

GEM3NFC
Hardware Manual
Version .2
October 30, 2019

NORTH POLE ENGINEERING INTELLECTUAL PROPERTY

THIS DOCUMENT IS INTENDED FOR USE BY APPLICATION DEVELOPERS TO CREATE APPLICATIONS COMPATIBLE WITH THE NORTH POLE ENGINEERING GEM MODULE. USE OF THE TECHNICAL INFORMATION CONTAINED IN THIS DOCUMENT TO CREATE COMPETING HARDWARE TO THE NORTH POLE ENGINEERING GEM MODULE IS STRICTLY PROHIBITED.

Revision History

| Version | Revision Date | Change History |
|---------|------------------|--------------------------|
| 0.1 | October 2, 2019 | Initial draft |
| 0.2 | October 30, 2019 | Added mechanical drawing |
| | | |
| | | |

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GEM3NFC Hardware Manual

Overview and Key Features

The GEM3NFC module is been designed to allow OEMs to easily add Bluetooth, ANT+, Apple GymKit, Samsung Galaxy Active/Active 2 and NFC reader connectivity in their product offering. The GEM3NFC module incorporates North Pole Engineering GEMHCI protocol software specifically designed to enable fitness machines such as treadmills, exercise bikes, ellipticals, stair climbers and step machines to wirelessly communicate exercise data with the Apple Watch, smart phones, tablets, fitness watches, and leaderboard software systems.

The GEM3NFC module is based on Nordic Semiconductor's nRF52840 multi-protocol Bluetooth and ANT+ chipset and integrates NXP's PN7150X NFC reader controller. There is also space on the board for the Apple authentication 3.0 coprocessor to be mounted for applications where Apple GymKit support is needed. The GEM3NFC module offers a serial host interface and has a maximum transmit power of +8dBm, and a sensitivity of -95dBm. This manual is intended to assist with hardware integration of the GEM3NFC module into a given design. Details on North Pole Engineering's GEMHCI protocol software can be found at <http://npe-inc.zendesk.com>.

Features

- -95 dBm sensitivity
- TX Power-20 to +8dBm in 4dB steps
- 240m line of sight range @ +8dBm
- 15 mA peak TX @ 8dB, 6.2mA @ 0dBm
- 4.6 mA peak RX
- 1dB dB RSSI resolution
- ARM® Cortex™M4F 32 bit processor running at 64MHz
- 1MB embedded flash memory and 256 kB RAM
- Serial Host Interface
- AES HW encryption
- FCC, CE, IC certified
- Integrated Bluetooth, ANT, and NFC antennas
- RoHS compliant
- Bluetooth End Product Listed
- Integrated GEMHCI software
- Integrated support for ANT+ FE and Bluetooth FTMS
- ANT+ and BLE HRM scanning and connection
- Integrated NFC tap to pair support for wearables including Apple Watch through GymKit and Samsung Galaxy Active/Active2 Watches and

