Macaron N Series

SM-MFAD4-C02

NFC Controller Module with Integrated Antenna

Datasheet Version 2.3

Smart Approach Co., Ltd.
Rm. 5, 3F., No.1, Taiyuan 2nd St.,
Zhubei City, Hsinchu County 302,
Taiwan, R.O.C.
+886-3-5601363
www.smart-approach.com.tw

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Revision History

This section describes the changes that were implemented in this document. The changes are listed by revision, starting with the most current publication.

Revision 1.0

Revision 1.0 of this datasheet was published in Sep. 2019. This was the first publication of the document.

Revision 1.1

Revision 1.1 of this datasheet was published in Oct. 2020. Update the transmission modes description on page 9. Power Reference in table 1 on page 10 is changed to 3.3V. The VBAT min value in Table 4 on page 11 is changed to 3.1V.

Revision 2.0

Revision 2.0 of this datasheet was published in Jan. 2022. The VDD_IO range is adjusted from 3.3V to 1.8V/3.3V.

Revision 2.1

Revision 2.1 of this datasheet was published in Mar. 2022. Modify some contents for application Brazil Anatel certification.

Revision 2.2

Revision 2.2 of this datasheet was published in Apr. 2022. Modify NFC connection recommendation on page 16, and added back the information which are vision 2.1 removed.

Revision 2.3

Revision 2.3 of this datasheet was published in Apr. 2022. Modify some contents for application certification.

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1 Product Overview

SM-MFAD4-C02 is full featured NFC controllers designed for integration in portable equipment. It is optimized for low power consumption with fully host controllable power states and for small footprint for portable equipment applications.

The module's compact, flexible design with and exposed pad is optimal for size-sensitive applications, assures robust performance.

The following illustration shows a high-level, generic view of a SM-MFAD4-C02 application.

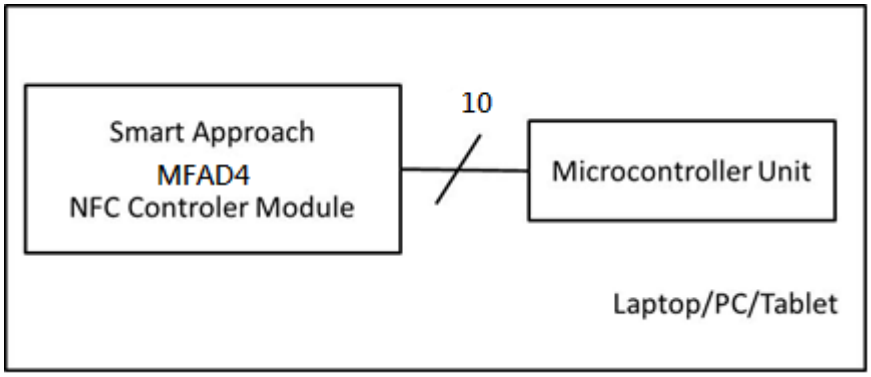


Figure 1 Typical Application

1.1 Features

- Includes NXP ISO/IEC14443-A and Innovatron ISO/IEC14443-B intellectual property licensing rights
- ARM Cortex-M0 microcontroller core
- Highly integrated demodulator and decoder
- Buffered output drivers to connect an antenna with minimum number of external components
- Integrated RF level detector
- Integrated Polling Loop for automatic device discovery
- RF protocols supported
  - NFCIP-1, NFCIP-2 protocol
  - ISO/IEC 14443A, ISO/IEC 14443B PICC, NFC Forum T4T modes via host interface
  - NFC Forum T3T via host interface
  - ISO/IEC 14443A, ISO/IEC 14443B PCD designed according to NFC Forum digital protocol T4T platform and ISO-DEP
  - FeliCa PCD mode
  - MIFARE Classic PCD encryption mechanism (MIFARE Classic 1K/4K)
  - NFC Forum tag 1 to 5 (MIFARE Ultralight, Jewel, Open FeliCa tag, MIFARE DESFire)
  - ISO/IEC 15693/ICODE VCD mode

- Supported host interfaces
  - NCI protocol interface according to NFC Forum standardization
  - I2C-bus High-speed mode
- Integrated power management unit
  - Direct connection to a battery (2.3 V to 5.5 V voltage supply range)
  - Support different Hard Power-Down/Standby states activated by firmware
  - Autonomous mode when host is shut down
- Automatic wake-up via RF field, internal timer and I2C-bus interface
- Integrated non-volatile memory to store data and executable code for customization

