

NORA-W40 series

Stand-alone single band Wi-Fi 6 and Bluetooth® LE modules

System integration manual



Abstract

This manual provides a functional overview combined with best-practice design guidelines for integrating NORA-W40 stand-alone Wi-Fi 6 (802.11b/g/n/ax), Bluetooth Low Energy, Zigbee 3.0 and Thread 1.3 (802.15.4) module in customer applications. Including a powerful microcontroller, MCU, NORA-W40 is intended for custom application software. The module has several important embedded security features, including secure boot, which ensures the module boots with authenticated software only.

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This document applies to the following products:

Product name	Document status
NORA-W401	Early Production Information
NORA-W406	Early Production Information

 For information about the related hardware, software, and status of listed product types, see also the data sheet [\[2\]](#).

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1 Product overview

The NORA-W40 series module comprises small, stand-alone, multiradio modules that integrate a powerful microcontroller, and a radio for wireless Bluetooth® and Wi-Fi communication. With Open CPU architecture, customers can develop advanced applications running on the single core high power 32-bit RISC-V MCU and a low power supplement 32-bit RISC-V MCU. The radio provides support for Wi-Fi 802.11b/g/n/ax in the 2.4 GHz ISM band, Bluetooth® Low Energy (LE), Zigbee 3.0, and Thread 1.3 (802.15.4).

Supporting integrated cryptographic hardware accelerators, NORA-W40 series modules are ideal for Internet of Things (IoT) devices, telematics, low-power sensors, connected factories, connected buildings (appliances and surveillance), point-of-sales, health devices, Artificial Intelligence (AI), facial recognition, and other design solutions that demand top-grade security.

NORA-W40 series modules will be compliant with the Radio Equipment Directive (RED) and certified in Great Britain (UKCA), US (FCC), Canada (IC / ISED RSS), Japan (MIC), Taiwan (NCC), South Korea (KCC), and Australia / New Zealand (ACMA). For the current approval status of certification in each country, see also [Country approvals](#).

NORA-W40 series modules support a temperature range of –40 °C to +85 °C and are qualified according to the u-blox qualification policy based on AEC-Q104 standard for professional grade operation. NORA-W40 modules are qualified against Bluetooth Core 5.3. For further information about the module operating conditions, see the NORA-W40 series data sheet [\[2\]](#).

1.1 Module architecture

NORA-W40 series modules provide developers with the flexibility to select a suitable variant according to the size of the embedded flash memory and the available antenna options.

The variants of NORA-W40 series are described in [Table 1](#).

Variant	Memory configuration	Antenna configuration	Antenna type
NORA-W401-00B	4 MB embedded flash	:2.4 GHz Wi-Fi, 2.4 GHz Bluetooth LE	Antenna pad
NORA-W406-00B	4 MB embedded flash	2.4 GHz Wi-Fi, 2.4 GHz Bluetooth LE	Single embedded PCB antenna
NORA-W401-10B	8 MB embedded flash	2.4 GHz Wi-Fi, 2.4 GHz Bluetooth LE	Antenna pad
NORA-W406-10B	8 MB embedded flash	2.4 GHz Wi-Fi, 2.4 GHz Bluetooth LE	Single embedded PCB antenna

Table 1: Supported configurations of the NORA-W40 series module

2 Module integration

The NORA-W40 series is designed for versatility. When configured as the primary processor in an application, it can operate as a stand-alone solution, efficiently managing a broad range of tasks on its embedded CPU — eliminating the need for additional hardware.

For more advanced applications that require higher processing power or extended functionality, NORA-W40 can also be integrated into a host system with an external CPU operating in coexistence with the module. This enables a scalable design where the NORA-W40 handles wireless communication and essential processing tasks, while the external CPU manages more complex computations..

Figure 1 shows a typical configuration in which NORA-W40 is integrated as the primary processor in a stand-alone solution in the application topology.

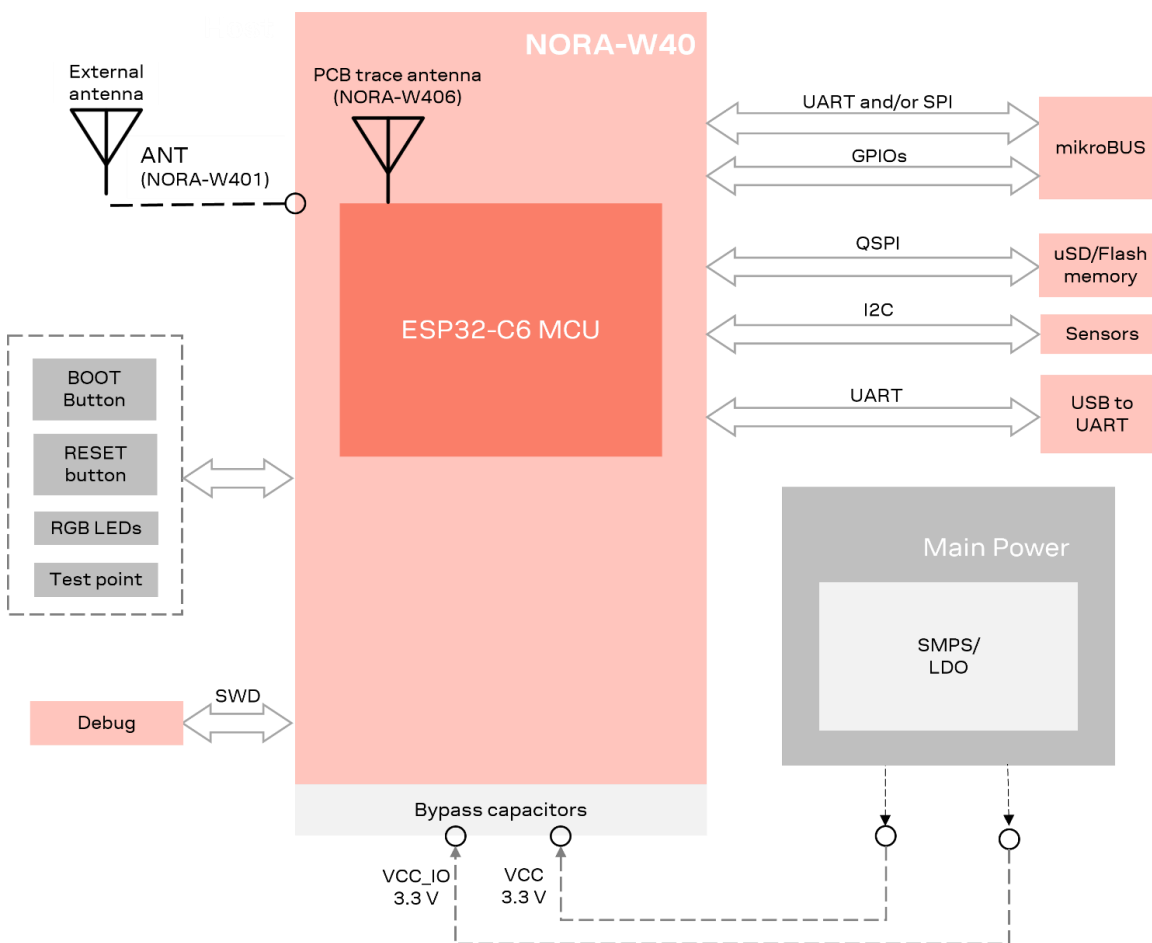


Figure 1: Example of NORA-W40 integrated as a host

Figure 2 shows a typical topology for applications that demand higher processing power or extended functionality, where NORA-W40 is integrated into a host system with an external CPU operating in coexistence with the module.

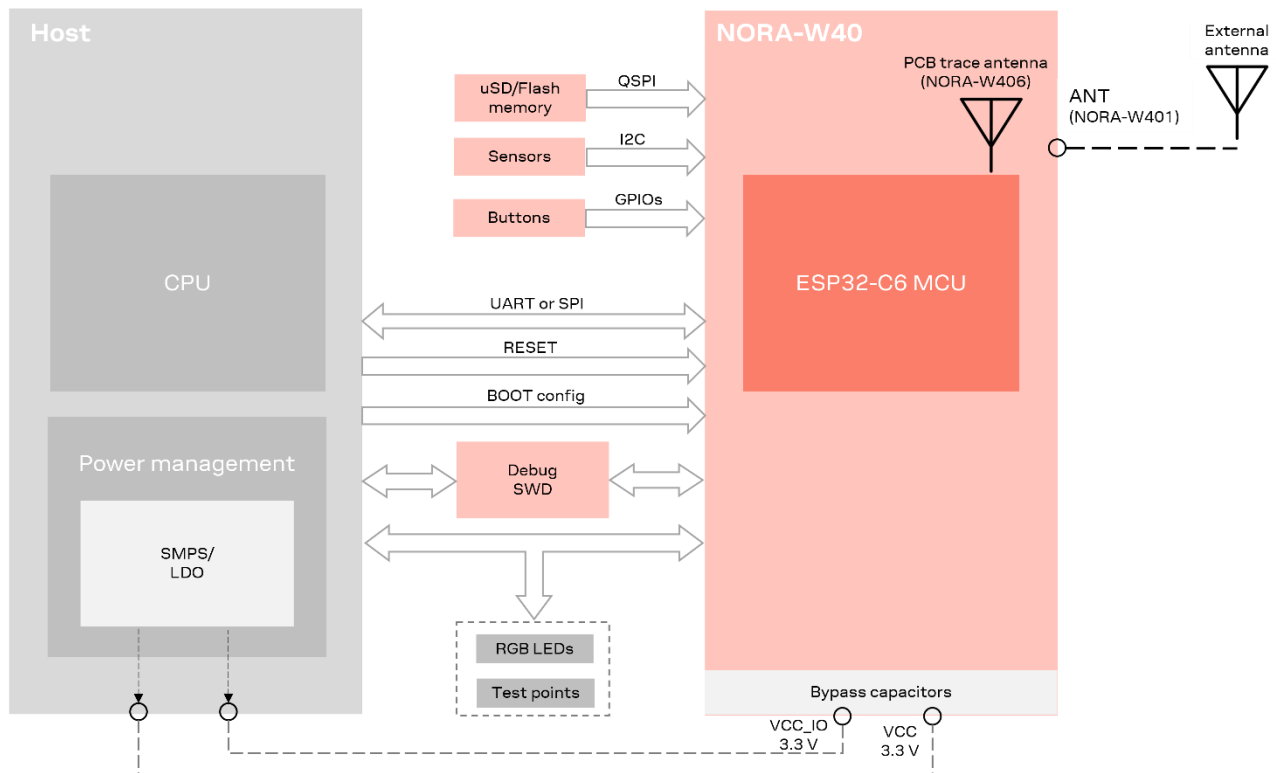


Figure 2: Example of NORA-W40 integrated in a host system with external CPU

2.1 Power supply

The **VCC** and **VCC_IO** pins supply DC power to NORA-W40 series modules.

The power supply circuit must be able to source the peak current of the power modes that consume the highest power. Note that the current drawn from **VCC** and **VCC_IO** can vary significantly depending on which Wi-Fi mode and modulation type is used.

NORA-W40 series modules use an integrated Linear Voltage converter to transform and stabilize the supply voltage applied to the **VCC** pin. The **VCC** and **VCC_IO** pins have a typical Input voltage of 3.3 V with an operating voltage range between 3.3 V and 3.6 V.

2.1.1 Digital I/O interfaces reference voltage (VCC_IO)

NORA-W40 series modules currently support 3.0–3.6 V IO voltage level only.

2.1.2 VCC application circuits

The power for NORA-W40 series modules is applied through the **VCC** pins, which are derived from either of the following sources:

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

An SMPS is the ideal design choice when the available primary supply source is significantly higher than the operating supply voltage of the module. This offers the best power efficiency for the application design and minimizes the amount of current drawn from the main supply source.

When taking VCC supplies from an SMPS, make sure that the AC ripple voltage is kept as low as possible at the switching frequency. Design layouts should focus on minimizing the impact of any high-frequency ringing.

Use an LDO linear regulator for primary VCC supplies that have a relatively low voltage. As LDO regulators dissipate power linearly related to the step-down voltage, LDOs are not recommended for step down of high voltages.

DC/DC efficiency should be regarded as a trade-off between the active and idle duty cycles of an application. Although some DC/DC devices achieve high efficiency at light loads, these efficiencies typically degrade as soon as the idle current drops below a few milliamps. This can have a negative impact on the life of the battery.

If decoupling capacitors are needed on the supply rails, it is best practice to position these as close as possible to the NORA-W40 series module. The power routing of some host system designs makes decoupling capacitance unnecessary.

For electrical specifications, see also the NORA-W40 series data sheet [\[2\]](#).

2.2 CPU and memory

NORA-W40 series modules include a single-core system with a 32-bit HP (High-Performance) RISC-V processor operating at a maximum 160 MHz internal clock frequency. Additionally, an LP (Low Power) 32-bit RISC-V processor resides in the NORA-W40 operating at maximum frequency of 20 MHz. This processor replaces the HP processor during sleep modes or as a supplement in *Active mode* to save power.

The NORA-W40 series module includes the following memories:

320 kB ROM for booting and core functions

512 kB HP SRAM for data and instructions

16 kB LP SRAM that can be accessed by HP CPU or LP CPU and retain data in Deep-sleep mode.

4/8 MB FLASH for code storage, including hardware encryption to protect programs. For information about the flash memory configurations supported in each of the NORA-W40 series module variants, see also [Module architecture](#).

4 kbit EFUSE (non-erasable memory) for MAC addresses, module configuration, flash encryption, and chip ID

2.3 System functions

2.3.1 Power modes

NORA-W40 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 they are not needed, and complex wake up events can be generated from different external and internal inputs.

The following are predefined power modes that power up different combinations of power domains:

Active mode: The HP CPU, RF circuits, and all peripherals are on. The module can process data, receive, transmit, and listen.

Modem-sleep mode: The HP CPU is operational, and the clock speed can be reduced. The wireless connections can be configured to remain active as RF circuits are periodically switched on when required.

Light-sleep mode: The HP CPU and part of peripheral are powered down and can be powered on optionally. The LP CPU and peripherals can be powered on periodically. The module can be woken up via all wake up mechanisms: MAC, host, RTC timer, or external interrupts. Wireless connections can remain active.

Deep-sleep mode: Only LP system is powered on. Wireless connection data is stored in LP memory. For more information about power modes, see the Espressif ESP32-C6 Datasheet [2].

2.3.1.1 Low Power mode with Low Frequency Clock

NORA-W40 series modules do not have an internal low power oscillator (LPO) or low frequency crystal (LXTAL), which is required for low power modes. If low power mode is required, an external high precision, +/- 20 ppm, 32.768 kHz crystal must be connected between pins **X_LP_N** (pin B6) and **X_LP_P** (pin C6).

On EVK-NORA-W40, the crystal is connected to **X_LP_N** (pin B6) and **X_LP_P** (pin C6) using 0 Ω 0402 package resistor configuration, as shown in Figure 3. By default, pin B6 and C6 are configured as GPIOs, which means that R9 and R11 are not installed. To use low power mode, install R9, R11 and uninstall R21, R25.

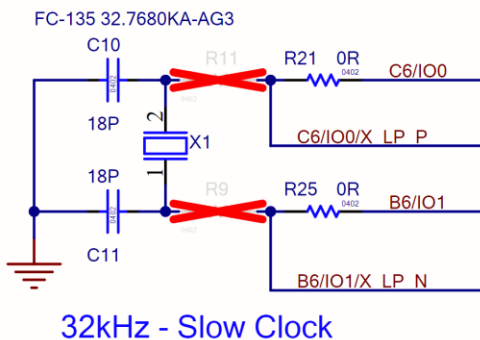


Figure 3: 32 kHz Low Frequency Clock

2.3.2 Module reset

NORA-W40 is reset (rebooted) by setting the **RESET_N** pin to low. **RESET_N** has an internal pull-up resistor setting its default state to high. The low-level input triggers a “hardware reset” of the module. The **RESET_N** signal should be driven by an open drain, open collector, or contact switch. The chip works at the minimum power when **RESET_N** is low (off).

2.3.3 Bootstrap pins

At each startup or reset, module requires some initial configuration parameters, such as in which boot mode to load. These parameters are passed over via the bootstrap pins. After reset, the bootstrap pins operate as regular IO pins. Several module pins related to the boot configuration must be strapped correctly using either pull-up/pull-down resistors, as shown in Table 2.

