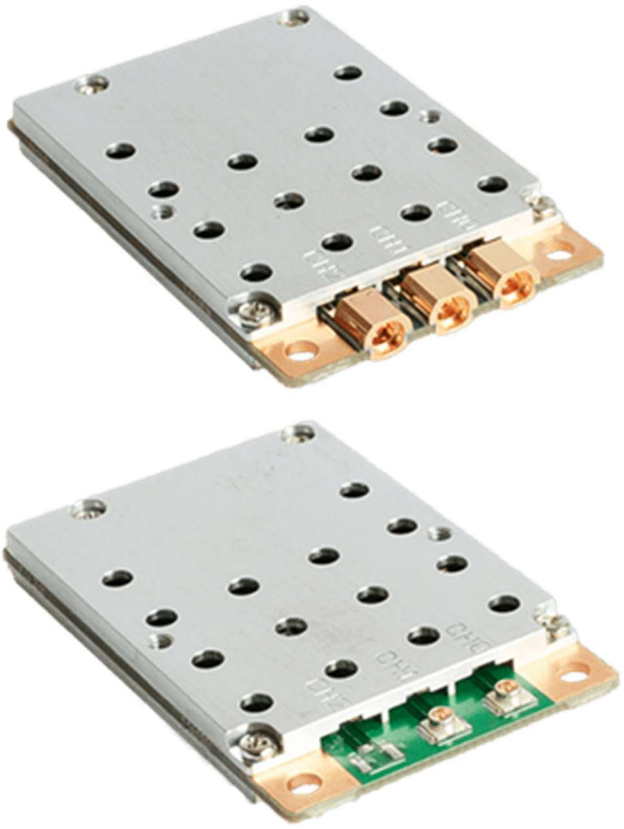
Datasheet: Doodle Labs NM-DB-3-R3 Wi-Fi® Radio Transceiver

Product Family Overview

Doodle Labs' portfolio of Wi-Fi® Radio Transceivers offer the industry's best-in-class performance. These transceivers have high transmit power to achieve long range and offer the rugged construction to withstand operation in the extended temperature range. In addition, our transceivers feature high interference immunity that allows successful operation in today's congested Wi-Fi environments. The transceivers are FCC, CE, and IC certified and have been deployed in numerous demanding applications.



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Target Applications

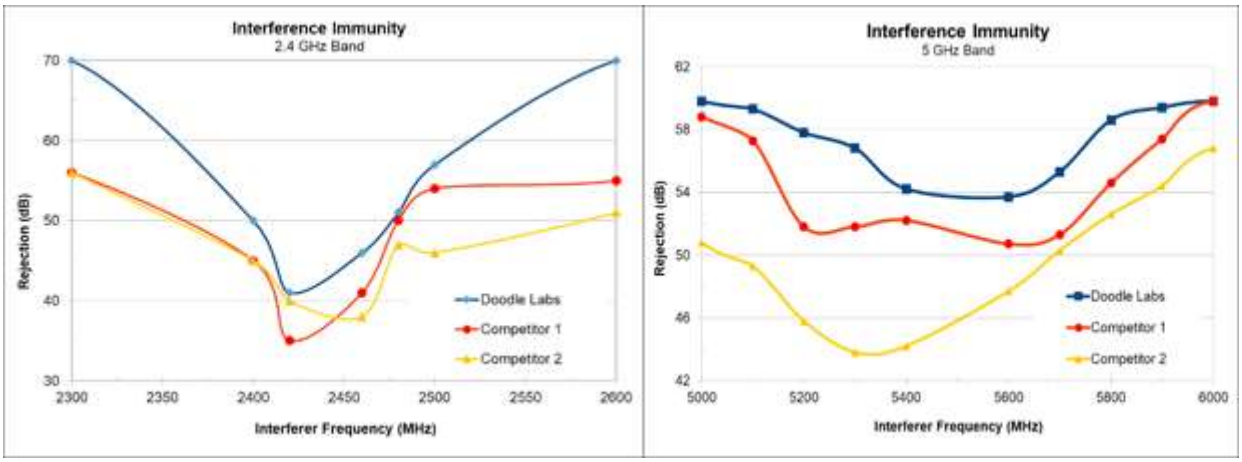
The Doodle Labs Wi-Fi® Radio Transceivers meet the demanding needs of customers across a broad range of industries. Examples include:

- Unmanned Vehicles - Drones
- Unmanned Robots
- Industrial IoT applications
- Rugged/Military requirements with extended temperature and vibration resiliency
- Mesh Networking deployments
- Passenger Wi-Fi access aboard airplanes and trains
- Streaming HD Video Surveillance Cameras
- Wireless Infrastructure in harsh operating conditions of the Oil/Gas fields and Mines

Features

Best-in-class features include:

- Modular FCC, CE and IC certifications to expedite system integration
- Integrated LNA for best-in-class Rx sensitivity to pick up low energy signals from mobile phones
- Up to 30 dBm of RF power to get the largest possible area coverage
- Extended temperature range from -40C to +85C.
- Electrical Stress protection on Antenna ports for outdoor operation
- Long product life cycle to meet the needs of Industrial IoT applications
- High interference immunity for Wi-Fi congested environment
- Hardware "RF Kill" feature to meet the FAA requirement for airborne applications
- High band isolation to support concurrent dual band operation for multi-band routers



Interference immunity performance compared to leading competitors

NM-DB-3-R3 Specifications

Technical Specifications

Model Number	NM-DB-3-R3 (Rugged/Military Applications)
Ordering Code	NM-DB-3M with MMCX connectors NM-DB-3U with U.FL connectors
Radio Configuration	3x3 MIMO, Dual Band
Special Features	•Extended lifespan with planned availability for long time •Extreme Reliability, IPC Class 2 standard with Class 3 options •Compliant to MIL-STD-202G, Qualified for high shock/vibration environments
MAC Chipset	Qualcomm Atheros: QCA9890-BR4B with Extended Temperature range
Software Support	Open Source Linux Drivers [ath10k](http://wireless.kernel.org/en/users/Drivers/ath10k) for 11ac models [OpenWRT](https://openwrt.org/) (Wireless Router/Linux OS)
Center Frequency Range	5.180 GHz ~ 5.825 GHz 2.412 GHz ~ 2.484 GHz This varies by the regulatory domain
Channel Bandwidth*	20, 40 MHz channels
Radio Modulation/Data Rates (Dynamic Link Adaptation)	802.11a: 6, 9, 12, 18, 24, 36, 48 and 54 Mbps (5.x GHz) 802.11n: MCS0-23 (5.x and 2.4 GHz) 802.11b/g: 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48 and 54 Mbps (2.4 GHz)
802.11n version 2.0 Capabilities	•802.11 dynamic frequency selection (DFS) as an AP and Client •Packet aggregation: A-MPDU (Tx/Rx), A-MSDU (Tx/Rx), Maximal ratio combining (MRC), Cyclic shift diversity (CSD), Frame aggregation, block ACK, 802.11e compatible bursting, Spatial multiplexing, cyclic-delay diversity (CDD), low-density parity check (LDPC), Space Time Block Code (STBC) •Phy data rates up to 450 Mbps (40 MHz channel)
Operating Modes	AP, Client, and Adhoc modes for Access Point, PtP, PtmP, and Mesh networks
MAC Protocol	TDD with Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)

Wireless Error Correction	FEC, ARQ
Wireless Data Security	128 bit AES, WEP, TKIP and WAPI hardware encryption. Support for IEEE 802.11d, e, h, i, k, r, v, w and time stamp standards
FIPS Certification	• Small packet size (96 bytes) in AES encryption at full packet rate. • FIPS 140-2, Level 2 (Temper Evidence Shield), Loop back mode to facilitate FIPS AES certification.

