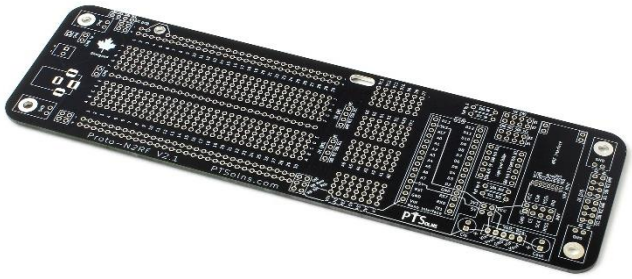
Proto-N2RF

1 DESCRIPTION



The PTSolns *Proto-N2RF* v2.1 is a prototyping board specialized for interfacing the common **N**ano microcontroller and n**RF**24L01+ transceiver, with additional I**2**C ports throughout the board. In fact, the *Proto-N2RF* got its name as a combination of the of these interfaces.

On the left-hand side of the board the same features as the *Proto-Half* can be found. The user is encouraged to familiarize themselves with the *Proto-Half* before using this more advanced board. The right-hand side of the *Proto-N2RF* contains the various interfaces. Along the top edge of the board are mounting holes for a common LCD module, which can be connected via the adjacent 5V I2C port. The board has added markings such as warnings and voltage connections to aid the user.

Table of Contents

2 DOCUMENT REVISION HISTORY

Current document revision is Rev 0.

3 PRODUCT FEATURES

This section highlights notable features of the *Proto-N2RF* v2.1.

3.1 Power Input

The *Proto-N2RF* has the following power input options:

1) 2-Pin screw terminal (2.54 mm/0.1 in).
2) Female barrel jack (2.1 mm X 5.5 mm).

These power input options are shown in Figure 1.

Note that the positive terminal of Option 1 is electrically connected to the positive terminal of Option 2. Similarly, the negative terminal of Option 1 is electrically connected to the negative terminal of Option 2. **It is not recommended to use both power input options simultaneously.**

Both power input options can be soldered onto either the front or back of the PCB. For this reason, the footprint of the female barrel jack of option 2) is unconventional. An additional, electrically isolated, through-hole exists such that the female barrel jack can be connected on either side while keeping the barrel opening in the same direction (away from the PCB). An example can be found in Section 6.1

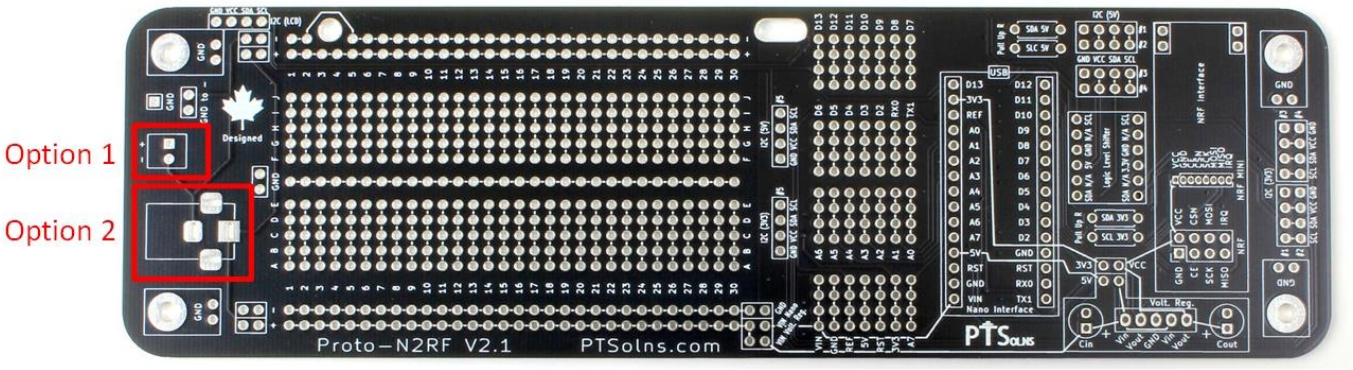


Figure 1: Two power input options for the Proto-N2RF.

3.2 Power Rails

The *Proto-N2RF* features five rails, each consisting of 30 tie-point through-holes[1], as shown in Figure 2. The rails can be electrically connected in different configurations. By default, all rails are initially electrically disconnected. Two of the rails can be connected to the positive terminal. Similarly, two other rails can be connected to the negative terminal. The remaining rail is suggested to be used in one of two ways:

1) Use the provided footprint connection to GND.
2) Use it for a data signal.

Connecting rails is suggested to be done in one of two methods:

1) Using a short wire to bridge the connection and soldering it in place. This is a permanent connection in which the user does not intend to change the configuration often.
2) Using male header pins connected with 2-Pin jumper caps. This is a temporary connection in which the user can easily disconnect the rail. This allows the jumper cap to act as an enable/disable for the rail and allows the rail to be reconfigured to transmit a different signal or voltage. An example can be found in Section 6.2.

