LNQ2900 Module Datasheet

General Description

The LNQ2900 RavenConnect SLR[1] module, with pre-installed Raven Network software stack, provides a turnkey solution for customers to equip their products with the Raven ad hoc network. Leveraging the popular LoRa Physical Layer (PHY), the LNQ2900 is suited for Super Long Range (SLR) point-to-point (P2P), point-to-multipoint (P2M) and mesh topologies for sensor, messaging, location sharing and other data applications. The FCC/ISED (pending) certified module allows for rapid product development and fast time to market.

Features

- **Raven Network Software Stack**
  - Raven stack pre-installed on the LNQ2900
  - Super Long Range (1 hop P2P)
  - No infrastructure required
  - Simple and quick network formation
  - Highly secure
  - Described further in Raven Stack Product Brief
- **Wireless SoC**
  - Multi-Protocol LPWAN STM32WL55[2] SoC
  - Integrated sub-GHz radio transceiver
    - Modulations: LoRa®, (G)FSK, (G)MSK & BPSK
  - Dual-Core 32-bit ARM® Cortex M4/M0+
  - 256KB embedded / 16-Mbit external FLASH
    - Memory fully reserved for Raven stack only
  - 64KB embedded SRAM
  - 5 GPIO's for mappable interrupts
  - On-board bootloader for easy firmware updates/upgrades
  - UART with command interface for quick provisioning
  - Highly secure architecture, including:
    - AES-256 hardware encryption
    - Hardware Public Key Accelerator support
  - ±0.5ppm TCXO reference
  - Ultra-low power sleep mode
- **RF Transceiver Section**
  - 915 MHz radio
  - LoRa® modulation
  - High Tx Power for max range: ≤ +30 dBm (@3.7V)
  - Low Tx Power for LPI/LPD[3] applications: ≥ -16 dBm
  - Rx Sensitivity down to -133 dBm (SF11)
- **Operating Range**
  - Dual supply voltages for enhanced RF power:
    - V_{DD} Typical: 3.3V
    - V_{DDRF} Typical: 3.7V (for +30dBm Tx power)
  - -40 to +85°C operating temp range
- **Dimensions**
  - 19mm x 19mm x 2.5 mm
- **Regulatory**
  - Modular certification – FCC & ISED (Pending)
  - RoHS Compliant

Applications

- Location sharing
- Asset tracking (especially long range)
- Internet of Things (IoT) sensors
- Messaging

[1] RavenConnect SLR is described in the Raven software stack Product Brief [1]
[2] ST Microelectronics STM32WL55 SoC datasheet provides specifics on the processor [2]
[3] LPI/LPD: Low Probability of Intercept/Low Probability of Detection

Table of Contents

1. Module Overview

The LNQ2900 module is a highly integrated system that comes pre-loaded with Lynq's Raven network protocol stack to provide a complete solution for reliable, long-range, ad hoc, simple to use and secure communications that can be deployed where other networks don't exist, can't be relied upon or are too expensive (e.g. cellular) from a Total Cost of Ownership (TCO) perspective. The module enables OEM's to shorten development cycles and achieve faster time-to-market than is otherwise possible with chip-down designs.

Built around ST Microelectronics' popular STM32WL55 Low Power Wide Area Network (LPWAN) System-on-Chip (SoC), the LNQ2900 module provides a powerful dual-core processing platform and robust radio transceiver operating in the 915 MHz unlicensed ISM band. The processing platform provides sufficient MIPS capacity to execute the Raven network software stack protocol. The RF transceiver section uses LoRa modulation to provide long range communications. For Super Long Range (SLR), the Raven stack provides proprietary range extension algorithms. In addition, the module includes a high power mode to provide a maximum Tx output power of +30 dBm (requires RF supply voltage of 3.7V). For quiet operation, such as that needed for LPI/LPD types of applications, the module can operate with a Tx output power down to -16 dBm. The receiver section is designed to provide a receive sensitivity down to -133 dBm when using a spreading factor of 11.

The module antenna port is matched to 50-Ohms for easy connection to a customer provided antenna. The RF front end is implemented with a Skyworks SKY65364-21 front end module (FEM) which includes the PA, LNA, T/R switch and matching networks among other things. In addition, the front end receive path includes a 915 MHz SAW filter external to the FEM for excellent out of band interference rejection.

The digital interface includes a UART for data transfer and module control along with 5 GPIOs which can be used as mappable interrupts.

