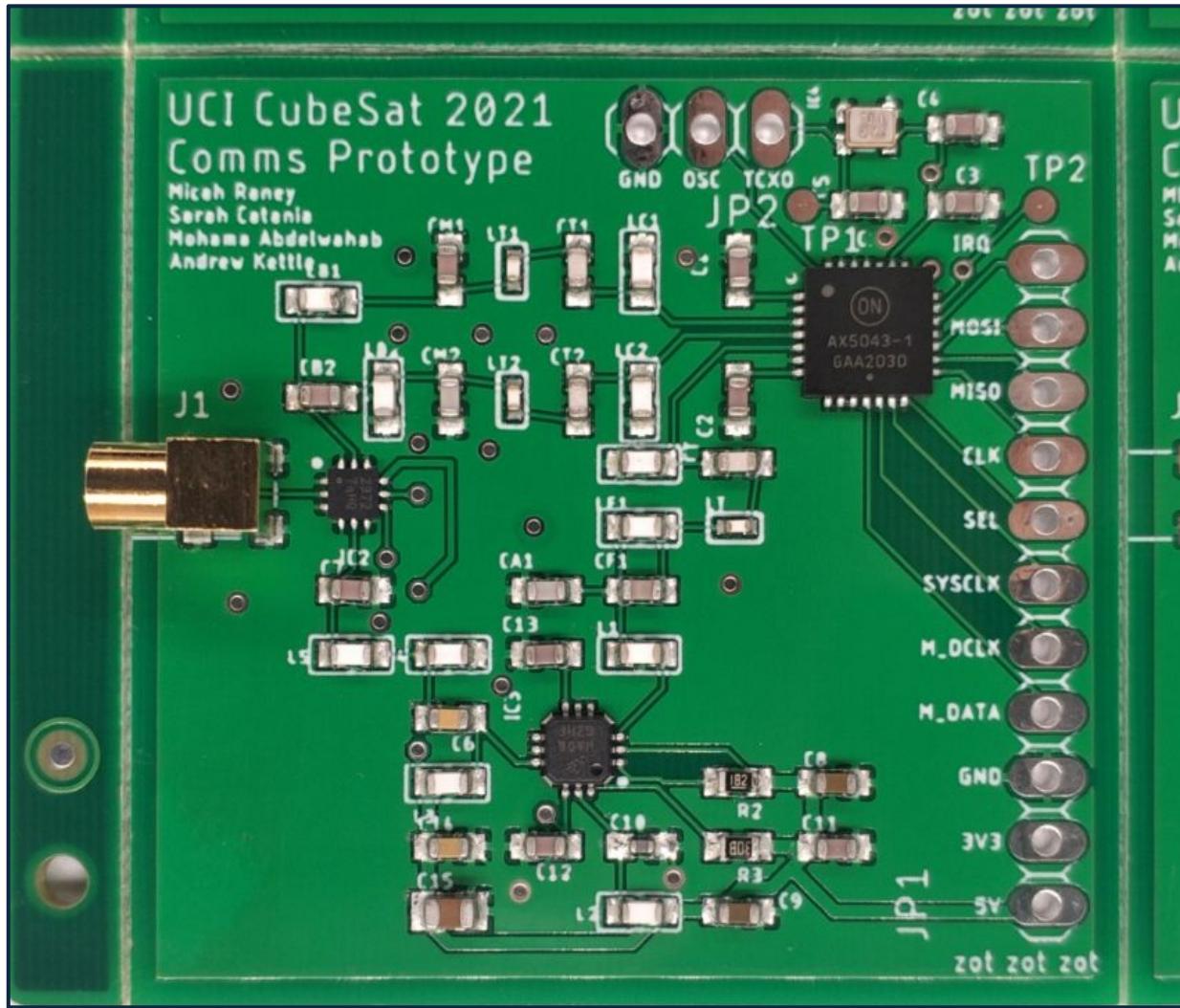


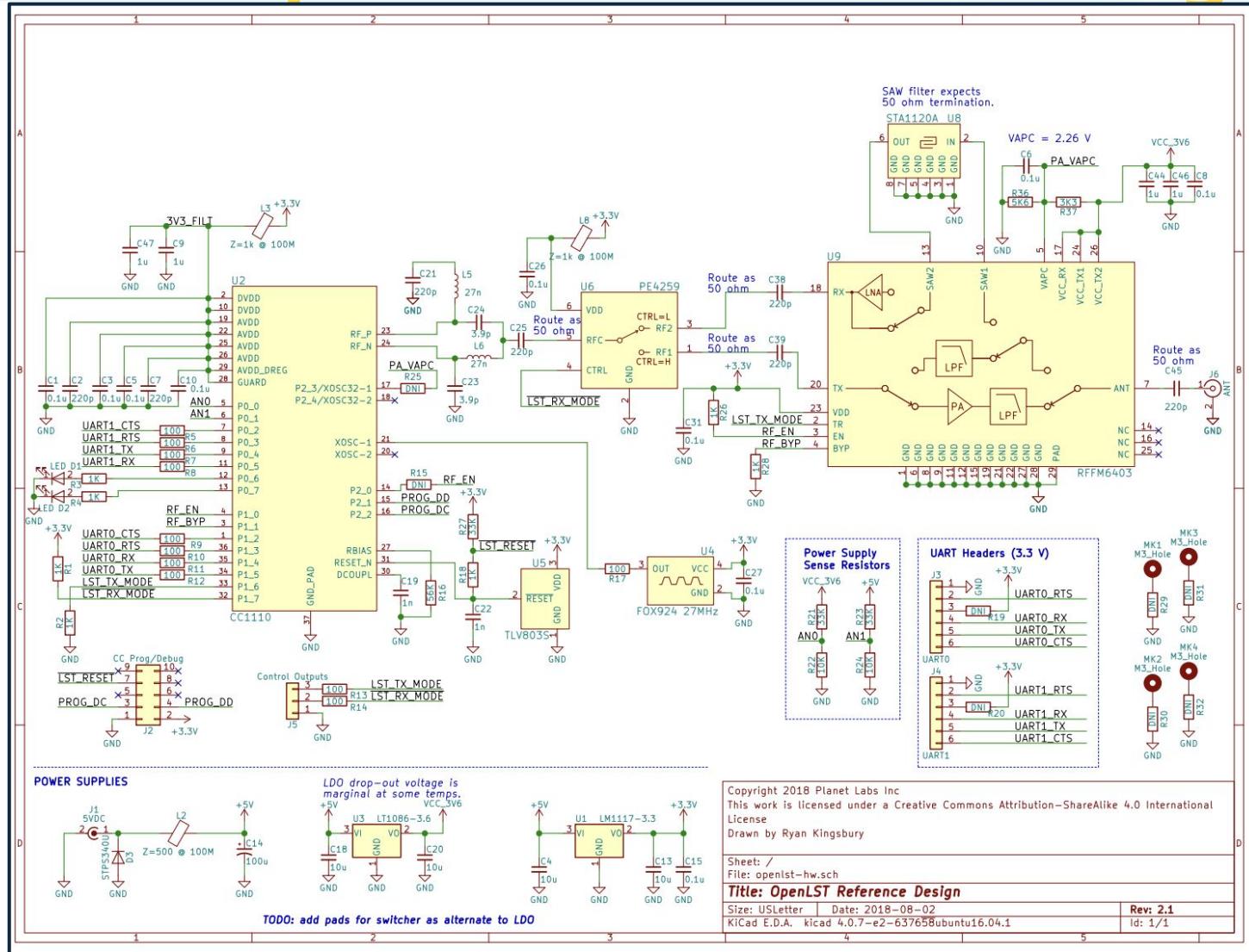
RF Transceiver Board

1. Transceiver Board Design
2. Reference Designs
3. Component Research
4. Transceiver Board Block Diagram
5. Schematic Layout
6. PCB Layout