Specification

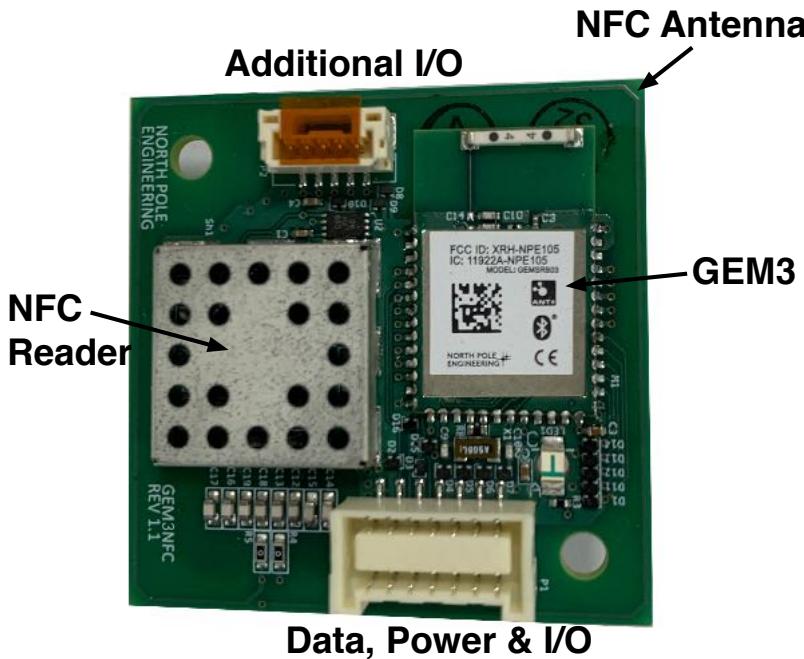
Specification Summary

| Category | Feature | Implementation |
|-------------------|---------------------------------|--------------------------------------------------|
| RF | Bluetooth | 4.2 Single Mode Peripheral |
| | ANT+ | Broadcast |
| | Frequency | 2.402-2.480 GHz |
| | Maximum Transmit Power | +8dBm |
| | Minimum Transmit Power | -20dBm |
| | Receive Sensitivity | -95dBm |
| | Range | up to 360m line of sight |
| NFC | Reader | Tag Type 1,2,3,4,5 |
| | Frequency | 13.56MHz |
| | Read/Write mode | MIFARE, FeliCA, ISO/IEC 14443 A/B, ISO/IEC 15893 |
| | Peer to Peer mode | ISO/IEC 18092 target and initiator |
| | Card emulation mode | NFC Forum T4T |
| Peripherals | Serial Host Interface | TX, RX 115.2kbps n,8,1 |
| FW Upgrade | North Pole Engineering Firmware | Over the air Via JTAG interface |
| Control Protocol | GEMHCI | binary command interface |
| Supply Voltage | Recommended | 3.3V |
| Power Consumption | | Less than 50mA peak |
| Physical | | 40mm x 40mm |
| Environmental | | -40 to +85C |
| Approvals | | FCC, IC, CE, Bluetooth EPL |

GEM3NFC Overview

Overview

The following picture provides an overview of the various hardware elements of GEM3NFC board.

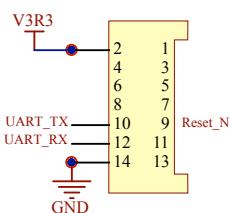


Data, power, & I/O connector

The data, power, and I/O connector provides a means to connect a supply voltage of 3.3V to the GEM3NFC module as well as UART TX and RX lines for serial communications between the GEM3NFC module and the fitness equipment console MCU. The GEM3NFC UART lines are TTL level and operate at 115.2Kbps.

The connector is JST BM14B-ZPDSS-TF(LF)(SN). The mating JST connector housing is JST ZPDR-14V-S and is [available](#) through Digi-Key and other distributors.

Data, power, and I/O connections:



Additional I/O

The GEM3NFC module includes an additional connector for I/O.

NFC Reader

The GEM3NFC module incorporates an NFC reader chip allowing for decoding of compatible NFC tag data records enabling tap to pair support as well as NFC based user identification.

NFC Antenna

The GEM3NFC module includes an integrated NFC antenna.

GEM3 module

The GEM3NFC includes North Pole Engineering's GEM3 Bluetooth 5.0 and ANT wireless OEM module and includes North Pole Engineering's embedded software specifically designed for fitness equipment mobile app, group fitness, and wearable connectivity applications.

Specifications

Operating Parameters

| Parameter | Min | Typical | Max |
|------------------------------|------|---------|-------|
| Supply Voltage | 3.0V | 3.3V | +3.6V |
| Operating Temperature @ 3.3V | -40C | | +85C |
| Serial Interface | 3.0 | 3.3V | 3.6V |

Operating Modes

GymKit

The GEM3NFC module when integrated into a fitness equipment device can pair with a compatible Apple Watch using a “tap to pair” method where by an Apple watch is brought near an area of the fitness equipment console where the GEM3NFC’s antenna has been located.

The GEM3NFC module will sense the presence of the Apple Watch through it's NFC antenna and reader circuitry and perform the necessary procedures to establish a Bluetooth connection with the Apple Watch. Once the connection has been established between the Apple Watch and GEM3NFC module, the console and Apple Watch can exchange workout data using the Bluetooth Fitness Machine Service and GymKit service.

The following diagram outlines the operating flow for using the GEM3NFC for GymKit Applications:



Fitness equipment is idle awaiting connection

User taps Apple Watch Area on fitness equipment where GEM3NFC antenna is located.