The module is equipped with an additional 16-Mbits of serial FLASH beyond the 256 KBytes embedded in the SoC. Timing for the module is provided by a 32 MHz TCXO as the primary clock source and a 32 kHz crystal for operation in low power mode(s).

In addition to active circuitry, the module comes equipped with all filtering, matching and shielding required for high performance, reliable operations when operated under specified operating conditions.

1.1 LNQ2900 Typical Application

Figure 1 below provides a diagram showing typical application of the LNQ2900 module.

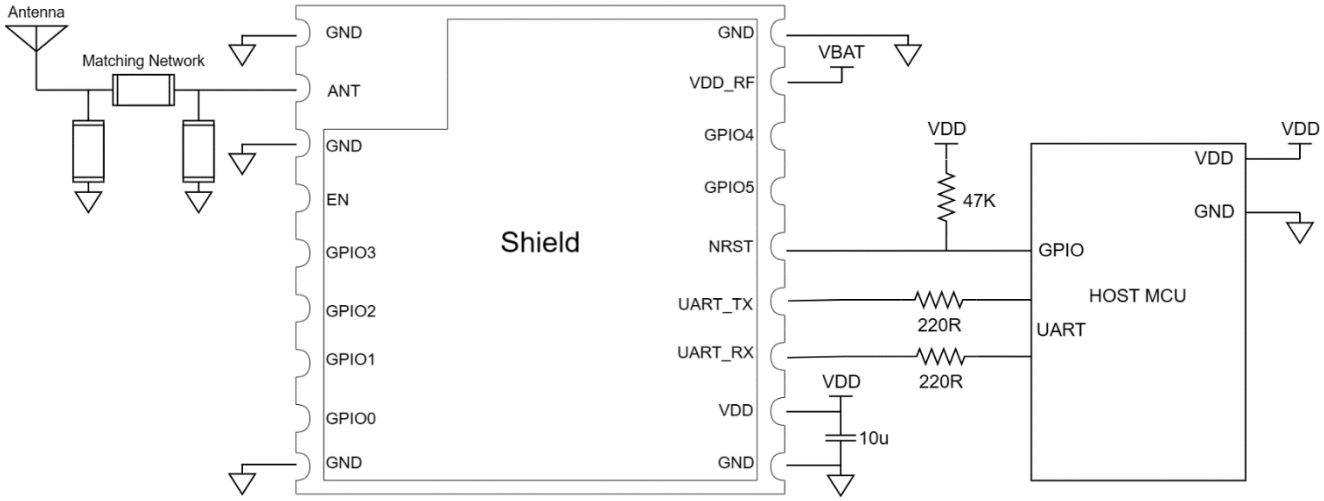


Figure 1 - LNQ2900 Typical Application

2. Interfaces

2.1 RF Interface

Pin 2 on the LNQ2900 is the RF signal pin and connects to a 915 MHz external antenna. It is matched to 50 Ohms. To maximize performance, it is important to make sure that any traces from the pin are matched to 50 Ohms. An external matching network may be required if an antenna with a different impedance is used.

2.2 Host Data & Control Interface

2.2.1 General Purpose I/O Pins

The module is equipped with six General Purpose I/O pins. From a module hardware perspective, their functions are programmable and based on application specific requirements. Actual function mapping is specified in the Raven Stack Software Reference Manual.

2.2.2 UART Pins

The LNQ2900 has a UART serial peripheral interface dedicated to communication with a host controller or processor. Module pin 12 is the UART Rx signal and pin 13 is the UART Tx signal. Default UART settings are provided in Table 1 below.

Table 1 - UART Default Settings

Parameter	Default Setting
Peripheral	Serial UART
UART Spec	8N1
Baud Rate	115,200 bps
Timeout (Bad Msg)	TBD ms
Wait Between Msg	TBD us
Wait after Power On	2.3 s
Maximum Msg Size	TBD bytes

2.2.3 Module Enable

The Module Enable input signal on Pin 4 serves as a means of placing module components into deep sleep. It is intended to minimize the current draw to the device to act as an effective ‘off’ switch for the module. When high, device operation is normal and all aspects of the system can be controlled. When the pin is pulled low, all on board components are disabled and UART communication is disabled. A weak pullup is implemented in the device.

2.3 Reset Interface

An active low reset input is provided on Pin 14. When brought low, the reset pin resets the LNQ2900 module MCU. A weak pullup is implemented in the device, but an external pullup may be added in particularly noisy environments. To prevent potential framing issues at power on, reset should be asserted after the host controller has been powered on and initialized.

