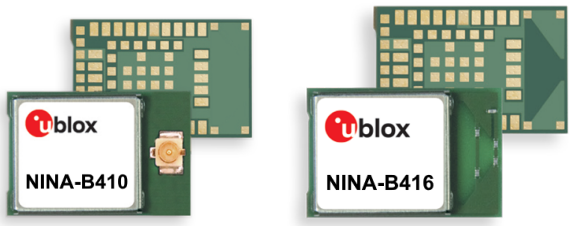
S

NINA-B41

Stand-alone Bluetooth 5.1 low energy modules

Data sheet



Abstract

Delivered with u-connectXpress software, NINA-B41 stand-alone modules provide support for u-blox Bluetooth Low Energy Serial Port Service, GATT client and server, beacons, NFC™, and simultaneous peripheral and central roles. This technical datasheet provides an overview and full functional description of the each module variant, including a detailed pin list, block diagram, mechanical and electrical specifications, and ordering information. Aimed towards developers and other technical staff, this document provides the critical information necessary for the design of customer applications based on the module.

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This document applies to the following products:

Product name	Type number	Software	Hardware version	PCN reference	Product status
NINA-B410	NINA-B410-00B-00	u-connectXpress 1.0	03	N/A	Initial Production
NINA-B416	NINA-B416-00B-00	u-connectXpress 1.0	04	N/A	Initial Production

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1 Functional description

The NINA-B41 series is comprised of small, standalone Bluetooth low energy wireless modules featuring full Bluetooth 5.1. Based on the Nordic Semiconductor nRF52833 chip, NINA-B41 modules include an integrated RF core and powerful Arm® Cortex®-M4 with FPU processor, and operate in all Bluetooth 5.1 modes.

With an operational temperature range that spans from -40 up to +105°C, NINA-B41 modules are ideal for harsh industrial or lighting applications that must operate at high ambient temperatures. NINA-B41 also caters towards applications in smart buildings, smart cities, industrial automation systems, sensor networks and asset tracking solutions.

NINA-B41 modules need only a single supply voltage in the range of 1.7 – 3.6 V and, as the supply voltage level can also be used as the I/O reference level, can be easily integrated into simple, single voltage rail systems. The broad supply voltage range makes the modules particularly useful in battery powered systems.

With the same pinout, physical size and mechanical design of NINA-B31 modules, NINA-B41 offers a natural upgrade path for existing NINA-B3 applications. See also the NINA-B3 data sheet [6] and NINA-B41 product summary [5].

The NINA-B41 series includes the following two sub-series, as listed in the table below:

Model	Description
NINA-B410	Bluetooth 5.1 module with a powerful Arm Cortex-M4 with FPU and u-connect software pre-flashed. The u-connect software in NINA-B41 modules provides support for u-blox Bluetooth low energy Serial Port Service, GATT client and server, beacons, NFC™, and simultaneous peripheral and central roles – all configurable from a host using AT commands. The NINA-B410 modules provide top grade security, thanks to secure boot, which ensures the module only boots up with original u-blox software. NINA-B410 has an U.FL connector for use with an external antenna.
NINA-B416	Bluetooth 5.1 module with a powerful Arm Cortex-M4 with FPU and u-connect software pre-flashed. The u-connect software in NINA-B41 modules provides support for u-blox Bluetooth low energy Serial Port Service, GATT client and server, beacons, NFC™, and simultaneous peripheral and central roles – all configurable from a host using AT commands. NINA-B416 modules provide top grade security, thanks to secure boot, which ensures the module only boots up with original u-blox software. NINA-B416 has an internal PCB antenna integrated in the module PCB. The internal antennas are specifically designed for embedded devices and provide an extensive range.

Table 1: NINA-B41 series

☞ **Note** Already globally certified for use with an internal antenna or range of external antennas, the time, cost, and effort spent on deploying NINA-B4 modules into customer applications is reduced significantly.

1.1 Applications

NINA-B41 modules provide ideal wireless solutions in the following application scenarios:

- Industrial automation
- Smart buildings and cities
- Low power sensors
- Wireless-connected and configurable equipment
- Point-of-sales
- Health devices
- Asset tracking

1.2 Product description

Item	NINA-B410	NINA-B416
Bluetooth version	5.1	5.1
Band support	2.4 GHz, 40 channels	2.4 GHz, 40 channels
Typical conducted output power	+8 dBm	-
Radiated output power (EIRP)	+11 dBm (with approved antennas)	+11 dBm
RX sensitivity (conducted)	-95 dBm	-95 dBm
RX sensitivity, long range mode (conducted)	-102 dBm	-102 dBm
Supported 2.4 GHz radio modes	Bluetooth Low Energy	Bluetooth Low Energy
Supported Bluetooth LE data rates	1 Mbps, 2 Mbps, 125 kbps	1 Mbps, 2 Mbps,125 kbps
Module size	10.0 x 15.0 mm	10.0 x 15.0 mm

Table 2: NINA-B41 series characteristics summary

1.3 Ordering information

Ordering Code	Product
NINA-B410-00B	NINA-B410 module with u-connectXpress software and antenna connector U.FL
NINA-B416-00B	NINA-B416 module with u-connectXpress software and internal PCB trace antenna

Table 3: Product ordering codes

1.4 Hardware options

Except for the different antenna solutions, NINA-B41 series modules use an identical hardware configuration. The integrated DC/DC converter is available for higher efficiency under heavy load situations. See also section Module supply input (VCC).

1.5 Software options

NINA-B41 modules comprises an Arm® Cortex®-M4 application processor with FPU, 512 kB flash memory and 128 kB RAM.

Figure 1 shows the software architecture and implementation of software components for NINA-B40 and NINA-B41 modules with the following notable features:

- NINA-B40 modules host the customer application and bootloader software, developed using the Nordic SDK, in an open-CPU configuration on the module.
- NINA-B41 modules are pre-flashed with bootloader and u-connectXpress software that interfaces through an AT command interpreter to control customer application software running on host MCUs.
- Both module variants include the Nordic S140 SoftwareDevice Low Energy protocol stack that supports the Bluetooth Low Energy Serial Port Service, GATT server and client, central and peripheral roles, and multidrop connections.