User confirms connection and GEM3NFC establishes a Bluetooth connection with the Watch, performs link bonding, encryption, and authentication functions with the Watch



User begins workout. GEM3NFC relays data from fitness equipment to Watch using Bluetooth fitness machine service. GEM3NFC receives HR and Calorie data from Watch using GymKit service.

Smartphone Connection

The GEM3NFC module when integrated into a fitness equipment device can pair with a mobile device with a compatible application such as North Pole Engineering GymTrakr using Bluetooth low energy.

The GEM3NFC module will broadcast its presence to the mobile device and through the application's user interface, the user can connect their mobile device to the fitness equipment over a Bluetooth link.

The following diagrams outlines the operating flow for using the GEM3NFC for Smartphone Connections:



GEM3NFC is idle awaiting connection from Watch or app through a Bluetooth connection. User initiates Bluetooth pairing through the console user interface and confirms connection with the smart device.



User begins workout. GEM3NFC relays workout data from fitness equipment to smart device app using Bluetooth fitness machine service.

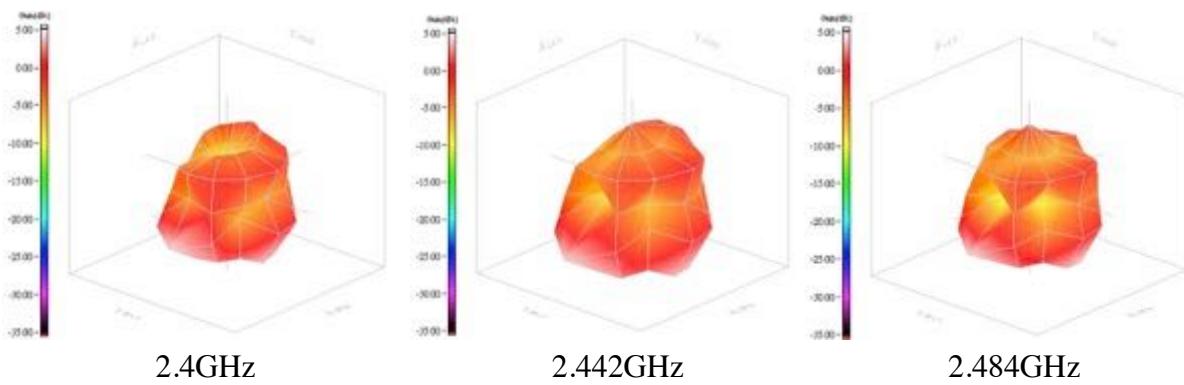
GEM3NFC sends received HR data to fitness equipment console for display.

GEM3NFC Considerations

Mechanical items (especially metal) should be kept as far as possible from the module antenna in all directions, including above and below the board surface. If possible, move mechanical items out and away from a keepout area of 53mm x 20mm from the GEM3NFC module edge.

Antenna Characteristics

The GEM3NFC module includes an integrated monopole chip antenna. Antenna performance will depend on host PCB layout. The following plots show antenna radiation pattern of the GEM3NFC antenna.

