

Operating Manual

nMIMO2458

2.4/5.8 GHz High Speed 1W Module

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nMIMO2458 Regulatory Requirements



WARNING:

To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 23 cm (33cm IC) or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.



WARNING:

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.



WARNING:

Changes or modifications not expressly approved by Microhard Systems Inc. could void the user's authority to operate the equipment. This device has been tested with UFL to Reverse Polarity SMA connectors with the antennas listed in Appendix A. When integrated in OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions).



WARNING:

MAXIMUM EIRP: Cannot exceed 31.51 dBm EIRP in 2.4 GHz band. Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 31.51 dBm.



WARNING:

MAXIMUM EIRP: For devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits specified for point-to-point and non-point-to-point operation.



WARNING:

Be advised that high-power radars are allocated as primary users (i.e. priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and that these radars could cause interference and/or damage to LE-LAN devices.



WARNING:

EQUIPMENT LABELING: The FCC and IC numbers depend on the model of the radio module. Do NOT use the Marketing Name of the product but the Model to distinguish the Certifications Numbers. This device has been modularly approved. The manufacturer, product name, and FCC and Industry Canada identifiers of this product must appear on the outside label of the end-user equipment.



WARNING:

This device complies with Industry Canada's license-exempt RSSs. 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.



WARNING:

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.

SAMPLE LABEL REQUIREMENT for Model: nMIMO2458:

Contains:

FCC ID: NS915NM2458 IC : 3143A-15NM2458

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.

nMIMO2458 Exigences Réglementaires



WARNING:

Pour satisfaire aux exigences de la FCC d'exposition RF pour la base et mobiles sur une distance de séparation de 23 cm (33cm IC) ou plus doit être maintenue entre l'antenne de cet appareil et des personnes lors de fonctionnement du dispositif. Pour assurer la conformité des opérations au plus près que cette distance n'est pas recommandée. L'antenne utilisée pour ce transmetteur ne doit pas être co-localisés en conjonction avec toute autre antenne ou transmetteur.



WARNING:

Son fonctionnement est soumis aux deux conditions suivantes : (1) ce dispositif ne doit pas causer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, incluant les interférences qui peuvent provoquer un fonctionnement indésirable .



WARNING:

Les changements ou modifications non expressément approuvés par Microhard Systems Inc. pourraient annuler l'autorité de l'utilisateur à utiliser l'équipement . Ce dispositif a été testé avec UFL et connecteurs SMA à polarité inverse sur les antennes répertoriées à l'annexe A Lorsqu'il est intégré dans les produits OEM , antennes fixes nécessitent une installation empêchant les utilisateurs finaux de les remplacer par des antennes non approuvées . Antennes ne figurant pas dans les tableaux doivent être testés pour se conformer à la Section 15.203 (connecteurs d'antenne uniques) et à la Section 15.247 (émissions) .



WARNING:

MAXIMUM EIRP: Vous ne pouvez pas dépasser 31.51 dBm EIRP dans la bande de 2,4 GHz. Par conséquent, la somme de la puissance émise (en dBm), la perte de câblage et le gain d'antenne ne peut pas dépasser 31.51 dBm.



WARNING:

MAXIMUM EIRP: Pour les appareils avec antenne (s) détachable , le gain d'antenne maximal autorisé pour les appareils dans la bande 5725-5850 MHz doit être telle que l'équipement satisfait encore la pire limites spécifiées pour un fonctionnement point à point et non point -à-point.



WARNING:

Soyez avisé que les radars à haute puissance sont désignés comme utilisateurs principaux (ieprioirty utilisateurs) des bandes 5250-535 0 MHz et de 5650 à 5850 MHz et que ces radars pourraient provoquer des interférences et / ou endommager les appareils LE- LAN .



WARNING:

ÉQUIPEMENT DE MARQUAGE: Les numéros FCC et IC dépendent du modèle du module radio . Ne pas utiliser le nom marketing du produit, mais le modèle de distinguer les numéros Certifications . Ce dispositif a été approuvé de façon modulaire . Le fabricant , nom du produit, et les indicateurs de la FCC et d'Industrie Canada de ce produit doivent figurer sur l'étiquette à l'extérieur de l'équipement de l'utilisateur final .



WARNING:

Cet appareil est conforme aux CNR exempts de licence d'Industrie Canada . Son fonctionnement est soumis aux deux conditions suivantes : (1) Ce dispositif ne peut causer des interférences ; et (2) Ce dispositif doit accepter toute interférence , y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.



