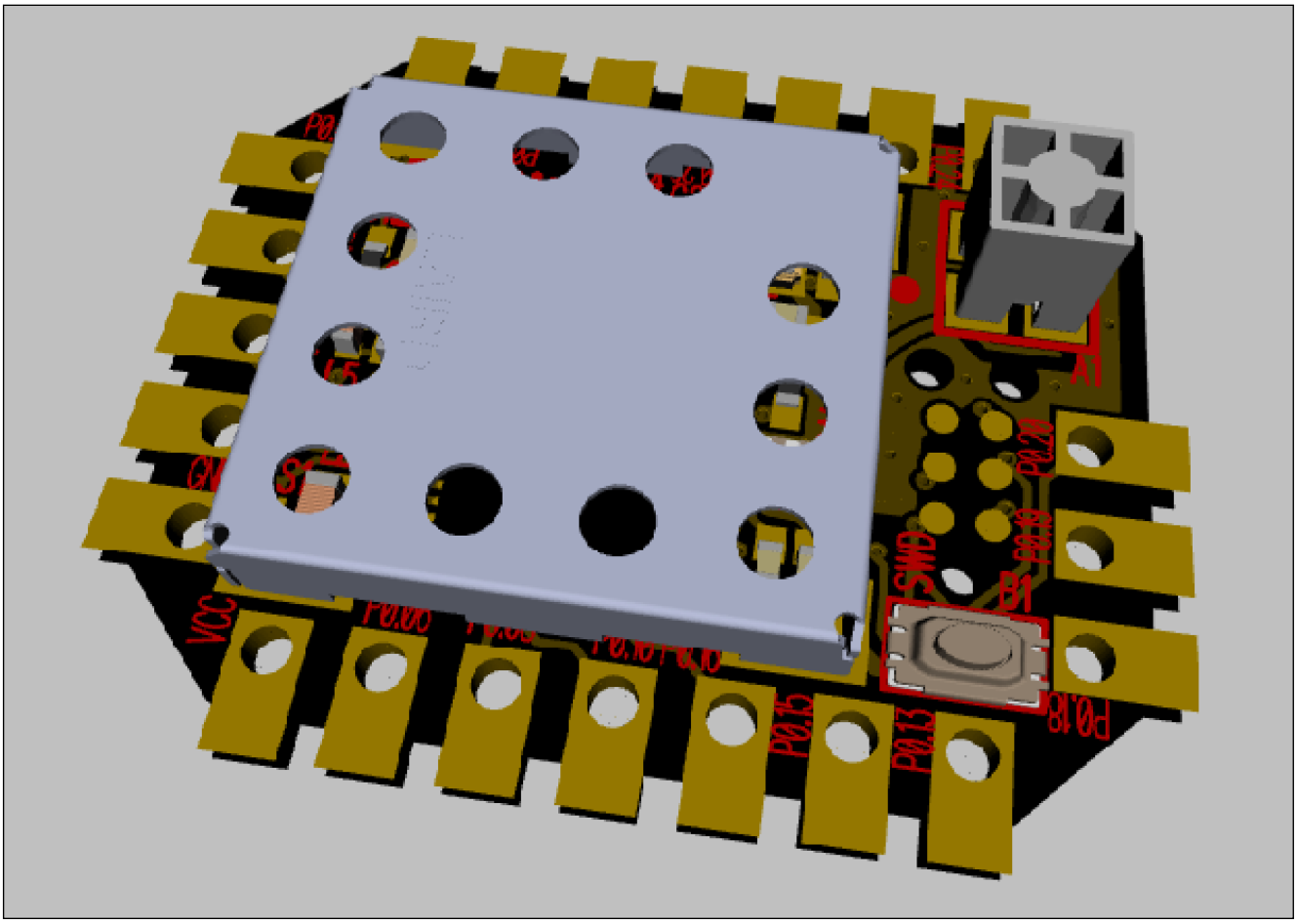
3dB BLE Flex Module

nRF51822 based Bluetooth Smart with 3dB Antenna

Chris Hamilton - March 25, 2015



Design

Nordic Semiconductor DC-DC reference design with Johanson Technology balun 2450BM14E0003T with recommended position from nRF51822. SWD programming through the Tag Connect TC2030.

