QN902x

Ultra Low Power BLE System-on-Chip Solution

General Description

QN902x is an ultra low power, high performance and highly integrated Bluetooth v4.0 Low Energy (BLE) solution for Bluetooth Smart applications such as sports/fitness, human interface devices, and app-enabled smart accessories. It is especially designed for wearable electronics and can run on small capacity battery such as a coin cell battery.

QN902x integrates a BLE radio, controller, protocol stack and profile software on a single chip, providing a flexible and easy to use BLE SoC solution. It also includes a high performance MCU and on-chip memory that can support users to develop a single-chip wireless MCU solution. Users could also utilize QN902x as a network processor by connecting to an application processor for more advanced applications.

Additional system features include fully integrated DC/DC and LDO, low power sleep timer, battery monitor, temperature sensor, general purpose ADC, and GPIOs, to further reduce overall system cost and size. QN902x operates with a power supply range of 2.4 V to 3.6 V and has very low power consumption in all modes, enabling long lifetimes in battery-operated systems while maintaining excellent RF performance.

Key Features

- **True single-chip BLE SoC solution**
  - *Integrated BLE radio*
  - *Complete BLE protocol stack and application profiles*
  - *Support both master and slave modes*
  - *Up to 8 simultaneous links in master mode*
- **RF**
  - *-95dBm RX sensitivity (non DC-DC mode)*
  - *-93dBm RX sensitivity (DC-DC mode)*
  - *TX output power from -20dBm to 4dBm*
  - *Fast and reliable RSSI and channel quality indication*
  - *Compatible with worldwide radio frequency regulations*
- **Very low power consumption**
  - *Single 2.4V~3.6V power supply*
  - *Integrated DC-DC and LDO*
  - *2uA deep sleep mode*
  - *3uA sleep mode (32kHz RC OSC on)*
  - *9.25mA RX current with DC-DC*
  - *8.8mA TX current @0dBm Tx power with DC-DC*
- **Compact 6x6 QFN48, 5x5 QFN32 and 3x3 CSP package**
- **Microcontroller**
  - *Integrated 32-bit ARM Cortex M0 MCU*
  - *64kB system memory*
  - *User controllable code protection*
- **High level integration**
  - *4-channel 10-bit general purpose ADC*
  - *2 general purpose analog comparator*
  - *Up to 31 GPIO pins*
  - *GPIO pins can be used as interrupt sources*
  - *Four general purpose timers*
  - *32kHz sleep timer*
  - *Watchdog timer*
  - *Real time clock with calibration*
  - *2-channel programmable PWM*
  - *Two SPI/UART interface*
  - *I2C master/slave interface*
  - *Brown-out Detector*
  - *Battery monitor and temperature sensor*
  - *AES-128 security coprocessor*
  - *16/32MHz crystal oscillator*
  - *Low power 32kHz RC oscillator*
  - *32.768kHz crystal oscillator*

Typical Applications

- Sports & Fitness
- Healthcare & medical
- Remote control
- Smartphone accessories
- PC peripherals (mouse, keyboard)
- Wireless Sensor networks

CONTENTS

FIGURES

TABLES

1 Introduction

QN902x is an ultra-low power wireless System-on-Chip (SoC) for Bluetooth Smart applications, supporting both master and slave modes. It integrates a high performance 2.4GHz RF transceiver with a 32-bit ARM Cortex-M0 MCU, Flash memory, and analog and digital peripherals.

By integrating a Bluetooth v4.0 Low Energy compliant radio, link controller and host stack, QN902x provides a single chip solution for Bluetooth Smart applications. The 32-bit ARM Cortex-M0 MCU and on-chip memory provide additional signal processing and room to run applications for a true single-chip Bluetooth Smart solution. In addition, QN902x can also be utilized as a network processor by connecting to an application processor via UART or SPI to add Bluetooth Smart feature to any products.

QN902x comes with complete analog peripherals and digital interfaces to enable easy connection to any analog or digital peripherals or sensors, and external application processor in network processor mode.

2 Pin Definition

2.1 QN9020

QN9020 is in a 6x6 mm QFN48 package. The back plate must be grounded to the application PCB in order to achieve optimal performance.

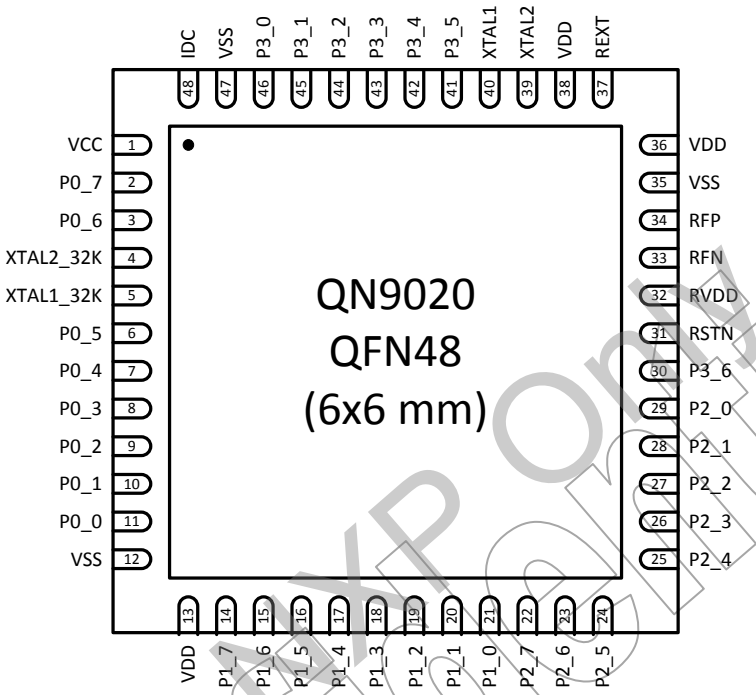


Figure 1 QN9020 Pin-out

Table 1 QN9020 Pin Descriptions

PINS	NAME	FUNCTION	DESCRIPTION
1	VCC	Power	Power supply
2	P0_7	I/O	General purpose I/O pin.
3	P0_6	I/O	General purpose I/O pin.
4	XTAL2_32K	Analog in	Connected to 32.768kHz crystal or external clock. Unconnected if RC OSC used
5	XTAL1_32K	Analog in	Connected to 32.768kHz crystal. Unconnected if RC OSC used or external clock used.
6	P0_5	I/O	General purpose I/O pin
7	P0_4	I/O	General purpose I/O pin
8	P0_3	I/O	General purpose I/O pin

PINS	NAME	FUNCTION	DESCRIPTION
9	P0_2	I/O	General purpose I/O pin
10	P0_1	I/O	General purpose I/O pin
11	P0_0	I/O	General purpose I/O pin
12	VSS	Ground	Digital ground
13	VDD	Power	Power supply
14	P1_7	I/O	General purpose I/O pin
15	P1_6	I/O	General purpose I/O pin
16	P1_5	I/O	General purpose I/O pin
17	P1_4	I/O	General purpose I/O pin
18	P1_3	I/O	General purpose I/O pin
19	P1_2	I/O	General purpose I/O pin
20	P1_1	I/O	General purpose I/O pin
21	P1_0	I/O	General purpose I/O pin
22	P2_7	I/O	General purpose I/O pin
23	P2_6	I/O	General purpose I/O pin
24	P2_5	I/O	General purpose I/O pin
25	P2_4	I/O	General purpose I/O pin
26	P2_3	I/O	General purpose I/O pin
27	P2_2	I/O	General purpose I/O pin
28	P2_1	I/O	General purpose I/O pin
29	P2_0	I/O	General purpose I/O pin
30	P3_6	I/O	General purpose I/O pin
31	RSTN	I	Hardware reset, active low
32	RVDD	Power	Regulated PA power output.
33	RF_N	RF	Differential RF input/output
34	RF_P	RF	Differential RF input/output
35	VSS	Ground	Ground
36	VDD	Power	Power supply
37	REXT	Analog out	Current reference terminal. Connect 56Kohm 1% resistor to ground.
38	VDD	Power	Power supply
39	XTAL1	Analog in	Connected to 16MHz crystal. Unconnected if external clock used.
40	XTAL2	Analog in	Connected to 16MHz crystal or external clock.
41	P3_5	I/O	General purpose I/O pin
42	P3_4	I/O	General purpose I/O pin
43	P3_3	I/O	General purpose I/O pin
44	P3_2	I/O	General purpose I/O pin
45	P3_1	I/O	General purpose I/O pin

PINS	NAME	FUNCTION	DESCRIPTION
46	P3_0	I/O	General purpose I/O pin
47	VSS	Ground	Ground
48	IDC	Power	PWM driver for the external LC filter if the DC/DC converter is enabled. If the DC/DC converter is disabled this pin shall not be connected.

