System description

Overview

The NORA-B106 series of small stand-alone, open CPU, modules support Bluetooth® device connectivity and operate in temperatures of up to 105 °C. The modules are built on the Nordic nRF5340 System on a Chip as an open CPU solution, where customer applications run on two Arm® Cortex®-M33 processor cores with integrated flash and RAM memory.

The application core implements TrustZone® technology that includes an Arm Cortex-M33 processor, Digital Signal Processing (DSP) extension, Floating-point Unit (FPU), and CryptoCell™-312 with roots-of-trust and other security mechanisms for IoT and high-performance applications. The processor is clocked at either 128 or 64 Mhz.

The network core includes an Arm® Cortex®-M33 processor with integrated 2.4 GHz radio capable of handling Bluetooth Low Energy (LE), 802.15.4 for Thread and Zigbee, and Nordic proprietary protocols. The processor is clocked at 64 MHz.

With features like Direction finding (Angle-of-Arrival and Angle-of-Departure), Bluetooth long range, and Bluetooth Low Energy (LE) Audio, NORA-B106 module supports Bluetooth LE services such as serial port communication, GATT, beacons, and mesh along with a range of wired interfaces, including UART, QSPI, SPI, I2C, I2S, USB, QDEC, PDM, PWM, and ADC. The NORA-B106 module is qualified as a tested component according to the Bluetooth Core 5.2 specification.

1.3 Architecture

1.3.1 Block diagram

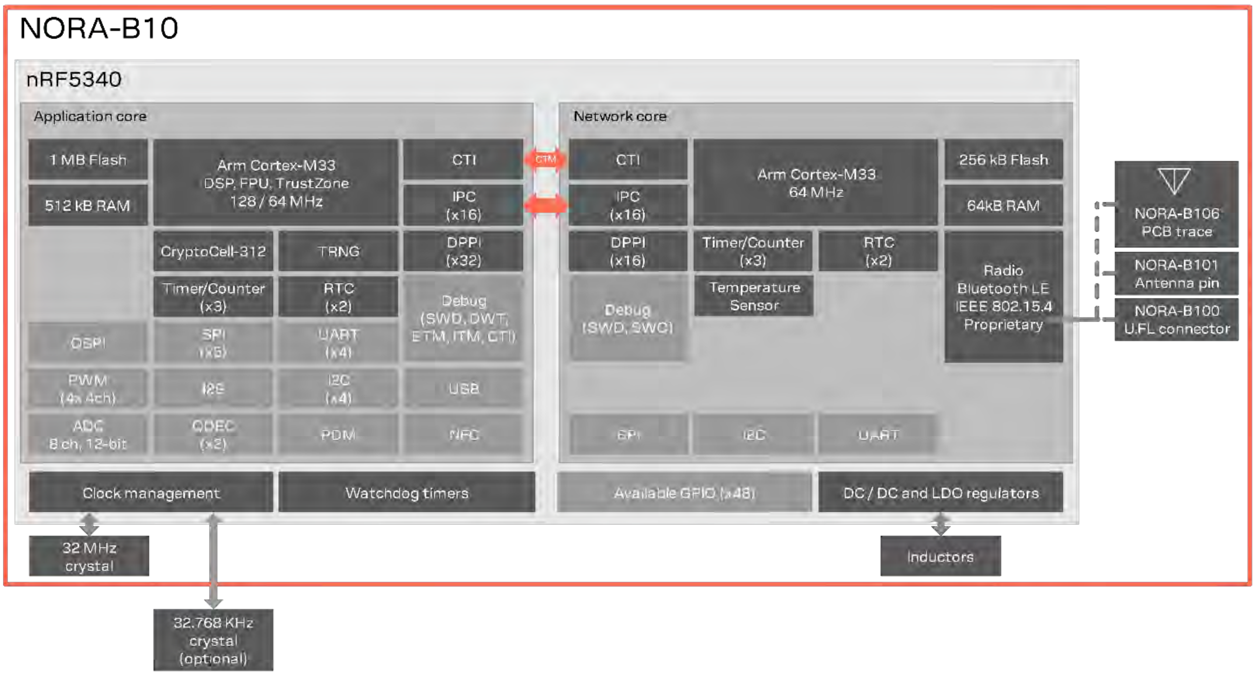

Figure 1: NORA-B106 series block diagram

Pin assignments

For information about the function, configuration, and characteristics of module pins, see the NORA-B106 series data sheet.

Supply interfaces

Main supply input

NORA-B106

NORA-B10 utilizes three power inputs, **VDDH**, **VDD,** and **VBUS**. These inputs connect to internal regulators that provide the application and network core operating voltages, USB subsystem power, and GPIO voltage references.

Figure 2 shows how in normal voltage mode, a single power source is connected to both **VDDH** and **VDD**. This bypasses the high voltage regulator (VREGH). The GPIO voltage is equal to the external power source voltage.

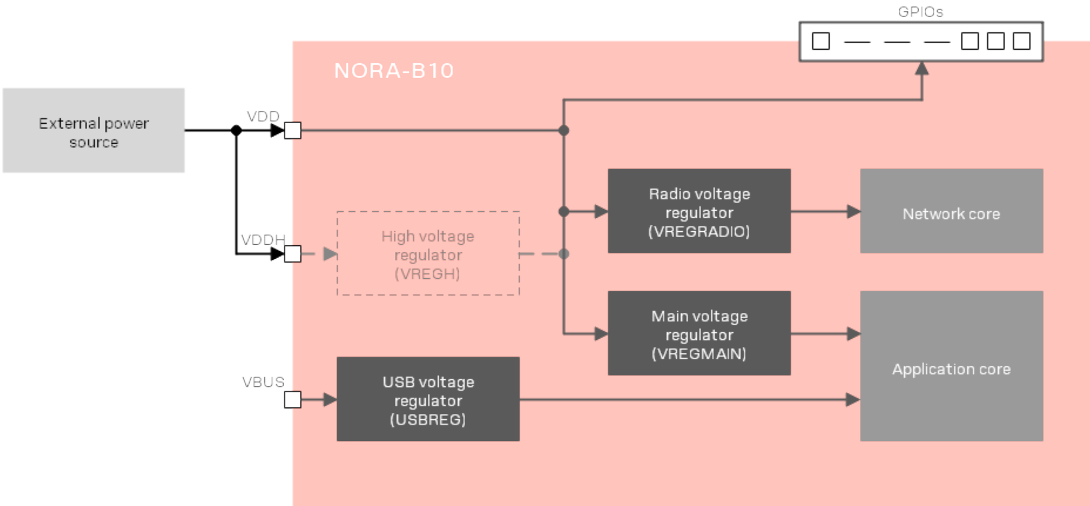

Figure 2: NORA-B106 normal voltage power connection

Figure 3 shows how in high voltage mode, a single power source is connected only to **VDDH**. The high voltage regulator (VREGH) then generates **VDD**, which can be configured between 1.8 and 3.3 VDC through VREGHVOUT in the user information configuration register (UICR) of the application core.

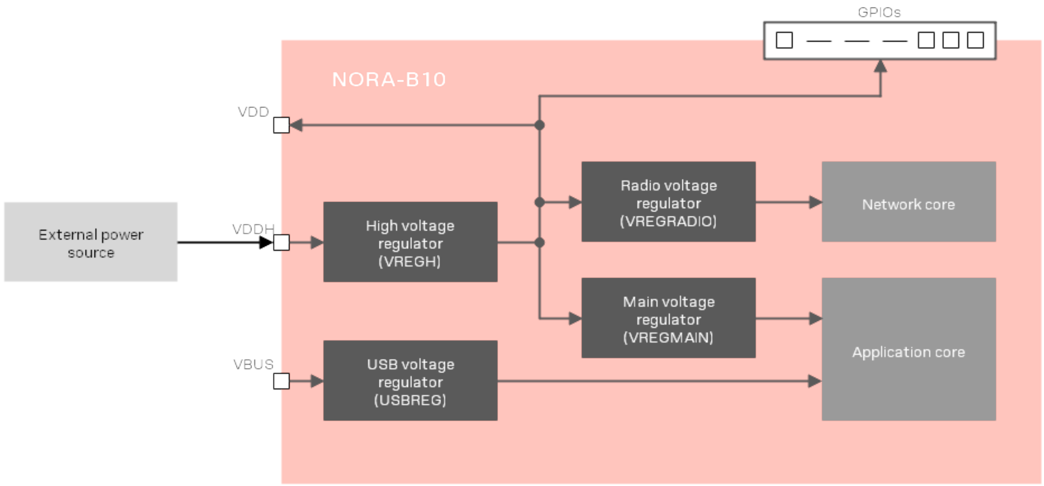

Figure 3: NORA-B10 high voltage power connection

The high voltage, radio voltage, and main voltage regulators have both a low drop-out regulator (LDO) and DC-DC converter. No additional components are required to use the DC-DC converters. Once the DC-DC converters are enabled by the application, switching between the LDO and DC-DC converter is automatic based on the required current.

