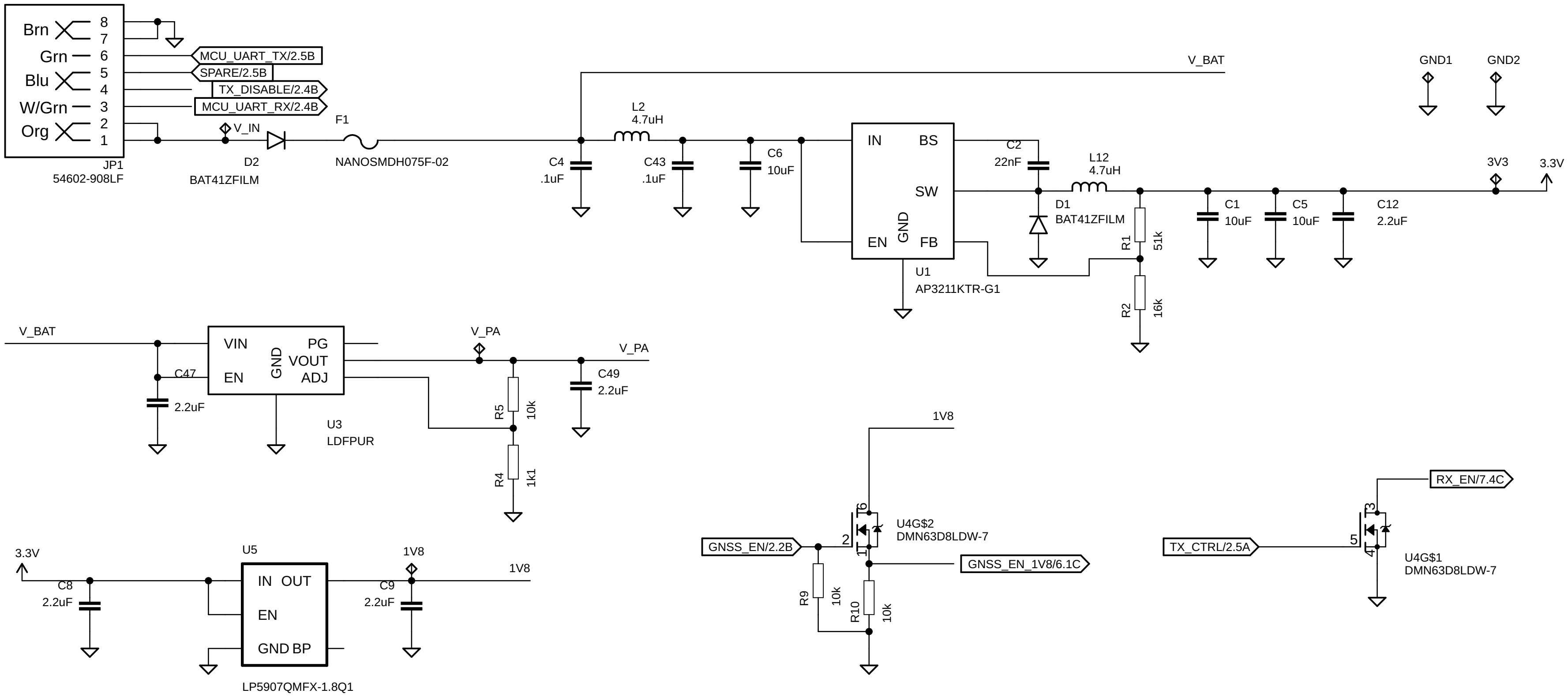
The device needs 3 voltages: 3.3V, 1.8V and 8V with a 700mA capacity.

Since we operate from 12V battery, a buck regulator is used to derive the 3.3V. Bucks present a lot of noise at their input, so there is an LC filter there to avoid turning the cable into a broadband VHF noise emitter.