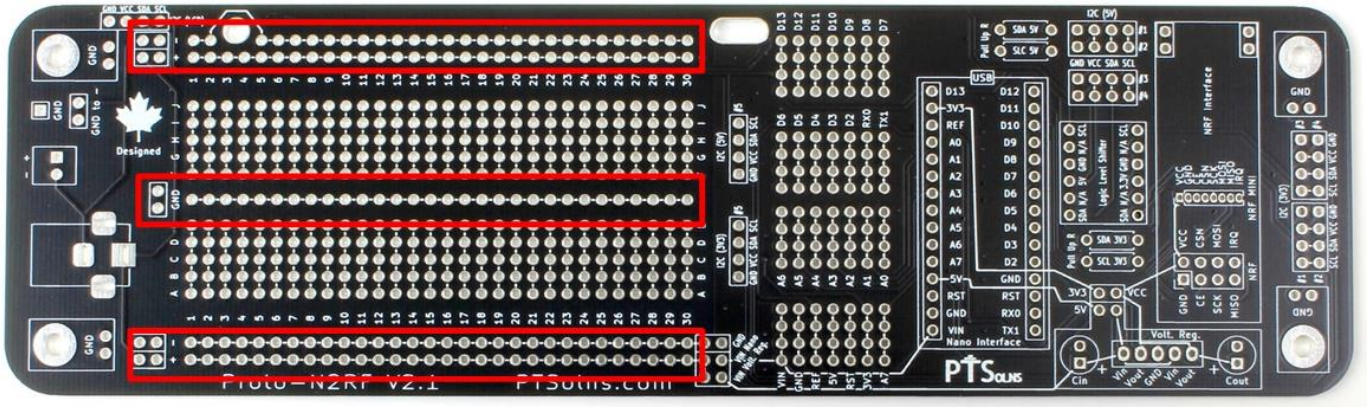


Figure 2: Five rails of the Proto-N2RF.

3.3 Ground (GND)

The ground (GND) of the PCB can be electrically connected to an external GND using the GND out pin. By default, this GND out pin is not connected to any other part of the PCB. Each of the four mounting holes can be connected to the GND of the PCB separately by closing the corresponding 2-Pin connections (one in each corner of the PCB). Additionally, the central rail can be connected to the GND of the PCB in a similar fashion.

The ground and negative terminal are by default electrically disconnected. To connect GND to the negative terminal the corresponding 2-Pin connection (marked as “GND to –“) must be electrically bridged. All GND connection options are shown in Figure 3. See Figure 12 for the electrical schematic.

[1] As seen in Figure 2, the top negative rail only has 28 tie-points due to the LCD mounting hole.

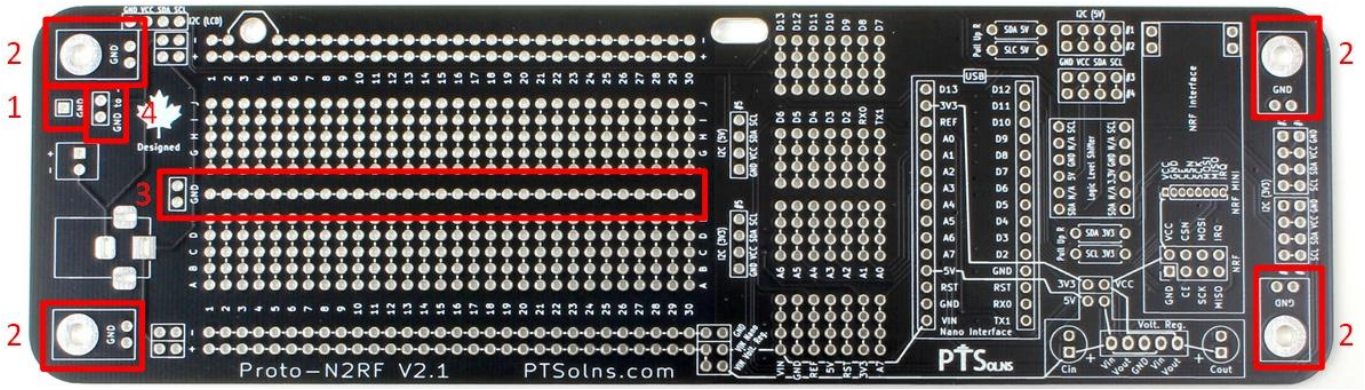


Figure 3: Various GND connection options of the Proto-N2RF. 1) GND out pin, 2) GND of each of the four mounting holes, 3) GND of the central rail, 4) GND to negative terminal connection.

3.4 Silkscreen Printing

The breakout section of the *Proto-N2RF* is fully labelled along the rows and columns. For ease of use, the silkscreen printing exists on both sides of the board. White dashed silkscreen lines between tie-points indicate an existing hardwired electrical connection. All components can be soldered on either side of the board, including asymmetrical components such as the female barrel jack.

3.5 Mounting

There are four 3.2 mm diameter mounting holes on the PCB as shown in Figure 4. These mounting holes are intended for hardware such as standoffs, of size M3. Each mounting hole has a 6.4 mm diameter copper pad and can be connected to the main ground (GND) of the PCB separately by bridging the respective 2-Pin jumper. Figure 10 shows the dimensions of the mounting holes.

In addition to the four corner mounting holes, there are two mounting holes along one of the long edges of the PCB. The intent is to be able to mount common 20x2 and 20x4 LCD modules directly onto the PCB. For an example application see Section 6.3. These LCD mounting holes are 75 mm apart (center-to-centre), which is a common distance among many LCD modules. The diameter of the LCD mounting holes are 3.2mm, with one of the mounting holes elongated to account for small variations in the hole spacing of various LCD modules. Figure 11 shows the dimensions of the mounting holes.

