MN52M Bluetooth® Low Energy Module

BLE Solution: Nordic NRF52832

RF IC	Crystal	Chip antenna
Nordic NRF52832/V2	32MHz/20ppm Embedded	Embedded

Overview and Benefits

The MN52M-C32 from Arad is a highly flexible, ultra-low power, Bluetooth Low Energy module based on the nRF52832 SoC from Nordic Semiconductor. With an Arm® Cortex®-M4 with FPU 32-bit processor, embedded 2.4GHz transceiver, and integrated chip antenna. Providing full use of the nRF52832's capabilities and peripherals, which include I2C, SPI, UART, I2S, ADC, GPIO, PWM and NFC interfaces.

Benefits

- **Bluetooth qualification and Regulatory certification reduce the burden to enter the market.**

- **Complete RF solution with no additional RF design, allowing faster time to launch a new product, and providing long working distance.**

  MN52M: up to 150 meters in open space. @1 Mbps

- **Compact size:** **(L) 15.8 x (W) 9.0 x (H) 2.2mm.**
  (L) 15.8 x (W) 9.0 x (H) 2.2mm。

- **Provides flexibility in the OEM's application development choice with full support for using Nordic SDK and firmware tools.**

1. Features and Application

1.1 Features

- **2.4 GHz transceiver**
  - -96 dBm sensitivity in Bluetooth® low energy mode
  - Supported data rates: 1 Mbps, 2 Mbps Bluetooth® low energy mode
  - -20 to +4 dBm TX power, configurable in 4 dB steps
  - 5.3 mA peak current in TX (0 dBm)
  - 5.4 mA peak current in RX
  - RSSI (1 dB resolution)
- **Arm® Cortex®-M4 32-bit processor with FPU, 64 MHz**
  - 215 EEMBC CoreMark® score running from flash memory
  - 58 µA/MHz running from flash memory
  - 51.6 µA/MHz running from RAM
  - Serial wire debug (SWD)
- **Flexible power management**
  - 1.7 V–3.6 V supply voltage range
  - Fully automatic LDO and DC/DC regulator system
  - 0.3 µA at 3 V in System OFF mode
  - 0.7 µA at 3 V in System OFF mode with full 64 kB RAM retention
  - 1.9 µA at 3 V in System ON mode, no RAM retention, wake on RTC
- **Memory**
  - 512 kB flash/64 kB RAM
- **Nordic SoftDevice ready**
- **Support for concurrent multi-protocol**
- **Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch-to-pair capabilities**
- **12-bit, 200 ksps ADC - 8 configurable channels with programmable gain**
- **64 level comparator**
- **15 level low power comparator with wakeup from System OFF mode**
- **Temperature sensor**
- **32 general purpose I/O pins**
- **3x 4-channel pulse width modulator (PWM) unit with EasyDMA**
- **Digital microphone interface (PDM)**
- **5x 32-bit timer with counter mode**
- **Up to 3x SPI master/slave with EasyDMA**
- **Up to 2x I2C compatible 2-wire master/slave**

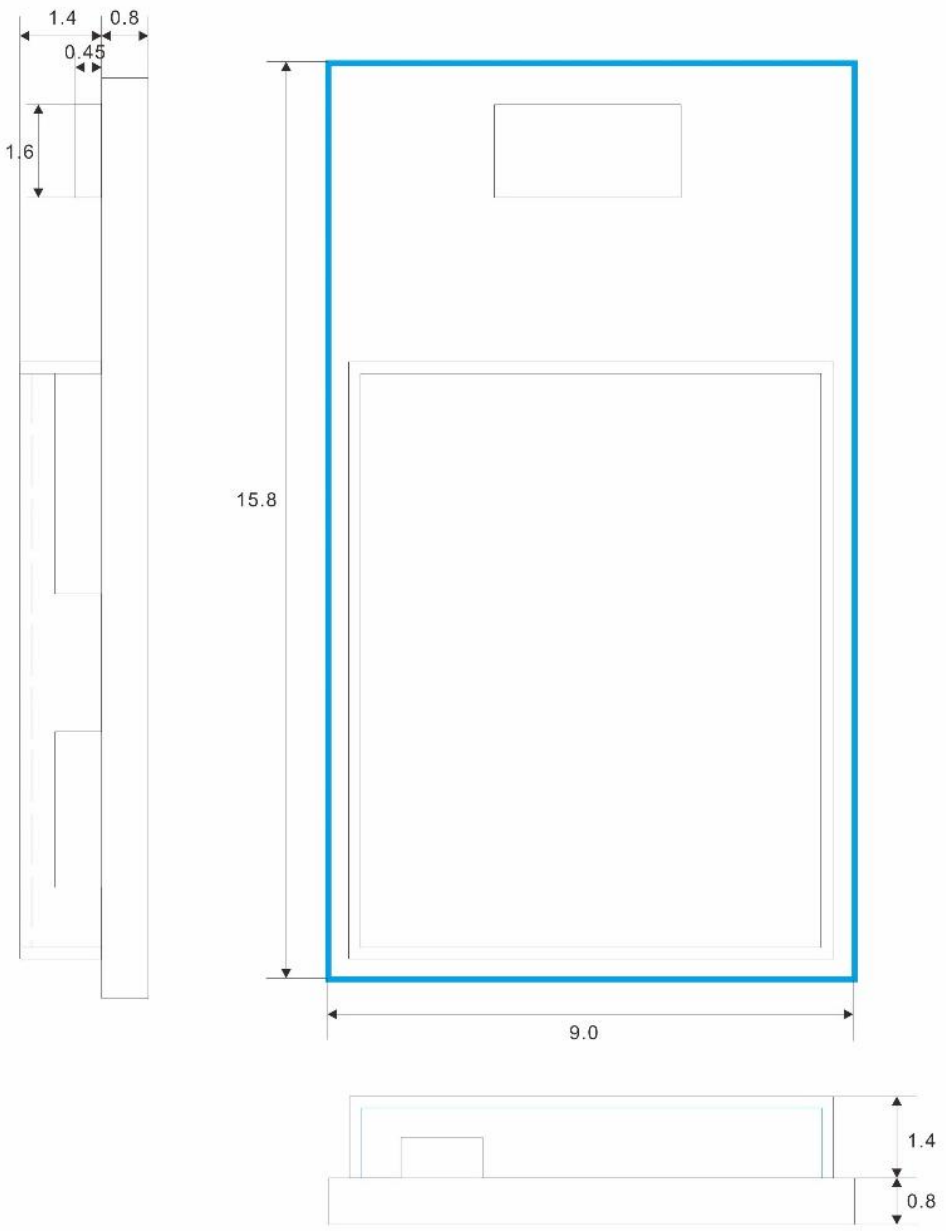
- **I2S with EasyDMA**
- **UART (CTS/RTS) with EasyDMA**
- **Programmable peripheral interconnect (PPI)**
- **Quadrature decoder (QDEC)**
- **AES HW encryption with EasyDMA**
- **Autonomous peripheral operation without CPU intervention using PPI and EasyDMA**
- **3x real-time counter (RTC)**
- **Single crystal operation**