Online information and full documentation for the project available:
http://hackaday.io/project/2239-nrf51822-ble-flex-module
https://github.com/FyberLabs/FlexModule/tree/master/processors/nRF51822/3dB

Antenna Feed and Placement

Feed line is a 50Hz coplanar waveguide 13.154mil trace width and spacing to ground of 5mil. Calculated by Wcalc.

Followed Molex recommendations for the antenna. There is a microstrip-line and matching circuit for impedance matching for receiving signals back to the nRF51822 from the antenna.

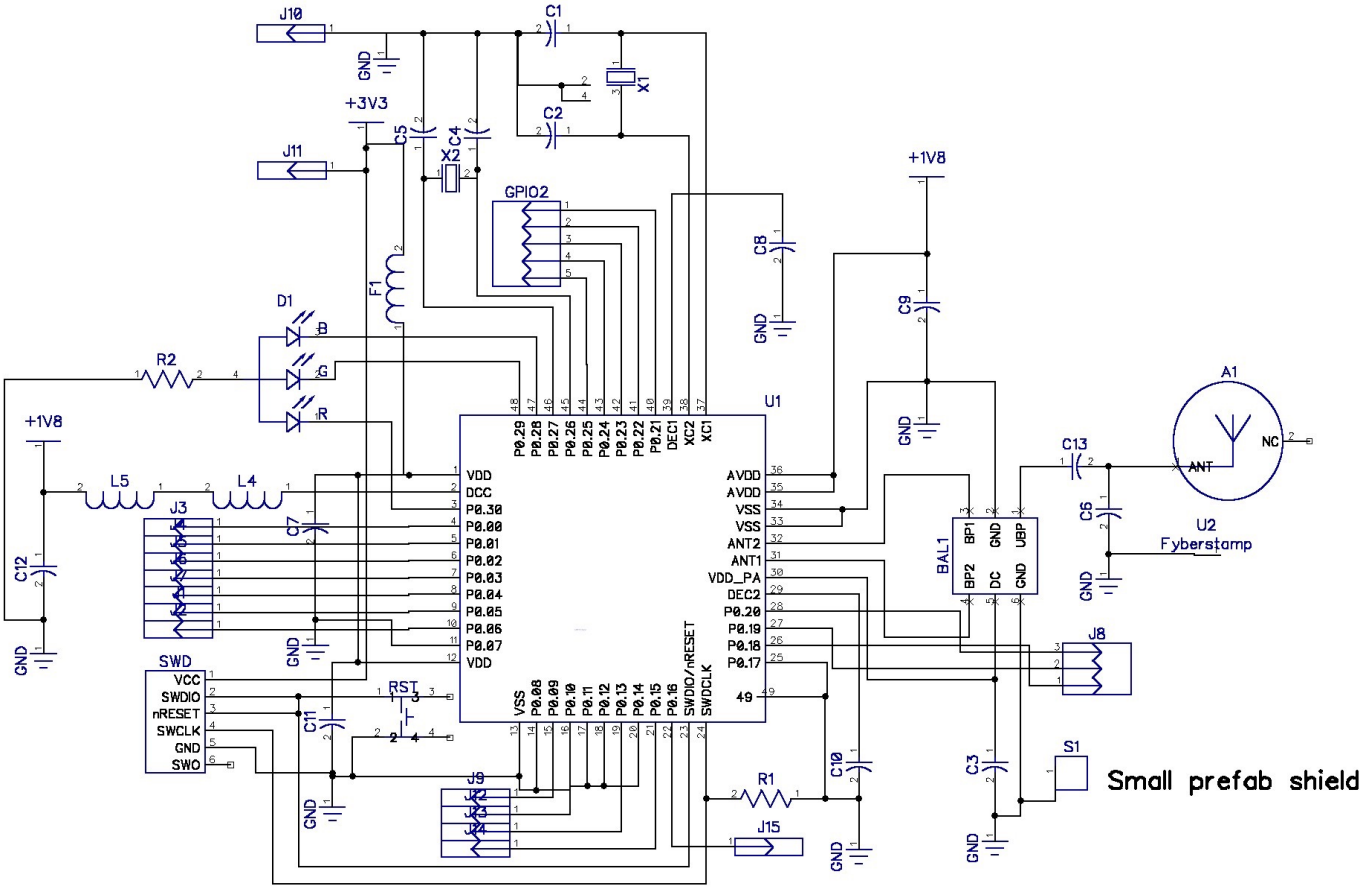
The antenna is ~3mm from the shield which will increase the return loss compared to the recommended minimum of 5mm.

