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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 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	Ordering code	Software	Hardware version	PCN reference	Product status
NINA-B410	NINA-B410-00B-00	u-connectXpress 1.0	03	N/A	Initial production
NINA-B410	NINA-B410-01B-00	u-connectXpress 2.0	03	N/A	Initial production
NINA-B410	NINA-B410-40B-00	u-connectLocate	03	N/A	Initial production
NINA-B411	NINA-B411-01B-00	u-connectXpress 2.0	02	N/A	Initial production
NINA-B411	NINA-B411-40B-00	u-connectLocate	02	N/A	Initial production
NINA-B416	NINA-B416-00B-00	u-connectXpress 1.0	04	N/A	Initial production
NINA-B416	NINA-B416-01B-00	u-connectXpress 2.0	04	N/A	Initial production

Contents

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-B410 and NINA-B411 modules with external antenna options also support u-connectLocate software with support for the Bluetooth 5.1 Direction Finding service. The service can be used for indoor positioning, wayfinding, and asset tracking. See also Direction finding.

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. 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-B411	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-B411 modules provide top grade security, thanks to secure boot, which ensures the module only boots up with original u-blox software. NINA-B411 has an RF pin 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

☞ 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 Block diagram

Figure 1 shows the functional components of NINA-B41 modules with the various antenna arrangements for each module variant.

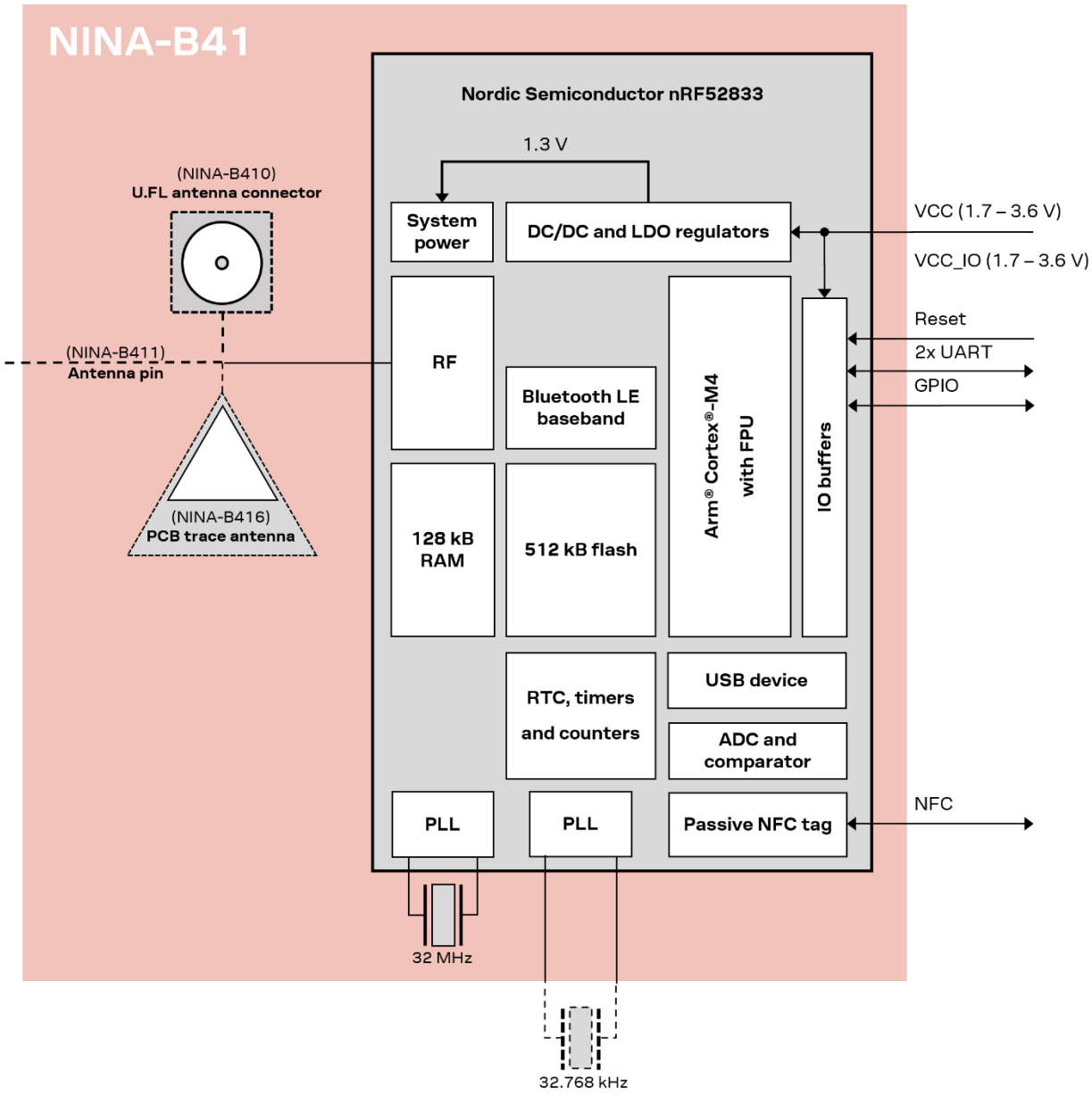


Figure 1: NINA-B41 block diagram

1.2.1 NINA-B410

NINA-B410 modules do not include an internal antenna, but have an U.FL connector to accommodate an external antenna when an RF signal is available. The module size is 10 x 15 x 2.2 mm.

1.2.2 NINA-B411

NINA-B411 modules also do not include an internal antenna, and thus the PCB has been trimmed to allow for a smaller module. Instead of an internal antenna, the RF signal is available at a module pin for routing to an external antenna or antenna connector. The module size is 10 x 11.6 x 2.2 mm.

1.2.3 NINA-B416

NINA-B416 modules include an internal PCB trace antenna that is integrated in the module PCB using antenna technology licensed from Proant AB. The RF signal pin is not connected to any signal path. The module size is 10 x 15 x 2.2 mm.

1.3 Product description

Item	NINA-B410	NINA-B411	NINA-B416
Bluetooth version	5.1	5.1	5.1
Band support	2.4 GHz, 40 channels	2.4 GHz, 40 channels	2.4 GHz, 40 channels
Typical conducted output power	+8 dBm	+8 dBm	-
Radiated output power (EIRP)	+11 dBm* (with approved antennas)	+11 dBm* (with approved antennas)	+11 dBm*
RX sensitivity (conducted)	-95 dBm	-95 dBm	-95 dBm
RX sensitivity, long range mode (conducted)	-102 dBm	-102 dBm	-102 dbm
Supported 2.4 GHz radio modes	Bluetooth Low Energy	Bluetooth Low Energy	Bluetooth Low Energy
Supported Bluetooth LE data rates	1 Mbps, 2 Mbps, 125 kbps	1 Mbps, 2 Mbps, 125 kbps	1 Mbps, 2 Mbps,125 kbps
Module size	10.0 x 15.0 mm	10.0 x 11.6 mm	10.0 x 15.0 mm

Table 2: NINA-B41 series characteristics summary

* Due to regulatory requirements, maximum allowed EIRP is +10 dBm in some regions.