1.2 Application (應用)

Iot	•Home automation •Sensor networks •Building automation • Industrial • Retail
Personal Area Networks	• Health / fitness sensor and monitor device • Medical devices • Key-fobs and wrist watches
Interactive entertainment devices	• Remote control • Gaming controller
Beacons	
A4WP wireless chargers and devices	
Remote control toys	
Computer peripherals and I/O devices	• Mouse • Keyboard • Multi-touch trackpad • Gaming

2. Mechanical specifications(機構尺寸圖)

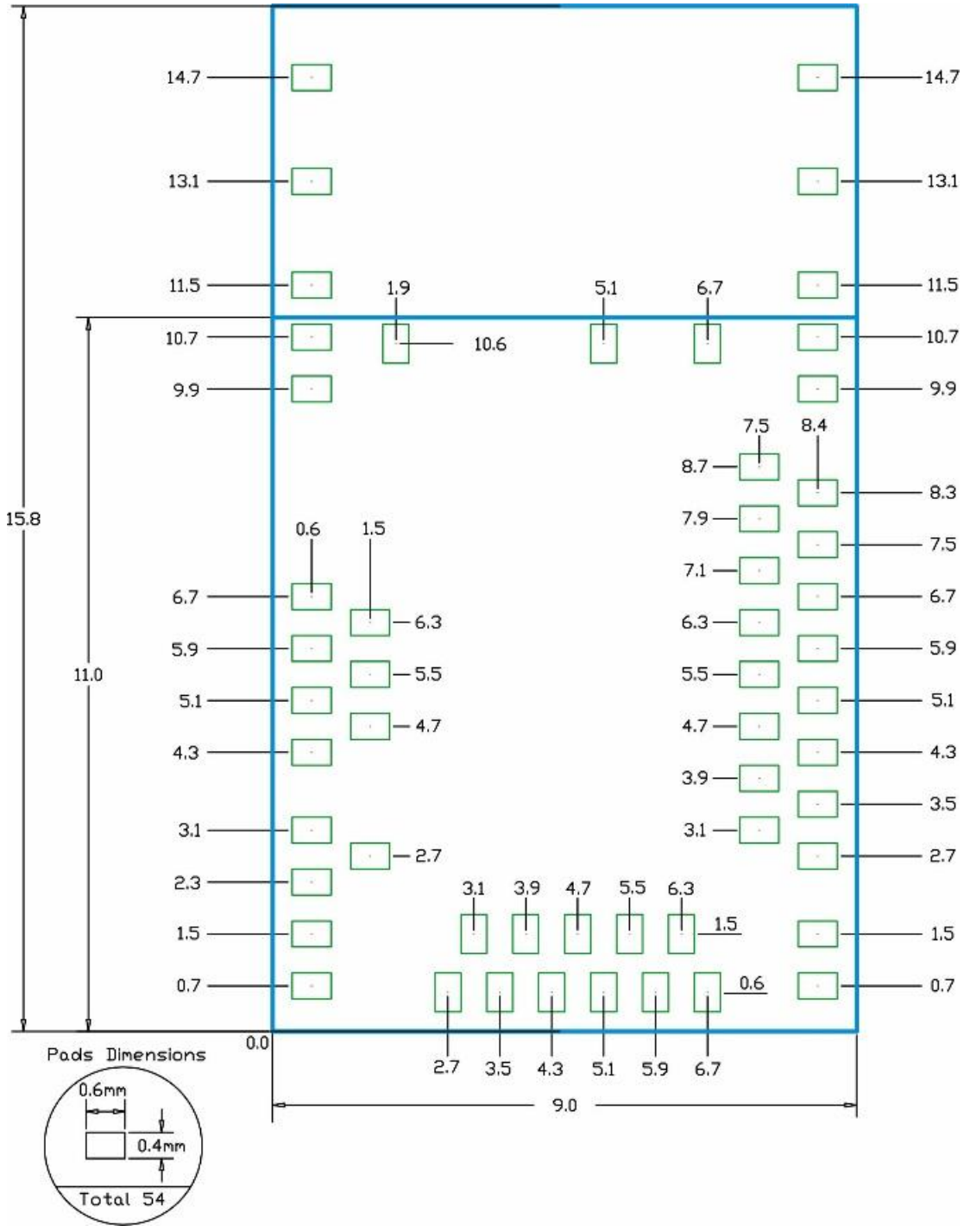
2.1 Dimensions (尺寸)



All dimensions are in millimeters.