2.4 Power & Ground

The LNQ2900 power supply pins must be provided with a power source that allows for operation under the operating conditions defined by the user's application. Refer to General Specifications, for more information. Additional decoupling capacitors are not required but may be recommended depending on the final layout and power source.

2.4.1 VDD

Pin 11 provides the primary power supply connection for the module. Refer to Table 5 for recommended operating conditions for supply connections.

2.4.2 VDD_{RF}

Pin 17 provides the secondary power supply connection for operating the RF portion of the module. Refer to Table 5 for the recommended operating conditions for this supply connection. When operating the module in the standard power transmit mode, this supply pin can be connected to Pin 11. For high power transmit mode, this pin should be supplied with 3.6-3.7V. The input range allows for this pin to be connected to a standard single cell Li-Ion or Li-Poly battery.

2.4.3 GND

Pins 1, 3, 9, 10, and 18 provide a ground reference to the module components. All pins must be connected to the same suitable power supply ground reference.

3. Pin Definition

3.1 Pin Assignment

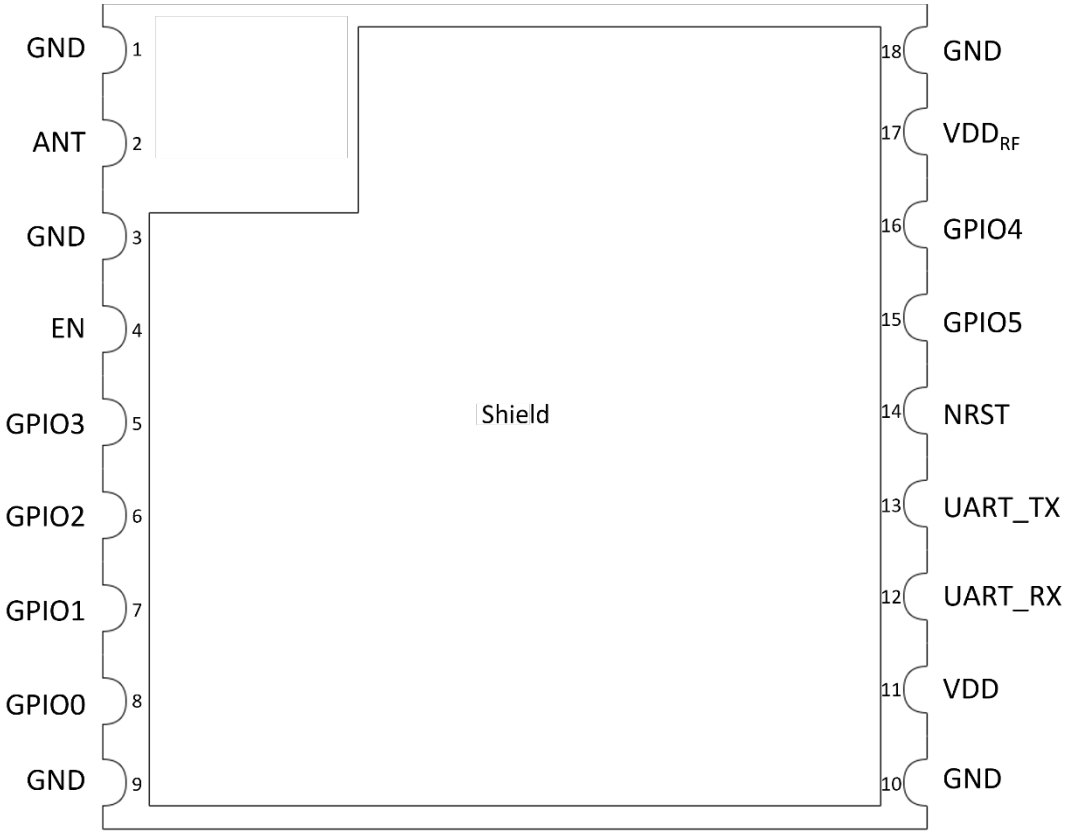


Figure 2 - LNQ2900 Pin Assignment Diagram

3.2 Pin Description

Table 2 - LNQ2900 Pin Descriptions

1	GND	Ground	Ground
2	ANT	Antenna Port	Input/Output
3	GND	Ground	Ground
4	EN	Module Enable/Disable	Input
5	GPIO3	General Purpose I/O 3	Input/Output
6	GPIO2	General Purpose I/O 2	Input/Output
7	GPIO1	General Purpose I/O 1	Input/Output
8	GPIO0	General Purpose I/O 0	Input/Output
9	GND	Ground	Ground
10	GND	Ground	Ground
11	VDD	Supply Voltage	Power
12	UART_RX	UART Interface - Receive	Input
13	UART_TX	UART Interface - Transmit	Output
14	NRST	Device Reset (Active Low)	Input
15	GPIO5	General Purpose I/O 5	Input/Output
16	GPIO4	General Purpose I/O 4	Input/Output
17	VDD_{RF}	Supply Voltage – RF Front End	Power
18	GND	Ground	Ground