WARNING:

NOTE : Cet équipement a été testé et jugé conforme aux limites d' un dispositif numérique de classe B, conformément à la partie 15 des règles de la FCC . Ces limites sont conçues pour fournir une protection raisonnable contre les interférences nuisibles dans une installation résidentielle . Cet équipement génère , utilise et peut émettre de l'énergie radiofréquence et, si non installé et utilisé conformément aux instructions , peut provoquer des interférences dans les communications radio . Cependant , il n'y a aucune garantie que des interférences ne se produiront pas dans une installation particulière . Si cet équipement provoque des interférences nuisibles à la réception radio ou de télévision , ce qui peut être déterminé en allumant et éteignant l'équipement , l'utilisateur est encouragé à essayer de corriger l'interférence par une ou plusieurs des mesures suivantes :

- Réorienter ou déplacer l'antenne de réception .
- Augmentez la distance entre l' équipement et le récepteur.
- Connecter l'équipement à une sortie sur un circuit différent de celui sur lequel est branché le récepteur.
- Consulter le revendeur ou un technicien radio / TV expérimenté.

SAMPLE LABEL REQUIREMENT for Model: nMIMO2458:

Contains:

FCC ID: NS915NM2458 IC : 3143A-15NM2458

Cet appareil est conforme à la partie 15 des règles de la FCC . Son fonctionnement est soumis aux deux conditions suivantes : (1) ce dispositif ne doit pas causer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, incluant les interférences qui peuvent provoquer un fonctionnement indésirable .

Co-Location with Cellular Modems

The maximum calculated MPE ratio for the EUT with 2 dBi dipole antenna is 0.238, this configuration can be co-located with other antennas provided the sum of the MPE ratios for all the other simultaneous transmitting antennas incorporated in a host device is $\leq 1.0 - 0.238 \leq 0.762$. The following co-location were evaluated for mobile configurations:

- 1) EUT with 2 dBi dipole antenna co-located with Data Card Module (FCC ID RI7LN930, IC: 5131A-LN930)
- 2) EUT with 2 dBi dipole antenna co- located with LTE Data Transmitter Module (FCC ID R5Q-TOBYL100, IC 8595B-TOBYL100)
- 3) EUT with 2 dBi dipole antenna co- located with GSM/UMTS/LTE Data Module (FCC ID XPYTOBYL200, IC 8595A-TOBYL200)

Co - localisation avec Cellular Modem

Le maximum calculé rapport EMT pour l'EST avec antenne dipôle 2 dBi est de 0,238 , cette configuration peut être co- située avec d'autres antennes à condition que la somme des rapports MPE pour tous les autres antennes de transmission simultanées incorporés dans un dispositif hôte est $< 1,0$ à $0,238 < 0,762$. Le co- emplacement suivant ont été évalués pour les configurations mobiles :

- 1) EUT avec 2 dBi antenne dipôle co-localisé avec module de carte de données (FCC ID RI7LN930 , IC : 5131A - LN930)
- 2) EUT avec 2 dBi antenne dipôle co- localisé avec LTE données Module émetteur (FCC ID R5QTOBYL100 , IC 8595B - TOBYL100)
- 3) EUT avec 2 dBi antenne dipôle situé coopération avec les réseaux GSM / UMTS / LTE du module de données (FCC ID XPYTOBYL200 , IC - 8595A TOBYL200)

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2. General

2.0 Product Overview

The nMIMO2458 is a high-performance embedded wireless data transceiver. Operating in the 2400 – 2483.5 MHz or 5725 – 5875 MHz ISM bands (selectable), this spread-spectrum module is capable of providing reliable wireless data transfer between almost any type of equipment. The small-size and superior RF performance of this module make it ideal for many applications.

While a pair of nMIMO2458 modules can link two terminal devices (“point-to-point” operation); multiple modules can be used together to create a network of various topologies, including “point-to-multipoint” and “repeater” operation. Multiple independent networks can operate concurrently, so it is possible for unrelated communications to take place in the same or a nearby area without sacrificing privacy or reliability.

