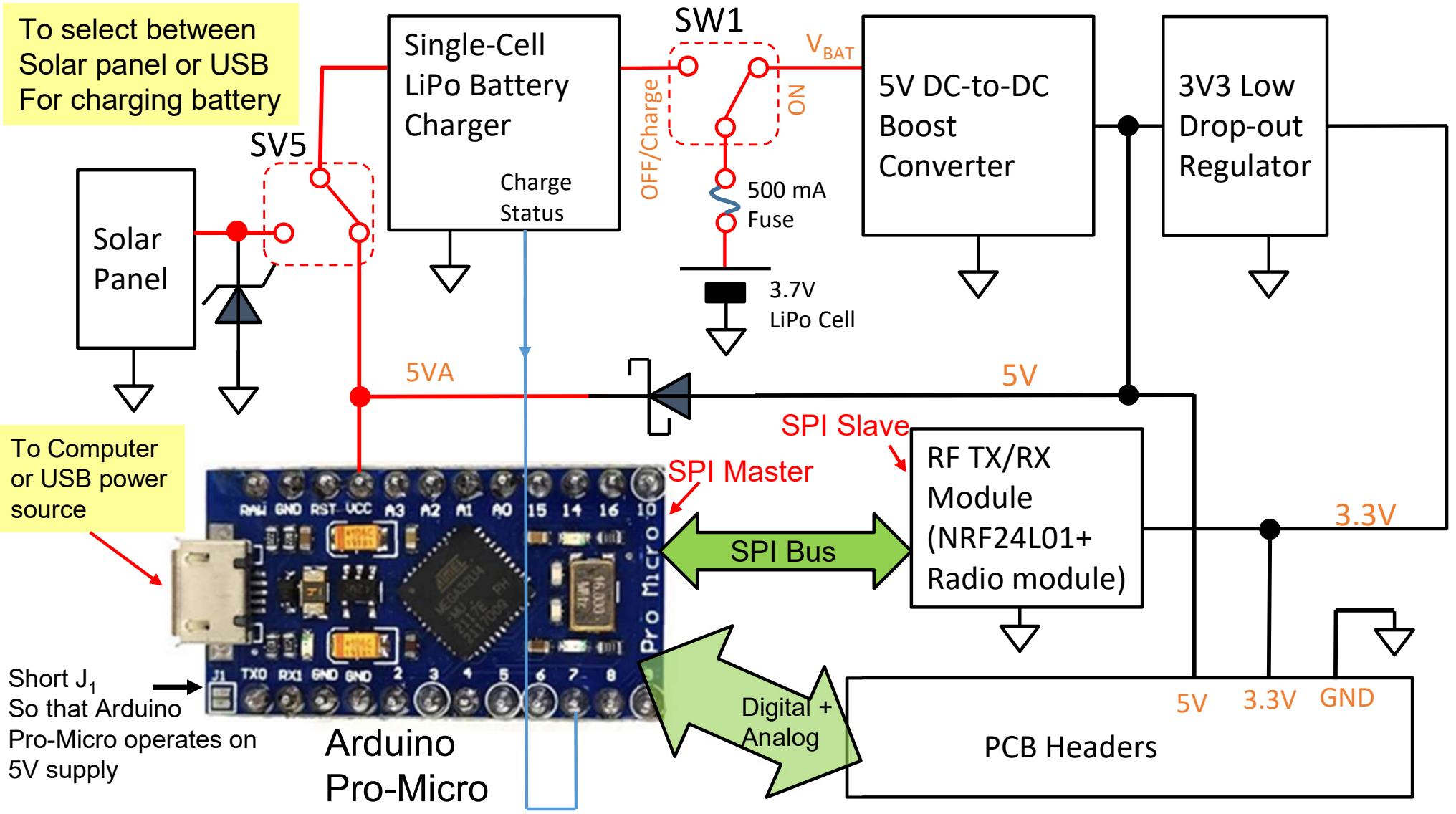
FOE SENSOR NODE

Version 0.99 (Initial Release A)

QUICK START GUIDE (REV A0)

Simplified Block Diagram (V0.90 and V0.99)