2.2 QN9021

QN9021 is in a 5x5 mm QFN32 package. The back plate must be grounded to the application PCB in order to achieve optimal performance.

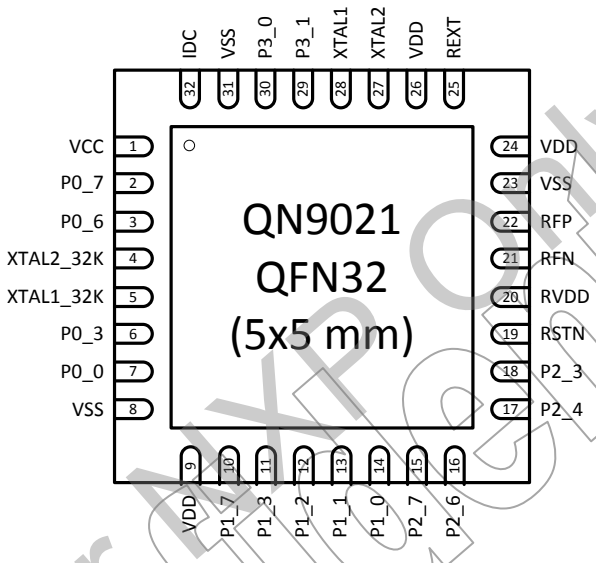


Figure 2 QN9021Pin-out

Table 2 QN9021 Pin Descriptions

PINS	NAME	FUNCTION	DESCRIPTION
1	VCC	Power	Power supply
2	P0_7	I/O	General purpose I/O pin.
3	P0_6	I/O	General purpose I/O pin.
4	XTAL2_32K	Analog in	Connected to 32.768kHz crystal or external clock. Unconnected if RC OSC used
5	XTAL1_32K	Analog in	Connected to 32.768kHz crystal. Unconnected if RC OSC used or external clock used.
6	P0_3	I/O	General purpose I/O pin
7	P0_0	I/O	General purpose I/O pin

PINS	NAME	FUNCTION	DESCRIPTION
8	VSS	Ground	Digital ground
9	VDD	Power	Power supply
10	P1_7	I/O	General purpose I/O pin
11	P1_3	I/O	General purpose I/O pin
12	P1_2	I/O	General purpose I/O pin
13	P1_1	I/O	General purpose I/O pin
14	P1_0	I/O	General purpose I/O pin
15	P2_7	I/O	General purpose I/O pin
16	P2_6	I/O	General purpose I/O pin
17	P2_4	I/O	General purpose I/O pin
18	P2_3	I/O	General purpose I/O pin
19	RSTN	I	Hardware reset, active low
20	RVDD	Power	Regulated PA power output.
21	RF_N	RF	Differential RF input/output
22	RF_P	RF	Differential RF input/output
23	VSS	Ground	Ground
24	VDD	Power	Power supply
25	REXT	Analog out	Current reference terminal. Connect 56Kohm 1% resistor to ground.
26	VDD	Power	Power supply
27	XTAL1	Analog in	Connected to 16MHz crystal. Unconnected if external clock used.
28	XTAL2	Analog in	Connected to 16MHz crystal or external clock.
29	P3_1	I/O	General purpose I/O pin
30	P3_0	I/O	General purpose I/O pin
31	VSS	Ground	Ground
32	IDC	Power	PWM driver for the external LC filter if the DC/DC converter is enabled. If the DC/DC converter is disabled this pin shall not be connected.

3 System Overview

QN902x integrates an ultra low power 2.4GHz radio, qualified software stack and application profiles on a single chip. The integrated Power Management Unit (PMU) controls the system operation in different power states to ensure low power operation. The high frequency crystal oscillator provides the reference frequency for the radio transceiver, while the low frequency oscillators maintain timing in sleep states.

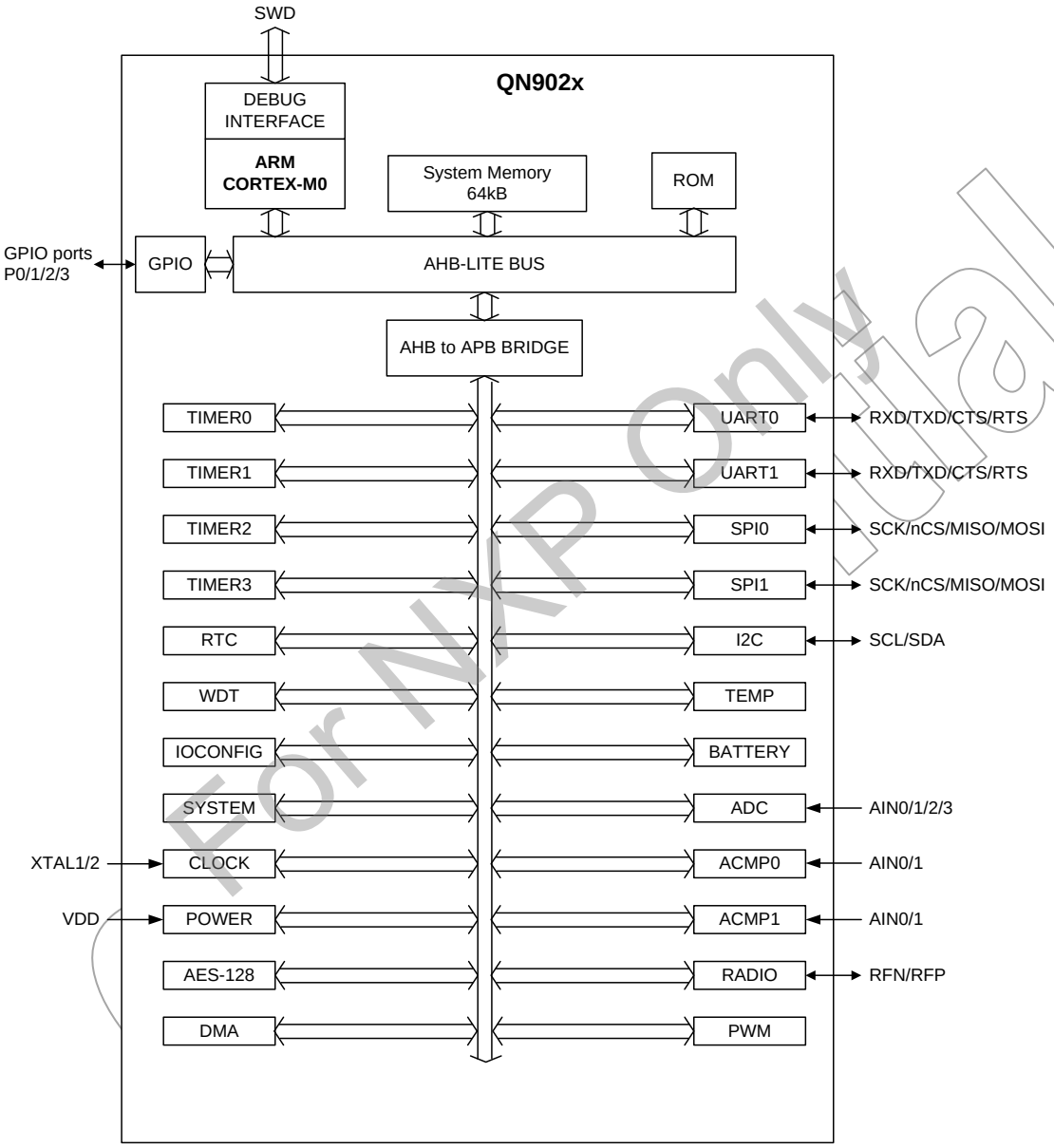


Figure 3 Block Diagram

The integrated AES coprocessor supports encryption/decryption with minimal MCU usage to offload MCU and reduce power consumption. The embedded MCU and additional memory provide additional signal processing capability and run user applications.

