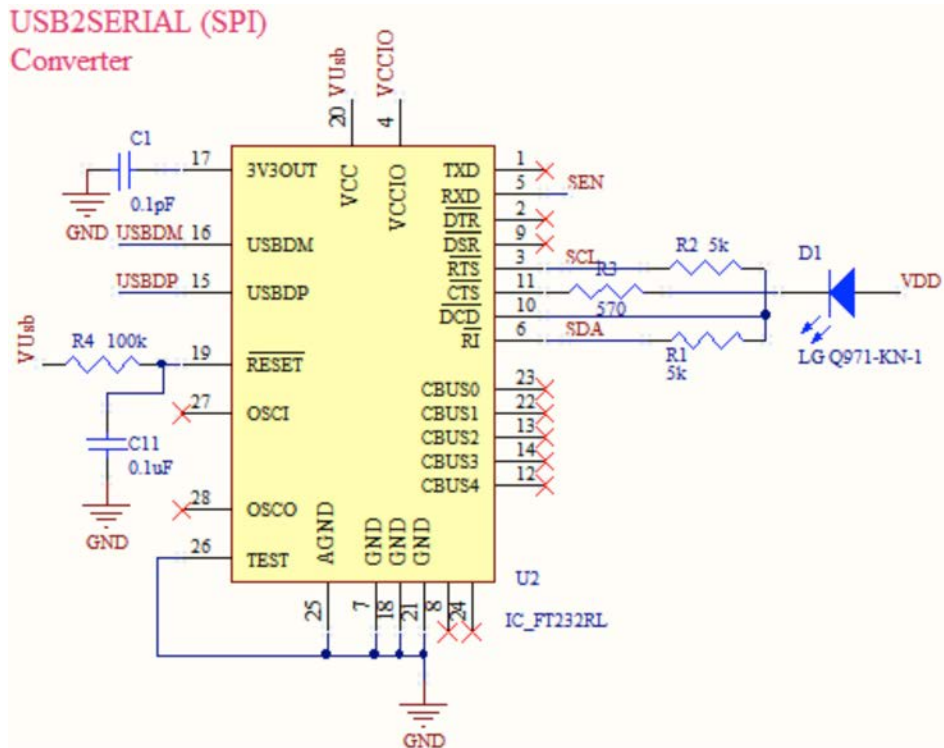


Figure 24. USB to SPI Converter

Matching Circuit +  