☞ In high voltage mode, VDD can provide a maximum external current of 7 mA (via VDD and GPIO pins) when VREGMAIN and VREGRADIO are in DC-DC mode and a maximum of 1 mA when they are in mode LDO or during System OFF.

Digital I/O interfaces reference voltage

The digital I/O pins operating voltage is equal to **VDD**, regardless of whether it is connected to an external source or generated from the high voltage regulator. As noted above, when in high voltage mode, **VDD** voltage is configured through the VREGHVOUT register in the application core UICR.

USB supply input

If used by the application, apply the VBUS power from the upstream USB host port to the **VBUS** pin. The USB voltage regulator is a 3.3 V LDO regulator used to power the USB subsystem and provide a reference voltage for the **USB_DP** and **USB_DM** signals.

VDD/VDDH application circuits

The power for NORA-B106 series modules is provided through the **VDD** and **VDDH** pins. The power can be taken from any of the following sources:

- Switching Mode Power Supply (SMPS)
- Low Drop Out (LDO) regulator
- Battery

An SMPS is the ideal choice when the available primary supply source has a higher value than the operating supply voltage of NORA-B106 series modules. The use of SMPS provides the best power efficiency for the overall application and minimizes the current drawn from the main supply source.

⚠ When using an SMPS source, ensure that the AC voltage ripple at the switching frequency is kept as low as possible. The layout must be implemented to minimize impact of high frequency ringing.

The use of an LDO linear regulator is convenient for a primary supply with a relatively low voltage where the typical 85-90% efficiency of the switching regulator leads to minimal current saving. Linear regulators are not recommended for high voltage step-down, as they dissipate a considerable amount of energy.

DC-DC efficiency should be evaluated as a tradeoff between active and idle duty cycles of the specific application. Although some DC-DC conversion can be efficient for extremely light loads, DC-DC conversion efficiency quickly degrades as the idle current drops below a few milliamps (mA), which significantly reduces the battery life.

Due to the low current consumption and wide voltage range of NORA-B106, a battery can be used as the main supply. The capacity of the battery should be selected to match the application. Care should be taken to ensure that the battery can deliver the peak current required by the module. See the NORA-B106 series data sheet for the electrical specifications.

Although it is best practice to include decoupling capacitors on the supply rails close to the NORA-B106 series module, the need for additional capacitance is normally dependent on the design of the power routing in the host system.

System function interfaces

Module reset

NORA-B106 is reset by applying a low level on the **nRESET** input pin for a minimum of 0.2 µsec. The pin is pulled high to VDD internally, and this low-level hold is sufficient to trigger an "external" or "hardware" reset of the module.

Internal temperature sensor

The radio chip in the NORA-B106 contains a temperature sensor that is used to monitor the temperature of the die.

⚠ The temperature sensor is located inside the radio chip and should not be used if an accurate temperature reading of the surrounding environment is required.

Debug

Serial Wire Debug (SWD)

NORA-B106 series modules leverage ARM Multi-drop SWD technology for flashing and debugging. Each core shares an external connection to one set SWD signals, **SWDIO** and **SWDCLK**. The cores are then addressed individually. Additionally, NORA-B106 can be connected over the same SWD interface to other CPUs that support Multi-drop SWD.

GPIO pins

☞ The code running on the application core determines the pin mapping for both application and network cores.

In an un-configured state, NORA-B106 has 48 GPIO pins and no analog or digital interfaces. All interfaces or functions must be allocated to a GPIO pin before use. Eight of the 48 GPIO pins are analog enabled, meaning that they can have an analog function allocated to them. Table 1 shows the digital and analog functions that can be assigned to a GPIO pin.

Function	Description	Default NORA-B106 pin	Configurable GPIOs
General purpose input	Digital input with configurable pull-up, pull-down, edge detection and interrupt generation		Any
General purpose output	Digital output with configurable drive strength, push-pull, or open drain output		Any
Pin disabled	Pin is disconnected from the input and output buffers.	All unconfigured	Any
Timer/ counter	High precision time measurement between two pulses/ pulse counting with interrupt/event generation		Any
Interrupt/ Event trigger	Interrupt/event trigger to software application/ Wake-up event		Any
HIGH/LOW/Toggle on event	Programmable digital level triggered by internal or external events without CPU involvement		Any
ADC input	8/10/12/14-bit analog to digital converter		Any analog
Analog comparator input	Compare two voltages, capable of generating wake-up events and interrupts		Any analog
PWM output	Output simple or complex pulse width modulation waveforms		Any
Serial interfaces	For information about pin assignment restrictions, see also Serial interfaces.		Any

Table 1: GPIO custom functions configuration

Analog interfaces

Eight of the 48 digital GPIOs can be multiplexed with the following analog functions:

- 1x 8-channel ADC
- 1x analog comparator*
- 1x low-power analog comparator*

*Only one of the comparators can be used simultaneously.

ADC

The Analog-to-Digital Converter (ADC) can sample up to 200 kHz using different inputs as sample triggers. Both one-shot conversion and continuous sampling are supported. Table 2 shows the sample speed in correlation to the maximum source impedance. It supports 8/10/12-bit resolution. The ADC includes 14-bit resolution if oversampling is used. Any of the eight analog inputs or **VDD** can be used either as single-ended inputs or differential pairs for measuring the voltage between them.

The ADC supports the full 0 V to **VDD** input range. If the sampled signal level is much lower than **VDD**, it is possible to lower the input range of the ADC to encompass the desired signal and obtain a higher effective resolution. Continuous sampling can be chosen for a configurable time interval, or actively triggered for different internal or external events – without any CPU involvement.

ACQ [us]	Maximum source resistance [kΩ]
3	10
5	40
10	100
15	200
20	400
40	800

Table 2: Acquisition versus source impedance

Comparator

The comparator compares voltages from any analog pin with different references, as shown in Table 3. It supports the full 0 V to **VDD** input range and can generate different software events to the rest of the system. The comparator can operate in one of the following two modes:

- Single-ended Mode: A single reference level or an upper and lower hysteresis selectable from a 64-level reference ladder with a range from 0 V to **VREF**, as described in Table 3.
- Differential Mode: Two analog pin voltage levels are compared, optionally with a ~35 mV hysteresis.

Low power comparator

The low-power comparator operates in the same way as the normal comparator, with reduced functionality. It can be used during system OFF modes as a wake-up source.

Analog pin options

Table 3 shows the supported connections of the analog functions.

☞ An analog pin may not be simultaneously connected to multiple functions.

Symbol	Analog function	Connects to
ADCP	ADC single-ended or differential positive input	Any analog pin or VDD
ADCN	ADC differential negative input	Any analog pin or VDD
VIN+	Comparator input	Any analog pin
VREF	Comparator single-ended mode reference ladder input	Any analog pin, VDD, 1.2 V, 1.8V or 2.4V
VIN-	Comparator differential mode negative input	Any analog pin
LP_VIN+	Low-power comparator IN+	Any analog pin
LP_VIN-	Low-power comparator IN-	GPIO_16 or GPIO_18, 1/16 to 15/16 VDD in steps of 1/16 VDD

Table 3: Possible uses of the analog pin

Serial interfaces

Universal Asynchronous Receiver/Transmitter (UART)

NORA-B106 series modules support up to five UART ports for data communication. Four are available through the application core. One is available through the network core.

The following UART signals are available:

- Data lines (**RXD** as input, **TXD** as output)
- Hardware flow control lines (**CTS** as input, **RTS** as output)

The UART can be used as either a 4-wire UART with hardware flow control or a 2-wire UART with only **TXD** and **RXD**.

Depending on the MCUboot bootloader configuration, one of the UART interfaces on the application core can be used for software upgrades.

The I/O level of the UART follows the VDD voltage and it can thus be in the range of 1.7 V and 3.6 V. A level shifter should be used if connecting NORA-B106 to a host with any other voltage on the UART interface.

Serial Peripheral Interface (SPI)

NORA-B106 supports up to six SPI ports that can operate with a maximum serial clock frequency of 8 MHz in either controller (master) or peripheral (slave) mode. Five are available through the application core. One is available through the network core. The SPI interfaces use the following signals:

- **SCLK**
- **MOSI**
- **MISO**
- **CS**
- **DCX** (Data/Command signal) - This signal is optional but is sometimes used by the SPI slaves to distinguish between SPI commands and data.