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 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 2 shows the fundamental difference between the NINA-B40 and NINA-B41 software architectures, namely:

- 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.

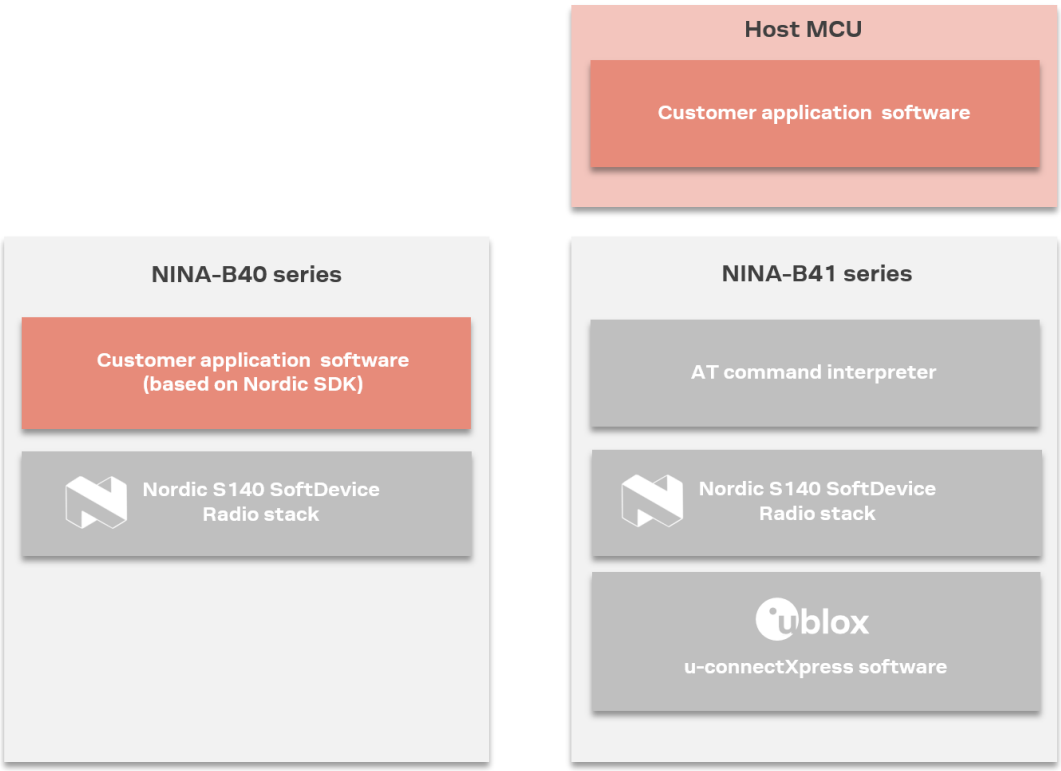


Figure 2: NINA-B4x software structures

1.5.1 u-connectXpress software

NINA-B41x modules are pre-flashed with u-connectXpress software and are delivered with the 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.

For more information about the features, capabilities and use of u-connectXpress software, see also the u-connectXpress 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 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.

☞ 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 different 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-B411 modules use an RF Pin for external antenna. The **ANT** pin is internally connected 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.

☞ For more information about the antennas that are approved for use with NINA-B41, see the Regulatory information application note [7]. See also 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.

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

2.2.3 Direction finding

NINA-B41x modules support the Bluetooth 5.1 location service called Bluetooth Direction Finding. The service is based on two solution architectures: Angle of Arrival (AoA) and Angle of Departure (AoD).

Bluetooth Direction Finding is supported in 1 Mbps and 2 Mbps Bluetooth LE modes and is used for indoor positioning, wayfinding, and asset tracking. This phase-based location service requires antenna arrays, estimation algorithms, and processing power to triangulate and detect the direction of a Bluetooth signal with sub-meter accuracy. The AoA receiver and AoD transmitter use antenna arrays, where individual antennas in the array are switched on one by one. This switching sequence allows the direction of a peer device to be calculated. The derived IQ samples are used to determine the relative path lengths between the antenna pairs and subsequent location of the transmitter.

NINA-B41x modules that support the Bluetooth 5.1 location service cannot run regular u-connectXpress but are delivered with u-connectLocate software from u-blox. Consequently, the flashing procedure for these modules is different from other u-blox modules.

For further information about the the ublox direction-finding solution, u-connectLocate and the unique flashing procedure associated with it, see also the XPLR-AOA explorer kits, user guide [8].

2.3 System functions

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 also 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, which essentially powers down the module. See also Module reset.

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 non-volatile memory of the module.

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 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

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.
- Using the `AT+CPWROFF` command causes an "internal" or "software" reset of the module. The current parameter settings are saved in the non-volatile memory of the module.

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 required for correct radio operation is provided on-module by a high-accuracy 32 MHz crystal. 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 also Electrical specifications.

☞ When using an external crystal with NINA modules at operating temperatures above 85 °C, certain limitations apply. For information about the extended operating temperature, see also the Nordic nRF52833 specification. under Normal operating temperatures, the LXFO debounce time is 0.25 s. When operating in the extended temperature range, the LXFO debounce time is 0.50 s.

2.5 System interfaces

This section describes system interfaces that are supported in NINA-B41 modules. For additional information, see also the u-connectXpress 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. For more information about how the interfaces are controlled using AT commands, see also 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 UART 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 Bluetooth 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:

- System mode
- SPS peer connection
- 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 3. The pins 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 3: System status indication

* = LED flashes on data activity

☞ 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 also Module reset.
- 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 enters bootloader mode.
- If both **SWITCH_1** and **SWITCH_2** are driven low during start up and held low for 10 seconds, the system exits the bootloader mode and restores all settings to their factory default.

3 Pin definition

3.1 NINA-B41 series pin assignment

The pin-out shown in Figure 3 describes the pin configuration used by the u-connectXpress software.