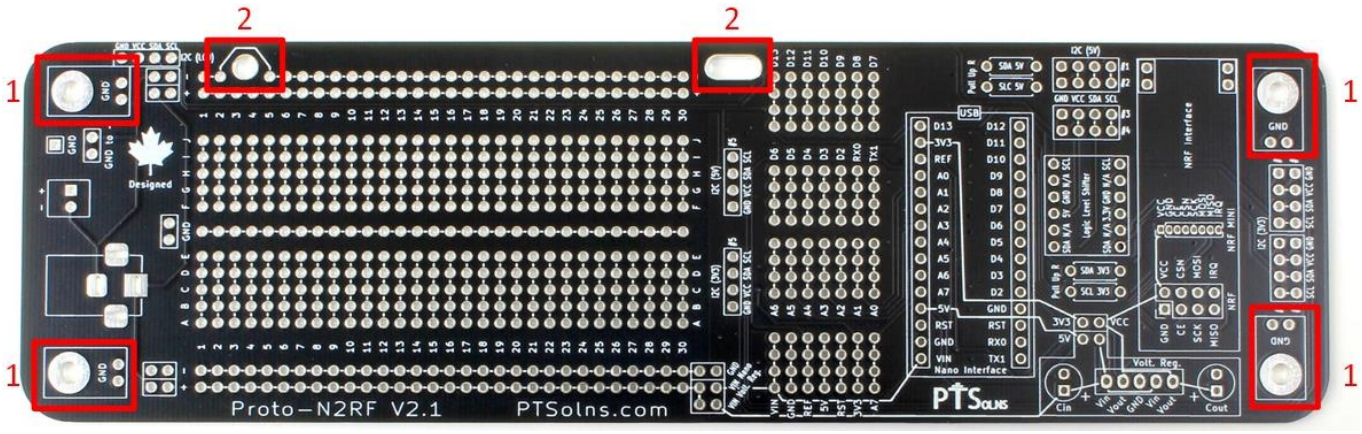


Figure 4: Various mounting holes of the Proto-N2RF. 1) Mounting hole in each corner of the PCB intended to secure the PCB or for stacking, 2) mounting holes for LCD.

3.6 Nano Microcontroller Interface

The *Proto-N2RF* is designed to easily interface with the common 5V Nano microcontroller. It is recommended not to solder the microcontroller directly onto the PCB, but rather use female headers soldered into the interface footprint. **There is only one correct way to connect the Nano microcontroller to the PCB.** That is, the Nano microcontroller should be connected onto the top side of the PCB, with the "USB" symbol printed in silkscreen aligning with the USB port on the microcontroller. The bottom side of the PCB can be identified by the silkscreen printing "Don't solder Nano on this side!" located on the PCB within the Nano interface. **Do not connect the microcontroller incorrectly as this could cause damage to components. Always ensure proper pin alignment by reading the pin labels on the microcontroller and the PCB interface.**

Next to the Nano microcontroller is the breakout section, which gives access to all the pins of the microcontroller. Each breakout consists of a row of four pins. The breakout section is arranged in this manner to give the user easy access to the nearby prototyping section of the PCB.

The Nano microcontroller can be powered in one of two ways:

1) Use the Vin and GND found within the breakout section (shown as item 2 in Figure 5).
2) Use it 2-Pin power rail connections for Vin and GND (shown as item 3 in Figure 5).

Note that if using method 2) that the GND of the Nano microcontroller will then be connected to the negative terminal of the PCB. **Do not power the Nano microcontroller with both methods 1) and 2) at the same time as this could result in damage to components.**

The Nano microcontroller interface, the corresponding rows of 4-Pin breakout section, and the powering options are shown in Figure 5.

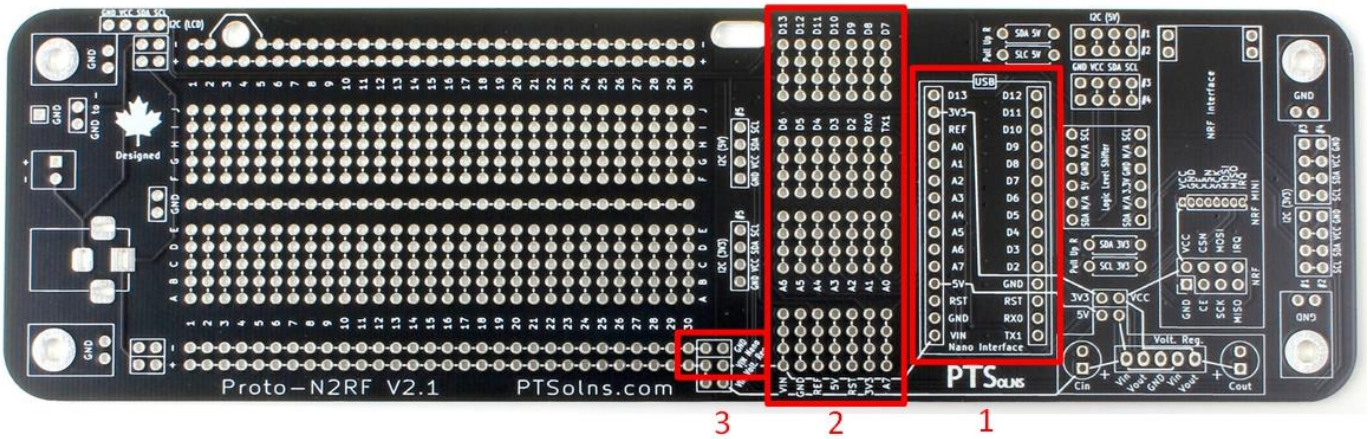


Figure 5: Nano microcontroller interface on the Proto-N2RF. 1) Footprint for the Nano microcontroller, 2) Rows of 4-pin breakout section 3) Optional method to power Nano microcontroller.