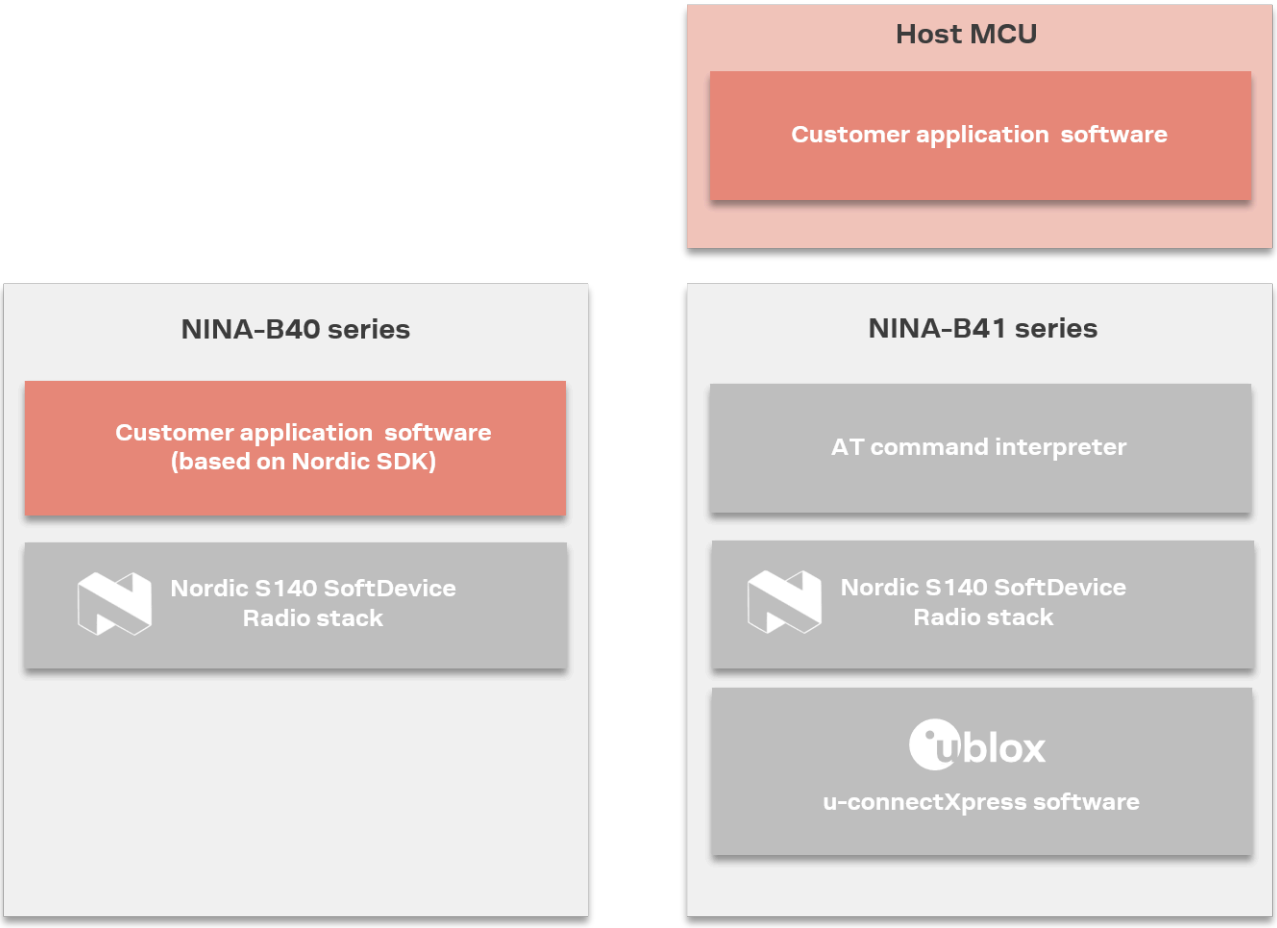


Figure 1: NINA-B41 software structure

1.5.1 u-connectXpress software

NINA-B41x-0xB modules are pre-flashed with u-connectXpress software, and are delivered with u-blox secure boot loader.

The u-connectXpress software enables use of the Bluetooth low energy functions, controlled by AT commands over the UART interface. Examples of supported features are u-blox low energy Serial Port Service, GATT server and client, central and peripheral roles, and multi-drop connections. NINA-B41 modules can be configured using the u-blox s-center evaluation software, which can be downloaded from the u-blox website and is available free of charge.

More information on the features and capabilities of the u-connectXpress software and how to use it can be found in the u-connect AT commands manual [2] and the u-connectXpress software user guide [4].

1.6 Bluetooth device address

Each NINA-B41 module is pre-programmed with a unique 48-bit Bluetooth device address. If the memory of a NINA-B41 module is corrupted or otherwise lost, the address can be recovered from the data matrix bar code printed on the module label.

2 Interfaces

2.1 Power management

2.1.1 Module supply input (VCC)

NINA-B41 series modules use integrated step-down converters to transform the supply voltage presented at the **VCC** pin into a stable system voltage. Consequently, the modules are compatible for use in battery powered designs – without the need of an additional voltage converter.

The modules support two on-board converters:

- Low-dropout (LDO)
- DC/DC buck

The module automatically switches between these converters to suit the prevailing current consumption. The DC/DC converter is more efficient under high loads when the radio is active, while the LDO converter is better suited for power saving modes.

2.1.2 Digital I/O interfaces reference voltage (VCC_IO)

All modules in the u-blox NINA series provide an additional voltage supply input for setting the I/O voltage level. In NINA-B41 series modules, the I/O voltage level is similar to the supply voltage and **VCC_IO** is internally connected to the supply input. Therefore, only a single supply voltage is needed for NINA-B41, which makes it ideal for battery powered designs.

☞ **Note** Other modules in the NINA series can require more than a single supply voltage. For a pin design that is compatible with other NINA-series modules the VCC and VCC_IO supply rails must be kept separate.

2.2 RF antenna interfaces

2.2.1 2.4 GHz radio (ANT)

The NINA-B41 model versions have their own 2.4 GHz antenna solutions respectively:

- NINA-B410 modules use an U.FL connector solution for external antenna. The **ANT** pin is internally disconnected on these models.
- NINA-B416 modules use an internal PCB trace antenna integrated into the module PCB. This low profile antenna solution is useful in space constrained designs. The **ANT** pin is internally disconnected on these models. This solution uses antenna technology licensed from Proant AB.

☞ **Note** See the NINA-B4 system integration manual [3] for antenna reference designs and integration instructions.

2.2.2 Near Field Communication (NFC)

NINA-B41 series modules include a Near Field Communication interface that can operate as a 13.56 MHz NFC tag at a bit rate of 106 kbps.

As an NFC tag, data can be read from or written to NINA-B41 modules using an NFC reader. NINA-B41 modules are not capable of reading other tags or initiating NFC communications.

The NFC interface can be used to wake the module from sleep mode, which means that the module can be kept in the deepest power save mode and still wake up properly to react to an NFC field.

Two pins are available for connecting to an external NFC antenna: **NFC1** and **NFC2**.

2.3 System functions

The NINA-B41 series modules are power efficient devices capable of operating in different power saving modes and configurations. Different sections of the module can be powered off when not needed and complex wake up events can be generated from different external and internal inputs.

2.3.1 Module power-on

You can switch on or reboot the NINA-B41 modules in one of the following ways:

- Rising edge on the VCC pin to a valid supply voltage
- Issuing a reset of the module (see section Module reset)
- Programmable digital event, rising voltage level on UART_DSR pin
- Supplying 5 V to the **VBUS** pin (plugging in the USB interface)

While waking up from the standby mode to active mode, an event can also be triggered by:

- The on-board Real Time Counter (RTC)
- The radio interface
- Detection of an NFC field

2.3.2 Module power off

There is no dedicated pin to power off the NINA-B41 modules. You can configure any GPIO pin to enter or exit the sleep mode (see section Sleep mode), which essentially powers down the module.

An under-voltage (brown-out) shutdown occurs on the NINA-B41 modules when the **VCC** supply drops below the operating range minimum limit. If this occurs, it is not possible to store the current parameter settings in the module's non-volatile memory.

2.3.3 Power modes

The radio part of the module operates independently from the CPU. The three main power modes are:

- Active
- Standby
- Sleep

Depending on the application, the module should spend most of its time in either standby or sleep mode to minimize current consumption.

2.3.3.1 Standby mode

Standby mode is one of the power saving modes in NINA-B41 modules that essentially powers down the module but keeps the system RAM and configurations intact. It also allows for complex, autonomous power-up events including periodic RTC events and radio events.

The following events can be used to bring the module out of the standby mode:

- Internal wake-up events from the RTC, radio, NFC and so on.
- Analog or digital sensor events (programmable voltage level or edge detection)

During standby mode, the module is clocked at 32.768 kHz, which is generated by an internal RC-oscillator.

2.3.3.2 Sleep mode

Sleep mode is the deepest power saving mode of NINA-B41 modules. During sleep mode, all functionality is stopped to ensure minimum power consumption. The module needs an external event in order to wake up from the sleep mode. The module always reboots after waking up from the sleep mode.

When using the u-connectXpress software, the module can be manually switched on or off with proper storage of the current settings using the UART **DSR** pin.

2.3.4 Module reset

The NINA-B41 modules can be reset using one of the following ways:

- Low level on the **RESET_N** input pin, normally kept high using an internal pull-up. This causes an “external” or “hardware” reset of the module. The current parameter settings are not saved in the module’s non-volatile memory and a proper network detach is not performed.
- With the NINA-B41 modules, using the AT+CPWROFF command. This causes an “internal” or “software” reset of the module. The current parameter settings are saved in the module’s non-volatile memory.

2.3.5 CPU and memory

The Nordic Semiconductor nRF52833 chip in the NINA-B41 series modules includes a powerful Arm® Cortex®-M4 with FPU processor. The processor works with a superset of 16 and 32-bit instructions (Thumb-2) at 64 MHz clock speed. It can use up to 37 interrupt vectors and 3 priority bits.

The nRF52833 chip has 512 kB of flash and 128 kB of RAM for code and data storage.

2.4 Low frequency clock

NINA-B41 modules require two clocks, a high frequency clock and a low frequency clock. The high frequency clock is provided on-module by a high-accuracy 32 MHz crystal as required by the radio operation. The low frequency clock can be provided externally by a 32.768 kHz crystal. An external crystal provides the lowest power consumption and greatest accuracy. For information about the LFXO operating parameters and performance of the clock, see Electrical specifications.

☞ **Note** When using an external crystal with NINA modules at operating temperatures above 85 °C, certain limitations apply. For further information, see the Nordic nRF52833 specification for extended operating temperature.