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Tx and Rx performance at 5 GHz

TX/RX Specification	Xtreme	Coding Rate	Tx Power(±2dBm)2	Rx Sensitivity (Typ)
5 GHz (20 MHz Channel) – 11n models				
802.11a, STBC	BPSK	1/2	27	-96
802.11a	64 QAM	3/4	22	-81
802.11n	BPSK	1/2	27	-96
802.11n	16 QAM	3/4	25	-84
802.11n	64 QAM	5/6	22	-75
5 GHz (40 MHz Channel) – 11n models				
802.11n	BPSK	1/2	27	-93
802.11n	16 QAM	3/4	25	-81
802.11n	64 QAM	5/6	22	-75

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Tx and Rx performance at 2.4 GHz

TX/RX Specification	Xtreme	Coding Rate	Tx Power(±2dBm)2	Rx Sensitivity (Typ)
2.4 GHz (20 MHz Channel) - 11n models				
802.11b	1 Mbps	CCK	29	-100
802.11g	64 QAM	3/4	24	-80
802.11n	BPSK	1/2	29	-95
802.11n	16 QAM	3/4	27	-83
802.11n	64 QAM	5/6	24	-76
2.4 GHz (40 MHz Channel) - 11n models				
802.11n	BPSK	1/2	29	-91
802.11n	16 QAM	3/4	27	-80
802.11n	64 QAM	5/6	24	-73

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Additional RF performance information

Antenna Signal Strength	-35 to -85 dBm (Recommended), Absolute Maximum=+12 dBm
Interference Immunity	SAW filters on RF ports for immunity against high power cellular transmissions in the neighboring 2.4 GHz bands.
Antenna port isolation for concurrent operation	Up to +10 dBm signal strength for 5 GHz signal without degrading 2.4 GHz operation Up to +5 dBm signal strength for 2.4 GHz signal without degrading 5.x GHz operation
Integrated Antenna Port Protection	10 kV
Receiver LNA Gain	>10 dB
Receiver Adjacent Channel Rejection (ACR)	>18 dB @ 11a, 6 Mbps (Typ)
Receiver Alternate Channel Rejection (ALCR)	>35 dB @ 11a, 6 Mbps (Typ)
Receive chain Noise Figure	+6 dB
Transmitter Adjacent Channel Leakage Power Ratio (ACLR)	45 dB (Fc ± ChBW)
Transmitter Spurious Emission Suppression	-40 dBc
RF Power control	In 0.5 dBm steps. Accuracy of power calibration loop ±2 dBm. Each transceiver individually calibrated and tested.
RF Hardware Disable (RF Kill)	Pin 20 of miniPCI-E interface. (Required for FAA compliance)
Spectral Analysis	8 bit resolution spectral FFTs available for software analysis

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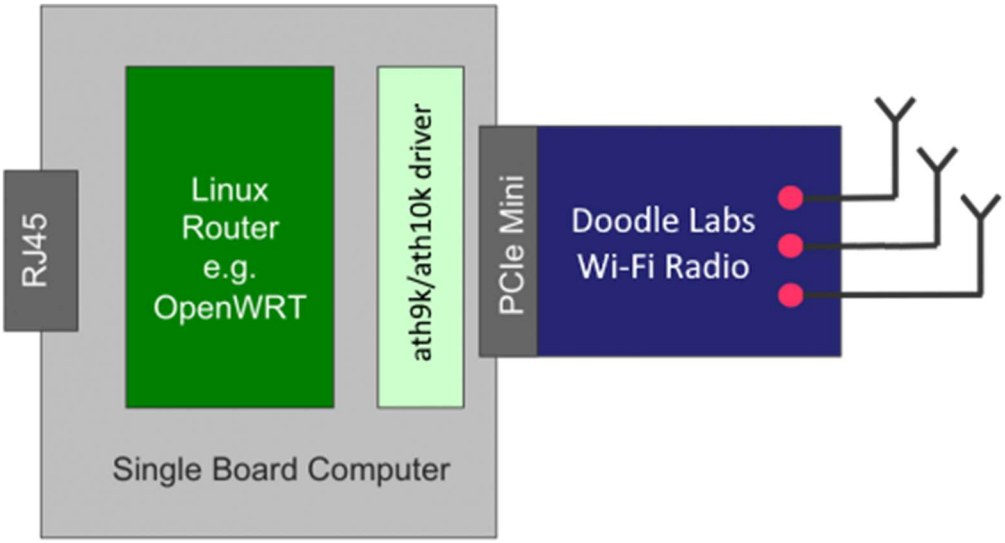
Physical, Environment, and Other Specifications