MAIANA™ AIS Transponder

Connections & Power

transponder-6.2.0

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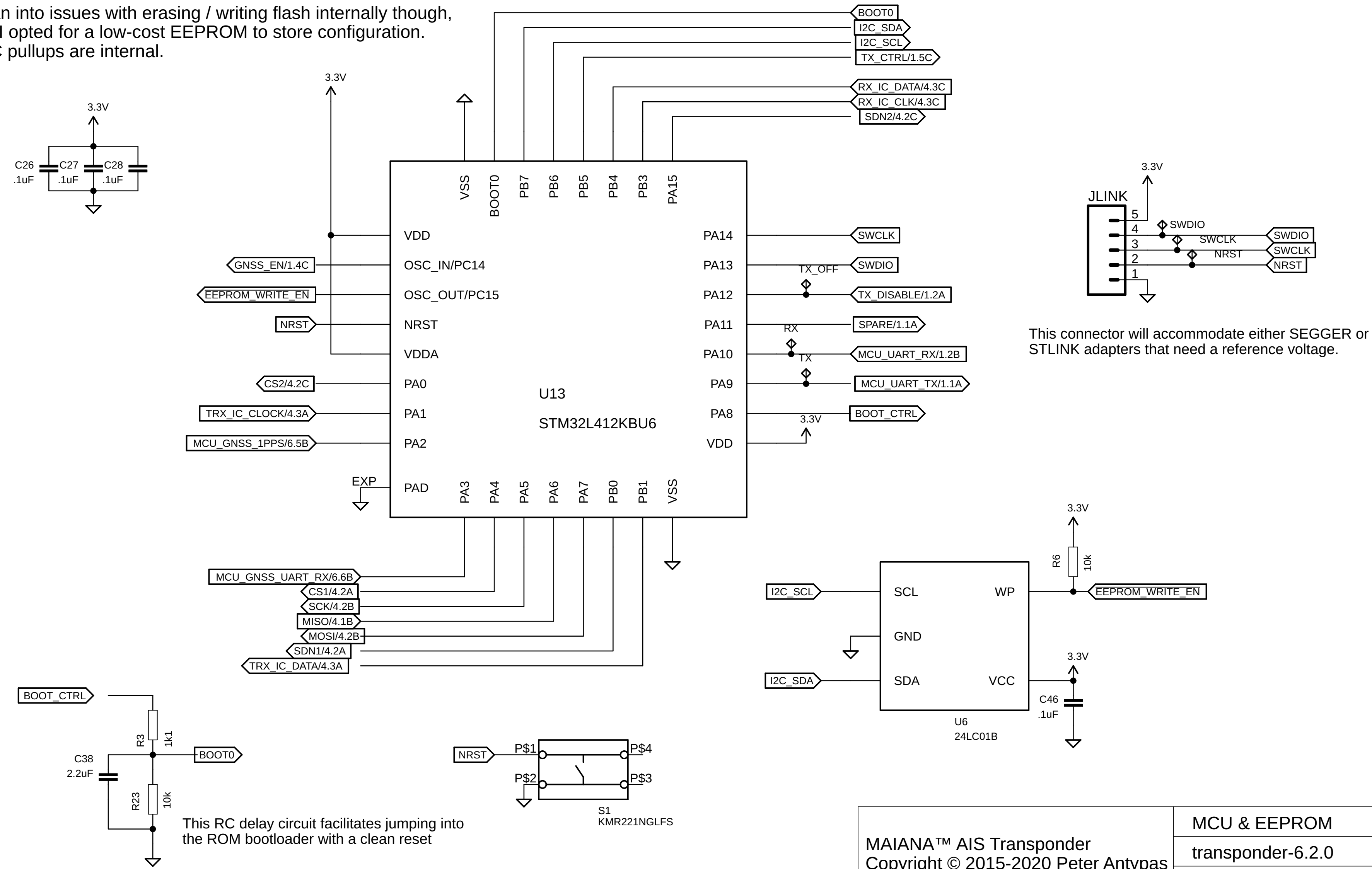
The STM32L412 is a reasonably low-cost L4 that offers enough flash for an -O2 optimized firmware build.

I ran into issues with erasing / writing flash internally though, so I opted for a low-cost EEPROM to store configuration. I2C pullups are internal.