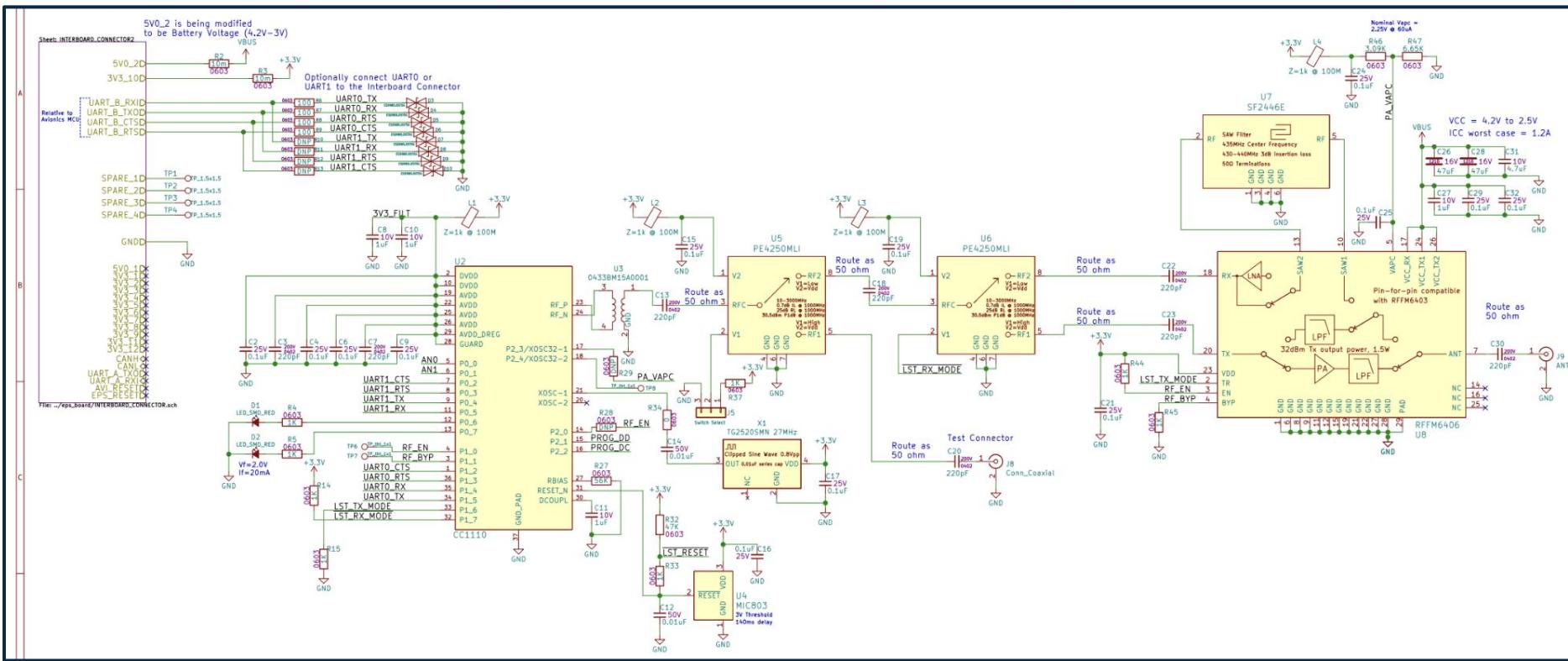




- 2021 CubeSat [Archive](#) Comms board
- Some outdated components like transceiver IC and RF switch had to be replaced with active components



- Original [OpenLST](#) Transceiver Board Schematic Layout Design
- Features integrated MCU+Transceiver, RF Switch, RF FEM, and SAW filter



- RGSat's Modified OpenLST Transceiver Board Schematic Layout Design
- Features integrated MCU+Transceiver, 2 RF Switches, refined RF FEM, SAW filter, and other additional passives/ ICs as necessary

CubeSat Transceiver Board

- MCU: [STM32H745ZIT3](#)
- Transceiver: [TI CC1101](#)
- Radio Frequency Switch: [PE4251MLI-Z](#)
- Radio Frequency Front End Module: [SKY65366-21](#)
- SAW Filter + other ICs + passives

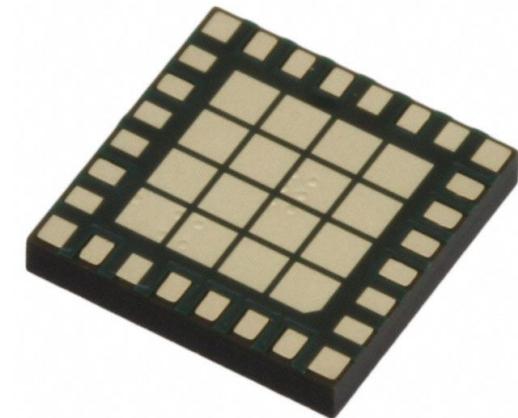
The goal of this project is to develop a PCB capable of RX and TX at 433 MHz. We must implement an RF system that interfaces with an STM32 and the EnduroSat UHF Antenna.

The board, including components and design choices, takes inspiration from the [OpenLST](#) and [RGSat](#) CubeSat projects.

RF Amplifier: SKY65366-21 (FEM)

Important Specifications

• Gain:	21dB
• TX Output Power:	+30dBm
• Frequency:	400 MHz
• RF Type:	UHF
• Noise Figure:	1.8 dB
• P1dB:	-17 dBm
• Digital Voltage Supply:	+5.5V max
• LNA Current Supply:	20 mA max
• Input Return Loss:	12 dB
• Output Return Loss:	27 dB
• Package:	28-pin 6x6mm SMT



RF Switch: PE4251MLI-Z

Important Specifications

- RF Type: General Purpose
- Topology: Absorptive
- **Circuit:** SPDT (Single Pole Double Throw)
- Isolation: 62 dB @ 1000 MHz
- Insertion Loss: 0.60 dB @ 1000 MHz
- P1dB: +30.5 dBm
- IIP3: 59 dBm (typical)

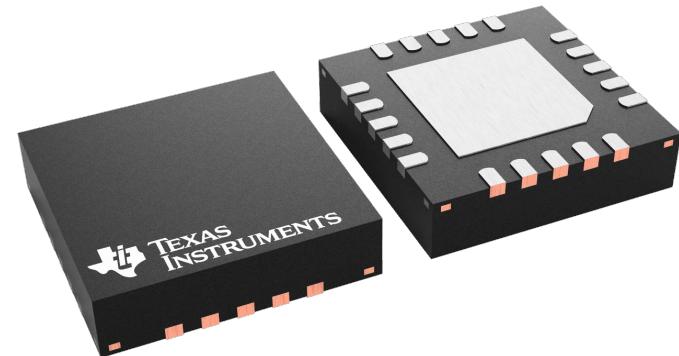


Note: The RF Switches are about the same but this one was selected for the topology advantage.

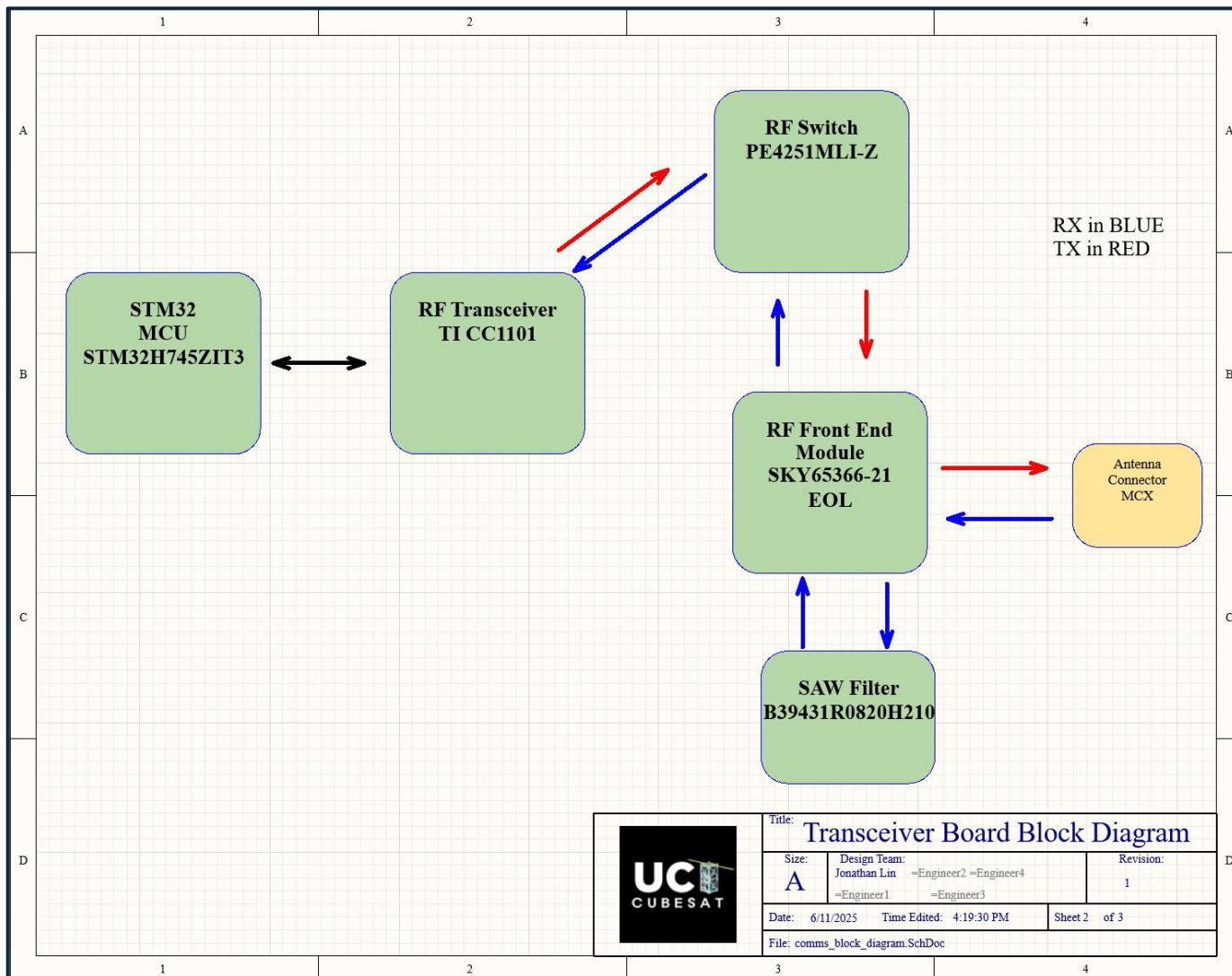
RF Transceiver: [TI CC1101](#)