3.7 nRF24L01+ Interfaces

There are three common versions of the popular nRF24L01+ RF module (collectively referred to in this document as *NRF*):

1) nRF24L01+ mini size (breakout 1 X 8 Pins, with 1.27mm pitch)
2) nRF24L01+ standard size (breakout 2 X 4 Pins, with 2.54mm pitch)
3) nRF24L01+PA+LNA (same breakout as standard size, with additional two 1 X 1 Pin to GND)

All three of these nRF24L01+ versions are compatible with the *Proto-N2RF*. The three footprints are shown in box 1 of Figure 6. It is recommended not to solder these modules directly into the PCB, but rather use the appropriate female headers so that the modules can be easily replaced if needed. **Do not connect two RF modules at the same time (e.g. the mini and the standard together). Doing so my cause damage to components.**

Box 2 in Figure 6 shows the three different ways to power the NRF modules:

1) Power the NRF with the 3.3V (3V3) pin of the Nano.
    - Connect the 3V3 pin to the VCC pin with a 2-Pin jumper or directly soldering a bridge. This is shown in shown within Box 2 with a yellow highlight
2) Power the NRF with the 5V pin of the Nano.
    - Connect the 5V pin to the unmarked pin with a 2-Pin jumper or directly soldering a bridge. This is shown in shown within Box 2 with a green highlight
3) Power the NRF with the bottom positive power rail.
    - Connect the two pins marked “Vin Volt. Reg.” with a 2-Pin jumper or directly soldering a bridge. This is shown in shown within Box 2 with a purple highlight

NOTE: Never connect more than one of the three powering options at the same time.

Options 2 and 3 require the use of a 3.3V voltage regulator, with optional smoothing capacitors across Vin and Vout. This is shown within Box 2. The footprint of the voltage regulator is such that any 3-pin combination of GND, Vin, and Vout will match the component.

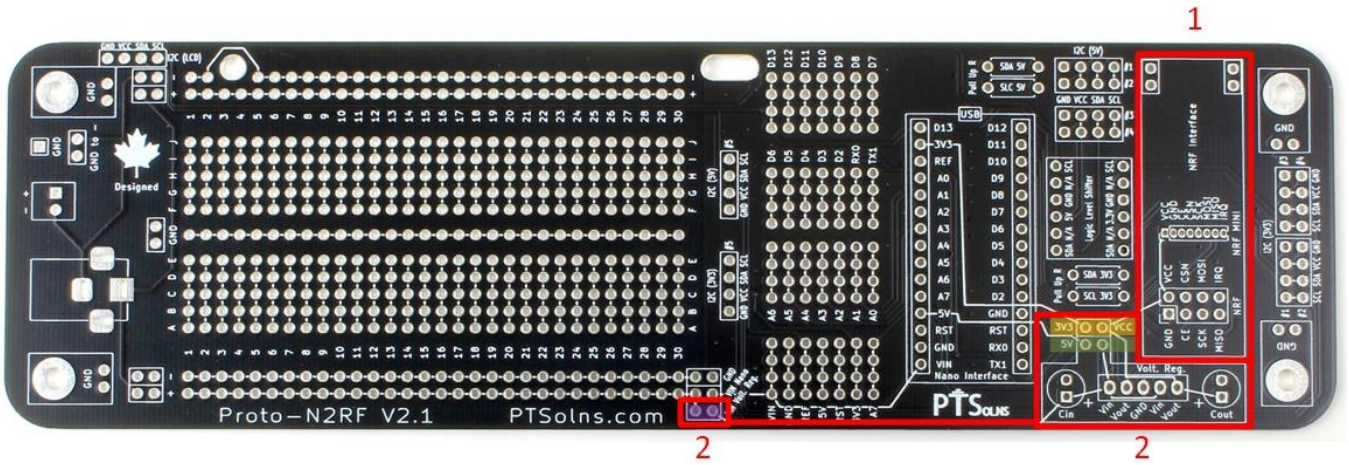


Figure 6: nRF24L01+ interface on the Proto-N2RF. 1) Interface to nRF24L01 (mini size), nRF24L01+ (standard size), and nRF24L01+PA+LNA, 2) Three methods to power the nRF24L01+ modules.

3.8 I2C Interfaces

The *Proto-N2RF* contains 6x 5V I2C breakouts (shown in Boxes 1a, 1b and 1c in Figure 7) and 5x 3.3V I2C breakouts (shown in Boxes 3a and 3b in Figure 7). Since the Nano microcontroller operates with 5V logic, the 5V I2C breakouts are directly connected to pins A4 (SDA) and A5 (SCL) on Nano microcontroller. There are also footprints to add external pull-up resistors to the 5V I2C bus (shown in Box 2 in Figure 7). The 5V I2C has a special breakout (shown in Box 1b) that is located to be adjacent to the LCD mounting holes. An application example of this is shown in Section 6.3.

To make use of the 3.3V I2C breakouts a logic-level shifter (LLS) is required. The footprint of a common[2] 4-channel LLS module is shown in Box 5 in Figure 7. With the LLS connected the 3.3V I2C breakouts become available. There are also footprints to add external pull-up resistors to the 3.3V I2C (shown in Box 4 in Figure 7).

[2] Such as SparkFun Logic Level Converter BOB-12009, or similar.