MAIANA™ AIS Transponder

MCU & EEPROM

transponder-6.2.0

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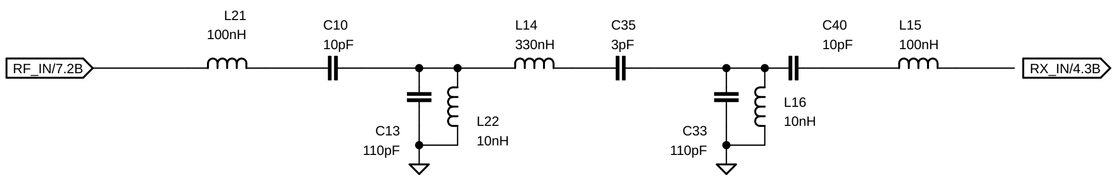
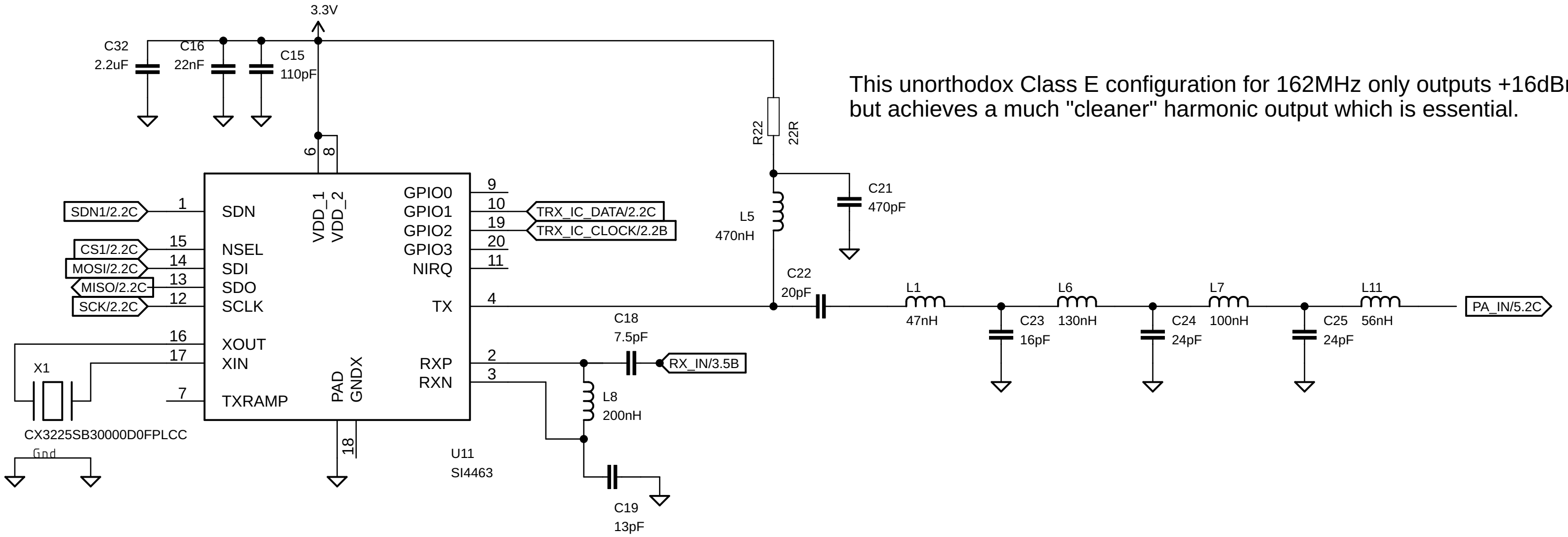
This 5-pole Butterworth is somewhat forgiving of component tolerances
so it is pretty easy to replicate. You may choose to stuff the pads
differently and use a 3-pole design instead.

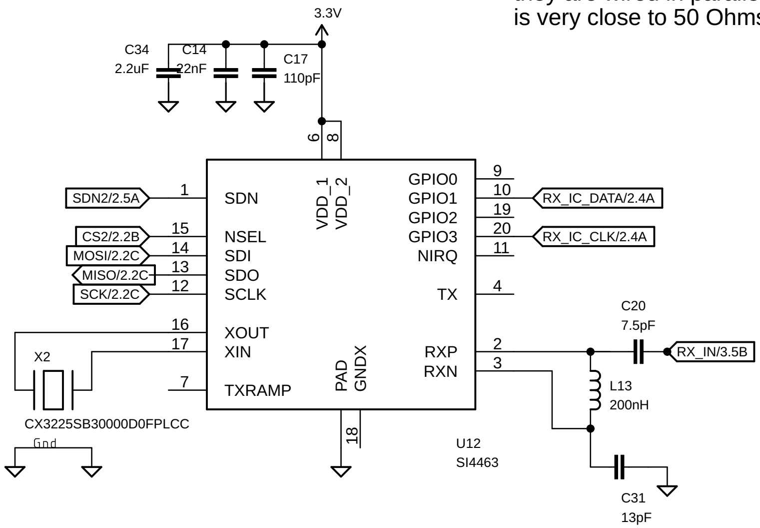


MAIANA™ AIS Transponder Copyright © 2015-2020 Peter Antypas Licensed under GPLv3	RX Bandpass Filter
	transponder-6.2.0
	10/7/20 11:01 AM
	Sheet: 3/7



This unorthodox Class E configuration for 162MHz only outputs +16dBm, but achieves a much "cleaner" harmonic output which is essential.