Important Specifications

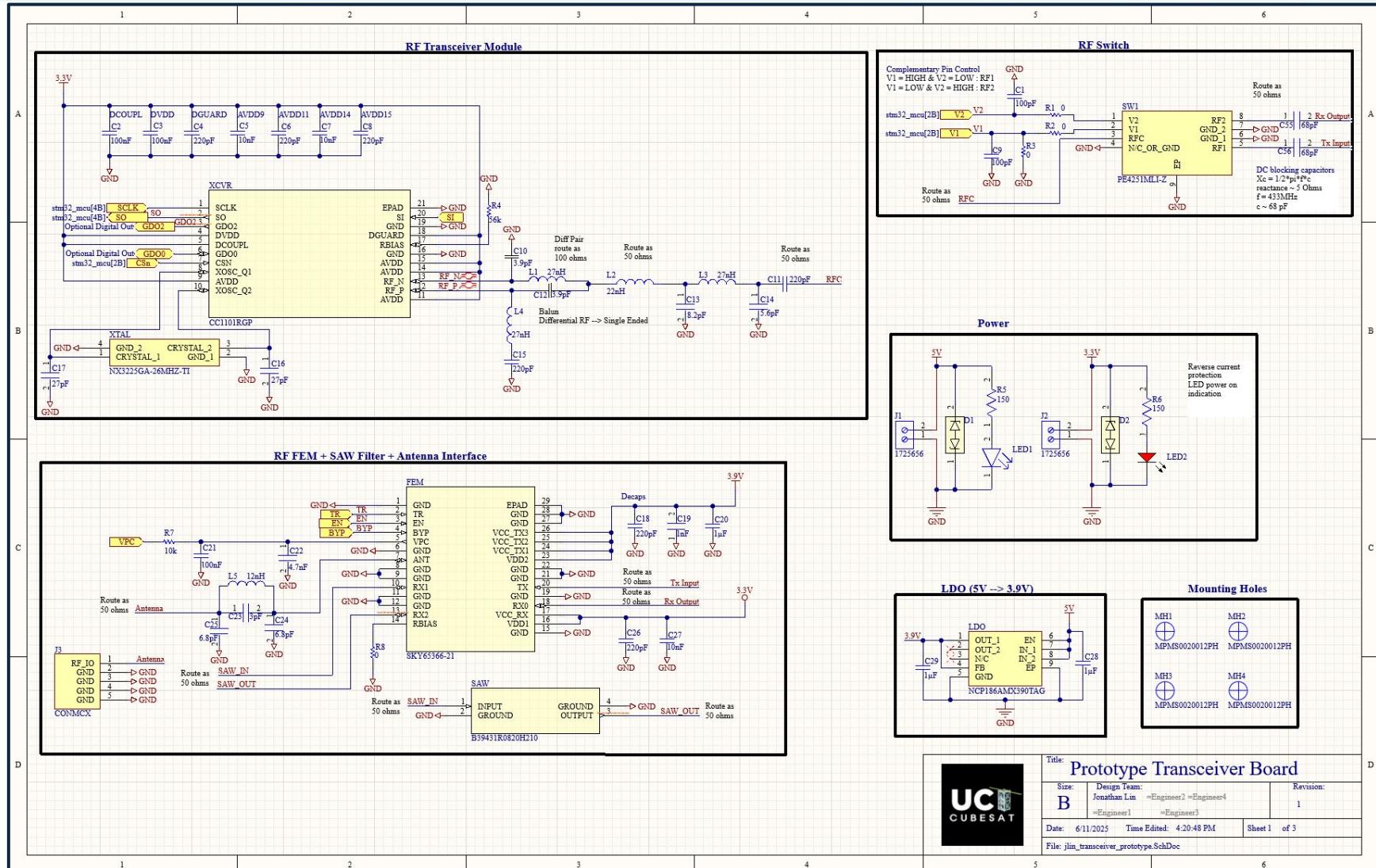
- RF Standard: ISM
- Protocols: Proprietary, Wireless M-Bus
- Modulation: 2-FSK, 4-FSK, GFSK, MSK, OOK
- **Frequency:** **387-464** + other bands
- Data Rate: 0.6 - 600 kbps (programmable)
- Power Out: +12 dBm
- Sensitivity: -116 dBm @ 0.6 kBaud, 433MHz
- Interface: SPI
- Voltage: 3.9V max (all supply pins same Vin)
- Package: 20 pin 4x4mm



Block Diagram



- Block diagram of the transceiver board design
 - Features a SAW filter on the RX path



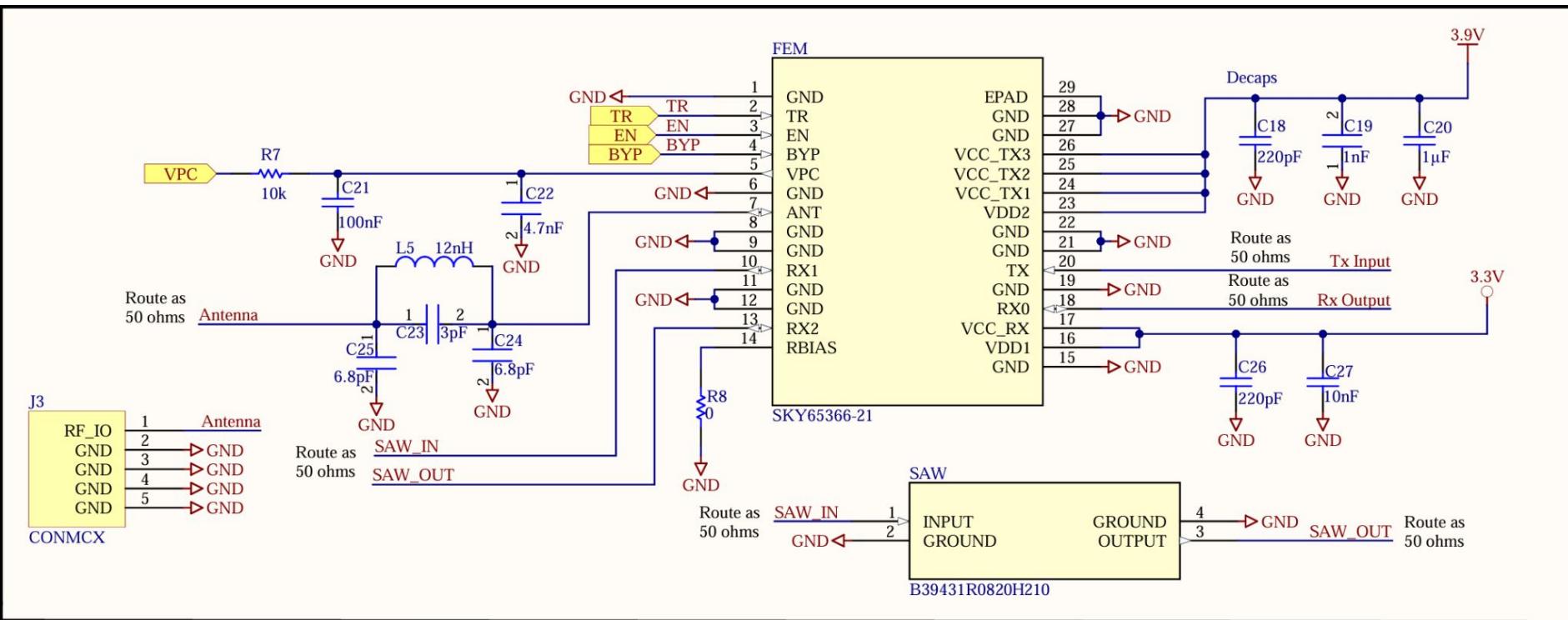
- Schematic layout of components and ICs
 - Used 0805 passives instead of 0402

Title: Prototype Transceiver Board

Size: B	Design Team: Jonathan Lin =Engineer1 =Engineer2 =Engineer3 =Engineer4	Revision: 1
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Date: 6/11/2025 Time Edited: 4:20:48 PM Sheet 1 of 3

