RFID Transceiver
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I designed a transceiver to read, write, and emulate 13.56MHz RFID cards. My goal was for the transceiver to be portable, be able to read at as long of a distance as possible, and to store data for later retrieval over USB.

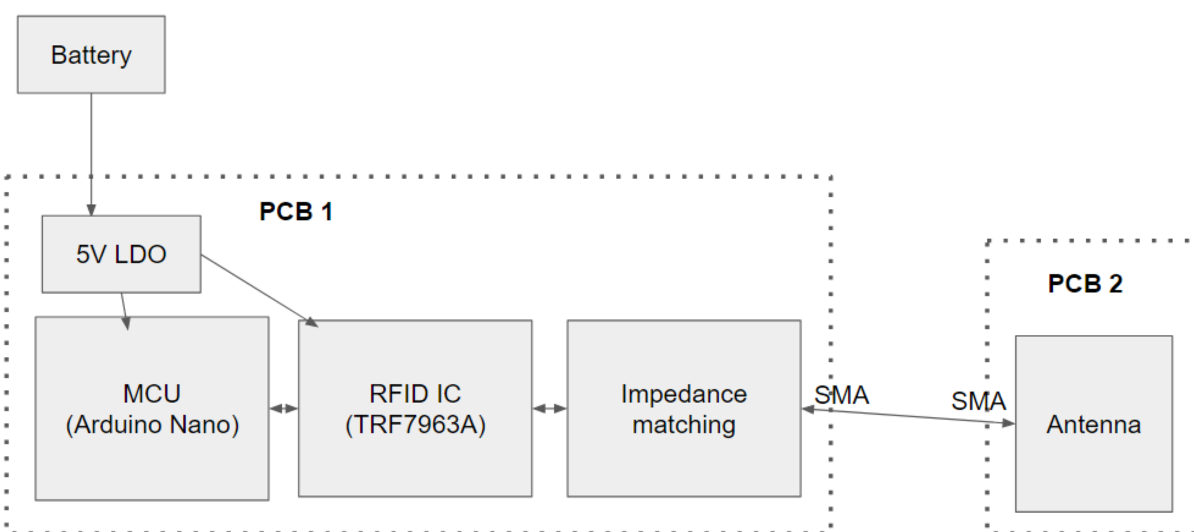
I'm using the TRF7963A integrated circuit. This is an IC that communicates with a microcontroller via SPI and then handles RF communication using the ISO 14443A standard, the most common 13.56MHz RFID communication protocol. Its transmit power can be set as high as 23dBm (200mW), which will help with long-range communication.

For a microcontroller, I'm using the Arduino Nano. It can handle SPI communication at the 2MHz frequency that the TRF7963A prefers. It also has a USB port, which makes it easily reprogrammable and simplifies offloading data.