When using the SPI interface in controller mode, it is possible to use GPIOs as additional Chip Select (CS) signals to allow the addressing of multiple slaves.

The application core has one high-speed SPI controller (SPIM4) that can run at up to 32 Mbps. For the fastest SPI mode, the pins shown in Table 4 must be used.

Signal	Pin name	Pin number	Direction	Pin drive setting	Description
SCK	P0.08	B106	O	H0H1	Serial clock, up to 32 MHz
MOSI	P0.09	C2	O	H0H1	Serial output data
MISO	P0.10	C1	I	H0H1	Serial input data
CSN	P0.11	B3	O	H0H1	Chip select, active low
DCX	P0.12	A2	O	H0H1	Data/command signal (optional)

Table 4: High-speed SPI dedicated pin assignments (SPIM4)

Quad Serial Peripheral Interface (QSPI)

To increase the memory size for application programs, external memory can be connected to NORA-B106 module through the Quad Serial Peripheral port.

The QSPI is available through the application core and uses dedicated pins for the interface, as shown in Table 5.

Signal	Pin name	Pin number	Direction	Pin drive setting	Description
IO0	P0.13	D2	I/O	H0H1	MOSI serial output data in single mode Data I/O bit 0 in dual/quad mode
IO1	P0.14	E2	I/O	H0H1	MISO serial input data in single mode Data I/O bit 1 in dual/quad mode
IO2	P0.15	D1	I/O	H0H1	Data I/O bit 2 in quad mode
IO3	P0.16	F2	I/O	H0H1	Data I/O bit 3 in quad mode
SCK	P0.17	F1	O	H0H1	Serial clock, up to 96 MHz
CSN	P0.18	E1	O	H0H1	Chip select, active low

Table 5: QSPI dedicated pin assignments

Inter-Integrated Circuit (I2C) interface

NORA-B106 supports up to five I2C ports that can operate in either controller or peripheral modes. Four ports are available through the application core. One port is available through the network core.

The I2C interfaces can be used to transfer or receive data on a 2-wire bus network. NORA-B106 can operate at 100 kbps (standard), 250 kbps, and 400 kbps (fast) transmission speeds. The interface uses the **SCL** signal to clock instructions and transfers data on the **SDA** signal.

External pull-up resistors are required for the I2C interface. The value of the pull-up resistor should be selected depending on the speed and capacitance of the bus. See Electrical specifications in the NORA-B106 series data sheet for recommended resistor values.

One of the application port I2C interfaces can be used in a high-speed mode at 1 Mbps. Dedicated pins are required for this speed.

Signal	Pin name	Pin number	Direction	Pin drive setting	Description
SCL or SDA	P1.02	B4	I/O	E0E1	Either SCL or SDA may be assigned to this pin
SCL or SDA	P1.03	A3	I/O	E0E1	Either SCL or SDA may be assigned to this pin

Table 6: High-speed TWI dedicated pin assignments

☞ Set the pin drive to the S0D1 setting when assigning a I2C port to other pins.

Pulse Width Modulation (PWM) interface

NORA-B106 supports up to four PWM instances, each with four channels. All four instances are available through the application core. The PWM module enables the generation of pulse width modulated signals on GPIO. The module implements an up or up-and-down counter with four PWM channels that drive assigned GPIOs.

Inter-IC Sound (I2S) interface

NORA-B106 supports a single I2S port available on the application core. The I2S module, supports the original two-channel I2S format, and left- or right-aligned formats.

Pulse Density Modulation (PDM) interface

NORA-B106 supports a single PDM interface available through the application core. The PDM module enables input of pulse density modulated signals from external audio frontends, for example, digital microphones. The PDM module generates the PDM clock and supports single-channel or dual-channel (left and right) data input.

USB 2.0 device interface

NORA-B106 supports a single, full-speed (12 Mbps) USB device (peripheral) compliant with version 2.0 of the USB specification. The USB device port is available through the application core.

The pin configuration of the USB interface is as follows:

- **VBUS**, 5 V supply input, required to use the interface
- **USB_DP**, **USB_DM**, differential data pair

The USB interface has a dedicated power supply that requires a 5 V supply voltage for the **VBUS** pin. This allows the USB interface to be used even though the rest of the module might be battery powered or supplied by a 1.8 V supply.

Reserved pins (RSVD)

Do not connect reserved (**RSVD**) pins. The reserved pins are allocated for future interfaces and functionality.

GND pins

Good connection of the module **GND** pins, using a solid ground layer in the host application board, is necessary for correct RF performance. Proper grounding provides a thermal heat sink for the module and reduces the possibility of EMC issues.

Software development

NORA-B106 series modules are used as open CPU modules in which applications developed with the Nordic Semiconductor nRF Connect SDK can be run. The most recent application development guidelines are found at the nRF Connect SDK documentation for application development and working with the nRF53. The following sections in this chapter provide details about Zephyr, MCUboot, and the nRF53 in NORA-B106.

Nordic Semiconductor nRF Connect SDK

With a broad selection of drivers and libraries, the Nordic Semiconductor nRF Connect SDK provides a rich development environment for various devices and applications. The software development kit (SDK) is delivered through the nRF Connect for Desktop application provided by Nordic Semiconductor.

nRF Connect SDK includes the Zephyr Project RTOS, MCUboot secure bootloader, nrfxdrv libraries for the peripherals provided within the nRF5340 chip, and extensions for Microsoft Visual Studio. The SDK can be downloaded from the Nordic Semiconductor website. Visual Studio can be downloaded from the Microsoft website.

After installing the main program, select the following software modules for installation:

- Bluetooth Low Energy – general tool for development and testing with Bluetooth Low Energy
- Toolchain Manager – install and manage tools to develop with the nRF Connect SDK

Other software modules in nRF Connect for Desktop can be useful but are not required for application development.

Toolchain Manager

Application development is done using the suite of tools installed by the Toolchain Manager.

1. Open the Toolchain Manager. Several versions of the nRF Connect SDK are offered. If this is a new install, select the latest one for installation.
2. Select an installation folder. If the default is not used, ensure that no spaces are included in the given folder path.
3. The installation can take several minutes to download and several more to install SES, Git tools, bash shell, a fork of the Zephyr RTOS source code, Nordic's custom source code (nrfxdrv), and MCUboot. While waiting, check the information using the "First steps to build" button. The displayed information is customized to the installation folder chosen above. If the EVK-NORA-B1 development board is used for development, the examples given for the nRF5340 DK (pca_10095) can be used without modification.
4. Once the install is complete, open the IDE.
5. From this point, follow the "First steps to build" instructions presented by the Toolchain Manager and nRF Connect SDK online documentation.

☞ Nordic Semiconductor provides a free, unlimited, commercial license for SES.

Documentation – nRF Connect SDK

Full documentation for the nRF Connect SDK is continually updated on the dedicated nRF Connect SDK documentation website.

Support – Nordic Semiconductor DevZone development forum

For support with questions about the development of software using the nRF Connect SDK, refer to the Nordic Semiconductor DevZone support site. Public discussions and private tickets are available on the site, where the Nordic engineers and forum members respond to all contributions.

Bluetooth device (MAC) address and other production data

NORA-B106 modules are programmed from the factory with a unique, public Bluetooth device address stored in the OTP[0] and OTP[1] registers of the User Information Configuration Registers (UICR) in the application core. The device addresses are duplicated in the CUSTOMER[0] and CUSTOMER[1] registers in the UICR of the network core.

The Bluetooth device address consists of the IEEE Organizationally Unique Identifier (OUI) combined with the hexadecimal digits that are printed within a 2D data matrix, as described in the Labeling and ordering section of the product data sheet.

The Bluetooth device address is stored in little-endian format. The two most significant bytes of the OTP[1] and CUSTOMER[1] registers are unused and assigned the value 0xFF to complete the 32-bit register.