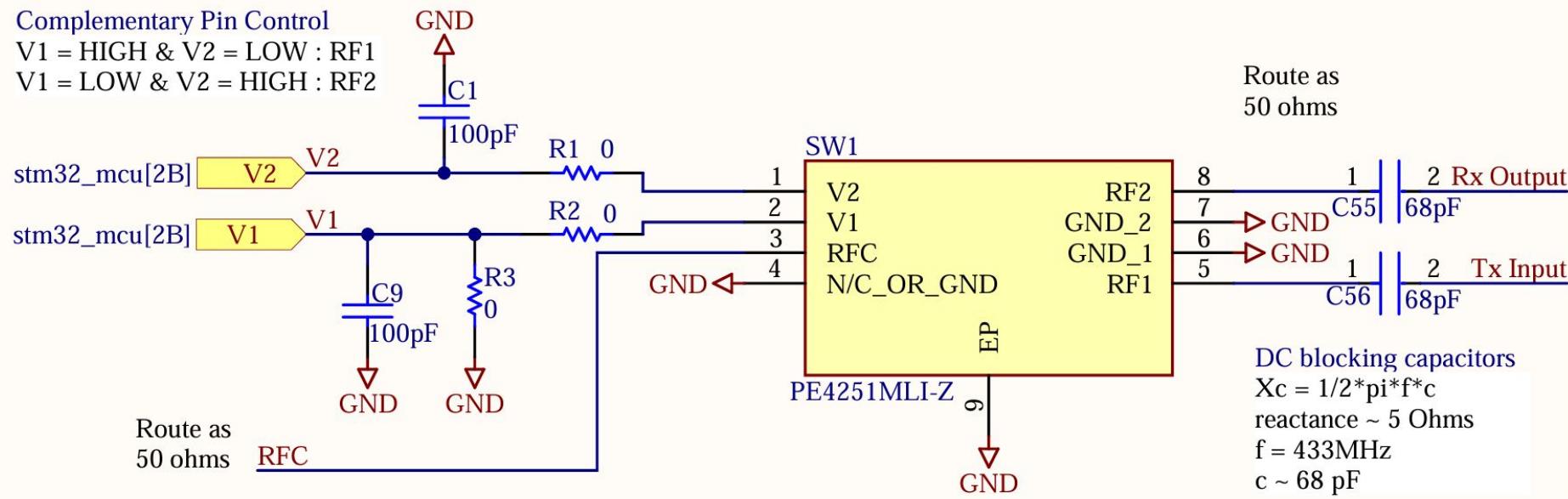
File: jlm_transceiver_prototype.SchDoc



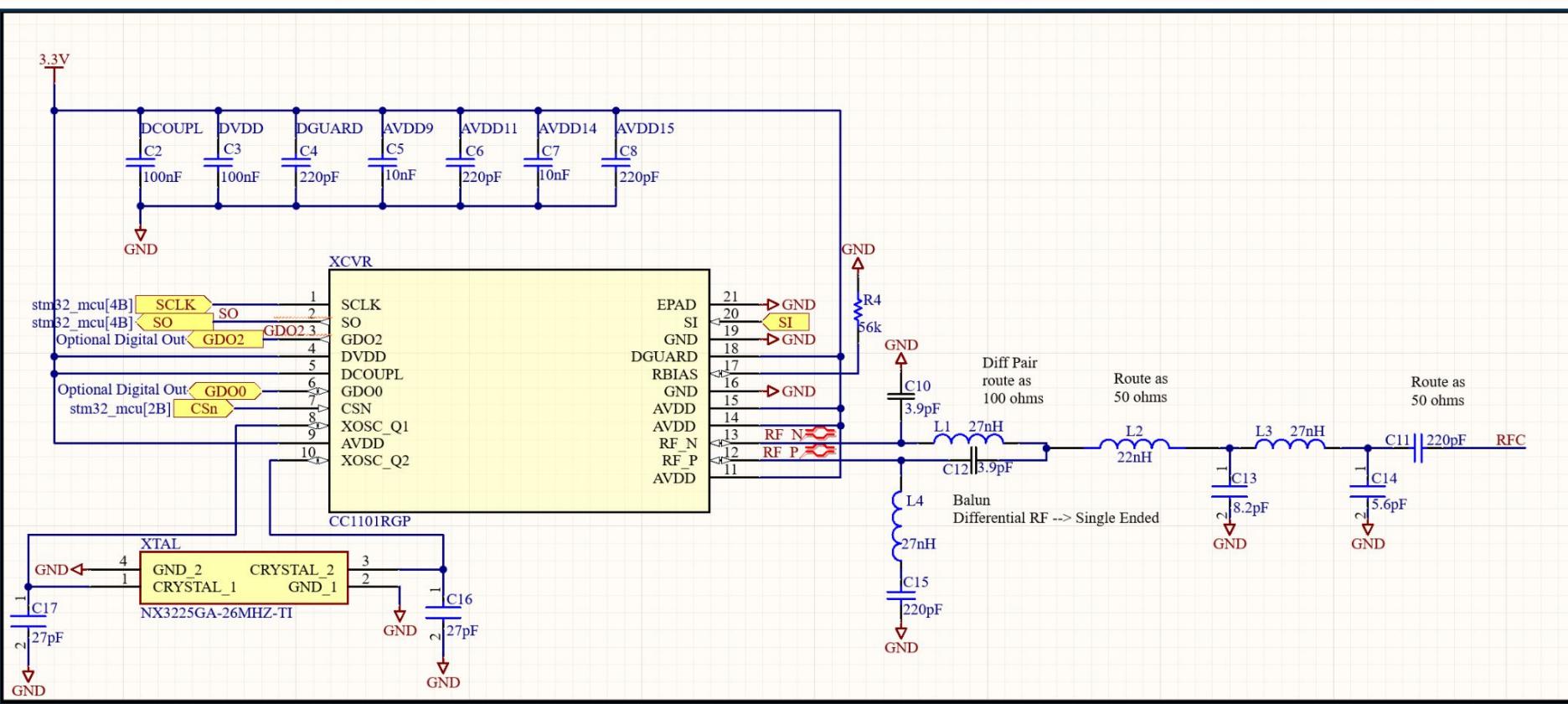
- SAW Filter on RX input
- 50 Ohm single ended impedance lines

Complementary Pin Control

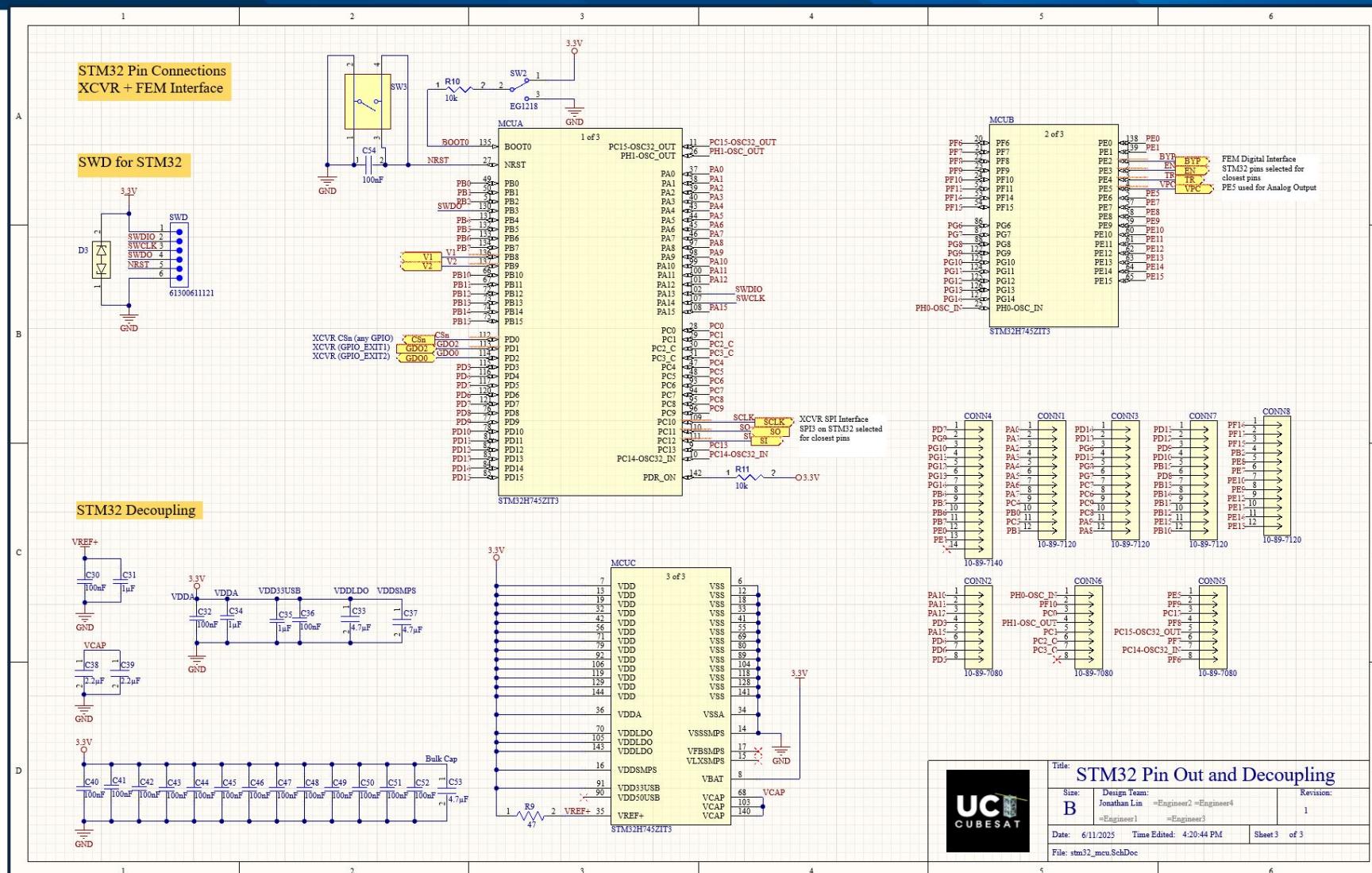
V1 = HIGH & V2 = LOW : RF1
V1 = LOW & V2 = HIGH : RF2



- DC Blocking capacitors on the RF lines
 - Very small resistance capacitors
- Complementary Pin control interface via MCU