Use of bootstrap pins as I/O should be avoided if other GPIO pins can be used.

Pin	ESP32-C6 GPIO	State during boot	Description
J8, F7	GPIO8*, GPIO9*	10	Firmware download mode
		11	Normal Boot from internal Flash

*Internally pulled high with a weak pull-up resistor. To set the pin low, use 4.7 k Ω resistors connected to GND.

Table 2: NORA-W40 series bootstrap pins

Pin **F7** (GPIO9 on **ESP32-C6**) is used to enter the ESP bootloader. Consequently, this pin must be exposed to a pin header (or similar) to flash the module.

To enter bootloader mode, make sure that pin **F7** is driven low during power up. To enter ‘Normal boot from internal flash’ mode, assert a reset in bootloader mode.

* Values are referred from ESP32-C6 Series Datasheet [3]

Table 3 describes the critical parameters in the bootstrap timing sequence shown in Figure 4.

Parameter	Description	Min	Max
t_{SU}	Setup time is the time reserved for the power rails to stabilize before the VCC pin is pulled high to activate the chip.	0 ms	-
t_H	Hold time is the time reserved for the chip to read the bootstrap pin values after VCC is already high and before these pins start operating as regular IO pins.	3 ms	-
* V_{IL_nRST}	Reset voltage	-0.3 V	0.825 V
* V_{IH}	High-level input voltage	2.475 V	3.6 V

* Values are referred from ESP32-C6 Series Datasheet [3]

Table 3: Timing Parameters for the bootstrap pins

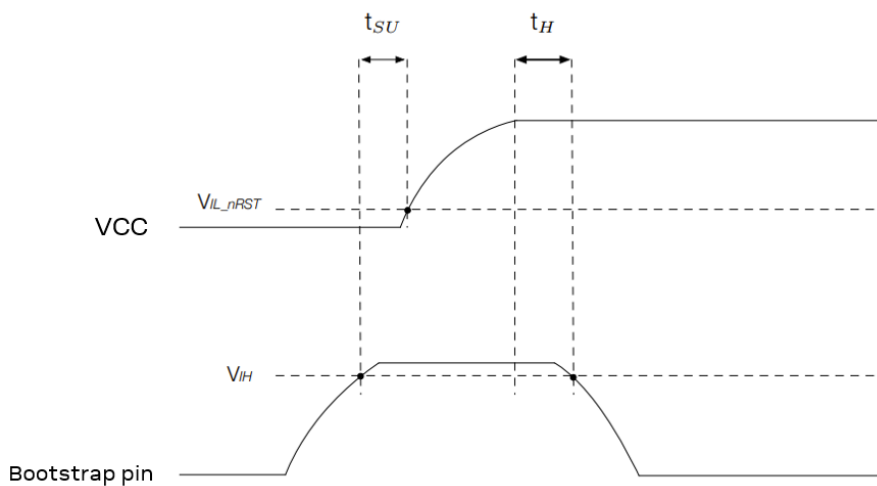


Figure 4: Timing sequence for the bootstrap pins

2.3.4 JTAG signal source

Pin **H9 (GPIO15 on ESP32-C6)** controls the source of JTAG signals during the early boot process, as described in Table 4. This pin is used together with *EFUSE_DIS_PAD_JTAG*, *EFUSE_DIS_USB_JTAG*, and *EFUSE_JTAG_SEL_ENABLE*.

Pin	eFuse			Signal source
H9	*eFuse 1	**eFuse 2	***eFuse 3	
X	0	0	0	JTAG signals come from USB Serial/JTAG Controller
0	0	0	1	JTAG signal from module JTAG pins
1	0	0	1	JTAG signals come from USB Serial/JTAG Controller
X	0	1	X	JTAG signal from module JTAG pins
X	1	0	X	JTAG signals come from USB Serial/JTAG Controller
X	1	1	X	JTAG is disabled

*eFuse 1: EFUSE_DIS_PAD_JTAG

**eFuse 2: EFUSE_DIS_USB_JTAG

***eFuse 3: EFUSE_JTAG_SEL_ENABLE

Table 4: JTAG signal source control

2.4 Antenna integration

The NORA-W40 series supports module variants for use with integrated SMD chip antennas, external antennas, or internal PCB trace antennas.

- NORA-W401 has an antenna pin that can be used with either:
 - Integrated SMD chip antenna
 - External antenna
- NORA-W406 includes an internal PCB trace antenna which is specifically designed and optimized for the NORA-W40 module. There is no need for an RF trace design on the host PCB which means less effort is required in the test lab.

2.4.1 Antenna solutions

Figure 5 summarizes each of the available antenna options.

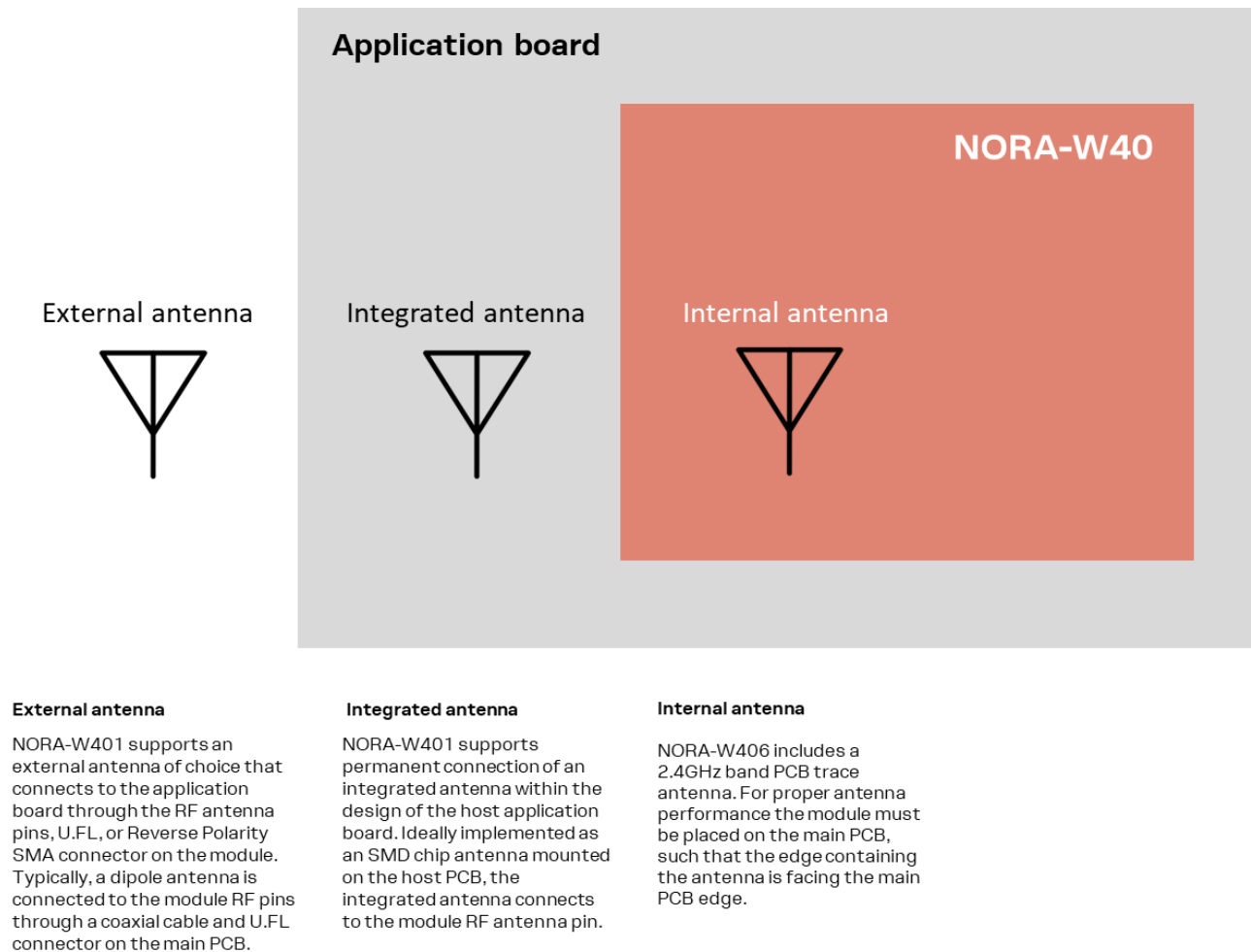


Figure 5: Antenna options

2.4.2 Approved antenna designs

NORA-W40 series modules come with a pre-certified design that can be used to save costs and time during the certification process. To leverage this benefit, designers are required to implement an antenna layout that is fully compliant with the u-blox reference design outlined in this document. Reference design source files are available from u-blox on request.¹

Designers integrating a u-blox reference design into an end-product is solely responsible for any unintentional RF emission generated by the end product.

For Bluetooth and Wi-Fi operation, NORA-W40 modules have been tested and approved for use with the antennas featured in the listed in the [Pre-approved antennas list](#).

To avoid invalidating the compliance and pre-certification of u-blox modules with the various regulatory bodies, use only external antennas included on the [Pre-approved antennas list](#). Reference design source files are available from u-blox on request.

The module may be integrated with other antennas. In which case, the OEM installer must certify the design with respective regulatory agencies, see [General requirements](#).

2.5 Data interfaces

2.5.1 Universal asynchronous serial interface (UART)

NORA-W40 series modules have three UART interfaces: two regular UARTs (UART0, UART1) and one low-power LP UART, for data communication and firmware upgrade. Each interface supports programmable baud rate up to 5 MBaud and provides full-duplex asynchronous communication support. RS485, IrDA standards (with external drivers) and High-speed data communication using GDMA are only available on UART0 and UART1.

Each UART supports the following signals:

- Data lines (RXD as input, TXD as output)
- Frame format configuration:
 - 8 data bits
 - Even or no-parity bit
 - 1 stop bit
 - 115200 bits/s baud rate

Default frame configuration is 8N1 means eight (8) data bits, no (N) parity bit, and one (1) stop bit.

2.5.1.1 Wire mode

All UARTs can be implemented in 4-wire mode with hardware flow control, or in 2-wire mode with TXD and RXD only.



2-wire mode is not recommended as it's often prone to buffer overruns.

2.5.1.2 Upgrades, debugging, and radio testing

The UART0 interface is used for firmware upgrade and is not recommended to be routed to any other pins. It is recommended that you make this interface available through a connector or test points for firmware upgrades, debugging and radio testing purposes. See also [Open CPU Software](#).



The IO level of the UARTs follows **VCC_IO**.

¹ Reference design available only after certification

2.5.2 Serial peripheral interface (SPI)

NORA-W40 supports a single SPI interface, which can operate in *Main* and *Sub* modes. It supports half and full duplex communications.

The available data modes are:

- 1-bit SPI
- 2-bit Dual SPI
- 4-bit Quad SPI

You can route the SPI signals to GPIO pins through the IO MUX, but this reduces the maximum SPI communication speed.

2.5.2.1 Dual/Quad SPI

You can use the dual/quad SPI (2 or 4 bi-bidirectional data signals) for connecting an additional external PSRAM. The SPI to dual/quad SPI signal mappings are described in [Table 5](#).

SPI signal	Dual SPI signal	Quad SPI signal
MOSI	IO0	IO0
MISO	IO1	IO1
WP	-	IO2
HD	-	IO3
CS	CS	CS
CLK	CLK	CLK

Table 5: SPI to dual/quad SPI signal mapping

2.5.3 Inter-Integrated Circuit interface (I2C)

NORA-W40 series modules have two I2C interfaces: one in the main system and another in the Low Power (LP I2C) system. To use I2C interface in LP mode you must implement it using the LP functions described in [Table 6](#).

NORA-W40 can operate both as *Controller* and *Peripheral* on the I2C bus, using both standard (100 kbit/s) and fast (400 kbit/s) transmission speeds.

The LP I2C can only act as a *Controller* and remains operational when the module is in low power mode. The interface uses the LP_I2C_SCL signal to clock instructions and LP_I2C_SDA signal to transfer data.

2.5.4 Low Power IO functions

In *Deep-sleep mode*, several GPIOs, UARTs, and I2C interfaces can become inactive. By using Low Power (LP) IO functions, these interfaces can stay active even in low-power mode. This ensures that critical low-power functions continue to operate and that essential connections are preserved independently of the main peripherals.

LP IO pins can be assigned to LP functions that can work as LP GPIOs or configured as LP data interface signals. Table 6 shows the LP functions of LP IO pin assignments.

Pin	Description	LP IO function	
		Function 1	Function 2
H1	LP UART interface	LP_GPIO5	LP_UART_TXD
H2		LP_GPIO4	LP_UART_RXD
J9		LP_GPIO3	LP_UART_CTSN
E8		LP_GPIO2	LP_UART_RTSN
B6		LP_GPIO1	LP_UART_DSRN
C6		LP_GPIO0	LP_UART_DTRN
B4, J2	LP I2C interface	LP_GPIO6	LP_I2C_SDA
A3, G1		LP_GPIO7	LP_I2C_SCL

Table 6: LP IO functions

2.5.5 Two-wire Automotive Interface (TWAI)

NORA-W40 series modules contain two TWAI controllers, TWAI 0 and TWAI 1. Each controller can individually be connected to a TWAI bus via an external transceiver. The controllers are compatible with ISO 11898-1 protocol (CAN Specification 2.0), which features *message prioritization* and *arbitration*. It supports multi-controller and multi-cast communication with error detection and signaling. The controllers can operate at bit rates of 1 Kbit/s to 1 Mbit/s with 64-byte receive FIFO.

2.5.6 SDIO 2.0 peripheral controller

NORA-W40 series modules contain a SDIO 2.0 peripheral controller, which provides hardware support for SDIO interface. It allows an SDIO host to access the NORA-W40 via an SDIO bus protocol.

The interface supports a clock range of 0 - 50 MHz, SPI, 1-bit SDIO and 4-bit SDIO transfer modes. It is possible to route SDIO signals to other pins via the IO MUX but the communication speed is limited.

 NORA-W40 series modules can't be configured as SDIO host device.

2.6 Digital interfaces

2.6.1 Pulse count controller

The Pulse Count Controller (PCNT) is designed to count input pulses by tracking rising and falling edges of the input pulse signal. NORA-W40 series modules support four independent counters that count between **1–65535** up to a maximum frequency of 40 MHz.

 Any GPIO can be configured as a Pulse count controller.

2.6.2 LED PWM controller

NORA-W40 series modules provide LED PWM Controller (LEDC), which is designed to generate Pulse Width Modulator (PWM) signals for LED control. The LEDC can also be used to generate PWM signals for other purposes. It has six independent PWM generators with maximum duty cycle resolution of 20 bits.

 Any GPIO can be configured as an LED PWM Controller.

2.6.3 Motor control PWM

NORA-W40 series modules have a Motor Control Pulse Width Modulator (MCPWM), which is designed for driving digital motors and smart light. It has three PWM timers for precise timing and frequency control and three PWM operators for generating waveform pairs.

 Any GPIO can be configured as a Motor control PWM.

2.7 Analog interfaces

2.7.1 Analog to digital converter (ADC)

NORA-W40 series modules support one 12-bit SAR Analog to Digital Converters (ADC) capable of measuring analog signals from up to seven channels. Any analog-capable pin can be used for ADC applications. For more about analog-capable pins, see the NORA-W40 series data sheet [\[2\]](#).

For lower power consumption, NORA-W40 modules can measure internal voltages in all sleep modes and threshold settings can be used to wake up the CPU.

 Analog pins can't be re-routed to other pins through the IO MUX.

2.8 Other remarks

2.8.1 No-connect pins (NC)

Do not connect the **NC** pin. No-Connect pins are allocated for future interfaces and functionality.

2.8.2 GND pins

Good electrical connection of module GND pins, using solid ground layer of the host application board, is required for correct RF performance. Firm connections provide a thermal heat sink for the module and significantly reduce EMC issues.

3 Design-in

Follow the design guidelines in this chapter to optimize the integration of NORA-W40 series modules in the final application board.

3.1 Overview

All application circuits must be properly designed, but there are several points that require special attention during application design. In an order of importance, consider:

Module antenna connection: **ANT** pad

- Antenna circuits affect the RF compliance of all applications that include the certification schemes related to the module. To maintain compliance and subsequent certification of the application design, it is important to observe the applicable parts of antenna schematic and layout design described in [Antenna design](#).

