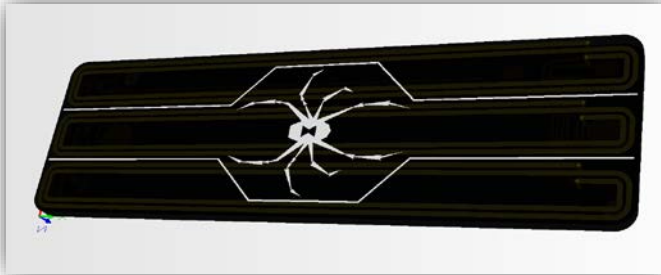


This RFID PCB antenna was designed to be integrated into the FRS-Light V1 matte box.
It was developed and tested with the ST25R391X series RFID reader



This PCB incorporates 3 matched antennas. Only ONE antenna can be activated at any given time. The desired antenna is selected using an RF switch in between the antenna and matching circuit.

ELECTRICAL SPECIFICATIONS	
Operating Frequency [MHz]*	13.56
Inductance [nH]**	327 ± 5
DC Resistance [$m\Omega$]**	1113 ± 2
Parallel Resistance [Ω]**	755 ± 10
Self Resonance Frequency [MHz]**	26.38 ± 0.01
Q Factor**	15
Matched Q Value	13

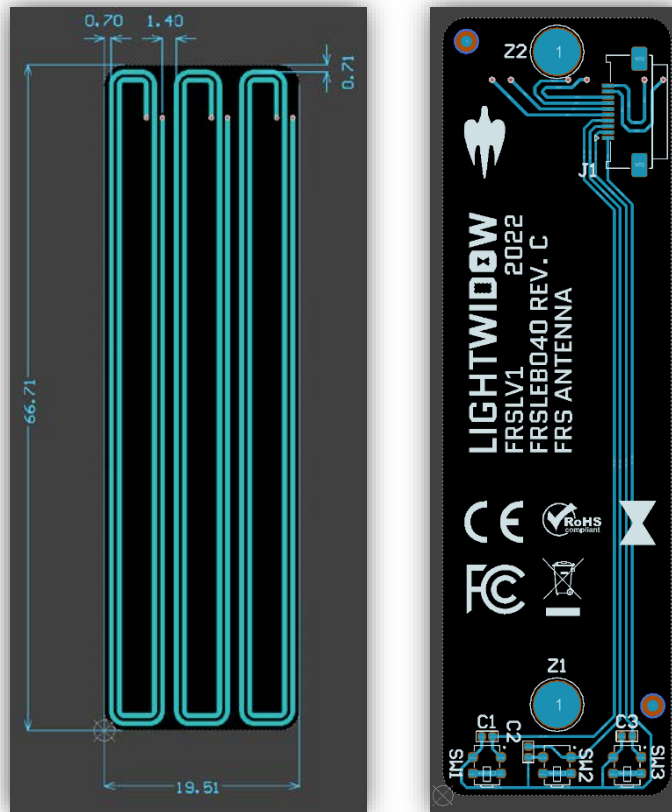
NOTE: This table includes the expected variation between all 3 matched antennas (denoted by the $\pm$ tolerance values)