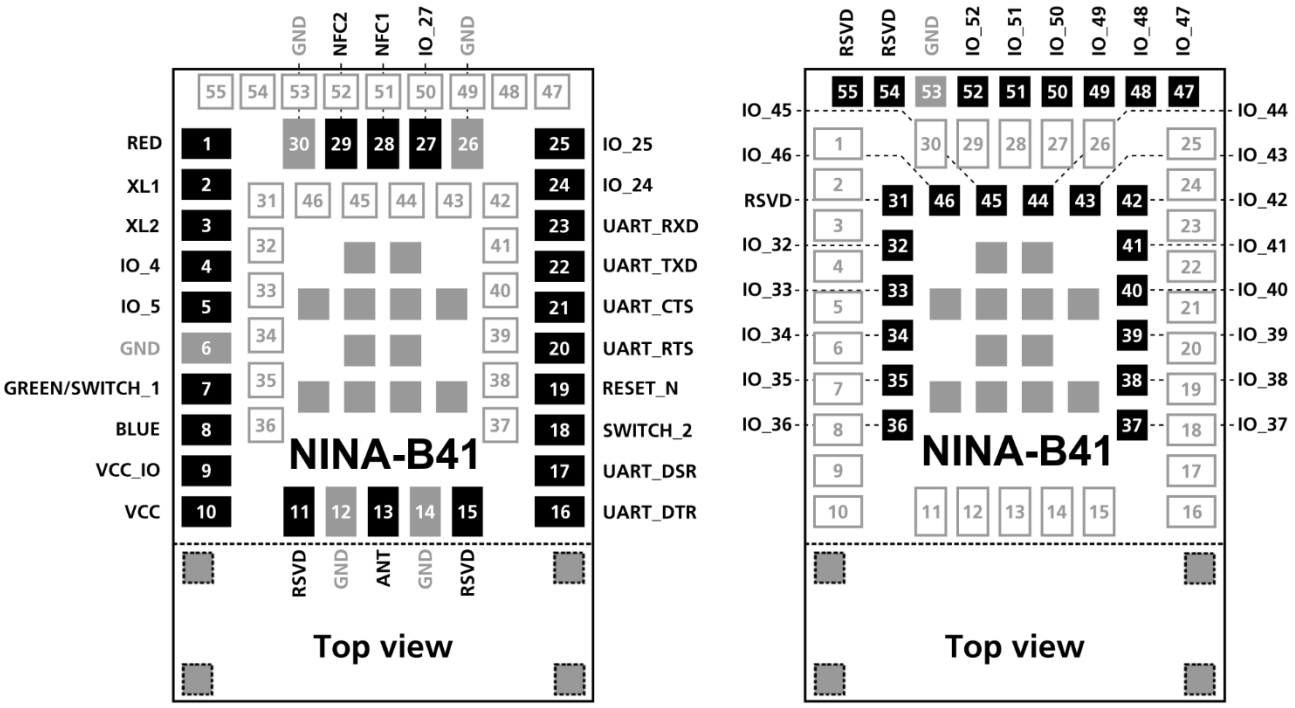


Figure 3: NINA-B41 series pin assignment (top view)

The gray pins in the center of the modules are **GND** pins. In Figure 3, the outline below the dotted line shows where the antenna area of the NINA- B410 and NINA-B416 begins. The four gray pins shown with dotted outlines in the antenna area are **GND** pins, which 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. Doing so can cause permanent damage to the module. When using the u-connectXpress software, the NFC pins are always set to NFC mode. See also 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-connectXpress (uX) IO pin Connection for 32.768 kHz crystal	If not used ground XL1 and XL2. If an external clock source is used.
3	XL2	I/O	u-connectXpress (uX) IO pin Connection for 32.768 kHz crystal	Apply external low swing signal to XL1, ground XL2. Apply external full swing signal to XL1, leave XL2 grounded.
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	
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 also System control signals.
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
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 also System control signals.
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

No.	Name	I/O	Description	Remarks
44	IO_44	I/O	uX IO pin	Can be used for manual digital I/O
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 4: NINA-B41 series with u-connectXpress software pinout

4 Electrical specifications

⚠ Stressing the device above one or more of the Absolute maximum ratings can 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 should be avoided. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

☞ Where application information is given, it is only advisory 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 5: Absolute maximum ratings

The product is not protected against overvoltage or reversed voltages. Use appropriate protection devices to avoid voltage spikes that might otherwise exceed the power boundary values shown in Table 6.

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 6: Maximum ESD ratings

*Tested on NINA-B40 evaluation board

⚠ NINA-B41 series modules are Electrostatic Sensitive Devices and require special precautions while handling. See also ESD precautions.

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 125 °C.

4.2.1 Operating temperature range

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

Table 7: 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_IO	I/O reference voltage		VCC		V

Table 8: Input characteristics of voltage supply pins

4.2.3 Current consumption

Table 9 shows the current consumption of NINA-B41 during some typical use cases 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 Mbits/s PHY	0.88 mA	20 mA	0.97 mA	35 mA
	2 Mbits/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	-	350 nA	-

Table 9: Current consumption during typical use cases

The standby mode advertising and connected use cases described in Table 9 describe the average current consumption of NINA-B41 modules when using the typical 1 s Bluetooth advertising interval and 50 ms connection interval.

☞ 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 Mbits/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		+3		dBi

Table 10: 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 11: Startup times

4.2.6 Throughput characteristics

Table 12 shows some typical values for the throughput, using the u-blox SPS service, of the NINA-B4 modules in room environment at short range. The test is performed between two NINA-B4 modules running u-connectXpress 4.0.0.

☞ Several connected devices will reduce throughput.

Radio mode	Activity	Power mode	Role	Typical value (kbit/s)	Remarks
Bluetooth LE	Transmitting (Simplex)	ACTIVE	Central->Peripheral	780	PHY 2M, MTU 247, UART 1Mbps, connection interval 7.5 ms
	Transmitting + Receiving (Duplex)	ACTIVE	Central<->Peripheral	555	PHY 2M, MTU 247, UART 1Mbps, connection interval 7.5 ms
				555	

Table 12: Throughput characteristics.

4.2.7 Latency

Latency is measured by having two modules connected to the same host and measure the time between the string is written to UART on module 1 and read in full on UART of module 2. The string is sent between the modules over SPS.

String length	UART Speed	Connection interval	Latency (ms)		Remarks
			Median	Max	
1	1 Mbps	7.5 ms	7.2	11.1	MTU 247
20	1 Mbps	7.5 ms	8.3	11.4	MTU 247
244	1 Mbps	7.5 ms	17.1	21.4	MTU 247

Table 13: Approximate latency values

☞ Latency measurements are performed in an automatic test system with a low latency host, where the UART driver latency is set to 1 ms.

4.2.8 LFXO crystal performance

Symbol	Parameter	Min	Typ.	Max.	Unit
f_{NOM_LFXO}	Crystal frequency		32.768	-	kHz
$f_{TOL\_LFXO\_BLE}$	Frequency tolerance, Bluetooth Low Energy applications		-	±500	ppm
$f_{TOL\_LFXO\_ANT}$	Frequency tolerance, ANT applications		-	±50	ppm
C_{L_LFXO}	Load capacitance		-	12.5	pF
C_{0_LFXO}	Shunt capacitance		-	2	pF
R_{S_LFXO}	Equivalent series resistance		-	100	kΩ
C_{pin}	Input capacitance on XL1 and XL2 pads		5	-	pF

Table 14: 32.768 kHz crystal (LFXO)

4.2.9 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 15: RESET_N pin characteristics

4.2.10 Antenna radiation patterns

Figure 4 provides an overview of the measurement procedure and shows 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, with each represented as a grid point in the radiation pattern to the right.