Features

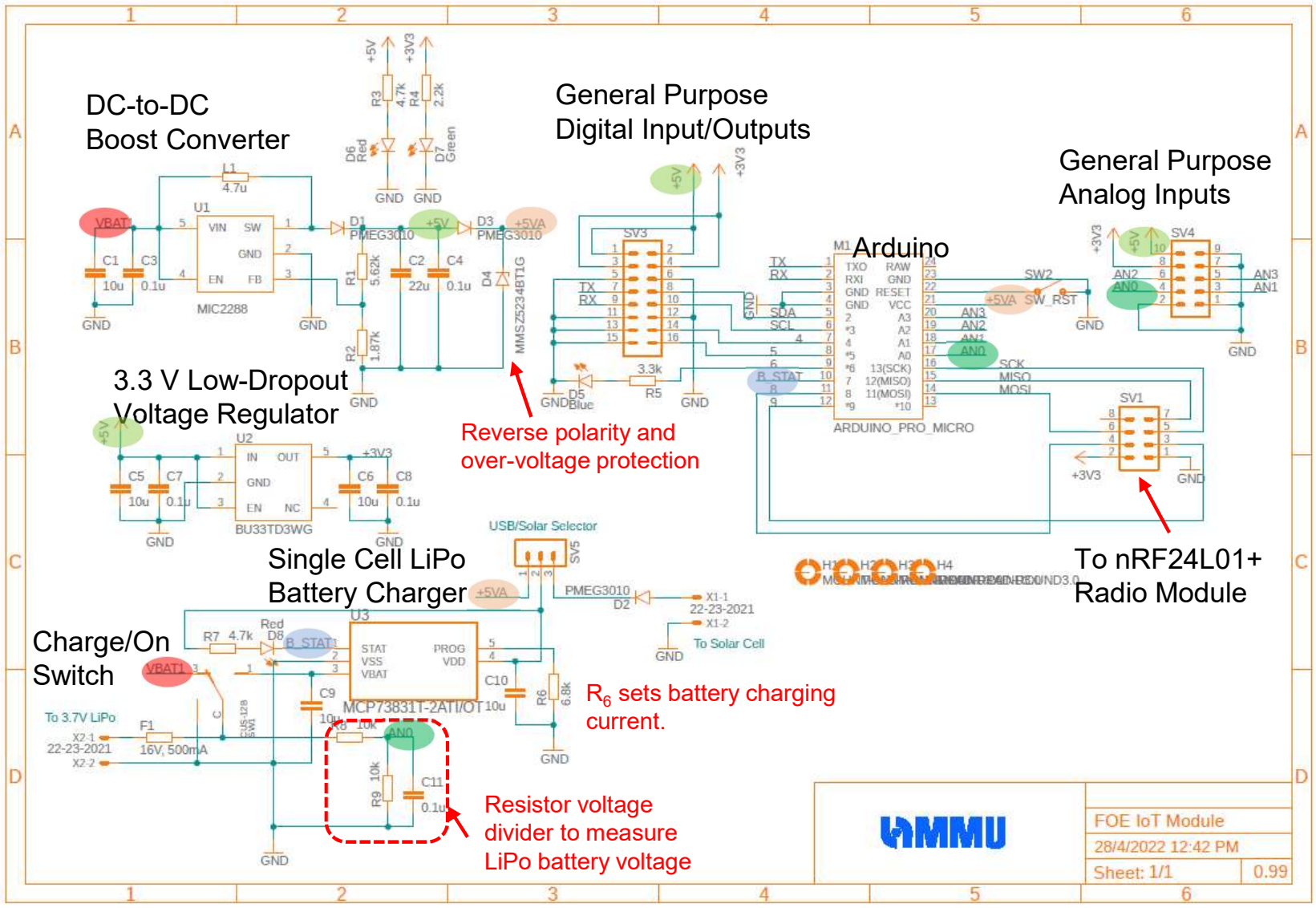
- Arduino based (Arduino Pro-Micro).
- Low power, 3.0 to 12.0 V input voltage to power the device.
- 4 Analog and 5 digital I/O pins, with 5V and 3.3V supply for interfacing with various sensors (Note: Analog pin A0 is used for monitoring input supply voltage).
- Secure 2.4 GHz RF link between sensor nodes and a Master node cum Internet gateway (10-20m).
- Rechargeable lithium polymer (LiPo) battery, battery can be charged via micro-USB receptable or optional solar panel.

Specifications

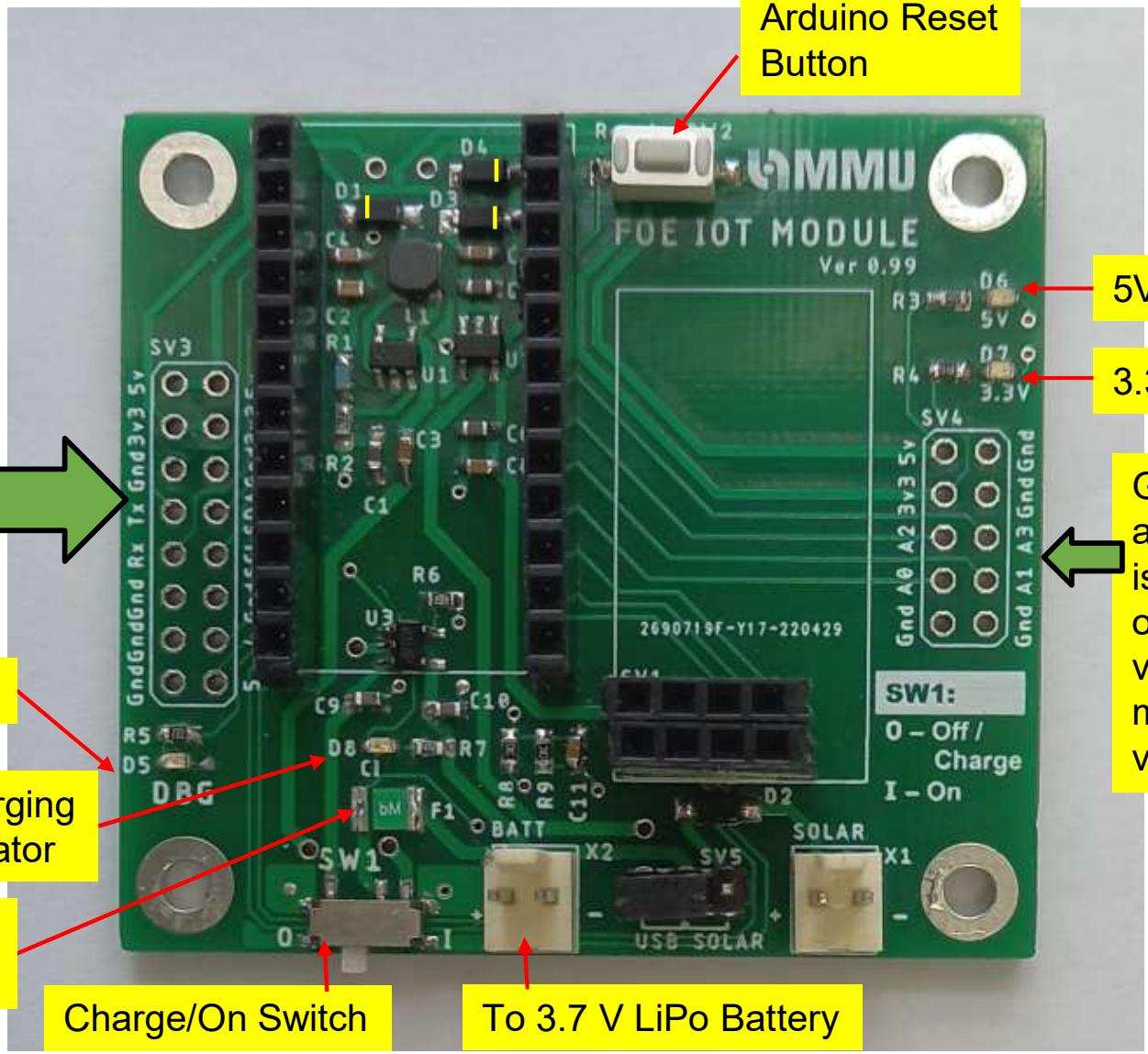
- **Main Controller**: Arduino Pro-Micro.
- **Wireless Module**: NRF24L01+ digital radio, 0.0 dBm EIRP with 2 Mbps data rate using GMSK modulation, 2.400-2.4835 GHz ISM band.
- **Analog input pins rating**: 0-5V.
- **Digital input/output pins**: 0-5V, 25 mA source/sink.
- **Battery**: Rechargeable 3.7V LiPo cell, 100 - 1500 mAH.
- **Charging options**: Micro-USB port or Solar Panel.
- **Indicators**: Debug LED, 5V supply LED, 3.3V supply LED.
- **Dimensions**: 55 x 50 x 20 mm