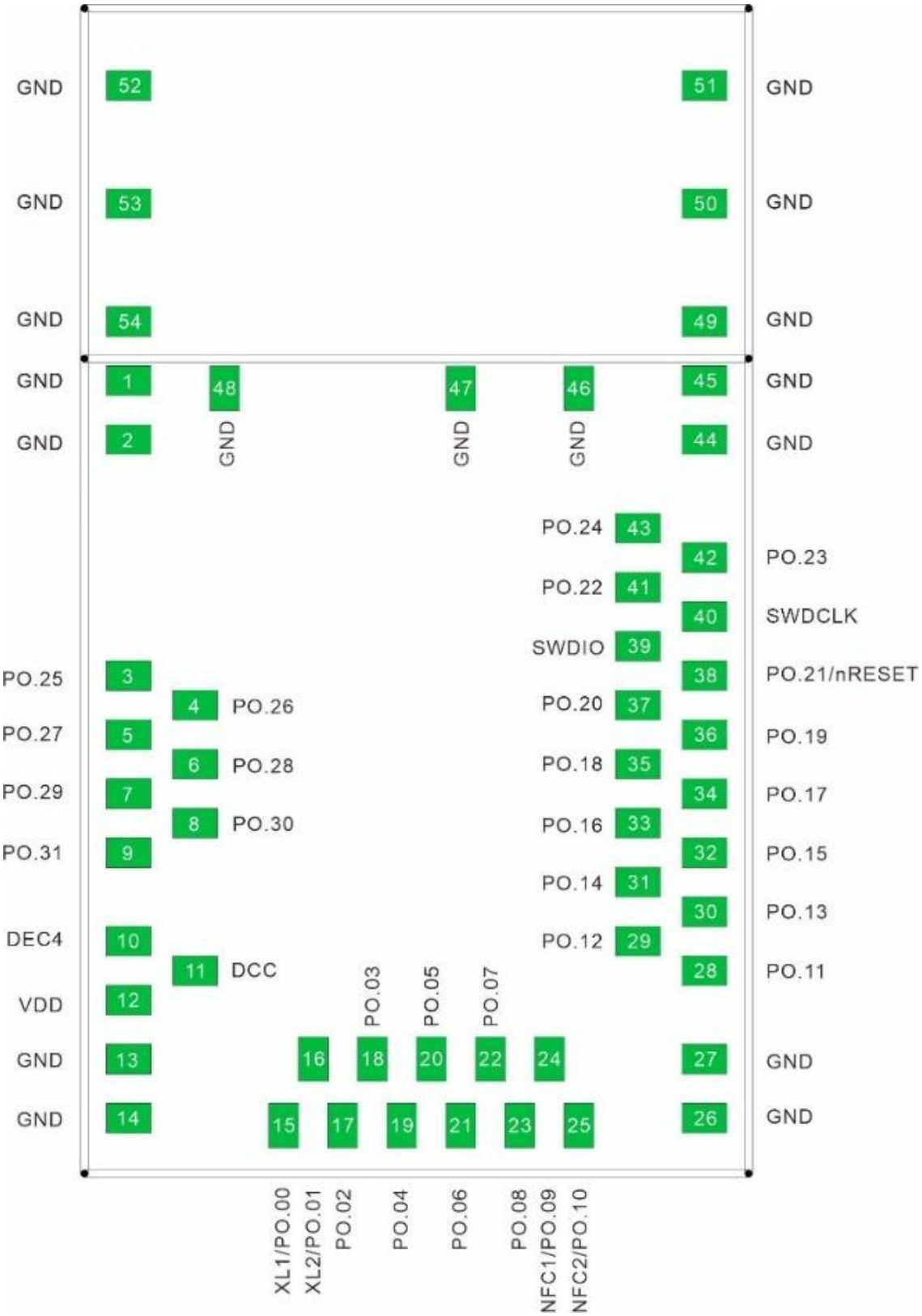
Item	Dimension	Tolerance
Length	15.5mm	±0.30 mm
Width	10.5mm	±0.30mm
Height	2.0mm	±0.30mm

2.2 Footprint (Layout PAD 圖)



All dimensions are in millimeters.