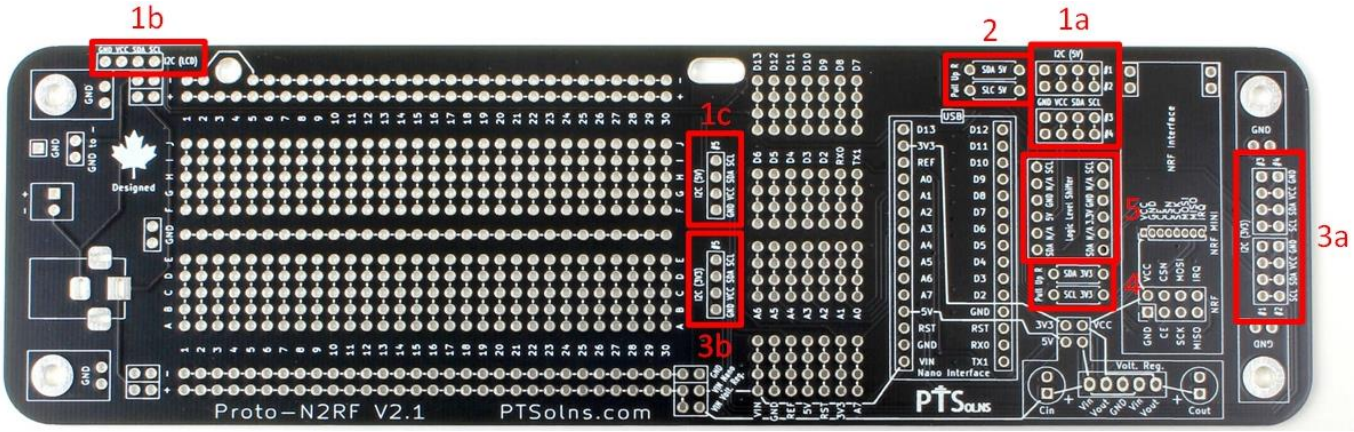


Figure 7: I2C interfaces on the Proto-N2RF. 1) a – 4x 5V breakout, b – 1x 5V breakout intended for LCD, c – 1x 5V breakout intended for use in prototyping section, 2) Interface for pull-up resistors for 5V I2C, 3) a – 4x 3.3V breakout, b – 1x 3.3V breakout intended for use in prototyping section, 4) Interface for pull-up resistors for 3.3 I2C, 5) Interface for 4-channel 5V-3.3V logic level shifter.

3.9 Mark of Authenticity

Authentic PTSolns PCBs have a black solder mask color and are marked with the “PTSolns” logo in white silkscreen printing. The “Canadian Designed” symbol, consisting of the Canadian Maple Leaf with the word “Designed” underneath, can also be found on the PCB in white silkscreen printing. The “PTSolns” trademark and the “Canadian Designed” symbols are shown in Figure 8.

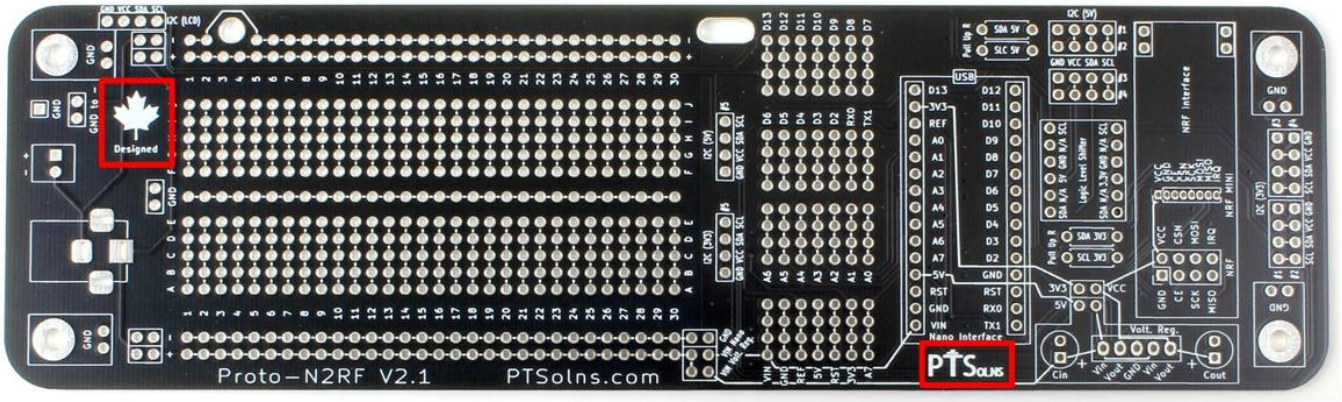


Figure 8: The "Canadian Designed" symbol found on authentic PTSolns PCBs.

4 PHYSICAL PROPERTIES

The physical properties of the *Proto-N2RF* are outlined in Table 1.

Table 1: Physical Properties.