2.5 System interfaces

This section describes system interfaces that are supported in NINA-B41 modules. For additional information, see the u-blox short range AT commands Manual [2] and u-connectXpress software user guide [4].

2.5.1 GPIO

NINA-B41 series modules have a versatile pin-out. In an un-configured state, the modules support a total of 26 GPIO pins with no analog interfaces. All interfaces or functions must be allocated to a GPIO pin before use.

2.5.2 Universal Asynchronous Receiver/Transmitter (UART)

There are two UART interfaces that may be used on NINA-B41; a primary and a secondary interface.

☞ **Note** For more information about how the interfaces are controlled using AT commands, see the u-connectXpress AT commands manual and u-connectXpress software user guide.

These 4-wire UART interfaces support hardware flow control and baud rates up to 1 Mbps. Other characteristics of the UART interface are listed below:

- Default baud rate is 115200 and frame configuration is 8N1, meaning eight (8) data bits, no (N) parity bit, and one (1) stop bit.
- Frames are transmitted in such a way that the least significant bit (LSB) is transmitted first.
- Pin configuration:
  - **TXD**, data output pin
  - **RXD**, data input pin
  - **RTS**, Request To Send, flow control output pin (optional)
  - **CTS**, Clear To Send, flow control input pin (optional)
- Hardware flow control or no flow control is supported.
  - Power saving indication available on the hardware flow control output (**RTS** pin): The line is driven to the OFF state when the module is not ready to accept data signals.
  - Programmable baud rate generator allows most industry standard rates, as well as non-standard rates up to 1 Mbps.

2.5.2.1 Primary UART

The primary interface is used for communication with NINA-B41 from a host controller. It is used to configure NINA-B41 and to transmit or receive data to or from a Bluettooth LE link or any sensors that are connected. The primary interface has a fixed pin configuration that may not be changed.

In addition to the normal **RXD**, **TXD**, **CTS**, and **RTS** signals, the u-connectXpress software adds the **DSR** and **DTR** pins to the UART interface. Note that they are not used as originally intended, but to control the state of the NINA module.

Depending on the current configuration, the **DSR** pin can be used to:

- Enter the command mode
- Disconnect and/or toggle connectable status
- Enable/disable the rest of the UART interface
- Enter/wake up from the sleep mode

The **DTR** pin can be used to indicate:

- The System mode
- If the SPS peers are connected
- A Bluetooth LE GAP connection

2.5.2.2 Secondary UART interface

The secondary UART interface can be used to "daisy chain" UART connections. It is useful in resource constrained systems where the host controller only has one UART interface available. To use it, the NINA-B3 module is configured to become a UART bridge, and UART data sent over the primary UART interface flows into the secondary UART interface.

The secondary UART interface pins can be freely configured to any free NINA GPIO pins. It uses four signals; **RXD**, **TXD**, **CTS** and **RTS**.

2.5.3 u-blox Serial Port Service (SPS)

The serial port service feature enables serial port emulation over Bluetooth LE.

2.5.4 System status signals

The **RED, GREEN, and BLUE** pins are used to signal the system status as shown in Table 4. They are active low and are intended to be routed to an RGB LED.

Mode	Status	RGB LED color	RED	GREEN	BLUE
Data mode/Extended Data mode (EDM)	IDLE	Green	HIGH	LOW	HIGH
Command mode	IDLE	Orange	LOW	LOW	HIGH
EDM/Data mode, Command mode	CONNECTING	Purple	LOW	HIGH	LOW
EDM/Data mode, Command mode	CONNECTED**	Blue	HIGH	HIGH	LOW

Table 4: System status indication

* = LED flashes on data activity

☞ **Note** CONNECTING and CONNECTED reflect the u-blox SPS connection status.

2.5.5 System control signals

The following input signals are used to control the system:

- **RESET_N** is used to reset the system. See section Module reset for detailed information.
- If **SWITCH_2** is driven low during start up, the UART serial settings are restored to their default values.
- The **SWITCH_2** can be used to open a Bluetooth LE connection with a peripheral device.
- If both **SWITCH_1** and **SWITCH_2** are driven low during startup, the system will enter bootloader mode.
- If both **SWITCH_1** and **SWITCH_2** are driven low during start up and held low for 10 seconds, the system will exit the bootloader mode and restore all settings to their factory default.

3 Pin definition

3.1 NINA-B41 series pin assignment

The pin-out as shown in Figure 2 describes the pin configuration used by the u-connectXpress software.

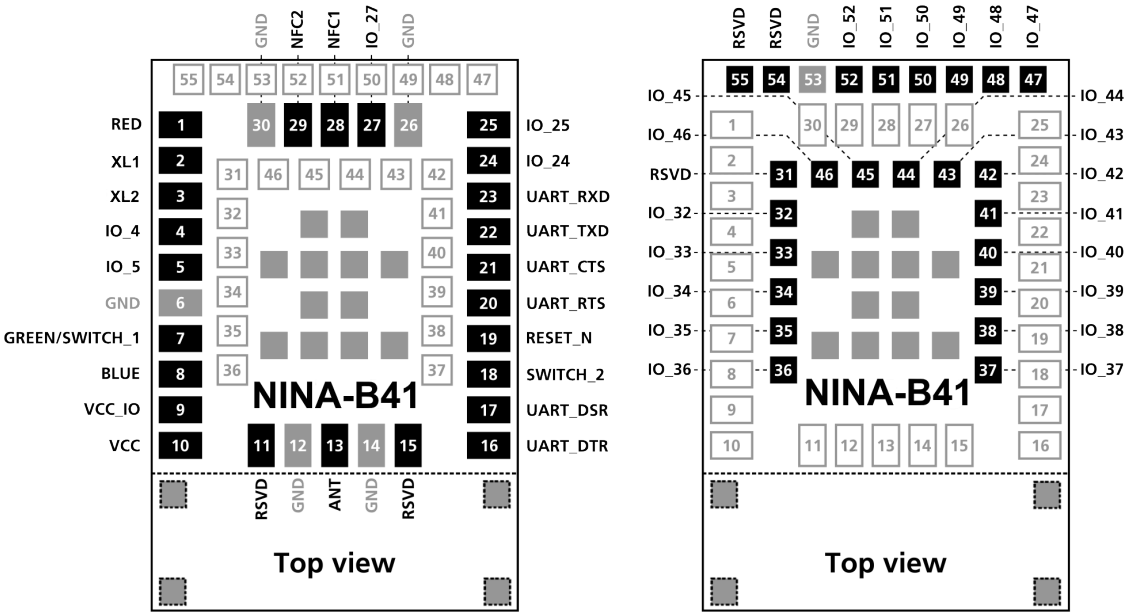


Figure 2: NINA-B41 series pin assignment (top view)

The grey pins in the center of the modules are GND pins. The outline below the dotted line as shown in Figure 2, the antenna area of the NINA- B410 and NINA-B416 begins. The four grey pins with dotted outlines in the antenna area are GND pins and are only present on NINA-B416.

- Follow this pin layout when using the u-connectXpress software. No interfaces can be moved or added.
- Do not apply an NFC field to the NFC pins when they are configured as GPIOs as it can cause permanent damage to the module. While using the u-connectXpress software, these pins will always be set to the NFC mode. See section Digital pins for more information.