1.2 Application

Suggested applications for the SM-MFAD4-C02 module include:

- All devices requiring NFC functionality especially those running in an Android or Linux environment
- TVs, set-top boxes, blu-ray decoders, audio devices
- Home automation, gateways, wireless routers
- Home appliances
- Wearables, remote controls, healthcare, fitness
- Printers, IP phones, gaming consoles, accessories

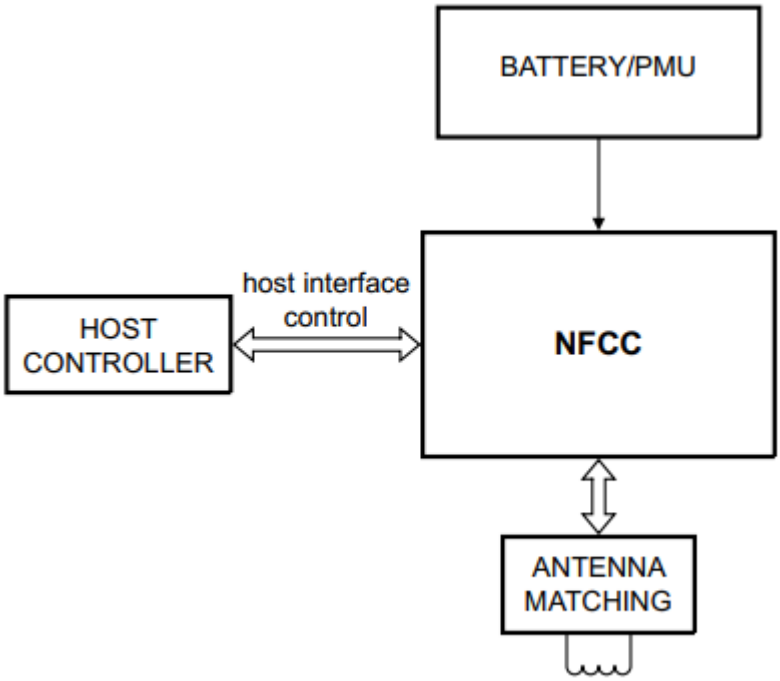


Figure 2 Typical Application II

SM-MFAD4-C02 can be connected on a host controller through I^2C-bus interfaces. The logical interface towards the host base band is NCI-compliant with additional command set for SA specific product features.

Moreover, SM-MFAD4-C02 provides flexible and integrated power management unit in order to preserve energy supporting Powered by the Field and Power Off mode.

2 Functional Descriptions

This section provides detailed information about how SM-MFAD4-C02 module works, what configurations and operational features are available.
The following illustration shows the primary functional blocks of SM-MFAD4-C02 module.