QN902x includes a general purpose ADC with four external independent input channels. The ADC can be utilized for power supply voltage monitoring and temperature sensing. Digital serial interfaces (SPI/UART/I2C) are integrated to communicate with application processor or digital sensors.

The UART supports the Bluetooth Low Energy Direct Test Mode (DTM).This interface is used to control the PHY layer with commercially available Bluetooth testers used for qualification.

I2C is integrated and support both master and slave mode. It can communicate with digital sensor or EEPROM.

4 Profiles and Services

QN902x offers a complete list of qualified profiles and services.

Table 3 Supported profile/services

Profiles/Services	Version
Device Information Service	1.1
Battery Service	1.0
Blood Pressure Profile	1.0
Find Me Profile	1.0
Glucose Profile	1.0
Heart Rate Profile	1.0
Health Thermometer Profile	1.0
HID over GATT Profile	1.0
Proximity Profile	1.0
Scan Parameter Profile	1.0
Time Profile	1.0
Alert Notification Profile	1.0
Phone Alert Status Profile	1.0
Cycling Speed and Cadence Profile	1.0
Running Speed and Cadence Profile	1.0

5 MCU Subsystem

The MCU subsystem includes

- 32-bit ARM Cortex-M0 MCU
- 64-kB system memory
- Reset generation
- Clock and power management unit
- Nested Vectored Interrupt Controller (NVIC)
- Serial Wire Debug interface (SWD)

5.1 MCU

The CPU core is a 32-bit ARM Cortex-M0 MCU, which offers significant benefits to application development, including:

- Simple, easy-to-use programmers model
- Highly efficient ultra-low power operation
- Excellent code density
- Deterministic, high-performance interrupt handling for 32 external interrupt inputs

The processor is extensively optimized for low power, and delivers exceptional power efficiency through its efficient instruction set, providing high-end processing hardware including a single-cycle multiplier.

5.2 Memory organization

QN902x integrates on-chip 64-kB system memory for application program and data. The system memory, all registers and external devices are allocated in the same memory map within 4GB, ranging from 0x00000000 to 0xFFFFFFFF, which is shown in Figure4. The system memory security is ensured with a user controllable protection scheme, preventing un-authorized read out.

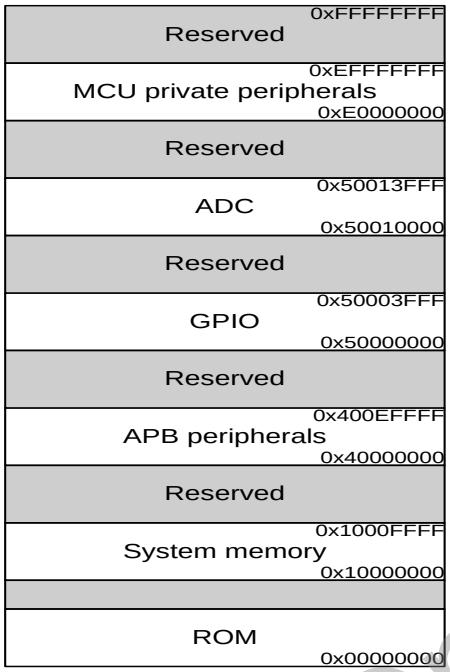


Figure 4 Memory Address Map

5.3 RESET generation

The device has four reset sources. The following events generate a reset:

- Forcing RSTN pin low
- Power-on reset
- Brown-out reset
- Watchdog timeout reset

5.4 Nested Vectored Interrupt Controller (NVIC)

QN9020 supports Cortext-M0 built-in Nested Vectored Interrupt Controller (NVIC) with 24 external interrupt inputs. External interrupt signals connect to the NVIC, and the NVIC prioritizes the interrupts. Software can set the priority of each interrupt. The NVIC and Cortex-M0 processor core are closely coupled, providing low-latency interrupt processing and efficient processing of late arriving interrupts.

5.5 Clock and power management

QN902x provides flexible clocking scheme to balance between performance and power. A high frequency crystal oscillator is utilized to provide reference frequency and system clock, which supports 16/32MHz external crystal with ±50ppm accuracy. The system clock could be 32MHz or its divided versions.

Two low speed 32kHz oscillators are integrated. The 32.768kHz crystal oscillator is used where accurate timing is needed, while 32kHz RC OSC could reduce cost and power consumption. Only one can work at any one time.

QN902x features ultra low power consumption with two sleep modes, SLEEP and DEEP SLEEP. After execution of Wait for Interrupt (WFI) instruction, the MCU stops execution, enters into sleep mode and stops the clock immediately. If DEEP SLEEP mode is entered, it must wait for external interrupts to wake it up. Before entering into SLEEP mode, MCU should set the sleep timer correctly and make the 32kHz clock ready.

Once an interrupt (external interrupt or sleep timer timeout) occurs, the Wakeup Interrupt Controller (WIC) enables the system clock, takes a number of clock cycles to wake up MCU and restore the states, before MCU can resume program execution to process the interrupt.

The power management unit is responsible to control the power states of the whole chip and switch on/off the supply to different parts according to the power state.

Table 4 Power Matrix

MODE	DIGITAL REGULATOR	32kHz OSC	SLEEP TIMER	NOTE
Deep sleep	Off	Off	Off	Wait external interrupt to wake it up. RAM/register content retained
Sleep	Off	On	On	Wait for SLEEP TIMER timeout to wake it up. RAM/register content retained
Idle	On	On	On	MHz XTAL on. MCU not execute.
Active	On	On	On	Radio off, MCU on
Radio	On	On	On	Radio on.

5.6 Serial Wire Debug (SWD) interface

QN902x provides a standard SWD interface and supports up to four hardware breakpoints and two watchpoints.

6 Digital Peripherals

6.1 TIMER (0/1)

TIMER0/1 are general-purpose 32-bit timer with programmable 10-bit prescaler. The prescaler source could be the system clock, 32kHz clock or an external clock input. The timers have below functions:

- Input capture function
- Compare function
- PWM output

The timer generates maskable interrupts for the events of overflow, compare and capture, which could be used to trigger MCU or ADC conversions.

6.2 TIMER (2/3)

TIMER2/3 are general-purpose 16-bit timer with programmable 10-bit prescaler. The prescaler source could be the system clock, 32kHz clock or an external input. The timers have below functions:

- Input capture function
- Compare function
- PWM output

The timer will generate maskable interrupts for the events of overflow, compare and capture, which could be used to trigger MCU or ADC conversions.

6.3 Real Time Clock (RTC)

The RTC is run off the 32kHz clock and provides real time with calibration, supporting below functions:

- Time and date configuration on the fly
- Alarm function for 24-hour and minute
- Input capture function with programmable noise canceller

6.4 Watchdog Timer (WDT)

The Watchdog timer (WDT) is a 16-bit timer clocked by 32kHz clock. It is intended as a recovery method in situations where the CPU may be subjected to software upset. The WDT resets the system when software fails to clear the WDT within the selected time interval. The WDT is configured as either a Watchdog Timer or as a timer for general-purpose use. If the watchdog function is not needed in an application, it is possible to configure the Watchdog Timer to be used as an interval timer that can be used to generate interrupts at selected time intervals. The maximum timeout interval is 1.5 days.