UICR register in application core	Address	Description	Remarks
OTP[0]	0x00FF8100	0xAA = Bluetooth_addr [5]	IEEE OUI[2]
OTP[0]	0x00FF8101	0xBB = Bluetooth_addr [4]	IEEE OUI[2]
OTP[0]	0x00FF8102	0xCC = Bluetooth_addr [3]	IEEE OUI[2]
OTP[0]	0x00FF8103	0xDD = Bluetooth_addr [2]	Example – actual value printed on label
OTP[1]	0x00FF8104	0xEE = Bluetooth_addr [1]	Example – actual value printed on label
OTP[1]	0x00FF8105	0xFF = Bluetooth_addr [0]	Example – actual value printed on label
OTP[1]	0x00FF8106	0xFF	Unused
OTP[1]	0x00FF8107	0xFF	Unused

Table 11: Bluetooth device address in application core

UICR register in network core	Address	Description	Remarks
CUSTOMER[0]	0x01FF8300	0xAA = Bluetooth_addr [5]	IEEE OUI[2]
CUSTOMER[0]	0x01FF8301	0xBB = Bluetooth_addr [4]	IEEE OUI[2]
CUSTOMER[0]	0x01FF8302	0xCC = Bluetooth_addr [3]	IEEE OUI[2]
CUSTOMER[0]	0x01FF8303	0xDD = Bluetooth_addr [2]	Example — actual value printed on label
CUSTOMER[1]	0x01FF8304	0xEE = Bluetooth_addr [1]	Example — actual value printed on label
CUSTOMER[1]	0x01FF8305	0xFF = Bluetooth_addr [0]	Example — actual value printed on label
CUSTOMER[1]	0x01FF8306	0xFF	Unused
CUSTOMER[1]	0x01FF8307	0xFF	Unused

Table 7: Bluetooth device address in network core

NORA-B106 modules are provided from the factory with access port protection and erase protection disabled. This allows reading of the address through the Nordic Semiconductor Command Line Tools and J-Link utilities.

☞ Use the versions of the Nordic Semiconductor Command Line Tools supplied with NCS. These can be accessed by opening a bash or command prompt window through the NCS Toolchain Manager, as shown in Figure 4. This configures the session with the necessary environment variables.

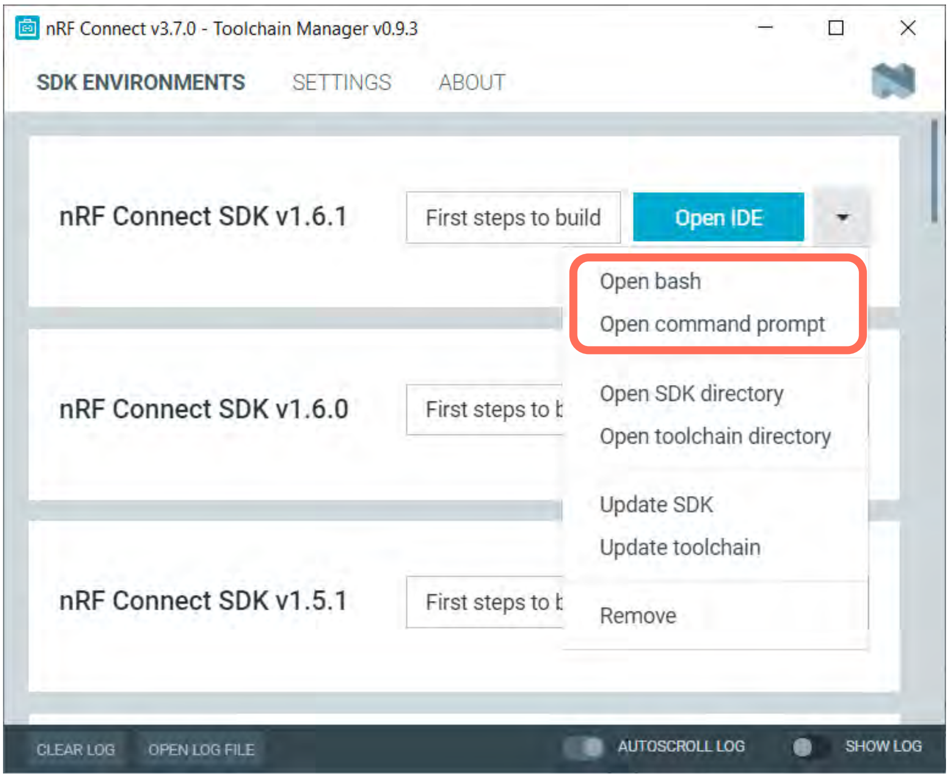

Figure 4: NCS command line selections

Read the Bluetooth device address from both cores with `nrfjprog` using the example values in Table 6 and Table 7.

```
C:\ubx>nrfjprog -f nrf53 –memrd 0x00ff8100 –n 8
0x00FF8100: DDCCBBAA FFFFFFEE                    |…......|

c:\ubx>nrfjprog -f nrf– --coprocessor CP_NETWO– --memrd 0x01ff83– --n 8
0x01FF8300: DDCCBBAA FFFFFFEE                    |........|
```

The Bluetooth device address can also be saved to a binary file using the `savebin` command in the SEGGER J-link tool suite:

```
J-Link>savebin bdaddr.bin, 0x00ff8100, 8
```

☞ When using J-Link, the cores are identified as `NRF5340_XXAA_APP` and `NRF5340_XXAA_NET` when establishing the connection to the application and network cores.

Having a copy of the Bluetooth device address stored in a file is useful when reprogramming each core after a chip erase or recovery.

The entire UICR memory area can hold other valuable information. Use the following command to save the entire UCIR memory area:

```
nrfjprog.e– --readuicr uicr.hex
```

The Bluetooth device address can only be written to the UICR of each core after a recovery or full chip erase. See also Flashing application software for recovery and erasing details. If an electronic copy of the address is not saved, the address may be recovered by scanning the 2D data matrix on the NORA-B106 label. See also the NORA-B106 data sheet.

Writing the Bluetooth device address may be done through the following `nrfjprog` commands following a chip erase or recovery.

```
c:\ubx>nrfjprog -f nrf– --memwr 0x00ff81– --val 0xddccbbaa
c:\ubx>nrfjprog -f nrf– --memwr 0x00ff81– --val 0xffffffee

c:\ubx>nrfjprog -f nrf– --coprocessor CP_NETWO– --memrd 0x01ff83– --val 0xddccbbaa
c:\ubx>nrfjprog -f nrf– --coprocessor CP_NETWO– --memrd 0x01ff83– --val 0xffffffee
```

J-Link may also be used. For the application core:

```
J-Link>loadbin bdaddr.bin, 0x00ff8100
```

For the network core:

```
J-Link>loadbin bdaddr.bin, 0x01ff8300
```

☞ The Bluetooth device address is provided in both cores for convenience. If only one core accesses the address, the other core does not need to be rewritten.

☞ Example programs provided with NCS do not use the programmed public Bluetooth device address. A static random address is used which is derived from the FICR registers. An application must read the public address and set the address with `bt_ctlr_set_public_addr()` in Zephyr or `sdc_hci_cmd_vs_zephyr_write_bd_addr()` in nrfxlib.

Applications

Application and network core projects

When developing for NORA-B106, at least two projects are required, one for each core. For most Bluetooth LE applications, the HCI interface resides on the network core where it operates the radio. The application running on the application core then performs most other functions and communicates with the network core through remote procedure messaging. When working with secured code, an additional project is required for non-secure code.

The application core must be used to configure the GPIO for both cores. Even if all functions operate on the network core, the application core must still be loaded with a minimal application (e.g., a simple `while(1);` loop).

Project folder

The `west build` of NCS is configured in such a way that an application project can be separated from the SDK itself. The development system environment variables contain the path information to the different SDK components. This allows developers to maintain clean, independent application folders for version control purposes.

The file structure of a minimal project looks like this:

```
<home>/app
|
+--- CMakeLists.txt
|
+--- prj.conf
|
+--- board.overlay (optional)
|
+--- src
     |
     +--- main.c
```

Project files for each core, and non-secure domain if used, are placed in separate folders. If an end-product incorporates both secure and non-secure code execution, a third project folder for the non-secure portion is also required.

CMakeLists.txt

As with the BSP, `CMakeLists.txt` instructs west where to find the source code, the Zephyr system, project name, and other application specific options.

prj.conf

`prj.conf` is a `_defconfig` overlay file. This is used to override Zephyr features that may be configured otherwise in the board `_defconfig` file. This allows the resulting code to only contain the necessary features of the application, which reduces the required memory.

board.overlay

`board.overlay` is an optional file. As with `prj.conf`, it is used to enable and disable drivers at a hardware level. For example, if a certain environmental sensor were connected to NORA-B106 over I2C bus, this file would provide additional information required by the sensor's device driver, like the I2C address and signal assignments, for the module to communicate with sensor over the I2C bus.

Source code

The `src` folder contains any source code files for the application. It is not necessary to include a `main.c` file if the Zephyr system initialization feature (SYS_INIT) is used. Initialization code can be called by SYS_INIT, allowing for an orderly system start-up. If a `main()` function is present, Zephyr uses that as an entry point for the application once SYS_INIT is complete.

Example code

NCS provides many samples (examples) to exercise all features of the NORA-B106 modules. Samples that are provided by mainline Zephyr are located in `.\ncs\vX.Y.X\zephyr\samples`. Samples provided from Nordic Semiconductor are located in `.\ncs\vX.Y.Z\nrf\samples`.