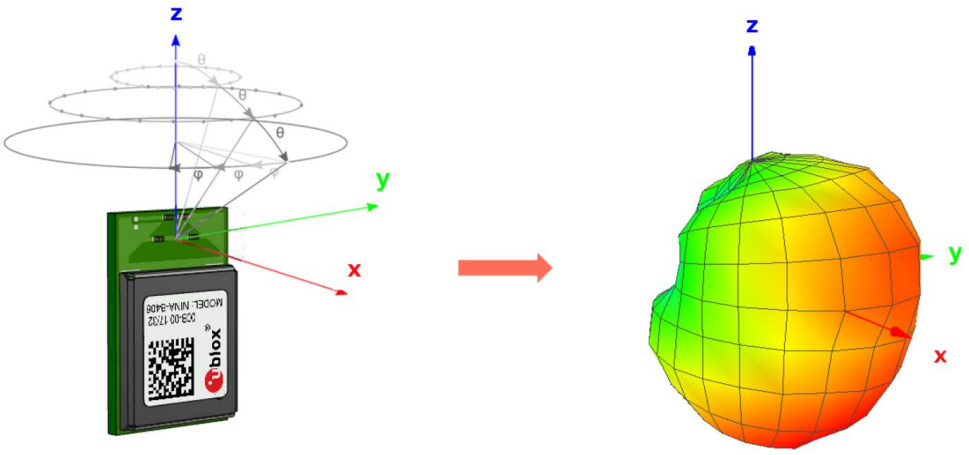
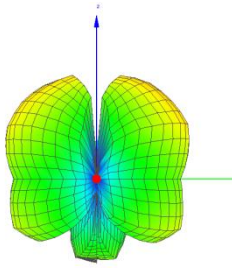
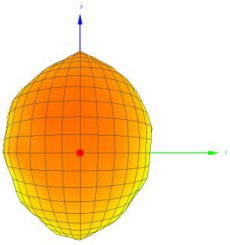
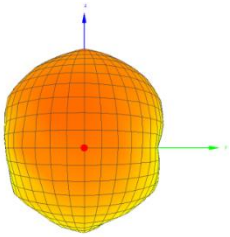
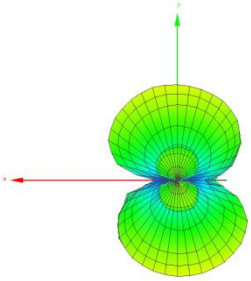
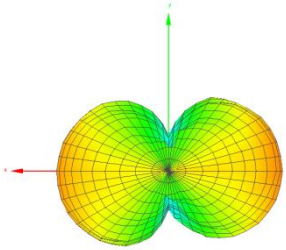
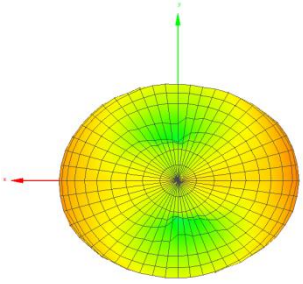


Figure 4: Measurement procedure for determining radiation patterns

The radiation patterns in Table 16 show the antenna gain of NINA-B41 module variants equipped with internal antennas.

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 			
Side view, XY plane negative Z direction 			

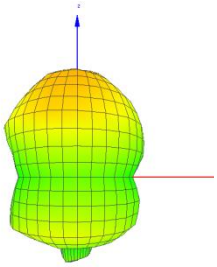
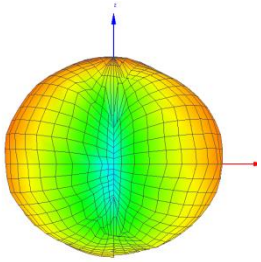
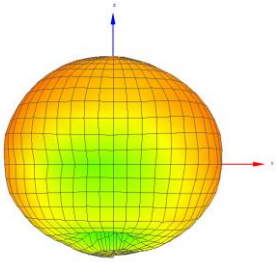
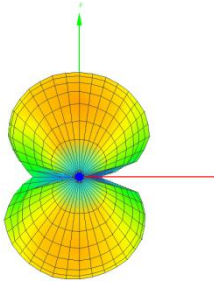
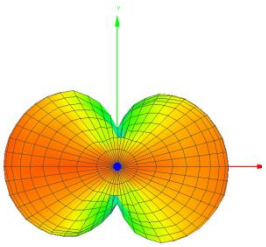
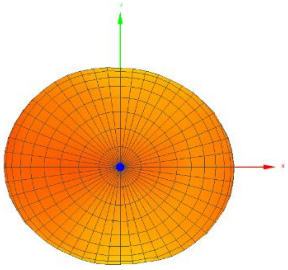
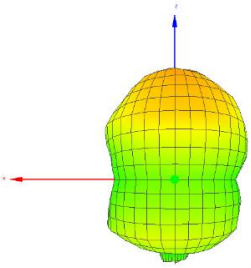
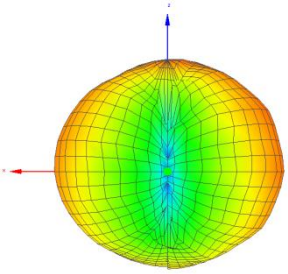
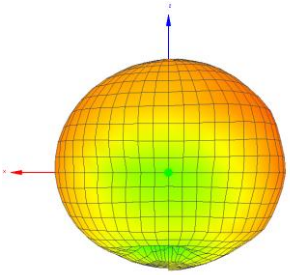
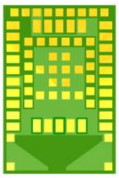
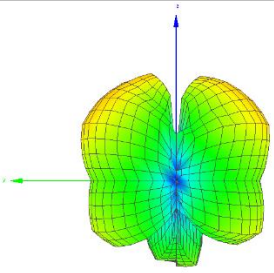
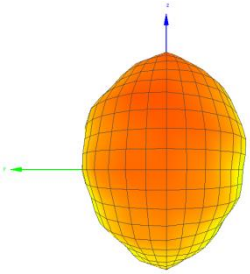
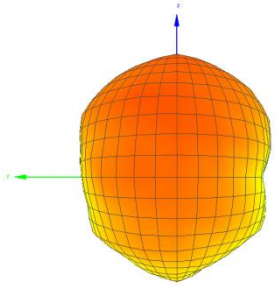
View	Vertical polarization	Horizontal polarization	Total (Vertical + Horizontal)
Side view, XZ plane negative Y direction 			
Side view, XY plane positive Z direction 			
Side view, XZ plane positive Y direction 			
Bottom view, YZ plane negative X direction 			

Table 16: NINA-B4x6 antenna radiation patterns

4.2.11 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 17: Digital pin characteristics

5 Mechanical specifications

This chapter describes the mechanical specifications of the product, including the mechanical outline and pin dimensions of the NINA-B410, NINA-B411, and NINA-B416 module variants.

5.1 NINA-B410 mechanical specification

Figure 5 shows the footprint for NINA-B410, which has the same compatible footprint and pad dimensions as the NINA-B16 module variant shown in Figure 8.