Gaussian Minimum Shift Keying (a variant of FSK with no phase discontinuity)

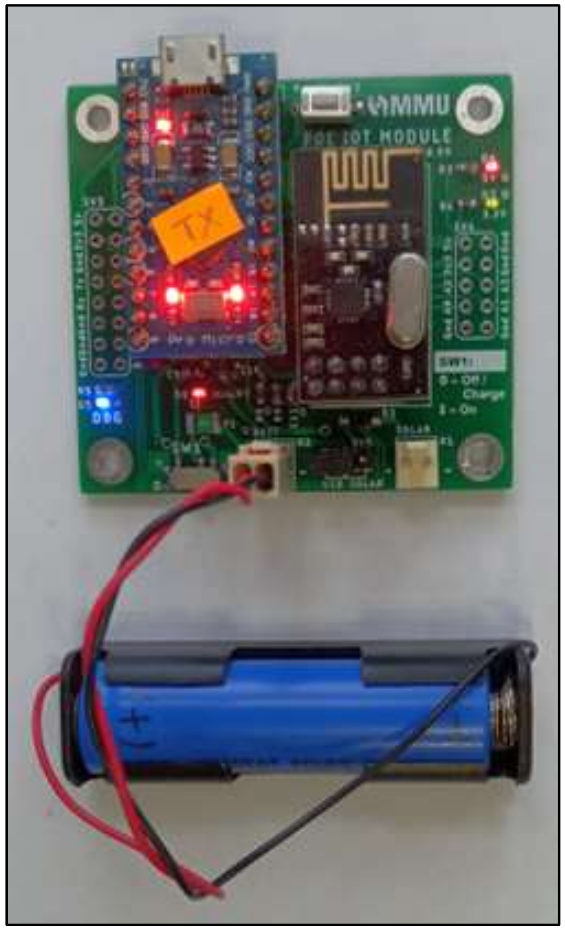
Detailed Schematic

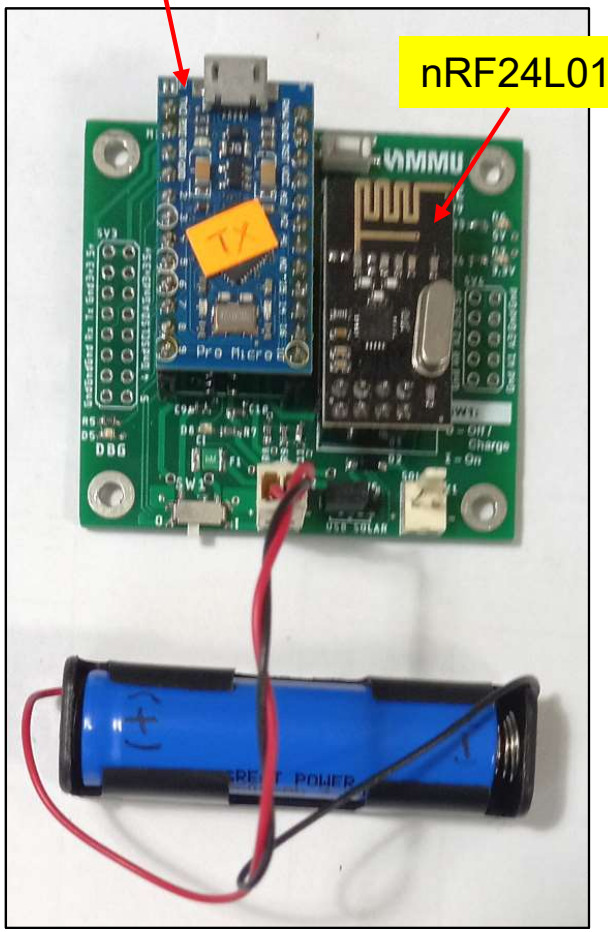


A Fully-Assembled Board

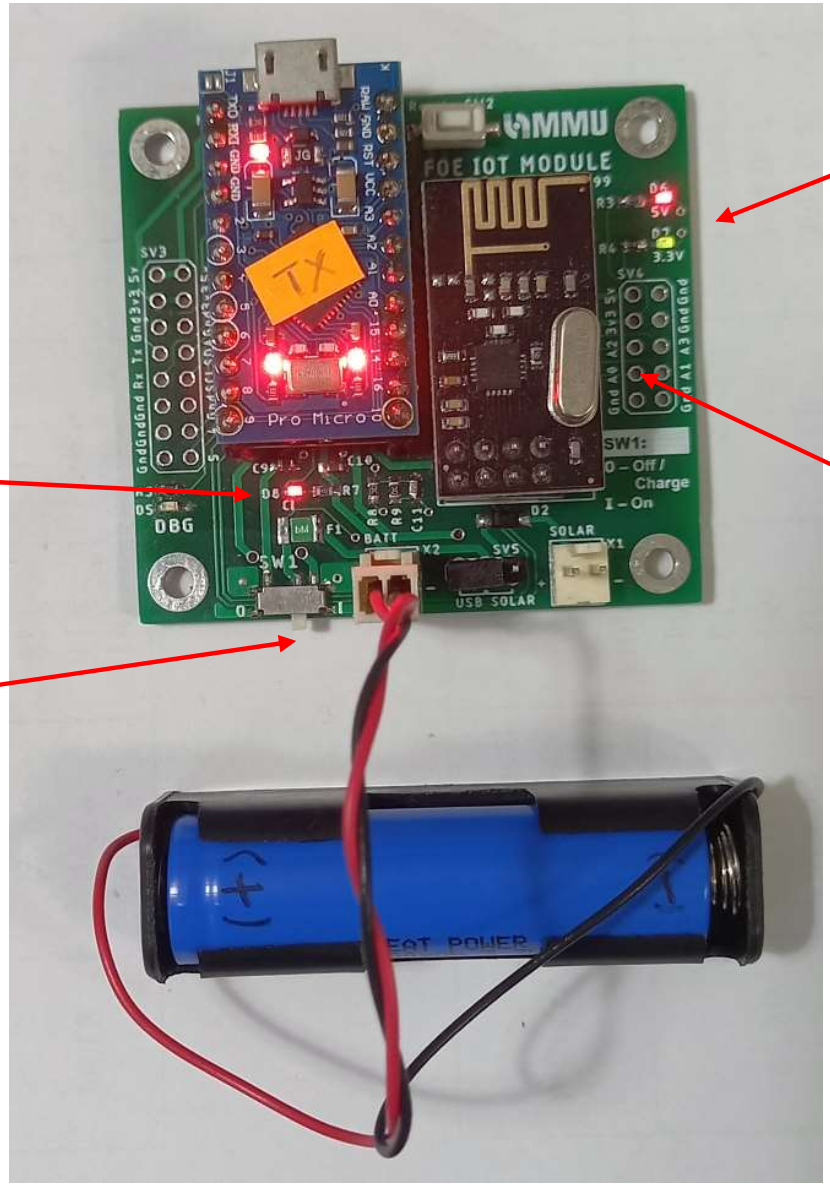


Fully Assembled Board with Arduino Pro-Micro and nRF24L01+ Radio Module Inserted