4. Electrical Specifications

All specifications are measured at ambient temperature of +25 °C. Operating temperatures in the environment and under load can significantly impact electrical specifications. Devices operating near the temperature limits may vary from those values in the tables. Data is provided only as an example of typical power requirements and operating characteristics. You should perform an evaluation of the device in your particular application.

4.1 Absolute Maximum Ratings

Stress above maximum temperature or electrical values may cause permanent damage to the device.

Table 3 - Absolute Maximum Ratings

Parameter	Min	Max	Unit
VDD Voltage, RF Off	-0.3	+3.9	V
VFEM Voltage, RF Off	-0.3	+6.0	V
Storage Temperature	-40	+85	°C

4.2 Operating Conditions

4.2.1 Temperature Range

Table 4 - Operating Temperature Range

Parameter	Min	Max	Unit
Operating Temperature, RF Off	-40	+85	°C
Operating Temperature, RF On	-40	+85	°C

4.2.2 Electrical Characteristics

Table 5 - Electrical Characteristics

Characteristic	Min	Typ	Max	Unit
VDD Operating Voltage	3.0	3.3	3.6	V
VDD_RF Operating Voltage	3.0	3.7	4.2	V
Voltage on any pin with respect to GND (except VDD and $\overline{\text{RESET}}$)	-0.3	VDD	+0.3	V
Disable Current	-	4	-	uA
Standby Current	-	10	-	mA
Receive Current	-	25	-	mA
Transmit Current	26	-	800	mA

Note: VDD = VDD_RF = 2.8V, 24dBm max; VDD = VDD_RF = 3.3V, 28dBm max; VDD = 3.3V / VDD_RF = 3.7V, 30dBm max

4.2.3 Transmitter Characteristics

Conditions: VDD = 3.3V / VDD_RF = 3.7V, Temperature = 25C, Matched antenna

Table 6 - Transmitter Characteristics

Parameter	Condition	Min	Typ	Max	Unit
Output power at ANT		-16	-	+30	dBm
Output power stability		-	+/- 1.5	-	dB
Active Current	ANT_OP = +10 dBm	-	26	-	mA
	ANT_OP = +24 dBm	-	375	-	mA
	ANT_OP = +27 dBm	-	525	-	mA
	ANT_OP = +30 dBm	-	790	-	mA
Duty Cycle				50	%

Note: VDD = VDD_RF = 2.8V, 24dBm max; VDD = VDD_RF = 3.3V, 28dBm max; VDD = 3.3V / VDD_RF = 3.7V, 30dBm max

4.2.4 Receiver Characteristics

Conditions: VDD = 3.3V / VDD_RF = 3.7V, Temperature = 25C, Matched antenna

Table 7 - Receiver Characteristics

Parameter	Condition	Min	Typ	Max	Unit
Current while receiving	VDD = 3.3V	-	25	-	mA
Receiver sensitivity (7.03kbps)	SF = 9, BW = 500kHz	-	-122	-	dBm
Receiver sensitivity (5.47kbps)	SF = 7, BW = 125kHz	-	-124	-	dBm
Receiver sensitivity (537bps)	SF = 11, BW = 125kHz	-	-134	-	dBm
RF input level	-	-	-	+10	dBm

4.2.5 General Radio Characteristics

Table 8 - General Radio Characteristics

Parameter	
Modulation	CSS (LoRa)
Frequency Range	902-928 MHz
Link Budget	Up to 164 dB
Receiver Sensitivity	As low as -134 dBm
Power Output	Up to 1 W
Frequency Stability	±0.5 ppm