Module supply: **VCC**, **VCC_IO**, and GND pins.

- Supply circuits can affect RF performance. It is important to observe the schematic and layout design for these supplies. See also [VCC application circuits](#). Select the appropriate power supply source and bypass capacitors and carefully route the power supply nets or planes. Modules normally include several supply pins described in the pin out of the NORA-W40 data sheet [\[2\]](#).

High-speed interfaces: UART, SPI pins.

- High-speed interfaces are a potential source of radiated noise that can affect the regulatory compliance standards for radiated emissions. It is important to follow the schematic and layout design recommendations described in the [General layout guidelines](#).

System functions: **RESET_N**, GPIO and other system input and output pins

- Careful utilization of these pins in the application design is required to ensure correct boot up and system operation. Ensure that the voltage level is correctly defined during module boot. It is important to follow the schematic and layout design recommendations described in the [General layout guidelines](#).

Other pins: ADC, and NC pins.

- Careful utilization of these pins is required to guarantee proper functionality. It is important to follow the schematic and layout design recommendations described in the [General layout guidelines](#).

3.2 Antenna design

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 product. To avoid later redesigns, it is important to decide the positioning of these components at an early phase of the product design.

Other than the product performance, the compliance and subsequent certification of the RF design depends heavily on the radiating performance of the antennas.

3.2.1 RF interface

The NORA-W40 series comprises several module variants with alternative RF interface options. As a starting point for your application development, choose the one most suited to your application:

- NORA-W406 features an internal PCB trace antenna, which makes it unsuitable for mounting in a metal enclosure. The RF signal is completely internal and not connected to any module pin. When using this variant, avoid using metal casings, plastics with metal flakes, and metallic-based paint or lacquer in your design.
- NORA-W401 provides greater flexibility as it can be implemented together with either an integrated antenna on the application board, or an external antenna that can be positioned farther from the module, which helps reduce potential interference with radio communication.

 To avoid RF disturbance, it is important to position the module with due consideration other radio communication. It can't be mounted arbitrarily.

 According to the FCC regulations, the transmission line from the module antenna pin to the antenna or antenna connector on the host PCB is considered part of the approved antenna design. Therefore, module integrators must either follow exactly one of the antenna reference designs used in the module's FCC type approval or certify their own designs.

3.2.2 Antenna implementation

To ensure proper performance of NORA-W40 modules, carefully follow the guidelines outlined below.

- External antennas, including, linear monopole classes:
 - Place the module and antenna connector in any convenient area on the board. External antennas do not impose any restriction on where the module is placed on the PCB.
 - Select antennas with an optimal radiating performance in the operating bands. The radiation performance depends mainly on the antennas.
 - Choose RF cables that offer minimum insertion loss. Unnecessary insertion loss is introduced by low quality or long cables. Large insertion losses reduce radiation performance.
 - Use a high-quality 50 Ω coaxial connector for proper PCB-to-RF-cable transition.
- Integrated antennas, such as PCB trace Inverted-F, monopole, monopole slot or similar antennas impose physical restrictions on the PCB design:
 - These antennas excite RF currents on its counterpoise. Typical the PCB ground plane of the device becomes part of the antenna and its dimensions define the minimum frequency that can be radiated. Therefore, the ground plane shall never be reduced to a size smaller than a quarter of the wavelength of the minimum frequency that shall be radiated. The placement of the ground plane related to the antenna shall also be considered.
 - When using a module with an integrated antenna, carefully follow the instructions given in the appendix, [Antenna reference design](#). Failure to do this can invalidate the u-blox grant.
 - The wavelength on a PCB, is calculated according: $\lambda = \frac{c}{f\sqrt{\epsilon}}$
 For Bluetooth and Wi-Fi in 2.4 GHz band, $f = 2.4 \text{ GHz}$, the wavelength in free spaces is $\lambda = 12.5 \text{ cm}$, Quarter wavelength $\lambda/4 = 3.125 \text{ cm}$ or about 1.5 cm on a FR4 substrate PCB.
- Choose antennas with optimal radiating performance in the operating bands. Radiation performance depends on the complete product and antenna system design, including the mechanical design and usage of the product. [Table 7](#) summarizes the requirements for the antenna RF interface.

- Make the RF isolation between the system antennas as high as possible, and the correlation between the 3D radiation patterns of the two antennas as low as possible. In general, RF separation of at least a quarter wavelength between the two antennas is required to achieve some isolation and low pattern correlation. If possible, increase the separation to maximize the performance and fulfill the requirements in [Table 7](#).

 To use the pre-certification grant, the integration must follow the antenna implementation reference design.

3.2.3 General antenna requirements

[Table 7](#) specifies general antenna requirements for single antenna designs.

Item	Requirements	Remarks
Impedance	50 Ω nominal characteristic impedance	The impedance of the antenna RF connection must match the 50 Ω impedance of Antenna pins.
Frequency Range	2400 - 2500 MHz	For 802.11b/g/n and Bluetooth.
Return Loss	S11 < -10 dB (VSWR < 2:1) recommended S11 < -6 dB (VSWR < 3:1) acceptable	The Return loss or the S11, as the VSWR, refers to the amount of reflected power, measuring how well the primary antenna RF connection matches the 50 Ω characteristic impedance of antenna pins. The impedance of the antenna termination must match as much as possible the 50 Ω nominal impedance of antenna pins over the operating frequency range, to maximize the amount of power transferred to the antenna.
Efficiency	> -1.5 dB (> 70%) recommended > -3.0 dB (> 50%) acceptable	Radiation efficiency is the ratio of the radiated power to the power fed to the antenna input: the efficiency is a measure of how well an antenna receives or transmits.
Maximum Gain	+3 dBi	Although higher gain antennas can be used, these must be evaluated and/or certified. To comply with regulatory agencies radiation exposure limits, the maximum antenna gain must not exceed the value specified in the Pre-approved antennas list . See also Regulatory compliance .

Table 7: Summary of antenna interface requirements

3.2.4 RF transmission line design

RF transmission line connecting the **ANT** pin to the antenna connectors or antenna, must be designed with a characteristic impedance of 50 Ω .

[Figure 6](#) shows the design options for implementing a transmission line, namely:

- Microstrip – track separated with dielectric material and coupled to a single ground plane.
- Coplanar microstrip – track separated with dielectric material and coupled to both the ground plane and side conductor. This is the most common transmission line implementation.
- Stripline – track separated by dielectric material and sandwiched between two parallel ground planes.

The parameters shown in the cross-sectional area of each trace design include:

- Width (W) – shows the width of the copper layer on the top layer
- Distance (S) – shows the distance between the top copper layer and the two adjacent GND planes.
- Dielectric substrate thickness (H) – shows the distance between the GND reference on the bottom plane and the copper layer on the top layer.
- Thickness of the copper layer (T) – can also be represented by “Base Copper Weight”, which is commonly used as the parameter for PCB stack-up.

Dielectric constant (ϵ_r) defines the ratio between the electric permeability of the material against the electric permeability of free space.

- The width of a 50 Ω microstrip depends on mainly “ ϵ_r ” and “H”, which must be calculated for each PCB layer stack-up.

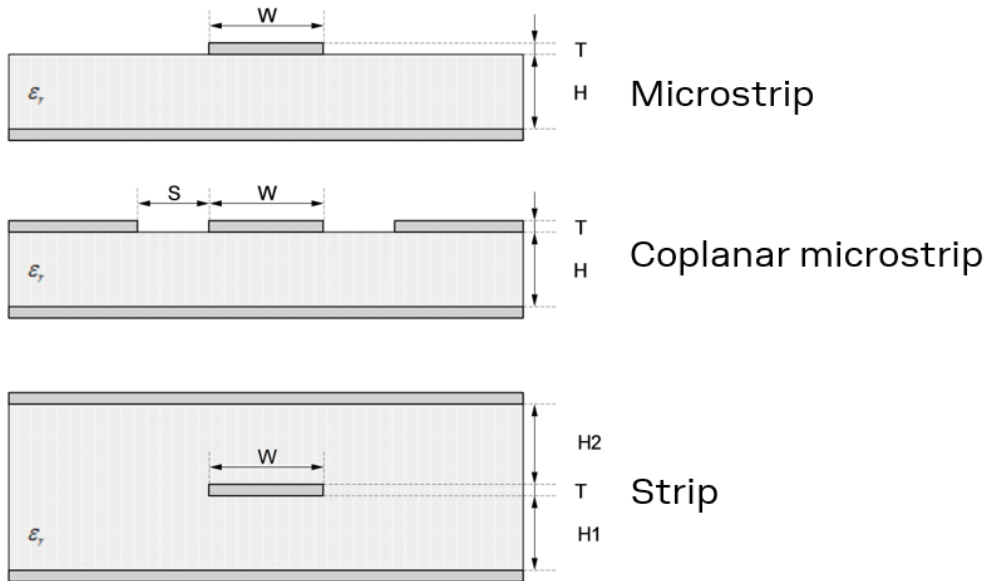


Figure 6: Transmission line trace design

3.2.4.1 Transmission line design guidelines

Follow these recommendations to design a 50 Ω transmission line correctly:

- The designer should provide enough clearance from surrounding traces and ground in the same layer; in general, a trace to ground clearance of at least two times the trace width should be considered. The transmission line should also be “guarded” by ground plane area on each side.
- The characteristic impedance can be calculated as first iteration using tools provided by the layout software. It is advisable to ask the PCB manufacturer to provide the final values that are usually calculated using dedicated software and available stack-ups from production. It could also be possible to request an impedance coupon on panel’s side to measure the real impedance of the traces.
- FR-4 dielectric material, although its high losses at high frequencies can be considered in RF designs provided that:
 - RF trace length must be minimized to reduce dielectric losses.
 - If traces longer than few centimeters are needed, it is recommended to use a coaxial connector and cable to reduce losses
 - Stack-up should allow for thick 50 Ω traces and at least 200 μm trace width is recommended to assure good impedance control over the PCB manufacturing process.
 - FR-4 material exhibits poor thickness stability and thus less control of impedance over the trace length. Contact the PCB manufacturer for specific tolerance of controlled impedance traces.
- The transmission lines width and spacing to the GND must be uniform and routed as smoothly as possible: route RF lines in 45 °C angle or in arcs.
- Add GND stitching vias around transmission lines.
- Ensure solid metal connection of the adjacent metal layer on the PCB stack-up to main ground layer, providing enough vias on the adjacent metal layer.
- Route RF transmission lines far from any noise source (as switching supplies and digital lines) and from any sensitive circuit to avoid crosstalk between RF traces and Hi-impedance or analog signals.

- Avoid stubs on the transmission lines, any component on the transmission line should be placed with the connected pad over the trace. Also avoid any unnecessary component on RF traces.

Figure 7 shows a typical trace and ground design for NORA-W401.

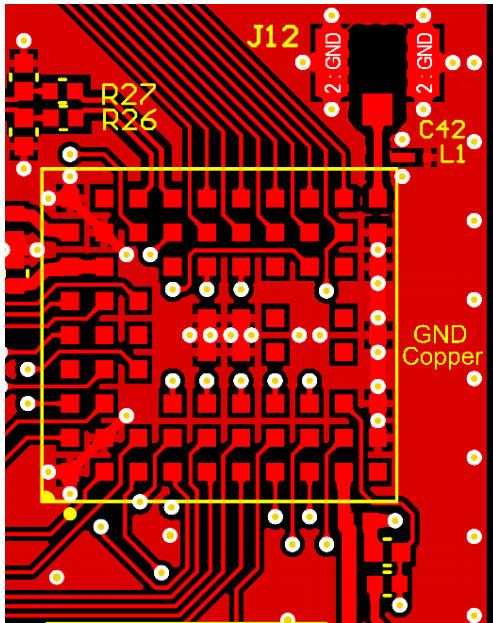


Figure 7: RF trace and ground design example for NORA-W401

3.2.5 NORA-W401

NORA-W401 is best suited for designs where an external antenna is needed due to mechanical integration or placement of the module.

Designers must take care of the antennas from all perspectives at the beginning of the design phase when the physical dimensions of the application board are under analysis/decision, as the RF compliance of the device integrating NORA-W401 module with all the applicable required certification schemes heavily depends on the radiating performance of the antennas. The designer is encouraged to consider one of the u-blox suggested antenna part numbers and follow the layout requirements.

3.2.5.1 RF connector

If an external antenna is required, the designer should consider using a proper RF connector. It is the responsibility of the designer to verify the compatibility between plugs and receptacles used in the design.

Table 8 describes several RF connectors that designers can use to connect antennas via coaxial cables, based on manufacturer specifications.

Manufacturer	Series	Remarks
Hirose*	U.FL® Ultra Small Surface Mount Coaxial Connector	Recommended
I-PEX	MHF® Micro Coaxial Connector	
Tyco	UMCC® Ultra-Miniature Coax Connector	
Amphenol RF	AMC® Amphenol Micro Coaxial	
Lighthouse Technologies, Inc.	IPX ultra micro-miniature RF connector	

* Hirose U.FL-R-SMT RF receptacles (or equivalent parts) require a compatible RF plug from the same connector series. Due to the widespread use of this connector type, multiple manufacturers offer interchangeable equivalents.

Table 8: U.FL compatible plug connector

3.2.5.1.1 Cable assembly

Typically, RF plugs are provided as part of a pre-assembled coaxial cable. Various cable assemblies are available, and designers should choose the most suitable option for their application.

When connecting an antenna with a coaxial cable to an RF connector on the application PCB, whether using an antenna with a pre-assembled coaxial cable or an antenna with an SMA connector and external coaxial cable, consider the following:

- RF plug type: Preferably select U.FL for board-to-board connections or SMA for panel mounting
- Nominal impedance: 50 Ω
- Cable thickness: Typically, 0.8 mm to 1.37 mm. Opt for thicker cables to minimize insertion loss.
- Cable length: Standard lengths are typically 100 mm or 200 mm; custom lengths may be available on request. Select shorter cables to minimize insertion loss.
- RF connector on the module side of the cable: Use either U.FL for board-to-board connection or SMA for panel mounting.

Note that U.FL connectors mounted on PCBs using Surface Mount Technology (SMT) are generally rated for a limited number of insertion cycles. Additionally, RF coaxial cables used with U.FL connectors may be relatively fragile compared to other types of cables. To increase application ruggedness, connect the coaxial cable to a more robust connector, such as an SMA fixed panel connector.

 A de-facto standard for SMA connectors suggests that the use of reverse polarity connectors (RP-SMA) on Wi-Fi and Bluetooth® end products makes it more difficult and less likely that the end user will replace the antenna with higher gain versions and exceed regulatory limits.

3.2.5.1.2 Connector layout

Strictly follow the connector manufacturer's recommended layout:

- SMA Pin-Through-Hole connectors require GND keep-out (clearance/void area) on all the layers around the central pin up to the annular pads of the four GND posts.
- SMA side-mounted connector (or similar): If the RF pad of the connector is wider than the microstrip, remove the GND layer beneath the RF connector. This minimizes stray capacitance and maintains the RF line at 50 Ω .
- U.FL surface mounted connectors require that no conductive traces are placed in the area below the connector between the GND land pads. For more detailed information see [RF trace specification](#).

[Figure 8](#) shows the layout of pads for U.FL connector on the application board or other host PCB. Consider especially the GND clearance under the signal pad.