3. Pin Assignment（PIN 腳定義圖)



Pin No.	Name	Pin function	Description
(1)	GND	Ground	The pad must be connected to a solid ground plane
(2)	GND	Ground	The pad must be connected to a solid ground plane
(3)	P0.10	Digital I/O	General-purpose digital I/O
	NFC2	NFC input	NFC antenna connection
(4)	P0.09	Digital I/O	General-purpose digital I/O
	NFC1	NFC input	NFC antenna connection
(3)	P0.25	Digital I/O	General-purpose digital I/O
(4)	P0.26	Digital I/O	General-purpose digital I/O
(5)	P0.27	Digital I/O	General-purpose digital I/O
(6)	P0.28	Digital I/O	General-purpose digital I/O
	AIN4	Analog input	SAADC/COMP/LPCOMP input
(7)	P0.29	Digital I/O	General-purpose digital I/O
	AIN5	Analog input	SAADC/COMP/LPCOMP input
(8)	P0.30	Digital I/O	General-purpose digital I/O
	AIN6	Analog input	SAADC/COMP/LPCOMP input
(9)	P0.31	Digital I/O	General-purpose digital I/O
	AIN7	Analog input	SAADC/COMP/LPCOMP input
(10)	DEC4	Power	1V3 regulator supply decoupling. Input from DC/DC converter. Output from 1V3 LDO
(11)	DCC	Power	DC/DC converter output pin
(12)	VDD	Power	Power-supply pin
(13)	GND	Ground	The pad must be connected to a solid ground plane
(14)	GND	Ground	The pad must be connected to a solid ground plane
(15)	P0.00	Digital I/O	General-purpose digital I/O
	XL1	Analog input	Connection to 32.768kHz crystal (LFXO)
(16)	P0.01	Digital I/O	General-purpose digital I/O
	XL2	Analog input	Connection to 32.768kHz crystal (LFXO)
(17)	P0.02	Digital I/O	General-purpose digital I/O
	AIN0	Analog input	SAADC/COMP/LPCOMP input
(18)	P0.03	Digital I/O	General-purpose digital I/O
	AIN1	Analog input	SAADC/COMP/LPCOMP input
(19)	P0.04	Digital I/O	General-purpose digital I/O
	AIN2	Analog input	SAADC/COMP/LPCOMP input
(20)	P0.05	Digital I/O	General-purpose digital I/O
	AIN3	Analog input	SAADC/COMP/LPCOMP input
(21)	P0.06	Digital I/O	General-purpose digital I/O
(22)	P0.07	Digital I/O	General-purpose digital I/O
(23)	P0.08	Digital I/O	General-purpose digital I/O
(24)	P0.09	Digital I/O	General-purpose digital I/O
	NFC1	NFC input	NFC antenna connection
(25)	P0.10	Digital I/O	General-purpose digital I/O
	NFC2	NFC input	NFC antenna connection
(26)	GND	Ground	The pad must be connected to a solid ground plane
(27)	GND	Ground	The pad must be connected to a solid ground plane

Pin No.	Name	Pin function	Description
(28)	P0.11	Digital I/O	General-purpose digital I/O
(29)	P0.12	Digital I/O	General-purpose digital I/O
(30)	P0.13	Digital I/O	General-purpose digital I/O
(31)	P0.14	Digital I/O	General-purpose digital I/O
	TraceData(3)		Trace port output
(32)	P0.15	Digital I/O	General-purpose digital I/O
	TraceData(2)		Trace port output
(33)	P0.16	Digital I/O	General-purpose digital I/O
	TraceData(1)		Trace port output
(34)	P0.17	Digital I/O	General-purpose digital I/O
(35)	P0.18	Digital I/O	General-purpose digital I/O
	TraceData(0)		Trace port output
(36)	P0.19	Digital I/O	General-purpose digital I/O
(37)	P0.20	Digital I/O	General-purpose digital I/O
	Trace CLK		Trace port clock output
(38)	P0.21	Digital I/O	General-purpose digital I/O
	RESET		Configurable as system RESET pin
(39)	SWDIO	Digital I/O	Serial Wire debug I/O for debug and programming
(40)	SWDCLK	Digital input	Serial Wire debug clock input for debug and programming
(41)	P0.22	Digital I/O	General-purpose digital I/O
(42)	P0.23	Digital I/O	General-purpose digital I/O
(43)	P0.24	Digital I/O	General-purpose digital I/O
(44)	GND	Ground	The pad must be connected to a solid ground plane
(45)	GND	Ground	The pad must be connected to a solid ground plane
(46)	GND	Ground	The pad must be connected to a solid ground plane
(47)	GND	Ground	The pad must be connected to a solid ground plane
(48)	GND	Ground	The pad must be connected to a solid ground plane
(49)	GND	Ground	The pad must be connected to a solid ground plane
(50)	GND	Ground	The pad must be connected to a solid ground plane
(51)	GND	Ground	The pad must be connected to a solid ground plane
(52)	GND	Ground	The pad must be connected to a solid ground plane
(53)	GND	Ground	The pad must be connected to a solid ground plane
(54)	GND	Ground	The pad must be connected to a solid ground plane

3.1 GPIO Located Near the Radio

Radio performance parameters, such as RX sensitivity, may be affected by high frequency digital I/O with a large sink/source current close to the Radio power supply and antenna pins.

Module pin number	NRF52832 GPIO	Recommended usage
41	P0.22	Low drive, low frequency I/O only. (These GPIO are not suit to set as UART, SPI, I2C, PWM, a frequency up to 10kHz on these GPIO will decrease Radio performance.
42	P0.23	
43	P0.24	
3	P0.25	
4	P0.26	
5	P0.27	
6	P0.28	
7	P0.29	
8	P0.30	