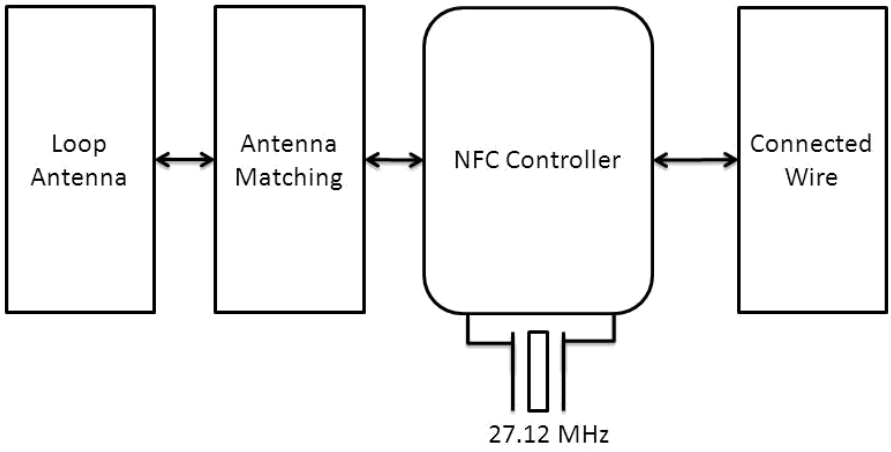
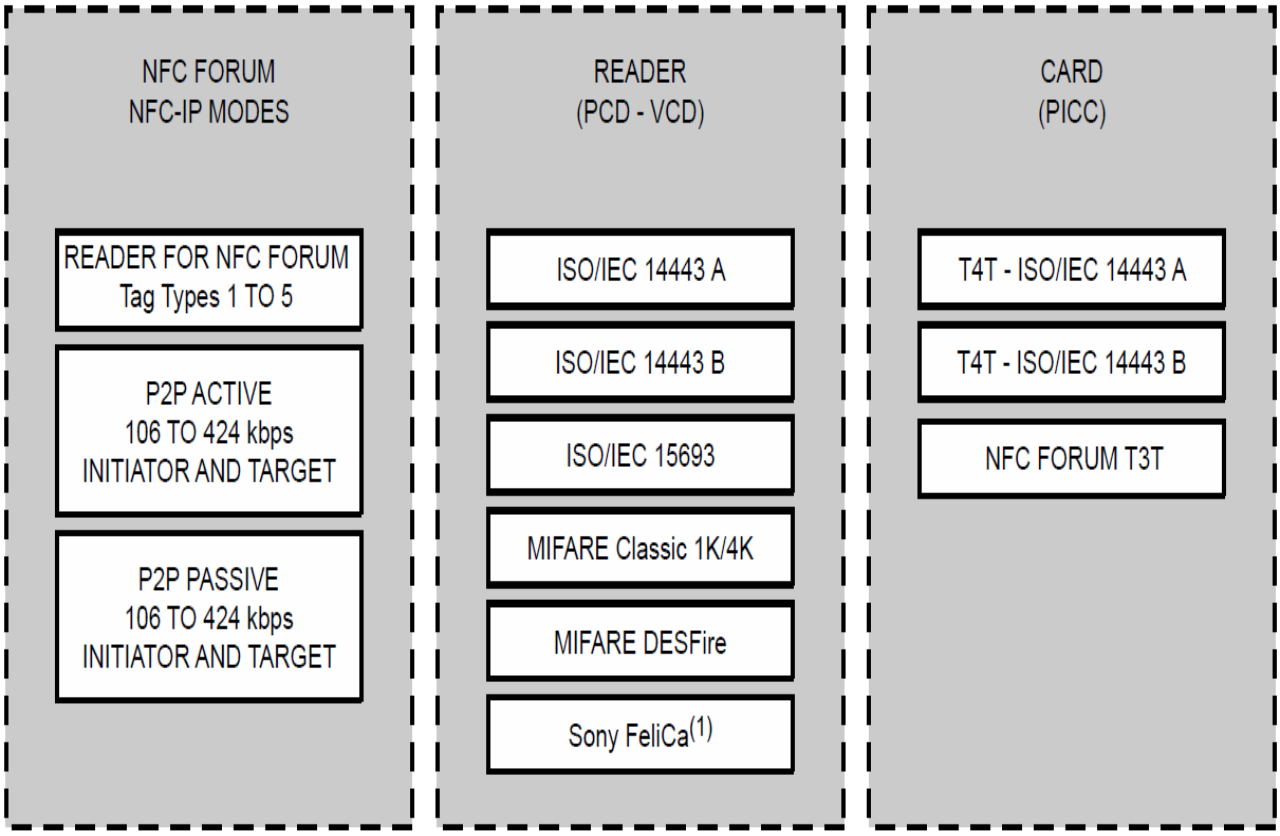


Figure 3 Module Block Diagram

Loop Antenna is Smart Approach customize solution, Antenna size of SM-MFAD4-C02 is 25mm x 25 mm. Antenna matching is also a customize solution. NFC controller includes NXP PN7150 chipset, and has an I^2C control interface through the connector to mother board.



1. According to ISO/IEC 18092(Ecma 340)standard.
2. PICC only for android HCE.

Figure 4 Transmission Modes

For contactless card functionality, SM-MFAD4-C02 can act autonomously if previously configured by the host in such a manner. PICC functionality can be supported without device being turned on or even with battery removed.

2.1 Communication overview for ISO/IEC 14443A / MIFARE Controller

The contactless coprocessor and the on-chip CPU of SM-MFAD4-C02 handle the complete ISO/IEC 14443A/MIFARE RF-protocol, nevertheless a dedicated external host has to handle the application layer communication.

3 Electrical Specifications

This section provides the DC characteristics, AC characteristics, recommended operating conditions. It includes information on the various timing functions of the module.