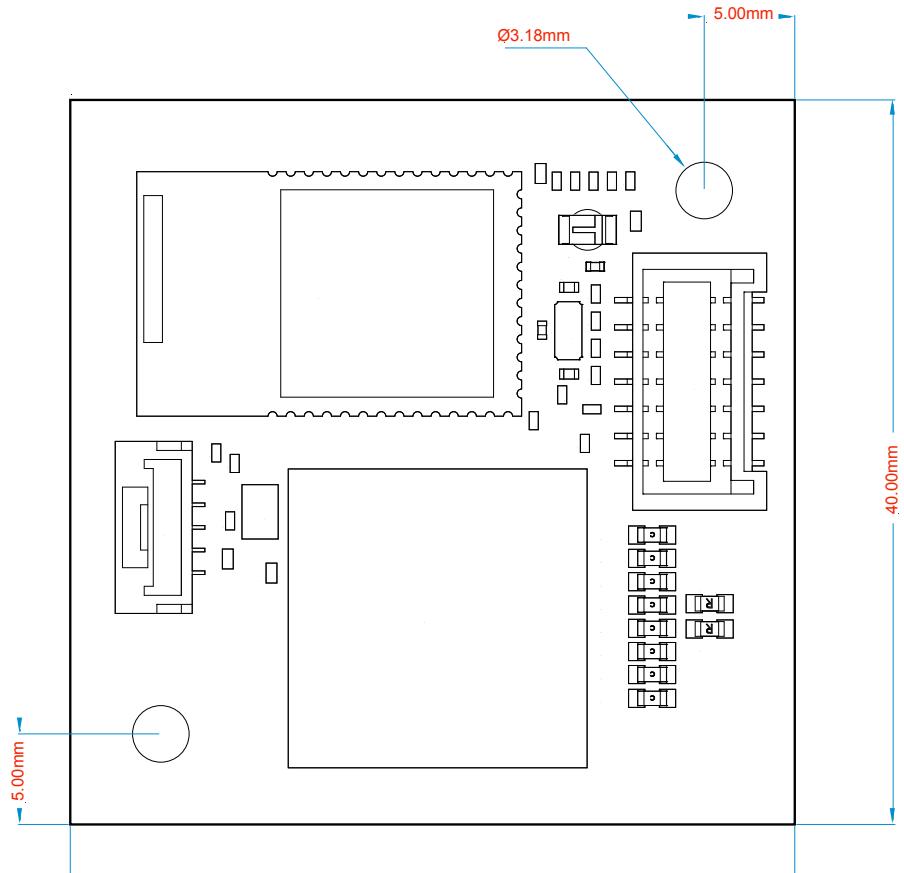


Antenna Performance

| | Efficiency | Peak Gain | S11 |
|---------|------------|-----------|----------|
| 2400MHz | 65.72% | 4.08 dBi | -16.0 dB |
| 2442MHz | 62.72% | 3.95 dBi | -14.8 dB |
| 2484MHz | 59.73% | 4.17dBi | -13.3 dB |

Mechanical Information

Dimensions (in mm)



Connecting GEM3NFC to Console MCU

The GEM3NFC is designed for connection to fitness equipment console MCUs through its Serial interface.

The GEM3NFC serial interface has a TX line and RX line that are 3.3V tolerant and operate at 115.2Kpbs.

GEM3NFC Host Protocol

The GEM3NFC supports North Pole Engineering's GEMHCI protocol for communication between the GEM3NFC board and the console MCU using the GEM3NFC module's serial host connection. The GEMHCI protocol supports a port speed of 115.2Kbps.

The GEMHCI protocol is a binary protocol and is used to configure the GEM3NFC operation as well as pass fitness equipment related data to the GEM3NFC for broadcasting to connection applications using its Bluetooth/ANT+ radio. The GEMHCI protocol can also be used to send data such as heart rate and calories from a connected fitness application or device to the console through the GEM3NFC module.

Details of the GEMHCI protocol are provided in the GEMHCI reference manual. Please visit our knowledge base at <http://npe-inc.zendesk.com> for the latest version of the GEMHCI reference manual.

NFC Reader T4T card mode operation

ISO/IEC 14443A card mode

| Communication direction | | ISO/IEC 14443A | ISO/IEC 14443A higher transfer speeds | |
|---------------------------------------|---------------------------|----------------------------|---------------------------------------|----------------------------|
| | Transfer speed | 106 kbit/s | 212 kbit/s | 424 kbit/s |
| | Bit length | (128/13.56) μ s | (64/13.56) μ s | (32/13.56) μ s |
| PCD → PN7150 | | | | |
| (data received by PN7150 from a card) | modulation on PCD side | 100 % ASK | > 25 % ASK | > 25 % ASK |
| | bit coding | Modified Miller | Modified Miller | Modified Miller |
| PN7150 → PCD | | | | |
| (data sent by PN7150 to a card) | modulation on PN7150 side | subcarrier load modulation | subcarrier load modulation | subcarrier load modulation |
| | subcarrier frequency | 13.56 MHz/16 | 13.56 MHz/16 | 13.56 MHz/16 |
| | bit coding | Manchester | BPSK | BPSK |