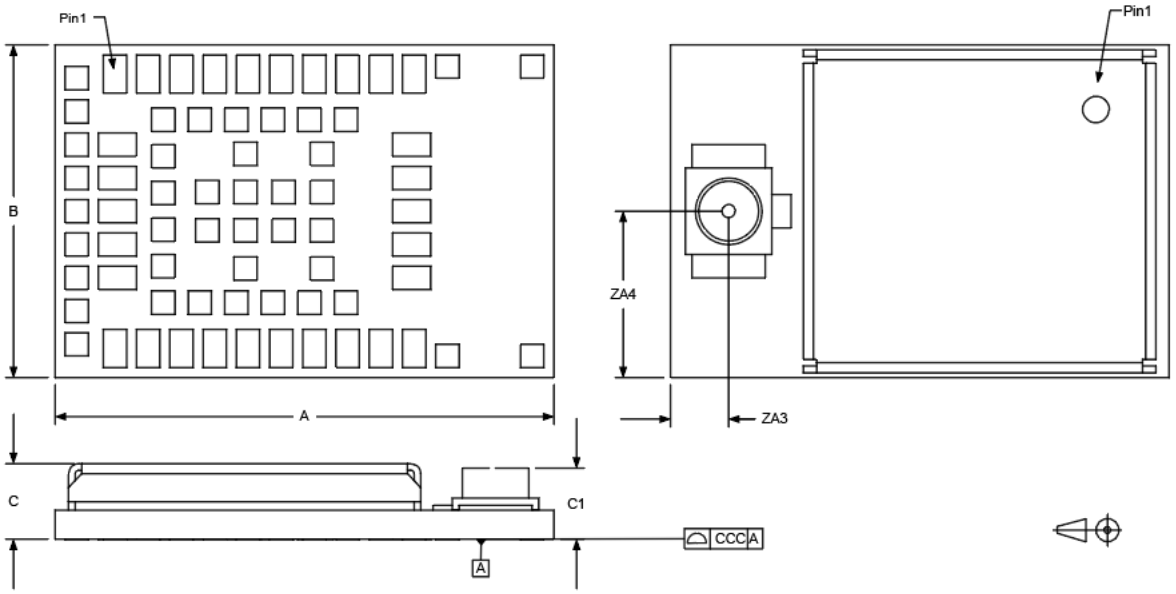


Figure 5: NINA-B410 mechanical outline

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/–0.20	+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 18: NINA-B410 mechanical outline data

5.2 NINA-B411 mechanical specification

Figure 6 shows the mechanical outline of NINA-B411 modules, which share the same pad dimensions of all other NINA-B41 modules shown in Figure 8.

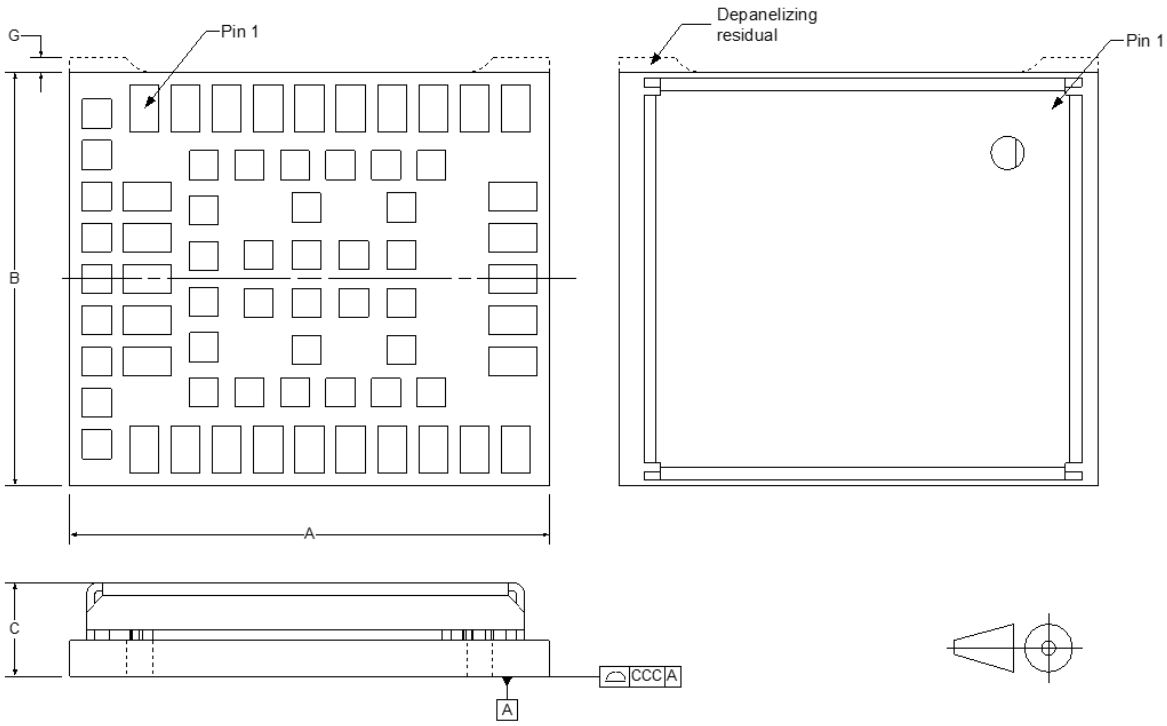


Figure 6: NINA-B411 mechanical outline

Parameter	Description	Typical [mm]	[mil]	Tolerance [mm]	[mil]
A	Module PCB length	11.6	456.7	+0.20/–0.10	+7.9/–3.9
B	Module PCB width	10.0	393.7	+0.20/–0.20	+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
G	Depanelizing residual	0.10	3.9	+0.25/-0.1	+9.8/-3.9
	Module weight [g]	<1.0			

Table 19: NINA-B411 mechanical outline data

5.3 NINA-B416 mechanical specification

Figure 7 shows the footprint for NINA-B416 modules. The footprint is common to both NINA-B410 and NINA-B416 modules.