For information about installing and using the development tools, see also the EVK-NORA-B106 user guide and MINI-NORA-B106 user guide.

NORA-B106 modules are loaded with a simple application to enable the debug interface in both the application and network cores. EVK-NORA-B106 and MINI-NORA-B106 EVKs are loaded with the `peripheral_lbs` sample on the application core and `hci_rpmsg` sample on the network core.

Design-in

Overview

For optimal integration of NORA-B106 in the final application board, the design guidelines described in this chapter are recommended. Every application circuit must be properly designed to ensure that the related interface functions correctly, but the following topics require special attention during the design of the application device.

1. Module antenna connection: **ANT** pad – NORA-B101 and NORA-B121 only.
   The antenna circuit affects the RF compliance of devices integrating NORA-B101 or NORA-B121 with the applicable certification schemes. Follow the design layout recommendations provided in Antenna interface.
2. Module supply: **VDDH**, **VDD**, and **GND** pins.
   The supply circuit affects the performance of devices integrating NORA-B106 series modules. Follow the PCB design layout recommendations for Supply interfaces.
3. Analog signals: **GPIO.**
   Analog signals are sensitive to noise and should be routed away from high frequency signals.
4. High speed interfaces: **I2C**, **I2S**, **SPI**, **QSPI**, **UART** and **USB** pins.
   High speed interfaces can be a source of radiated noise that can affect compliance with regulatory standards for radiated emissions. Follow the schematic and General high-speed layout guidelines.
5. System functions: **nRESET**, **SWD**, **GPIO** and other system input and output pins.
   Accurate design is required to ensure that the voltage level is well defined during module boot.
6. Other pins: unused GPIO pins should be left open.

Design for NORA family

NORA-B106 is based on the Nordic Semiconductor nRF5340 Bluetooth LE System-on-Chip (SoC). The 10.4 mm x 14.3 mm footprint is common to all NORA-B106 series modules. Future module variants may contain a subset of the NORA footprint to accommodate space-constrained designs.

6.3 Antenna interface

To optimize the radiated performance of the final product, the selection and placement of both the module and antenna must be chosen with due regard to the mechanical structure and electrical design of the end-product. To avoid later redesigns, it is important to decide the positioning of these components at an early phase of the end-product design. Carefully consider the placement of the embedded antenna in NORA-B106.

On-board antenna (NORA-B106)

To reach an optimum operating performance, follow these instructions:

- The module should be placed in the center of an edge of the host PCB, preferably on the longest edge. Placing the module in or near a corner will distort the radiation pattern and reduce performance.
- A large ground plane on the host PCB is a prerequisite for good antenna performance. It is recommended to have the ground plane extending at least 10 mm on the three sides of the module that are not against the edge. See also Figure 5.
- The host PCB should include a full GND plane underneath the entire module, with a ground keep-out under the antenna according to the description in Figure 6.
- NORA-B106 has six extra GND pads under the antenna that need to be connected for good antenna performance. Detailed measurements of the footprint including these extra GND pads can be found in the NORA-B106 series data sheet.
- High / large parts including metal shall not be placed closer than 10 mm to the module antenna.
- The module is designed to accommodate a small amount of material near the antenna, such as thin (1-2 mm) plastic enclosures, with minor effect. A large amount of dielectric material near the antenna area can detune the antenna, reducing performance.
- Ensure all ground pads are well connected to the ground plane via wide traces and/or stitching vias
- Ensure the antenna keep-out is followed on all layers.
- Designs that accommodate the other NORA modules may also use this keep-out area to provide a common host PCB for different antenna arrangements.

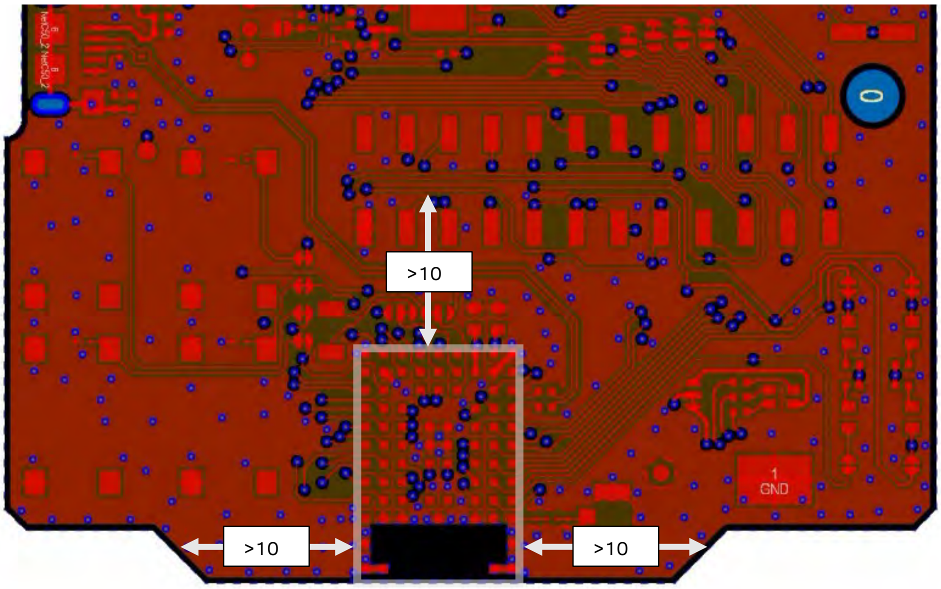

Figure 5: Extend GND plane outside the NORA-B106 and NORA-B126 modules

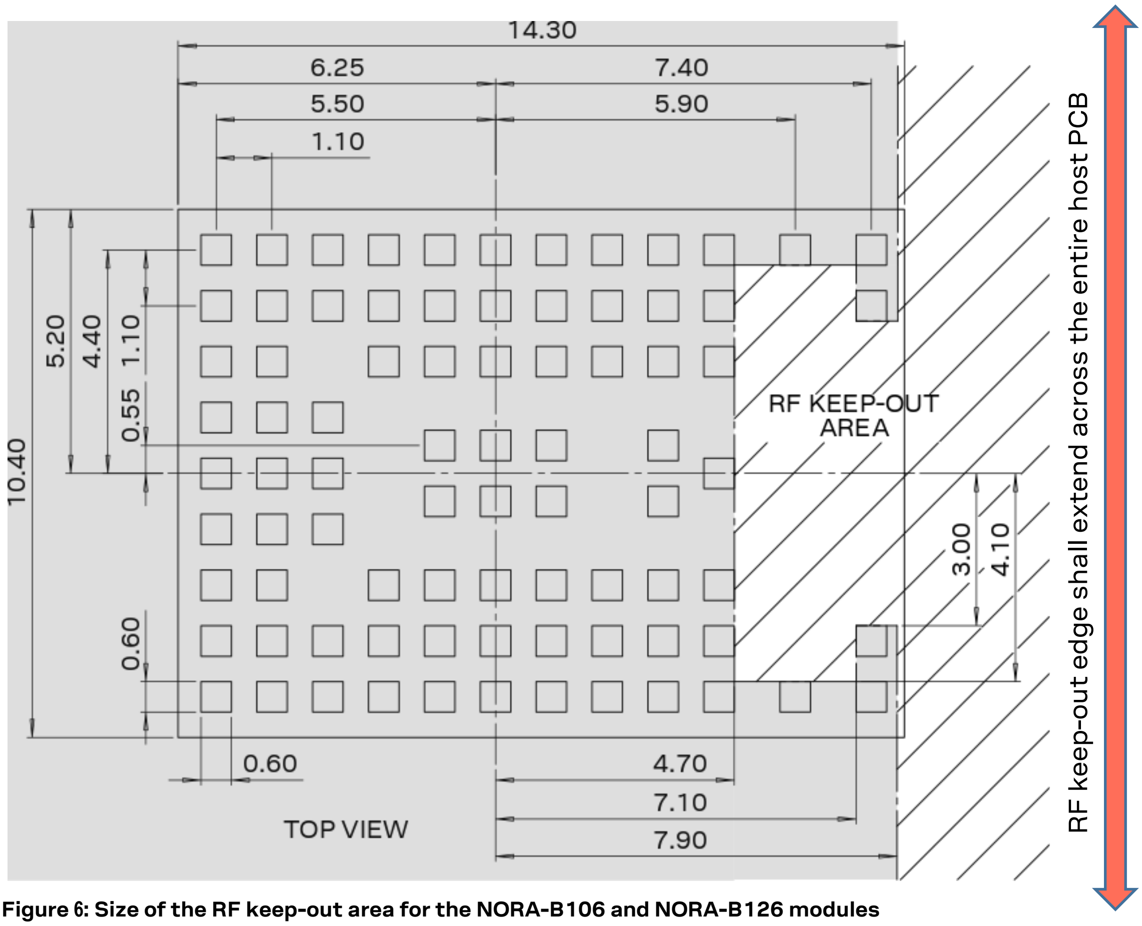

Figure 6: Size of the RF keep-out area for the NORA-B106 and NORA-B126 modules

Supply interfaces

Module supply design

A good connection of the module's **VDD** and/or **VDDH** pins with DC supply source is required for proper module operation. The guidelines are summarized below:

- The **VDD** and **VDDH** connections must be sufficient to support the maximum current of the application.
- The **VDD** and **VDDH** connections must be routed through a PCB area separated from sensitive analog signals and sensitive functional units. It is a good practice to interpose at least one layer of PCB ground between the **VDD** track and other signal routing.