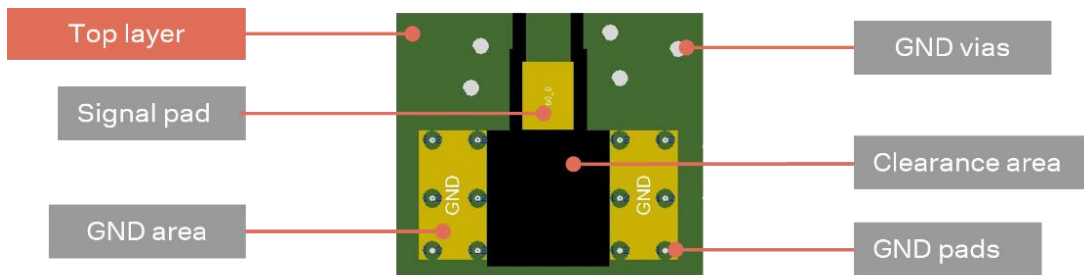


Figure 8: GND keepout on top layer under U.FL connector

3.2.5.2 Integrated antenna design

Observe the following guidelines when using integrated antennas in your application design:

- The antenna design process should start at the beginning of the whole product design process. Self-made PCBs and antenna assemblies are useful in estimating overall efficiency and radiation path of the intended design.
- Use antennas designed by an antenna manufacturer to provide the best possible return loss (or VSWR). Note that the transmission line is terminated by the integrated antennas themselves.
- Provide a ground plane large enough to meet the related integrated antenna requirements. The ground plane of the application PCB may be reduced to a minimum size that must be similar to one quarter of wavelength of the minimum frequency that has to be radiated. However, larger ground planes can improve antenna efficiency.
- Proper placement of the antenna and the surrounding area is also critical for antenna performance. Avoid placing the antenna close to conductive or RF-absorbing parts, such as metal objects, ferrite sheets, and so on. These objects tend to absorb part of the radiated power, shift the resonant frequency of the antenna or affect the antenna radiation pattern.
- To correctly install and deploy the antenna system, including PCB layout and matching circuitry, it is strongly advised that you adhere to the manufacturer's detailed guidelines.
- Further to the custom PCB and product restrictions, antennas may require tuning/matching to comply with all the applicable required certification schemes. It is strongly advised that you consult the antenna manufacturer for specific design-in guidelines and plan validation activities for the final prototypes, such as tuning, matching, and performance assessments.
- Avoid placing the antenna close to buses such as DDR or consider taking specific countermeasures like metal shields or ferrite sheets to reduce interference. Noise sources like hi-speed digital buses can affect the RF section.

 Give due consideration to the interaction between co-located RF systems like LTE sidebands on 2.4 GHz band. Transmitted power can interact or disturb the performance of NORA-W40 series modules.

3.2.6 NORA-W406

NORA-W406 modules include an internal PCB trace antenna that is integrated on the module PCB using antenna technology from Abracon. The RF signal is completely internal and not connected to any module pin.

NORA-W406 modules can't be mounted inside a metal enclosure. Metal casings or plastics that include metal flakes should not be used. Metallic-based paints and lacquers should also be avoided.

3.2.6.1 Internal PCB trace antenna

For optimal operating performance, observe the following layout considerations when developing the antenna layout:

- The module shall be placed in the center of an edge of the host PCB.
- 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 non-edge sides of the module as shown in [Figure 9](#).
- The host PCB shall include a full GND plane underneath the entire module, with a ground cut out under the internal PCB trace antenna on all layers as shown in [Figure 9](#).
- NORA-W406 has six GND pads located close to the antenna that need to be connected to GND for good antenna performance. Detailed measurements of the footprint can be found in the NORA-W40 series data sheet [\[2\]](#).
- Include plenty of stitching vias from the module ground pads to the GND plane layer. Ensure that the impedance between the module pads and ground reference is minimal.

- High / large parts including metal shall not be placed closer than 10 mm to the module's antenna.
- At least 10 mm clearance between the antenna and the casing is recommended. If the clearance is less than 10 mm, the antenna performance can be adversely affected. Polycarbonate (PC) and Acrylonitrile butadiene styrene (ABS) materials have less impact on antenna performance than other types of thermoplastics.
- The module shall be placed such that the antenna faces outwards from the product and is not obstructed by any external items in close vicinity of the products intended use case.

Figure 9 shows a typical trace and ground design for NORA-W406, including the critical dimensions between the ground plane and three non-edge sides of the module.

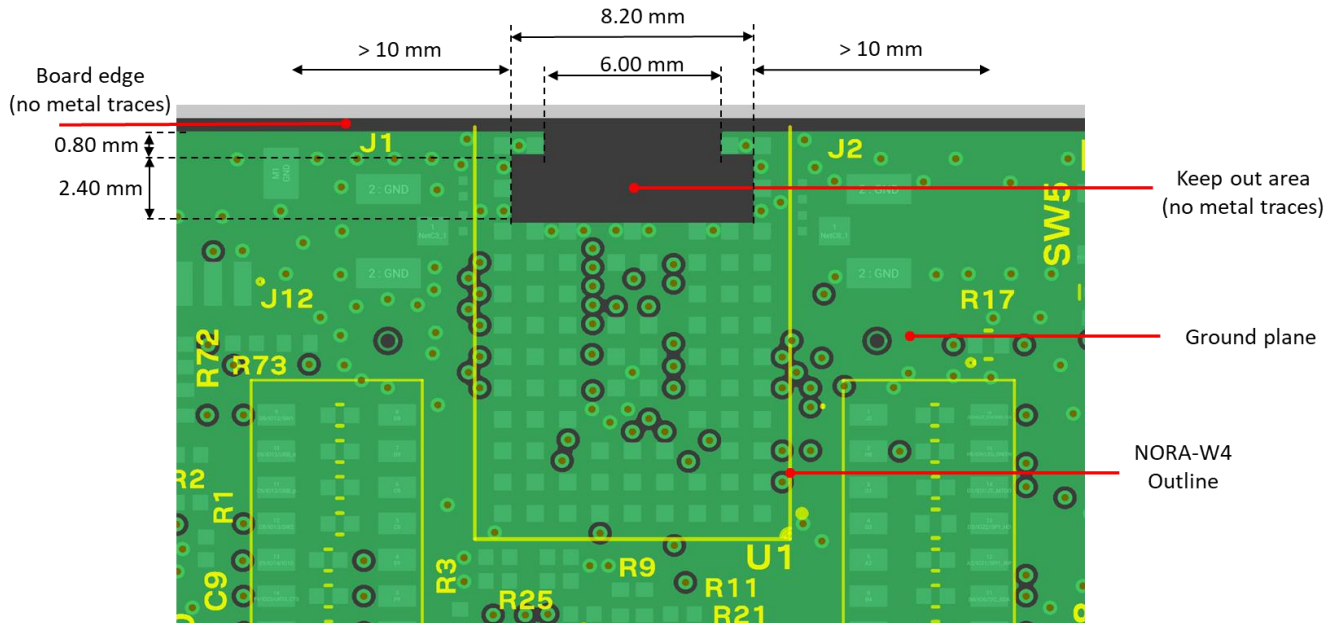


Figure 9: Antenna keepout area and GND plane design

3.3 General layout guidelines

This section describes the best practices for designing the circuit layout of the application.

3.3.1 Considerations for schematic design and PCB floor-planning

- Low frequency signals are generally not critical to the layout and designers should focus on the higher speed buses. One exception to this general rule is when high impedance traces, such as signals driven by weak pull resistors, might be affected by crosstalk. For these and similar traces, a supplementary isolation of 4w (four times the line width) from other buses is recommended.
- Verify which interface bus requires termination and add series resistor terminations to these buses.
- Carefully consider the placement of the module with respect to the antenna position and host processor.
- Verify the controlled impedance dimensions of the selected PCB stack-up. The PCB manufacturer might be able to provide test coupons.
- Verify that the power supply design and power sequence are compliant with module specifications, as described in the NORA-W40 series data sheet [2].

-  Take particular care not to place components close to the antenna area and follow the recommendations from the antenna manufacturer to determine the safe distance between the antenna and any other part of the system. Designers should also maximize the distance between the antenna and high-frequency buses, like DDRs and related components, or consider the use of an optional metal shield to reduce the potential interference picked up by the module antenna.

3.3.2 Component placement

- Place the module such that it provides optimum RF performance. This includes short low loss antenna connections and unobstructed antenna placement. For more information about the module placement and other antenna considerations, see also [Antenna integration](#).
- Place bypass capacitors as close as possible to the module. Prioritize the placement of capacitors with the least capacitance so that these are closest to module pads. The supply rails must be routed through the capacitors from the power supply to the supply pad on the module.
- Do not place components close to the antenna area. Follow the recommendations of the antenna manufacturer to determine distance of the antenna in relation to other parts of the system. Designers should also maximize the distance of the antenna to High-frequency buses, like DDRs and related components. Alternatively, consider an optional metal shield to reduce interferences that might otherwise be picked up by the antenna and subsequently reduce module sensitivity.

3.3.3 Layout and manufacturing

- Avoid stubs on high-speed signals which might adversely affect signal quality. Test points or component pads should be placed over the PCB trace.
- Verify the recommended maximum signal skew for differential pairs and length matching of buses.
- Minimize the routing length. Ensure that the maximum allowable length for high-speed buses is not exceeded. Longer traces generally degrade signal performance.
- For impedance matched traces, consult with your PCB manufacturer early in the project for proper stack-up definition.
- Separate the RF and digital sections of the board.
- Don't split ground layers under the module.
- Couple all traces (including low speed or DC traces) with a reference plane (GND or power), and reference all hi-speed buses against the ground plane. If any ground reference needs to be changed, add an adequate number of GND vias in the area in which the layer is switched. This is necessary to provide a low impedance path between the two GND layers for the return current.
- Don't change the reference plane for Hi-Speed buses. If changes in the reference plane are unavoidable, add capacitors in the transition area of the reference planes. This is necessary to ensure that a low impedance return path exists through the different reference planes.
- Following the "3w rule", keep traces at a distance no less than three times that of its own width from the routing edge of the ground plane.
- For EMC purposes and the need to shield against any potential radiation, it is advisable to add GND stitching vias around the edge of the PCB. Traces on the PCB peripheral are not recommended.

3.4 Module footprint and paste mask

Figure 10 shows the pin layout of NORA-W40 series modules. The proposed land pattern layout complements the pin layout of the module. Both Solder Mask Defined (SMD) and Non-Solder Mask Defined (NSMD) pins can be used with adherence to the following considerations:

All pins should be Non-Solder Mask Defined (NSMD)

- To help with the dissipation of the heat generated by the module, GND pads must have good thermal bonding to PCB ground planes.

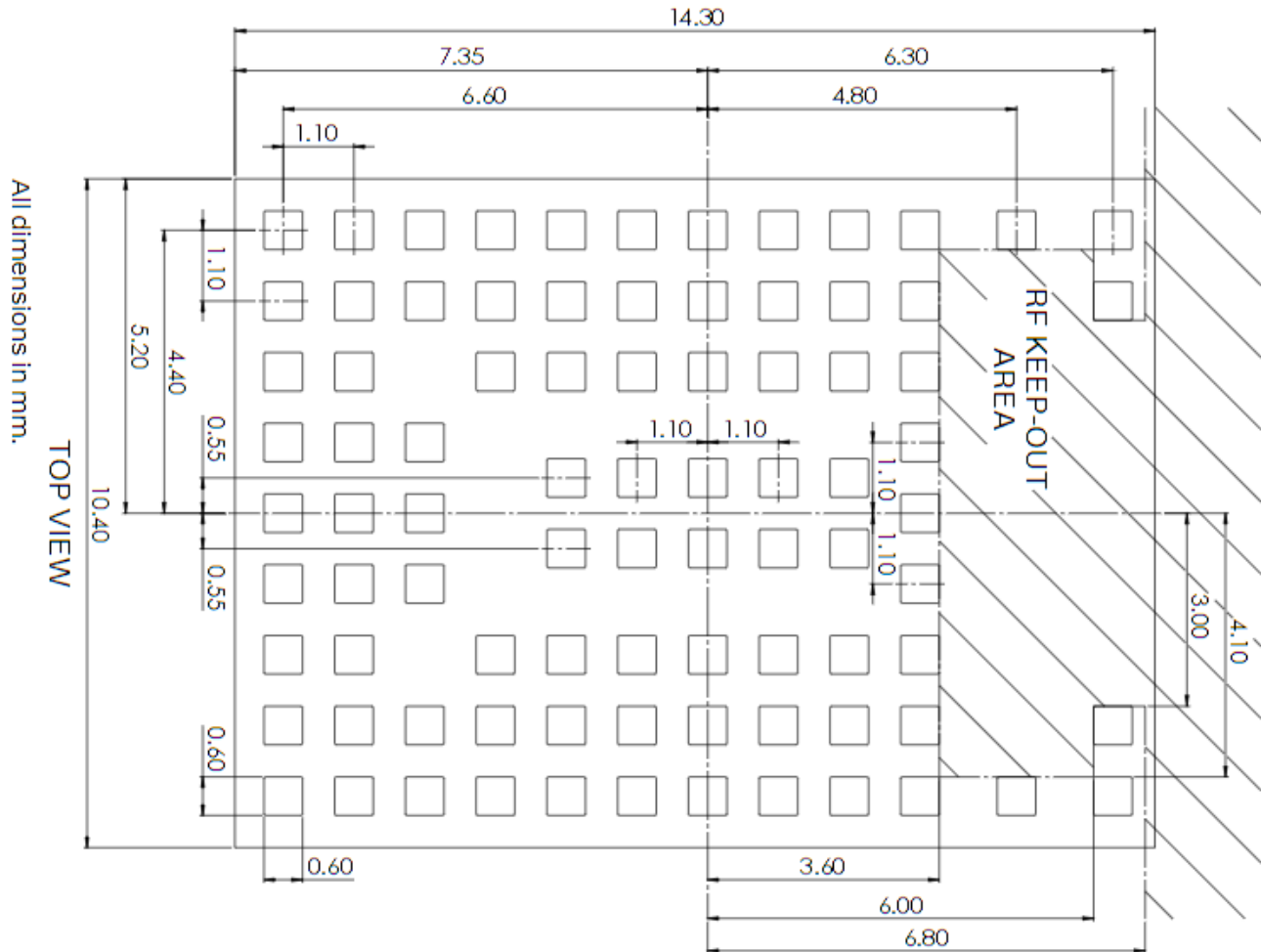


Figure 10: NORA-W40 mechanical outline

The suggested stencil layout for the NORA-W40 series modules should follow the copper pad layout, as shown in Figure 10. The assembly housing should determine the thickness of the solder paste stencil based on the entire host PCB, typically 100-120 μm .

- The RF keep-out area is not required for NORA-W401.

3.5 Thermal guidelines

NORA-W40 series modules are designed to operate in a specified temperature range at an ambient temperature within the enclosure box. The PCB generates heat during high loads that must be dissipated to sustain the lifetime of the components.

The improvement of thermal dissipation in the module decreases its internal temperature and consequently increases the long-term reliability of device applications operating at high ambient temperatures.

For best performance, layouts should adhere to the following guidelines:

- Vias specification for ground filling: 300/600 μ m with no thermal reliefs allowed on vias.
- Ground via densities under the module: 50 vias/cm². Place thermal vias in the gaps between the thermal pads of the module.
- Minimum layer count and copper thickness: 4 layers, 35 μ m.
- Minimum board size: 55x70 mm.
- To optimize the heat flow from the module, avoid crossing the layers of power planes and signal beneath the module.
- Use the following hardware techniques to further improve thermal dissipation in the module and optimize its performance in customer applications:
- Maximize the return loss of the antenna to reduce reflected RF power to the module.
- Improve the efficiency of any component that generates heat, including power supplies and processor, by dissipating it evenly throughout the application device.
- Provide sufficient ventilation in the mechanical enclosure of the application.
- For continuous operation at high temperatures, particularly in high-power density applications or smaller PCB sizes, include a heat sink on the bottom side of the main PCB. The heat sink is best connected using electrically insulated / high thermal conductivity adhesive².

3.6 ESD guidelines

The immunity of devices integrating NORA-W40 modules to Electro-Static Discharge (ESD) is part of the Electro-Magnetic Compatibility (EMC) conformity, which is required for products bearing the CE marking, compliant with the R&TTE Directive (99/5/EC), the EMC Directive (89/336/EEC) and the Low Voltage Directive (73/23/EEC) issued by the Commission of the European Community.

Compliance with these directives implies conformity to the following European Norms for device ESD immunity: ESD testing standard *CENELEC EN 61000-4-2* and the radio equipment standards *ETSI EN 301 489-1*, *ETSI EN 301 489-7*, *ETSI EN 301 489-24*, the requirements of which are summarized in [Table 9](#).

The ESD immunity test is performed at the enclosure port, defined by *ETSI EN 301 489-1* as the physical boundary through which the electromagnetic field radiates. If the device implements an integral antenna, the enclosure port is seen as all insulating and conductive surfaces housing the device. If the device implements a removable antenna, the antenna port can be separated from the enclosure port. The antenna port includes the antenna element and its interconnecting cable surfaces.