Peregrine + Antenna

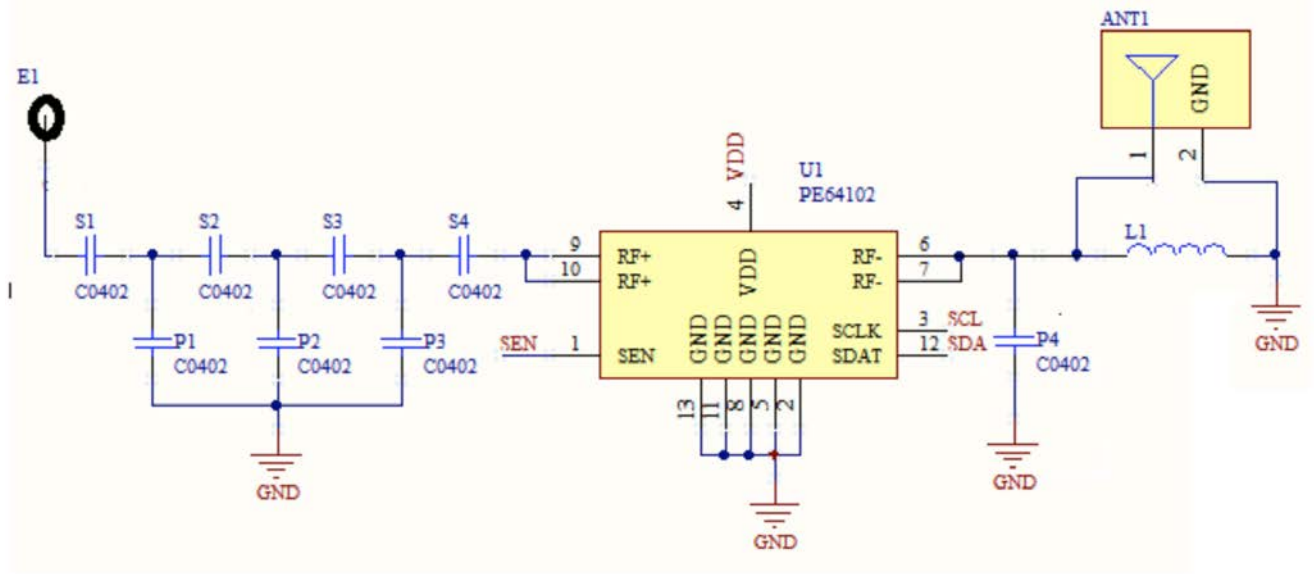
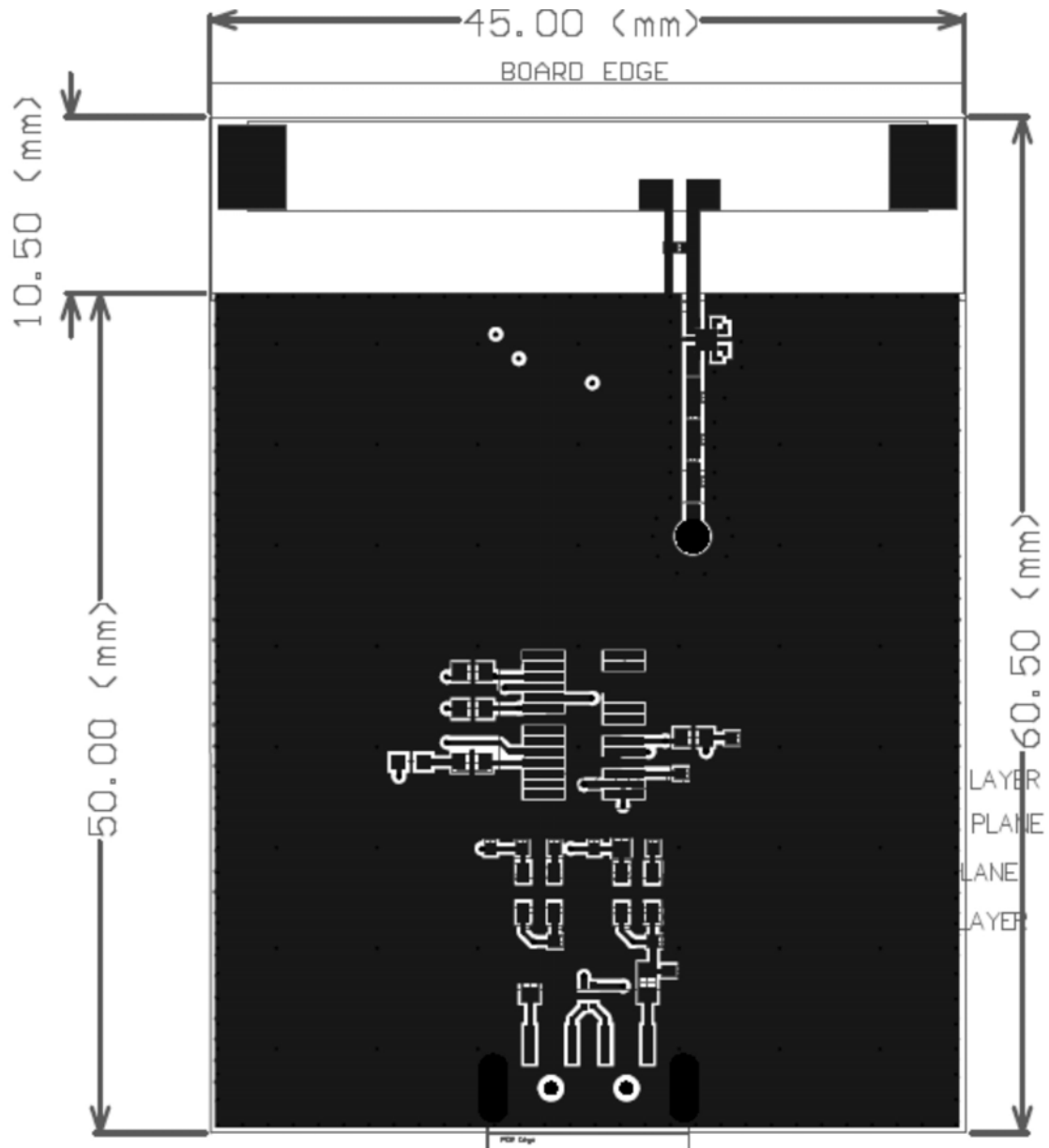