There is no strict requirement for adding bypass capacitance to the supply net close to the module. But depending on the layout of the supply net and other consumers on the same net, r capacitors might still be beneficial. Though the **GND** pins are internally connected, connect all the available pins to solid ground on the application board, as a good (low impedance) connection to an external ground can minimize power loss and improve RF and thermal performance.

Debug interface

NORA-B106 modules support Serial Wire Debug (SWD) and Serial Wire Viewer. When designing a host board with the NORA-B106, the SWD interface must be made available. The module does not contain any software from the factory and to initially flash the module the SWD interface must be used. During software development, a debug connector to the module is useful.

Figure 7 shows the pinout of the 10-pin, 50 mil pitch connector that is used on the EVK-NORA-B106. This is a compact debug header that can be used on a host board design as well. Other solutions such as spring-loaded connectors (e.g., Tag-Connect-pads) or simple test points can be used as well.

Keep in mind that a minimum of four signals are required for the SWD interface to work: **SWDIO**, **SWDCLK**, **GND** and **VDD** reference are needed for the SWD interface to work. **nRESET** and **SWO** are optional, though suggested. Pin 9 connected to GND is only needed when used with an EVK providing an on-board debugger, such as the EVK-NORA-B106.

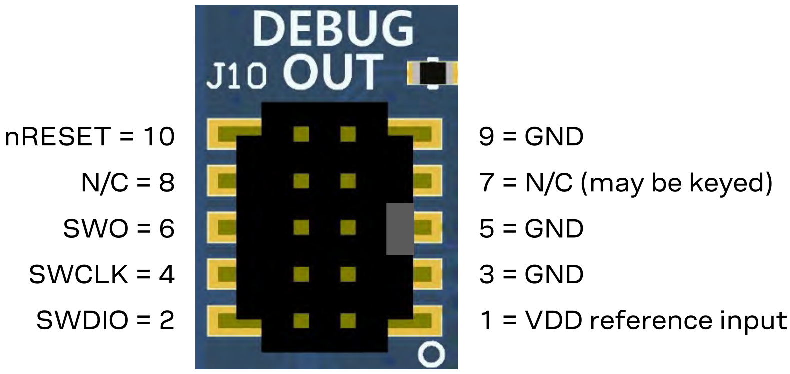

Figure 7: Cortex-M debug connector pin out on EVK-NORA-B106 for SWD

Serial interfaces

UART

The layout of the UART bus should be made so that noise injection and cross talk are avoided.

Use hardware flow control with **RTS/CTS** to prevent temporary UART buffer overrun.

RTS/CTS flow control signals are active low. The UART can transmit when either of these signals are set to “0” (ON state = low level).

- **CTS** is an input to NORA-B106. The module can transmit when the host sets this signal to “0” (ON state = low level).
- **RTS** is an output from NORA-B106. The module sets this signal to “0” (ON state = low level) when it is ready to receive transmission.

USB

The layout of the USB bus should be made so that noise injection and crosstalk are avoided.

The signals **MODUSB_DP** and **MODUSB_DM** have controlled 90 Ω differential-pair impedance.

Power and ground connections from the upstream USB host should be filtered and ESD protected. Figure 8 shows one possible USB power filter circuit.

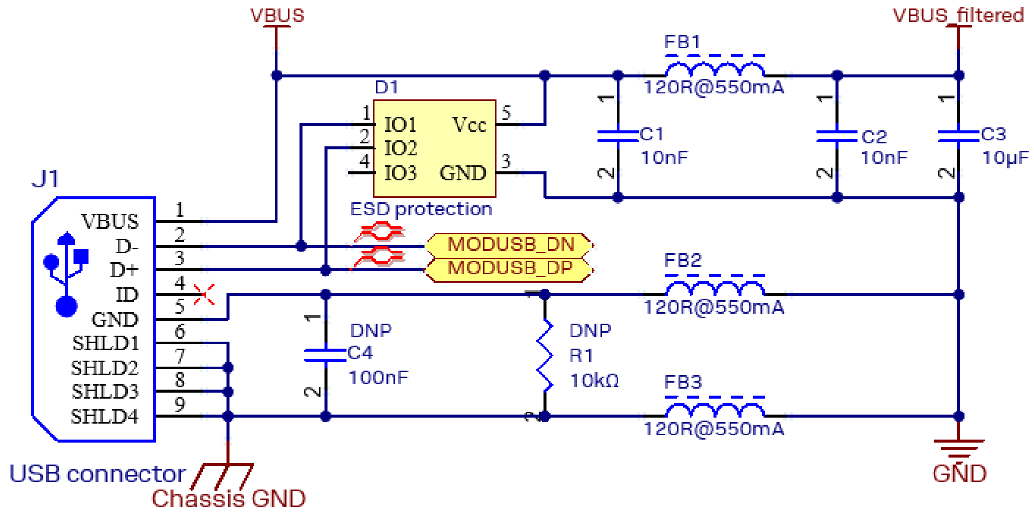

Figure 8: USB device power filtering and signal protection

☞ R1 and/or C4 may only be necessary if EMC tests indicate additional filtering is required. R1 and C4 are marked as do not populate (DNP) here.

☞ USB-IF certified cables are recommended.

SPI, QSPI, I2C, I2S, PDM

The layout of these communication buses should be designed so that noise injection and cross talk are avoided.

General high-speed layout guidelines

These general design guidelines are considered as best practices and are valid for any bus present in NORA-B106 series modules; designers should prioritize the layout of higher speed buses. Low frequency signals are generally not critical for layout.

⚠ One exception is represented by high impedance traces (such as signals driven by weak pull resistors) that may be affected by crosstalk. For those traces, a supplementary isolation of 4w (four times the line width) from other buses is recommended.

General considerations for schematic design and PCB floor-planning

- Verify which signal bus requires termination and add series resistor terminations to the schematics.
- Carefully consider the placement of the module with respect to antenna position and host processor.
- Verify with PCB manufacturer allowable stack-ups and controlled impedance dimensioning.

- Verify that the power supply design and power sequence are compliant with NORA-B106 series module specification described in the NORA-B106 data sheet.

Module placement

⚠ Care should be taken not to place components close to the antenna area. Designers should carefully follow the recommendations from the antenna manufacturer about the distance of the antenna versus other parts of the system. Designers should also maximize the distance of the antenna to high-frequency buses like SPI and related components. Otherwise, consider an optional metal shield to reduce interferences that could be picked up by the antenna and subsequently reduce sensitivity in the module.

- An optimized module placement allows better RF performance. For more information about other antenna considerations during module placement, see also Antenna interface.

Layout and manufacturing

- Avoid stubs on high-speed signals. Even through-hole vias may have an impact on signal quality.
- Verify the recommended maximum signal skew for differential pairs and length matching of buses.
- Minimize the routing length; longer traces degrade signal performance. Ensure that the maximum allowable length for high-speed buses is not exceeded.
- Ensure that impedance matched traces are correctly routed. Consult with the PCB manufacturer early in the project for proper stack-up definition.
- RF and digital sections should be clearly separated on the board.
- Ground splitting is not allowed below the module.
- Minimize the bus length to reduce potential EMI issues from digital buses.
- All traces (including low speed or DC traces) must couple with a reference plane (**GND** or power); high-speed buses should be referenced to the ground plane. In this case, if the designer needs to change the ground reference, an adequate number of **GND** vias must be added near the transition to provide a low impedance path between the two **GND** layers for the return current.
- High-speed buses are not allowed to change reference plane. If a reference plane change is unavoidable, some capacitors should be added in the area to provide a low impedance return path through the different reference planes.
- Trace routing should keep a distance greater than 3w from the ground plane routing edge.
- Power planes should keep a distance from the PCB edge that is sufficient to route a ground ring around the PCB. The ground ring must then be connected to other layers through vias. The ground ring must not violate the antenna keep-out areas.