² Typically, not required.

The applicability of ESD immunity test to the whole device depends on the device classification as defined by *ETSI EN 301 489-1*. Applicability of ESD immunity test to the related device ports or the related interconnecting cables to auxiliary equipment, depends on the device accessible interfaces and manufacturer requirements, as defined by the *ETSI EN 301 489-1*.

Contact discharges are performed at conductive surfaces, while air discharges are performed at insulating surfaces. Indirect contact discharges are performed on the measurement setup horizontal and vertical coupling planes as defined in the *CENELEC EN 61000-4-2*.

For the definition of integral antenna, removable antenna, antenna port, and device classification, refer to the *ETSI EN 301 489-1*. For the contact and air discharges definitions, refer to *CENELEC EN 61000-4-2*.

Parameter	Min.	Typical	Max.	Unit	Remarks
ESD immunity. All exposed surfaces of the radio equipment and ancillary equipment in a representative configuration			8*	kV	Indirect discharge according to IEC 61000-4-2
ESD sensitivity, tested for all pins except ANT and NC pins			2.0*	kV	Human body model according to JEDEC JS001

* Test pending

Table 9: Electro-Magnetic Compatibility ESD immunity requirements as defined by CENELEC EN 61000-4-2, ETSI EN 301 489-1, ETSI EN 301 489-7, ETSI EN 301 489-24

NORA-W40 is manufactured with consideration to the specific standards for minimizing the occurrence of ESD events. The highly automated process complies with the IEC61340-5-1 (STM5.2-1999 Class M1 devices) standard. Consequently, the designer should implement proper measures to protect from ESD events on any pin that may be exposed to the end user.

Compliance with standard protection level specified in the EN61000-4-2 can be achieved by including the ESD protection in parallel to the line, close to areas accessible by the end user.

3.7 Design-in checklists

3.7.1 Schematic checklist

- ☐ All module pins have been properly numbered and designated on the schematic (including thermal pins) as shown in the pin list of the data sheet [\[2\]](#).
- ☐ All module pins have been properly numbered and designated on the schematic (including thermal pins) as shown in the pin list of the data sheet [\[2\]](#).
- ☐ Power supply design complies with the voltage supply requirement, as described in data sheet [\[2\]](#).
- ☐ Adequate bypassing has been included in front of each power pin, as described in data sheet [\[2\]](#).
- ☐ Each signal group is consistent with its own power rail supply or proper signal translation has been provided. as described in data sheet [\[2\]](#).
- ☐ Configuration pins are properly set at bootstrap, as described in data sheet [\[2\]](#).
- ☐ SDIO bus includes series resistors and pull-ups, if needed.
- ☐ Unused pins are properly terminated.
- ☐ When using an external antenna, A pi-filter is provided in front of each antenna for final matching. See Layout checklist
- ☐ PCB stack-up and controlled impedance traces follow the recommendations given by the PCB manufacturer. See [RF transmission line design](#).
- ☐ All pins are properly connected, and the footprint follows u-blox pin design recommendations. See the solder mask information in the data sheet [\[2\]](#).
- ☐ Proper clearance has been provided between the RF and digital sections of the design.
- ☐ Proper isolation has been provided between antennas (RF co-location, diversity, or multi-antenna design).
- ☐ Bypass capacitors have been placed close to the module. See [Layout and manufacturing](#).
- ☐ Low impedance power path has been provided to the module.
- ☐ Controlled impedance traces have been properly implemented in the layout (both RF and digital) and the recommendations provided by the PCB manufacturer have been followed. See [RF transmission line design](#).
- ☐ 50 Ω RF traces and connectors follow the rules described in [RF connector](#).
- ☐ Antenna design has been reviewed by the antenna manufacturer.
- ☐ Proper grounding has been provided to the module for the low impedance return path and heat sink. See [Layout and manufacturing](#).
- ☐ Reference plane skipping has been minimized for high frequency busses.
- ☐ All traces and planes are routed inside the area defined by the main ground plane.
- ☐ u-blox has reviewed and approved the PCB3.

³ This is applicable only for end-products based on u-blox reference designs.

4 Open CPU Software

4.1 SDK for Open CPU modules

As NORA-W40 Open CPU modules are delivered without flashed software, you develop your application design using the utilities and device-level APIs supported by the module chipset supplier. The ESP-IDF Software Development Kit [\[4\]](#) is available from the Espressif website. It bundles the Wi-Fi stack and the broad range of drivers and libraries necessary for building your development environment.

[Figure 11](#) shows the architecture of NORA-W40 Open CPU software in relation to the MCU, transceiver and ESP-IDF SDK.

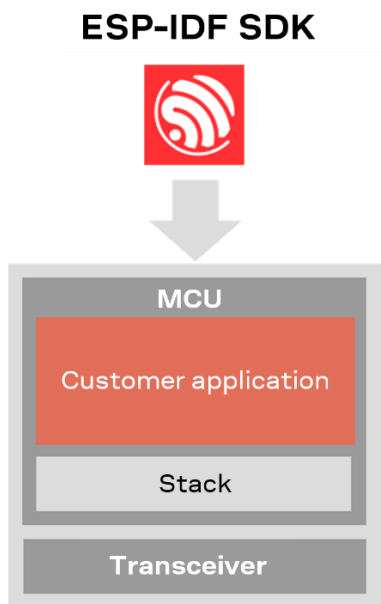


Figure 11: NORA-W40 open CPU software

4.2 Developing and flashing NORA-W40 Open CPU software

It is recommended to make the following pins available through a header or similar connector:

- RESET_N
- U0TXD
- U0RXD
- GPIO9
- MTDO
- MTDI
- MTMS
- MTCK
- USB_D+
- USB_D-

For the Espressif SDK documentation, see also reference [\[5\]](#). This URL provides information on how to set up the software environment using the hardware based on the Espressif ESP32-C6. It also describes how to use the latest ESP-IDF (Espressif IoT Development Framework) – which might have been changed since the publication of this document.

Use the following workflow setup to compile, flash, and execute a program on NORA-W40:

1. [Set up Toolchain and ESP-IDF v5.1 source files](#) Windows, Mac, and Linux are supported.
2. Get ESP-IDF. Download the GIT repository provided by Espressif
3. [Setup path to ESP-IDF](#). The toolchain program can access the ESP-IDF using the `IDF_PATH` environment variable
4. [Build and flash](#). Start a Project, Connect, Configure, Build and Flash a program.

See also the ESP-IDF Programming Guide [\[4\]](#).

4.2.1 Set up Toolchain and ESP-IDF v5.1 source files

 ESP-IDF v5.1+ is mandatory for NORA-W401 and NORA-W406.

Follow the appropriate toolchain instructions to use ESP-IDF v5.1 for your development environment:

[Windows](#)

[Linux and macOS](#)

After installing the appropriate toolchain, install ESP-IDF using the [Get ESP-IDF](#) instructions on the Espressif web site. The toolchain for the ESP-IDF uses the `IDF_PATH` environment variable, which must be set up to build the toolchain projects.

 The source files for Espressif ESP-IDF repository are located on GitHub at:
<https://github.com/espressif/esp-idf>.

4.2.2 Setup path to ESP-IDF

The [Set up Toolchain and ESP-IDF v5.1 source files](#) include the resources to install all the required tools. If you want to install the tools without the help of ESP-IDF Tools Installer, open the Command Prompt in Windows and use the following commands. The toolchain for the ESP-IDF uses the `IDF_PATH` environment variable. This variable must be set up for building the projects.

```
%userprofile%\esp\esp-idf\install.bat esp32c6
%userprofile%\esp\esp-idf\export.bat
```

4.2.3 Build and flash

The environment is now ready to build and flash a project. Use the following procedure to build a sample project. This project prints out “Hello World” ten times on the UART and then reboots.

1. Build the sample project. Go to the “hello world” folder using the following command:

```
cd examples/get-started/hello_world
```

2. Plug in NORA-W40 to the PC and note down the Com Port number with which it is connected. In this example, the Com Port number is assumed to be “COM10”.
3. Enter “idf.py menuconfig” to open the ESP-IDF configuration window.
4. In the ESP-IDF configuration window, select and modify the configuration options to suit your environment.

```
idf.py set-target esp32c6
idf.py menuconfig
```

- In the following example, only the COMPORT that is used to flash NORA-W40 is modified.

```
(Top)
Espressif IoT Development Framework Configuration
SDK tool configuration --->
Build type --->
Application manager --->
Bootloader config --->
Security features --->
Serial flasher config --->
Partition Table --->
Compiler options --->
Component config --->
Compatibility options --->

[Space/Enter] Toggle/enter [ESC] Leave menu [S] Save
[O] Load [?] Symbol info [/] Jump to symbol
[F] Toggle show-help mode [C] Toggle show-name mode [A] Toggle show-all mode
[Q] Quit (prompts for save) [D] Save minimal config (advanced)
```

- Exit the configuration window by pressing “Q” and confirm save the configuration. Now the project is ready to build.
- Before building and flashing, prepare NORA-W40 to accept the downloaded file. Hold the **GPIO0** low while resetting or powering on the board.
- Use the following command to build the application and all ESP-IDF components and generate the bootloader, partition table, and application binaries. After all files are compiled, the application is flashed to the port defined by “-p” and the series monitor starts.

```
idf.py -p COM10 flash monitor
```

The `idf.py` command can be used on different variations with different arguments. For the full options list, enter `idf.py --help`.

4.2.4 ESP-IDF partition table

NORA-W40 flash can contain multiple apps, as well as different kinds of data (calibration data, file systems, bootloader, OTA, and so on). To specify the module flash size as well as which data is allocated in a specific section of the flash, the partition table is used.

When running “menuconfig” under “Partition Table” or `CONFIG_PARTITION_TABLE_TYPE`, few predefined options are available when configuring the project.

For example, “Single factory app, no OTA”:

```
# ESP-IDF Partition Table
# Name, Type, SubType, Offset, Size, Flags
nvs, data, nvs, 0x9000, 0x6000,
phy_init, data, phy, 0xf000, 0x1000,
factory, app, factory, 0x10000, 1M,
```

At a 0x10000 (64 KB) offset in the flash is the app labelled “factory”. The bootloader runs this app by default.

There are also two data regions defined in the partition table for storing NVS library partition and PHY init data.

If the preconfigured options do not include suitable configuration for the project a custom partition scheme can also be set, where addresses and data type are defined. See also “Creating Custom Tables” in the *Espressif ESP-IDF Programming Guide* [4].

4.2.5 Automatic bootloader on NORA-W40 EVK

The “`esptool.py`” flash tool supports automatic entry to the bootloader on the NORA-W40 EVK without pressing the BOOT button to reset the module.

 It is not possible to use the Hardware Flow control or the **DSR** signals on the UART while using this setup.

More information about `esptool` is available at <https://github.com/espressif/esptool>

4.2.6 Output power configuration

To ensure compliance with regulatory output power limits, the module must be configured according to the guidelines given in this section.

The following power configurations for Wi-Fi and Bluetooth Low Energy are only valid for the official `esp-idf` SDK git repositories.

4.2.6.1 Wi-Fi output power configuration

The components required to perform the output power configuration and RF calibration are included (with examples) under the product subfolder in the u-blox SHO-OpenCPU GitHub repository [8].

4.2.6.2 Bluetooth Low Energy output power configuration

No output power configuration for Bluetooth low energy is required. Using the default settings, the module operates at ~6 dBm, which is within the regulatory limit for NORA-W40.

5 Handling and soldering

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

⚠ NORA-W40 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.

5.1 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 12](#).

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, don't 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, don't 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).

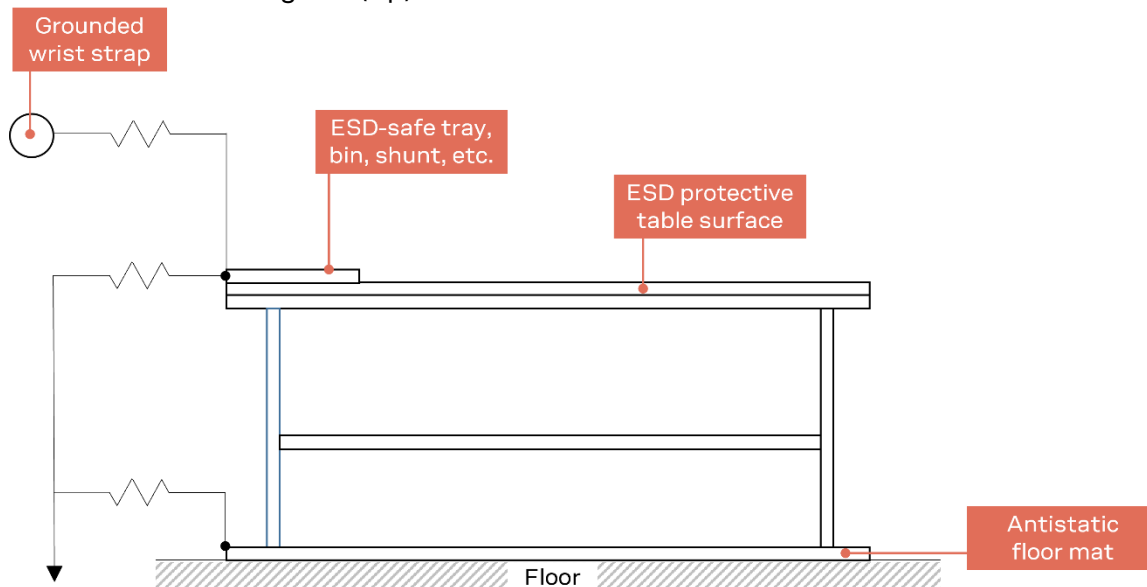


Figure 12: Standard workstation setup for safe handling of ESD-sensitive devices

5.2 Packaging, shipping, storage, and moisture preconditioning

For information pertaining to reels, tapes, or trays, moisture sensitivity levels (MSL), storage, shipment, and drying preconditioning, see the NORA-W40 series data sheet [\[2\]](#) and Product Packaging guide [\[5\]](#).

5.3 Reflow soldering process

NORA-W40 series modules are surface mount modules supplied on a FR4-type PCB with gold plated connection pads and are produced in a lead-free process with a lead-free soldering paste. The thickness of solder resist between the host PCB top side and the bottom side of the NORA-W40 series module must be considered for the soldering process.

- NORA-W40 series modules are compatible with the industrial reflow profile for common SAC type RoHS solders. No-clean soldering paste is strongly recommended. The reflow profile is dependent on the thermal mass over the entire area of the fully populated host 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 target values given in [Table 10](#) and [Figure 13](#) are given as general guidelines for a Pb-free process only. For further information, see also the *JEDEC J-STD-020E standard* [\[6\]](#).

Process parameter		Unit	Value
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
	Allowed soldering cycles	-	2

Table 10: Recommended reflow profile

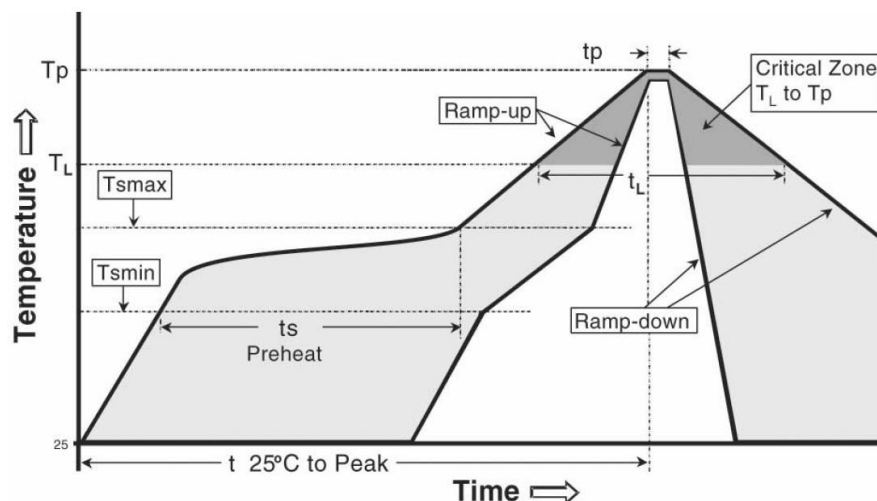


Figure 13: Reflow profile



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

5.3.1 Repeated reflow soldering

For application boards with components on both sides, a two-reflow process may be required. In such cases, NORA-W40 can be mounted in both reflow cycles. To reduce the risk of detachment due to its relatively higher weight compared to other components on the board, it is advisable to place the module on the side of the board that undergoes the final cycle. This reduces the risk of detachment due to its relatively higher weight compared to other components.