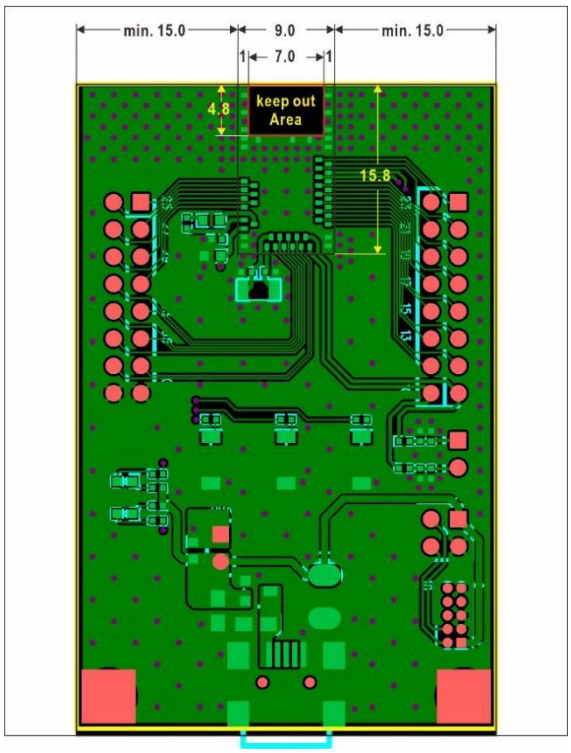
4 Layout design notes

4.1 Recommended RF layout and ground plane

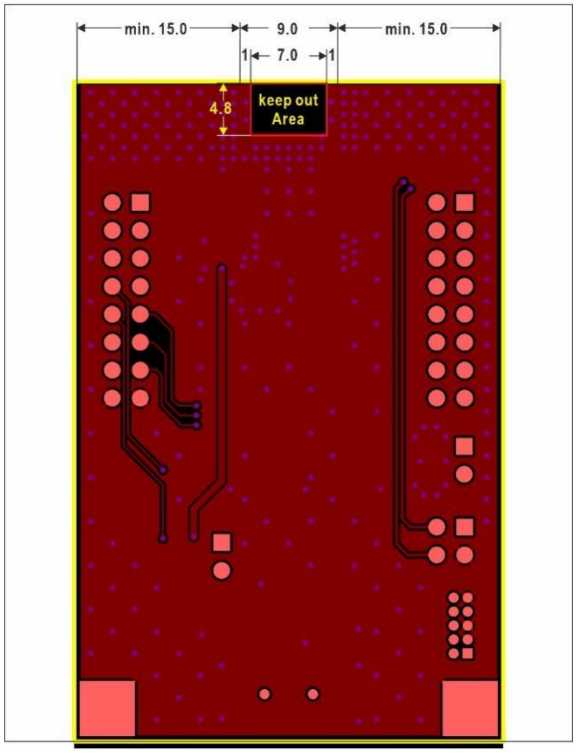
It is recommended to place the module:

- In the center (horizontal) of any mother PCB edge, with GND planes to the left and right
- Keep out Area should be included in the corresponding position of the antenna in each layer.
- Add via hole around GND pads on the mother PCB as many as you can, especially on the four corners and antenna area.

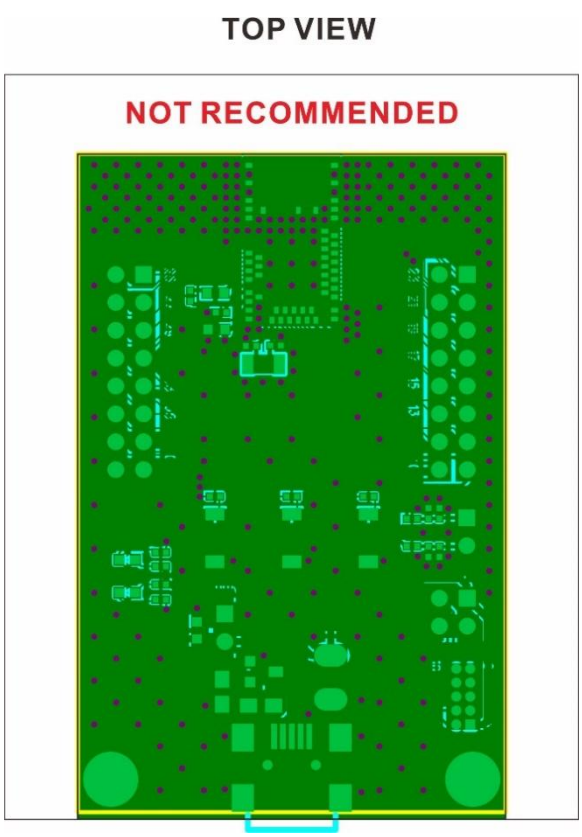
TOP VIEW

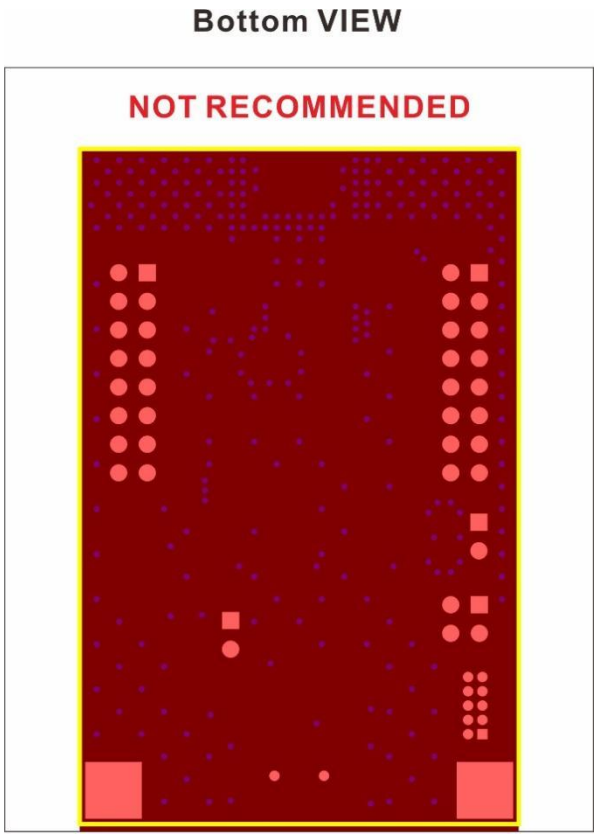


Bottom VIEW



4.2 Not Recommended RF layout and ground plane





4.3 Antenna keep out when proximity to Metal

• The minimum safe distance for metals without seriously compromising the antenna tuning is 4cm (bottom, top, left, right).

• Metal close to the antenna (bottom, top, left, right) will degrade RF performance. Any metal closer than 2 cm will significantly degrade RF performance.