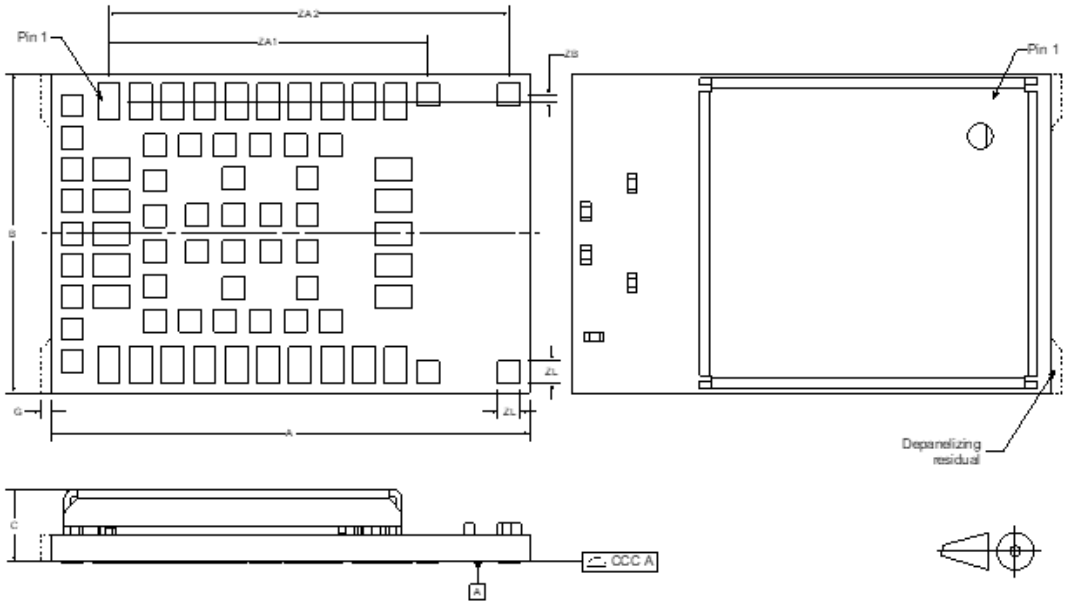


Figure 7: NINA-B416 mechanical outline

Figure 8 shows the pad dimensions that are common for all NINA-B41 variants.

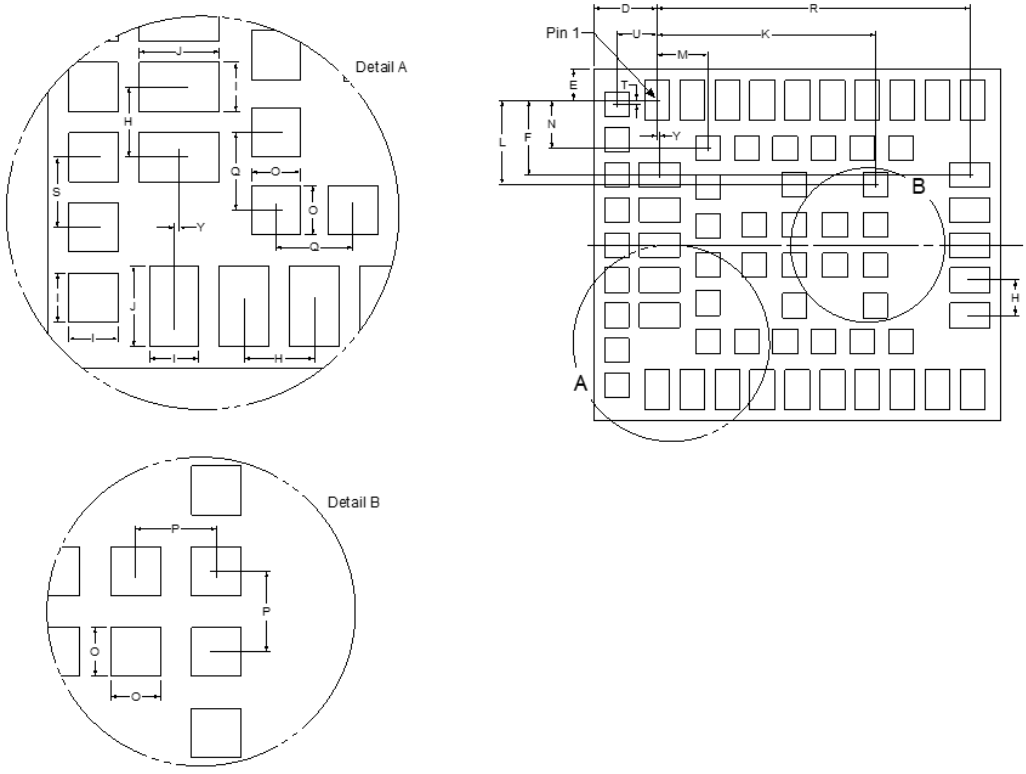


Figure 8: NINA-B41 pad dimensions

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/–0.20	+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 1 center	1.80	70.9	±0.10	±3.9
E	Vertical edge to pin 1 center	0.875	34.5	±0.10	±3.9
F	Vertical pin 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 1 center to central pin center	6.225	245.1	±0.05	±2.0
L	Vertical pin 1 center to central pin center	2.40	94.5	±0.05	±2.0
M	Horizontal pin 1 center to inner row pin center	1.45	57.1	±0.05	±2.0
N	Vertical pin 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 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 1 center to outer row pin center	0.125	4.9	±0.05	±2.0
U	Horizontal pin 1 center to outer row pin center	1.15	45.3	±0.05	±2.0
Y	Horizontal pin 1 center to lateral pin center	0.075	3.0	±0.05	±2.0
ZA1	Horizontal pin 1 center to first set of antenna GND pins pin center	10.0	393.7	±0.05	±2.0
ZA2	Horizontal pin 1 center to second set of antenna GND pins pin center	12.55	494.1	±0.05	±2.0
ZB	Vertical pin 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 20: 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 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-B411	NINA-B416
Europe	Approved	Approved	Approved
USA	Approved	Approved	Approved
Canada	Approved	Approved	Approved
Japan	Approved	Approved	Approved
Taiwan	Pending	Pending	Pending
South Korea	Approved	Approved	Approved
Brazil	Approved	Approved	Approved
Australia	Approved	Approved	Approved
New Zealand	Approved	Approved	Approved
South Africa	Pending	Pending	Pending

☞ 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	20-10-13

Table 21: NINA-B41 series Bluetooth qualified design ID

7 Product handling

7.1 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 Package information reference guide [1].

7.1.1 Reels

NINA-B41 modules are deliverable in quantities of 500 pieces on a reel. Table 22 describes the reel types for NINA-B41 modules. For more information about the reel types, see also the Package information reference guide [1].

Model	Reel type
NINA-B410	A3
NINA-B411	B1
NINA-B416	A3

Table 22: Reel types for different models in the NINA-B41 series

7.1.2 Tapes

Figure 9 shows the orientation of NINA-B41 modules in relation to the feed direction of the tape.