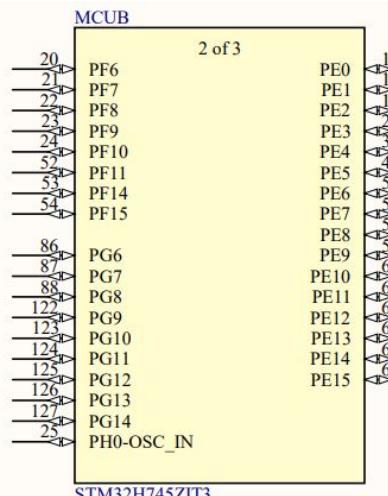
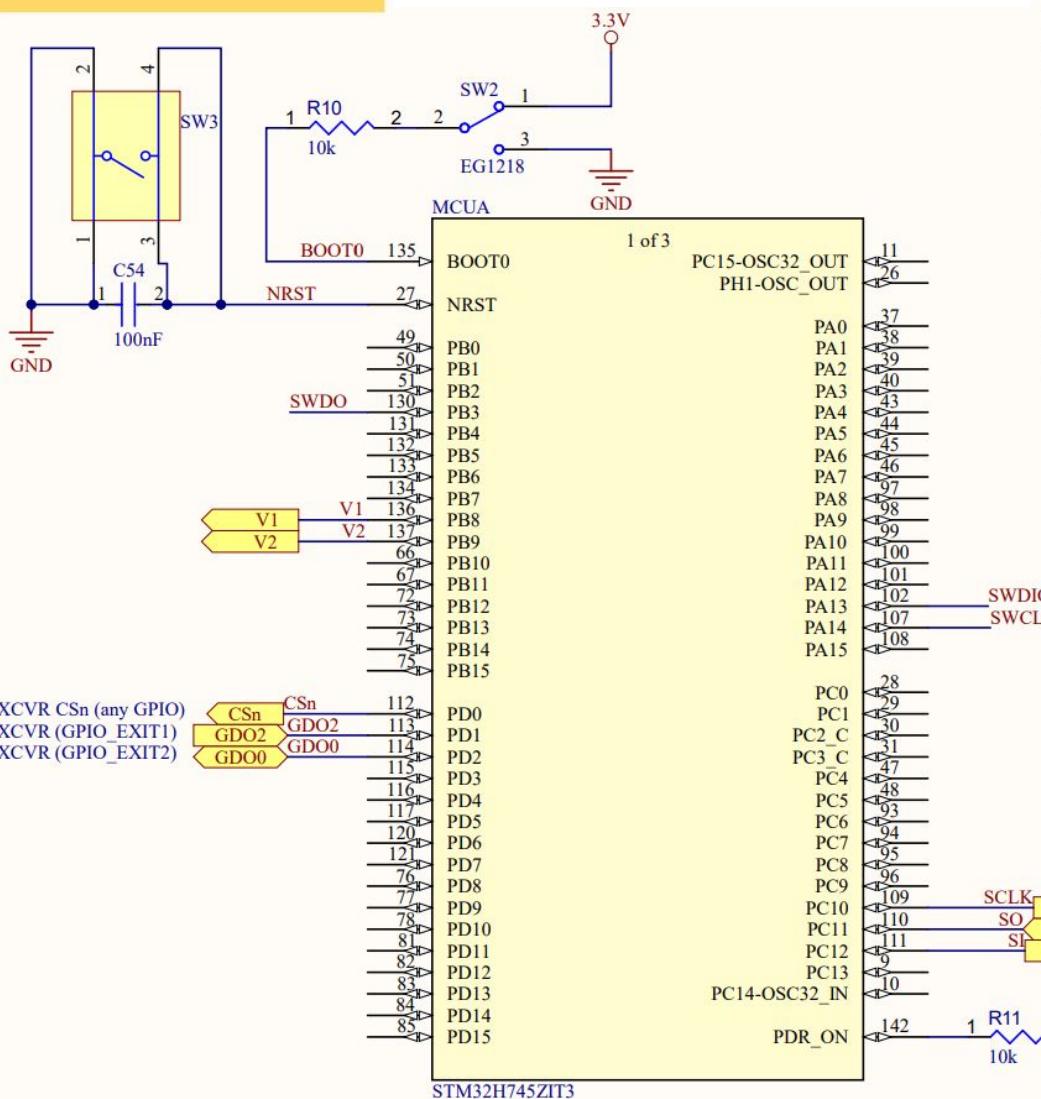


- Power supply decoupling capacitors on every power pin
- Balun network
- Crystal oscillator for RF transmission



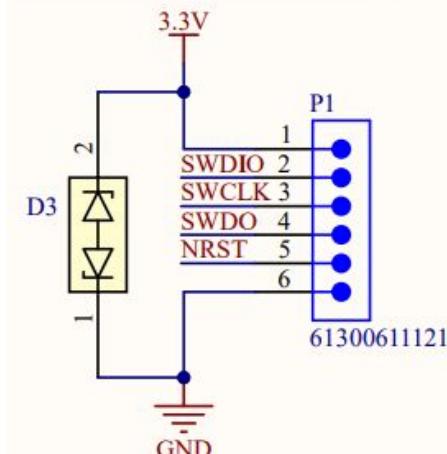
- Power pin decoupling
 - SWD (Serial Wire Debug) connector

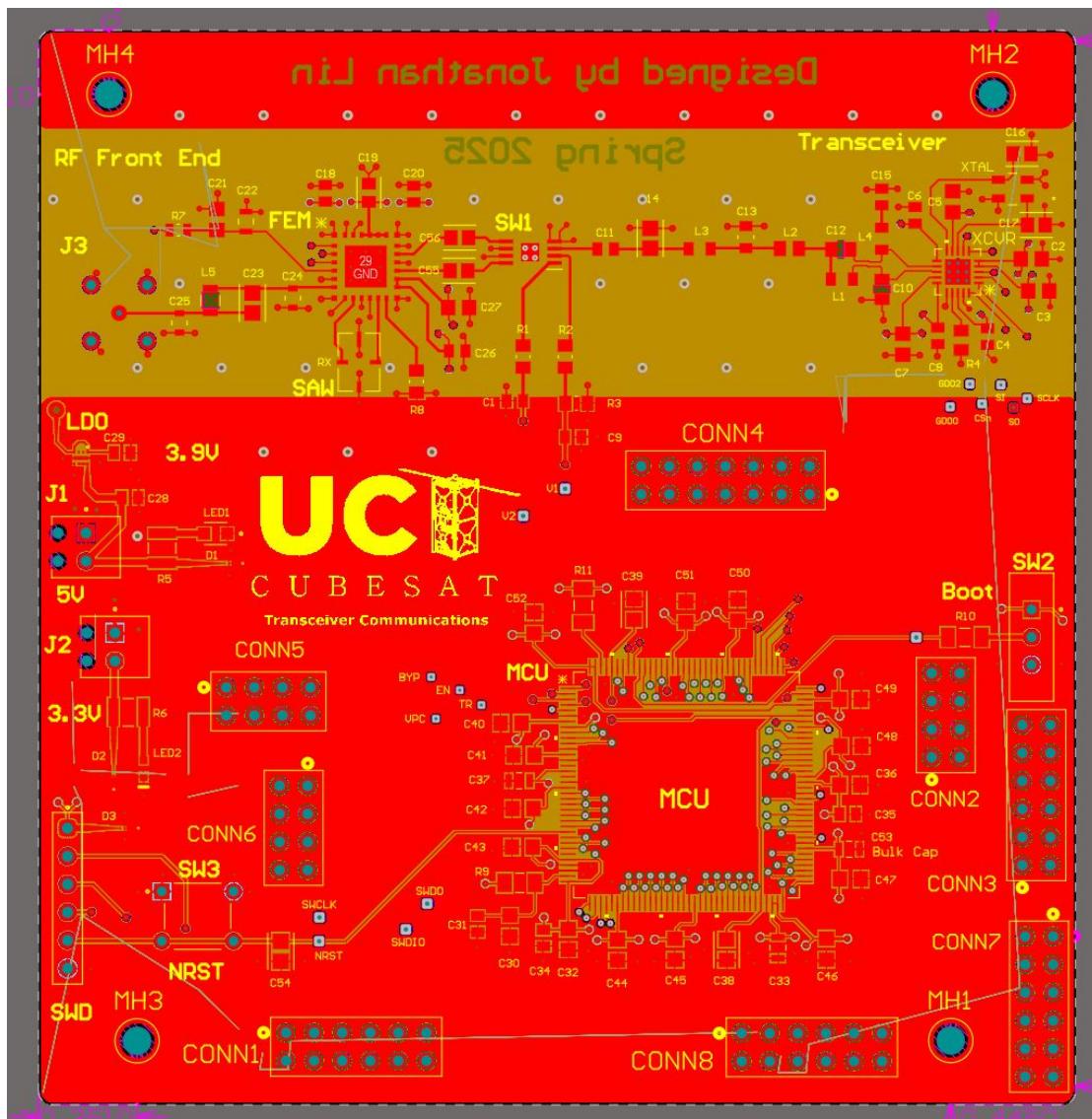
STM32 Pin Connections XCVR + FEM Interface