Host Interface	miniPCI-Express 1.2 Standard
Host CPU Board	Any CPU board with miniPCIe interface
Operating Voltage	3.3 Volts from miniPCI-Express connector
Power Consumption	5.3W @ Max power, in continuous data transfer mode on all chains 2.5W @ 20 dBm power (ETSI max), in continuous data transfer mode on all chains 0.9W in continuous data receive mode 250 mW in Sleep mode
Shield case temperature range (Operating)	-40°C to +85°C
Humidity (Operating)	0% - 95% (Non-condensing)
Dimensions	30 x 50 x 4.75 mm, 12 grams. High Res Photos - Mechanical drawings and 3D-CAD files available upon request
MTBF	27 years
Regulatory Requirements	Designed and verified to meet various regulatory requirements. Formal testing and approval is required based on the Integrator's particular host platform and antenna type. The Integrator is also responsible for obtaining all required regulatory approvals in target markets for the finished product.
FCC ID	2AG87NM-DB-3-R3 (In Progress)
CE/ETSI	Conforms with all the requirements of the European Directive 2014/53/EU – EN IEC 62368-1:2020+A11:2020, EN IEC 62311:2020, EN 301 489-17 V3.3.1, EN 301 489-3 V2.3.2, EN 301 489-1 V2.2.3, EN 300 328 V2.2.2, EN 301 893 V2.1.1, EN 300 440 V2.2.1 (In Progress)
Industry Canada (IC)	21411-NMDB3R3 (In Progress)
RoHS/WEEE Compliance	Yes. 100% Recyclable/Biodegradable packaging
EXPORT INFORMATION	
ECCN Code	5A992
HS Code	85256010

System Integration



System Integration Block Diagram

As shown in the block diagram, the modular nature of the MIMO radio transceivers allow for accelerated development of the wireless modem. Any embedded Single Board Computer with standard miniPCI-Express interface is required. The Linux distribution OpenWRT has evolved over time and provides advanced features in a wireless router. It is a stable distribution and many OEMs are using OpenWRT as a starting point and customize further for their application. The distribution includes the ath10k driver to interface with the MIMO transceivers. Both OpenWRT and open source drivers (ath9k and ath10k) have extensive online documentation available. User group forums also provide responsive technical support.

Portfolio Index

Doodle Labs' Wi-Fi® Radio Transceiver portfolio provides configurations optimized for a vast variety of project needs. All models are form-factor compatible. For information on other models, please visit - https://doodlelabs.com/industrial-wifi-transceivers/

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FCC Statement

1, List of applicable FCC rules

FCC standards: FCC CFR Title 47 Part 15 Subpart C Section 15.407, 15.247

2, Summarize the specific operational use conditions

The modular can be installed or integrated in a host with minimum distance of 20 cm between the radiator and user body. This modular cannot be installed in portable device if without further certification such as C2PC with SAR. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. We will retain control over the final installation of the modular such that compliance of the end product is assured. In such cases, an operating
condition on the limit modular approval for the module must be only approved for use when installed in devices produced by a specific manufacturer.

3, Trace antenna designs

The module comply with all specific rules applicable to the transmitter including all the conditions provided in the integration instructions by the grantee, Refer to test report. EUT consists of three External antennas.
Nominal Impedance：50 ohms
Antenna gain:
Antenna 0: 3dBi
Antenna 1: 3dBi
Antenna 2: 3dBi
The concrete contents of a check are the following three points.
1) It is the same type as the antenna type of antenna specifications.
2) An antenna gain is lower than a gain given in antenna specifications.
Measure the gain, and confirm the peak gain is less than the application value.
3) The emission level is not getting worse.
The antenna shall not be accessible for modification or change by the end user

4, Single module procedures

The Module is a Single module, Refer to the manual for detailed instructions.