Normal Operation (On)



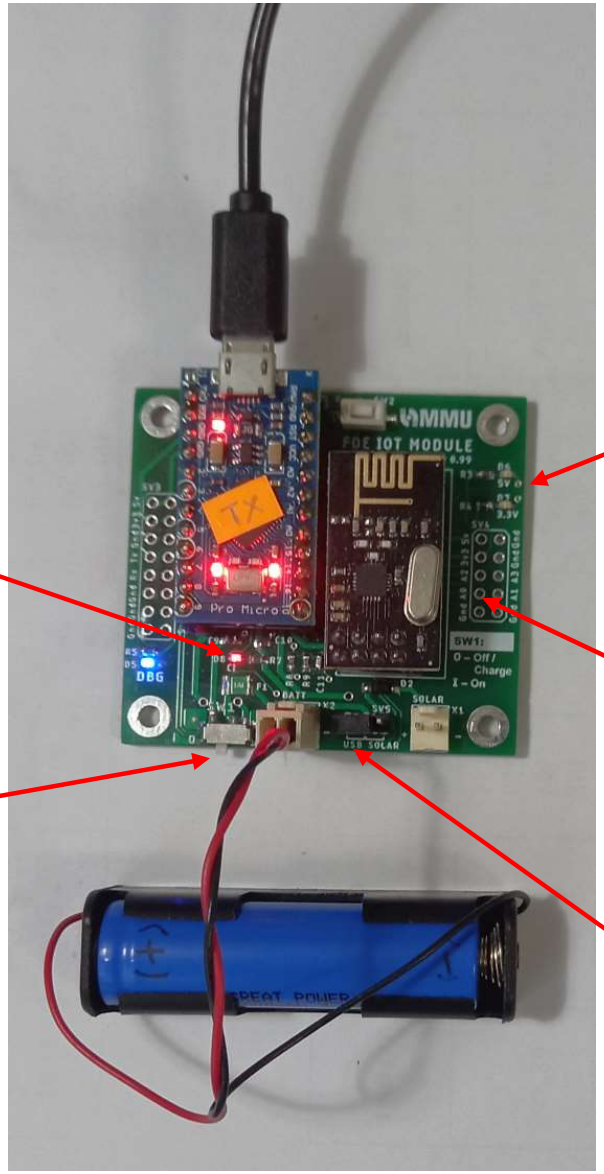
Both supply indicator LEDs should light up

Can ignore battery charging status Indicator during normal operation

SW1 to ‘On’ position

Analog pin A0 indicates battery Voltage level via a divide-by-2 Resistor network.
For example if battery voltage is 3.7 V, pin A0 voltage should be 1.85 V.