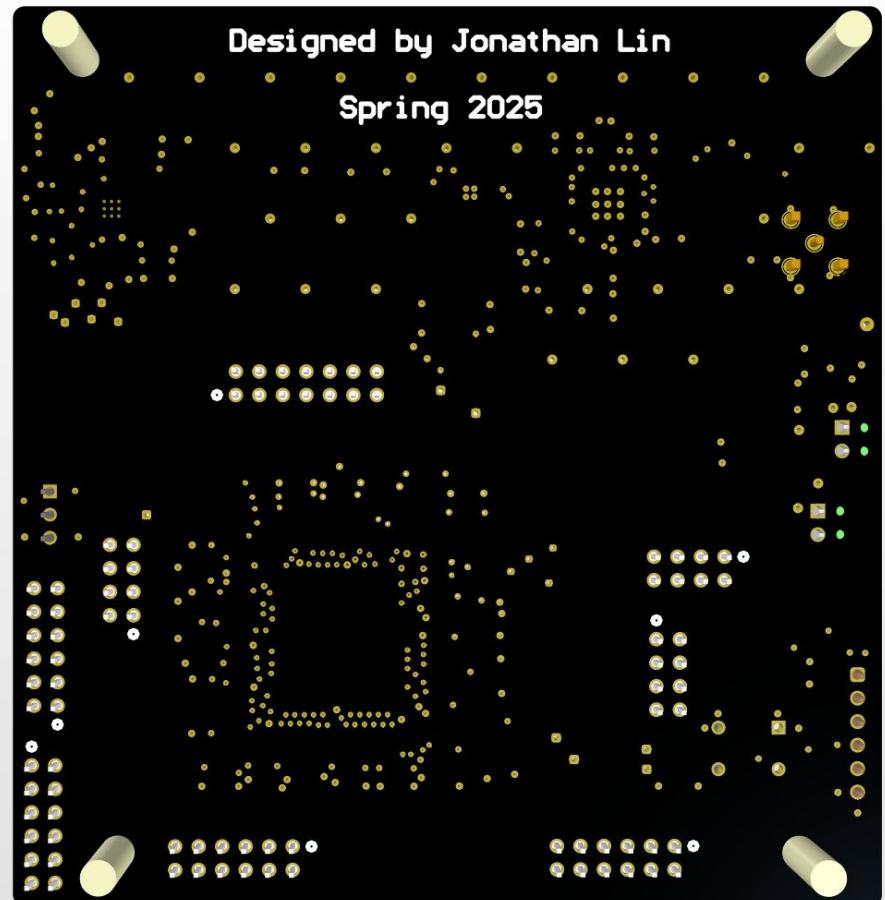
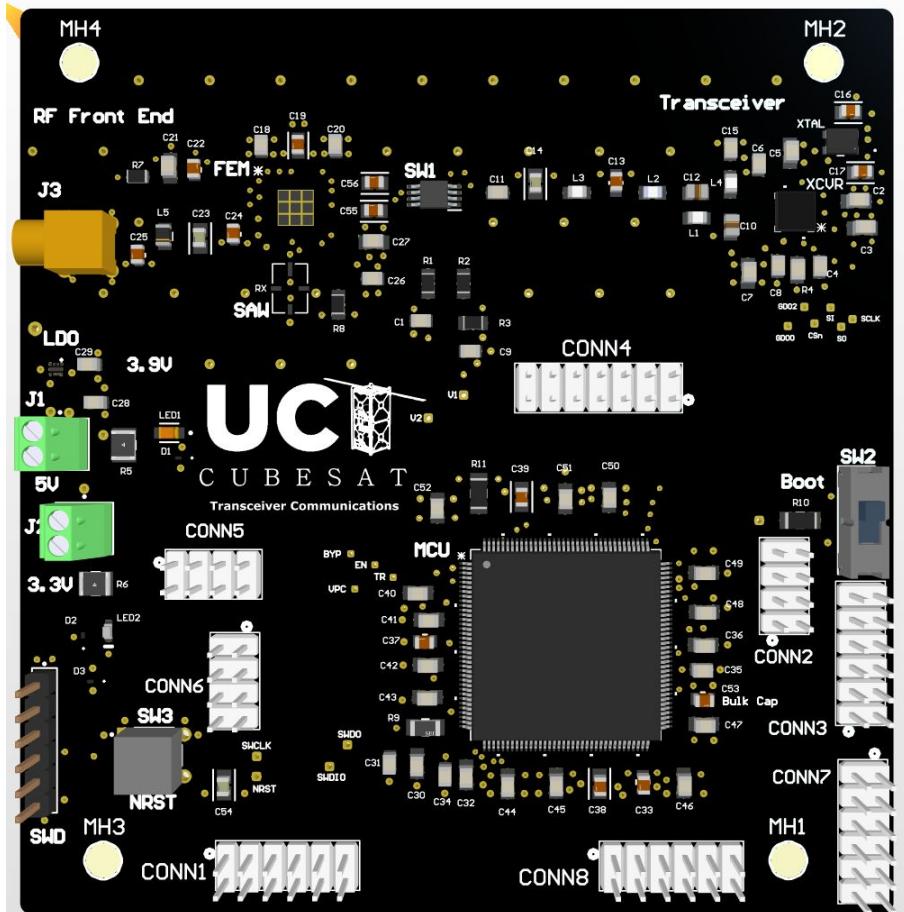
FEM Digital Interface
STM32 pins selected for
closest pins
PE5 used for Analog Output

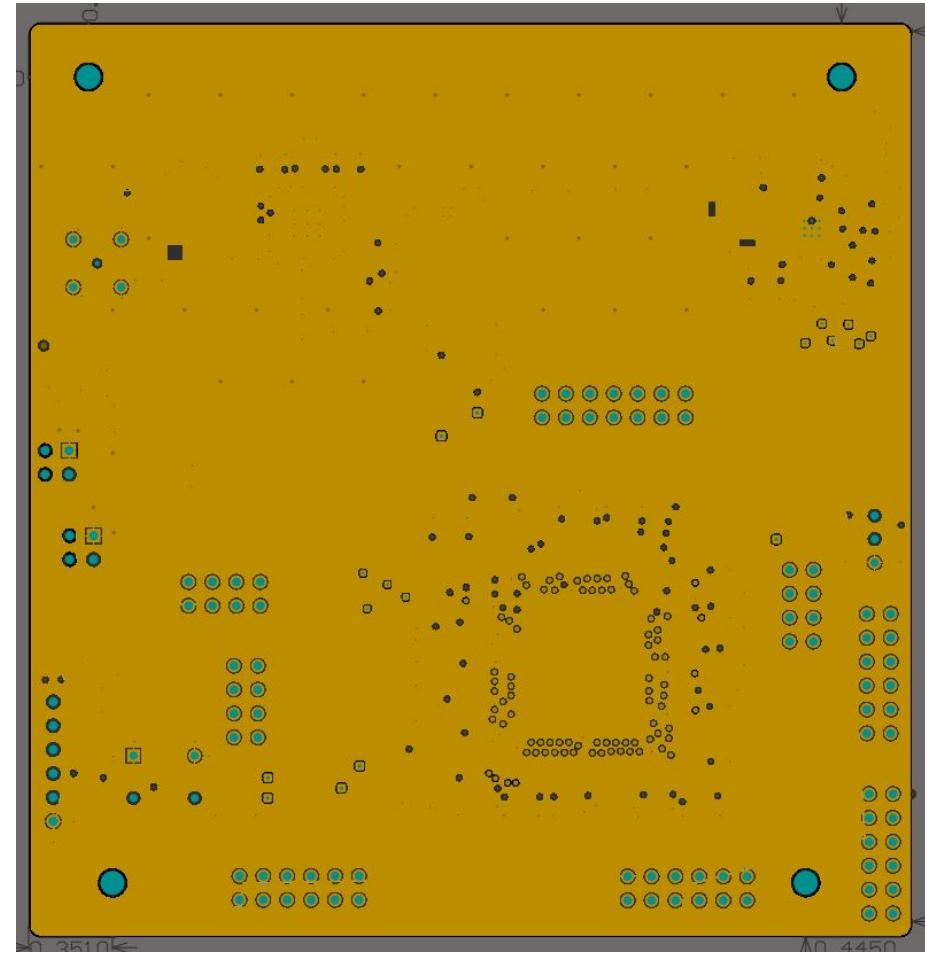
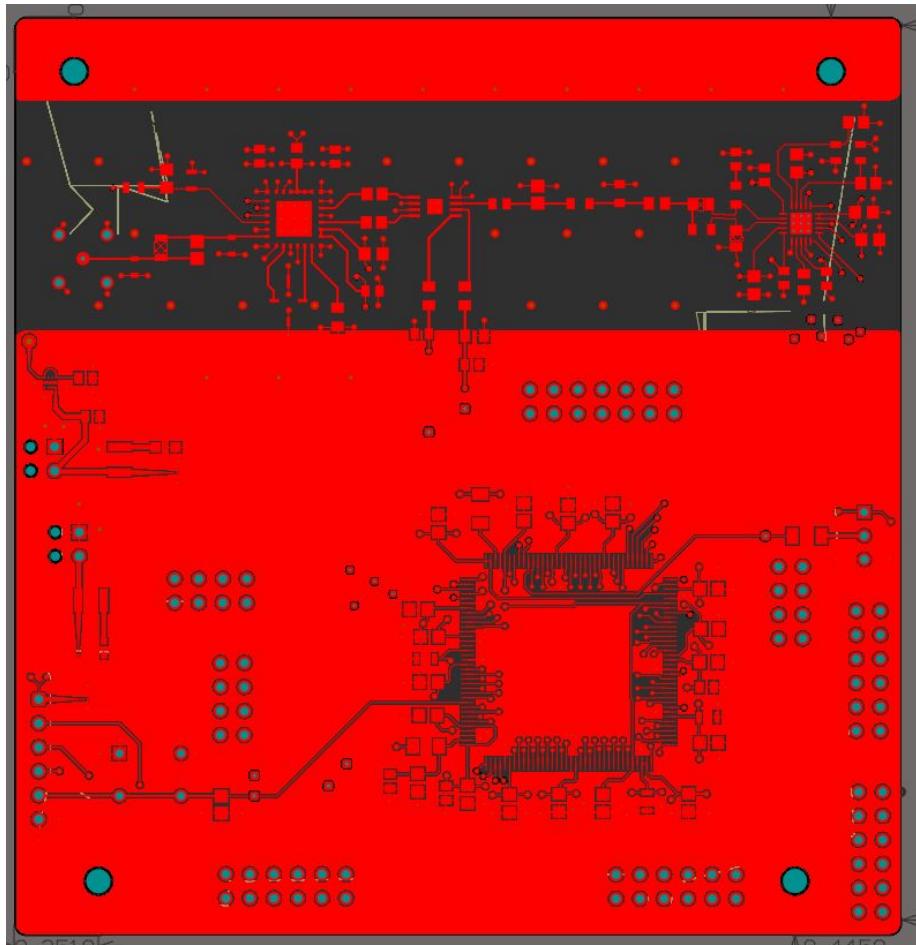
SWD for STM32