Ground Isolation

32kHz, 16MHz crystals have partial ground ring guards and separate planes. GPIO pins are routed under the ground ring guards out of necessity. Epson recommends FC-12M to not have a ground plane directly below the crystal area - http://www5.epsondevice.com/en/quartz/tech/c_design/st_micro/stm32f401.html . Feed line ground plane is isolated with a second ground plane to help complete total ground shielding under the prefab shield area. The planes extend out from the shield to under the antenna identically on both planes to not disrupt any current flows between them.

Schematic

Nordic Semiconductor DC-DC reference design with 20 exposed GPIOs including 7 analog.



BOM

Ferric Bead BLM18GG471SN1D is added to prevent high frequency leakage from VDD. Alternative inductors meeting requirements have been identified for L4 and L5. Samsung and Murata capacitors are selected for common availability. I similarly picked Panasonic resistors based on availability and price.

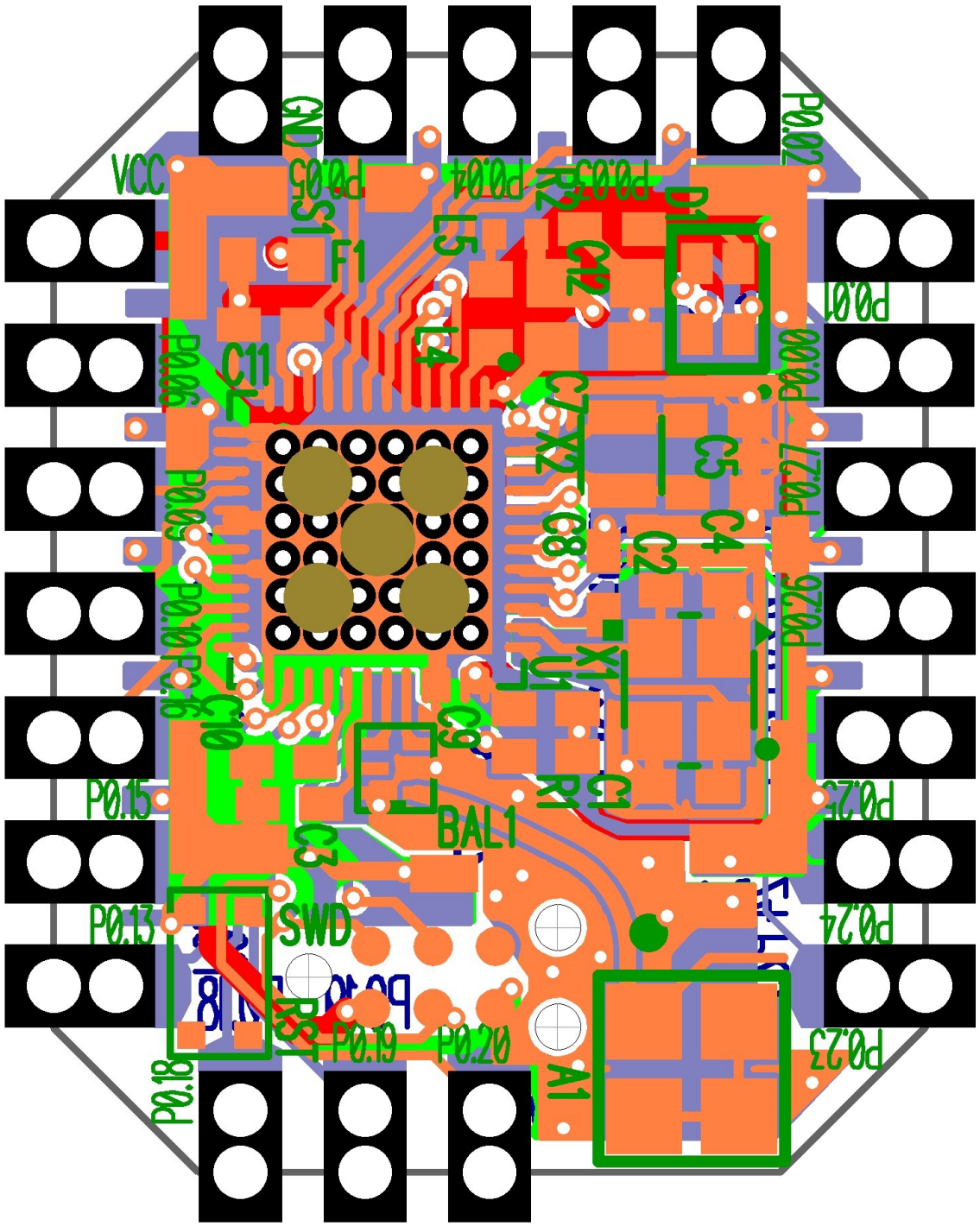
After testing with several Johanson Technology chip antennas, the 3dB antenna Molex 47948-0001 was selected for performance and space efficiency. The Johanson Technology Balun 2450BM14E0003T is specifically designed for the nRF51822. Epson FC-12M 9pF, FA-20H 16MHz 9pF were selected for power efficiency and simpler capacitor selection.