1.1 Features

Key features of the nMIMO2458 include:

- transmission within a public, license-exempt band(s) of the radio spectrum¹ – this means that it can be used without access fees (such as those incurred by cellular airtime).
- Up to 30dB transmit power in 2.4GHz mode, or up to 20dB in 5.8 GHz mode.
- a serial I/O data port with handshaking and hardware flow control, allowing the nMIMO2458 to interface directly to any equipment with an asynchronous serial interface.
- ease of installation and use – the nMIMO2458 module uses a subset of standard AT style commands, very similar to those used by traditional telephone line modems.
- all units in a system are physically identical, and can be configured as a master, repeater or slave using the AT command set. No hardware modifications are required
- 128 sets of user-selectable pseudo-random hopping patterns, intelligently designed to offer the possibility of separately operating multiple networks while providing security, reliability and high tolerance to interference.
- encryption key with 65536 user-selectable values to maximize security and privacy of communications.
- 32-bit of CRC error detection and auto re-transmit to provide accuracy and reliability of data.

¹ 2400-2483.5 MHz or 5725 – 5875 MHz, which are license-free within North America; may need to be factory-configured differently for some countries.

- TDMA (time division multiple access) support, allowing multi-slave access in point-to-point mode.
- roaming ability, allowing repeaters and slaves to re-synchronize with a new master if the synchronization pulse from the original master is lost.

While the typical application for the nMIMO2458 is to provide a short- to mid-range wireless communications link between DTEs, it can be adapted to almost any situation where an asynchronous serial interface is used and data intercommunication is required.

2.1 Output Power Level

The Output Power Level determines at what power the nMIMO2458 transmits. The nMIMO2458's sensitive receiver can operate with very low power levels, so it is recommended that the lowest power necessary is used; using excessive power contributes to unnecessary "RF pollution".

Ideally, you should test the communications performance between units starting from a low power level and working upward until the RSSI is sufficiently high and a reliable link is established. The conditions will vary widely between applications, the output power settings can be calculated based on following information.

- Transmitter antenna gain
- Cable loss
- Equivalent Isotropically Radiated Power (EIRP)

$$\text{Power Setting} = 31.51 - \text{Antenna Gain} - \text{Cable Loss}$$

The power setting must be no more than the above calculation value.

Table 1 Output Power

Power Setting (dBm)	Approx. Output Power (mW)
20	100
21	125
22	160
23	200
24	250
25	320
26	400
27	500
28	630
29	800
30	1000

3. Installation

3.0 Overview

The nMIMO2458 complies with FCC part 15 at the modular level for operation in the license-free 2400-2483.5 MHz or 5725 – 5875 MHz ISM bands. This chapter provides guidelines for installing and deploying equipment which incorporates the nMIMO2458 module.

3.1 Estimating the Gain Margin

Successful communication between nMIMO2458 modules is dependent on three main factors:

- System Gain
- Path Loss
- Interference

System gain is a calculation in dB describing the performance to be expected between a transmitter-receiver pair. The number can be calculated based on knowledge of the equipment being deployed. The following four factors make up a system gain calculation:

1. Transmitter power (user selectable)
2. Transmitter gain (transmitting antenna gain minus cabling loss between the transmitting antenna and the nMIMO2458 module)
3. Receiver gain (Receiving antenna gain minus cabling loss between the receiving antenna and the module)
4. Receiver sensitivity (Specified as -108dBm on the nMIMO2458 module)

In the following illustration, the transmitting antenna has a gain of 2 dB, and the receiving antenna has a gain of 2 dB. The cable loss between the module and the antenna is 0.49 dB on both the transmitting and receiving side.

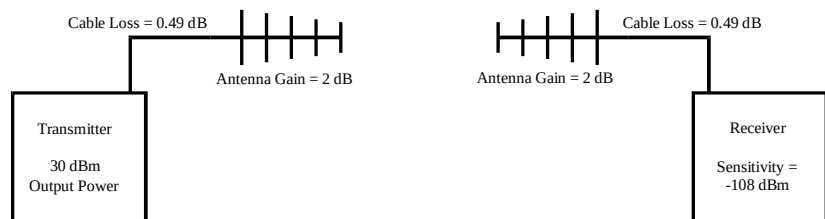


Figure 1 Gain Calculation

The power level has been set to 30dBm (1W) on the transmitter, and the receiver sensitivity for the nMIMO2458 is -108dBm.