6.5 Sleep Timer

The sleep timer is a 32-bit timer running at 32kHz clock rate. It is in always-on power domain, being used to set the interval for system to exit Sleep mode and wakeup MCU.

6.6 PWM

The PWM provides two channel PWM waveforms with programmable period and duty cycle. It has two 8-bit auto reload down counter and programmable 10-bit prescaler for both channels. It supports below functions

- Predictable PWM initial output state
- Buffered compare register and polarity register to ensure correct PWM output
- Programmable overflow interrupt generation

6.7 DMA

The DMA controller is used to relieve MCU of handling data transfer operations to achieve high performance and efficiency. It has a single DMA channel to support fixed and undefined length transfer. The source address and destination address are programmable. It can be aborted immediately in a transfer process by configuring ABORT register, and a DMA done interrupt is generated meanwhile.

6.8 Random number generator

QN902x integrates a random number generator for security purpose.

6.9 AES coprocessor

The Advanced Encryption Standard (AES) coprocessor allows encryption/decryption to be performed with minimal CPU usage. The coprocessor supports 128-bit key and DMA transfer trigger capability.

7 Communication Interfaces

7.1 UART 0/1

The two UARTs have identical function and include the following features:

- 8-bit payload mode: 8-bit data without parity
- 9-bit payload mode: 8-bit data plus parity
- The parity in 9-bit mode is odd or even configurable
- Configurable start- and stop- bit levels
- Configurable LSB- or MSB-first data transfer
- Parity and framing error status
- Configurable hardware flow control
- Support overrun
- Flexible baud rate: 1.2/2.4/4.8/9.6/14.4/19.2/28.8/38.4/57.6/76.8/115.2/230.4 kbps

7.2 SPI 0/1

The two SPIs have identical function and include the following features:

- Master/slave mode configurable
- 4-wire or 3-wire configurable
- Clock speed configurable for master mode (divided from 16/32MHz)
- 4MHz max. clock speed in slave mode
- 16MHz max. clock speed in master mode
- Configurable clock polarity and phase
- Configurable LSB or MSB first transfer

7.3 I2C

The I2C module provides an interface between the device and I2C-compatible devices connected by the two-wire I2C serial bus. The I2C module features include:

- Compliance with the I2C specification v2.1
- 7-bit device addressing modes
- Standard mode up to 100 kbps and fast mode up to 400 kbps support
- Support master arbitration in master mode
- Support line stretch in slave mode

8 Radio and Analog Peripherals

8.1 RF transceiver

QN902x radio transceiver is compliant with the Bluetooth v4.0 Low Energy specification Volume 6, Part A. The transceiver requires a 32MHz or 16MHz crystal to provide reference frequency and a matching network to match an antenna connected to the receiver/ transmitter pins.

8.2 On-chip oscillators

QN902x includes three integrated oscillators:

- HFXO: low power high frequency crystal oscillator supporting 32MHz or 16MHz external crystal.
- LFXO: ultra low power 32.768kHz crystal oscillator
- LFRCO: ultra low power 32kHz RC oscillator with ± 250 ppm frequency accuracy after calibration

The high frequency crystal oscillator provides the reference frequency for the radio transceiver. The low frequency 32.768kHz oscillators provide the protocol timing. The low-frequency clock can also be obtained from a 32.768kHz external clock source.

For HFXO, the external capacitance is integrated to reduce BOM cost. The capacitance can be adjusted by software.

8.3 DC/DC converter

QN902x includes highly efficient integrated regulators to generate all internal supply voltages from a single external supply voltage. Optional integrated DC-DC down converter can be utilized to further reduce the current consumption by 30%. This is particularly useful for applications using battery technologies with higher nominal cell voltages.

8.4 General purpose ADC

QN902x integrates a general purpose 8/10-bit SAR ADC, with up to 50k sampling rate. It includes an analog multiplexer with up to four external input channels. Conversion results can be moved to memory through DMA.

The main features of the ADC are as follows:

- Four single-end input channels, or two differential channels
- Reference voltage selectable as internal, external single-ended, AVDD
- Interrupt request generation
- DMA triggers at end of conversions
- Window compare function
- Temperature sensor input
- Battery measurement capability

The ADC could operates in

- Single conversion mode
- Continuous conversion mode
- Scan mode (automatic switching among external inputs)

8.5 Analog comparator

The analog comparator is used to compare the voltage of two analog inputs and a digital output to indicate the higher input voltage. The positive input is always from external pin, and the negative input can either be one of the selectable internal references or from external pin.

The analog comparator features for low-power operation and the comparing result can be used as interrupt source to wake up the system from sleep.

8.6 Temperature sensor

A temperature sensor is integrated by connecting a diode to ADC input to measure the voltage and then the silicon temperature is calculated.

8.7 Battery monitor

A battery monitor is integrated by connecting supply voltage (VDD/3) to the ADC input, which would use the internal regulated reference for the conversion.

9 Electrical Specifications

Table 5 Absolute Maximum Ratings

SYMBOL	PARAMETER	CONDITIONS	MIN	MAX	UNIT
V_{CC}	Supply voltage	VCC to GND	-0.3	5.0	V
V_{DD}	Supply voltage	VDD to GND	-0.3	5.0	V
T_s	Storage temperature		-55	+150	^oC
ESD	Human-body model	RFN, RFP		1.5	kV
		Other pads	2		kV
	Machine model	All pads	200		V
	Charged-device model	All pads	1		kV

Table 6 Recommended Operating Conditions

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{CC}	Power supply[1]	Relative to GND	2.4	3.0	3.6	V
V_{DD}	Power supply[1]	Relative to GND	2.4	3.0	3.6	V
T_A	Operating temperature		-40	+25	+85	^oC

Table 7 DC Characteristics

(Typical values are T_A = 25^{o}C and VCC/VDD=3V).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Icc	Current consumption	Deep sleep mode		2		uA
		Sleep mode		3		uA
		Idle mode (w/o DC-DC)		0.84		mA
		MCU @8MHz (w/o DC-DC)		1.35		mA

		RX mode(w/o DC-DC)		13.6		mA
		RX mode (w/t DC-DC)		9.25		mA
		TX mode @0dBm Tx power (w/o DC-DC)		13.3		mA
		TX mode @0dBm Tx power (w/t DC-DC)		8.8		mA
INTERFACE						
V_{OH}	High level output voltage		0.9*V_{CC}			V
V_{OL}	Low level output voltage				0.1*V_{CC}	V
V_{IH}	High level input voltage		0.7*V_{CC}			V
V_{IL}	Low level input voltage				0.3*V_{CC}	V

Notes:
1. Current include current for both analog and digital;
2. Depend on IO conditions.
3. **Deep sleep mode:** digital regulator off, no clocks, POR, RAM/register content retained
4. **Sleep mode:** digital regulator off, 32k RC OSC on, POR, sleep timer on, and RAM/register content retained
5. **Idle:** 16MHz OSC on, no radio or peripherals, 8 MHz system clock and MCU idle (no code execution)
6. **MCU@8 MHz:** MCU running at 8 MkHz RC OSC clock, no radio or peripherals
7. **RX sensitivity** is -95dBm sensitivity when DC-DC is disabled.
8. **RX sensitivity** is -93dBm sensitivity when DC-DC is enabled.

Table 8 16/32MHz Crystal Oscillator Reference Clock

(Typical values are T_A = 25 °C and VCC/VDD=3V).

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT
$F_{XTAL-MHz}$	Crystal frequency			16 or 32		MHz
△f	Crystal accuracy requirement		-50		50	ppm
C_L	Crystal load capacitance		8		20	pF
	Start-up time			0.5		ms

Table 9 32kHz Crystal Oscillator Reference Clock

(Typical values are T_A = 25 °C and VCC/VDD=3V).