Mounting the module in an upside-down position (with the module on the underside of the board during reflow) is not recommended, as this increases the likelihood of detachment.

-  u-blox does not provide warranty coverage for damages to NORA-W40 modules caused by performing more than two total reflow soldering processes (one for mounting the module and one for mounting other components).

5.3.2 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 baseboard and the module. The combination of residues of soldering flux and encapsulated water leads 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 two housings areas that are not accessible for post-wash inspections. The solvent will also damage the sticker and the ink-jet printed text.
- Ultrasonic cleaning will permanently damage the module and crystal oscillators in particular.

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

5.3.3 Other remarks

- Boards with combined through-hole technology (THT) components and surface-mount technology (SMT) devices may require wave soldering to solder the THT components. Only a single, wave-soldering process is allowed for boards populated with the modules. Miniature Wave Selective Solder processes are preferred over traditional wave soldering processes.
- Hand soldering is not recommended.
- Rework is not recommended.
- Conformal coating may affect the performance of the module, 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; therefore, care is required when applying the coating. Conformal coating of the module will void the warranty.
- Grounding metal covers: Attempts to improve grounding by soldering ground cables, wick, or other forms of metal strips directly onto the EMI covers is done at the customer's own risk and will void the module warranty. The numerous ground pins on the module are adequate to provide optimal immunity to interferences.
- The modules contain components that are sensitive to Ultrasonic Waves. Use of any ultrasonic processes, such as cleaning, welding, etc., may damage the module. The use of ultrasonic processes during the integration of the module into an end product will void the warranty.

6 Regulatory compliance

This chapter describes the current approval status of certification in each country and the regulatory requirements that must be met when using NORA-W40 modules in an end product.

 Approvals for the NORA-W40 module series are currently pending. For further information about the current approval status, see *Qualifications and approvals* in the NORA-W40 data sheet [2].

6.1 General requirements

NORA-W40 series modules are designed to comply with the regulatory demands of Federal Communications Commission (FCC), Innovation, Science and Economic Development Canada (ISED)⁴ and the CE mark. This chapter contains instructions on the process needed for an integrator when including the NORA-W40 module into an end-product.

- Any deviation from the process described may cause the NORA-W40 series modules not to comply with the regulatory authorizations of the module and thus void the user's authority to operate the equipment.
- Any changes to hardware, hosts or co-location configuration may require new radiated emission and SAR evaluation and/or testing.
- The regulatory compliance of NORA-W40 does not exempt the end-product from being evaluated against applicable regulatory demands; for example, FCC Part 15B criteria for unintentional radiators [14].
- The end-product manufacturer must follow all the engineering and operating guidelines as specified by the grantee (u-blox).
- NORA-W40 is for OEM integrators only.
- Only authorized antenna(s) may be used. For the list of authorized antennas, see the data sheet [2].
- In the end-product, the NORA-W40 module must be installed in such a way that only authorized antennas can be used.
- The end-product must use the specified antenna reference design as described in [Antenna implementation](#) and [Antenna reference designs](#). A custom trace design can be approved and submitted through C2PC. See [Adding a new antenna for authorization](#).
- Any notification to the end user about how to install or remove the integrated radio module is NOT allowed.
- Electromagnetic interference compatibility (EMI / EMC) and spurious emissions tests are required for end-products targeted for most world regions.
- Region codes must be properly set to comply with regulatory RF output power requirements.

 If these conditions can't be met or any of the operating instructions are violated, the u-blox regulatory authorization will be considered invalid. Under these circumstances, the integrator is responsible for re-evaluating the end-product including the NORA-W40 module. The integrator is then also responsible for obtaining their own regulatory authorization, or u-blox may be able to support updates of the u-blox regulatory authorization.

⁴ Formerly known as IC (Industry Canada).

6.2 European Union (CE)

For information about the regulatory compliance of NORA-W40 series modules against requirements and provisions in the European Union, see the NORA-W40 Declaration of Conformity [9].

6.2.1 Radio Equipment Directive (RED) 2014/53/EU

NORA-W40 series modules comply with the essential requirements and other relevant provisions of Radio Equipment Directive (RED) 2014/53/EU.

6.2.2 Compliance with the RoHS directive

NORA-W40 series modules comply with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

6.2.3 CE end-product regulatory compliance

6.2.3.1 Safety standard

In order to fulfil the safety standard EN 62368-1, NORA-W40 modules must be supplied by an external power supply classified ES1, PS1 according to EN 62368-1.

6.2.4 ETSI Equipment classes

In accordance with Article 1 of Commission Decision 2000/299/EC⁵, NORA-W40 is defined as either Class-1 or Class-2 radio equipment, the end-product integrating NORA-W40 inherits the equipment class of the module.

 For guidance concerning end product marking in accordance with RED go to: <http://ec.europa.eu/>.

 The EIRP of the NORA-W40 module must not exceed the limits of the regulatory domain that the module operates. Depending on the host platform implementation and antenna gain, integrators must limit the maximum output power of the module through the host software. For information about the corresponding maximum transmit power levels, see the Pre-approved antennas list.

6.3 Great Britain regulatory compliance (UKCA)

For information about the regulatory compliance of NORA-W40 series modules against requirements and provisions in Great Britain, see also the NORA-W40 UKCA Declaration of Conformity [10].

6.3.1 UK Conformity Assessed (UKCA)

 The United Kingdom is made up of the Great Britain (including England, Scotland, and Wales) and the Northern Ireland. Northern Ireland continues to accept the CE marking. The following notice is applicable to Great Britain only.

NORA-W40 series modules have been evaluated against the essential requirements of the Radio Equipment Regulations 2017 (SI 2017 No. 1206, as amended by SI 2019 No. 696).

Guidance about using the UKCA marking: <https://www.gov.uk/guidance/using-the-ukca-marking>

6.4 US / Canada (FCC / ISED)

This device complies with Part 15 of the FCC Rules and with Industry Canada license-exempt RSS standard(s).

⁵ 2000/299/EC: Commission Decision of 6 April 2000 establishing the initial classification of radio equipment and telecommunications terminal equipment and associated identifiers.

Any changes or modifications NOT explicitly APPROVED by u-blox AG may cause the module to not comply with the FCC rules part 15 thus void the user's authority to operate the equipment.

Model	FCC ID	ISED certification number
NORA-W401	XPYNORAW4	8595A- NORAW4
NORA-W406	XPYNORAW4	8595A- NORAW4

Table 11: FCC and ISED Certification Number for the NORA-W40 series modules

6.4.1 FCC compliance statements

NORA-W40 modules are for OEM integrations only. The end-product will be professionally installed in such a manner that only the authorized antennas can be used.

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.

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 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.

 NORA-W40 modules are for OEM integrations only. The end product has to be professionally installed in such a manner that only the authorized antennas can be used. See also [Pre-approved antennas list](#).

 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-W40 series 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.

 Any changes or modifications NOT explicitly APPROVED by u-blox AG may invalidate compliance with FCC rules part 15 and subsequently void the user's authority to operate the equipment.

 The end-product manufacturer (OEM integrator) is responsible for verifying the end-product compliance with FCC Part 15, subpart B limits for unintentional radiators through an accredited test facility.

6.4.2 Configuration control and software security of end-products

 "Modular transmitter" hereafter refers to FCC ID.

As the end-product must comply with the requirements addressed by the OET KDB 594280 [11], the host product integrating the NORA-W40 must comply with the following requirements:

- Upon request from u-blox, the host product manufacturer will provide all of the necessary information and documentation to demonstrate how the requirements listed below are met.
- The host product manufacturer will not modify the modular transmitter hardware.
- The configuration of the modular transmitter when installed into the host product must be within the authorization of the modular transmitter at all times and cannot be changed to include unauthorized modes of operation through accessible interfaces of the host product. The Wi-Fi Tx output power limits approved by FCC grant must be followed. In particular, the modular transmitter installed in the host product will not have the capability to operate on the operating channels/frequencies referred to in the section(s) below, namely one or several of the following channels: 12 (2467 MHz), 13 (2472 MHz). The channels 12 (2467 MHz), 13 (2472 MHz), are allowed to be used only for modules that are certified for the usage (“modular transmitter”). Customers must verify that the module in use is certified as supporting DFS client/master functionality.
- The host product uses only authorized firmware images provided by u-blox and/or by the manufacturer of the RF chipset used inside the modular transmitter.
- The configuration of the modular transmitter must always follow the requirements specified in Operating frequencies and cannot be changed to include unauthorized modes of operation through accessible interfaces of the host product.
- The modular transmitter must when installed into the host product have a regional setting that is compliant with authorized US modes and the host product is protected from being modified by third parties to configure unauthorized modes of operation for the modular transmitter, including the country code.
- The host product into which the modular transmitter is installed does not provide any interface for the installer to enter configuration parameters into the end product that exceeds those authorized.
- The host product into which the modular transmitter is installed does not provide any interface to third parties to upload any unauthorized firmware images into the modular transmitter and prevents third parties from making unauthorized changes to all or parts of the modular transmitter device driver software and configuration.

 *OET KDB 594280 D01* [11] lists the topics that must be addressed to ensure that the end-product specific host meets the Configuration Control requirements.

 *OET KDB 594280 D02* [15][15] lists the topics that must be addressed to ensure that the end-product specific host meets the Software Security Requirements for U-NII Devices.

6.4.3 Operating frequencies

NORA-W40 802.11b/g/n operation outside the 2412–2462 MHz band is prohibited in the US and Canada. Configuration of the module to operate on channels 12–13 must be prevented accordingly. The channels allowed while operating under the definition of a master or client device⁶ are described in [Table 12](#).

Channel number	Channel center frequency [MHz]	Allowed channels	Remarks
1 – 11	2412 – 2462	Yes	
12 – 13	2467 – 2472	No	

Table 12: Allowed channel usage under FCC/ISED regulation

⁶ 47 CFR §15.202

6.4.4 RF exposure statement

6.4.4.1 IC compliance

All transmitters regulated by IC must comply with RF exposure requirements listed in *RSS-102 - Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*. This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with Industry Canada's multi-transmitter guidelines. End-users must be provided with transmitter operating conditions for satisfying RF Exposure compliance.

To fulfil the requirements of the SAR evaluation Exemption limits defined in *RSS-102 issue 5*, an OEM integrator implementing NORA-W40 WLAN capability into an end-product must ensure a separation distance of at least 44 mm between the user (or bystander) and the antenna (or radiating element). The separation distance may be reduced to 37 mm in applications where the WLAN capability is turned off and only the Bluetooth LE capability of NORA-W40 is utilized. The separation distance may be reduced to 29 mm in applications where the WLAN capability and the Bluetooth LE capability is turned off and only the IEE 802.15.4 capability of NORA-W40 is utilized.

6.4.4.2 FCC compliance

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

NORA-W40 modules are approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter – except in accordance with FCC multi-transmitter guidelines.

To ensure that the max output power of NORA-W40 remains below the SAR Test Exclusion Threshold defined in *KDB 447498 D01v06*, an OEM integrator implementing NORA-W40 WLAN capability into an end-product must ensure a separation distance of at least 39 mm between the user (or bystander) and the antenna (or radiating element). The separation distance may be reduced to 31 mm in applications where the WLAN capability is turned off and only the Bluetooth LE capability of NORA-W40 is utilized. The separation distance may be reduced to 22 mm in applications where the WLAN capability and the Bluetooth LE capability is turned off and only the IEEE 802.15.4 capability of NORA-W40 is utilized.

 *KDB 996369 D03 section 2.4* (limited module procedures) is not applicable to NORA-W40 series modules.

 *KDB 996369 D03 section 2.5* (trace antenna designs) is not applicable to NORA-W40 series modules.

6.4.5 End-product user manual instructions

6.4.5.1 ISED compliance

The NORA-W40 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 final host device, into which this RF Module is integrated, has to be labeled with an auxiliary label stating the IC of the RF Module, such as "Contains transmitter module IC: 8595A- NORAW4"

 Le périphérique hôte final, dans lequel ce module RF est intégré "doit être étiqueté avec une étiquette auxiliaire indiquant le CI du module RF, tel que "Contient le module émetteur IC: 8595A- NORAW4"

 This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-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.

 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'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

6.4.6 End-product labeling requirements

6.4.6.1 ISED Compliance

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, as shown in [Figure 14](#).

Le produit hôte devra être correctement étiqueté, de façon à permettre l'identification des modules qui s'y trouvent.

L'étiquette d'homologation d'un module d'Innovation, Sciences et Développement économique Canada devra être posée sur le produit hôte à un endroit bien en vue, en tout temps. En l'absence d'étiquette, le produit hôte doit porter une étiquette sur laquelle figure le numéro d'homologation du module d'Innovation, Sciences et Développement économique Canada, précédé du mot « contient », ou d'une formulation similaire allant dans le même sens et qui va comme suit:

This device contains FCC ID: XPYNORAW4 IC: 8595A- NORAW4

Figure 14: Example of an end-product label

6.4.6.2 FCC Compliance

For an end product that uses the NORA-W40 modules, there must be a label containing, at least, the information shown in [Figure 14](#).

The label must be affixed to an exterior surface of the end product such that it will be visible upon inspection in compliance with the modular approval guidelines developed by the FCC.



In accordance with 47 CFR § 15.19, the end product shall bear the following statement in a conspicuous location on the device:

"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.*"*

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 cases where the final product will be installed in locations where the end-user is not able to see the FCC ID and/or this statement, the FCC ID and the statement shall also be included in the end-product manual.

6.4.7 End-product compliance

6.4.7.1 General requirements

- Any changes to hardware, hosts or co-location configuration may require new radiated emission and SAR evaluation and/or testing.
- The regulatory compliance of the NORA-W40 modules does not exempt
- Only authorized antenna(s) may be used.
- Any notification to the end user about how to install or remove the integrated radio module is NOT allowed.
- The approval of the modular transmitter in NORA-W40 series modules does not exempt the end product from being evaluated against any applicable regulatory demands. The evaluation of the end product shall be performed with the NORA-W40 module installed and operating in a way that reflects the intended use case of the end product. The upper frequency measurement range for the end product evaluation is the 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 complies with the requirements of FCC part 15B the integrator shall perform sufficient measurements using equipment compliant with ANSI 63.4-2014.
 - Subpart C - INTENTIONAL RADIATORS
The integrator must carry out sufficient verification measurements, using compliant ANSI 63.10-2013 equipment, to validate that the fundamental and out-of-band emissions of the transmitter part of the composite device comply with the requirements of FCC part 15C.
- When the items listed above are fulfilled, the end product manufacturer can use the authorization procedures mentioned in Table 1 of 47 CFR Part 15.101, before marketing the end product. This means the customer has to either market the end product under a Suppliers Declaration of Conformity (SDoC) or to certify the product using an accredited test lab.

6.4.7.2 Co-location (simultaneous transmission)

If the module is to be co-located with another transmitter, additional measurements for simultaneous transmission is required. The results must be added to the grant file as a Class II Permissive Change.

6.4.7.3 Adding a new antenna for authorization

If the authorized antennas and/or antenna trace design cannot be used, the new antenna and/or antenna trace designs must be added to the grant file. This is done by a Class I Permissive Change or a Class II Permissive Change, depending on the specific antenna and antenna trace design.

- Antennas of the same type and with less or same gain as an already approved antenna can be added under a Class I Permissive Change.
- Antenna trace designs deviating from the u-blox reference design and new antenna types are added under a Class II Permissive Change.

 Integrators who want to refer to the u-blox FCC ID / IC certification ID should [contact](#) their local support team to discuss the Permissive Change Process. Class II Permissive Changes will be subject to NRE costs.

6.5 Japan radio equipment compliance

 Approvals are pending for NORA-W40 series modules.

6.5.1 Compliance statement

NORA-W40 series modules comply with the Japanese Technical Regulation Conformity Certification of Specified Radio Equipment (ordinance of MPT N°. 37, 1981), Article 2, Paragraph 1:

Item 19 "2.4 GHz band wide band low power data communication system".