Charging LiPo Battery Via USB Port



Battery
charging status
Indicator will lights up
during charging and
turned off when fully
Charged
(Max charging current is
200 mA)

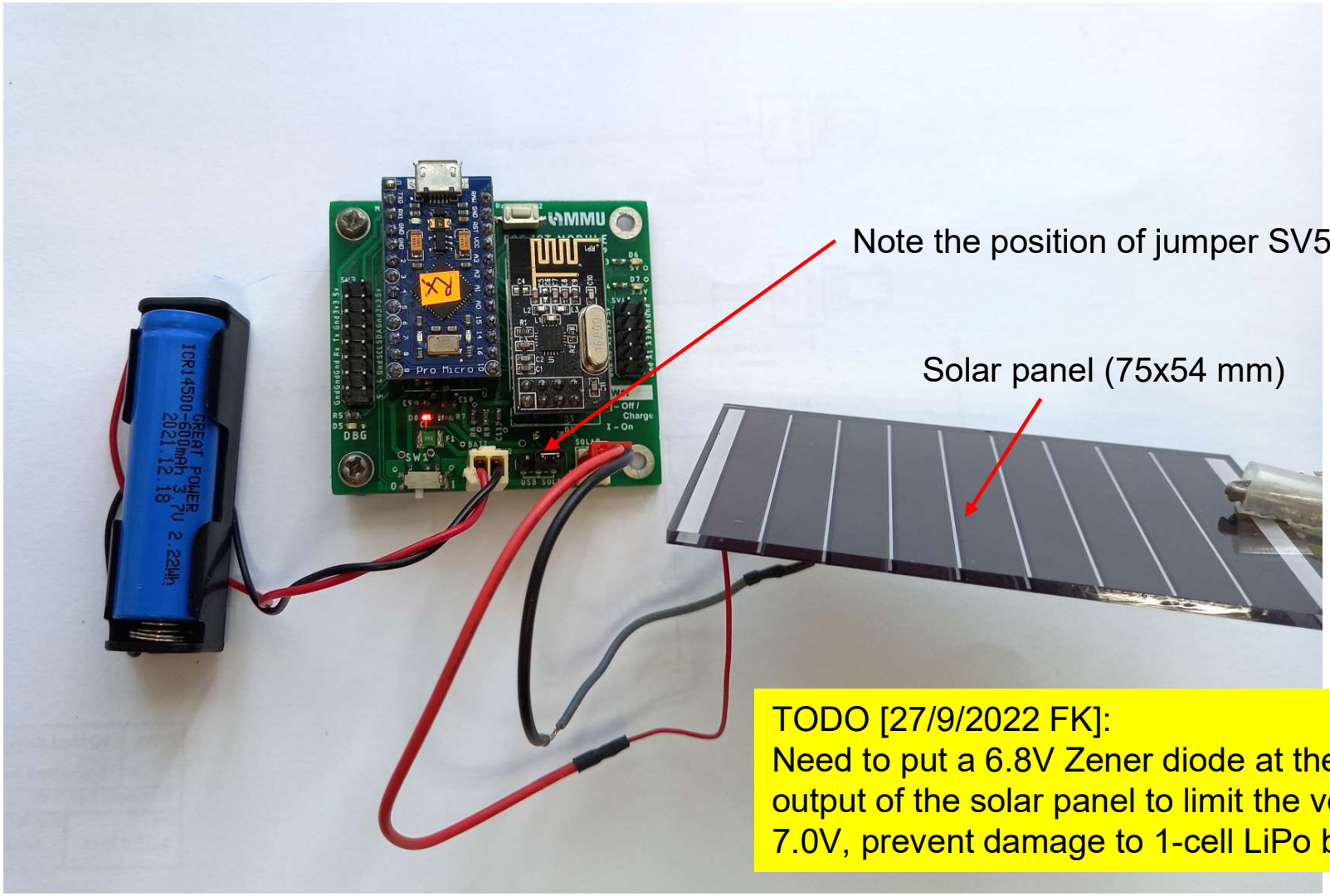
SW1 to ‘Off/Charge’
position

Both supply indicator
LEDs should not light up

Analog pin A0 indicates battery
Voltage level via a divide-by-2
Resistor network.
For example if battery voltage is 3.7 V, pin A0 voltage should be 1.85 V.

Note the position of jumper SV5

Charging LiPo Battery via Solar Panel



TODO [27/9/2022 FK]:
Need to put a 6.8V Zener diode at the output of the solar panel to limit the voltage below 7.0V, prevent damage to 1-cell LiPo battery charger

APPENDIX

Basic Functional Test for Newly Assembled PCB (1 off 2)

- 1. Do not connect any wires or battery to the IOT board.
- 2. Set Switch SW1 to “0 - Off/Charge” position.
- 3. Connect USB port of Arduino module to computer.
- 4. Load the firmware “Wireless_TX_Basic.ino” into the Arduino module.
- 5. If the firmware is successfully loaded and IOT board no hardware error, LED “DBG” should blink at 2 Hz rate. Also LED D_8 should lights up.