ISO/IEC 14443B card mode

| Communication direction | | ISO/IEC 14443B | ISO/IEC 14443B higher transfer speeds | |
|-----------------------------------------|---------------------------|----------------------------|---------------------------------------|----------------------------|
| | Transfer speed | 106 kbit/s | 212 kbit/s | 424 kbit/s |
| | Bit length | (128/13.56) µs | (64/13.56) µs | (32/13.56) µs |
| PCD → PN7150 | | | | |
| (data received by PN7150 from a Reader) | modulation on PCD side | 8 % - 14 % ASK | 8 % - 14 % ASK | 8 % - 14 % ASK |
| | bit coding | NRZ | NRZ | NRZ |
| PN7150 → PCD | | | | |
| (data sent by PN7150 to a Reader) | modulation on PN7150 side | subcarrier load modulation | subcarrier load modulation | subcarrier load modulation |
| | subcarrier frequency | 13.56 MHz/16 | 13.56 MHz/16 | 13.56 MHz/16 |
| | bit coding | BPSK | BPSK | BPSK |

Regulatory & Standards Information

FCC & Industry Canada

The GEM3NFC module has modular approval for the United States and Canada. To ensure compliance when using the GEM3NFC module in a design, the OEM is required to adhere to the implementation considerations supplied in this hardware integration guide.

Federal Communication Commission (FCC) Radiation Exposure Statement:

This device is in compliance with SAR for general population/uncontrolled exposure limits in ANSI/IEEE C95.1-1999 and had been tested in accordance with the measurement methods and procedures specified in OET Bulletin 65 Supplement C.

This transceiver must not be co-located or operating in conjunction with any other antenna, transmitter, or external amplifiers. Further testing / evaluation of the end product will be required if the OEM's device violates any of these requirements.

The GEM3NFC Module is fully approved for mobile and portable applications.

FCC Labeling Requirements

WARNING: The OEM must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate FCC identifier is visible.

Contains FCC ID: XRH-NPE109
 IC: 11922A-NPE109

If OEM device is larger than 8x10cm, the following FCC part 15.19 statement has to be visible on outside of device:

The enclosed 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.

Label and text information type should be large enough to be legible and consistent with the dimensions of the equipment and the label. The type size is not required to be larger than eight points.

Comments

The OEM should have their device tested by a qualified test house to verify compliance with FCC Part 15 Subpart B limits for unintentional radiators.

Any modifications to the GEM3NFC module could void the OEM's authority to operate the equipment.

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 not cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit that is different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Warning:

"THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES AND INDUSTRY CANADA LICENSE-EXEMPT RSS STANDARD(S). 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.

Industry Canada (IC) Warning:

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.

French equivalent:

Le présent appareil est conforme aux CNR d'Industrie Canada applicable 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.

IC Radiation Exposure Statement

This device is in compliance with SAR for general population/uncontrolled exposure limits in IC RSS-102 and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528.

REMARQUE IMPORTANTE

Déclaration IC d'exposition aux radiations

Ce EUT est conforme avec SAR pour la population générale / limites d'exposition non contrôlée à IC RSS-102 et a été testé en conformité avec les méthodes de mesure et procédures spécifiées dans la norme IEEE 1528.

Modular Approval

OEM is still responsible for testing their product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

Approbation modulaire

OEM intégrateur est toujours responsable de tester leur produit final pour les exigences de conformité supplémentaires nécessaires à ce module installé (par exemple, les émissions de périphériques numériques, les exigences de périphériques PC, etc.)

IMPORTANT NOTE:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID cannot 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 Canadian authorization.

North Pole Engineering

221 N 1st St, Minneapolis, MN 55401

www.npe-inc.com

612.305.0440

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NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "GEM3NFC Module Contient des IC: 11922A-NPE109"

CE

The GEM3NFC Module has been tested against the appropriate regulatory standards for European market. OEMs should consult a qualified test house to ensure their product meets all regulatory requirements.

The GEM3NFC Module Declaration of Conformities is below. Test reports are available upon request.

Health and Safety – EN60950-1: 2006+A11:2009+A1:2010+A12:2011

Electromagnetic compatibility – EN301489-17 V2.2.1 in accordance with EN 301 489-1 V1.9.2

Radio Frequency Radiated Emissions: EN300 328 V1.9.1

North Pole Engineering declares under our sole responsibility that the essential radio tests have been carried out and that the GEM Module to which this declaration relates is in conformity with all applicable essential requirements of Article 3 of the EU Directive 1999/5/EC when used for its intended purpose.