No.	Name	I/O	Description	Remarks
1	RED	O	RED system status signal	Active low, should be routed to an RGB LED
2	XL1	I/O	u-connextXpress (uX) IO pin Connection for 32.768 kHz crystal	If not used ground XL1 and XL2. If an external clock source is used. Apply external low swing signal to XL1, ground XL2. Apply external full swing signal to XL1, leave XL2 grounded.
3	XL2	I/O	u-connextXpress (uX) IO pin Connection for 32.768 kHz crystal	
4	IO_4	I/O	uX IO pin	Can be used for manual digital I/O
5	IO_5	I/O	uX IO pin	Can be used for manual digital I/O
6	GND	-	Ground	

No.	Name	I/O	Description	Remarks
7	GREEN/ SWITCH_1	I/O	This signal is multiplexed: GREEN: System status signal. SWITCH_1: Multiple functions	Active low. GREEN: Should be routed to an RGB LED. SWITCH_1: See section System control signals for more information.
8	BLUE	O	BLUE system status signal	Active low, should be routed to an RGB LED
9	VCC_IO	I	Module I/O level voltage input	Must be connected to VCC on NINA-B41
10	VCC	I	Module supply voltage input	1.7-3.6 V range
11	RSVD	-	RESERVED pin	Leave unconnected
12	GND	-	Ground	
13	ANT	I/O	Tx/Rx antenna interface	50 Ω nominal characteristic impedance, only used with NINA-B410 modules
14	GND	-	Ground	
15	RSVD	-	RESERVED pin	Leave unconnected
16	UART_DTR	O	UART data terminal ready signal	Used to indicate system status
17	UART_DSR	I	UART data set ready signal	Used to change the system modes
18	SWITCH_2	I	Multiple functions	Active low, see section System control signals for more information.
19	RESET_N	I	External system reset input	Active low
20	UART_RTS	O	UART request to send control signal	Used only when hardware flow control is enabled
21	UART_CTS	I	UART clear to send control signal	Used only when hardware flow control is enabled
22	UART_TXD	O	UART data output	Also used by the bootloader
23	UART_RXD	I	UART data input	Also used by the bootloader
24	IO_24	I/O	uX IO pin	Can be used for manual digital I/O
25	IO_25	I/O	uX IO pin	Can be used for manual digital I/O
26	GND	-	Ground	
27	IO_27	I/O	uX IO pin	Can be used for manual digital I/O
28	NFC1	I/O	NFC pin 1	
29	NFC2	I/O	NFC pin 2	
30	GND	-	Ground	
31	RSVD	-	RESERVED pin	Leave unconnected
32	IO_32	I/O	uX IO pin	Can be used for manual digital I/O
33	IO_33	I/O	uX IO pin	Can be used for manual digital I/O
34	IO_34	I/O	uX IO pin	Can be used for manual digital I/O
35	IO_35	I/O	uX IO pin	Can be used for manual digital I/O
36	IO_36	I/O	uX IO pin	Can be used for manual digital I/O
37	IO_37	I/O	uX IO pin	Can be used for manual digital I/O
38	IO_38	I/O	uX IO pin	Can be used for manual digital I/O
39	IO_39	I/O	uX IO pin	Can be used for manual digital I/O
40	IO_40	I/O	uX IO pin	Can be used for manual digital I/O
41	IO_41	I/O	uX IO pin	Can be used for manual digital I/O
42	IO_42	I/O	uX IO pin	Can be used for manual digital I/O
43	IO_43	I/O	uX IO pin	Can be used for manual digital I/O
44	IO_44	I/O	uX IO pin	Can be used for manual digital I/O

No.	Name	I/O	Description	Remarks
45	IO_45	I/O	uX IO pin	Can be used for manual digital I/O
46	IO_46	I/O	uX IO pin	Can be used for manual digital I/O
47	IO_47	I/O	uX IO pin	Can be used for manual digital I/O
48	IO_48	I/O	uX IO pin	Can be used for manual digital I/O
49	IO_49	I/O	uX IO pin	Can be used for manual digital I/O
50	IO_50	I/O	uX IO pin	Can be used for manual digital I/O
51	IO_51	I/O	uX IO pin	Can be used for manual digital I/O
52	IO_52	I/O	uX IO pin	Can be used for manual digital I/O
53	GND	-	Ground	
54	RSVD	-	RESERVED pin	Leave unconnected
55	RSVD	-	RESERVED pin	Leave unconnected
	EGP	-	Exposed Ground Pins	Connect exposed center to GND
	EAGP	-	Exposed Antenna Ground Pins	Connect exposed pins underneath the antenna to GND

Table 5: NINA-B41 series with u-connectXpress software pin-out

4 Electrical specifications

CAUTION Stressing the device above one or more of the ratings listed in the Absolute maximum ratings section may cause permanent damage. These are stress ratings only. Operating the module at these or at any conditions other than those specified in the Operating conditions section of this document should be avoided. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note Operating condition ranges define those limits within which the functionality of the device is guaranteed. Where application information is given, it is advisory only and does not form part of the specification.

4.1 Absolute maximum ratings

Symbol	Description	Condition	Min	Max	Unit
VCC	Module supply voltage	Input DC voltage at VCC pin	–0.3	3.9	V
V_DIO	Digital pin voltage	Input DC voltage at any digital I/O pin, VCC ≤ 3.6 V	–0.3	VCC + 0.3	V
		Input DC voltage at any digital I/O pin, VCC > 3.6 V	–0.3	3.9	V
P_ANT	Maximum power at receiver	Input RF power at antenna pin		+10	dBm

Table 6: Absolute maximum ratings

Note The product is not protected against overvoltage or reversed voltages. The voltage spikes exceeding the power supply voltage specification, provided in Table 6, must be limited to the values within the specified boundaries by using appropriate protection devices.

4.1.1 Maximum ESD ratings

Parameter	Min	Typical	Max	Unit	Remarks
ESD sensitivity for all pins except **ANT** pin			2**	kV	Human body model class 3A according to JEDEC JS001
			500**	V	Charged device model according to JESD22-C101
ESD indirect contact discharge			±8	kV	According to EN 301 489-1

Table 7: Maximum ESD ratings

***Tested on NINA-B40 evaluation board.**

****Target values, module qualification is ongoing.**

CAUTION NINA-B41 series modules are Electrostatic Sensitive Devices and require special precautions while handling. See section ESD precautions for ESD handling instructions.

4.2 Operating conditions

- Unless otherwise specified, all operating condition specifications are at an ambient temperature of 25 °C and a supply voltage of 3.3 V.
- Operation beyond the specified operating conditions is not recommended and extended exposure beyond them may affect device reliability.

The RAM Data retention endurance is 10,000 write/erase cycles (10 years) up to the temperature range of 85 °C. RAM Data retention is limited to 1000 write/erase cycles (3 years) at extended temperature range of 105 °C.

4.2.1 Operating temperature range

Parameter	Min	Max	Unit
Storage temperature	–40	+125	°C
Operating temperature	–40	+105	°C

Table 8: Temperature range

4.2.2 Supply/Power pins

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Input supply voltage	1.7	3.3	3.6	V
t_RVCC	Supply voltage rise time			60	ms
VCC_ripple	VCC input noise peak to peak, 10 - 100 KHz			TBD	mV
	VCC input noise peak to peak, 100 KHz - 1 MHz			TBD	mV
	VCC input noise peak to peak, 1 - 3 MHz			TBD	mV
VCC_IO	I/O reference voltage		VCC		V

Table 9: Input characteristics of voltage supply pins

4.2.3 Current consumption

Table 10 shows the current consumption of NINA-B41 during some typical use cases when using the u-connectXpress software:

		3.3 V VCC		1.8 V VCC	
Mode	**Condition**	**Average**	**Peak**	**Average**	**Peak**
Active	Advertising (u-blox Serial Service, Apple iBeacon etc.) at 1 s intervals with +8 dBm output power and 31 bytes payload, CPU and UART interface is running				
	1 Mbit/s PHY	0.80 mA	20 mA	0.87 mA	34 mA
	CODED PHY	0.90 mA	20 mA	1.04 mA	34 mA
Standby	Advertising (u-blox Serial Service, Apple iBeacon etc.) at 1 s intervals with +8 dBm output power and 31 bytes payload				
	1 Mbit/s PHY	35 µA	20 mA	50 µA	34 mA
	CODED PHY	140 µA	20 mA	226 µA	34 mA
Active	Connected as peripheral, 50 ms connection interval, +8 dBm output power, no data throughput, CPU and UART interface is running				
	1 Mbit/s PHY	0.88 mA	20 mA	0.97 mA	35 mA
	2 Mbit/s PHY	0.86 mA	20 mA	0.95 mA	35 mA
	CODED PHY	1.15 mA	20 mA	1.40 mA	35 mA
Standby	Connected as peripheral, 50 ms connection interval, +8 dBm output power, no data throughput				
	1 Mbit/s PHY	128 µA	18 mA	163 µA	32 mA
	2 Mbit/s PHY	112 µA	18 mA	138 µA	32 mA
	CODED PHY	408 µA	18 mA	614 µA	32 mA
Sleep	UART DSR pin is used to enter the sleep mode. No RAM retention.	400 nA	3 mA	350 nA	3 mA

Table 10: Current consumption during typical use cases

The standby mode advertising and connected use cases described in Table 10 list the average current consumption of a NINA-B41 module when using the typical configuration of a 1 s Bluetooth advertising interval and a 50 ms connection interval.

☞ **Note** Make sure that the configured output power of your product does not exceed the maximum allowed limits of your intended target market(s), as described in the Regulatory information application note [7].