5, RF exposure considerations

FCC Radiation Exposure Statement
The modular can be installed or integrated in a host with a fix or mobile position. This modular cannot be installed in any portable device if without further certification such as C2PC with SAR. This modular complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

6, Antenna

The module comply with all specific rules applicable to the transmitter including all the conditions provided in the integration instructions by the grantee, Refer to test report. EUT consists of three External antennas.
Input Impedance：50-ohm

Antenna gain:
Antenna 0: 3dBi
Antenna 1: 3dBi
Antenna 2: 3dBi

7, Label and compliance information

If the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module ID: 2AG87NM-DB-3-R3" When the module is installed inside another device, the user manual of the host must contain below warning Statements; 1. 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;
(2) This device must accept any interference received, including interference that may cause undesired operation.

8, Information on test modes and additional testing requirements

The module comply with all specific rules applicable to the transmitter including all the conditions provided in the integration instructions by the grantee, Refer to test report

9, Additional testing, Part 15 Subpart B disclaimer

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part15 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.
Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product.
Any company of the host device which install the modular with modular approval should perform the test of FCC Part 15B requirement.

ISED Statement

1, List of applicable ISED rules

ISED standards: RSS-Gen Issue 5, RSS-247 Issue 4

2, Summarize the specific operational use conditions

5150MHz-5250MHz indoor use only.

The modular can be installed or integrated in a host with minimum distance of 20 cm between the radiator and user body. This modular cannot be installed in portable device if without further certification such as C2PC with SAR. If the end product will involve the Multiple simultaneously transmiting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. We will retain control over the final installation of the modular such that compliance of the end product is assured. In such cases, an operating condition on the limit modular approval for the module must be only approved for use when installed in devices produced by a specific manufacturer.

3, Trace antenna designs

The module comply with all specific rules applicable to the transmitter including all the conditions provided in the integration instructions by the grantee, Refer to test report. EUT consists of three External antennas.

Nominal Impedance:50 ohms

Antenna gain:

Antenna 0: 3dBi

Antenna 1:3dBi

Antenna 2:3dBi

The concrete contents of a check are the following three points.

1) It is the same type as the antenna type of antenna specifications.

2) An antenna gain is lower than a gain given in antenna specifications.

Measure the gain, and confirm the peak gain is less than the application value.

3) The emission level is not getting worse.

The antenna shall not be accessible for modification or change by the end user

4, Single module procedures

The Module is a Single module, Refer to the manual for detailed instructions.

5, RF exposure considerations

ISED Radiation Exposure Statement

The modular can be installed or integrated in a host with a fix or mobile position. This modular cannot be installed in any portable device if without further certification such as C2PC with SAR. This modular complies with ISED RF radiation exposure limits set forth for an uncontrolled environment. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

6, Antenna

The module comply with all specific rules applicable to the transmitter including all the conditions provided in the integration instructions by the grantee, Refer to test report. EUT consists of three External antennas.

Input Impedance: 50-ohm

Antenna gain:
Antenna 0: 3dBi
Antenna 1: 3dBi
Antenna 2:3dBi

7, Label and compliance information

If the ISED identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module IC: 21411-NMDB3R3 Or Contains IC: 21411-NMDB3R3 ”.When the module is installed inside another device, the user manual of the host must contain below warning Statements:
(1) This device may not cause harmful interference;
(2) This device must accept any interference received, including interference that may cause undesired operation.

8, Information on test modes and additional testing requirements

The module comply with all specific rules applicable to the transmitter including all the conditions provided in the integration instructions by the grantee, Refer to test report

9, Additional testing, disclaimer

This device contains licence-exempt transmiter(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.

Déclaration d'ISDE

1, Liste des règles ISDE applicables

Normes ISDE : RSS-Gen, édition 5, RSS-247, édition 4

2. Résumer les conditions d'utilisation opérationnelles spécifiques

5150 MHz-5250 MHz - Usage intérieur uniquement.

Le module peut être installé ou intégré dans un hôte, avec une distance minimale de 20 cm entre le radiateur et l'utilisateur. Il ne peut pas être installé dans un appareil portable sans certification supplémentaire, telle que C2PC avec DAS. Si le produit final implique des conditions de transmission simultanée multiples ou des conditions de fonctionnement différentes pour un émetteur modulaire autonome dans un hôte, le fabricant de l'hôte doit consulter le fabricant du module pour la méthode d'installation dans le système final. Nous conserverons le contrôle de l'installation finale du module afin de garantir sa conformité. Dans ce cas, une condition de fonctionnement relative à l'homologation modulaire limite du module doit être approuvée uniquement pour une utilisation dans des appareils produits par un fabricant spécifique.