5.1 Operation Conditions (工作環境)

Parameter	Min.	Nom.	Max.	Units
VDD (independent of DCDC)	**1.7**	**3.0**	**3.6**	**V**
VDD rise time (0V to 1.7V)			**60**	**ms**
Operating temperature	**-40**	**25**	**85**	**°C**

Important: The on-chip power-on reset circuitry may not function properly if the rise times exceed the specified maximum.

5.2 System Clock (系統時脈)

The MN52M-C32 requires two clocks, a high frequency clock and a low frequency clock.
MN52M-C32。

- The high frequency clock (HFCLK)

HFCLK is provided on-module by a high-accuracy 32 MHz/±20 ppm crystal for radio and CPU operation.

- The low frequency clock (LFCLK)

LFCLK can be provided internally by an RC oscillator (±250 ppm) with calibration, or externally by a 32.768 kHz crystal.

Internal 32.768 kHz RC oscillator (LFRC) 32.768 kHz RC

Description	Min.	Typ.	Max.	Unit
Nominal frequency		32.768		kHz
Frequency tolerance for LFRC after calibration (calibration performed at least every 8 seconds)			±250	ppm
Run current for 32.768 kHz RC oscillator		0.6	1	uA
Startup time for 32.768 kHz RC oscillator		600		us

External 32.768 kHz crystal oscillator (LFXO) 外部 32.768 kHz 晶體振盪器

Parameter	Description	Min.	Typ.	Max.	Unit
	Crystal frequency		32.768		kHz
	Frequency tolerance requirement for BLE stack			±250	ppm
	Frequency tolerance requirement for ANT stack			±50	ppm
	Run current for 32.768 kHz crystal oscillator		0.25		uA
CL	Load capacitance			12.5	pF
C0	Shunt capacitance			2	pF
RS	Equivalent series resistance			100	Kohm
PD	Drive level			1	uW
Cpin	Input capacitance on XL1 and XL2 pads			4	pF

An external crystal provides the lowest power consumption and greatest accuracy.

Using the internal RC oscillator with calibration provides acceptable performance for BLE stack at a reduced cost and slight increase in power consumption.

Important:

- The ANT protocol requires the use of an external crystal for high accuracy.
- Nordic SDK example program P0.00/P0.01 as external LFXO, you need an external crystal to work.
- Nordic SDK example program P0.00/P0.01 as external LFXO, if you would like to reduce material

cost, save layout space or requires 2 more GPIO for application. you need program p0.00/p0.01 as internal LFRC.

6. BN52M-C32 evaluation board

BN52M-C32 is a full-featured evaluation board for MN52M-C32 that supports:

BN52M-C32 是 MN52M-C32

M1:MN52M-C32 module

J6: A power over mini-USB

J3/J4: Complete I/O pinout to headers

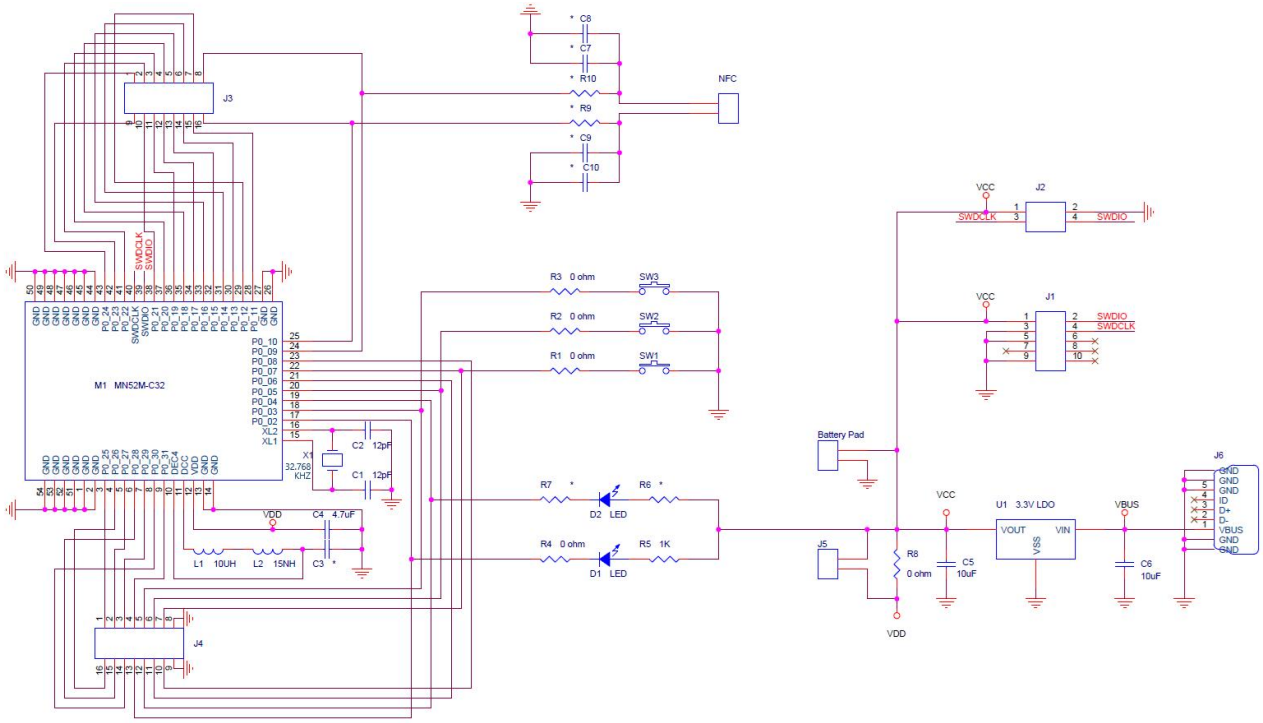
J1: On-board programming and debugging interface