4.2.4 RF performance

Parameter	Test condition	Min	Typ	Max	Unit
Receiver input sensitivity	Conducted at 25 °C, 1 Mbit/s Bluetooth LE mode		–95		dBm
	Conducted at 25 °C, 2 Mbit/s Bluetooth LE mode		–92		dBm
	Conducted at 25 °C, 125 kbit/s Bluetooth LE mode		–102		dBm
Maximum output power	Conducted at 25 °C		+8		dBi
NINA-B416 antenna gain	Mounted on an EVB-NINA-B4		+2		dBi

Table 11: RF performance

4.2.5 Startup times

Parameter	Time	Unit
Hardware reset (toggling the RESET_N pin of module)	1.37	s
Software reset (reboot using AT command)	1.26	s

Table 12: Startup times

4.2.6 LFXO crystal performance

Symbol	Parameter	Typ.	Max.	Unit
FNOM_LFXO	Crystal frequency	32.768	-	kHz
FTOL_LFXO_BLE	Frequency tolerance, Bluetooth low energy applications	-	±500	ppm
fTOL_LFXO_ANT	Frequency tolerance, ANT applications	-	±50	ppm
CL_LFXO	Load capacitance	-	12.5	pF
C0_LFXO	Shunt capacitance	-	2	pF
RS_LFXO	Equivalent series resistance	-	100	kΩ
Cpin	Input capacitance on XL1 and XL2 pads	5	-	pF

Table 13: 32.768 kHz crystal (LFXO)

4.2.7 RESET_N pin

Pin name	Parameter	Min	Typ	Max	Unit	Remarks
RESET_N	Low-level input	0		0.3*VCC	V	
	Internal pull-up resistance		13		kΩ	
	RESET duration			55	ms	Time taken to release a pin reset.

Table 14: RESET_N pin characteristics

4.2.8 Antenna radiation patterns

Figure 3 gives an overview of the measurement procedure, and how the NINA-B41 module is aligned to the XYZ-coordinate system.

A measurement is taken at every dot in the figure to the left, and is represented as a grid point in the radiation pattern to the right.

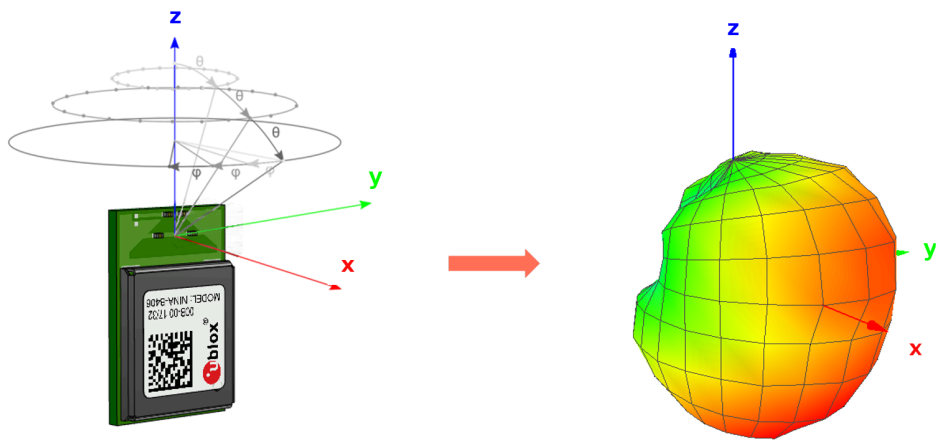
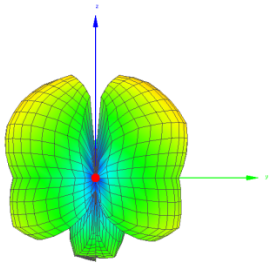
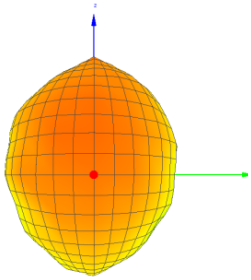
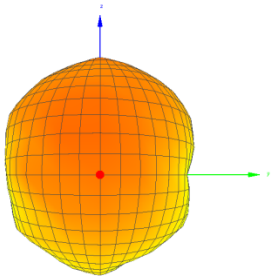
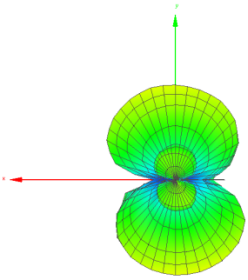
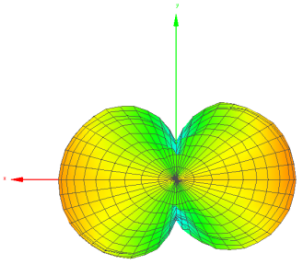
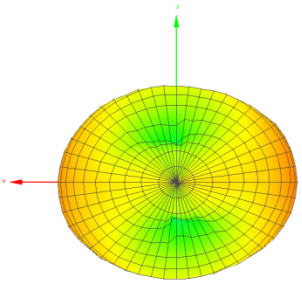
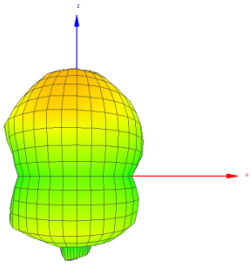
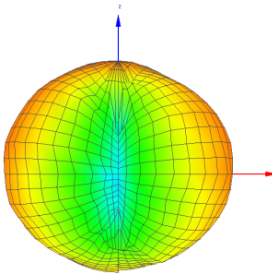
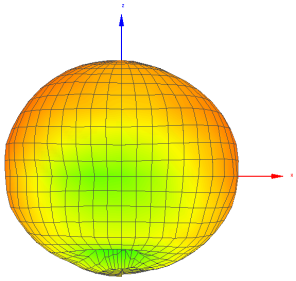
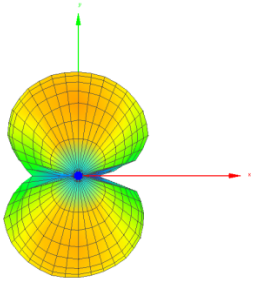
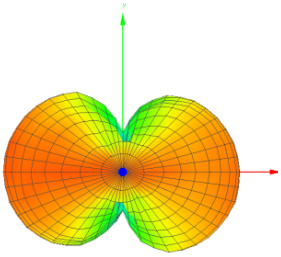
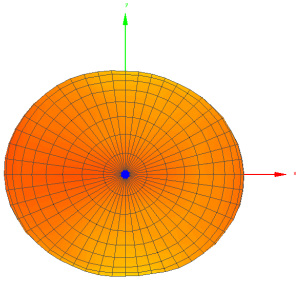
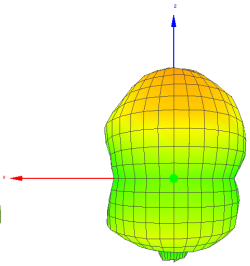
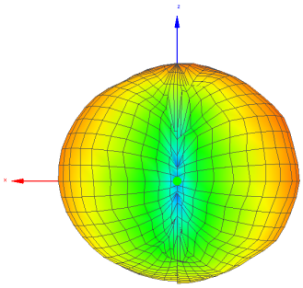
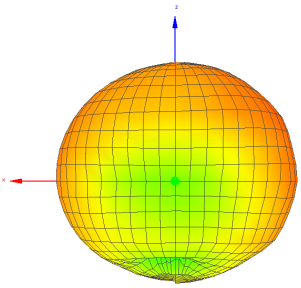


Figure 3: Measurement procedure for determining radiation patterns

The radiation patterns displayed in Table 15 show the antenna gain of the NINA-B41 variants with internal antenna.