5. Mechanical Specifications

5.1 Module Dimensions

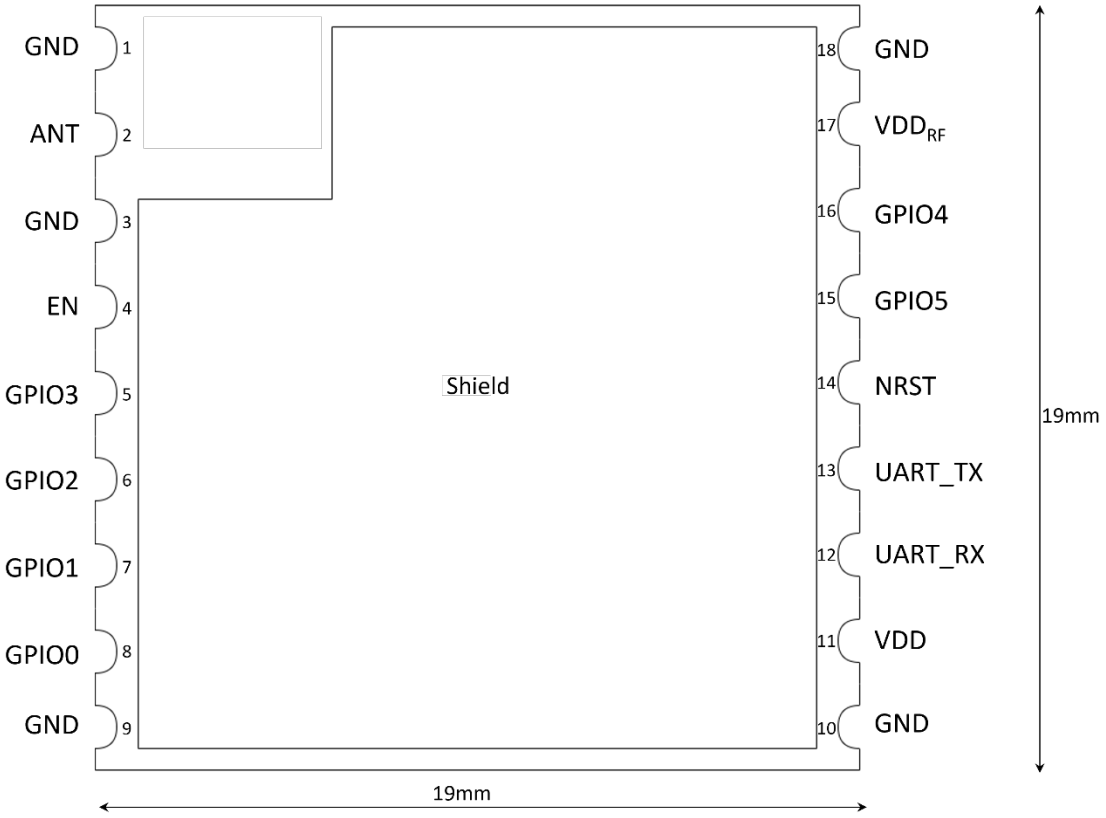


Figure 3 - LNQ2900 Module Dimensions

6. Qualification & Certifications

6.1 Reliability Tests

Reliability tests for LNQ2900 modules are executed according to Lynq Technologies qualification policy.

6.2 Regulatory Compliance

The LNQ2900 has been approved for operation in the United States and Canada. Implementation of this product must follow the guidelines in this section under each respective country for the allowance of permissive operation.

6.2.1 United States

The LNQ2900 module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C “Intentional Radiators” modular approval in accordance with Part 15.212 Modular Transmitter approval. Modular approval allows the end user to integrate the LNQ2900 module into a finished product without obtaining subsequent and separate FCC approvals for intentional radiation, provided no changes or modifications are made to the module circuitry. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance. The finished product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion. For example, compliance must be demonstrated to regulations for other transmitter components within the host product; to requirements for unintentional radiators (Part 15 Subpart B “Unintentional Radiators”), such as digital devices, computer peripherals, radio receivers, etc.; and to additional authorization requirements for the non-transmitter functions on the transmitter module (i.e., Verification, or Declaration of Conformity) (e.g., transmitter modules may also contain digital logic functions) as appropriate. Lynq provides functions and test modes available through the digital interface that allow the integrator to achieve additional compliance testing, as necessary.

6.2.1.1 Labeling and User Information Requirements

The LNQ2900 module has been labeled with its own FCC ID number, and if the FCC ID is not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording as follows:

> Contains Transmitter Module FCC ID: 2ARHMLNQ2900
>
> This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation

A user's manual for the finished product should include the following statement:

> This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference

to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

• Reorient or relocate the receiving antenna.

• Increase the separation between the equipment and receiver.

• Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

• Consult the dealer or an experienced radio/TV technician for help.