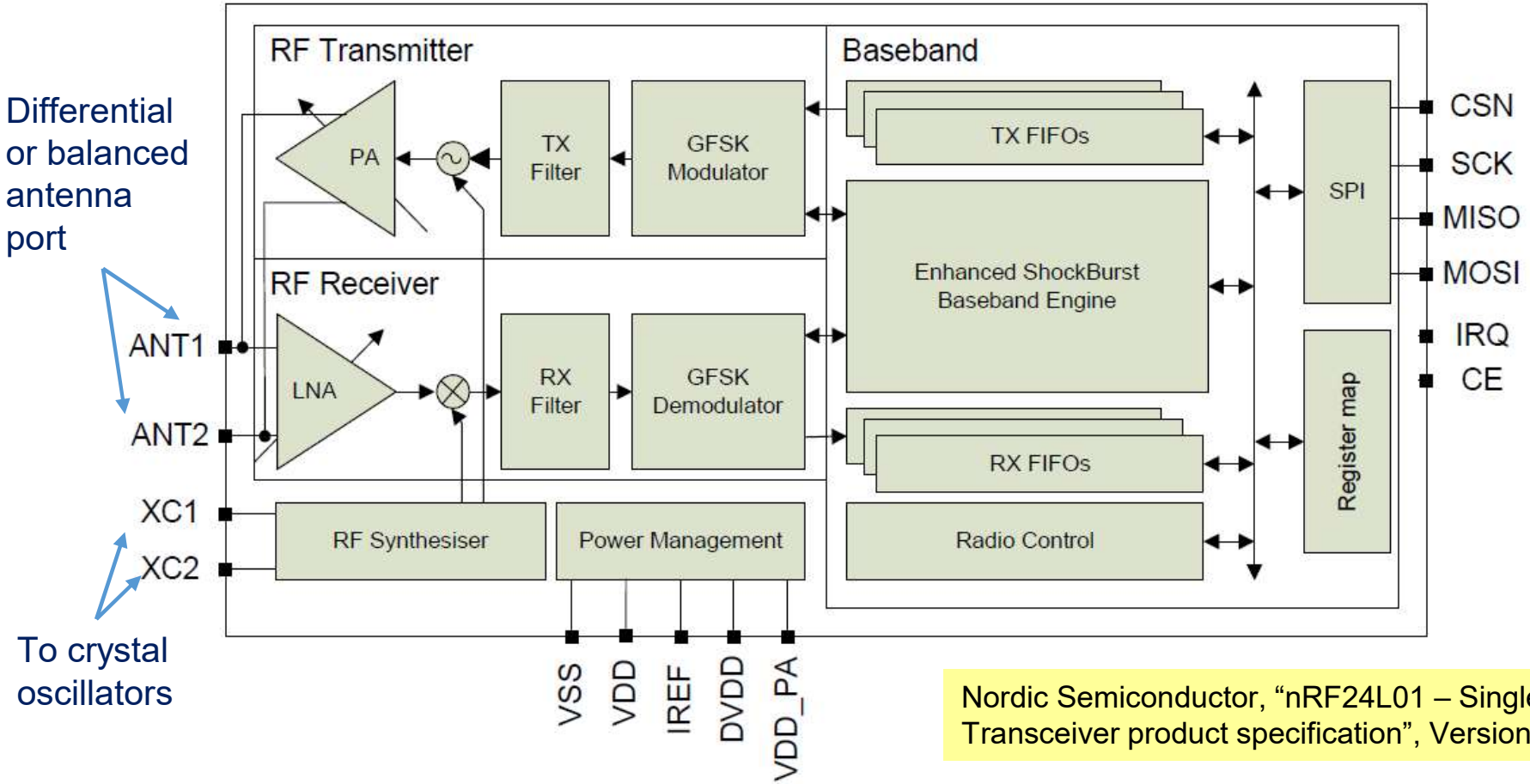
Basic Functional Test for Newly Assembled PCB (1 off 2)

- 6. Now connect the LiPo battery to PCB header X_2 (Batt), LED D_8 should continues to light up indicating that the LiPo battery is being charged.
- 7.LED D_8 would turn off when LiPo battery is fully charged.
- 8. Once the LiPo battery is partially charged for 15 minutes, set switch SW1 to “I – On” position.
  - LEDs 3.3 V (D_7) and 5.0 V (D_6) should light up, indicating presence of 3.3 V and 5.0 V supplies to the system.
  - LED “DBG” should continues to blink.
  - LED D_8 should not turn on.
- 9. Now the IOT module should be ready for use.

Debug Tips

- As the nRF24L01+ radio module does not have any indicator LED, we would need to probe it's pin with digital oscilloscope to check if the Arduino is communicating with the radio module.
- Under normal operations:
  - MOSI pin should be logic high.
  - MISO pin should contain digital data.
  - SCK pin should have burst of 8-pulses.
  - CSN pin should alternate between logic high and low.
  - CE pin should be logic high (enable the radio module).

nRF24L01 2.4 GHz Radio Chip



Nordic Semiconductor, “nRF24L01 – Single chip 2.4 GHz Transceiver product specification”, Version 2.0, July 2007.

Figure 1. nRF24L01 block diagram

nRF24L01 Serial Peripheral Interface (SPI) (1 of 2)

Abbreviation	Description
Cn	SPI command bit
Sn	STATUS register bit
Dn	Data Bit (**Note:** LSByte to MSByte, MSBit in each byte first)

Table 17. Abbreviations used in Figure 23. to Figure 25.