Laird Technologies BMI-S-101 prefabricated shield will fit the circuit components and not interfere with the castellations. Leader Tech produce a compatible shield too. ALPS SKSVCAE010 reset button (RST) is the smallest button on the market. Similarly, the Lite-On LTS-C19HE1WT RGB LED(D1) is selected for its size.

#	RefDes	Value	Part
1	A1		47948-0001
2	BAL1		2450BM14E0003T
3	C1	12pF Capacitor, NP0, ±2%	GRM1555C1H120FA01D
4	C2	12pF Capacitor, NP0, ±2%	GRM1555C1H120FA01D
5	C3	2.2nF Capacitor, X7R, ±10%	GRM155R70J222KA01D
6	C4	12pF	GRM1555C1H120FA01D
7	C5	12pF	GRM1555C1H120FA01D
8	C6	0201	Part 1
9	C7	4.7µF Capacitor, X5R, ±10%	CL10A475KP8NNNC
10	C8	100nF Capacitor, X7R, ±10%	CL05B104KO5NNNC
11	C9	1.0nF Capacitor, X7R, ±10%	GRM155R71C102KA01D
12	C10	47nF Capacitor, X7R, ±10%	GRM155R71A473KA01J
13	C11	100nF Capacitor, X7R, ±10%	CL05B104KO5NNNC
14	C12	1.0µF Capacitor, X5R, ±10%	CL10B105KP8NNNC
15	C13	0201	Part 1
16	D1		LTST-C19HE1WT
17	F1	BLM18HE or BLM18GG	BLM18GG471SN1D
18	L4	10µH Inductor, 50mA, ±20%	LBMF1608T100K or MLZ1608N100L
19	L5	15nH Inductor, 300mA, ±10%	HK100515NJ-T or LQG15HS15NJ02D
20	R1	12k	ERJ-2GEJ123X
21	R2	150, 100mW+	ERJ-2GEJ151X
22	RST		SKSVCAE010
23	S1		BMI-S-101
24	U1		NRF51822-QFAA-T
25	X1	16MHz 9pF	FA-20H 16.0000MF12Z-AC3
26	X2	9pF	X1A0000610008