6.2.1.2 RF Exposure

All transmitters regulated by FCC must comply with RF exposure requirements. KDB 447498 General RF Exposure Guidance provides guidance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to Radio Frequency (RF) fields adopted by the Federal Communications Commission (FCC).

Currently this device is approved for use for when 20 cm can be maintained between the antenna and users. Specific Absorption Rate (SAR) evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm.

Output power listed is conducted. This grant is valid only when the module is sold to OEM integrators and must be installed by the OEM or OEM integrators. This transmitter is restricted for use with the specific antenna tested in this application for Certification and must not be co-located or operating in conjunction with any other antenna or transmitters within a host device, except in accordance with FCC multi-transmitter product procedures.

6.2.2 Canada

The LNQ2900 module has been certified for use in Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSS-Gen. Modular approval permits the installation of a module in a host device without the need to recertify the device.

6.2.2.1 Labeling and User Information Requirements

The host device shall be properly labeled to identify the module within the host device:

Contains Transmitter Module IC: 24896-LNQ2900

A user's manual for the finished product should include the following statement:

This device complies with Innovation, Science and Economic Development (ISED) Canada license exempt RSS regulations. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

6.2.2.2 RF Exposure

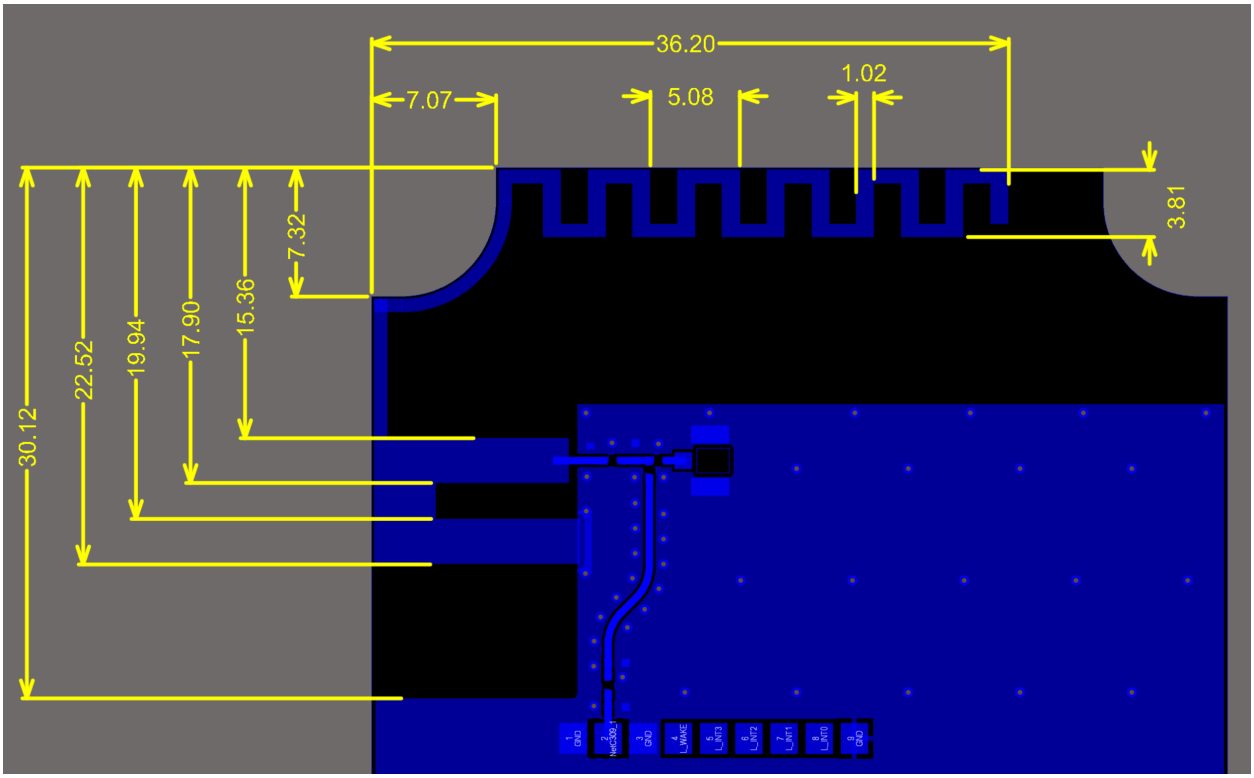
All transmitters regulated by IC must comply with RF exposure requirements listed in RSS-102 - Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands). Currently this device is approved for use for when 20 cm can be maintained between the antenna and users.