6.5.2 End product labelling requirement

End products based on NORA-W40 series modules and targeted for distribution in Japan must be affixed with a label with the "Giteki" marking, as shown in [Figure 15](#). The marking must be visible for inspection.



Figure 15: Giteki mark R and NORA-W40 MIC certification number

6.5.3 End product user manual requirement

As the MIC ID is not included on the NORA-W40 marking, the end product manufacturer must include a copy of the NORA-W40 Japan Radio Certificate in the end product technical documentation.

6.6 NCC Taiwan compliance

 Approvals are pending for NORA-W40 series modules.

6.6.1 Taiwan NCC Warning Statement

取得審驗證明之低功率射頻器材，非經核准，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

低功率射頻器材之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前述合法通信，指依電信管理法規定作業之無線電通信。低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。應避免影響附近雷達系統之操作。

系統廠商應於平台上標示「本產品內含射頻模組：XXXyyyLPDzzzz-x」字樣

Statement translation:

- Without permission granted by the NCC, any company, enterprise, or user is not allowed to change frequency, enhance transmitting power, or alter original characteristic as well as performance to an approved low power radio-frequency device.

- The low power radio-frequency devices shall not influence aircraft security and interfere legal communications; If any interference is found or suspected, the user shall immediately cease operating the equipment until the interference has been prevented. The said legal communications means radio communications is operated in compliance with the Telecommunications Act. The low power radio-frequency devices must be susceptible with the interference from legal communications or ISM radio wave radiated devices.

6.6.2 Labeling requirements for end product

End products based on NORA-W40 series modules and targeted for distribution in Taiwan must carry labels with the textual and graphical elements shown below.

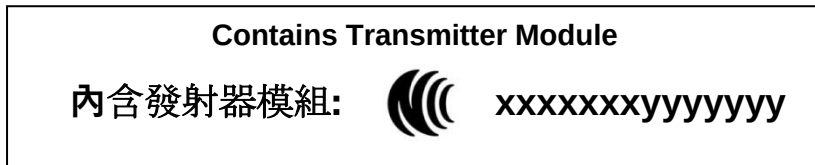


Figure 16: Example of an end product label that includes a NORA-W401 module

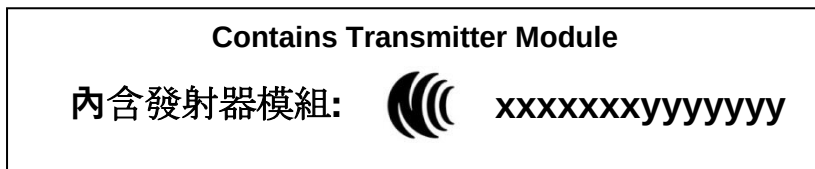


Figure 17: Example of an end product label that includes a NORA-W406 module

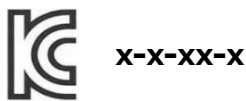
Other wording can be used, but only if the meaning of original messaging remains unchanged. The label must be physically attached to the product and made clearly visible for inspection.

6.7 KCC South Korea compliance

-  Approvals are pending for NORA-W40 series modules.

NORA-W40 series modules are certified by the Korea Communications Commission (KCC).

End products based on NORA-W40 series modules and targeted for distribution in South Korea must carry labels containing the KCC logo and certification number, as shown below. This information must also be included in the product user manuals.



-  The height of the KCC logo must be at least 5 mm.

6.8 Australia and New Zealand regulatory compliance

-  Approvals are pending for NORA-W40 series modules.



The NORA-W40 modules are compliant with the standards made by the Australian Communications and Media Authority (ACMA).

The modules are compliant with AS/NZS 4268:2012 standard – Radio equipment and systems – Short range devices – Limits and methods of standard measurement. The test reports for NORA-W40 modules can be used as part of the product certification and compliance folder. For more information on the test reports, email the respective support team at the local mail address in your region. See also [Contact](#).

To meet the overall Australian and/or New Zealand end product compliance standards, the integrator must create a compliance folder containing all the relevant compliance test reports such as RF, EMC, electrical safety and DoC (Declaration of Conformity). It is the responsibility of the integrator to know what is required in the compliance folder for ACMA compliance.

For more information on Australia compliance, refer to the Australian Communications and Media Authority web site <http://www.acma.gov.au/>.

For more information on New Zealand compliance, refer to the New Zealand Radio Spectrum Management Group web site www.rsm.govt.nz.

6.9 Safety compliance

In order to fulfil the safety standard EN 62368-1, NORA-W40 modules must be supplied by an external power supply classified ES1, PS1 according to EN 62368-1.

6.10 Pre-approved antennas list

This chapter provides an overview of the different antennas that can be used together with the modules.

 All approvals are currently pending.

 Note that not all antennas are approved for use in all markets/regions.

For each antenna, the "Approvals" field defines in which test reports the antenna is included. Definitions of the «Approvals» field are:

- FCC - The antenna is included in the FCC test reports and thus approved for use in countries that accept the FCC radio approvals, primarily US.
- IC - The antenna is included in the IC (Industrie Canada) test reports and thus approved for use in countries that accept the IC radio approvals, primarily Canada.
- RED - The antenna is included in the ETSI test reports and thus approved for use in countries that accept the Radio Equipment Directive, primarily the European countries.
- MIC - The antenna is included in the Japanese government affiliated MIC test reports and thus approved for use in the Japanese market.
- NCC - The antenna is included in the Taiwan NCC test reports and thus approved for use in Taiwan.
- KCC - The antenna is included in the KCC test reports and thus approved for use in South Korea.
- ACMA – The antenna is included in the Australia and New Zealand test reports and thus approved for use in Australia and New Zealand.

6.10.1 Antenna accessories

Name	U.FL to SMA adapter cable
Connector	U.FL and SMA jack (outer thread and pin receptacle)
Impedance	50 Ω
Minimum cable loss	0.5 dB, The cable loss must be above the minimum cable loss to meet the regulatory requirements. Minimum cable length 100 mm.
Comment	The SMA connector can be mounted in a panel. For information on how to integrate the U.FL connector, see RF connector design .
Approval	RED, UKCA, MIC, NCC, KCC and ACMA



Name	U.FL to Reverse Polarity SMA adapter cable
------	--

Connector	U.FL and Reverse Polarity SMA jack (outer thread and pin)
Impedance	50 Ω
Minimum cable loss	0.5 dB. The cable loss must be above the minimum cable loss to meet the regulatory requirements. Minimum cable length 100 mm.
Comment	The Reverse Polarity SMA connector can be mounted in a panel. For information on how to integrate the U.FL connector, see RF connector design . This reference design must be followed to comply with the NORA-W40 FCC/IC modular approvals.
Approval	FCC, IC, RED, UKCA, MIC, NCC, KCC, and ACMA



6.10.2 Single band antennas

NORA-W406 internal antenna

Manufacturer	Abracon
Gain	+3 dBi
Impedance	N/A
Size (HxWxL)	1.1 x 3.4 x 10 mm
Type	PCB trace
Comment	PCB antenna on NORA-W406. The antenna should not be mounted inside a metal enclosure.
Approval	FCC, IC, RED and UKCA



Wi-Fi / Bluetooth external antenna, PN PRO-EX-296

Manufacturer	Abracon
Polarization	Vertical
Gain	+3.0 dBi
Impedance	50 Ω
Size	Ø 12.0 x 28.0 mm
Type	Monopole
Cable length	100 mm
Connector	U.FL. connector
Comment	This antenna requires to be mounted on a metal ground plane for best performance. To be mounted with a U.FL connector. For information on how to integrate the U.FL connector, see RF connector design . This reference design must be followed to comply with the NORA-W40 FCC/IC modular approvals.
Approval	FCC, IC, RED and UKCA



Wi-Fi / Bluetooth / Bluetooth LE external whip antenna, PN PRO-EX-333

Manufacturer	Abracon
Polarization	Vertical
Gain	+3.6 dBi
Impedance	50 Ω
Size	Ø 10 x 83 mm
Type	Monopole
Connector	Reverse Polarity SMA plug (inner thread and pin receptacle)
Comment	To be mounted with a U.FL to Reverse Polarity SMA adapter cable. An SMA version antenna is also available but not recommended for use (PN PRO-EX-332).
Approval	FCC, IC, RED and UKCA



Wi-Fi / Bluetooth / Bluetooth LE board antenna, PN PRO-IS-237

Manufacturer	Abracon
Gain	+3.0 dBi
Impedance	50 Ω
Size	27 x 12 mm (triangular)
Type	Patch
Cable length	100 mm
Connector	U.FL. connector
Comment	Should be attached to a plastic enclosure or part for best performance. To be mounted with a U.FL connector. For information on how to integrate the U.FL connector, see RF connector design . This reference design must be followed to comply with the NORA-W1 FCC/IC modular approvals.
Approval	FCC, IC, RED and UKCA



Wi-Fi / Bluetooth / Bluetooth LE board antenna, PN PRO-IS-299

Manufacturer	Abracon
Gain	+2.5 dBi
Impedance	50 Ω
Size	27 x 12 mm (triangular)
Type	Patch
Cable length	100 mm
Connector	U.FL. connector
Comment	Should be attached to a plastic enclosure or part for best performance. Dual-band (2.4 GHz / 5 GHz) antenna to be mounted with a U.FL connector. For information on how to integrate the U.FL connector, see RF connector design . This reference design must be followed to comply with the NORA-W1 FCC/IC modular approvals.
Approval	FCC, IC, RED and UKCA



7 Product testing

7.1 u-blox in-line production test

As part of our focus on high quality products, u-blox maintain stringent quality controls throughout the production process. This means that all units in our manufacturing facilities are fully tested and that any identified defects are carefully analyzed to improve future production quality.

The Automatic test equipment (ATE) deployed in u-blox production lines logs all production and measurement data – from which a detailed test report for each unit can be generated.

[Figure 18](#) shows the ATE typically used during u-blox production.

u-blox in-line production testing includes:

- Digital self-tests (firmware download, MAC address programming)
- Measurement of voltages and currents
- Functional tests (host interface communication)
- Digital I/O tests
- Measurement and calibration of RF characteristics in all supported bands, including RSSI calibration, frequency tuning of reference clock, calibration of transmitter power levels, etc.
- Verification of Wi-Fi and Bluetooth RF characteristics after calibration, like modulation accuracy, power levels, and spectrum, are checked to ensure that all characteristics are within tolerance when the calibration parameters are applied.



Figure 18: Automatic test equipment for module test

7.2 OEM manufacturer production test

As all u-blox products undergo thorough in-series production testing prior to delivery, OEM manufacturers do not need to repeat any firmware tests or measurements that might otherwise be necessary to confirm RF performance. Testing over analog and digital interfaces is also unnecessary during an OEM production test.

OEM manufacturer testing should ideally focus on:

- Module assembly on the device; it should be verified that:
 - Soldering and handling process did not damage the module components
 - All module pins are well soldered on device board
 - There are no short circuits between pins
- Component assembly on the device; it should be verified that:
 - Communication with host controller can be established
 - The interfaces between module and device are working
 - Overall RF performance test of the device including antenna

In addition to this testing, OEMs can also perform other dedicated tests to check the device. For example, the measurement of module current consumption in a specified operating state can identify a short circuit if the test result deviates from that taken against a “Golden Device”.

The standard operational module firmware and test software on the host can be used to perform functional tests (communication with the host controller, check interfaces) and perform basic RF performance testing. Special manufacturing firmware can also be used to perform more advanced RF performance tests.

7.2.1 “Go/No go” tests for integrated devices

A “Go/No go” test compares the signal quality of the Device under Test (DUT) with that of “Golden Device” in a location with a known signal quality. This test can be performed after establishing a connection with an external device.

A very simple test can be performed by just scanning for a known Bluetooth low energy device and checking that the signal level (Received Signal Strength Indicator (RSSI)) is acceptable.

 Tests of this kind may be useful as a “go/no go” test but are not appropriate for RF performance measurements.

Go/No go tests are suitable for checking communication between the host controller and the power supply. The tests can also confirm that all components on the DUT are well soldered.

A basic RF functional test of the device that includes the antenna can be performed with standard Bluetooth low energy devices configured as remote stations. In this scenario, the device containing NORA-W40 and the antennas should be arranged in a fixed position inside an RF shield box. The shielding prevents interference from other possible radio devices to ensure stable test results.

7.3 Radio performance test

Users can take full advantage of the ESP RF Test Tool is a specialized utility developed by Espressif Systems for conducting RF performance tests on their range of ESP series chips, including ESP32, ESP32-C3, ESP32-S2, ESP32-C6, ESP32-C2, ESP32-H2, and ESP82661. This tool is essential for ensuring that devices meet regulatory compliance and performance standards.

The ESP RF Test Tool consists of five parts: Serial Port Configuration, Download Status, Download Path Configuration, RF Test settings and Control, and Log Management as shown in [Figure 19](#).



Figure 19: ESP RF performance test tool

The tool allows users to perform various RF tests to evaluate the performance of NORA-W40 modules under different conditions. It includes specific firmware designed to facilitate RF performance testing and a test guide that offers detailed instructions on setting up and conducting tests, ensuring accurate and reliable results.

This tool is invaluable for developers and engineers working with NORA-W40 modules, providing a robust framework for ensuring their applications are compliant and perform optimally in real-world scenarios.

7.3.1 Download and setup

To download and set up the ESP RF Test Tool, follow these steps:

1. Go to Espressif website for the [EspRFTestTool Toolkit](#).
2. Follow the “Download Link” on this website to obtain the zip package with the latest version of the toolkit. This zip file includes the EspRFTestTool toolkit, necessary firmware for RF tests, and test guides. The downloaded file should be named something similar to “EspRFTestTool_v3.6_Manual.zip”.
3. Unzip the package and open the “ESP_RF_Test_Guide_EN.pdf” found in the “help” folder. Within the “RF Test” chapter, you will find “Download Instructions” on how to download firmware for RF testing to the module.
4. During the step “Select which firmware to download,” ensure you select the correct file for the ESP32-S3. The file should be named something similar to “ESP32-C6_XXXXXX_XXXX.bin.”
5. For FCC, CE, or SRRC certifications, refer to the following documents located in the “help” folder of the downloaded package:
 - FCC_Certification_Guide_EN.pdf
 - CE_Certification_Guide_EN.pdf
 - SRRC_Certification_Guide_EN.pdf

7.3.2 Wi-Fi emission test

During these tests, the radio can be configured to transmit a modulated carrier at 90% duty cycle and maximum output power. It is important to use the correct power parameter for each channel according to FCC/ETSI certifications.

The power parameter is the attenuation (higher value -> lower output power) related to maximum allowed output power and is different depending on the channel. The step size is 0.25dB -> add 4 will decrease the output power 1 dB. For example, attenuation value of Channel 1, 11b rate would be $16 \times 0.25 = 4$ dB.

 The band edge requirement for FCC requires the output power for the band edge channels to be reduced.

Table 13 and Table 14 list the attenuation values for each channel and Wi-Fi rate for operation in the FCC/ISED and ETSI regulatory domains.

7.3.2.1 FCC/ISED

Channel	802.11b CCK-20M	802.11g OFDM-20M	802.11n HT-20M	802.11n HT-40M	802.11ax HE-20 SU	802.11ax HE-20 RU 26
1	0	10	8	-	5	5
2	0	0	0	-	0	0
3	0	0	0	4	0	0
4	0	0	0	4	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	10	8	4	0	0
10	0	10	8	-	0	0
11	0	10	8	-	5	5

Table 13: FCC/ISED Wi-Fi power parameters

7.3.2.2 ETSI

Channel	802.11b CCK-20M	802.11g OFDM-20M	802.11n HT-20M	802.11n HT-40M	802.11ax HE-20 SU	802.11ax HE-20 RU 26
1	20	11	7	-	37	37
2	20	11	7	-	37	37
3	20	11	7	4	37	37
4	20	11	7	4	37	37
5	20	11	7	4	37	37
6	20	11	7	4	37	37
7	20	11	7	4	37	37
8	20	11	7	4	37	37
9	20	11	7	4	37	37
10	20	11	7	4	37	37
11	20	11	7	4	37	37
12	20	11	7	-	37	37
13	20	11	7	-	37	37

Table 14: ETSI Wi-Fi power parameters

7.3.3 Bluetooth LE emission test

The firmware used for BLE emission tests are the same as that for Wi-Fi emission tests.