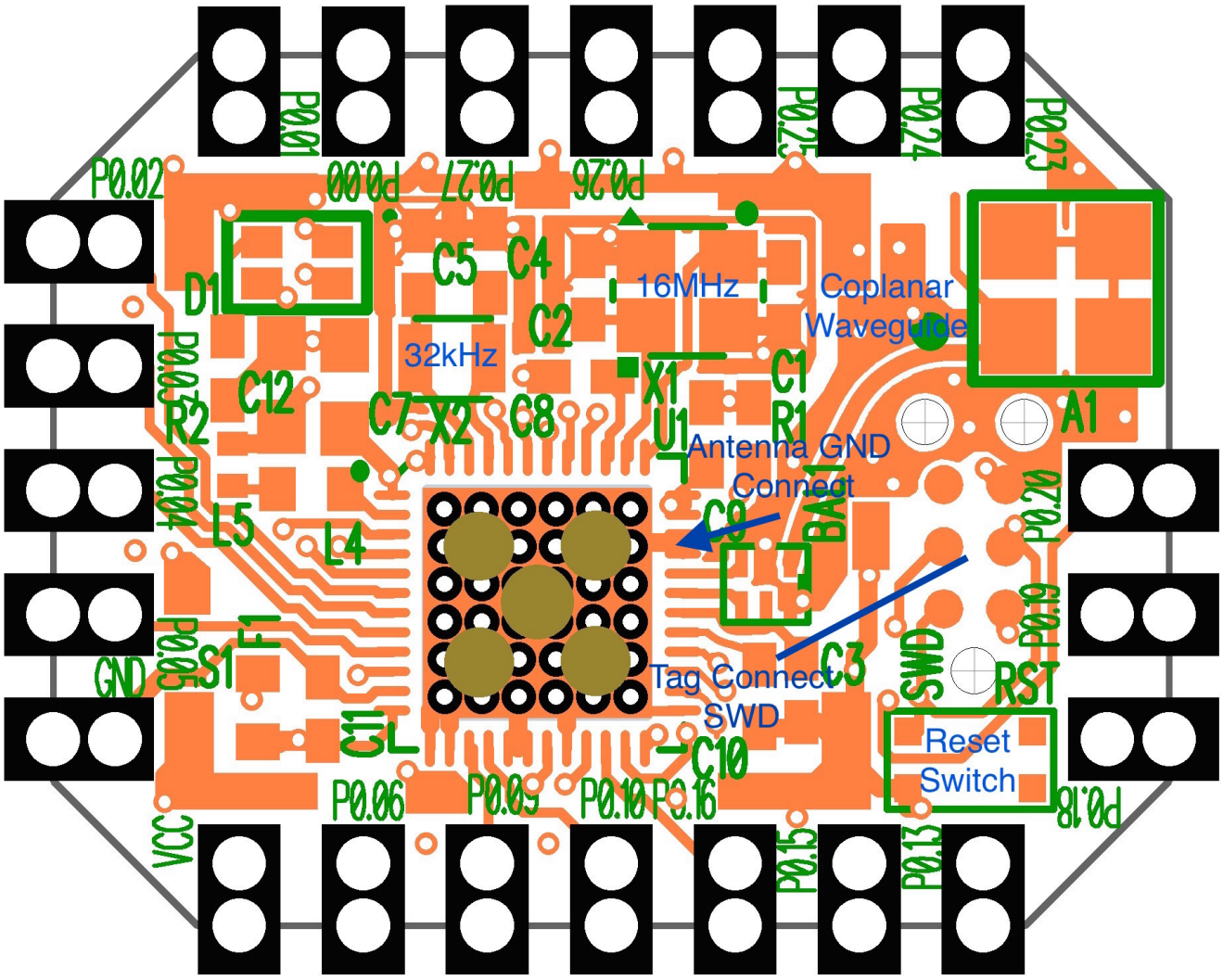
Layout

BMI-S-101 prefabricated shield has a slightly shortened pattern.