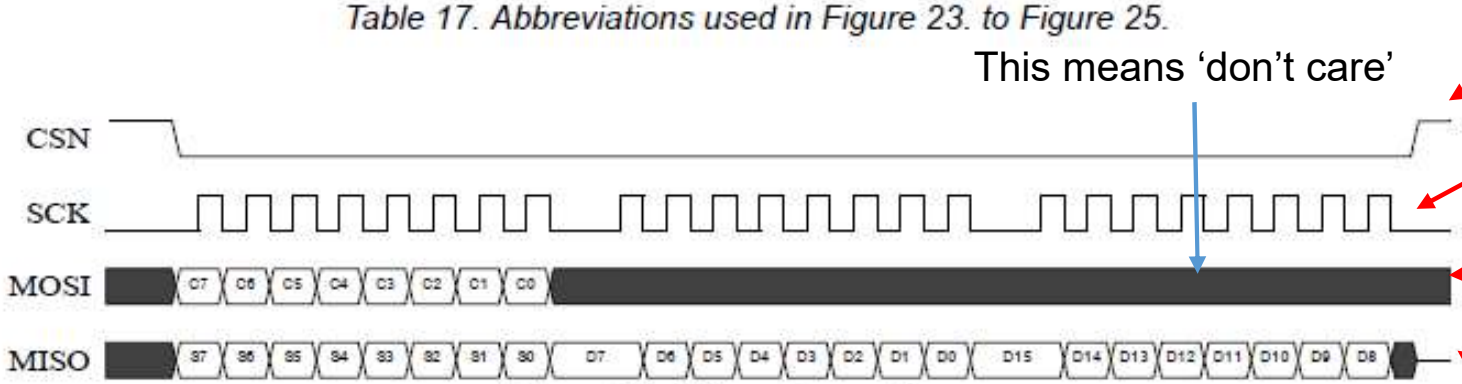


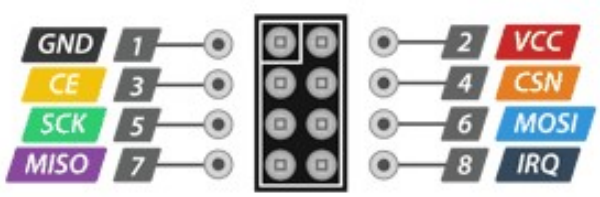
Figure 23. SPI read operation

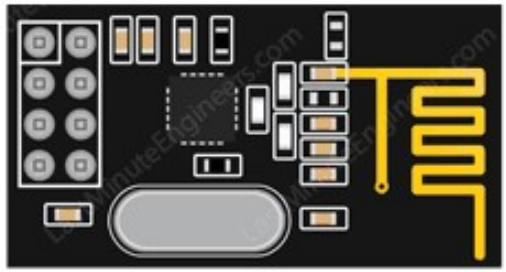
Chip Select

Serial Clock

Master Out Slave In (from master to slave)

Master In Slave Out (from slave to master)





nRF24L01 Serial Peripheral Interface (SPI) (2 of 2)

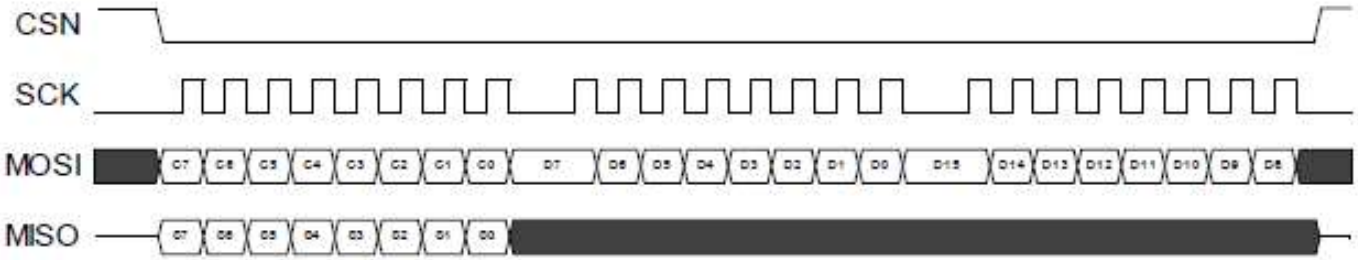


Figure 24. SPI write operation

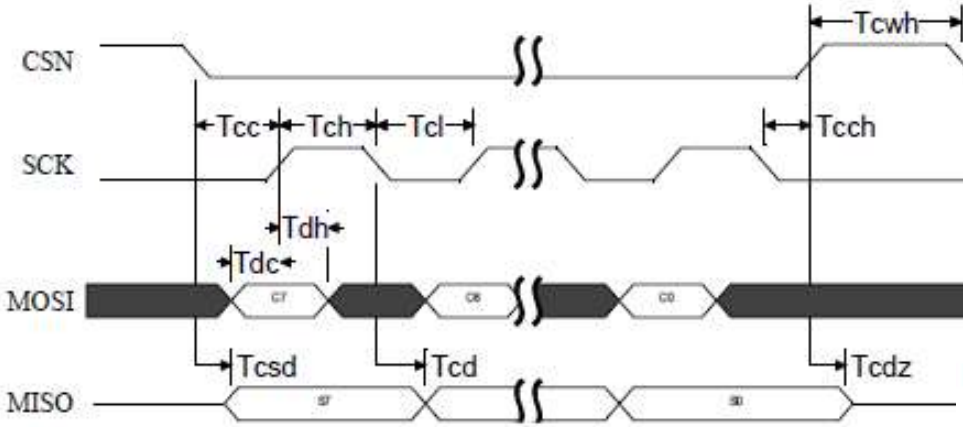
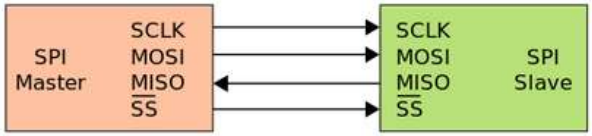