View	Vertical polarization	Horizontal polarization	Total (Vertical + Horizontal)
	Antenna Gain (dBi) -25 -20 -15 -10 -5 0 5		
Top view, YZ plane positive X direction 			

View	Vertical polarization	Horizontal polarization	Total (Vertical + Horizontal)
Side view, XY plane negative Z direction			
Side view, XZ plane negative Y direction			
Side view, XY plane positive Z direction			
Side view, XZ plane positive Y direction			

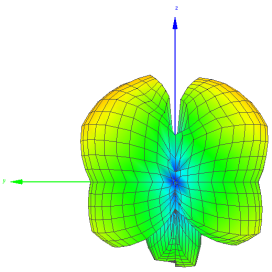
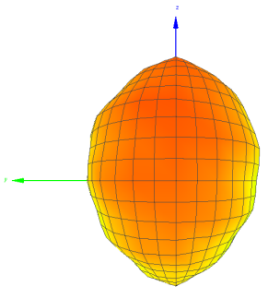
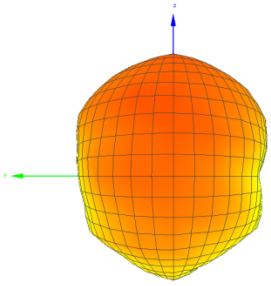
View	Vertical polarization	Horizontal polarization	Total (Vertical + Horizontal)
Bottom view, YZ plane negative X direction			

Table 15: NINA-B4x6 antenna radiation patterns

4.2.9 Digital pins

Pin name	Parameter	Min	Typ	Max	Unit	Remarks
Any digital pin	Input characteristic: Low-level input	0		0.3*VCC	V	
	Input characteristic: high-level input	0.7*VCC		VCC	V	
	Output characteristic: Low-level output	0		0.4	V	Standard drive strength
	Output characteristic: High-level output	VCC-0.4		VCC	V	Standard drive strength
	Sink/Source current	1	2	4	mA	Standard drive strength
	Rise/Fall time		9 – 25		ns	Standard drive strength, depending on load capacitance
	Input pull-up resistance	11	13	16	kΩ	Can be added to any GPIO pin configured as input
	Input pull-down resistance	11	13	16	kΩ	Can be added to any GPIO pin configured as input
GPIO_28, GPIO_29	Leakage current		1	10	µA	When not configured for NFC and driven to different logic levels

Table 16: Digital pin characteristics

5 Mechanical specifications

This chapter describes the mechanical specifications, including the mechanical outline and pin dimensions, of the NINA-B410 and NINA-B416 module variants.

5.1 NINA-B410 mechanical specification

Figure 4 shows the footprint for NINA-B410. NINA-B416 modules have the same compatible footprint and pad dimensions, as shown in Figure 5 and Figure 6.

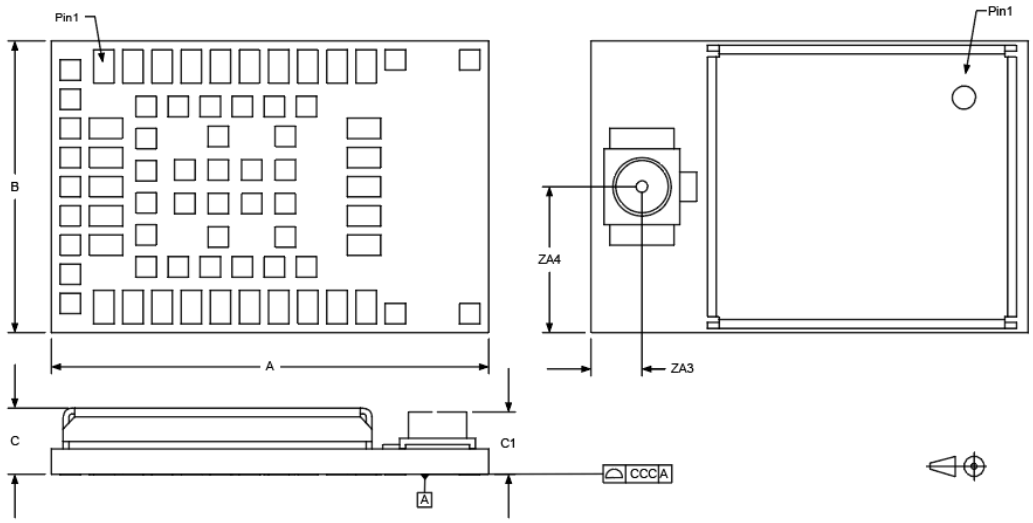


Figure 4: NINA-B410 mechanical outline

Parameter	Description	Typical [mm]	[mil]	Tolerance [mm]	[mil]
A	Module PCB length	15.0	456.7	+0.20/–0.10	+7.9/–3.9
B	Module PCB width	10.0	393.7	+0.20/–0.10	+7.9/–3.9
C	Module thickness	2.23	87.8	+0.40/–0.20	+15.8/–7.9
C1	Module thickness at U.FL antenna connector	2.13	83.9	+0.40/–0.20	+15.8/–7.9
ccc	Seating plane coplanarity	0.10	3.9	+0.02/–0.10	+0.8/–3.9
ZA3	Horizontal pin of U.FL antenna connector center to left lower corner	1.40	55.1	±0.20	±7.9
ZA4	Vertical pin of U.FL antenna connector center to left lower corner	5.00	196.8	±0.20	±7.9
	Module weight [g]	<1.0			

Table 17: NINA-B410 mechanical outline data

5.2 NINA-B416 mechanical specification

Figure 5 shows the footprint for NINA-B416 modules. The footprint is common to both NINA-B410 and NINA-B416 modules.

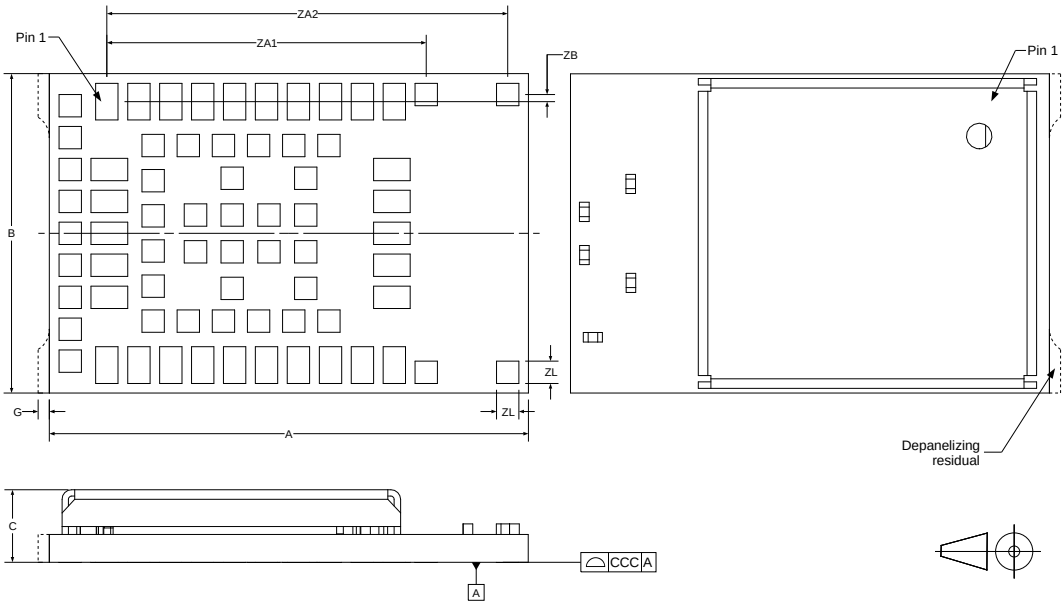


Figure 5: NINA-B416 mechanical outline

Figure 3 shows the pad dimensions for NINA-B41 modules.