	Quantity	**Value**	**Reference**
PCB	Length	200.7 mm	Figure 9
	Width	58.4 mm	Figure 9
	Thickness	1.6 mm	Figure 9
	Corner radius	7.6 mm	Figure 9
	Weight	37 g	--
	Color	Black	--
	Silkscreen	White	--
Tie-point	Number of tie-points	448	Figure 9
	Tie point spacing	2.54 mm/0.1 in	Figure 9
	Tie-point hole diameter	1.0 mm	Figure 10
	Tie-point copper pad diameter	1.7 mm	Figure 10
Mounting (Corners)	Hole diameter	3.2 mm	Figure 10
	Copper pad diameter	6.4 mm	Figure 10
	Center-to-center distance along length	185.4 mm	Figure 9
	Center-to-center distance along width	43.2 mm	Figure 9
Mounting (LCD)	Hole diameter (circular hole)	3.2 mm	Figure 11
	Copper pad diameter (circular hole)	4.0 mm	Figure 11
	Hole diameter (oval hole)	3.2 mm X 8.0 mm	Figure 11
	Copper pad diameter (oval hole)	4.0 mm X 8.8 mm	Figure 11
	Center-to-center distance	75.0 mm	Figure 9
Material	Lead free HASL-RoHS surface finish		--
	FR-4 substrate		--

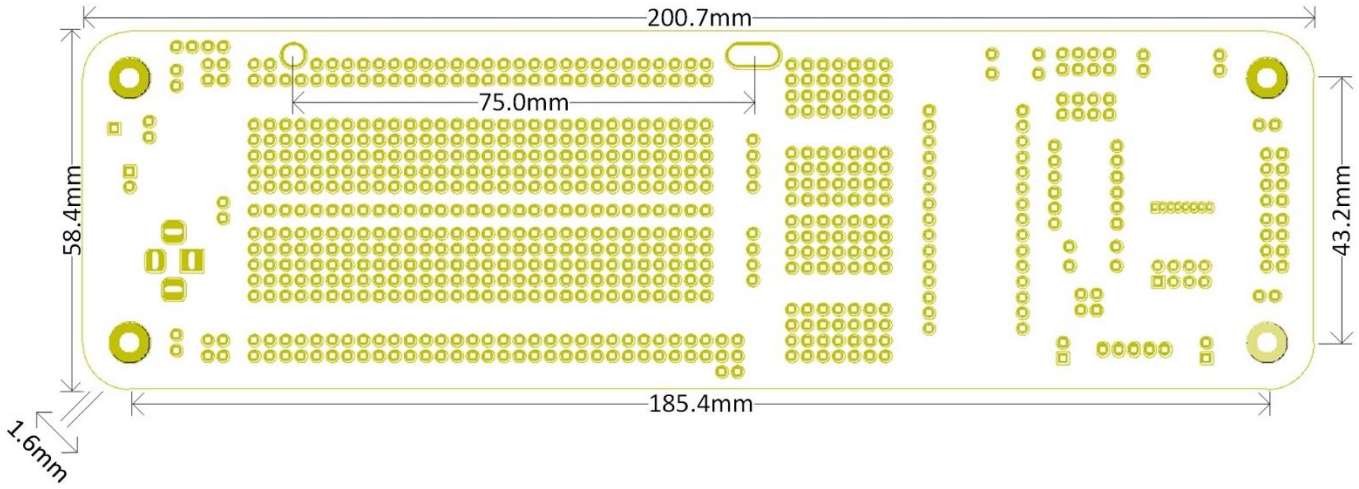


Figure 9: Dimensions of the Proto-N2RF PCB.

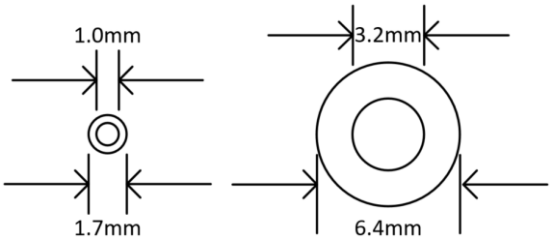


Figure 10: Dimensions of tie-point (left) and corner mounting hole (right).

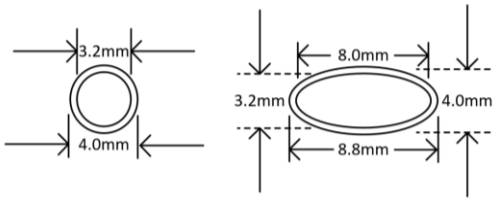


Figure 11: Dimensions of circular LCD mounting hole (left) and oval LCD mounting hole (right).

5 ELECTRICAL PROPERTIES

The current ratings of the *Proto-N2RF* are outlined in Table 2. Electrical connections made by copper traces are shown in Figure 12. Copper traces have a weight of 1 oz/ft^2.

Table 2: Current rating for *Proto-N2RF.*

Type of trace	**Current rating**[3]
Positive power rails	1.5 A
Negative power rails	1.5 A
Central ground rails	1.5 A
Power input female barrel jack	1.5 A
Power input 2-Pin screw terminal	1.5 A
All GND connections (excluding any traces related to interfaces)	1.5 A
5-Pin breakout rows	1.0 A
All traces relating to the following interfaces: Nano (including 4-Pin breakout rows), I2C (5V & 3.3V), NRFs	0.8 A