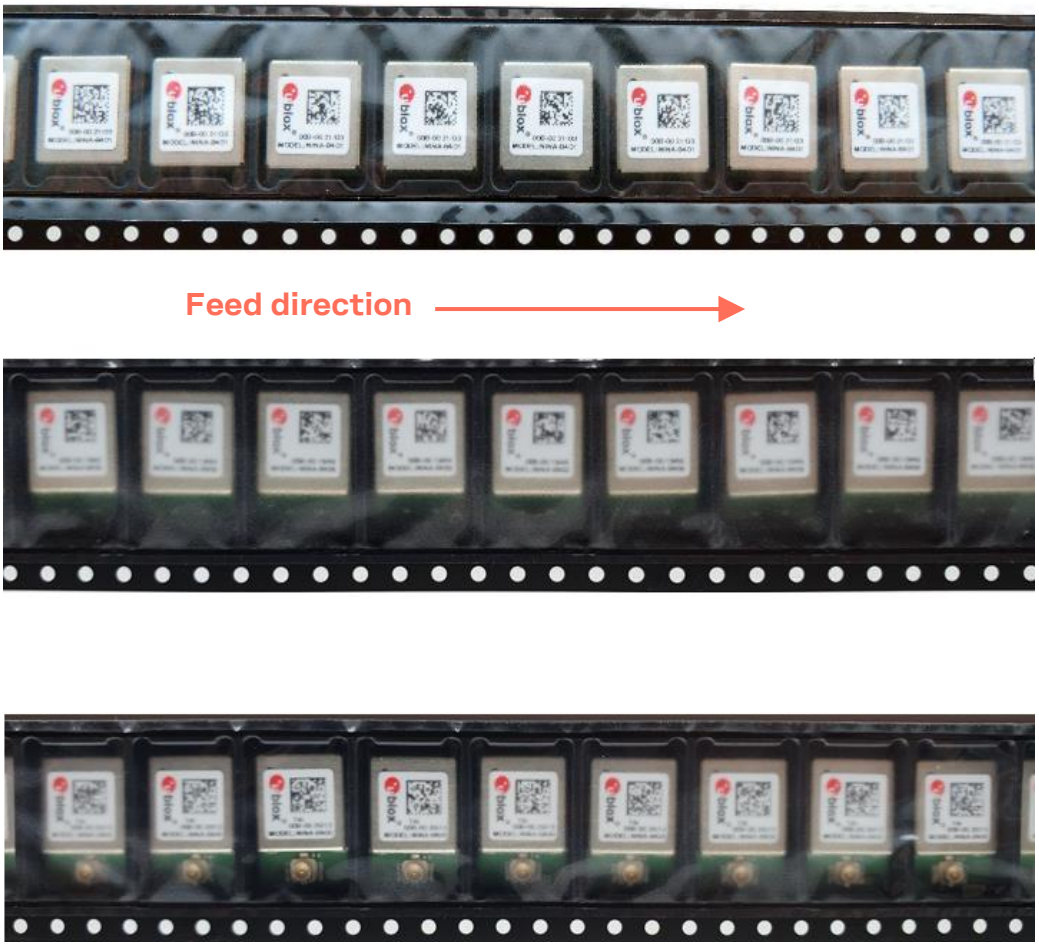
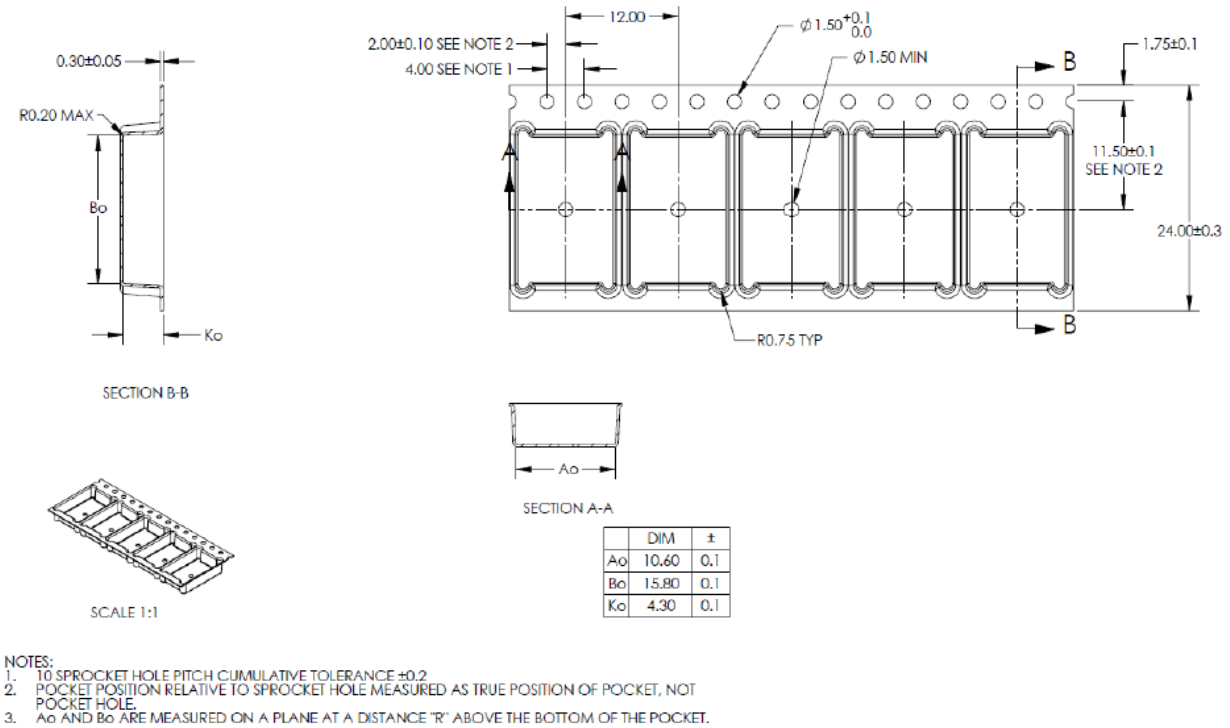


Figure 9: Orientation of NINA-B41 modules on tape

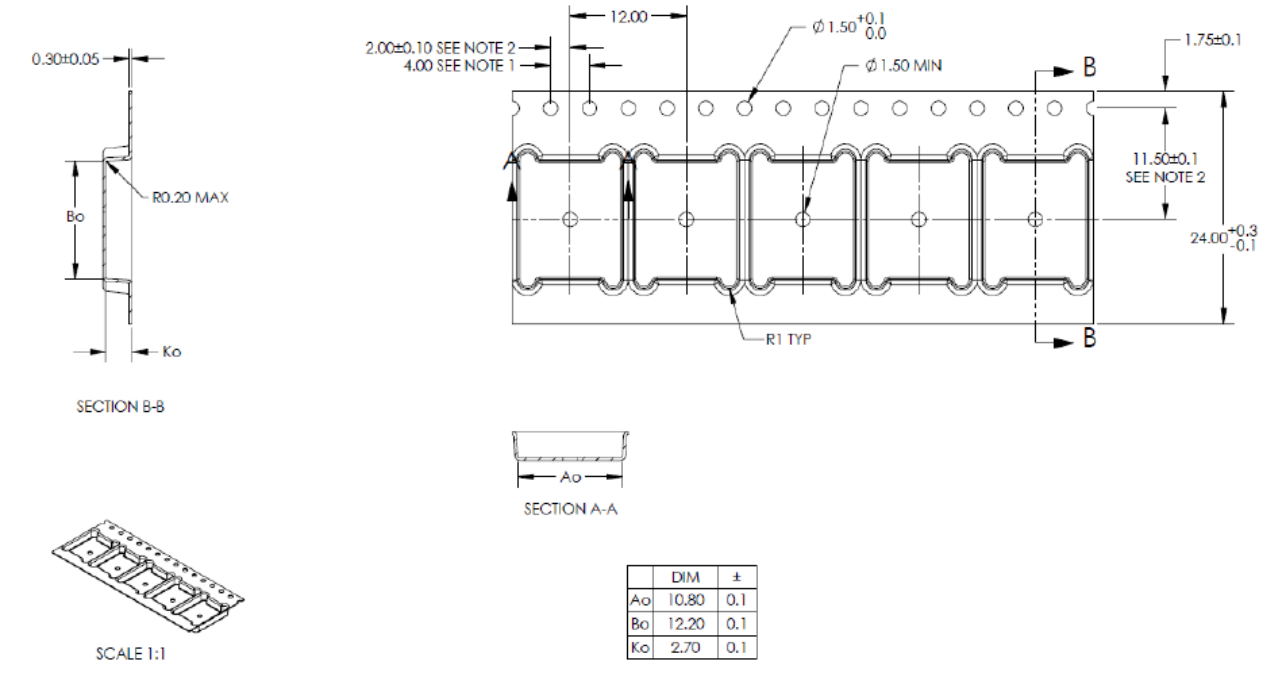
Figure 10 the physical dimensions of NINA-Bx0 and NINA-B4x6.