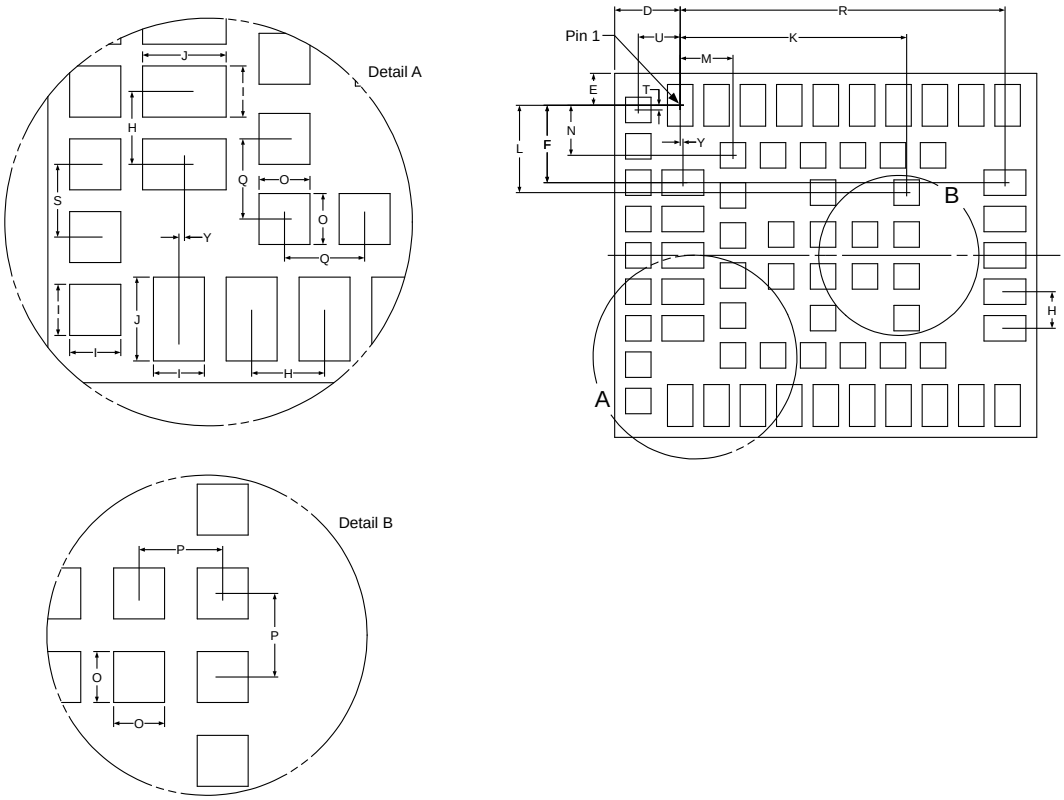


Figure 6: NINA-B41 pad dimensions

Parameter	Description	Typical [mm]	[mil]	Tolerance [mm]	[mil]
A	Module PCB length	15.0	456.7	+0.20/–0.10	+7.9/–3.9
B	Module PCB width	10.0	393.7	+0.20/–0.10	+7.9/–3.9
C	Module thickness	2.23	87.8	+0.40/–0.20	+15.8/–7.9
ccc	Seating plane coplanarity	0.10	3.9	+0.02/–0.10	+0.8/–3.9
D	Horizontal edge to pin no. 1 center	1.80	70.9	±0.10	±3.9
E	Vertical edge to pin no. 1 center	0.875	34.5	±0.10	±3.9
F	Vertical pin no. 1 center to lateral pin center	2.125	87.9	±0.05	±2.0
G	Depanelizing residual	0.10	3.9	+0.25/-0.1	+9.8/-3.9
H	Lateral and antenna row pin to pin pitch	1.00	39.4	±0.05	±2.0
I	Lateral, antenna row and outer pin width	0.70	27.6	±0.05	±2.0
J	Lateral and antenna row pin length	1.15	45.3	±0.05	±2.0
K	Horizontal pin no. 1 center to central pin center	6.225	245.1	±0.05	±2.0
L	Vertical pin no. 1 center to central pin center	2.40	94.5	±0.05	±2.0
M	Horizontal pin no. 1 center to inner row pin center	1.45	57.1	±0.05	±2.0
N	Vertical pin no. 1 center to inner row pin center	1.375	54.1	±0.05	±2.0
O	Central, inner and outer row pin width and length	0.70	27.6	±0.05	±2.0
P	Central pin to central pin pitch	1.15	45.3	±0.05	±2.0
Q	Inner row pin to pin pitch	1.10	43.3	±0.05	±2.0
R	Horizontal pin no. 1 center to antenna row pin center	8.925	351.4	±0.05	±2.0
S	Outer row pin to pin pitch	1.00	39.4	±0.05	±2.0
T	Vertical pin no. 1 center to outer row pin center	0.125	4.9	±0.05	±2.0
U	Horizontal pin no. 1 center to outer row pin center	1.15	45.3	±0.05	±2.0
Y	Horizontal pin no. 1 center to lateral pin center	0.075	3.0	±0.05	±2.0
ZA1	Horizontal pin no. 1 center to first set of antenna GND pins pin center	10.0	393.7	±0.05	±2.0
ZA2	Horizontal pin no. 1 center to second set of antenna GND pins pin center	12.55	494.1	±0.05	±2.0
ZB	Vertical pin no.1 center to antenna GND pin center	0.225	8.9	±0.05	±2.0
ZL	Antenna GND pin width and length	0.70	27.6	±0.05	±2.0
	Module weight [g]	<1.0			

Table 18: NINA-B416 mechanical outline data

6 Qualification and approvals

The validation and approvals described in this section are only valid after each module variant has been fully tested and approved during the Initial Production stage. The current product status of each NINA-B41 product variant is defined in the Document information.

6.1 Country approvals

NINA-B410 and NINA-B416 modules are certified for use in the following countries/regions:

Country/region	NINA-B410	NINA-B416
Europe	Approved	Approved
USA	Approved	Approved
Canada	Pending	Pending
Japan	Pending	Pending
Taiwan	Pending	Pending
South Korea	Pending	Pending
Brazil	Pending	Pending
Australia	Pending	Pending
New Zealand	Pending	Pending
South Africa	Pending	Pending

Note See the Regulatory information application note [7] for information about the regulatory requirements that must be met when integrating NINA-B41 modules into an end product.

6.2 Bluetooth qualification

NINA-B4 series modules are qualified as end products according to the Bluetooth 5.1 specification.

Product type	QD ID	Listing Date
End product	157158	2020-10-13

Table 19: NINA-B41 series Bluetooth qualified design ID

7 Antennas

See the Regulatory information application note [7] for information of approved antennas.

8 Product handling

8.1 Packaging

NINA-B41 series modules are delivered as hermetically sealed, reeled tapes to enable efficient production, production lot set-up and tear-down. For more information about packaging, see the u-blox package information guide [1].

8.1.1 Reels

NINA-B41 modules are deliverable in quantities of 500 pieces on a reel. The reel types for the modules are provided in Table 20 and detailed information about the reel types are described in the u-blox package information guide [1].

Model	Reel type
NINA-B410	A3
NINA-B416	A3

Table 20: Reel types for different models of the NINA-B41 series

8.1.2 Tapes

Figure 7 shows the position of NINA-B41 modules as they are delivered on tape.