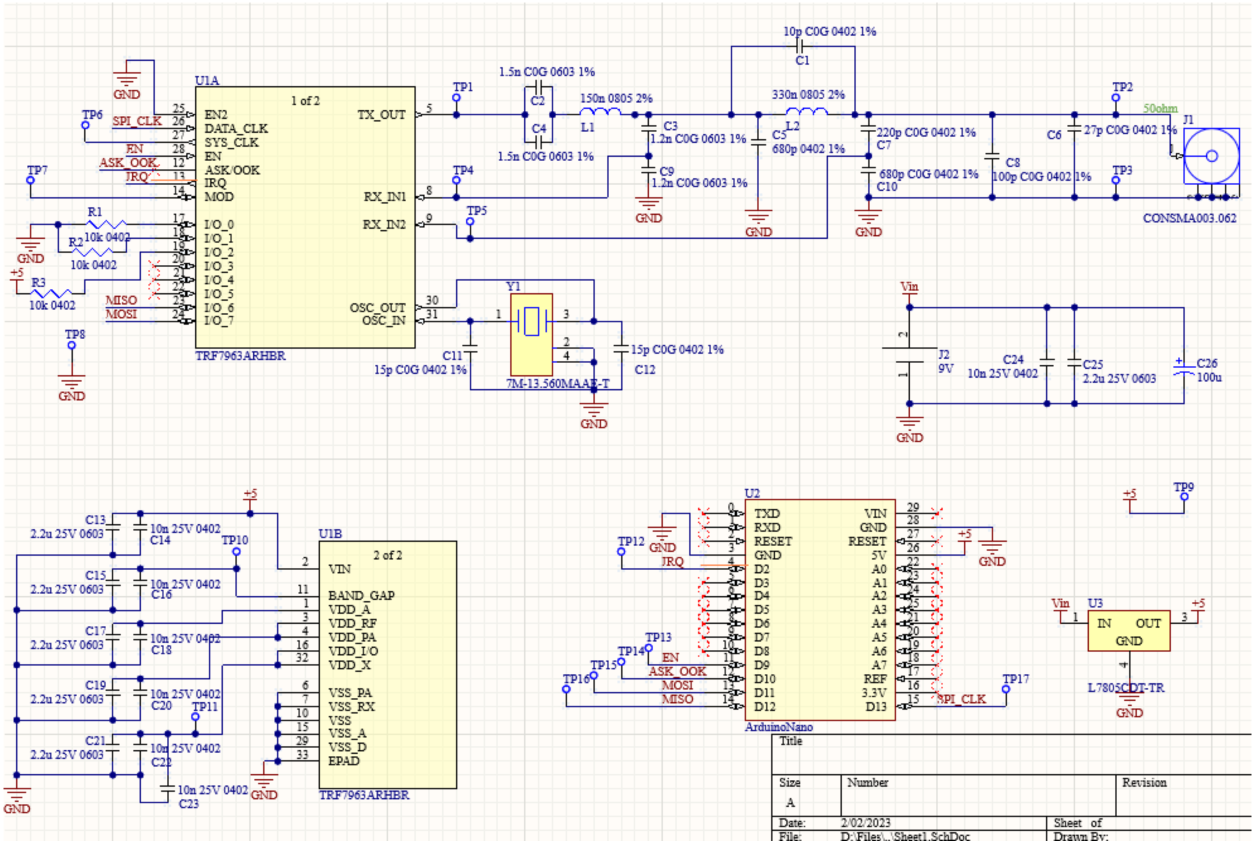
The power source will be a two-cell (7.4V) LiPo battery. The input will be run through a L7805CDT-TR linear voltage regulator (5V / 1.5A), which will supply the 5V required by the TRF7963A and the Arduino Nano.

The antenna will be off the board, connected by an SMA cable.

Here's a block diagram:

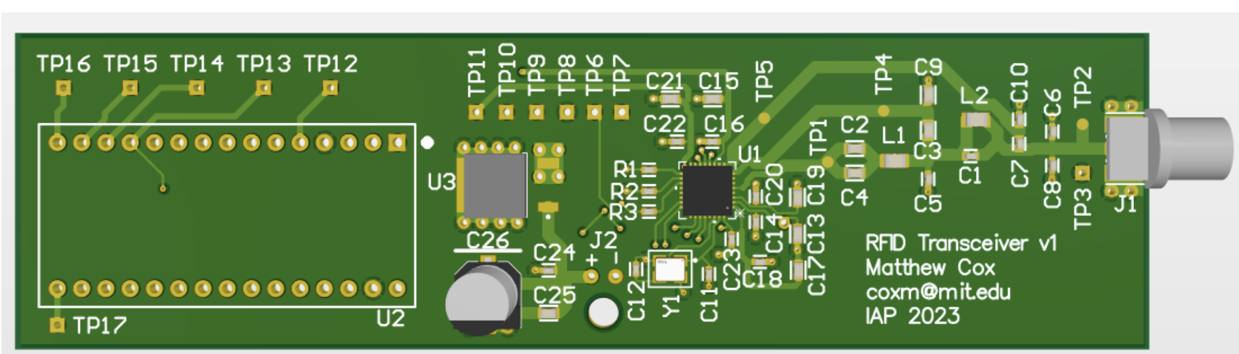


Here’s a schematic of the main board:



One thing of note is the impedance matching section in the top right. The TRF7963A has an output impedance of 4Ω, which must be converted to the 50Ω of the SMA connector. I did this using the scheme recommended in the TRF7963A datasheet. I could have designed a different impedance-matching circuit, but the datasheet didn’t specify the importance of the voltage dividers on the lines returning to the receive ports, so I thought it would be safer to stick with exactly what the datasheet specified.