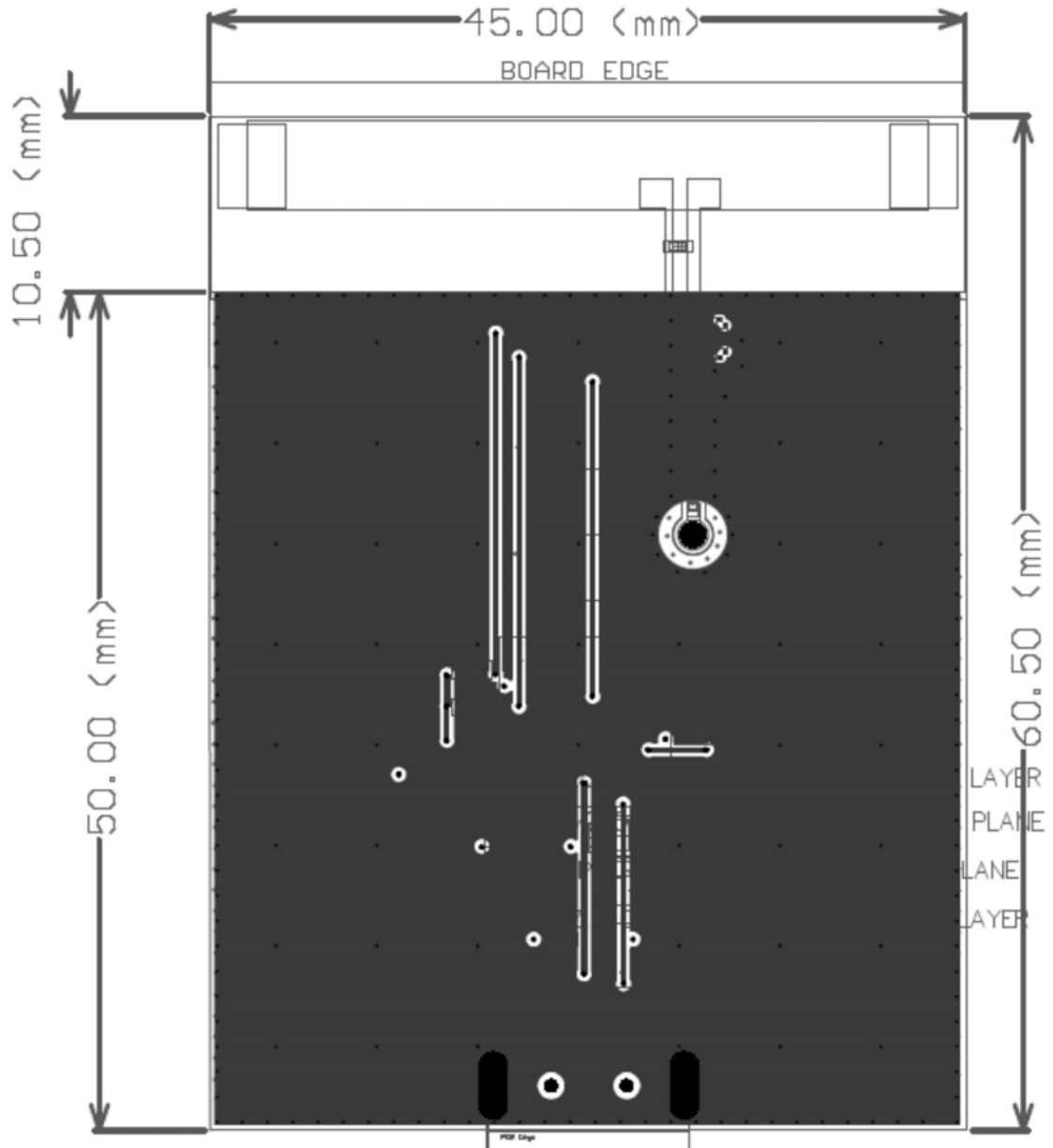
Figure 25. Matching Circuit, PE64102 and DTA01 Antenna.

