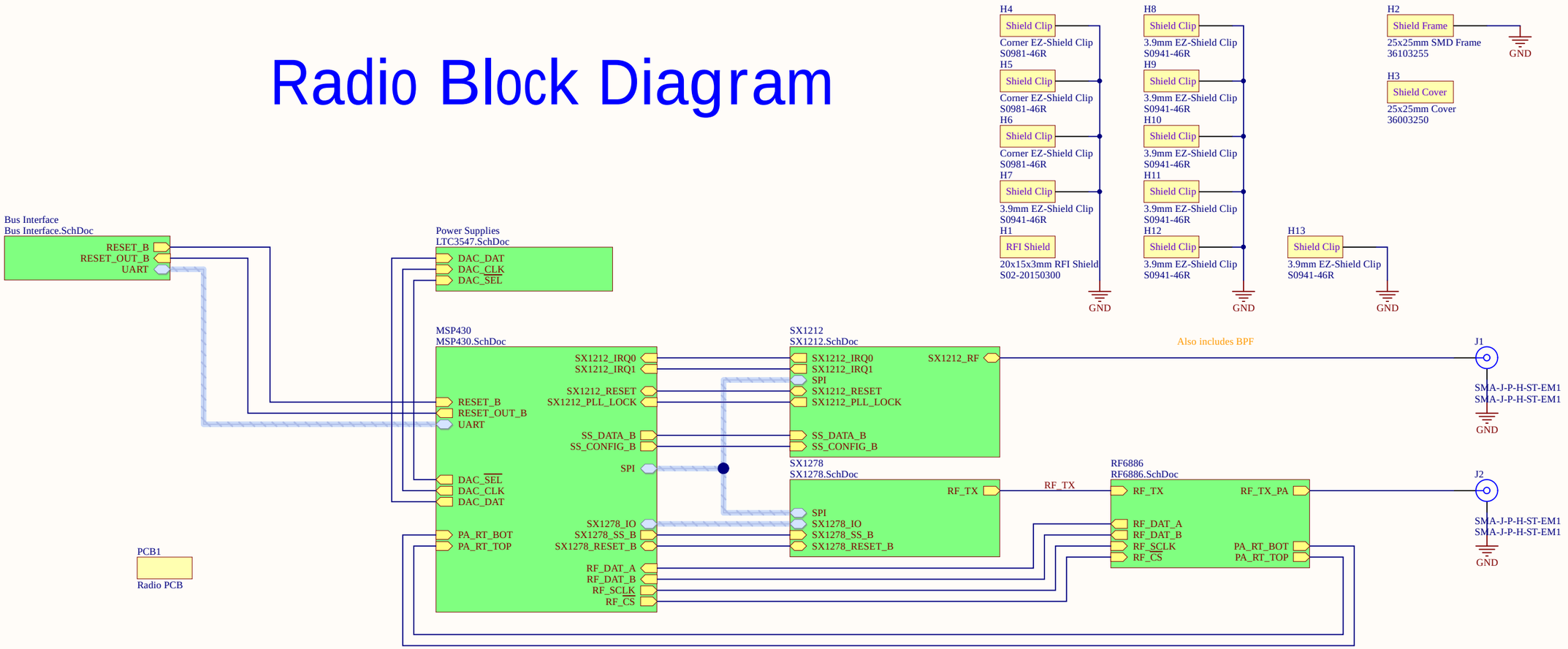
Radio Block Diagram



Revision Log File

Version B

1. Mechanical changes: Increased board size to 47mm x 47mm. Increased hole size to 3mm diameter. Increased thermal connection of holes by making planes and pours direct connect. Recessed SMA connectors by 1.75mm (2.75mm from new edge).
2. RX path changes: Added an LNA to the RX path. Improved the RF sheilding of the RX path.
3. TX path changes: Improved the RF sheilding of the TX path. Removed the LF part of the TX path.
4. Fixed all DRC problems. Increased the width of many (but not all) 6mm wires to 8mm (7mm in some cases). Removed all vias in pads.
5. Updated and made corrections to BOM. Updated discrete components in BOM: capacitors and inductors.
6. Removed solder mask above all 50 ohm signals
7. Replaced two out of stock components: XTL1020P 12.8 MHz crystal, and TPS82085 3A step-down converter module.
8. Changed voltage supply to 3V3 for new LNA.
9. Added probe pads for SCLK, MISO, and MOSI.
10. Added 4 LEDs for debugging
11. Removed thermal relief from thermal pipes for heat sync.
12. Replaced SAW filter with one that has correct center frequency (460 MHz).