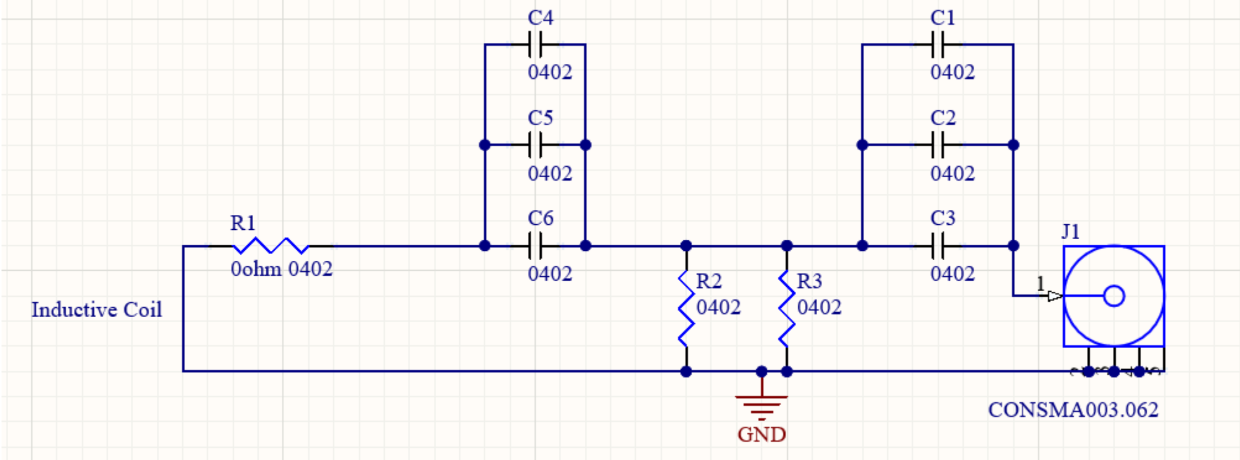
Here’s the layout of the main board:



It’s a four-layer PCB. where the top layer is components and signal, the 2nd layer is ground, the 3rd layer is +5V power, and the bottom layer is another signal layer.

The TRF7963A is the black IC in the center, and the impedance-matching section is the portion in the top right leading to the SMA connector.

The antenna daughterboard is relatively simple:



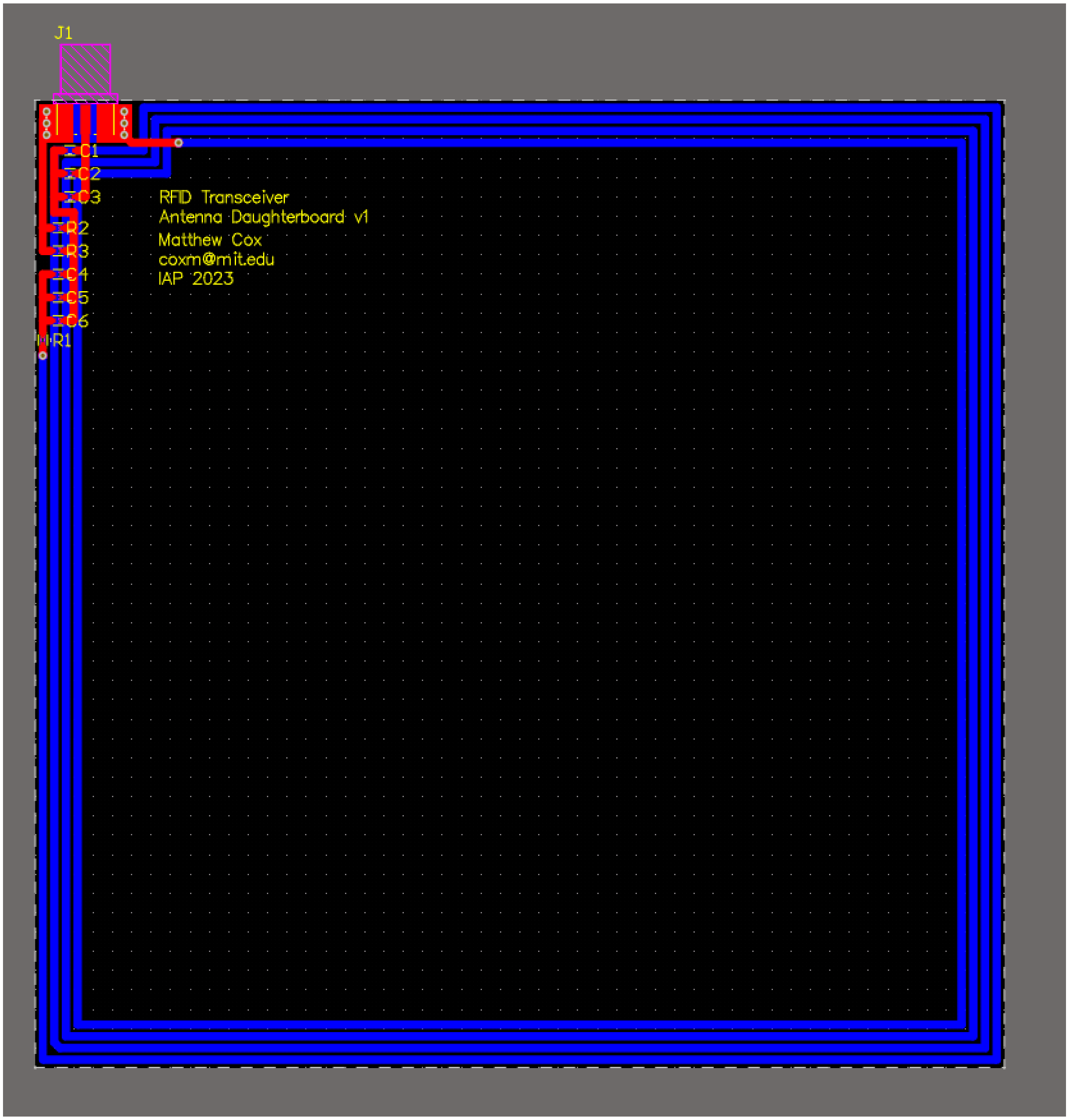
It will consist of a roughly 5” square PCB, with a 4-turn inductive loop antenna running around the outside on one side, and matching components on the other side. The matching components will convert the inductive loop’s impedance to the 50Ω of the SMA connectors. They’ll also adjust the Q of the antenna board to approximately 7, for the 2MHz bandwidth required for the sidebands.

I calculate the loop to have an inductance of 6.2 µH based on its dimensions, which is an impedance of 528j Ω. Then we can set C4||C5||C6 to 68 pF, so that the impedance looking left into that section is 356j Ω. Then for Q=7, we can set R2||R3 to 2.5kΩ, so the impedance looking left into the resistor section is (50+348j)Ω. Then we just need to set C1||C2||C3 to 34pF to cancel that reactance and leave 50Ω impedance for the SMA connector. And 2.5kΩ is 7 times 356 Ω, so Q will be approximately 7, as desired.

The matching components’ values will need to be manually tested and iterated, though, since the coil’s inductance is likely to differ from the calculated value, and there will also be parasitics.

Based on an inductive loop antenna design guide from TI (linked below in Resources), the expected read range is twice the diagonal of the innermost coil, which should come out to about 13 inches

Here’s the layout of the antenna coil:



Resources:
[TRF7963A datasheet]
[TI RFID Antenna Design Guide]