Module footprint and paste mask

The mechanical outline of the NORA-B106 series module can be found in the NORA-B106 series data sheet. The proposed land pattern layout reflects the pad's layout of the module.

The Non Solder Mask Defined (NSMD) pad type is recommended over the Solder Mask Defined (SMD) pad type, which implements the solder mask opening 50 µm larger per side than the corresponding copper pad.

The suggested paste mask layout for NORA-B106 series modules is to follow the same pad layout 1:1 as described in the NORA-B106 series data sheet.

⚠ These are recommendations only and not specifications. The exact mask geometries, distances, and stencil thicknesses must be adapted to the specific production processes of the customer.

Thermal guidelines

NORA-B106 series modules have been successfully tested from –40 °C to +105 °C. Although NORA-B106 is a low power device that generates only a small amount of heat during operation, proper grounding is necessary for temperature relief during high ambient temperatures.

Handling and soldering

⚠ NORA-B106 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.

ESD handling precautions

⚠ As the risk of electrostatic discharge in the RF transceivers and patch antennas of the module is of particular concern, standard ESD safety practices are prerequisite. See also Figure 9.

Consider also:

- When connecting test equipment or any other electronics to the module (as a standalone or PCB-mounted device), the first point of contact must always be to local GND.
- Before mounting an antenna patch, connect the device to ground.
- When handling the RF pin, do not touch any charged capacitors. Be especially careful when handling materials like patch antennas (~10 pF), coaxial cables (~50-80 pF/m), soldering irons, or any other materials that can develop charges.
- To prevent electrostatic discharge through the RF input, do not touch any exposed antenna area. If there is any risk of the exposed antenna being touched in an unprotected ESD work area, be sure to implement proper ESD protection measures in the design.
- When soldering RF connectors and patch antennas to the RF pin on the receiver, be sure to use an ESD-safe soldering iron (tip).

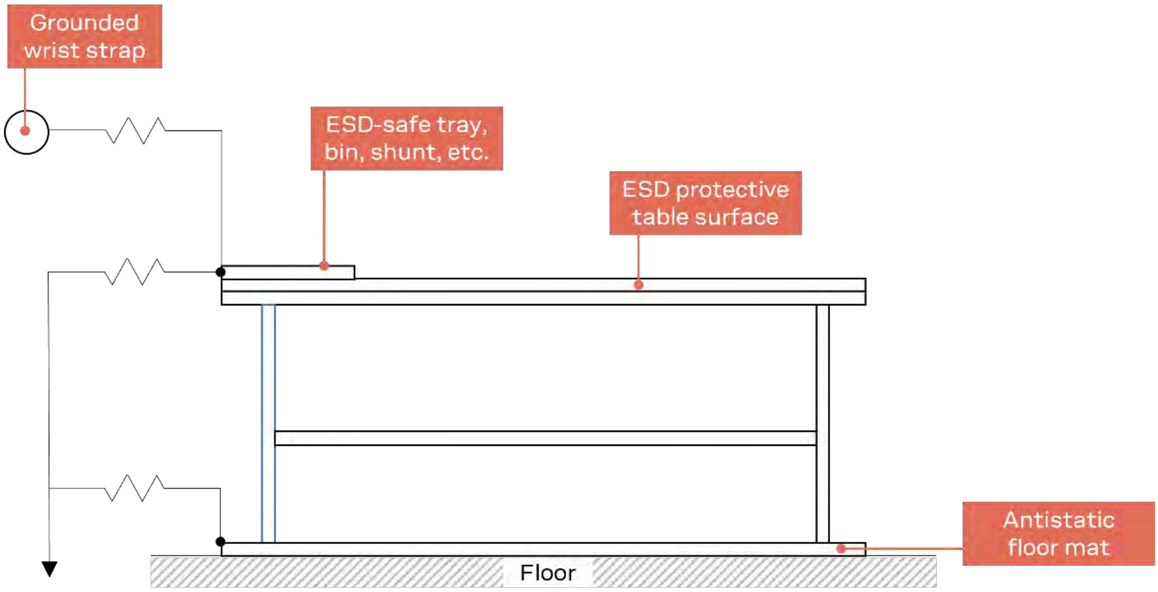

Figure 9: Standard workstation setup for safe handling of ESD-sensitive devices

Packaging, shipping, storage, and moisture preconditioning

For information pertaining to reels, tapes or trays, moisture sensitivity levels (MSL), shipment and storage, as well as drying for preconditioning, see also the NORA-B106 series data sheet and Packaging information guide.

Soldering

☞ No natural rubbers, hygroscopic materials or materials containing asbestos are employed.

Reflow soldering process

NORA-B106 series modules are surface mounted devices supplied on a FR4-type PCB with gold-plated connection pads. The modules are manufactured in a lead-free process using lead-free soldering paste. The thickness of solder resist between the host PCB top side and the bottom side of the NORA-B106 series module must be considered for the soldering process.

NORA-B106 modules are compatible with the industrial reflow profile for common SAC type RoHS solders. No-clean solder paste is strongly recommended. Only one-time reflow processes are allowable for host devices integrating NORA-B1x modules.

The reflow profile used is dependent on the thermal mass of the entire populated PCB, the heat transfer efficiency of the oven, and the type of solder paste that is used. The optimal soldering profile that is used must be trimmed for each case depending on the specific soldering process and PCB layout.

⚠ The parameter target values shown in Table 8 are only general guidelines for a SAC type Pb-free process. The given values are tentative and subject to change. Refer to the JEDEC J-STD-020C standard for further information

Process parameter		Unit	Target
Pre-heat	Ramp up rate to T_{SMIN}	K/s	3
	T_{SMIN}	°C	150
	T_{SMAX}	°C	200
	t_S (from +25 °C)	s	150
	t_S (Pre-heat)	s	60 to 120
Peak	T_L	°C	217
	t_L (time above T_L)	s	40 to 60
	T_P (absolute max)	°C	245
Cooling	Ramp-down from T_L	K/s	4

Table 8: Recommended reflow profile

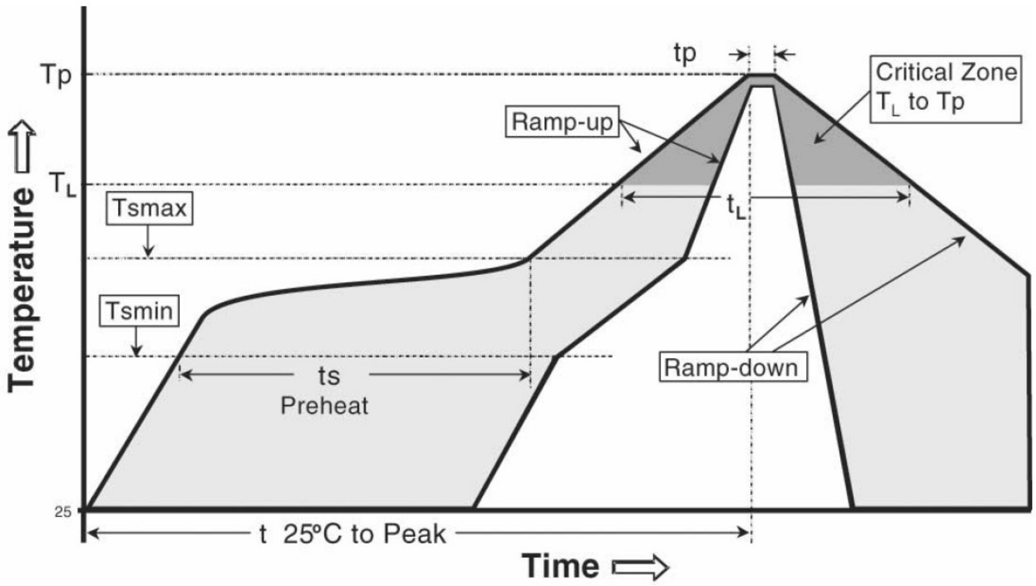

Figure 10: Reflow profile

☞ Lower value of TP and slower ramp down rate (2 – 3 °C/sec) is preferred.

Cleaning

Cleaning the modules is not recommended. Residues underneath the modules cannot be easily removed with a washing process.

- Cleaning with water will lead to capillary effects where water is absorbed in the gap between the host board and the module. The combination of residues of soldering flux and encapsulated water can lead to short circuits or resistor-like interconnections between neighboring pads. Water will also damage the sticker and the inkjet printed text.
- Cleaning with alcohol or other organic solvents can result in soldering flux residues flooding into the housing, an area that is not accessible for post-wash inspections. The solvent will also damage the sticker and the inkjet printed text.
- Ultrasonic cleaning will permanently damage the module and crystal oscillators in particular.