	DIM	±
Ao	10.60	0.1
Bo	15.80	0.1
Ko	4.30	0.1

Figure 10: NINA-Bx0 and NINA-B4x6 tape dimensions

Figure 11 shows the tape dimensions of NINA-B4x1 modules on tape.



	DIM	±
Ao	10.80	0.1
Bo	12.20	0.1
Ko	2.70	0.1

Figure 11: NINA-Bx1 tape dimensions

7.2 Moisture sensitivity levels

⚠ NINA-B41 modules are rated as MSL Level 4 devices in accordance with the IPC/JEDEC J-STD-020 standard. For detailed information, see the moisture sensitive warning label on the MBB (Moisture Barrier Bag).

After opening the dry pack, the modules must be mounted within 168 hours in factory conditions of maximum 30 °C/60%RH or must be stored at less than 10%RH. The modules require baking if the humidity indicator card shows more than 10% when read at 23±5 °C or if the conditions mentioned above are not met. For information about the bake procedure, see also the J-STD-033B standard.

☞ For more information regarding MSL (Moisture Sensitivity Level), labeling, and storage, see also the Packaging information guide [1].

7.3 Reflow soldering

NINA-B41 modules are approved for one-time reflow processes. Although two-time reflow soldering can be used during manufacturing, it is not recommended and customers do so at their own risk. For information about the testing results and recommendations concerning reflow processes, contact your local u-blox technical support team.

⚠ Reflow soldering profiles must be selected in accordance with u-blox soldering recommendations described in the NINA-B41 series system integration manual [3]. Failure to observe these recommendations can result in severe damage to the product.

7.4 ESD precautions

⚠ NINA-B41 series modules are Electrostatic Sensitive Devices that demand the observance of special handling precautions against static damage. Failure to observe these precautions can result in severe damage to the product. See also Maximum ESD ratings.

Proper ESD handling and packaging procedures must be applied throughout the processing, handling, and operation of any application that incorporates the NINA-B41 module. ESD precautions are particularly relevant when handling the application board on which the module is mounted.

For further information about the handling of NINA-B41 series modules, see also the NINA-B41 system integration manual [3].

8 Labeling and ordering information

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

Figure 12 shows the label applied to all the NINA-B41 series modules, which includes the product type number, revision, production date, and data matrix that bears a unique serial number and the u-blox logo.

Figure 12: Location of product type number on module labels

Reference	Description
1	Date of unit production (year/week)
2	Major and minor product version information
3	Product (model) name (NINA-B410, NINA-B411, or NINA-B416)
4	Data Matrix with unique serial number comprising 19 alphanumeric symbols: - The first 3 symbols are used for production tracking and are an abbreviated representation of the Type number that is unique to each module variant. - The following 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.
5	u-blox logo with the red dot to indicate pin 1

Table 23: Label description

8.1 Product identifiers

Table 24 describes the three product identifiers, namely the Type number, Model name and Ordering code.

Format	Description	Nomenclature
Model name	Describes the form factor, platform technology and platform variant. Used mostly in product documentation like this data sheet, the model name represents the most common identity for all u-blox products	PPPP-TGVV
Ordering code	Comprises the model name – with additional identifiers to describe the major product version and quality grade	PPPP-TGVV-TTQ
Type number	Comprises the model name and ordering code – with additional identifiers to describe minor product versions.	PPPP -TGVV-TTQ-XX

Table 24: Product code formats

8.2 Identification codes

Table 25 describes the various parts that comprise 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 25: Part identification code

8.3 Ordering information

Ordering Code	Product
NINA-B410-01B	NINA-B410 module with u-connectXpress software and U.FL connector for use with an external antenna.The module has a standard physical size of 10 x 15 x 2.2 mm.
NINA-B410-40B	NINA-B410 module with U.FL connector and bootloader for use with an external antenna and u-connectLocate direction-finding (AoA) software. The module has a standard physical size of 10 x 15 x 2.2 mm.
NINA-B411-01B	NINA-B411 module with u-connectXpress software and RF pin for use with an external antenna. The module has a trimmed physical size of 10 x 11.6 x 2.2 mm.
NINA-B411-40B	NINA-B410 module supplied with an RF pin and bootloader for use with an external antenna and u-connectLocate direction-finding (AoA) software. The module has a trimmed physical size of 10 x 11.6 x 2.2 mm.
NINA-B416-01B	NINA-B416 module with u-connectXpress software and internal PCB trace antenna integrated in the module PCB. The module has a standard physical size of 10 x 15 x 2.2 mm.

Table 26: Product ordering codes

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
DF	Direction Finding
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 27: Explanation of the abbreviations and terms used

Related documentation

[1] Packaging information reference, UBX-14001652
[2] u-connectXpress 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-20045962
[6] NINA-B3 data sheet, UBX-17052099
[7] Regulatory information application note, UBX-20037320
[8] XPLR-AOA explorer kits, user guide, UBX-21004616

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
R02	03-Mar-2021	asoh	Revised document scope and content to include NINA-B410 and NINA-B411 variants
R03	05-Aug-2021	fkru	Updated country approval status
R04	03-Sep-2021	mape	Revised information implying that the NFC interface can be used to wake the module from sleep mode. Deleted the previously obsolete Antennas chapter (now maintained in the Regulatory information note). Revised Labeling and ordering information. Updated product status in Document Information.
R05	05-Jan-2022	mape, fkru, asoh	Added Throughput characteristics and Latency chapters. Updated styles of symbol names in LFXO crystal performance. Removed ambiguous description of operating condition ranges in Electrical specifications. Updated information describing Moisture sensitivity levels, Reflow soldering, and ESD precautions. Updated country approval status and product label.

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