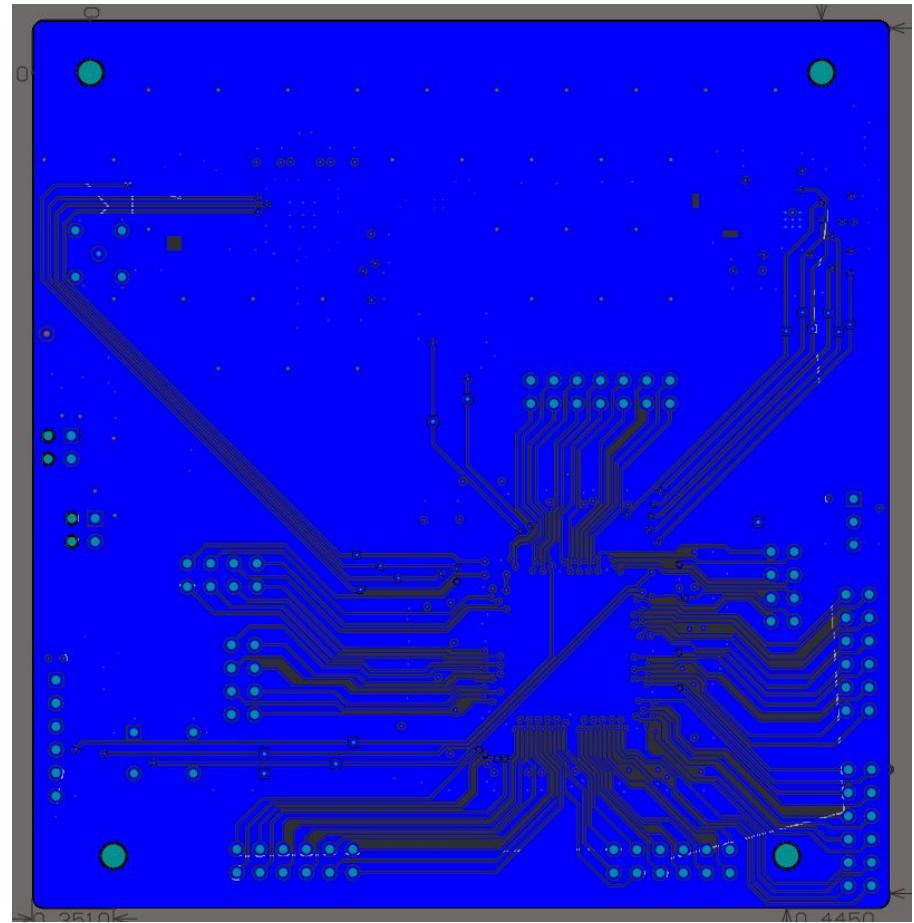
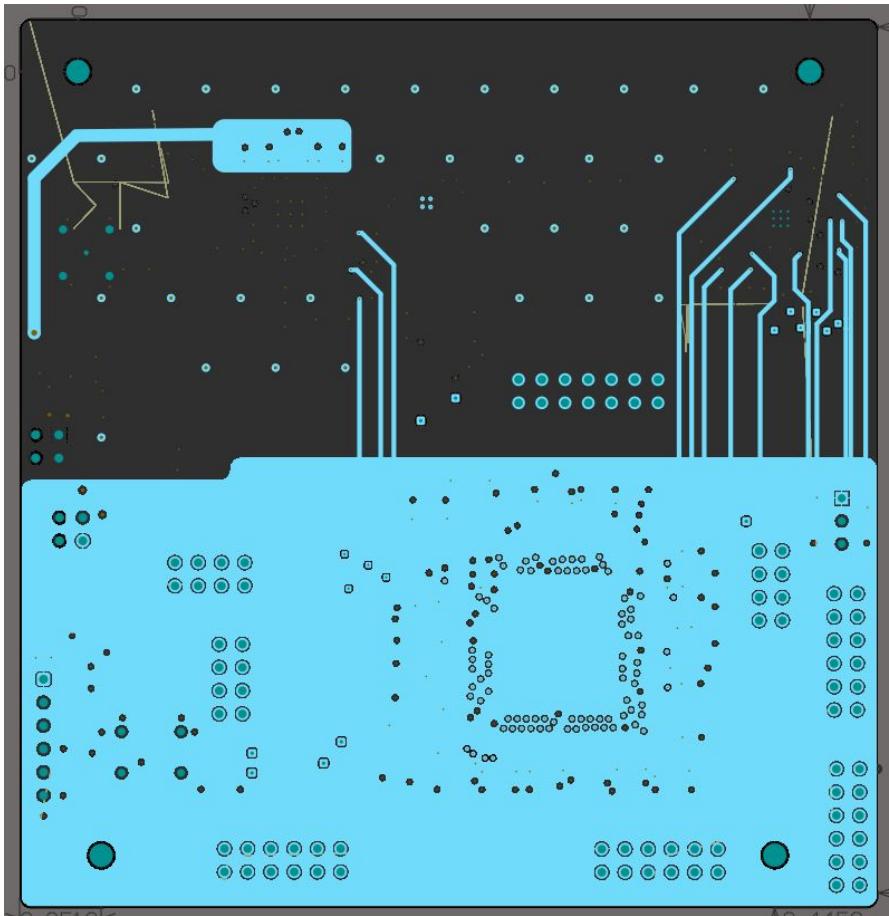


- View of 2D all layers
- MCX Connector to antenna
- Power ports interface with EPS board
- Screw standoff holes
- Isolated RF section
- 2 power rails
 - 3.3V
 - 3.9V





- Differential pair routing + 50 Ohm impedance routing on L1
- Solid ground plane on L2



- Power routing on L3
- Digital signals routing on L4

< H161H-3313(Finished thickness 1.56mm±10%)		JLC04161H-3313A(Special/Finished thickness 1.58mm±10%)		JLC04161H-7628(Standard/Finished thickness 1.59mm±10%) >			
Impedance (Ω)	Type	Signal Layer	Top Ref	Bottom Ref	Trace Width	Trace Spacing	Impedance trace to copper
100	Coplanar Differential Pair	L1	/	L2	7.3500	7.0000	8.0000
50	Coplanar Single Ended	L1	/	L2	13.4800	/	20.0000
Layer	Material			Thickness (mil)		Thickness (mm)	
L1	Outer Copper Weight 1oz			1.38		0.0350	
Prepreg	7628, RC 49%, 8.6 mil			8.28		0.2104	
L2	Inner Copper Weight			0.60		0.0152	
Core	1.1mm H/HOZ with copper			41.93		1.0650	
L3	Inner Copper Weight			0.60		0.0152	
Prepreg	7628, RC 49%, 8.6 mil			8.28		0.2104	
L4	Outer Copper Weight 1oz			1.38		0.0350	