Revision Log File

Version C

13. Corrected power to LNA, Connected to output (pin 1) insted of input (pin 4).
14. Added 10 uF cap (C19) to RF6886, pin 1.
15. Corrected footprints for:
    U15 (pinout error which caused the LEDs to not work),
    F1 (missing pin 1 indicator which was misleading to the assembler),
    U4 (added solder paste to pads which meant solder had to be added by hands)
16. Re-routed interconnect to U15 to correct error with LEDs
17. Removed VR_PA circuitry from SX1212 and left VR_PA floating.
18. Added Bead to VCC_PA circuitry attached to RF6886 and adjusted size of L4 to match reference design.
19. Corrected location of designators R8, R9 in layout.
20. Added Version info to top overlay.
21. Removed C25 (conflicted with L4) and C26 because they were not used.
22. Change C1 and C2 from 1000 pF to 100 pF
23. Changed both PA_VCC and LNA_VCC to 3V3.
    Adjusted output of Buck Converter U2 to 3V3 by changing R8 to 510K and R9 to 162K.
    Increased L10 to 1uH and added more output capacitors C3 and C4 to reduce ripple voltage.
24. Added Linear Regulator U1, C5, C6, to produce 2V5.
25. Inductor R17 renamed to L3.
26. Changed transmit attenuator AT1 from 4 dB to 2 dB.
27. Power circuit for 3V1 (Vreg1, Vreg2) changed to a 3V3 DAC connected to microcontroller.
28. Test points added to all voltage lines.

Revision Log File

Version C continued

29. Added an ADC to read voltages of PWR_SENSE and PWR_REF.
    ADC attached to microcontroller to complete control loop for TX PA.
30. Dumb inputs to microcontroller removed: LNA_SENSE, LNA_EN,
    PA_EN, PA_GOOD, PWR_SENSE, PWR_REF.
31. Made 3 test point I/O from microcontroller.
32. Added tapers to TX and RX connections to SMA connectors.

TO DO:
1. Specification of properly sized heat sink.
2. Power system. Input 3V3 instead of 5V. (Change initial buck converter to Buck-Boost converter.
3. Replace MSP430 with ARM M4 (STM32F423XH) ?
4. Change 6-pin connect to Picoblade connector + ziptie to match EPS board.