* With matching circuit

** Without matching circuit

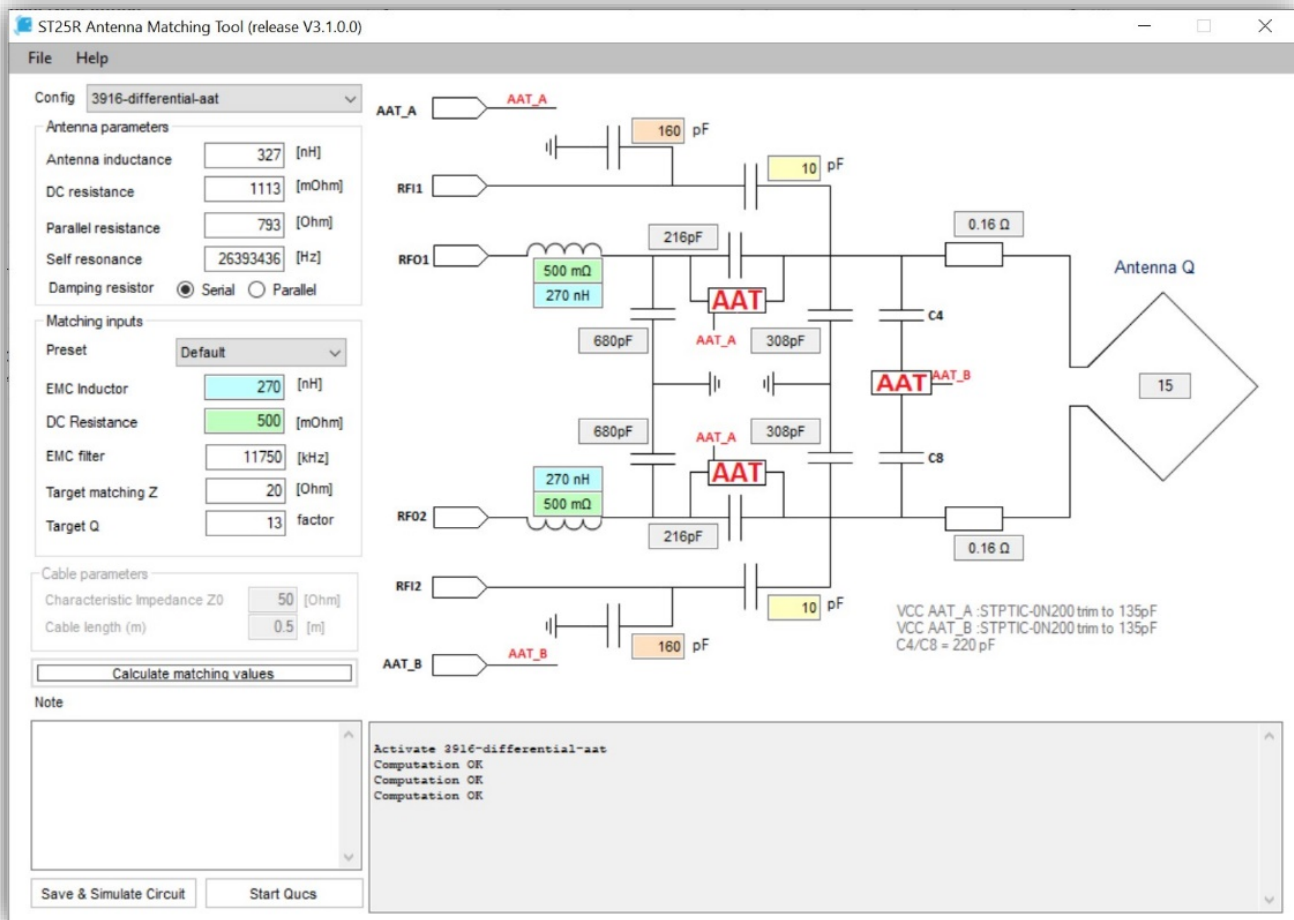
PCB SPECIFICATIONS	
Trace Width [mm]	0.5
Trace Spacing [mm]	0.3
Loop Count	2
Loop Trace Length [mm]	290.91 ± 0.09
Connector Part Number	Molex 5051101097

NOTE: This table includes the expected variation between all 3 matched antennas (denoted by the $\pm$ tolerance values)



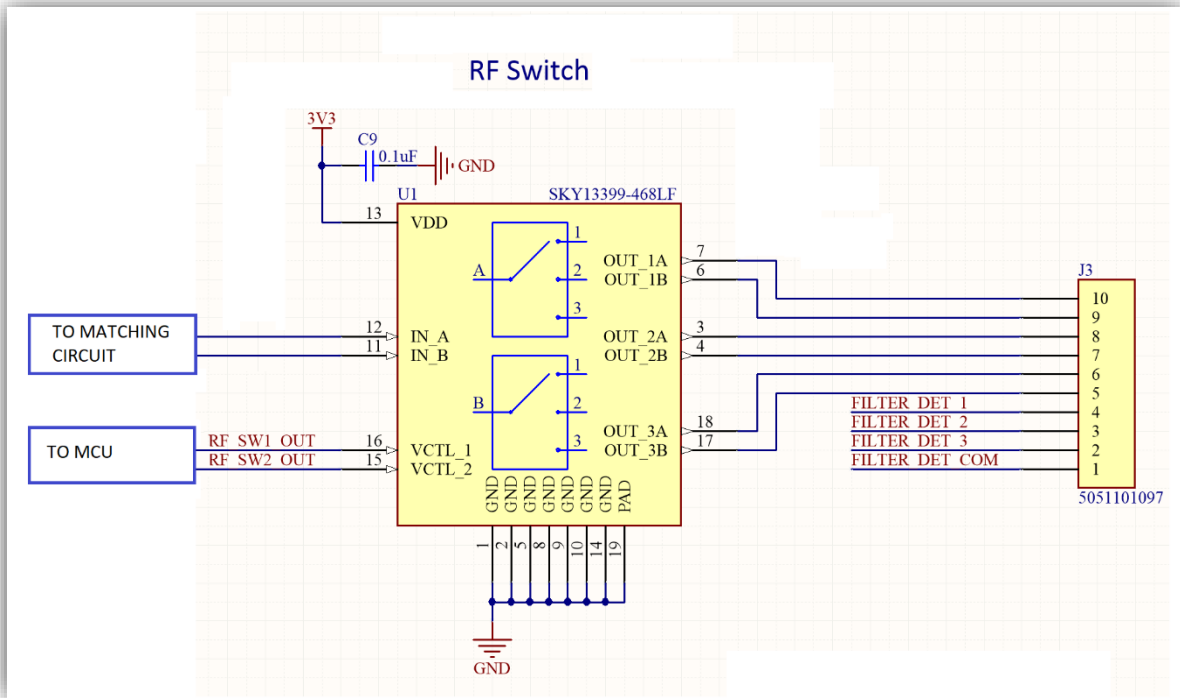
PCB CONSTRUCTION		
Layer	Thickness [mm]	Dielectric Constant
Top Soldermask	0.0254	3.5
Top Copper	0.0356 (1oz Copper)	
Dielectric	1.524	4.6
Bottom Copper	0.0356 (1oz Copper)	
Bottom Soldermask	0.0254	3.5
Total PCB Thickness	1.646	