Specific Absorption Rate (SAR) evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm. Exceptions are listed in RSS-102. Note that integration < 20 cm will require further certification with IC such as a Multiple listing and Class IV Permissive Change application.

7. Product Implementation Notes

7.1 PCB Trace Antenna Guidelines

LNQ2900 is certified with a PCB trace antenna as shown in the below figure. The PCB trace antenna is fabricated on the top copper layer and covered in solder mask. The layers below the antenna do not have copper trace. The PCB material is FR4 and the thickness is 0.062 inches (1.6 mm). The antenna has 50 ohm impedance. The supporting board must be 90.5 mm long and 48.6 mm wide in order to generate that impedance and the average gain of 0.9 dBi. The host PCB must follow these design guidelines to maintain compliance under the modular grant (FCC) and certificate (IC). Gerber files are available upon request from Lynq Technologies.



7.2 Packaging

LNQ2900 modules are delivered in hermetically sealed, ESD safe trays to enable efficient production, production lot set-up and tear-down.

7.3 ESD Precautions

LNQ2900 modules contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling these modules without proper ESD protection may destroy or damage them permanently.

Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates LNQ2900 modules.

Failure to observe these precautions can result in severe damage to the device.

7.4 Soldering and Assembly

The LNQ2900 module is assembled using a standard lead-free, reflow profile, IPC-A-610 Class II and fabrication in accordance with J-STD-001 current revision. The LNQ2900 module can be soldered to the host PCB by using a reflow profile that does not exceed the peak temperature of +245 Celsius. Figure 4 below depicts the module footprint. Lynq can provide Altium Designer files for recommended module footprint upon request.

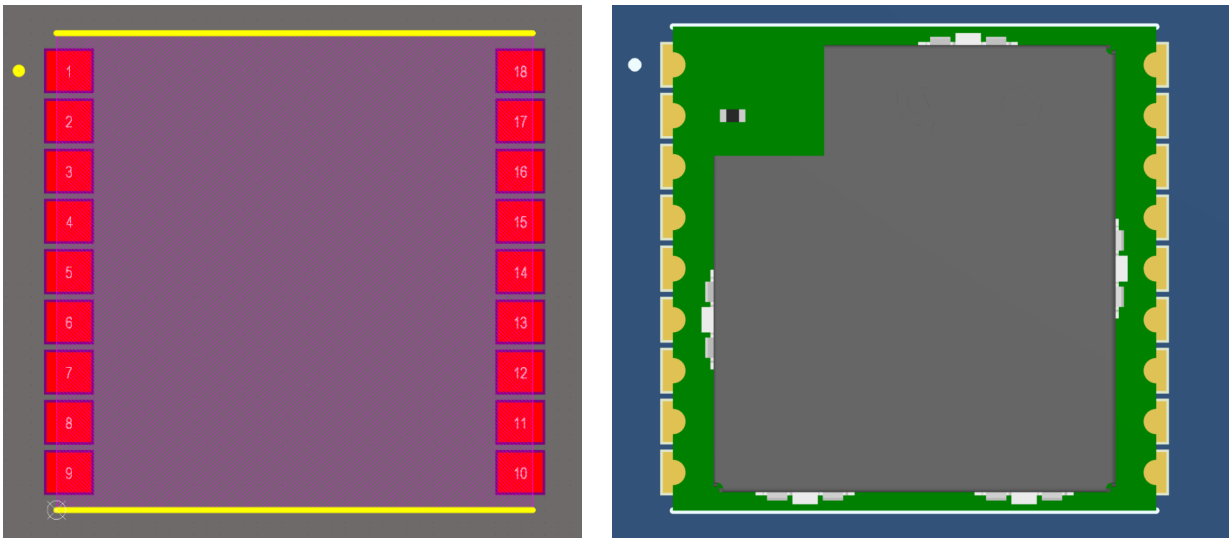


Figure 4 - LNQ2900 Module Footprint

Assembly Notes:

- There are 18 castellated holes in the LNQ2900 module
- Pin 1 of the module is marked by a cutout in the corner of the shield
- PCB solder pads and the solder paste aperture should follow the recommended design provided in the Altium PCB Library files
- After soldering optical inspection is recommended to verify proper alignment of the module, that all castellated pads are properly soldered, and that no excess solder is present
- Only single reflow processes are recommended.
- On boards with components populated on both sides, it is recommended that the module should be placed on the side of the board which is subjected to the last reflow cycle. This is due to the higher weight of the module relative to other components and risk of it falling off.
- Repeated reflow processes and soldering the module upside down are not recommended.
- Do not wash the LNQ2900 module, as moisture can be trapped under the shield.
- Hand soldering is allowed. Use a soldering iron temperature setting equivalent to 350 °C. Place the module precisely on the pads.
- Never attempt a rework on the module itself, for example, replacing individual components. Such actions immediately void the warranty.