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT
$F_{XTAL-32K}$	32k Crystal frequency			32.768		kHz
△f	32k Crystal tolerance			250		ppm
C_L	Crystal load capacitance			12		pF
	Start-up time			1		s
$F_{RC-32kHz}$	32k RC oscillator frequency			32		kHz
$F_{RC-32kHz}$	32k RC clock accuracy after calibration			±0.1%		
	Temperature coefficient			0.04		%/℃
	Supply-voltage coefficient			3		%/V
	Calibration time				1	ms

Table 10 RF receiver characteristics

(Typical values are T_A = 25 °C and VCC/VDD=3V, fc=2440MHz, BER<0.1%).

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT
	RX sensitivity (high performance mode)			-95		dBm
	RX sensitivity(low power mode, w/t DC-DC)			-93		dBm
	Maximum input signal level			0		dBm
	Co-channel rejection(C/I)			6		dB
	Adjacent-channel rejection(C/I)	±1MHz		-1		dB
	Alternate-channel rejection(C/I)	±2MHz		-40		dB
	Image rejection (C/I_{imag})			-19		dB
	Out of band blocking 30~2000MHz			-18		dBm
	Out of band blocking 2003~2399MHz			-18		dBm
	Out of band blocking 2484~2997MHz			-18		dBm
	Out of band blocking 3~12.75GHz			-18		dBm

Table 11 RF transmitter characteristics

(Typical values are T_A = 25 °C and VCC/VDD=3V, fc=2440MHz).

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT
F	Frequency range		2400		2483.5	MHz
P_{TX}	Output power		-20		4	dBm
	TX power adjust step			2		dB

Table 12 ADC characteristics

(Typical values are T_A = 25 °C and VCC/VDD=3V).

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT
	Input voltage		0		V_{DD}	V
ENOB	Effective number of bits	Single end input				bits
		Different input				bits
THD	Total harmonic distortion	Single end input				dB
		Different input				
CMRR	Common-mode rejection ratio					dB
DNL	Differential nonlinearity					LSB
INL	Integral nonlinearity					LSB
	Gain error					%
	Conversion time					us
	Power consumption					mA

Table 13 Temperature sensor and battery monitor characteristics

(Typical values are T_A = 25 °C and VCC/VDD=3V).

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT
	Temperature sensor range		-40		85	C
	Temperature sensor accuracy			0.25		C
	Battery monitor range					V
	Battery monitor accuracy					V

Table 14 Analog comparator characteristics

(Typical values are T_A = 25 °C and VCC/VDD=3V).

SYMBOL	PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNIT
V_{ACMPIN}	Input voltage range		0		V_{DD}	V
	Offset voltage					mV
	Current consumption			0.3		uA
	Hysteresis			40		mV

10 Application Information

10.1 Schematic for QN9020 with DC-DC Converter

A typical application schematic for QN9020 with DC-DC converter is shown in Figure5.

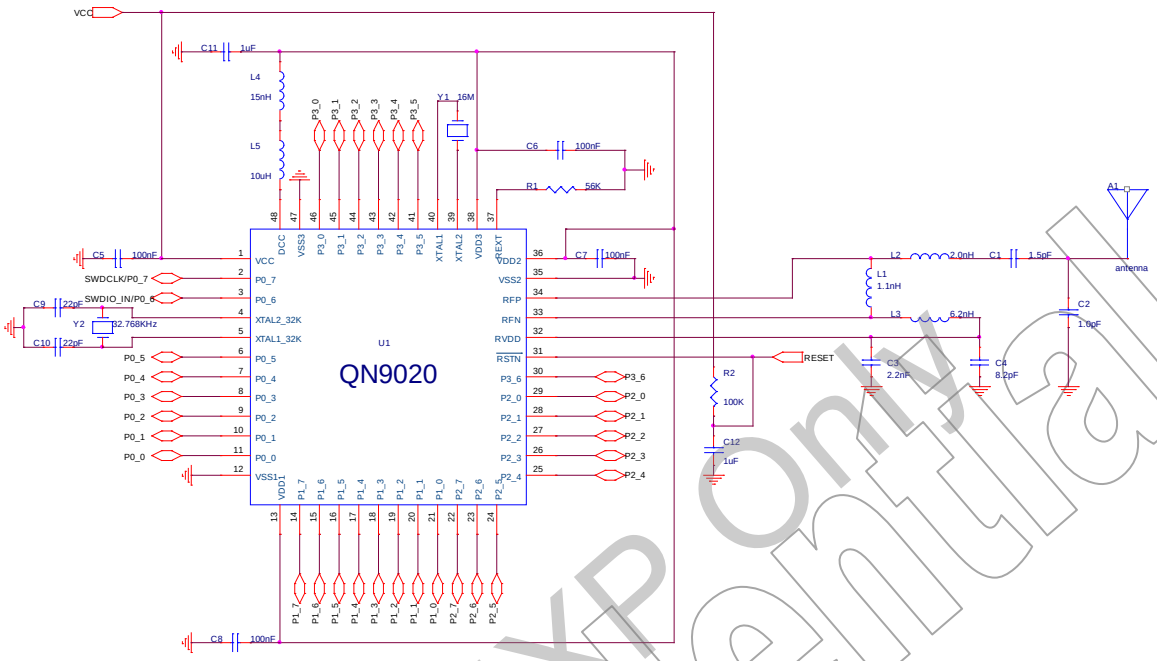


Figure 5 QN9020 Typical Application Schematic with DC-DC Converter

For application using battery supply, it is highly recommended to apply the circuit for QN9020 with internal DC-DC converter.

10.2 Schematic for QN9020 without DC-DC Converter

To use QN9020 without DC-DC converter, please follow the schematic in Figure 6 to use LDO regulator only.