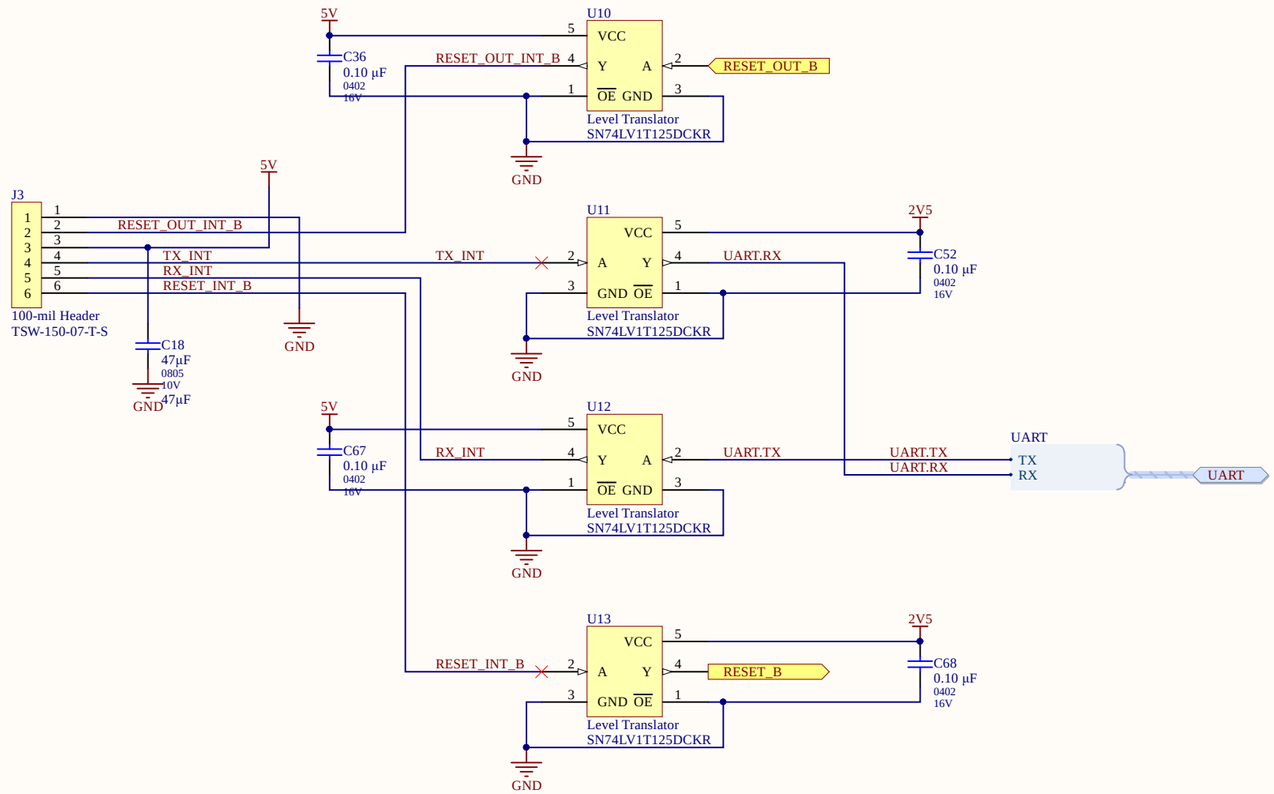
Title	**Radio Block Diagram**		*Altium Limited* *L3, 12a Rodborough Rd* *Frenchs Forest* *NSW* *Australia 2086*
Size: Tabloid	Number:1	Revision:	
Date: 12/8/2018	Time: 10:53:06 AM	Sheet 1 of 8	
File: C:\Users\Doran\Dropbox\Elysium\Altium\Elysium C\Block Diagram.SchDoc			

CIRCUITSTUDIO

Interface Level Translators

DESIGN NOTE:

Future: Convert the interface to 3.3V instead of 5V.



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Date: 12/8/2018	Time: 10:53:06 AM	Sheet2 of 8	
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Power Supply

DESIGN NOTE:

R8 / R9 (FB) = 510K / 162K (from WebBench)

Provides 3.3V at 3A max current.

DESIGN NOTE:

RF6886 Power Amplifier
3.3 V, 2.1 A for VCC_PA

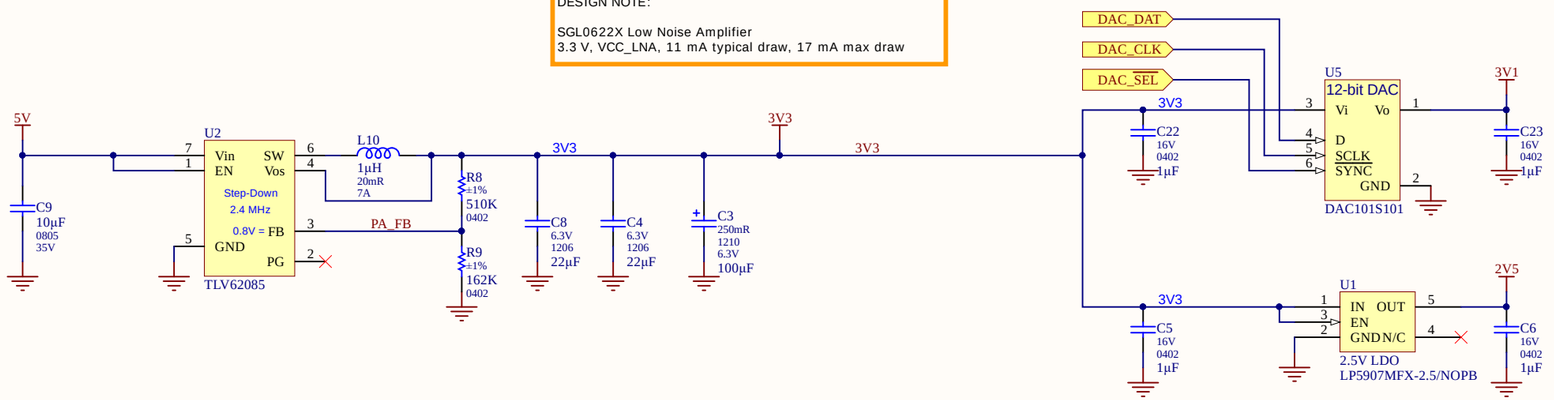
DESIGN NOTE:

SGL0622X Low Noise Amplifier
3.3 V, VCC_LNA, 11 mA typical draw, 17 mA max draw

DESIGN NOTE:

DAC is used for the Vreg1 and Vreg2 of the RF6886 Power Amp.

DAC Vout, 50 mA > 3 mA x 2 required by RF6886.



DESIGN NOTE:

2.5 V, 250 mA used for :

microcontroller, ?????
SX1276 Transmitter, 120 mA max when transmitting
SX1212 Receiver, 85 uA idle, 3 mA max

Title	***Power Supply***		*Altium Limited* *L3, 12a Rodborough Rd* *Frenchs Forest* *NSW* *Australia 2086*
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Date: 12/8/2018	Time: 10:53:07 AM	Sheet3 of 8	
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CIRCUITSTUDIO

MicroController

Address + WP pins pulled down internally

U9
1 Mbit FRAM
FM24V10-G

Thermistors

U3A
MSP430FR5969
MSP430FR5969

U3B
MSP430FR5969
MSP430FR5969

SPI
UART

U3C
MSP430FR5969
MSP430FR5969

U3D
MSP430FR5969
MSP430FR5969

U3E
MSP430FR5969
MSP430FR5969

U4
1.9V LDO
LP5907UVX19/NOPB

Y1
SiT1552AI-JE-DCC-32.768

Y2
24MHz

DESIGN NOTES:

SX1278_IO.DIO4 is PLL_LOCK for the SX1276

GPIO P2.2 and PJ.2 outputs may drive LEDs.

P2.4 is pre-wired to TP3. If TP3 is driven by something else, the processor needs to not drive P2.4 (make it an input).