## 11. Gerbers



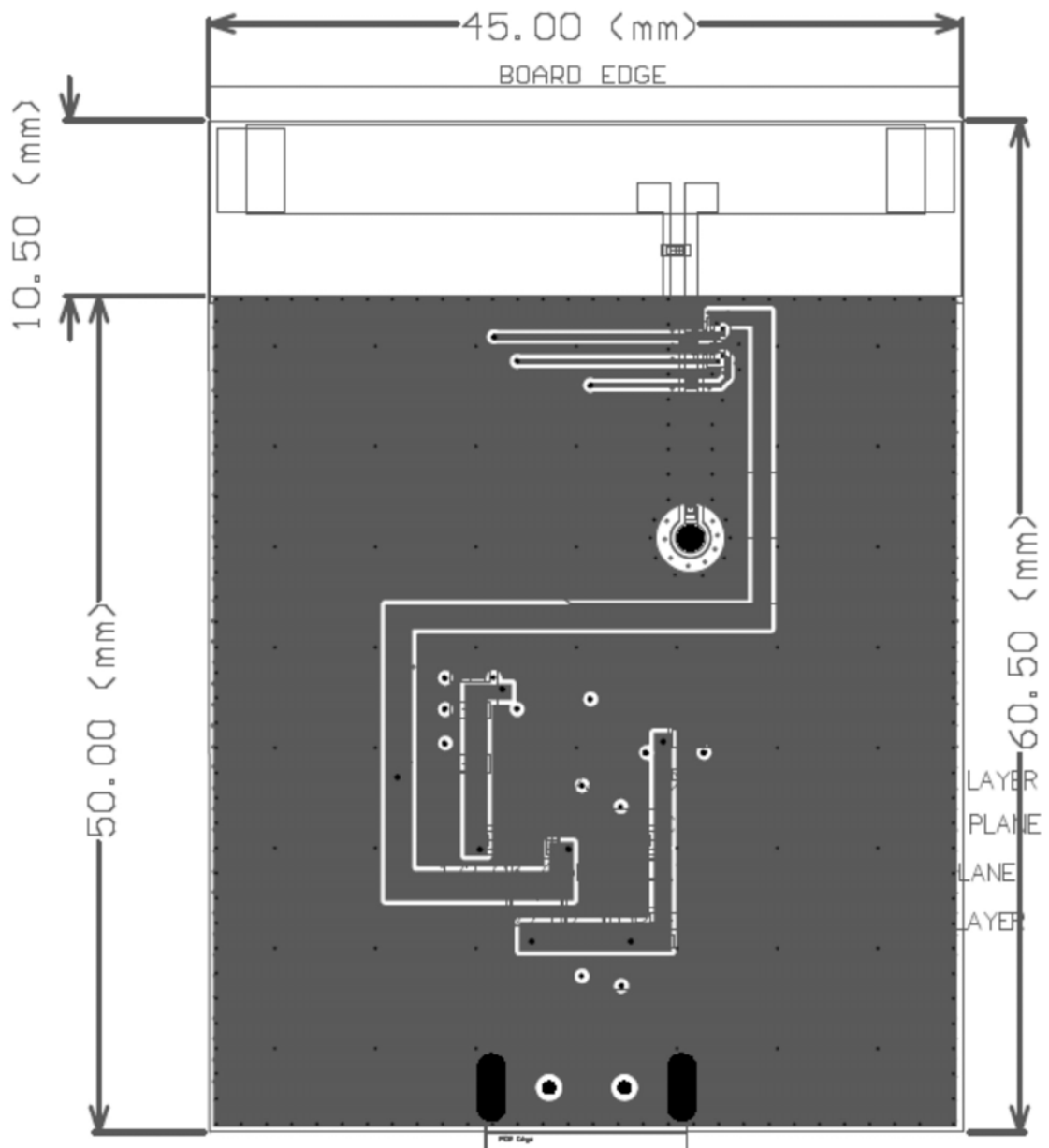
**Figure 26.** DTA01 Top Layer (Ground-Components)