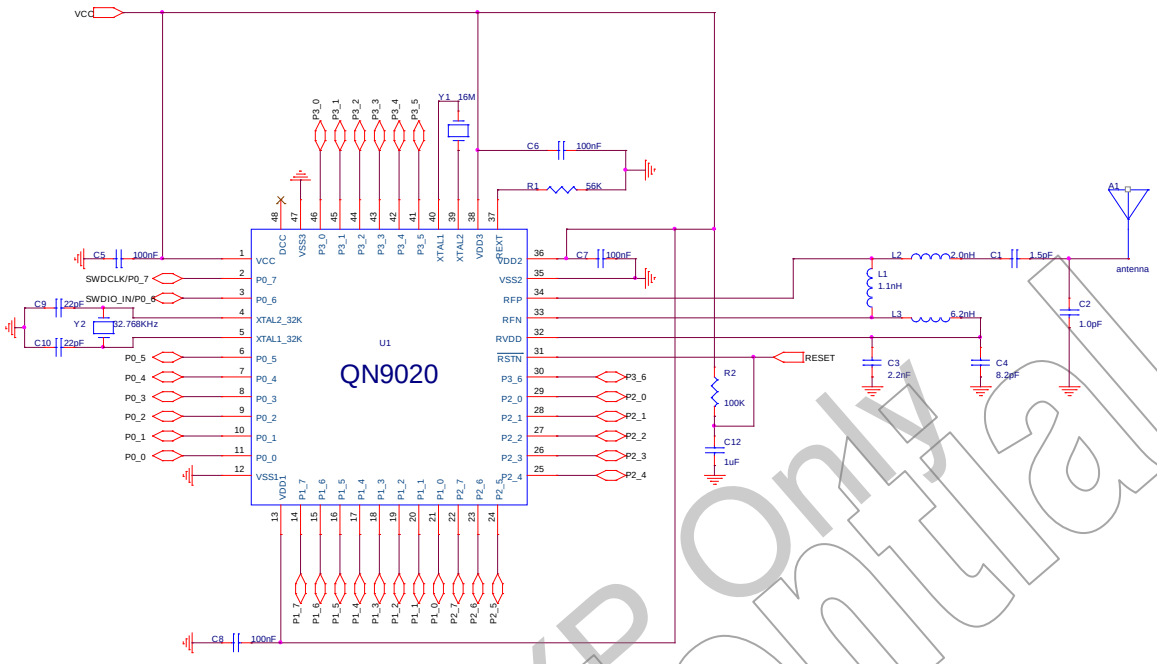


Figure 6 QN9020 Typical Application Schematic without DC-DC Converter

10.3 Schematic for QN9021 with DC-DC Converter

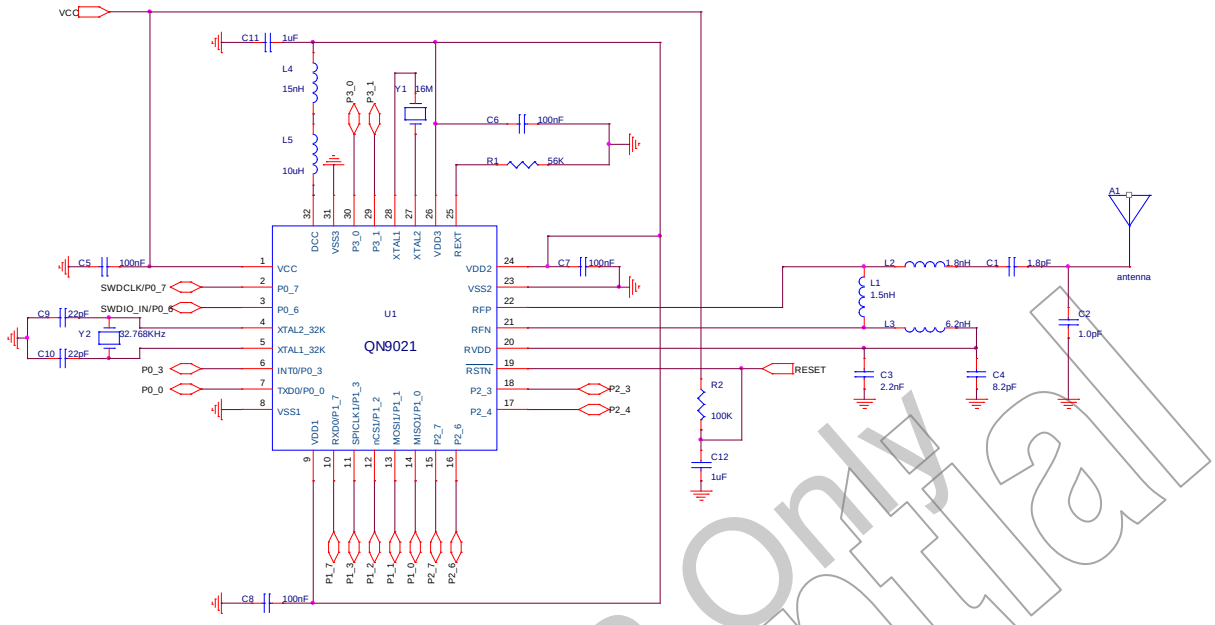


Figure 7 QN9021Typical Application Schematic with DC-DC Converter

For application using battery supply, it is highly recommended to apply the circuit for QN9021 with internal DC-DC converter.

10.4 Schematic for QN9021 without DC-DC Converter

To use QN9021 without DC-DC converter, please follow the schematic in Figure 8 to use LDO regulator only.

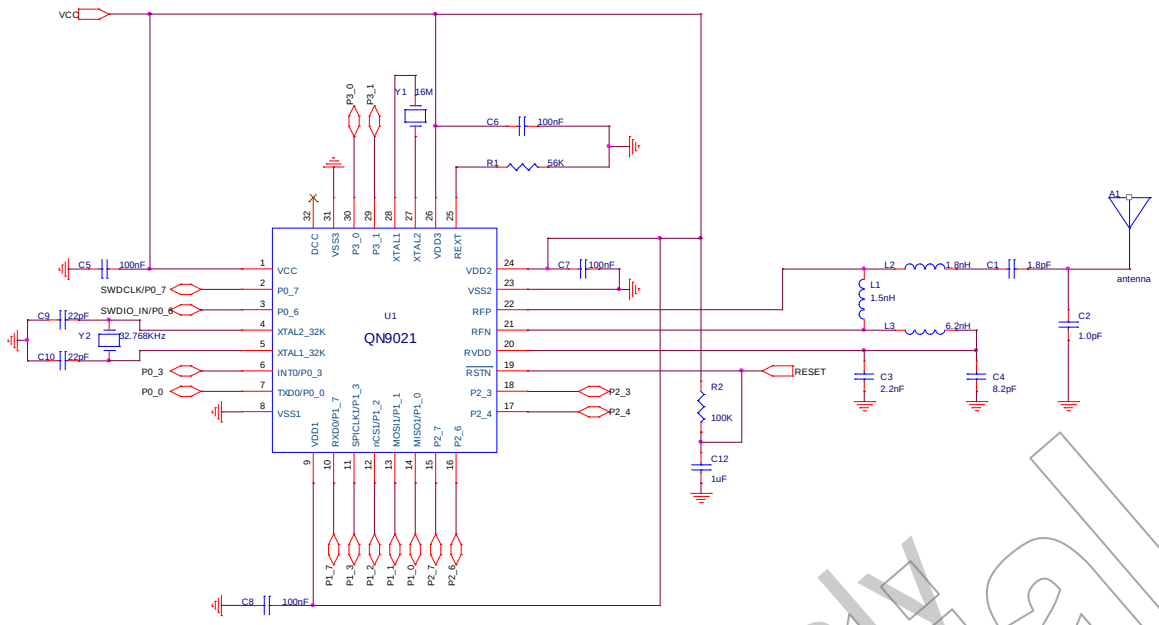


Figure 8 QN9021Typical Application Schematic without DC-DC Converter

10.5 QN902x External Components List

Component	Description	Value
C5, C6, C7, C8	Supply Decoupling Capacitors	C_SMD, 100nF, X5R, ±10%, 6.3V, 0402
C11	Supply Decoupling Capacitors	C_SMD, 1uF, NP0, 5%, 6.3V, 0402
C12	Capacitor used for reset	C_SMD, 1uF, NP0, 5%, 6.3V, 0402
C9, C10	Crystal Loading Capacitors	C_SMD, 22pF, NP0, 5%, 25V, 0402
R1	Resistor used for current reference	R_SMD,56K, ±1%, 0402
R2	Resistor used for reset	R_SMD, 100K, ±1%, 0402
L4	Chip Inductor for DC-DC	15nH
L5	Chip Inductor for DC-DC	10uH
L3	Inductor for RF matching network	6.2nH
L1	Inductor for RF matching network	1.1nH (QN9020) / 1.5nH (QN9021)
L2	Inductor for RF matching network	2.0nH (QN9020) / 1.8nH (QN9021)
C3	Capacitor for RF matching network	2.2nF
C4	Capacitor for RF matching network	8.2pF
C1	Capacitor for RF matching network	1.5pF (QN9020) / 1.8pF (QN9021)
C2	Capacitor for RF matching network	1.0pF

11 Ordering Information

Part Number	Description	Package
QN9020-NLNE	Plastic-Encapsulated 48-Pin Bluetooth Low Energy 4.0 SoC Chip	6x6 mm Body [QFN48]
QN9021-NINE	Plastic-Encapsulated 32-Pin Bluetooth Low Energy 4.0 SoC Chip	5x5 mm Body [QFN32]

12 Package Description

12.1 QN9020 Package Description

48-Lead plastic Quad Flat, No Lead Package (ML) – 6x6 mm Body [QFN]