3. Conceptions d'antennes de trace

Le module est conforme à toutes les règles spécifiques applicables à l'émetteur, y compris toutes les conditions fournies dans les instructions d'intégration du bénéficiaire. Voir le rapport d'essai. L'EUT est composé de trois antennes externes.

Impédance nominale : 50 ohms

Gain d'antenne :

Antenne 0 : 3 dBi

Antenne 1 : 3 dBi

Antenne 2 : 3 dBi

Les points suivants doivent être vérifiés :

1) Le type d'antenne est identique à celui spécifié dans les spécifications de l'antenne.

2) Le gain de l'antenne est inférieur au gain indiqué dans les spécifications de l'antenne.

Mesurer le gain et confirmer que le gain de crête est inférieur à la valeur d'application.

3) Le niveau d'émission n'est pas altéré.

L'antenne ne doit pas être accessible à l'utilisateur final pour modification ou remplacement.

4. Procédures pour module unique

Le module est un module unique. Se référer au manuel pour des instructions détaillées.

5. Considérations relatives à l'exposition aux RF

Déclaration d'ISED concernant l'exposition aux rayonnements

Le module peut être installé ou intégré dans un appareil hôte fixe ou mobile. Ce module ne peut pas être installé dans un appareil portable sans certification supplémentaire, telle qu'une certification C2PC avec mesure du DAS. Ce module est conforme aux limites d'exposition aux rayonnements RF d'ISED établies pour un environnement non contrôlé. Ce module doit être installé et utilisé avec une distance minimale de 20 cm entre l'antenne et le corps de l'utilisateur.

6. Antenne

Le module est conforme à toutes les règles spécifiques applicables à l'émetteur, y compris toutes les conditions fournies dans les instructions d'intégration par le titulaire de la licence. Se référer au rapport d'essai. L'équipement testé (EUT) est composé de trois antennes externes.

Impédance d'entrée : 50 ohms

Gain d'antenne :

Antenne 0 : 3 dBi

Antenne 1 : 3 dBi

Antenne 2 : 3 dBi

7. Étiquette et informations de conformité

Si le numéro d'identification ISED n'est pas visible lorsque le module est installé à l'intérieur d'un autre appareil, l'extérieur de l'appareil hôte doit également comporter une étiquette faisant référence au module intégré. Cette étiquette extérieure peut utiliser une formulation telle que : « Contient le module émetteur IC : 21411-NMDB3R3 » ou « Contient IC : 21411-NMDB3R3 ». Lorsque le module est installé à l'intérieur d'un autre appareil, le manuel d'utilisation de l'appareil hôte doit contenir les avertissements suivants :

(1) Cet appareil ne doit pas causer d'interférences nuisibles ;

(2) Cet appareil doit accepter toute interférence reçue, y compris les interférences susceptibles de provoquer un fonctionnement indésirable.

8. Informations sur les modes de test et les exigences de test supplémentaires

Le module est conforme à toutes les règles spécifiques applicables à l'émetteur, y compris toutes les conditions fournies dans les instructions d'intégration par le titulaire de la licence. Se référer au rapport d'essai.

9. Tests supplémentaires, clause de non-responsabilité

Cet appareil contient des émetteurs/récepteurs exempts de licence conformes aux normes RSS (Radio Standards Specifications) d'Innovation, Sciences et Développement économique Canada. Son fonctionnement est soumis aux deux conditions suivantes :

(1) Cet appareil ne doit pas causer d'interférences.

(2) Cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil.

Antenna Type: External Antenna

Antenna Gain:

ANT0: 3 dBi

ANT1: 3 dBi

ANT2: 3 dBi

Frequency Range:

2.4G WIFI: 2412MHz~2462MHz

5G WIFI:

Band 1: 5180MHz~5240MHz

Band 3: 5745MHz~5825MHz