MATCHING CIRCUIT AND REFERENCE VALUES	
Component	Value
EMC Inductor	270 nH, 500 mΩ
EMC Capacitor	680 pF
Series Capacitors	220 pF
Parallel Capacitors	300 pF
Series Shunt Resistors	0.16 Ω
Variable Capacitor	100pF to 200pF
Variable Capacitor PN	LXRW0YV201-059

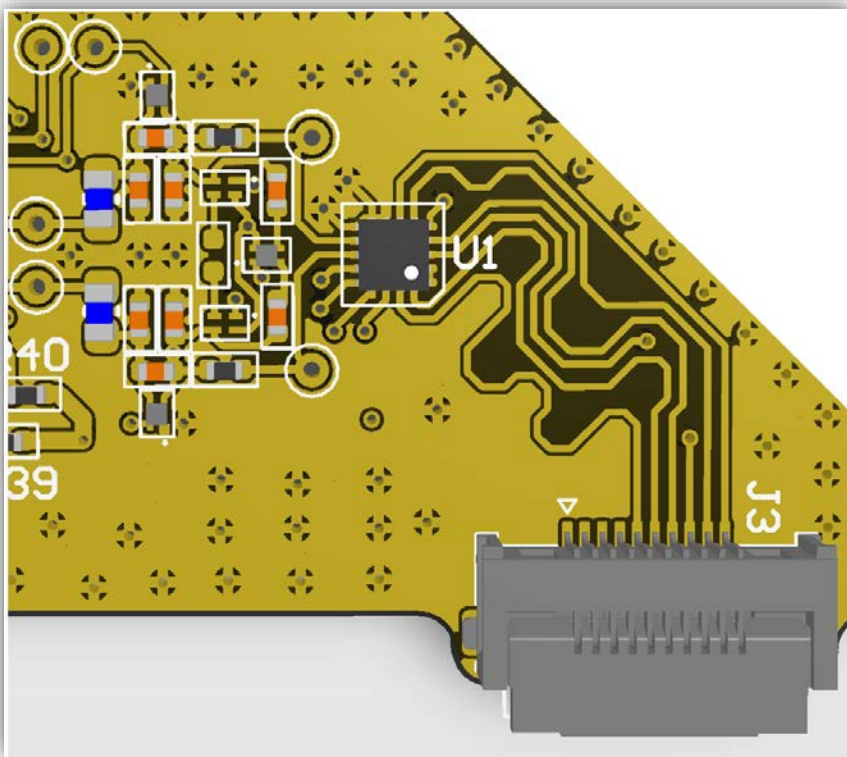


Because of the slight variation between the 3 antennas, variable capacitors have been included which enables automatic antenna tuning (AAT). The capacitors are trimmed to 135pF.

The system requires 3 separate antennas. Only one antenna may be active at any given time so an RF switch is placed in series between the antenna and the matching circuit.



Matching Circuit and RF Switch PCB Layout on the main PCB:



VECTOR NETWORK ANALYZER MEASUREMENTS

Marker 1

Frequency:	1.00000 MHz	VSWR:	44.936
Impedance:	1.115 +j2.09 Ω	Return loss:	-0.387 dB
Series L:	332.11 nH	Quality factor:	1.872
Series C:	-76.27 nF	S11 Phase:	175.22°
Parallel R:	5.0213 Ω	S21 Gain:	-90.741 dB
Parallel X:	426.87 nH	S21 Phase:	105.71°

Marker 2

Frequency:	26.3777 MHz	VSWR:	14.508
Impedance:	725.3 -j6.5 Ω	Return loss:	-1.199 dB
Series L:	-39.19 nH	Quality factor:	0.009
Series C:	928.95 pF	S11 Phase:	-0.07°
Parallel R:	725.39 Ω	S21 Gain:	-96.259 dB
Parallel X:	74.483 fF	S21 Phase:	-33.31°

Marker 3

Frequency:		VSWR:	
Impedance:		Return loss:	
Series L:		Quality factor:	
Series C:		S11 Phase:	
Parallel R:		S21 Gain:	
Parallel X:		S21 Phase:	

S11

Min VSWR: 4.022 @ 28.4118MHz
Return loss: -4.412 dB

S21

Min gain: -130.152 dB @ 15.8011MHz
Max gain: -81.722 dB @ 76.8674MHz

S11 Smith Chart