Feed direction

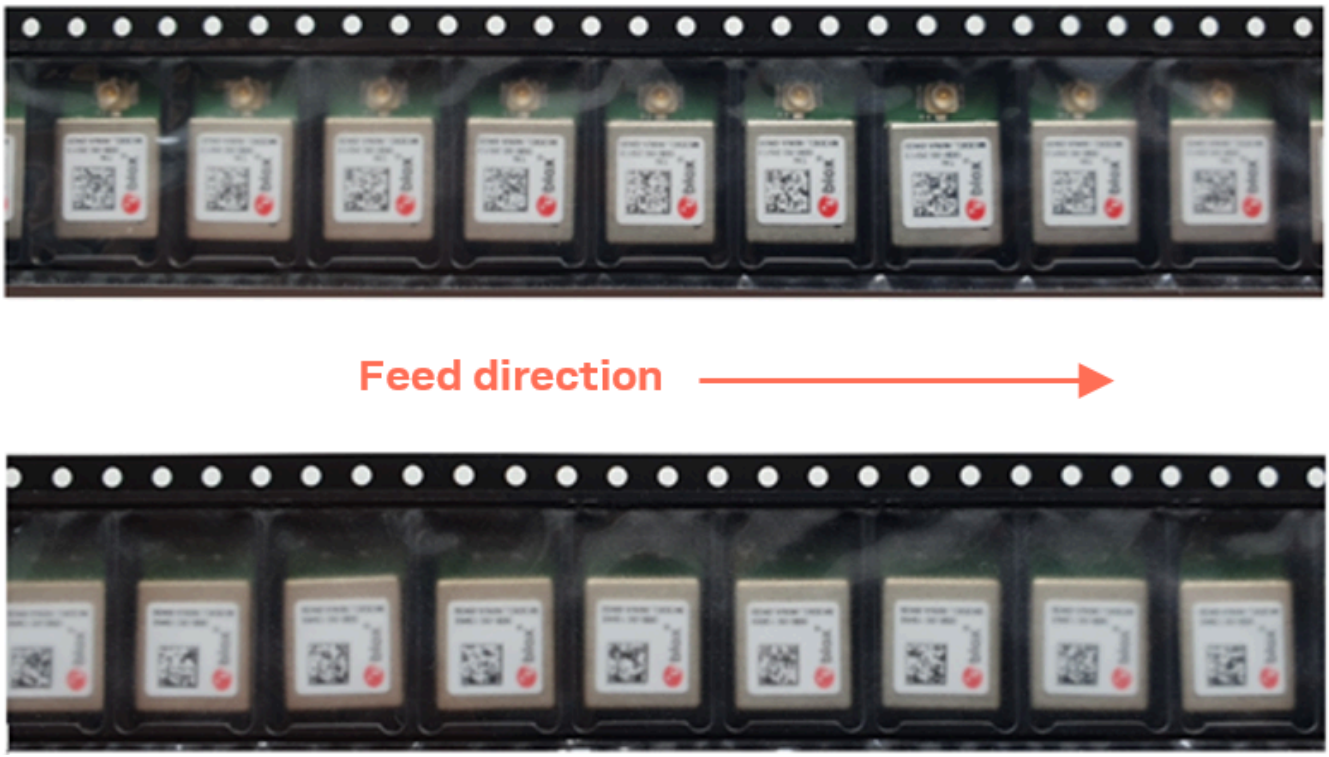
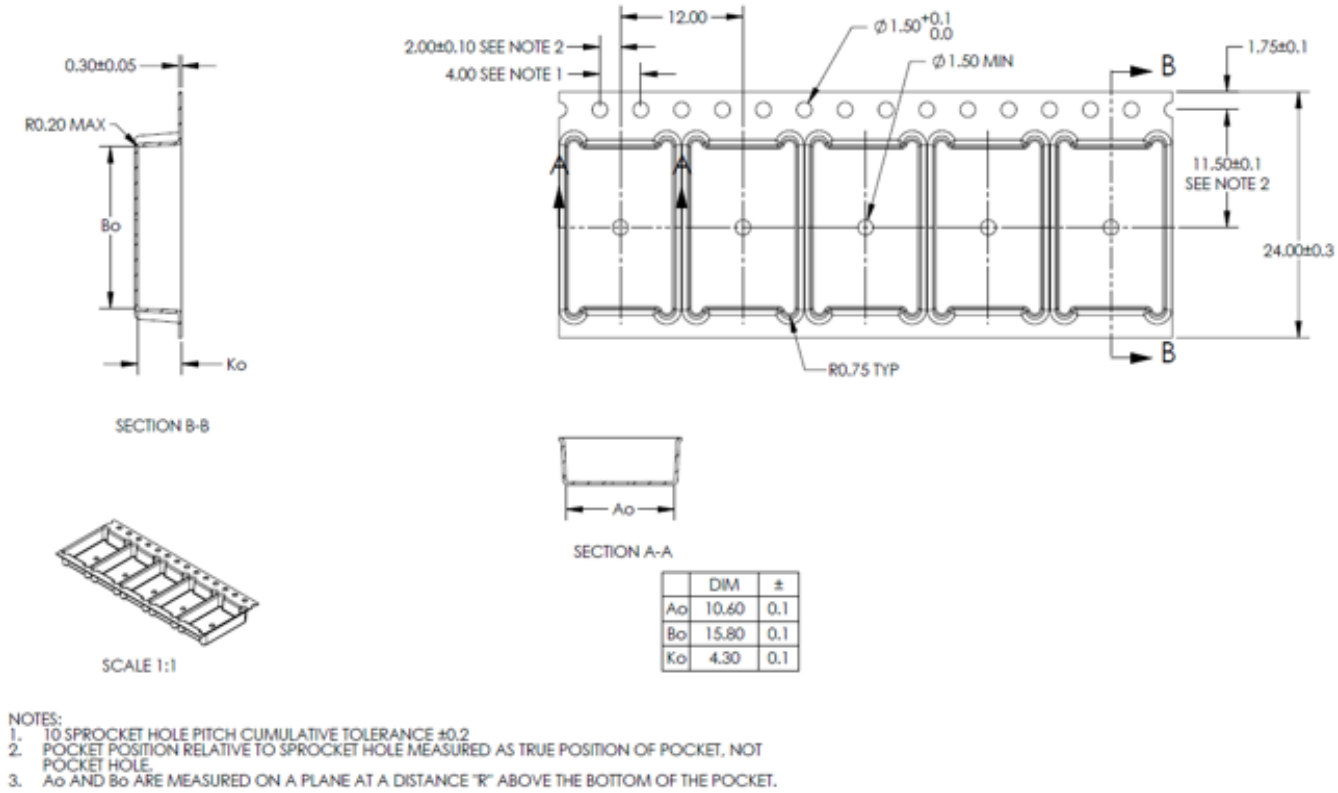


Figure 7: Orientation of NINA-B41 modules on tape



	DIM	±
Ao	10.60	0.1
Bo	15.80	0.1
Ko	4.30	0.1

Figure 8: NINA-B4x2 and NINA-B4x6 tape dimension

8.2 Moisture sensitivity levels

CAUTION The NINA-B41 series modules are Moisture Sensitive Devices (MSD) in accordance with the IPC/JEDEC specification.

The Moisture Sensitivity Level (MSL) relates to the required packaging and handling precautions. NINA-B41 series modules are rated at MSL level 4. For more information regarding moisture sensitivity levels, labeling and storage, see the u-blox package information guide [1].

Note or MSL standards, see IPC/JEDEC J-STD-020, which can be downloaded from www.jedec.org.

8.3 Reflow soldering

Reflow profiles are selected according to u-blox recommendations. See NINA-B4 series system integration manual [3] for more information.

CAUTION Failure to follow these recommendations can result in severe damage to the device.

8.4 ESD precautions

CAUTION The NINA-B41 series modules contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling the NINA-B41 series modules without proper ESD protection may destroy or damage them permanently.

The NINA-B41 series modules are electrostatic sensitive devices (ESD) and require special ESD precautions typically applied to the ESD sensitive components. Section Maximum ESD ratings provides the maximum ESD ratings of the NINA-B41 series modules.

Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the NINA-B41 series module. Failure to observe these recommendations can result in severe damage to the device.

9 Product labeling

The labels displayed on all u-blox series modules include important product information.

Figure 9 shows the standard label for all u-blox modules. It includes the u-blox logo, production lot, product type number, and certification numbers (if applicable).

Figure 9: Location of product type number on module labels

Reference	Description
1	Date of unit production (year/week)
2	Product version
3	Product name
4	Data Matrix with unique serial number of 19 alphanumeric symbols. The first 3 symbols represent module type number unique to each module variant, the next 12 symbols represent the unique hexadecimal Bluetooth address of the module AABBCCDDEEFF, and the last 4 symbols represent the hardware and firmware version encoded HHFF.

Table 21: Label description

9.1 Explanation of codes

Three different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all u-blox products, independent of packaging and quality grade. The **Ordering Code** includes options and quality, while the **Type Number** includes the hardware and software versions. Table 22 below details these three different formats:

Format	Structure
Product Name	PPPP-TGVV
Ordering Code	PPPP -TGVV-TTQ
Type Number	PPPP -TGVV-TTQ-XX

Table 22: Product code formats

Table 23 explains the parts of the product code.

Code	Meaning	Example
PPPP	Form factor	NINA
TG	Platform (Technology and Generation) T – Dominant technology, for example, W: Wi-Fi, B: Bluetooth G - Generation	B4: Bluetooth Generation 4
VV	Variant based on the same platform; range [00…99]	11: default configuration, with antenna pin
TT	Major product version	00: first revision
Q	Quality grade A: Automotive B: Professional C: Standard	B: professional grade
XX	Minor product version (not relevant for certification)	Default value is 00

Table 23: Part identification code

10 Appendix A: Glossary

Abbreviation	Definition
ADC	Analog to Digital Converter
AOA	Angle of Arrival
AOD	Angle of Departure
Bluetooth LE	Bluetooth low energy
BPF	Band Pass Filter
CTS	Clear To Send
EDM	Extended Data mode
ESD	Electro Static Discharge
FCC	Federal Communications Commission
GATT	Generic ATTribute profile
GPIO	General Purpose Input/Output
IC	Industry Canada
I2C	Inter-Integrated Circuit
MCU	Micro Controller Unit
MSD	Moisture Sensitive Device
RTS	Request To Send
SPI	Serial Peripheral Interface
TBD	To be Defined
UART	Universal Asynchronous Receiver/Transmitter
uX	u-connectXpress

Table 24: Explanation of the abbreviations and terms used

Related documents

[1] u-blox package information guide, UBX-14001652
[2] u-blox short range AT commands manual, UBX-14044127
[3] NINA-B4 system integration manual, UBX-19052230
[4] u-connectXpress software user guide, UBX-16024251
[5] NINA-B41 product summary, UBX-16024251
[6] NINA-B3 data sheet, UBX-17052099
[7] Regulatory information application note, UBX-20037320

☞ **Note** For product change notifications and regular updates of u-blox documentation, register on our website, www.u-blox.com.

Revision history

Revision	Date	Name	Comments
R01	20-Nov-2020	asoh	Initial release.

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