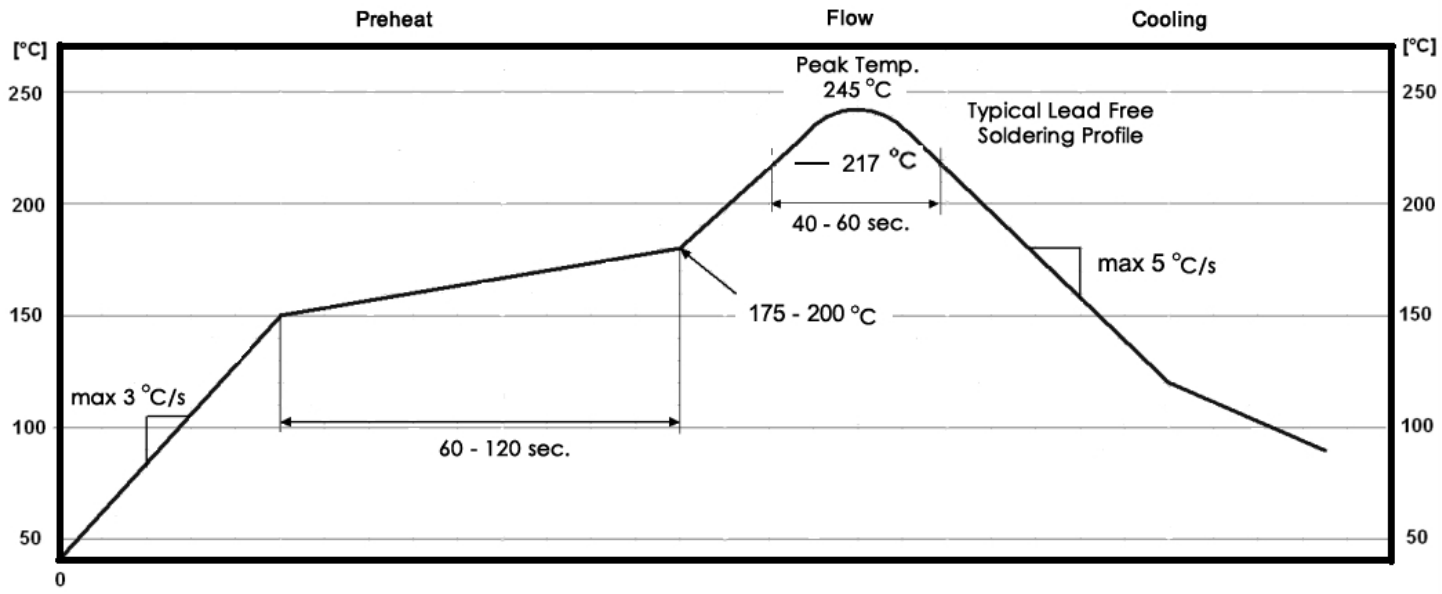


Figure 5 – Soldering Temperature Profile

7.5 Moisture and Storage Considerations

Store LNQ2900 modules in a moisture-controlled environment and handle in accordance with Moisture Sensitivity Level 3 (MSL 3). Desiccant packs shall be included with each LNQ2900 tray inside a sealed ESD bag.

8. Labeling & Ordering Information

8.1 Module Product Labeling

TBD

8.2 Ordering Information

TBD

Appendix A - References

[1] Raven Network Protocol Software Stack Product Brief

[2] "*STM32WL55xx STM32WL54xx Datasheet*" Revision 5, 19 December 2022
https://www.st.com/resource/en/datasheet/stm32wl55cc.pdf

Appendix B – Revision History

Revision	Date	Comments
0.6	16-Aug-2024	Updates to Regulatory Compliance sections
0.5	25-Mar-2024	Added image of actual module
0.4	10-Feb-2023	Updated with new part number designation
0.3	25-Jan-2023	Updates to spec tables, module drawings and text
0.2	19-Jan-2023	Updated after internal datasheet review
0.1	19-Dec-2022	DRAFT version

Lynq Technologies, Inc.
4760 Walnut St., Suite 108
Boulder, CO 80301

Visit us at: www.lynqnetworks.com