The input matching networks for the RF ICs are 100 Ohm each and they are wired in parallel using 100Ohm traces. The combined impedance is very close to 50 Ohms and is fully characterised.



MAIANA™ AIS Transponder

RF Backend	
transponder-6.2.0	
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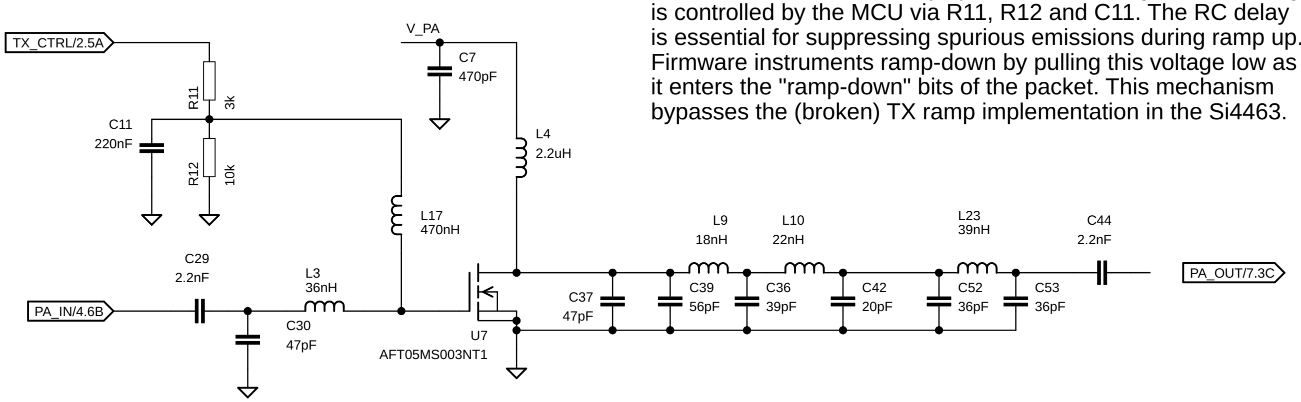
This power amplifier adds more than 17dB of gain for a total conducted output power of +33dBm.

It is based on the reference designs in the datasheet, but includes a narrowband input matching network to better reject harmonics from the backend and a very steep Chebyshev low pass filter to deal with a pesky 2nd harmonic that falls in the restricted aviation band (324MHz).

Do not combine capacitor values into single components. Use them in parallel as designed to better compensate for tolerances.

The MOSFET drain is always powered, but the gate bias voltage is controlled by the MCU via R11, R12 and C11. The RC delay is essential for suppressing spurious emissions during ramp up. Firmware instruments ramp-down by pulling this voltage low as it enters the "ramp-down" bits of the packet. This mechanism bypasses the (broken) TX ramp implementation in the Si4463.