Do not populate both resistors

J4
100-mil Header
TSW-150-07-T-S

U3F
MSP430FR5969
MSP430FR5969

U15A
U15B
U15C
U15D
U15E

Title	MicroController		
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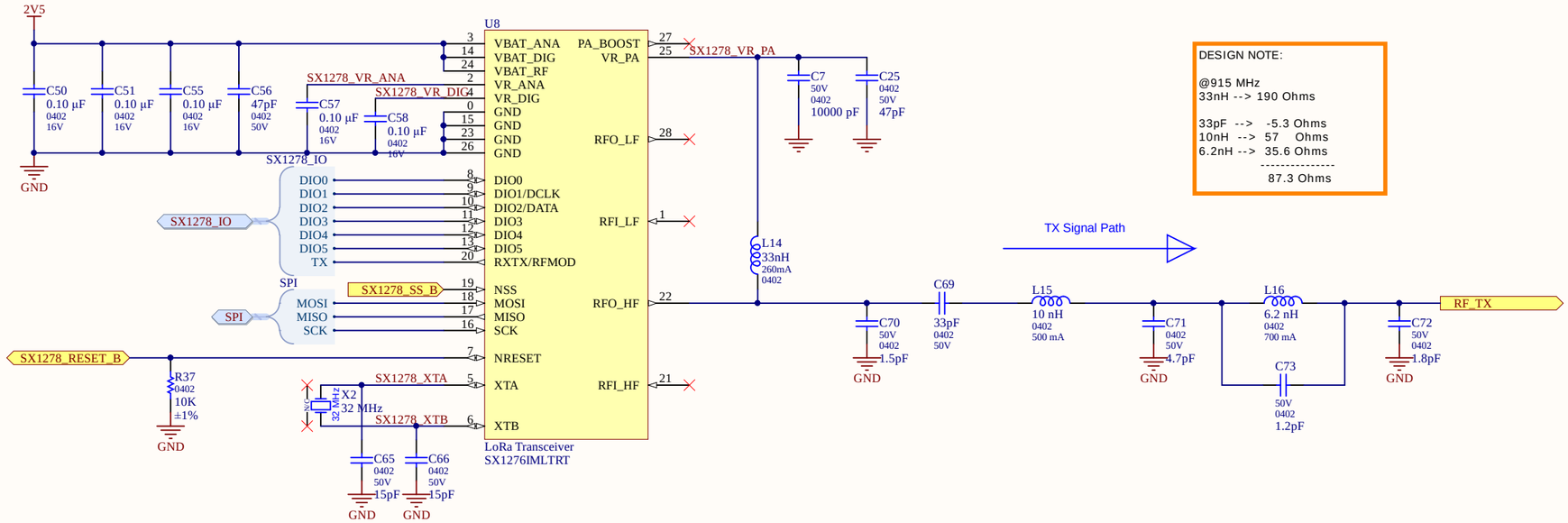
CIRCUITSTUDIO

Transmitter

DESIGN NOTE:

Transmit frequency is 915 MHz.
At 915 MHz, the wavelength is 328mm (12.9 inches)



DESIGN NOTE:

@915 MHz
33nH --> 190 Ohms

33pF --> -5.3 Ohms
10nH --> 57 Ohms
6.2nH --> 35.6 Ohms

87.3 Ohms

Title	*Transmitter*		*Altium Limited* *L3, 12a Rodborough Rd* *Frenchs Forest* *NSW* *Australia 2086*
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Date: 12/8/2018	Time: 10:53:07 AM	Sheet5 of 8	
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CIRCUITSTUDIO

Transmitter Power Amplifier

DESIGN NOTE:

Transmit Power Amp operating at 915 MHz

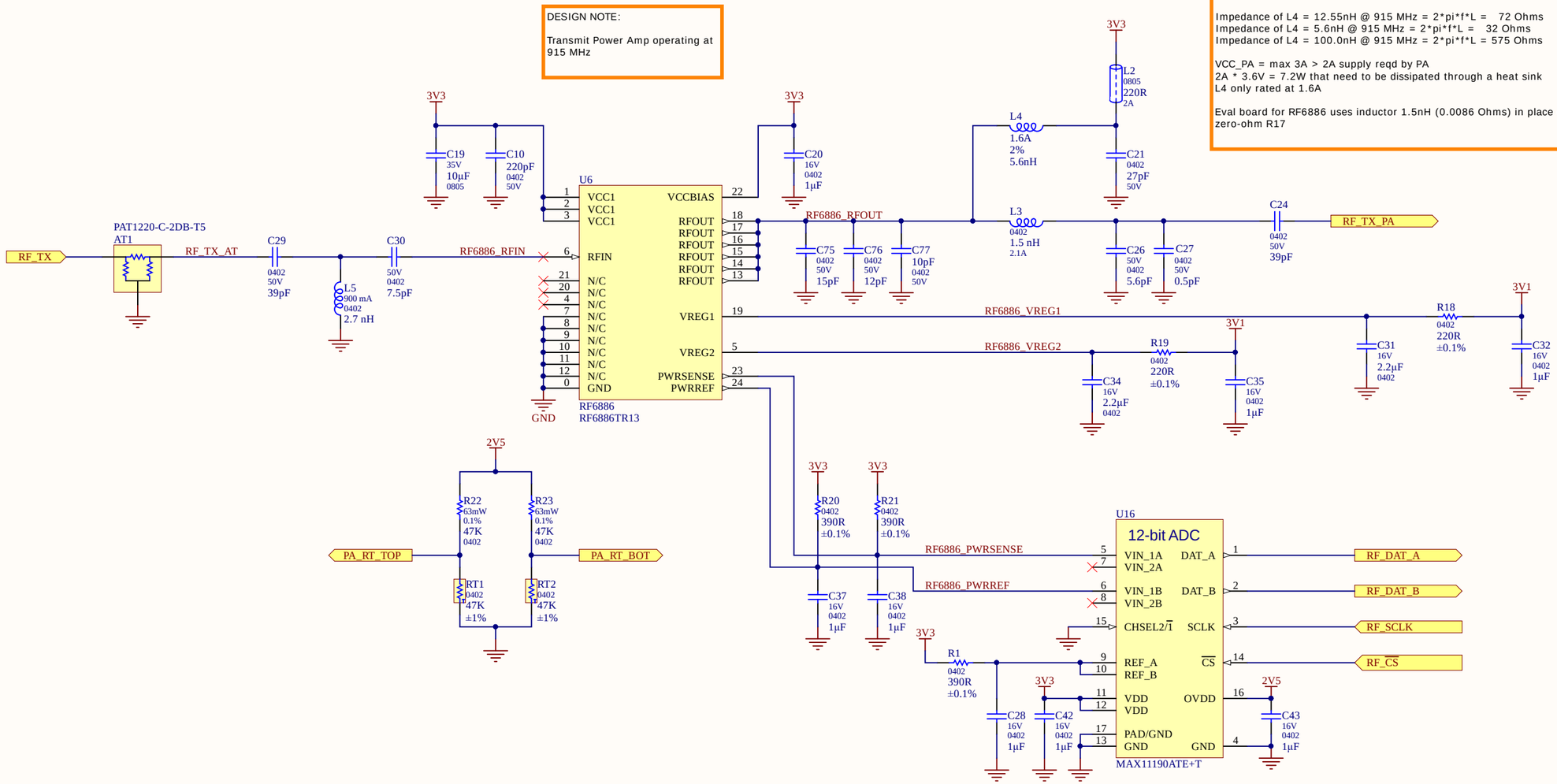
DESIGN NOTE:

Impedance of C24 = 39pF @ 915 MHz = 1 / (2*pi*f*C) = 4.46 Ohms

Impedance of L4 = 12.55nH @ 915 MHz = 2*pi*f*L = 72 Ohms
Impedance of L4 = 5.6nH @ 915 MHz = 2*pi*f*L = 32 Ohms
Impedance of L4 = 100.0nH @ 915 MHz = 2*pi*f*L = 575 Ohms

VCC_PA = max 3A > 2A supply reqd by PA
2A * 3.6V = 7.2W that need to be dissipated through a heat sink
L4 only rated at 1.6A