3.1 Temperature Maximum Ratings

Thermal specifications for this module have been modeled using a two-layer test board.

Table 1 Temperature Maximum Ratings

Symbol	Definition	Value		Units
		Min	Max	
T	Operating Temperature	-30	85	℃
T_S	Storage Temperature	-55	150	℃

3.2 DC Electrical Parameters

DC Electrical specifications for this module have been modeled using a two-layer test board.

Table 2 DC Electrical Specification

Symbol	Definition	Value			Units	Note
		Min	Typ	Max		
V_{BAT}	Power Supply	2.7	3.3	5.5	Volts	
I_{VBAT}	DC Current			190	mA	(1)

Note:

1. Continuous polling total current consumption at 3.0V

3.3 Antenna Specifications

Antenna specifications for this module have been modeled using a two-layer test board.

Table 3 Antenna Specifications

Item	Value			Unit	Note
	Min	Typ	Max		
DC Resistance	0.5	1	2	Ω	
AC Impedance		50		Ω	
Frequency	13.06	13.56	14.06	MHz	
Q factor	25	30	35		
Antenna Type	FR4 Loop Coil				Add the Ferrite sheet
Size	(25 ±0.2) X (25±0.15)			mm	

3.4 Power Consumption

Table 4 Current Consumption

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{HPD}	Hard power down current	V_{BAT}=3.6V, V_{EN}=0V	-	10	14	μA
I_{STBY}	Standby state current	V_{BAT}=3.6V	-	20		μA
I_{ACT}	Active state current	V_{BAT}=3.6V	-	4.55	-	mA
I_{TVDD}	Transmitter supply current	V_{BAT}=3.0V	-	-	190	mA

**Active state : Idle and Listenser modes.*

3.5 Thermal Protection

Table 5 Thermal Protection

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{OVERTEMP}$	Temperature protection trigger		120	125	130	^{0}C

3.6 NFC Connection Recommendation

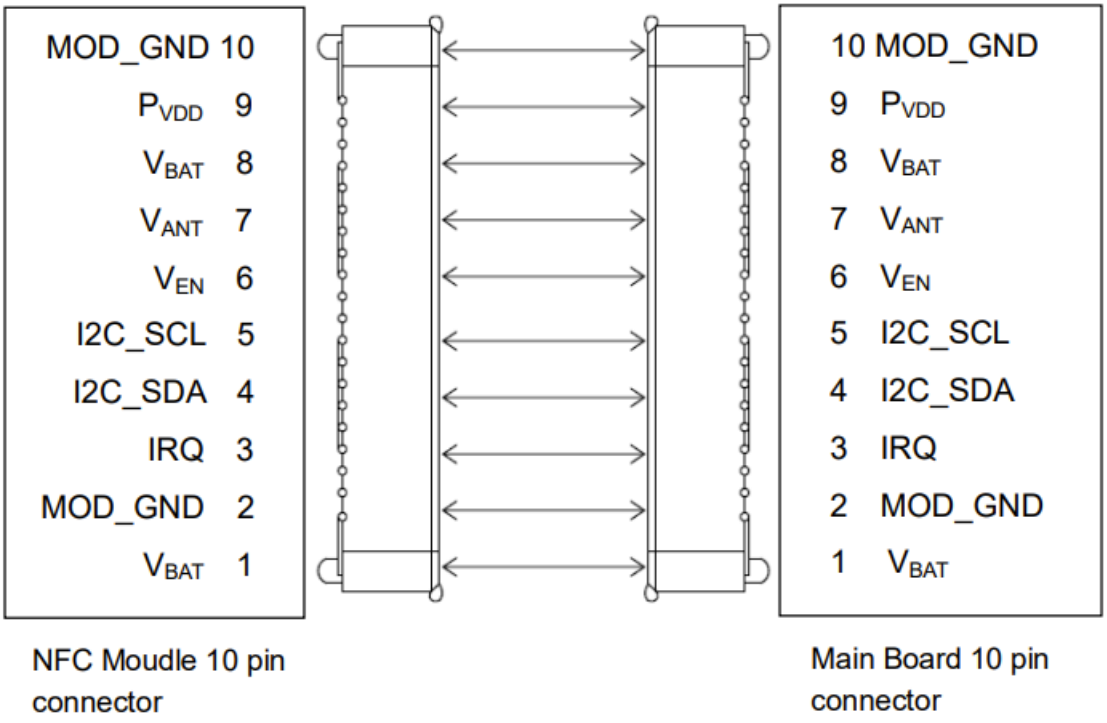


Figure 5 Connection Recommendation

4 Ordering Information

Table 6 Ordering Information Table

Order Number	Descriptions
SM-MFAD4-C02	NFC Macaron Module (NXP PN7150) with Integrated Antenna
Dimension	Module: 25.0x48.4x2.46 mm