X1:32.768 kHz crystal

D1: One user LED

SW1/SW2/SW3: Three user buttons

J3/J4: Complete I/O pinout to headers

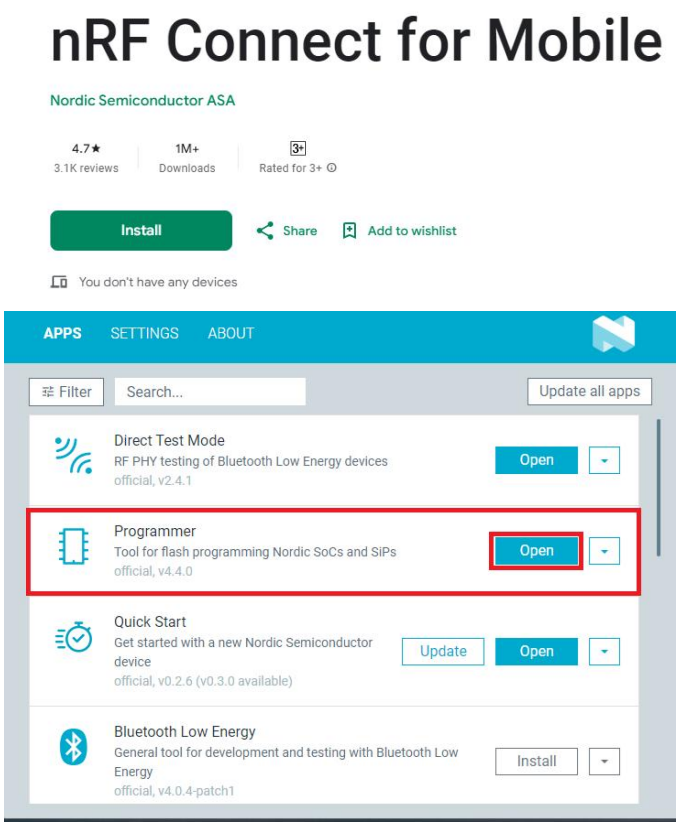


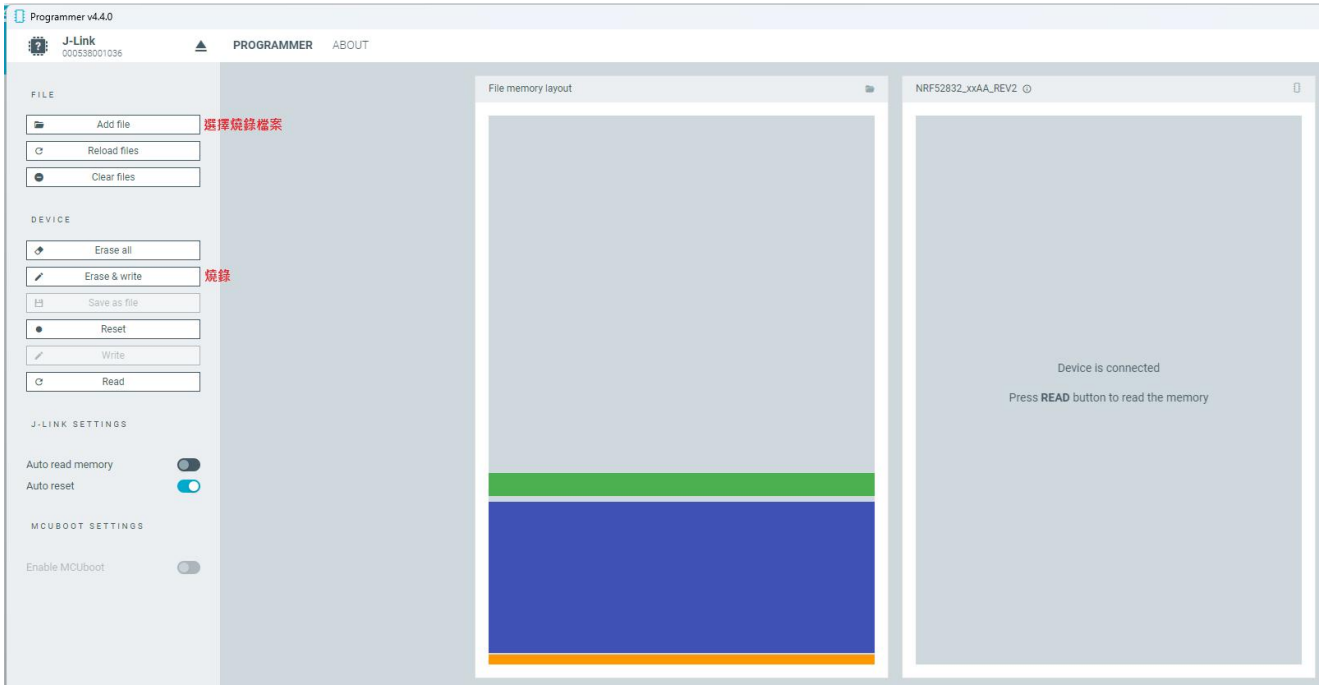
REMARK: 、

- **When using DC-DC mode, please add L1 / L2 .**

- **When using internal 32.768kHz RC oscillator, please remove X1 / C1 / C2 and calibration performed at least every 8 seconds.**

7.1 NRFConnect for Desktop





FCC Warning

15.19 Labeling requirements.

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.

15.21 Changes or modification warning.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.105 Information to the user.

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

-Reorient or relocate the receiving antenna.