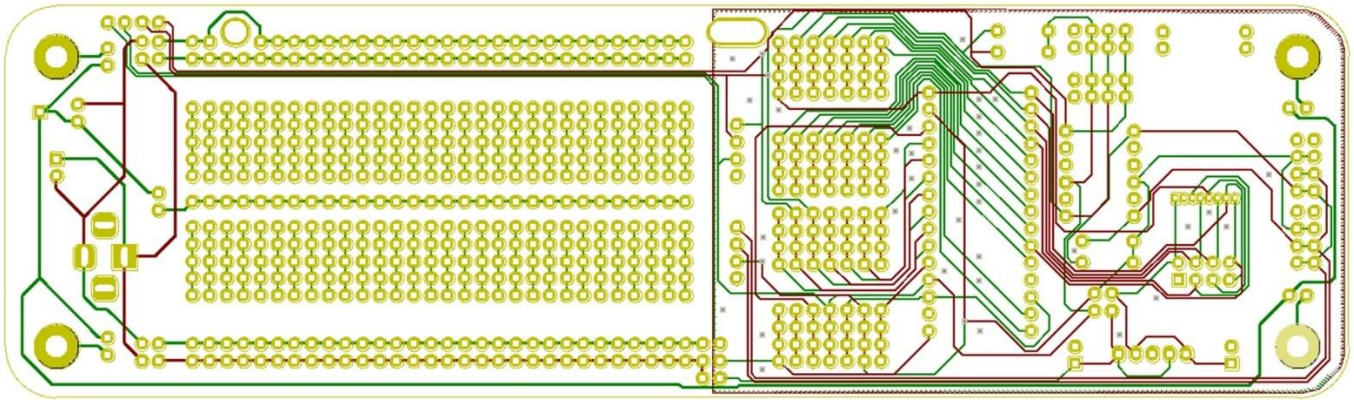


Figure 12: Electrical connections of the Proto-N2RF.

[3] Current ratings based on IPC-2221B and are in part determined assuming a maximum temperature rise of 20 °C.

6 USAGE AND APPLICATION

This section presents some usages and applications of the *Proto-N2RF*.

6.1 Power Input

This example shows two different options to power the *Proto-N2RF*. The image on the left in Figure 13 shows a green 2-Pin screw terminal and a black female barrel jack, both soldered onto the top side of the PCB. The image on the right in Figure 13 shows the same screw terminal on the top side, however, the female barrel jack is soldered onto the bottom side of the PCB. In both configurations stand-offs are used to lift the PCB up off the surface.

Figure 13: Power input configuration examples.

Both a screw terminal and a female barrel jack can be soldered into place simultaneously. This gives the user the ability to power the PCB with different connections, or easily switch between two different sources. Since these inputs are electrically connected in parallel, care should be taken to not power the PCB via both input methods at the same time.

6.2 Jumper Cap Connections

Rails and GND connections can be made by simply soldering across the respective 2-Pin gap. This is a permanent connection. A more temporary connection can be made by soldering male header pins across the 2-Pin gaps and using 2-Pin jumper caps, as shown in Figure 14.

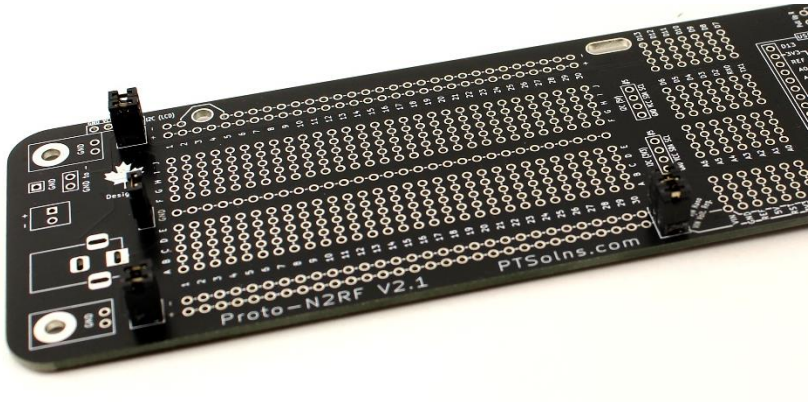


Figure 14: Connecting rails and GND using 2-Pin jumper caps.

The 2-Pin gap for the various GND connections consists of two through-holes separated by 2.54 mm/0.1 in. Using the jumper cap method, the male headers required are 1 X 2 Pin with a pitch of 2.54 mm/0.1 in. The gap for the adjacent positive and negative power rails consists of four through-holes arranged in a 2 X 2 pattern, separated by 2.54 mm/0.1 in. In this situation, a 2 X 2 Pin male header is recommended using the jumper cap method. However, two 1 X 2 Pin male headers can also be used. Similarly, the connection shown on the right-hand side in Figure 14 consists of 6 through-holes arranged in a 2 X 3 patterns. In this situation, a 2 X 3 Pin male header is recommended using the jumper cap methods. **Note that when using jumper caps to connect negative to negative and positive to positive always ensure the jumper caps are not crossed the negative and positive terminal. Mind the direction the jumper caps are placed in the 2 X 2 configuration.**

6.3 Mounting an LCD

The *Proto-N2RF* is designed to easily mount common LCD modules that have a hole-to-hole spacing of 75 mm. Figure 15 shows how an LCD module can be mounted. Two small stand-offs (size M3) are used but are not required. The right mounting hole has an oval shape to allows for small variations in hole-to-hole spacing on the LCD module between different manufacturers. To the left of the LCD mounting footprint is a breakout for a 5V I2C interface.

Figure 15: Mounting a common LCD module to the Proto-N2RF.

6.4 Powering nRF24L01+ Options

There are three methods on the *Proto-N2RF* to power the nRF24L01+ (mini, standard, +PA+LNA). These methods are outlined in Section 3.7. As an example, Figure 16 shows all three methods being utilized. In the top sub-image, the external power rail is used. This rail feeds into the Vin of the voltage regulator. Two smoothing capacitors of 10 µF are used on the input and output voltages of the voltage regulator. Note that in this case the two jumper caps across the 5V and 3V3 (3.3V) output of the Nano microcontroller are not connected.