## 11. Gerbers



**Figure 27.** DTA01 First Middle Layer (Ground-Signal)

## 11. Gerbers



**Figure 28.** DTA01 Second Middle Layer (Ground-Signal-Power)

## 11. Gerbers

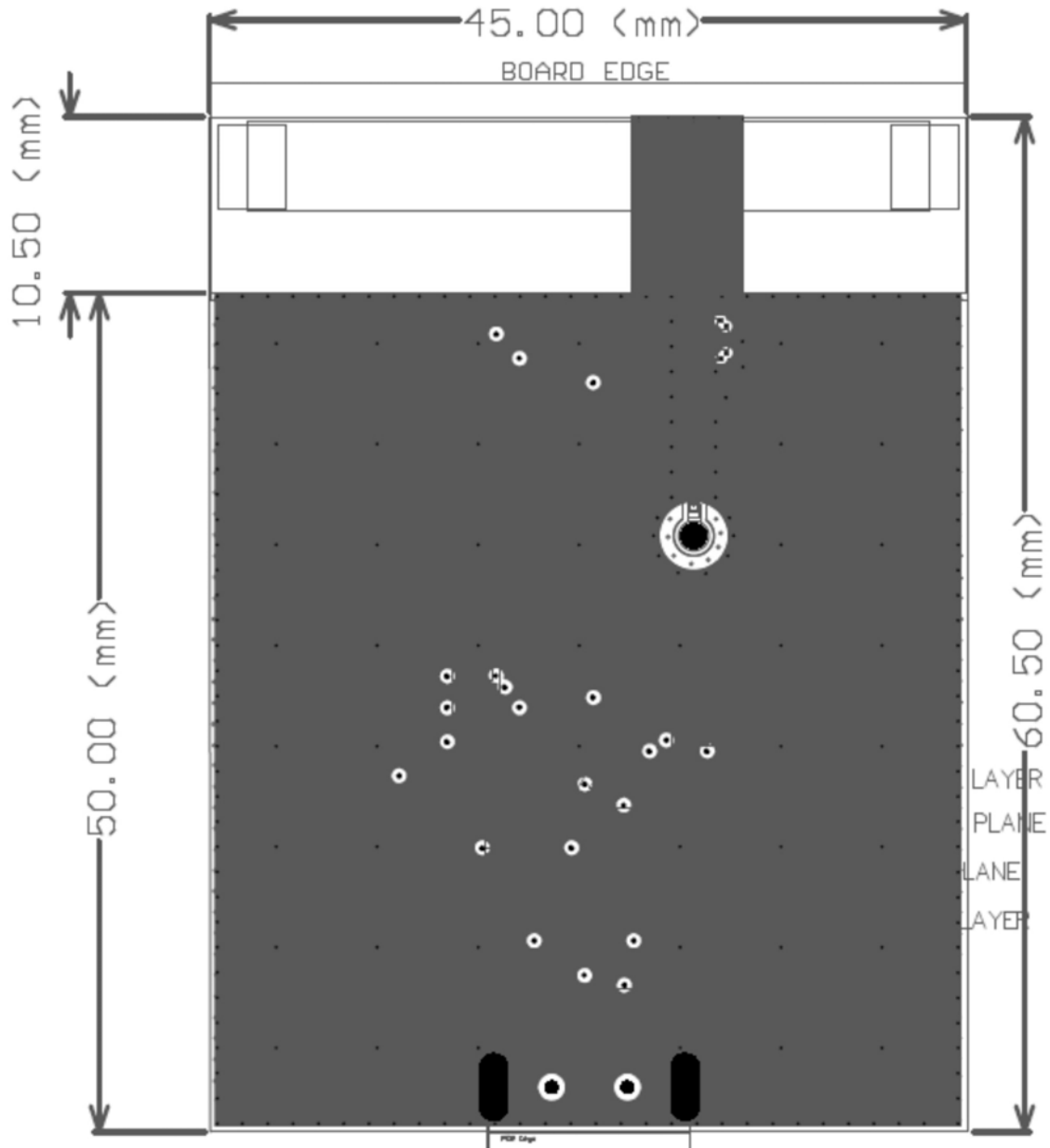


Figure 29. DTA01 Bottom Layer (Ground-Components)