2) JLC04161H-7628 Stackup

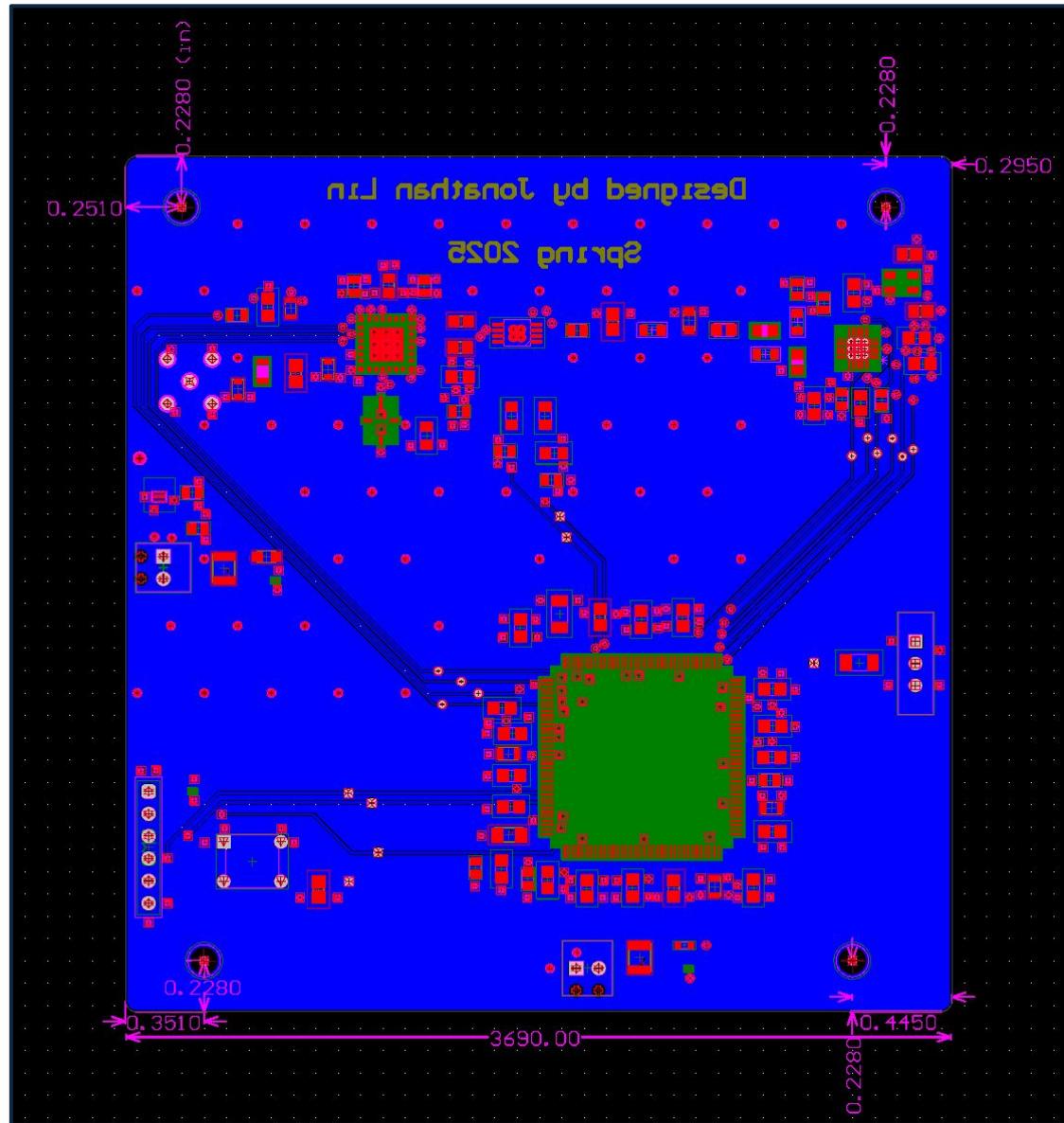
Layer	Material Type	Thickness	
Top Layer	Copper	0.035mm	
Prepreg	7628*1	0.21040mm	
Inner Layer L2	Copper	0.0152mm	
Core>	Core	1.065mm	1.1mm H/HOZ with copper
Inner Layer L3	Copper	0.0152mm	
Prepreg	7628*1	0.21040mm	
Bottom Layer	Copper	0.035mm	

- 4 layers
- JLC PCB Impedance Calculator

Home Page [1] jlin_transceiver_prototype.SchDoc transceiver_board_V1.PcbDoc * transceiver_board_V1.PcbDoc [Stackup] * CAMtastic_updated.Cam

+ Add Modify Delete

#	Name	Material	Type	Weight	Thickness	Dk	Df
	Top Overlay		Overlay				
	Top Solder	Solder Resist	Solder Mask		0.01001mm	3.3	
1	L1-CU	CF-004	Signal	1oz	0.03505mm		
	Dielectric 1	PP-023	Prepreg		0.21844mm	4.5	0.02
2	L2-CU	CF-004	Signal	1/2oz	0.01524mm		
	Core	FR4	Core		1.06502mm	4.6	0.02
3	L3-CU	CF-004	Signal	1/2oz	0.01524mm		
	Dielectric 3	PP-023	Prepreg		0.21844mm	4.5	0.02
4	L4-CU	CF-004	Signal	1oz	0.03505mm		
	Board Layer Stac...	Solder Resist	Solder Mask		0.01001mm	3.3	
	Board Layer Stac...		Overlay				



Item Details											Primary Solution				
Line #	Name	Description	Designator	Revision ID	Revision Status	Quantity	Manufacturer 1	Manufacturer Part Number 1	Manufacturer Lifecycle 1	Supplier 1	Supplier Part Number 1	Supplier Status			
1	SKY65366-21	RF and Baseband Ci...	FEM	CMP-00025...	Up to date	1	Skyworks Soluti...	SKY65366-21	Volume Production	Newark	65T8836	⚠️			
2	ERJ-6GEYJ563V	Fixed Resistor, Metal...	R4			1	Panasonic	ERJ-6GEYJ563V	Volume Production	Newark	98K7773	⚠️			
3	Resistor 0R +/- 5%...	Chip Resistor, 0 Ohm...	R1, R2, R3, R8			4	Yageo	RC0805JR-070RL	Volume Production	Newark	311-10.0KFRCT-ND	⚠️			
4	CRCW1210150RJNEA	Fixed Resistor, Metal...	R5, R6			2	Vishay Dale	CRCW1210150RJNEA	Volume Production	Arrow Elec...	CRCW1210150RJNEA	⚠️			
5	Resistor 10k +/-1%	Chip Resistor, 10 KO...	R10, R11			2	Yageo	RC1206FR-0710KL	Volume Production	Digikey	CC0805CRNPO9BN3R9	⚠️			
6	CC0805CRNPO9BN...	3.9 pF ±0.25pF 50V...	C10, C12			2	Yageo	CC0805CRNPO9BN3R9	Volume Production	Arrow Elec...	CC0805CRNPO9BN3R9	⚠️			
7	C0805C309C5GACTU	Ceramic Capacitor,...	C23			1	KEMET	C0805C309C5GACTU	Volume Production	Newark	68AC4840	⚠️			
8	C0805C104K5RACTU	Ceramic Capacitor,...	C54			1	KEMET	C0805C104K5RACTU	Volume Production	Newark	19C6015	⚠️			
9	1825910-6 Tact Swit...	Keypad Switch, 1 Sw...	SW3			1	TE Connectivity...	1825910-6	Volume Production	Avnet	1825910-6	⚠️			
10	GRM2165C1H221JA...	Ceramic Capacitor,...	C4, C6, C8, C11, C15...			7	Murata	GRM2165C1H221JA01D	Not Recommended for N...	Digikey	490-1616-1-ND	⚠️			
11	AIMC-0805-22NJ-T	General Purpose Ind...	L2			1	Abracan	AIMC-0805-22NJ-T	Volume Production	Digikey	535-11560-1-ND	⚠️			
12	RMCF1206JT47R0	Fixed Resistor, Metal...	R9			1	Stackpole Electr...	RMCF1206JT47R0	Volume Production	Digikey	RMCF1206JT47R0CT-ND	⚠️			
13	GRM21BR71C105K...	Ceramic Capacitor,...	C20, C28, C29, C31,...			6	Murata	GRM21BR71C105KA01L	Volume Production	Farnell	4327079	⚠️			
14	AIMC-0805-12NJ-T	General Purpose Ind...	L5			1	Abracan	AIMC-0805-12NJ-T	Volume Production	Digikey	535-11555-1-ND	⚠️			
15	GRM2165C2A102JA...	Ceramic Capacitor,...	C19			1	Murata	GRM2165C2A102JA01D	Volume Production	Digikey	490-6445-1-ND	⚠️			
16	GRM2165C1H101JA...	Ceramic Capacitor,...	C1, C9			2	Murata	GRM2165C1H101JA01D	Not Recommended for N...	Digikey	490-1615-1-ND	⚠️			
17	GRM2195C1H472JA...	Ceramic Capacitor,...	C22			1	Murata	GRM2195C1H472JA01D	Volume Production	Digikey	490-1634-1-ND	⚠️			
18	LTST-C190KRKT	LED Uni-Color Red,...	LED2			1	Vishay Lite-On	LTST-C190KRKT	Volume Production	ouser	859-LTST-C190KRKT	⚠️			
19	RC0805FR-0710KL	Fixed Resistor, Metal...	R7			1	Yageo	RC0805FR-0710KL	Volume Production	ouser	603-RC0805FR-0710KL	⚠️			
20	GRM21BR72A104K...	Ceramic Capacitor,...	C2, C3, C21, C30, C3...			19	Murata	GRM21BR72A104KAC4L	Not Recommended for N...	ouser	81-GRM21BR72A104KAC4L	⚠️			
21	GRM21BR71E225KE...	Ceramic Capacitor,...	C38, C39			2	Murata	GRM21BR71E225KE11L	Volume Production	Digikey	490-14467-1-ND	⚠️			
22	LTST-C170KFKT	Single Color LED, Or...	LED1			1	Vishay Lite-On	LTST-C170KFKT	Volume Production	Digikey	160-1413-1-ND	⚠️			
23	GRM21BR72A103K...	Ceramic Capacitor,...	C5, C7, C27			3	Murata	GRM21BR72A103KA01K	Not Recommended for N...	Digikey	490-11603-1-ND	⚠️			
24	NCP186AMX390TAG	Fixed Positive LDO R...	LDO			1	ON Semiconduc...	NCP186AMX390TAG	Volume Production	Heisener	NCP186AMX390TAG	⚠️			
25	7447880127	Multilayer Inductor,...	L1, L3, L4			3	Wurth Electronics	7447880127		Digikey	732-7447880127CT-ND	⚠️			
26	KGM21BCG2A8R2DT	Cap Cer 8.2PF 100V...	C13			1	Kyocera AVX	KGM21BCG2A8R2DT		Digikey	478-KGM21BCG2A8R2D...	⚠️			