In the middle sub-image, the 5V output of the Nano microcontroller is used. In this situation the external power rail is not connected as before. The 5V jumper cap is installed, forming a connection to the Vin of the voltage regulator.

Two smoothing capacitors of 10 µF are used on the input and output voltages of the voltage regulator. Note that in this case the jumper cap across the 3V3 output of the Nano microcontroller is not connected.

In the bottom sup-image, the 3V3 output of the Nano microcontroller is used. In this situation the external power rail is not connected as before, although the voltage regulator and smoothing capacitors are present. The 3V3 jumper cap is installed, forming a connection directly to the input voltage of the NRF interface. Note that in this case the jumper cap across the 5V output of the Nano microcontroller is not connected. Lastly, since the smoothing capacitor across the Vout of the voltage regulator is present, it will also smooth the 3V3 output of the Nano microcontroller.

NOTE: Never connect more than one powering methods at any time.

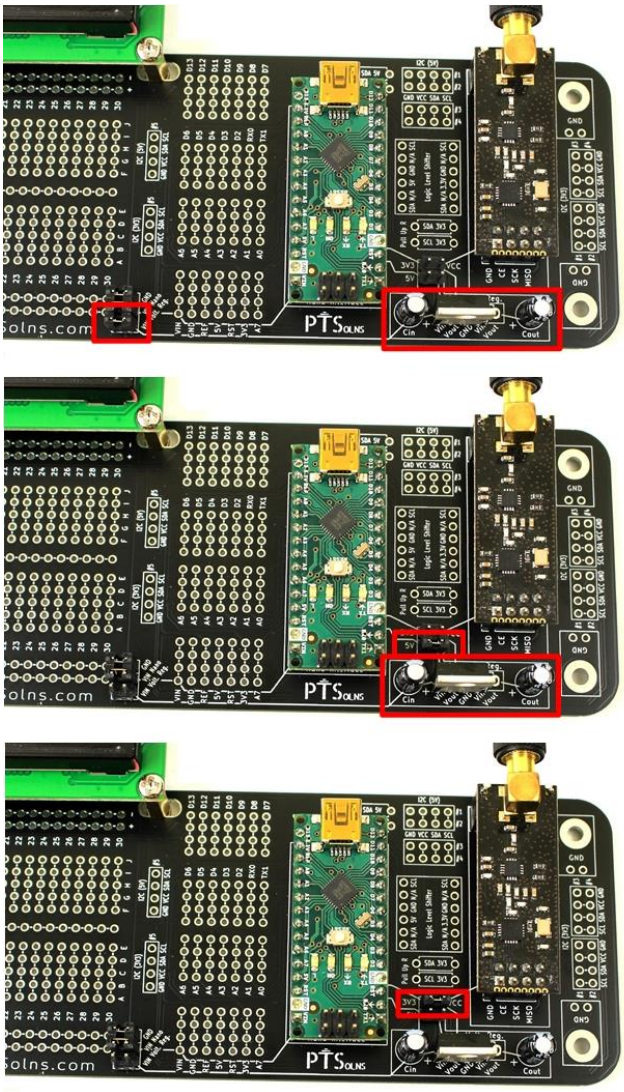


Figure 16: Different ways to power the NRFs. Top) External power rail and external voltage regulator (with smoothing capacitors), Middle) 5V output from the Nano microcontroller and external voltage regulator (with smoothing capacitors), Bottom) 3V3 output from the Nano microcontroller.

7 RECOMMENDED ACCESSORIES

The following is a list of recommended components and accessories to help the user best utilize the *Proto-N2RF*.

- **Female barrel jack**. Size: 2.1 mm X 5.5 mm
  - Used as one of the power input options for positive and negative connections.

- **Female header**. Pins: 1 X 40 Pin; Pitch: 2.54 mm/0.1 in
  - The user can break the full row of pins into smaller sections as required.

- **Jumper cap**. Pins: 2; Pitch: 2.54 mm/0.1 in
  - Used to make temporary connection for power rails.

- **LCD module**. Any of the following common LCD modules: 2X20, 3X20 or 4X20. Mounting hole-to-hole distance along long edge should be around 75mm.
  - Used in the corresponding interface

- **Logic Level Shifter**. 4-Channel, bi-directional.
  - SparkFun Logic Level Converter BOB-12009, or similar.

- **Male header**. Pins: 1 X 40 Pin, 2 X 40 Pin; Pitch: 2.54 mm/0.1 in
  - The user can break the full row of pins into smaller sections, such as 2 X 2 Pin, which can be used to connect the positive and negative power rails (with 2-Pin jumper caps)

- **Nano microcontroller**. 5V, ATmega328
  - Used in the corresponding interface

- **nRF24L01+**. Mini, Standard, or +PA+LNA
  - Used in the corresponding interface

- **Screw terminal**. Pins: 2; Pitch: 2.54 mm/0.1 in
  - Used as one of the power input options for positive and negative connections.

- **Stand-off set**. Size: M3; Length: various
  - Used in mounting holes to secure PCB.

- **Voltage Regulator and Capacitors**. Any voltage regulator with Vout=3.3V and can handle the required current. Suggest is the LM1117-3.3 or similar. Smoothing capacitors may vary. Suggest is 10µF.
  - Used in the corresponding interface

- **Wire set**. A.W.G.: ≥19; Length: various; Type: preformed, DuPont, etc.
  - Used in any of the tie-point breakout sections.