For best results, use a "no clean" soldering paste and eliminate the need for cleaning stage after the soldering process.

Other remarks

- Only a single reflow soldering process is allowed for boards with a module populated on them.
- Boards with combined through-hole (THT) components and surface-mount (SMT) devices may require wave soldering. Only a single wave soldering process is allowed for boards populated with the modules. Miniature Wave Selective Solder processes are preferred over the traditional wave soldering processes.
- Hand soldering is not recommended.
- Rework is not recommended.
- Conformal coating can affect the performance of the module, so it is important to prevent the liquid from flowing into the module. The RF shields do not provide protection for the module from coating liquids with low viscosity, and so care is required in applying the coating. Conformal coating of the module will void the module warranty.
- Grounding metal covers: Attempts to improve grounding by soldering ground cables, wick, or other forms of metal strips directly onto the EMI covers are made at the customer’s own risk and will void the module warranty. The numerous ground pins included in the module design are adequate to provide optimal immunity to interferences.
- Take care when handling the NORA-B106. Applying force to the module might damage the RF shield.
- The module contains components that are sensitive to ultrasonic waves. The use of any ultrasonic processes, such as cleaning, welding, etc., can damage the module. Use of ultrasonic processes on an end-product integrating this module will void the warranty.

Regulatory information and requirements

NORA-B106 modules are certified for use in different regions and countries, such as USA, and Canada. See also the NORA-B106 series data sheet for a list of approved countries/regions where NORA-B106 modules are approved for use. Each market has its own regulatory requirements that must be fulfilled, and NORA-B106 series modules must comply with the requirements for a radio transmitter in each of the listed markets.

In some cases, limitations must be placed on the end-product that integrates a NORA-B106 module to comply with the regulatory requirements. This chapter describes the limitations and requirements that a module integrator must take into consideration. The chapter is divided into different sections for each market. The checklist at the end of this chapter summarizes some of the requirements for each market.

⚠ This information in this chapter reflects u-blox' interpretation of different regulatory requirements of a radio device in each country/region. It does not cover all the requirements placed on an end-product that uses the radio module of u-blox or any other manufacturer.

☞ Regulatory certification and testing have been performed on the following radio functions: Bluetooth LE, and IEEE 802.15.4 functionality.

⚠ Nordic Semiconductor proprietary RF modes have not been tested. Use of the proprietary modes may require additional testing or certification.

FCC/ISED – USA/Canada

Compliance statements – US

Model	FCC ID	ISED Certification Number
NORA-B106	XPYNORAB1	8595A-NORAB1

Table 9: FCC IDs and ISED Certification Numbers for the NORA-B1 series modules

NORA-B106! module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C "Intentional Radiators" modular approval in accordance with Part 15.247 Modular Transmitter approval. Limited module procedures are not applicable.

NORA-B106 module and its antenna(s) must not be co-located or operating in conjunction with any transmitter.

NORA-B106 module complies with Part 15 of the FCC Rules and with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that the interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference using either one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

⚠ NORA-B106 modules are for OEM integrations only. The end-product must be professionally installed in such a manner that only the authorized antennas can be used. See also Antenna selection.

⚠ Any changes to hardware, hosts or co-location configuration may require new radiated emission and SAR evaluation and/or testing. Any changes or modifications NOT explicitly APPROVED by u-blox may cause the NORA-B1 module to cease to comply with the FCC rules part 15 thus void the user's authority to operate the equipment on the US market.

Compliance statements – Canada

NORA-B106

This radio transmitter [IC: 8595A-NORAB1] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed in the Pre-approved antennas list, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Cet émetteur radio [IC : 8595A-NORAB1] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antennes énumérés dans la liste des antennes préapprouvées, avec le gain maximal admissible indiqué. Les types d'antenne non inclus dans cette liste qui ont un gain supérieur au gain maximum indiqué pour tout type répertorié sont strictement interdits pour une utilisation avec cet appareil.

Radio Frequency Exposure Statement for IC: (IC RF Exposure)

The device has been evaluated to meet general RF exposure requirements. The device can be used in mobile exposure conditions. The min separation distance is 20cm.

Déclaration d'exposition aux radiofréquences pour IC:

L'appareil a été évalué pour répondre aux exigences générales en matière d'exposition aux RF. L'appareil peut être utilisé dans des conditions d'exposition mobiles. La distance de séparation minimale est de 20 cm.

Antenna selection

KDB 996369 D03 section 2.5 (trace antenna designs) is not applicable to the NORA-B106 series modules.

End-product verification requirements

⚠ The modular transmitter approval of NORA-B106, or any other radio module, does not exempt the end-product from being evaluated against applicable regulatory demands.

The evaluation of the end-product shall be performed with the NORA-B106 module installed and operating in a way that reflects the intended end-product use case. The upper frequency measurement range of the end-product evaluation is th^{e} 5th harmonic of 2.4 GHz as declared in 47 CFR Part 15.33 (b)(1).

The following requirements apply to all products that integrate a radio module:

- Subpart–B - UNINTENTIONAL RADIATORS
  To verify that the composite device of host and module comply with the requirements of FCC part 15B, the integrator shall perform sufficient measurements using ANSI 63.4-2014.
- Subpart–C - INTENTIONAL RADIATORS
  It is required that the integrator carries out sufficient verification measurements using ANSI 63.10-2013 to validate that the fundamental and out of band emissions of the transmitter part of the composite device complies with the requirements of FCC part 15C.

When the items listed above are fulfilled, the end-product manufacturer can use the authorization procedures as mentioned in Table 1 of 47 CFR Part 15.101, before marketing the end-product. This means the customer must either market the end-product under a Suppliers Declaration of Conformity (SDoC) or to certify the product using an accredited test lab.

End-product labelling requirements

US market

NORA-B106 is assigned the FCC ID number: 2BBOV-NUPULSENXS.

The final host device, into which this RF Module is integrated must be labeled with an auxiliary label stating the FCC ID of the RF Module, such as:

Contains FCC ID: 2BBOV-NUPULSENXS This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: 1. This device may not cause harmful interference, and 2. This device must accept any interference received, including interference that may cause undesired operation.

The following statement must be included in the end-user manual or guide:

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: • Reorient or relocate the receiving antenna. • Increase the separation between the equipment and receiver. • Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. • Consult the dealer or an experienced radio/TV technician for help.

☞ When the device is so small or for such use that it is not practicable to place the statement above on it, the information shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed.

In case where the final product will be installed in locations where the end user is unable to see the FCC ID and/or this statement, the FCC ID and the statement shall also be included in the end-product manual.

Canadian market

The NORA-B106 module is certified for use in Canada under Innovation, Science and Economic Development Canada (ISED) Radio Standards Specification (RSS) RSS-247 Issue 2 and RSSGen. The host product shall be properly labelled to identify the modules within the host product.

The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labelled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, such as:

NORA-B106:

Contains transmitter module IC: 30770-NUPLUSE This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions: 1. This device may not cause interference. 2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le périphérique hôte final, dans lequel ce module RF est intégré "doit être étiqueté avec l'etiquettette auxiliaire indiquant le CI du module RF, tel que:

NORA-B106:

Contient le module émetteur IC: 8595A-NORAB1 L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: 1. L' appareil ne doit pas produire de brouillage; 2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre lefonctionnement.

Integration checklist

The following checklist can be used to get an overview of the requirements of each market. It is in no way a complete list of all actions required but should cover the essentials of integrating a NORA-B106 radio module.

General requirements

☐ The SWD interface cannot be accessed by an end-product user.

Specific to the European market

☐ The EIRP. of the end-product is measured to be within the applicable limit.

☐ A Class-2 limited power source is used to supply the module.

☐ A Declaration of Conformity has been created.

Specific to the US and Canadian markets

☐ The fundamental and out of band emissions of the end-product has been measured and complies with the applicable limits.

☐ An SDoC has been created, or an accredited test lab has been used to certify the end-product.

☐ The end-product labelling requirements are fulfilled.

☐ The end-product documentation requirements are fulfilled. The necessary legal statements are included at a prominent location in the user guide.

Single band antennas

NORA-B106	
Applicable module	NORA-B106
Manufacturer	u-blox (Abracon license)
Gain	+2 dBi
Impedance	N/A
Size	Integrated into module
Type	PCB trace
Comment	PCB antenna on NORA-B106 and NORA-B126. Should not be mounted inside a metal enclosure.
Approval	FCC, ISED, CE-RED, UKCA, MIC, KCC, ANATEL, RCM, NCC, and ICASA