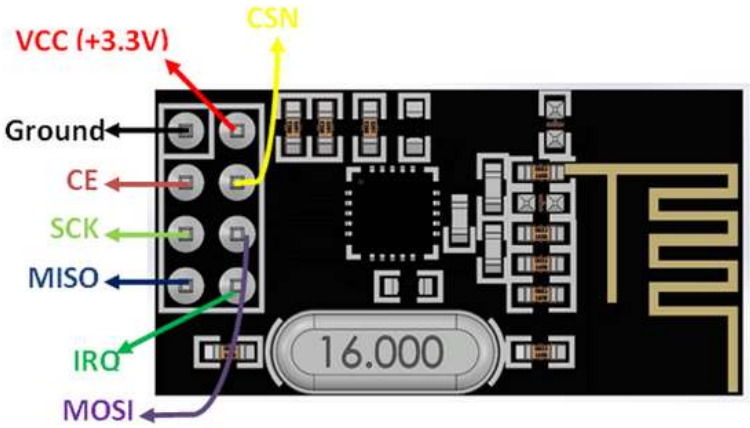
Figure 25. SPI NOP timing diagram

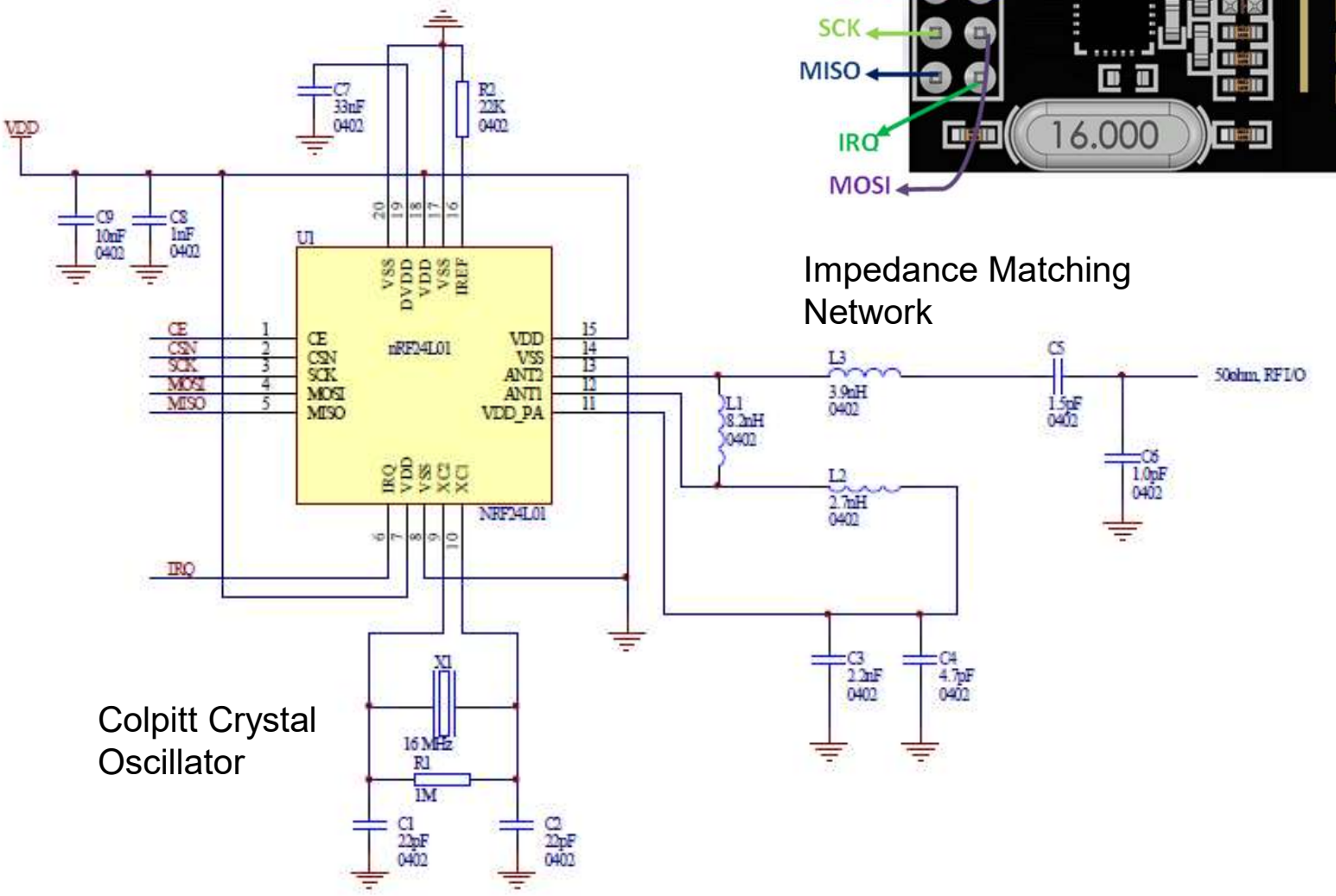


Symbol	Parameters	Min	Max	Units
Tdc	Data to SCK Setup	2		ns
Tdh	SCK to Data Hold	2		ns
Tcsd	CSN to Data Valid		38	ns
Tcd	SCK to Data Valid		55	ns
Tcl	SCK Low Time	40		ns
Tch	SCK High Time	40		ns
Fsck	SCK Frequency	0	8	MHz
Tr,Tf	SCK Rise and Fall		100	ns
Tcc	CSN to SCK Setup	2		ns
Tcch	SCK to CSN Hold	2		ns
Tcwh	CSN Inactive time	50		ns
Tcdz	CSN to Output High Z		38	ns

Table 18. SPI timing parameters (C_{load} = 5pF)

Sample Schematic of nRF24L01 Radio Module





Impedance Matching Network

To RF Load Or Antenna

Colpitt Crystal Oscillator

Suggested Component List

Quantity

- Capacitive based analog soil moisture sensor (MAKER-SOIL-MOISTURE) x 3
  - https://my.cytron.io/c-sensor/c-liquid-flow-ph-sensor/p-grove-capacitive-soil-moisture-sensor-corrosion-resistant (RM30) or
  - https://my.cytron.io/c-sensor/c-liquid-flow-ph-sensor/p-maker-soil-moisture-sensor (RM20)
- Ambient light sensor (SN-LIGHT-MOD) x 3
  - https://my.cytron.io/c-sensor/c-optical-infrared-sensor/p-light-sensor-module (RM5)
- DHT22 ambient humidity and temperature sensor (SN-DHT22-MOD) x 2
  - https://my.cytron.io/p-dht22-sensor-module-breakout (RM16)
- Brushed DC motor driver (MAKER-DRIVE) x 2
  - https://my.cytron.io/p-maker-drive-simplifying-h-bridge-motor-driver-for-beginner (RM20)