System gain would be calculated to be:

$$30 - 0.49 + 2 + 2 - 0.49 + 108 = 141 \text{ dB.}$$

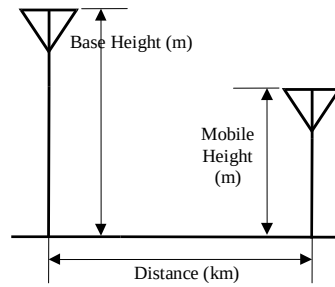


Figure 2 System Deploying

When deploying your system, care must be taken to ensure the **path loss** (reduction of signal strength from transmitter to receiver in dB) between equipment does not exceed the system gain (141 dB in the above example). It is recommended to design for a **gain margin** of at least 20 dB to ensure reliable communication. Gain margin is the difference between system gain and path loss. Referring to the same example, suppose the path loss is 100 dB, the gain margin would be 41 dB, which is more than adequate for reliable communication.

Path loss is a very complicated calculation which mainly depends on the terrain profile, and the height of the antennas off the ground.

The following table provides path loss numbers for varying antenna heights and antenna separation: These numbers are real averages taken from rural environments. They do not apply to urban, non-line-of-sight environments.

Table 2 Path Loss

Distance (km)	Base Height (m)	Mobile Height (m)	Path Loss (dB)
5	15	2.5	116.5
5	30	2.5	110.9
8	15	2.5	124.1
8	15	5	117.7
8	15	10	105
16	15	2.5	135.3
16	15	5	128.9
16	15	10	116.2
16	30	10	109.6
16	30	5	122.4
16	30	2.5	128.8

Once the equipment is deployed, you can verify the signal strength by entering into Command Mode and reading Register S123. This register provides the average signal strength in dBm. The minimum strength for communication is roughly -108dBm. For consistent reliable communication, you should try to deploy the equipment such that signal strength exceeds -90dBm.

3.2 Antennas and Cabling

This section describes the recommended procedure for installing cabling and antennas for use with the nMIMO2458 module.

3.2.1 Internal Cabling

The most common method for installing the module is to run a cable from the module's UFL connector to a reverse TNC bulkhead connector on the chassis of the equipment as shown in Figure 3. This cable can be purchased from Microhard Systems.

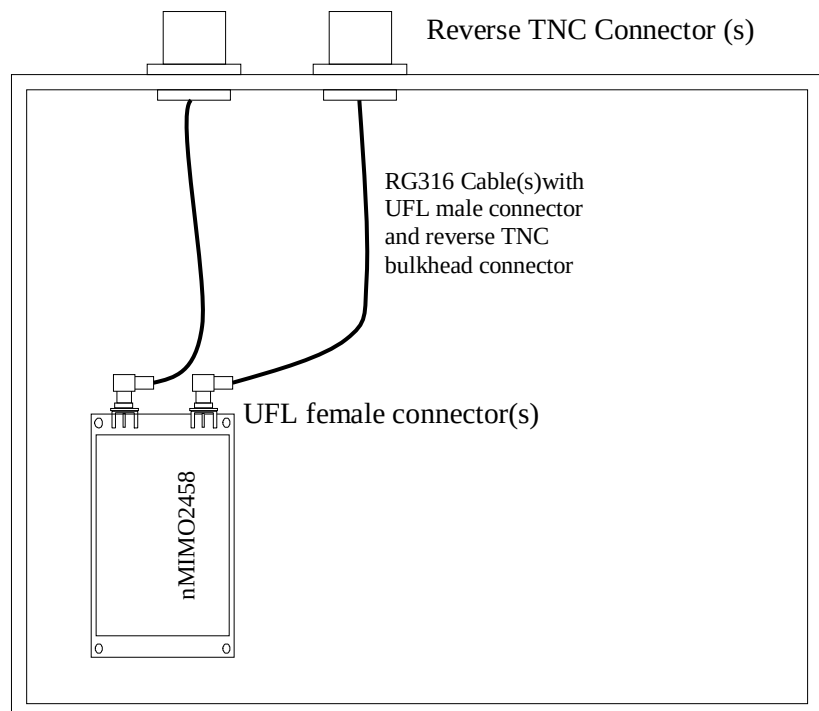


Figure 3 Suggested Internal Cabling

Cable losses are negligible for the short piece used within the chassis. Additional losses up to 0.5 dB may be present in the UFL and Reverse TNC connections.



WARNING:

MAXIMUM EIRP

Up to 31.51 dBm effective isotropically radiated power (EIRP) in 2.4 GHz Band.

Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 31.51 dBm with respect to the isotropic radiator.