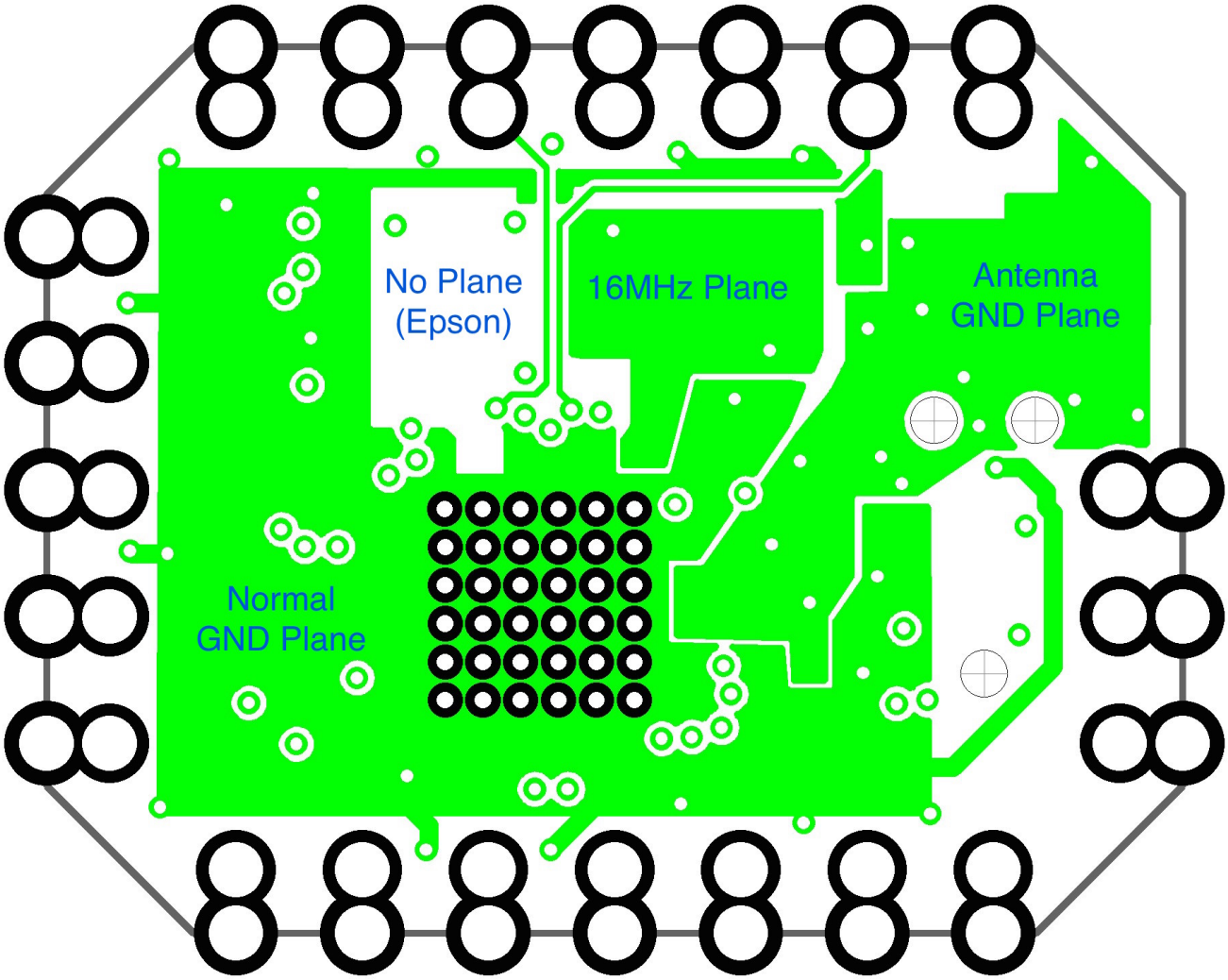


Top Layer 1oz

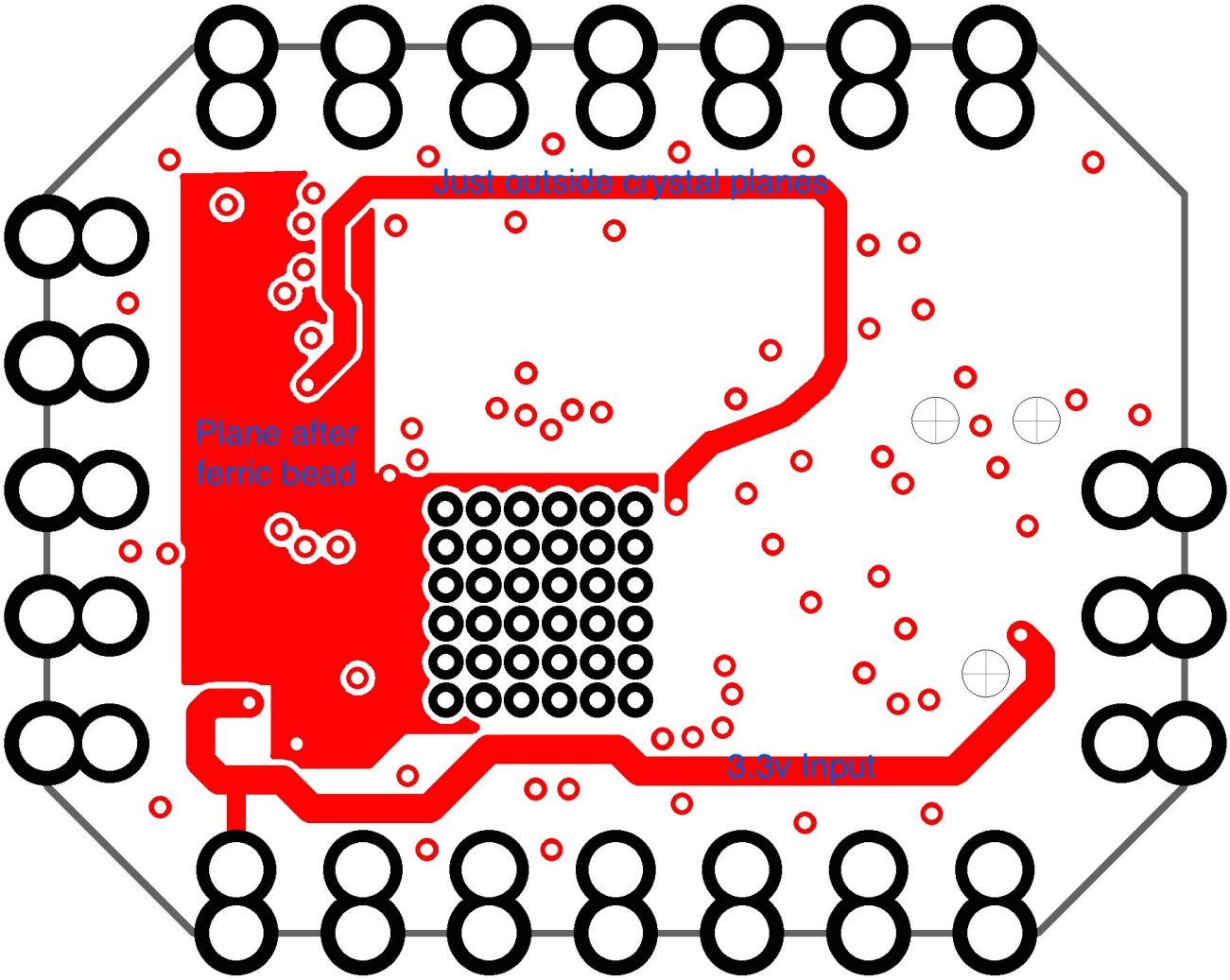
Antenna ground plane is connected on the top layer near the nRF51822 ground pad. Via stitching at lambda/20 = 6.04mm around the prefab shield and around the antenna feed plane to the bottom ground planes.



2nd/GND Layer 0.5oz



3rd/3.3v/VDD Layer 0.5oz



Bottom Layer 1.0oz