Eval board for RF6886 uses inductor 1.5nH (0.0086 Ohms) in place of zero-ohm R17



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Date: 12/8/2018	Time: 10:53:07 AM	Sheet6 of 8	
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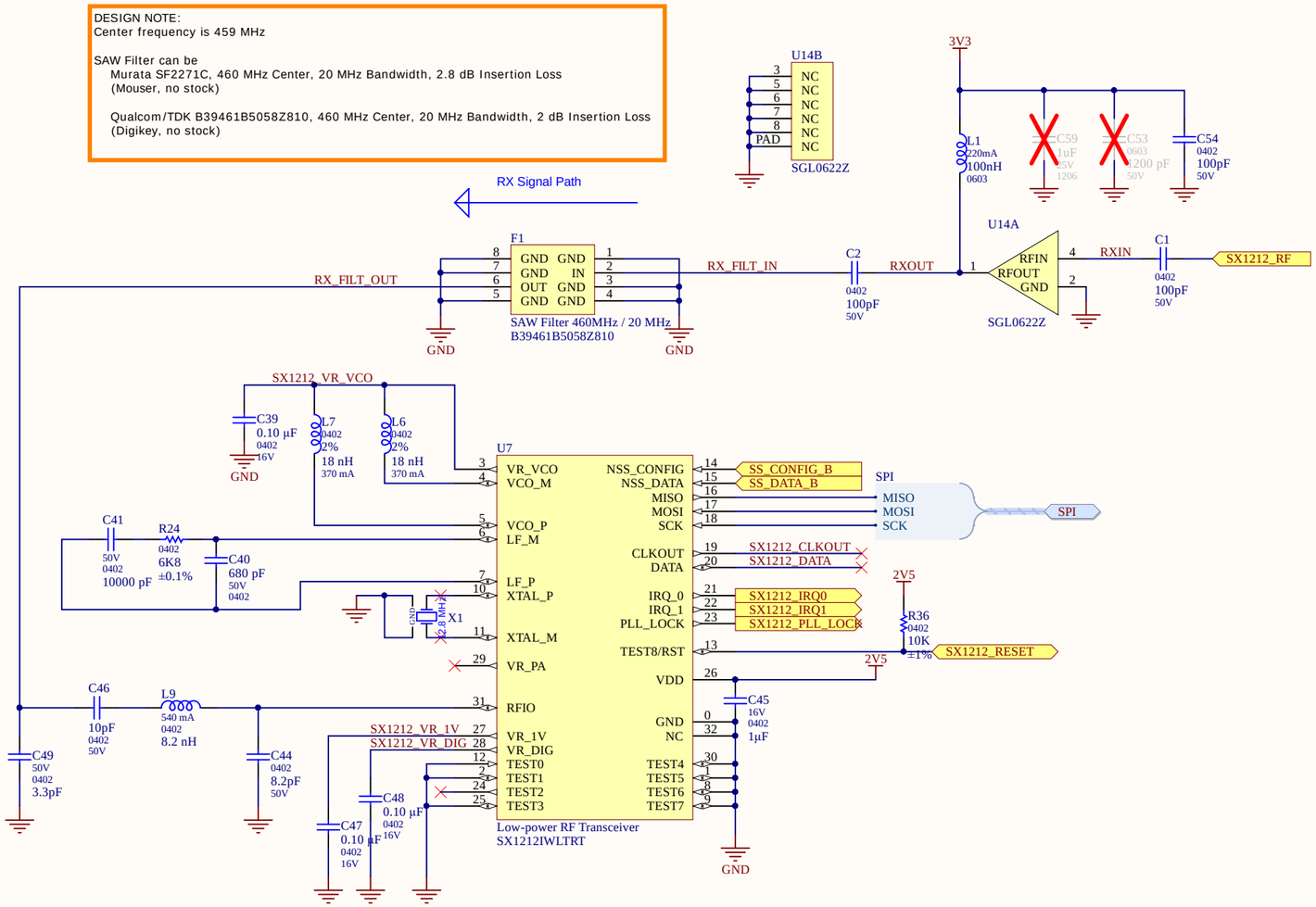
CIRCUITSTUDIO

Receiver

DESIGN NOTE:
Center frequency is 459 MHz

SAW Filter can be
Murata SF2271C, 460 MHz Center, 20 MHz Bandwidth, 2.8 dB Insertion Loss
(Mouser, no stock)

Qualcom/TDK B39461B5058Z810, 460 MHz Center, 20 MHz Bandwidth, 2 dB Insertion Loss
(Digikey, no stock)



DESIGN NOTE:

Impedance of C1 = 1000pF @ 450 MHz
= 1 / (2*pi*f*C)= 0.35 Ohms

Impedance of L1 = 1.2uH @ 450 MHz
= 2*pi*f*L = 3400 Ohms > 10*50 Ohms

VCC_LNA = 25 mA > 15 mA supply reqd by LNA

Title: **Receiver**			*Altium Limited* *L3, 12a Rodborough Rd* *Frenchs Forest* *NSW* *Australia 2086*
Size: Tabloid	Number: 8	Revision:	
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