5 Reliability Verification

Table 7 Reliability Item Table

No.	Item	Condition	Benchmark	Result	Qty
1	Low Temperature Storage Test	-55ºC	IEC60068-2-1	Pass	5
2	High Temperature Storage Test	85ºC, Humidity: 95%	IEC60068-2-78	Pass	5
3	Low Temperature Operation Test	-30ºC	IEC60068-2-1	Pass	5
4	High Temperature Operation Test	85ºC	IEC60068-2-2	Pass	5
5	High Temperature Operation Test	85ºC, Humidity: 95%	IEC60068-2-78	Pass	5
6	Salt Test	PH: 3.0 ~ 3.2 ,50℃, 72 hrs, Density: 5%±1%	ASTM B368	Pass	5
7	RoHS	Normal	Compliance	Pass	5
8	HF	Normal	Compliance	Pass	5

6 NFC Module Outline

The following illustration shows the package drawing for SM-MFAD4-C02 module. The drawing contains the detail views, dimensions, tolerances, and notes.

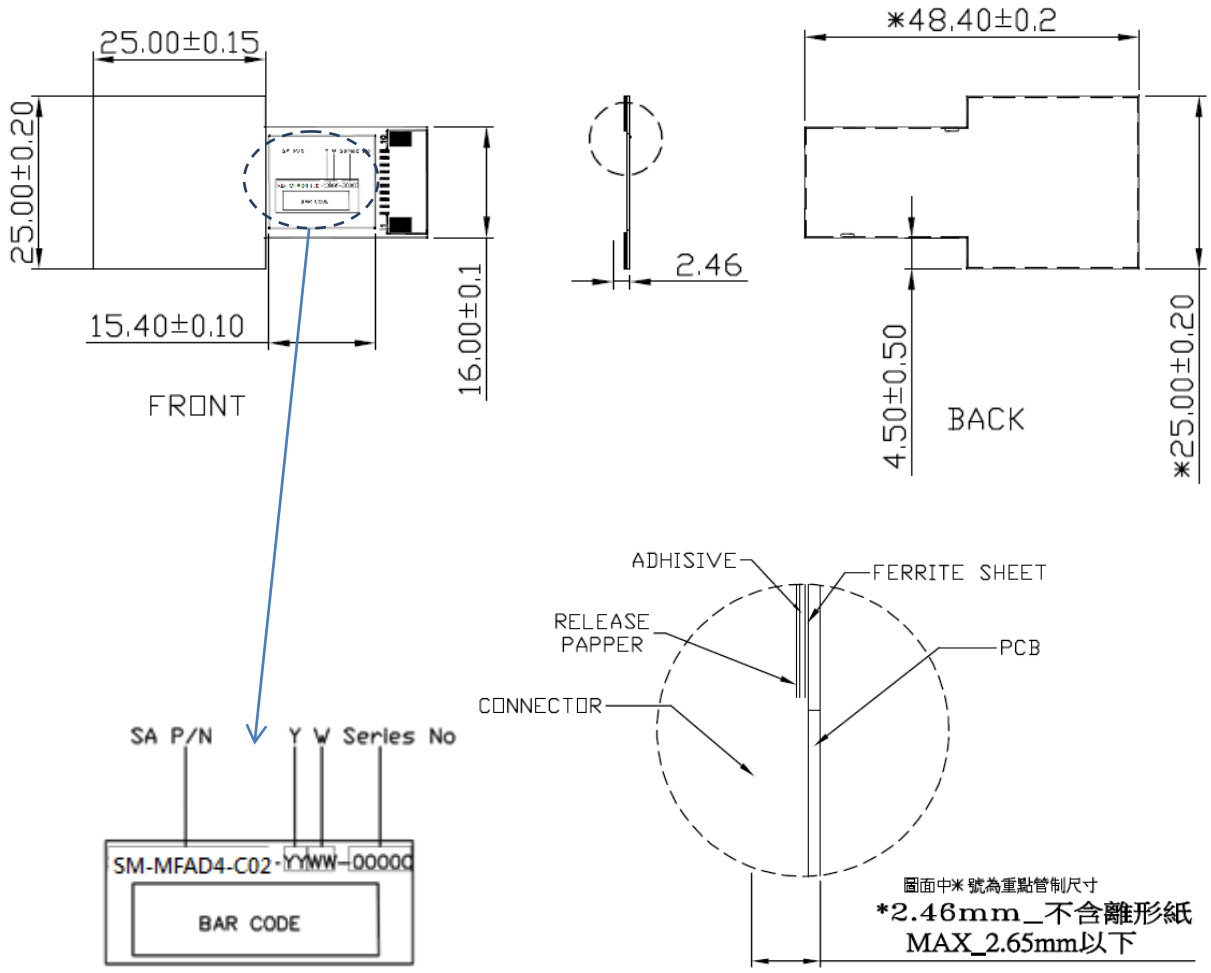


Figure 6 Antenna Module Drawing

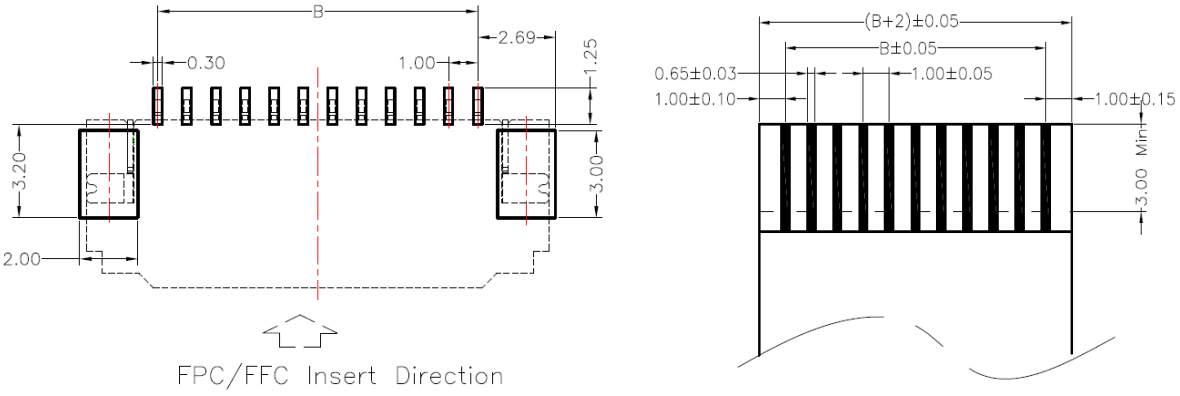


Figure 7 Module FPC Connection Footprint (Button Contact)

Number of Contacts	Dimension			
	A	B	C	D
04	8.90	3.00	8.50	5.10
05	9.90	4.00	9.50	6.10
06	10.90	5.00	10.50	7.10
07	11.90	6.00	11.50	8.10
08	12.90	7.00	12.50	9.10
09	13.90	8.00	13.50	10.10
10	14.90	9.00	14.50	11.10

Figure 8 FPC Wire Dimension

7 Precautions

FEDERAL COMMUNICATIONS COMMISSION INTERFERENCE STATEMENT
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.

CAUTION:
Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the equipment.

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 module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used.
USERS MANUAL OF THE END PRODUCT:
In the user’s manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated.
The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied.
The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.
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.

Labelling Requirements for the Host device
The host device shall be properly labelled to identify the modules within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the FCC ID and

IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:
Contains FCC ID: 2AAYI-MFAD4-C02
Contains IC: 11378A-SMMFAD4C02

L'appareil hôte doit être étiqueté comme il faut pour permettre l'identification des modules qui s'y trouvent. L'étiquette de certification du module donné doit être posée sur l'appareil hôte à un endroit bien en vue en tout temps. En l'absence d'étiquette, l'appareil hôte doit porter une étiquette donnant le FCC ID et le IC du module, précédé des mots « Contient un module d'émission », du mot « Contient » ou d'une formulation similaire exprimant le même sens, comme suit :
Contains FCC ID: 2AAYI-MFAD4-C02
Contains IC: 11378A-SMMFAD4C02

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

CAN ICES-003(B) / NMB-003(B)

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