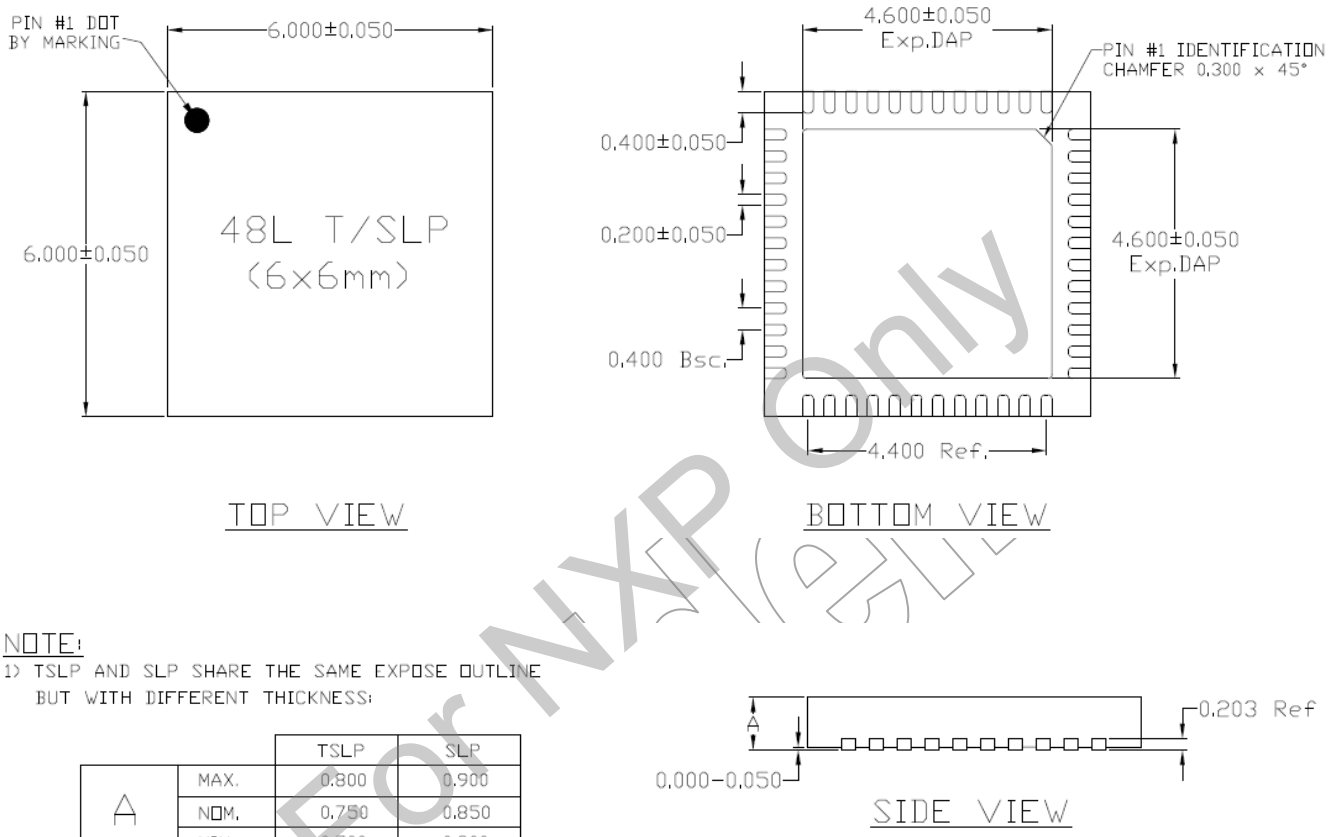


Figure 9 QN9020 Mechanical Drawing

Note: only SLP is available.

Carrier Tape Dimensions

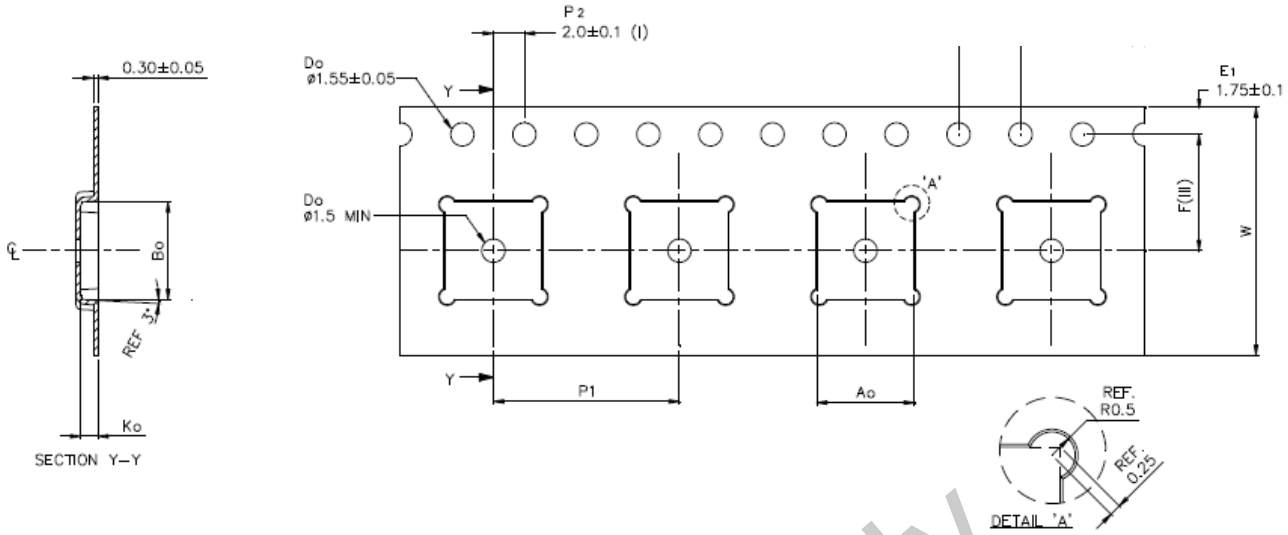


Figure 10 QN9020 Carrier Tape Dimensions

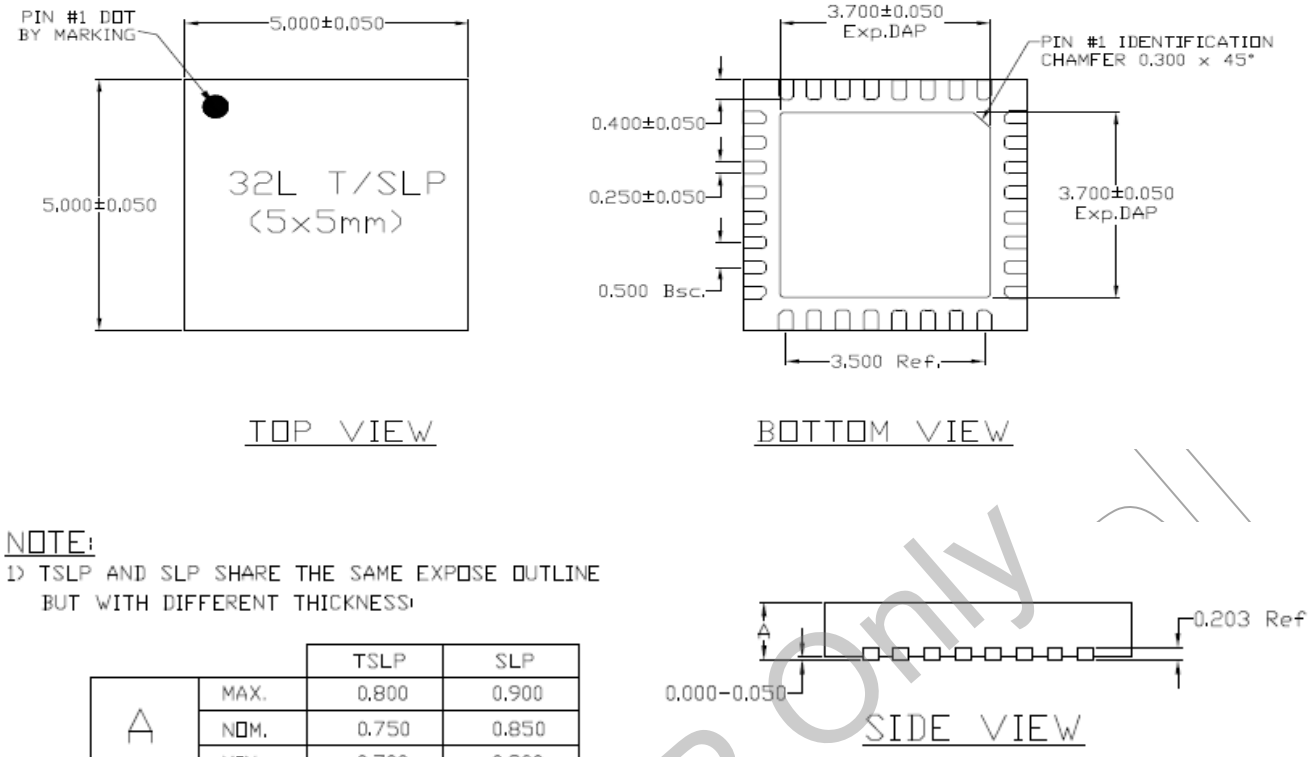
NOTES:

1. Measured from centerline of sprocket hole to centerline of pocket.
2. Cumulative tolerance of 10 sprocket holes is ±0.20.
3.