-Increase the separation between the equipment and receiver.

-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-Consult the dealer or an experienced radio/TV technician for help

RF warning for Mobile device:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This module is intended for OEM integrators only. Per FCC KDB 996369 D03 OEM Manual v01 guidance, the following conditions must be strictly followed when using this certified module:

KDB 996369 D03 OEM Manual v01 rule sections:

2.2 List of applicable FCC rules

This module has been tested for compliance to FCC Part 15

2.3 Summarize the specific operational use conditions

The module is tested for standalone mobile RF exposure use condition. Any other usage conditions such as co-location with other transmitter(s) or being used in a portable condition will need a separate reassessment through a class II permissive change application or new certification.

2.4 Limited module procedures

Not application

2.5 Trace antenna designs

Not application

2.6 RF exposure considerations

This equipment complies with FCC mobile radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. If the module is installed in a portable host, a separate SAR evaluation is required to confirm compliance with relevant FCC portable RF exposure rules.

2.7 Antennas

The following antennas have been certified for use with this module; antennas of the same type with equal or lower gain may also be used with this module. The antenna must be installed such that 20 cm can be maintained between the antenna and users.

	Antenna type	Manufacturer	Antenna peak gain (dBi)
Antenna Information	Ceramics	Arad Connectivity Co., Ltd.	1.05
	PCB	Arad Connectivity Co., Ltd.	0.8
	Dipole	Pulse Electronics	2
	PCB	Pulse Electronics	3.3
	PCB	Pulse Electronics	2.3

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following: “Contains FCC ID: 2BLIDMN52M”. The grantee's FCC ID can be used only when all FCC compliance requirements are met.

2.9 Information on test modes and additional testing requirements

This transmitter is tested in a standalone mobile RF exposure condition and any co-located or simultaneous transmission with other transmitter(s) or portable use will require a separate class II permissive change re-evaluation or new certification.

2.10 Additional testing, Part 15 Subpart B disclaimer

This transmitter module is tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B (unintentional radiator) rule requirement applicable to the final host. The final host will still need to be reassessed for compliance to this portion of rule requirements if applicable.
As long as all conditions above are met, further transmitter test will not be required.
However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

Manual Information To the End User:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual

OEM/Host manufacturer responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and EMF essential requirements of the FCC rules. This module must not be incorporated into any other device or system without retesting for compliance as multi-radio and combined equipment

CE Warning

Doc：

Products with CE Marking comply with the radio Equipment Directive（2014/53/EU） The full text of the EU declaration of conformity is available at the following internet address:

http://www.aradconn.com

RF exposure statement：

RF exposure information: The Maximum Permissible Exposure (MPE) level has been calculated based on a distance of d=20 cm between the device and the human body. To maintain compliance with RF exposure requirement, use product that maintain a 20cm distance between the device and human body.

Temperature: -40° C ~ +85° C

Bands:

The Radio equipment operation with following frequecy bands Maximum tune-up power(dBm)

Ble: 8dBm(eirp)

Radiation Exposure Statement:

This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with greater than 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé à plus de 20 cm entre le radiateur et votre corps.

IC statement

The final end product must be labeled in a visible area with the following "Contains IC: 33328-MN52M"

The Host Marketing Name (HMN) must be indicated at any location on the exterior of the host product or product packaging or product literature, which shall be available with the host product or online.

This radio transmitter [IC: 33328-MN52M] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

	Antenna type	Manufacturer	Antenna peak gain (dBi)
Antenna Information	Ceramics	Arad Connectivity Co., Ltd.	1.05
	PCB	Arad Connectivity Co., Ltd.	0.8
	Dipole	Pulse Electronics	2
	PCB	Pulse Electronics	3.3
	PCB	Pulse Electronics	2.3

1.The OEM integrator must be aware not to provide information to the end user regarding how to install or remove this RF module in the user manual of the end product. The user manual which is provided by OEM integrators for end users must include the following information in a prominent location.

L'intégrateur OEM doit être conscient de ne pas fournir d'informations à l'utilisateur final sur la manière d'installer ou de retirer ce module RF dans le manuel d'utilisation du produit final. Le manuel d'utilisation fourni par les intégrateurs OEM pour les utilisateurs finaux doit inclure les informations suivantes dans un emplacement visible.

2.To comply with IC RF exposure compliance requirements, the antenna used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with IC multi-transmitter product procedures. Pour se conformer aux exigences de conformité de l'exposition RF IC, l'antenne utilisée pour cet émetteur ne doit pas être co-localisée ou fonctionner en conjonction avec une autre antenne ou un autre émetteur, sauf conformément aux procédures du produit multi-émetteur IC.

3.The final system integrator must ensure there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module except such device has implemented two-ways authentication between module and the host system. L'intégrateur système final doit s'assurer qu'aucune instruction n'est fournie dans le manuel de l'utilisateur ou dans la documentation du client indiquant comment installer ou retirer le module

transmetteur, sauf qu'un tel dispositif a mis en place une authentification bidirectionnelle entre le module et le système hôte.

4. The host device shall be properly labelled to identify the module within the host device. The end product must be labeled in a visible area with the following: "Contains IC: 33328-MN52M " Any similar wording that expresses the same meaning may be used.

Le périphérique hôte doit être correctement étiqueté pour identifier le module dans le périphérique hôte. Le produit final doit être étiqueté dans une zone visible avec: "Contains IC: 12208A-10 " Toute formulation similaire exprimant la même signification peut être utilisée.

The IC Statement below should also be included on the label. When not possible, the IC Statement should be included in the User Manual of the host device. "This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie 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, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le onctionnement."