Figure 20 shows the BLE TX data test settings on Channel 7 with power level 6, No hopping, packet type is LE_1M and 1010.

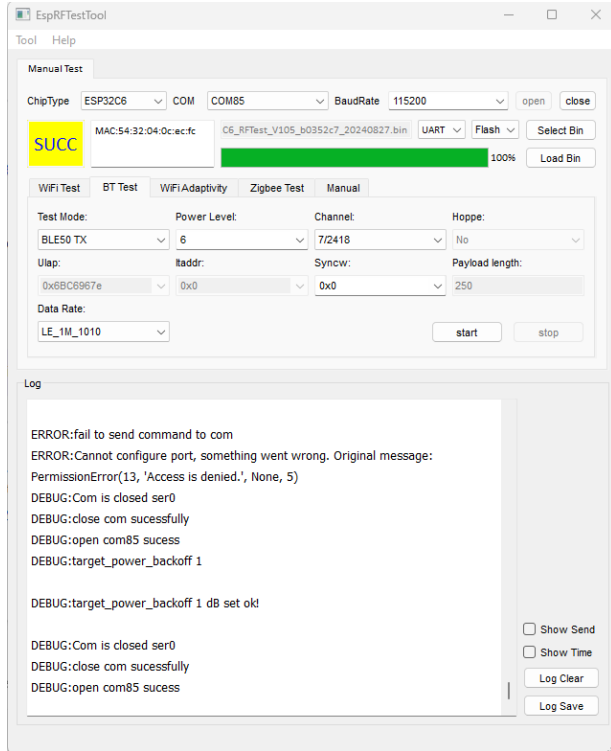


Figure 20: Bluetooth TX data Test

Appendix

A Antenna reference designs

Designers can take full advantage of NORA-W40's Single-Modular Transmitter certification approval by integrating the u-blox reference design into their products. This approach requires compliance with the following rules:

- Only listed antennas can be used. See also [Pre-approved antennas list](#).
- Schematics and parts used in the design must be identical to the reference design. Use only parts validated by u-blox for antenna matching.
- PCB layout must be identical to the one provided by u-blox. Implement one of the reference designs described in this section or [contact](#) u-blox.
- The designer must use the PCB stack-up provided by u-blox. RF traces on the carrier PCB are part of the certified design.

When using the NORA-W401 with this antenna reference design, the circuit trace layout must be made in strict compliance with the antenna reference design described in this appendix.

A.1 Reference design for external antennas (U.FL connector)

The reference design uses a U.FL micro-coaxial connector to connect the external antenna via a 50 Ω coaxial cable. [Figure 21](#) shows the placement of the connector in relation to the module footprint. The components connected to the RF trace must be kept as shown in the reference design.

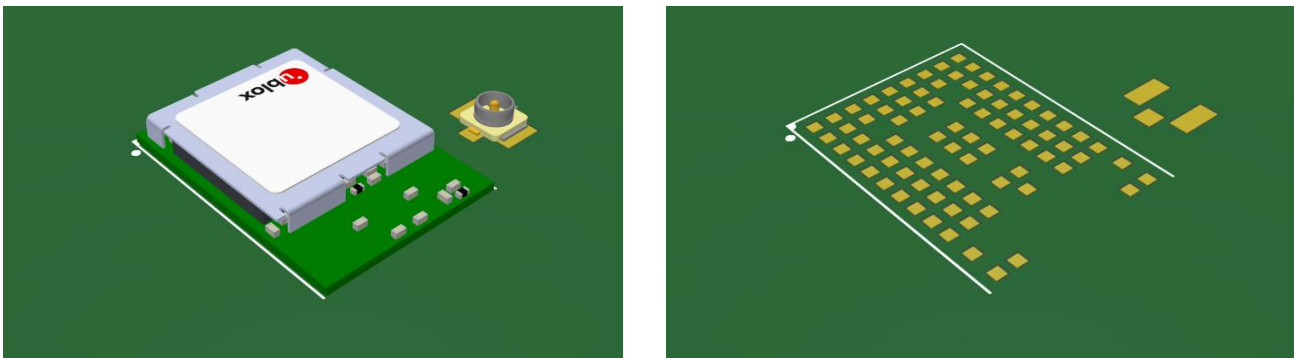


Figure 21: U.FL connector placement (left) and module footprint (right)

A.1.1 Floor plan

Figure 22 and Figure 23 show the critical components and positioning of the copper traces in the reference design. The itemized references are described in Table 15.

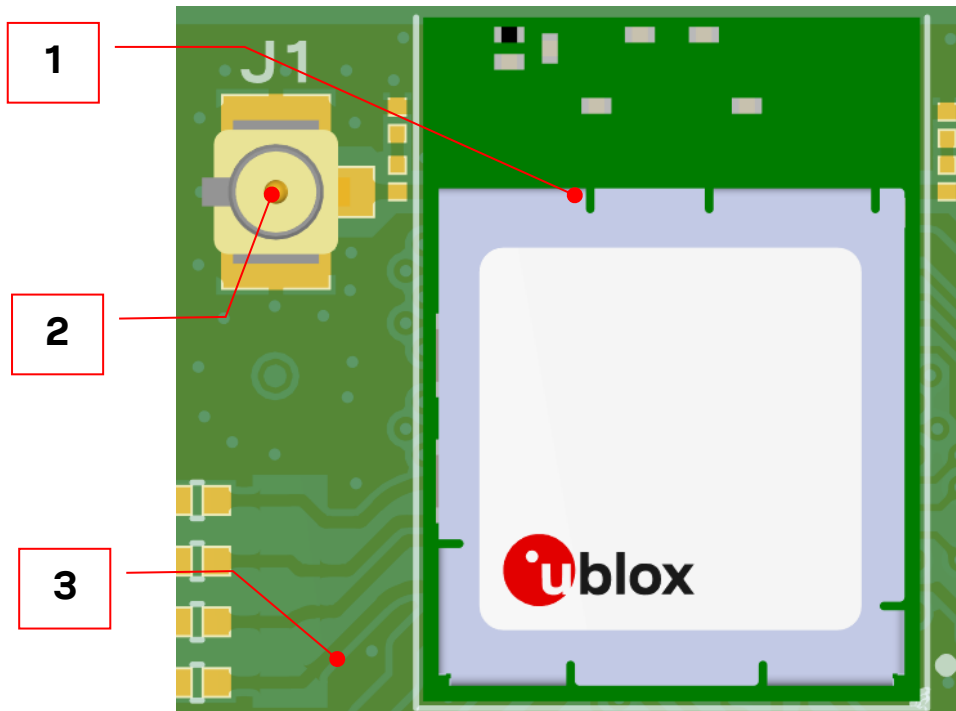


Figure 22: Assembled PCB layout - showing mounted components: Module, UFL for external antenna, and GND plane

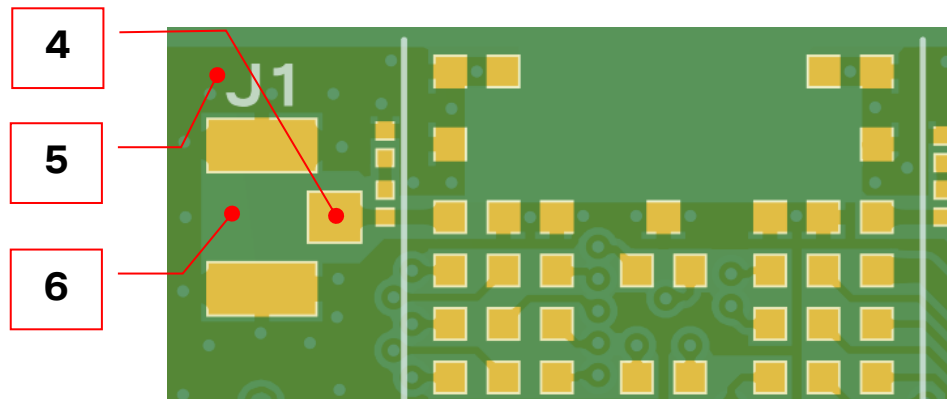


Figure 23: PCB layout with unmounted components, traces, and connector keep-out area

Reference	Part	Manufacturer	Description
1	NORA-W401	u-blox	NORA-W40 module with antenna pin
2	U.FL-R-SMT-1(10)	Hirose	Coaxial connector, 0 – 6 GHz, for external antennas
3	Carrier PCB		Should have a solid GND inner layer underneath and around the RF components (vias and small openings are allowed)
4	RF trace		Antenna coplanar microstrip, matched to 50 Ω
5	GND trace		Minimum required top layer GND-trace. See also Figure 25. All dimensions are shown in millimeters (mm).
6	Copper keep-out area		Keep this area free from any copper on the top layer

Table 15: Antenna reference design – item descriptions

A.1.2 RF trace specification

The dimensions of the 50 Ω coplanar microstrip used in the reference design are shown in Figure 24 and described in Table 16. GND stitching vias should be used around the RF trace to ensure a proper GND connection. No other components are allowed within this area.

The solid GND layer beneath the “top layer” shall surround at least the entire RF trace and connector. No signal traces are allowed to be routed on the GND layer within this area but vias and small openings are allowed.

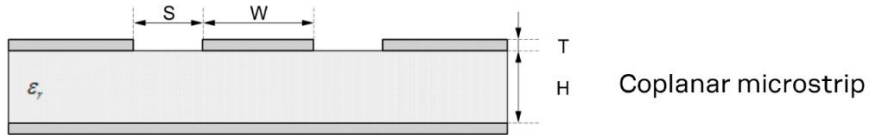


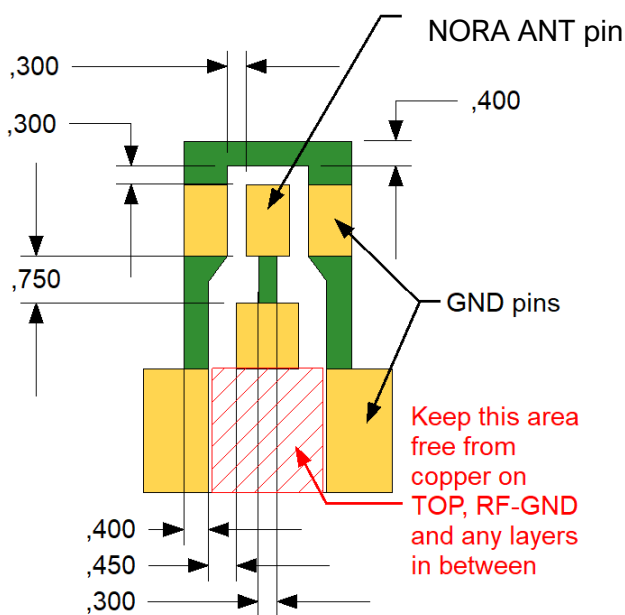
Figure 24: Coplanar microstrip dimension specification

Reference	Item	Value
S	Spacing	200 +/- 50 μm
W	Conductor width	300 +/- 30 μm (match as close to 50 Ω as possible)
T	Copper and plating/surface coating thickness	35 +/- 15 μm
H	Conductor height	150 +/- 20 μm
ϵ_r	Dielectric constant (relative permittivity)	3.77 +/- 0.5 @ 2 GHz

Table 16: Coplanar microstrip specification

 The GND spacing requirements of the NORA **ANT** pin and the U.FL connector RF pins are greater than the spacing requirement of a 50 Ω coplanar microstrip. However, when using the conductor width and height specified in Figure 25, the increased spacing to GND does not significantly affect the trace impedance for short trace lengths. Therefore, the impedance is still close to 50 Ω .

Figure 25 shows the **ANT** and **GND** pins, with the dimensions of the U.FL connector, and the copper-free area on RF-GND.



All dimensions are shown in mm

Figure 25: RF trace and minimum required GND trace of the U.FL antenna connector reference design

B Glossary

Abbreviation	Definition
AEC	Automotive Electronics Council
AP	Access Point
API	Application Programming Interface
ATE	Automatic Test Equipment
CDM	Charged Device Model
CE	European Conformity
CTS	Clear to Send
D/C	Don't Care
DC	Direct Current
DDR	Double Data Rate
DFS	Dynamic Frequency Selection
DHCP	Dynamic Host Configuration Interface
EDR	Enhanced Data Rate
EEPROM	Electrically Erasable Programmable Read-Only Memory
EIRP	Equivalent Isotropic Radiated Power
EMI	Electromagnetic Interference
ESD	Electro Static Discharge
FCC	Federal Communications Commission
GND	Ground
GPIO	General Purpose Input/Output
HBM	Human Body Model
HS	High-Speed
HCI	Host Controller Interface
ISED	Innovation, Science and Economic Development Canada
I2C	Inter-Integrated Circuit
KDB	Knowledge Database
LAN	Local Area Network
LDO	Low Drop Out
LED	Light-Emitting Diode
LPO	Low Power Oscillator
LTE	Long Term Evolution
MAC	Medium Access Control
MMC	Multi Media Card
MWS	Mobile Wireless Standards
NRE	Non-recurring engineering
NSMD	Non Solder Mask Defined
OEM	Original equipment manufacturer
OET	Office of Engineering and Technology
OS	Operating System
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PCIe	PCI Express
PCM	Pulse-code modulation

Abbreviation	Definition
PHY	Physical layer (of the OSI model)
PMU	Power Management Unit
RF	Radio Frequency
RSDB	Real Simultaneous Dual Band
RST	Request to Send
SDIO	Secure Digital Input Output
SMD	Solder Mask Defined
SMPS	Switching Mode Power Supply
SMT	Surface-Mount Technology
SSID	Service Set Identifier
STA	Station
TBD	To be Decided
THT	Through-Hole Technology
TWAI	Two-Wire Automotive Interface
UART	Universal Asynchronous Receiver-Transmitter
VCC	IC power-supply pin
VIO	Input offset voltage
VSDB	Virtual Simultaneous Dual Band
VSWR	Voltage Standing Wave Ratio
WFD	Wi-Fi Direct
WLAN	Wireless local area network
WPA	Wi-Fi Protected Access

Table 17: Explanation of the abbreviations and terms used

Related documentation

- [1] NORA-W40 series product summary, [UBX-23009094](#)
- [2] NORA-W40 series data sheet, [UBXDOC-465451970-3088](#)
- [3] Espressif System ESP32-C6 Series Datasheet v1.0
https://www.espressif.com/sites/default/files/documentation/esp32-c6_datasheet_en.pdf
- [4] Espressif ESP32-C6 v5.1 [SDK Get Started](#)
- [5] ESP-IDF [Programming Guide](#)
- [6] Packaging information reference, [UBX-14001652](#)
- [7] JEDEC J-STD-020E - Moisture/Reflow Sensitivity Classification for Non-hermetic Surface Mount Devices
- [8] u-blox [SHO-OpenCPU GitHub repository](#)
- [9] NORA-W40 EU Declaration of Conformity, [UBXDOC-465451970-3272](#)
- [10] NORA-W40 UKCA Declaration of Conformity, [UBXDOC-465451970-3273](#)
- [11] FCC guidance [594280 D01 Configuration Control v02 r01](#)
- [12] EN 62368-1 - Audio/video, information and communication technology equipment - Part 1: Safety requirements
- [13] espressif/arduino-esp32 GitHub repository, [espressif/arduino-esp32](#)
- [14] FCC Regulatory Information – Title 47 - Telecommunications
- [15] FCC guidance [594280 D02 U-NII Device Security v01r03](#)

 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	14-Jun-2024	Ikis	Initial release
R02	15-Nov-2024	Ikis	Minor editorial updates. Antenna keepout area and GND plane dimensions updated in Figure 8. Allowed number of Soldering cycle removed and added Repeated reflow soldering section to explain soldering cycle conditions. Net attributes updated in Figure 3 and Figure 4 . Added Radio performance test in chapter 7.3. Relevant references added in Design-in checklists . Antenna keepout area and GND plane dimensions updated in Figure 11 . Added Antenna reference designs in Appendix.
R03	23-Apr-2025	Ikis	Added chapters Low Power IO functions and Digital interfaces . Updated regulatory compliance of CE, UKCA, FCC and ISSED in Regulatory compliance . Figure and table xref updated. Wi-Fi power parameters updated in Table 13 and Table 14 .

Contact

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