Ao	6.30 +/−0.1
Bo	6.30 +/−0.1
Ko	1.10 +/−0.1
F	7.50 +/−0.1
P1	12.00 +/−0.1
W	16.00 +/−0.3

12.2 QN9021 Package Description

32-Lead plastic Quad Flat, No Lead Package (ML) – 5x5 mm Body [QFN]

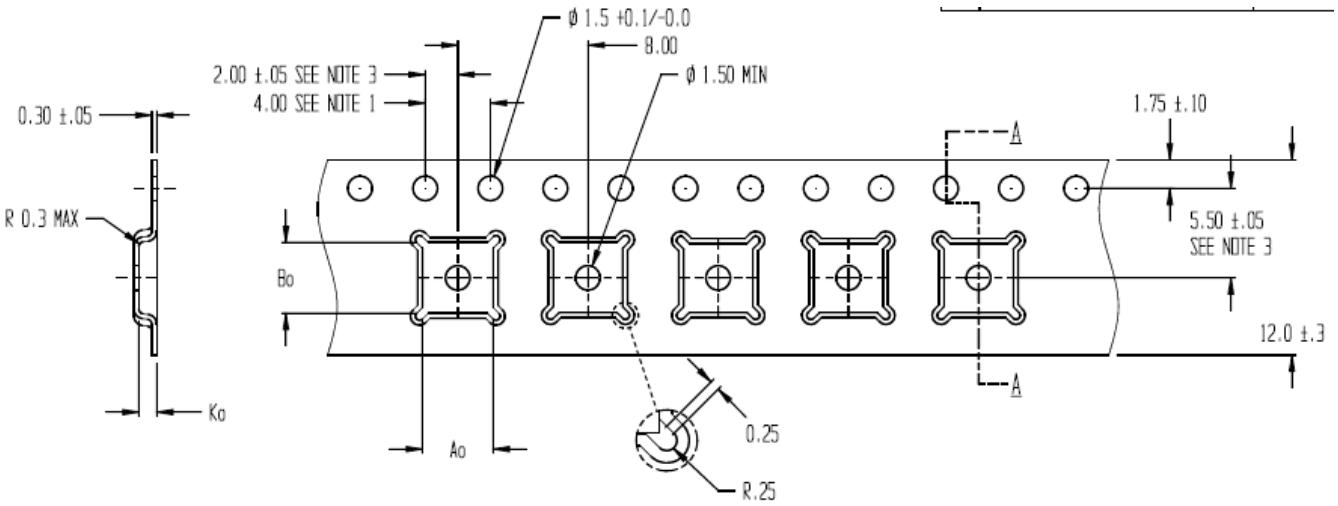


		TSLP	SLP
A	MAX.	0.800	0.900
	NOM.	0.750	0.850
	MIN.	0.700	0.800

Figure 11 QN9021Mechanical Drawing

Note: only SLP is available.

Carrier Tape Dimensions



NOTES:

1. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.
2. Cumulative tolerance of 10 sprocket holes is ±0.20.
3.

Ao = 5.25
Bo = 5.25
Ko = 1.10

13 Solder Reflow Profile

Package Peak Reflow Temperature

QN902x is assembled in a lead-free QFN48 package or QFN32 package. Since the geometrical size of QN9020 is 6×6× 0.85 mm, and the geometrical size of QN9021 is 5×5× 0.85 mm, the volume and thickness is in the category of volume<350 mm^3 and thickness<1.6 mm in Table 4-2 of IPC/JEDEC J-STD-020C. The peak reflow temperature is:

$$T_p = 260^o C$$

The temperature tolerance is $+0^oC$ and -5^oC. Temperature is measured at the top of the package.

Classification Reflow Profiles

Profile Feature		Specification*
Average Ramp-Up Rate (tsmax to tP)		3°C/second max.
Pre-heat:	Temperature Min (Tsmin)	150°C
	Temperature Max (Tsmax)	200°C
	Time (ts)	60-180 seconds
Time maintained above:	Temperature (T_L)	217°C
	Time (t_L)	60-150 seconds
Peak/Classification Temperature (Tp)		260°C
Time within 5°C of Actual Peak Temperature (tp)		20-40 seconds
Ramp-Down Rate		6°C/second max.
Time 25°C to Peak Temperature		8 minutes max.

*Note: All temperatures are measured at the top of the package.

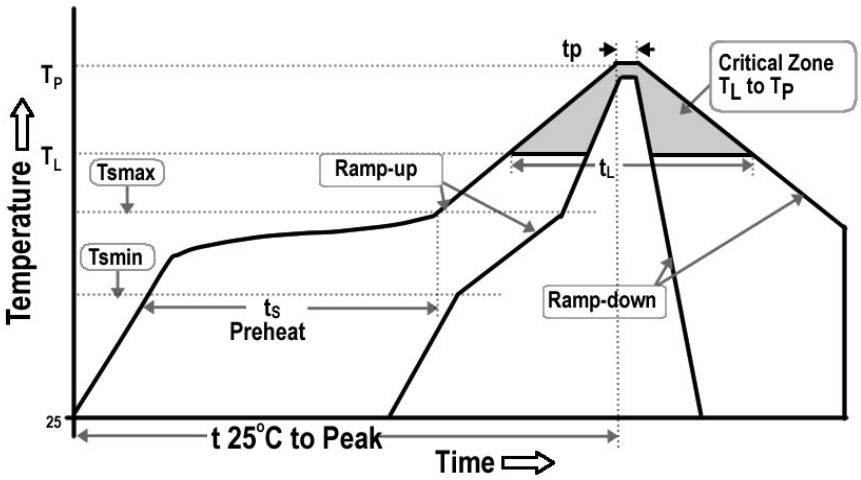


Figure 12 Reflow Temperature Profile

Maximum Reflow Times

All package reliability tests were performed and passed with a pre-condition procedure that repeat a reflow profile, which conforms to the requirements in Section 0, three (3) times.

RELEASE HISTORY

REVISION	CHANGE DESCRIPTION	DATE
0.7	Initial release	2012-10-31
0.8	Add schematic and detailed package information	2012-12-5
0.9	Update pin name definition and system block diagram. Add sleep timer, PWM and DMA modules in digital peripherals.	2013-1-11
0.93	Update for QN902x	2013-3-18
0.94	Update Electrical Specifications	2013-4-24
0.95	Update Electrical Specifications for B0	2013-8-12
0.96	Update current number	2013-8-15
0.97	Update chip marking for B1	2013-11-12
0.98	Update part number and package thickness	2013-11-17
0.99	Update Electrical Specifications for B2	2014-01-14

CONTACT INFORMATION

Quintic Corporation (USA)

1290 Oakmead Parkway Suite #218
Sunnyvale, CA 94085, USA
Tel: +1 408 215 9733
Fax: +1 408 970 8829
Email: support@quinticcorp.com
Web: www.quinticcorp.com

Quintic Microelectronics (China)

Building 8 B-301A Tsinghua Science Park
1st East Zhongguancun Rd, Haidian
Beijing, China 100084
Tel: +86 (10) 8215-1997
Fax: +86 (10) 8215-1570
Web: www.quinticcorp.com