WARNING:

The nMIMO2458 can only be used with any antennas listed in Appendix A.



WARNING:

Be careful with dBi vs dBd gains on antenna specifications.

Antenna manufactures may not clearly indicate the gain on the antenna if it is dBd or dBi. Note 1dBd = 2.15dBi.

3.2.2 Antennas

Direct human contact with the antenna is potentially unhealthy when the nMIMO2458 is generating RF energy. Always ensure that the nMIMO2458 equipment is powered down during installation. At all times a distance of 23 cm (33cm for Industry Canada) must be maintained between the antenna and any person when the device is in operation.

Antenna Type

The nMIMO2458 is tested and approved to be used with a Rubber Ducky, Omni-directional antenna which is suitable for applications where there are multiple units that you must communicate with, or with units that are in motion.

Antenna Type Note (Rubber Ducky):

Maximum Gain of 2dBi for 2.4GHz Band with a minimum cable loss of 0.49, the antenna assembly gain shall not exceed (2 – 0.49) dBi.

Maximum Gain of 3dBi for 5.8GHz Band with a minimum cable loss of 1.02, the antenna assembly gain shall not exceed (3 –1.02) dBi.

Microhard Systems Inc. can provide you with approved antennas to ensure FCC and Industry Canada compliance.

The nMIMO2458 (2.4 GHz Band) has a maximum of 31.51 dBm effective isotropically radiated power (EIRP).

EIRP is calculated as follows:

$$\text{EIRP} = \text{Tx Power(dBm)} - \text{Cable/Connector Loss(dB)} + \text{Ant Gain(dBi)}$$

Antenna Gains must be in dBi when calculating the EIRP limit.

$$1\text{dBd} = 2.15\text{dBi}$$

Use the guidelines in the previous section for calculating cable and connector losses. If cabling and connector losses are 2 dB, then the maximum allowable gain of the antenna will be 2 dB.

Maximum Antenna, Power and EIRP values for nMIMO2458

Band	Antenna (Rubber Ducky)	Power Level	Minimum Cable / Loss	EIRP
2.4 GHz	2 dBi	30dBm	0.49dBi	31.51dBm
5.8 GHz	3 dBi	24.33dBm	1.02dBi	26.31dBm

A. Approved Antennas

This radio transmitter (IC:3143A-15NM2458) has been approved by *Industry Canada* to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet émetteur radio (IC : 3143A – 15NM2458) a été approuvé par *Industrie Canada* pour fonctionner avec les types d'antenne énumérés ci-dessous avec le gain maximal admissible indiqué . Types d'antennes ne figurant pas dans cette liste, ayant un gain supérieur au gain maximum indiqué pour ce type, sont strictement interdits pour une utilisation avec cet appareil.

Part Number	Description
Rubber Ducky	
MHS031100	2dBi, 2.4GHz Rubber Ducky Antenna RPTNC Swivel
MHS031110	2dBi, 2.4GHz Rubber Ducky Antenna Reverse SMA Swivel
MHS031120	2dBi, 2.4GHz Rubber Ducky Antenna Reverse SMA Straight
MHS035030	2dBi, Dual Band 5 GHz Rubber Ducky Reverse SMA Swivel



WARNING:

Changes or modifications not expressly approved by Microhard Systems Inc. could void the user's authority to operate the equipment. This device has been tested with UFL connectors with the antennas listed in Appendix A. When integrated in OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions). Please Contact Microhard Systems Inc. if you need more information.

Industry Canada: This device has been designed to operate with the antennas listed above, and having a maximum gain of 2 dBi (3 for 5.8GHz Band). Antennas not included in this list or having a gain greater than 2 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication. This Class B digital apparatus complies with Canadian ICES-003.

Industrie Canada: Cet appareil a été conçu pour fonctionner avec les antennes énumérées ci-dessus, et ayant un gain maximal de 2 dBi(3 à 5.8GHz). Antennes pas inclus dans cette liste ou présentant un gain supérieur à 2 dBi sont strictement interdits pour une utilisation avec cet appareil. L'impédance d'antenne requise est de 50 ohms. Pour réduire les interférences radio potentielles pour les autres utilisateurs, le type d'antenne et son gain doivent être choisis afin que la puissance isotrope équivalente (EIRP) ne soit pas supérieure à celle requise pour une communication réussie rayonnée. Cet appareil numérique de classe B est conforme à la norme ICES -003 du Canada.