## 12. Bill of Materials

Comment	Pattern	QTY	Components	Provider	Provider Part	Manufacturer	Manufacturer Part
0.1pF Capacitor	0402	1	C1	Digikey	<a href="#">490-6259-2-ND</a>	Murata	<a href="#">GRM1555C1HR10WA01D</a>
1uF Capacitor	0402	2	C2, C6	Digikey	<a href="#">490-3890-1-ND</a>	Murata	<a href="#">GRM155R61A105KE15D</a>
10nF Capacitor	0402	2	C3, C7	Digikey	<a href="#">490-1312-1-ND</a>	Murata	<a href="#">GRM155R71E103KA01D</a>
10uF Capacitor	0603	1	C4	Digikey	<a href="#">490-3896-1-ND</a>	Murata	<a href="#">GRM188R60J106ME47D</a>
33pF Capacitor	0402	3	C5, C9, C10	Digikey	<a href="#">490-6177-1-ND</a>	Murata	<a href="#">GRM1555C1E330JA01D</a>
2.2uF Capacitor	0402	1	C8	Digikey	<a href="#">490-4518-1-ND</a>	Murata	<a href="#">GRM155R60G225ME15D</a>
100nF Capacitor	0402	1	C11	Digikey	<a href="#">490-1318-1-ND</a>	Murata	<a href="#">GRM155R61A104KA01D</a>
0 Ohm Resistor	0402	1	S1	Digikey	<a href="#">P0.0JCT-ND</a>	Panasonic	<a href="#">ERJ-2GE0R00X</a>
10pF Capacitor	0402	1	S2	Digikey	<a href="#">490-5921-1-ND</a>	Murata	<a href="#">GRM1555C1H100JA01D</a>
0.5nH Inductor	0402	2	S3, S4	Digikey	<a href="#">445-6306-1-ND</a>	TDK	<a href="#">MLG1005S0N5C</a>
47nH Inductor	0402	1	P1	Digikey	<a href="#">490-6820-1-ND</a>	Murata	<a href="#">LQW15AN47NH00D</a>
6.2nH Inductor	0402	1	P2	Digikey	<a href="#">490-2620-1-ND</a>	Murata	<a href="#">LQG15HS6N2S02D</a>
1pF Capacitor	0402	1	P3	Digikey	<a href="#">490-3083-1-ND</a>	Murata	<a href="#">GJM1555C1H1R0CB01D</a>
3.9nH Inductor	0402	1	P4	Digikey	<a href="#">490-2617-1-ND</a>	Murata	<a href="#">LQG15HS3N9S02D</a>
5k Resistor	0603	2	R1, R2	Digikey	<a href="#">RR08P4.99KDCT-ND</a>	Susumu	<a href="#">RR0816P-4991-D-68H</a>
570 Resistor	0603	1	R3	Digikey	<a href="#">RR08P560DCT-ND</a>	Susumu	<a href="#">RR0816P-561-D</a>
100k Resistor	0402	1	R4	Digikey	<a href="#">RR08P100KDCT-ND</a>	Susumu	<a href="#">RR0816P-104-D</a>
Ferrite	0603	2	L3, L4	Digikey	<a href="#">490-5208-1-ND</a>	Murata	<a href="#">BLM18BB470SN1D</a>
PE64102	SMT	1	U1	Digikey	<a href="#">1046-1066-1-ND</a>	Peregrine	<a href="#">PE64102MLAA-Z</a>
IC_FT232RL	28-SSOP	1	U2	Digikey	<a href="#">768-1007-1-ND</a>	FTDI	<a href="#">FT232RL-REEL</a>
LP2985AIM5-2.8	SOT-23-5	1	U3	Digikey	<a href="#">LP2985AIM5-2.8/NOPBCT-ND</a>	TI	<a href="#">LP2985AIM5-2.8/NOPB</a>
LP2985AIM5-1.8	SOT-23-5	1	U4	Digikey	<a href="#">LP2985AIM5-1.8/NOPBCT-ND</a>	TI	<a href="#">LP2985AIM5-1.8/NOPB</a>
LG Q971-KN-1	0603	1	D1	Digikey	<a href="#">475-1409-1-ND</a>	OSRAM	<a href="#">LG Q971-KN-1</a>
DLP11SN900HL2L	0504	1	DLP1	Mouser	<a href="#">DLP11SN900HL2L</a>	Murata	<a href="#">81-DLP11SN900HL2L</a>
PA710.A	SMT	1	Ant1	Digikey	<a href="#">PA.720.A</a>	Taoglas	<a href="#">PA.720.A</a>
SMA female	Flange	1	Con1	Digikey	<a href="#">931-1179-ND</a>	Taoglas	<a href="#">PCB.SMAFST.2H.B.HT</a>
USB A SINGLE SMT	USB/SM 2.5-4H4	1	USB/CONN	Mouser	<a href="#">855-M701-280442</a>	Harwin	<a href="#">M701-280442</a>

## 13. Appendix

### **Product Overview Peregrine PE64102**

[http://www.psemi.com/pdf/sell\\_sheet-psg/73-0039.pdf](http://www.psemi.com/pdf/sell_sheet-psg/73-0039.pdf)

### **Datasheet Peregrine PE64102**

[http://www.psemi.com/pdf/datasheets/PE64102\\_70-0428-01.pdf](http://www.psemi.com/pdf/datasheets/PE64102_70-0428-01.pdf)

### **Application Note Peregrine PE64102**

[http://www.psemi.com/pdf/app\\_notes/an29.pdf](http://www.psemi.com/pdf/app_notes/an29.pdf)

### **Software and driver for the Peregrine PE64102**

<http://www.psemi.com/content/products/product.php?product=PE64102>

### **Design Files for the DTAD01**

<http://taoglas.com/files/DTAD01-Design-Files.zip>

### **Software and Driver for the DTAD01**

<http://taoglas.com/files/DTAD01-Eval-Board-Software.zip>