MAIANA™ AIS Transponder

RF Power Amplifier

transponder-6.2.0

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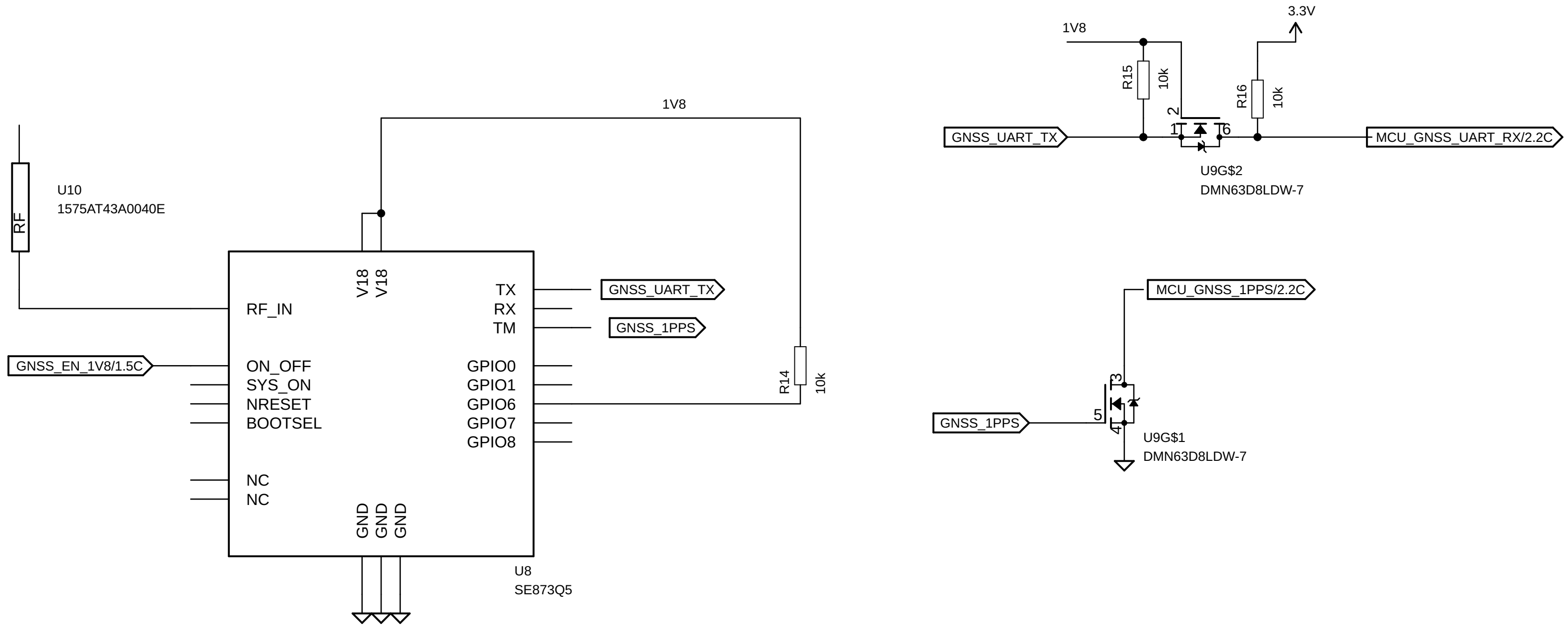
The Telit SE873Q5 GNSS module is a 1.8V devices so it needs level shifting for both the UART and the 1PPS signal. Simple N-Channel MOSFETs do the trick. No need for anything fancy.

The 1PPS signal is inverted, so the MCU IO is configured with an internal pullup and reacts to a falling edge instead.



MAIANA™ AIS Transponder Copyright © 2015-2020 Peter Antypas Licensed under GPLv3	GNSS
	transponder-6.2.0
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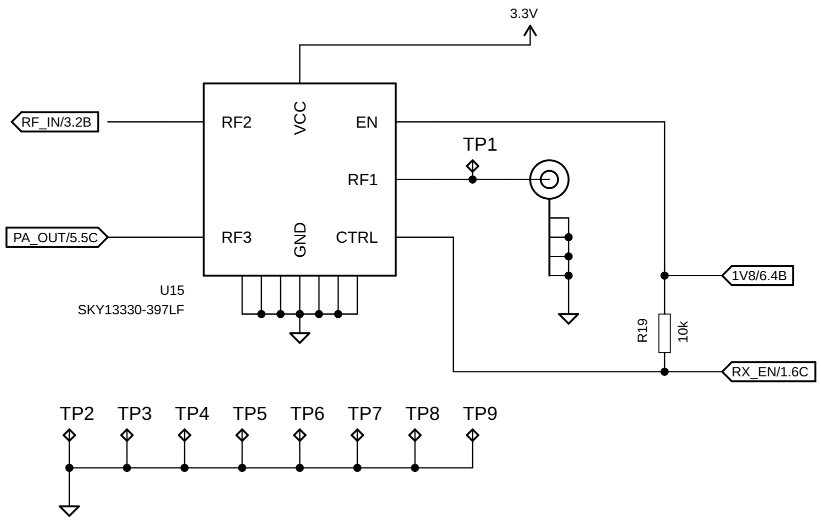
This type of RX/TX switch needs no DC blocking caps.
Although it runs on 3.3V, all logic inputs must be well below 3V, so I opted for 1.8 since it's already available.

The test pads at the output form a coaxial connector for pogo pins to automate production testing.



MAIANA™ AIS Transponder	Antenna Switch
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