Place of Issue: North Pole Engineering
 221 North First Street, Suite 310
 Minneapolis, MN 55401

Date: 8/1/2018

Authorized Person: Don Schroeder

Signature:

Bluetooth Qualification

The Bluetooth SIG requires every product implementing Bluetooth technology to have a Declaration ID even though the end product references a Bluetooth design with its own Declaration ID.

An overview of the Bluetooth SIG Qualification Process is as follows:

1. Register as a member of the Bluetooth SIG – www.bluetooth.org
2. Go to product listing page <https://www.bluetooth.org/en-us/test-qualification/qualification-overview>
3. Go to Create a Listing: https://www.bluetooth.org/tpg/QLI_SDoc.cfm
4. In the area “Reference a Qualified Design, Enter End Product ID: 77930
5. Select your Declaration ID or Purchase a Declaration ID. Fees for Declaration IDs vary based on Bluetooth SIG membership level.
6. Once you have completed your listing and paid your declaration fee, your design will be listed on the Bluetooth SIG website.

You can find more details on the Bluetooth SIG listing process at the following webpage:
<https://www.bluetooth.org/en-us/test-qualification/qualification-overview>

Ordering Details

| Part Number | Trays | Shipping Weight | MOQ | Multiple |
|-------------|------------|-----------------|-----|----------|
| GEM3NFC0201 | 100 pieces | | 100 | 100 |

Further Assistance

Please contact North Pole Engineering at 1-612-305-0440 or via email at sales@npe-inc.com if additional help is needed.

NORTH POLE ENGINEERING

221 North 1st Street, Suite 310
Minneapolis, MN 55401
Telephone: 1-612-305-0440
Email: sales@npe-inc.com
www.npe-inc.com

FCC 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.

To assure continued compliance, any changes or modifications not expressly approved by the party.

Responsible for compliance could void the user's authority to operate this equipment. (Example- use only shielded interface cables when connecting to computer or peripheral devices).

This equipment 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.

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance.

Note 1: This module certified that complies with RF exposure requirement under mobile or fixed condition, this module is to be installed only in mobile or fixed applications.

A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20 centimeter separation requirement.

A fixed device is defined as a device is physically secured at one location and is not able to be easily moved to another location.

Note 2: Any modifications made to the module will void the Grant of Certification, this module is limited to OEM installation only and must not be sold to end-users, end-user has no manual instructions to remove or install the device, only software or operating procedure shall be placed in the end-user operating manual of final products.

Note 3: Additional testing and certification may be necessary when multiple modules are used.

Note 4: The module may be operated only with the antenna with which it is authorized. Any antenna that is of the same type and of equal or less directional gain as an antenna that is authorized with the intentional radiator may be marketed with, and used with, that intentional radiator.

Note 5: To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements. Since this may depend on the details of how the module is integrated with the host, North Pole Engineering. shall provide guidance to the host manufacturer for compliance with the Part 15B requirements.

Note 6: FCC ID label on the final system must be labeled with "Contains FCC ID: XRH-NPE109&FCC ID: XRH-NPE105" or "Contains transmitter module FCC ID: XRH-NPE109&FCC ID: XRH-NPE105"

IC Radiation Exposure Statement:

This device and its antenna(s) must not be co-located with any other transmitters except in accordance with IC multi-transmitter product procedures. Referring to the multi-transmitter policy, multiple-transmitter(s) and module(s) can be operated simultaneously without reassessment permissive change.

Cet appareil et son antenne (s) ne doit pas être co-localisés ou fonctionnement en association avec une autre antenne ou transmetteur.

This equipment complies with IC RSS-102 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.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20cm de distance entre la source de rayonnement et votre corps.

This module is limited to OEM installation only and must not be sold to end-users, end-user has no manual instructions to remove or install the device, only software or operating procedure shall be placed in the end-user operating manual of final products. Additional testing and certification may be necessary when multiple modules are used.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

The final end product must be labeled in a visible area with the following " Contains IC: 11922A-NPE109;IC:1922A-NPE105".

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