

GEMNFC

Hardware Manual

Version 1.01

March 28, 2018

WAHOO FITNESS INTELLECTUAL PROPERTY

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

© Wahoo Fitness LLC 2017

Revision History

Version	Revision Date	Change History
1.0	December 14, 2017	Version 1.0
1.01	March 28, 2018	Updated to include NFC details

Table of Contents

Revision History	2
Overview and Key Features	4
Features	4
Specification	5
Specification Summary	5
Hardware Specifications	7
Block Diagrams.....	7
GEMNFC Overview	8
Overview	8
Serial Host and power connector	8
Power LED.....	9
Link LED	9
Pair/LED connector.....	9
Mounting holes	9
NFC Antenna Connector	9
Specifications	9
Operating Parameters	9
Operating Modes	10
GymKit Connection.....	10
Smartphone Connection.....	12
GEMNFC Considerations	15
Antenna Characteristics	15
Mechanical Information	16
Dimensions (in mm).....	16
Connecting GEMNFC to Console MCU	16
GEMNFC Host Protocol	16
NFC Reader T4T card mode operation	17
ISO/IEC 1444A card mode	17
ISO/IEC 14443B card mode.....	18
Regulatory & Standards Information	18
FCC & Industry Canada	18
Federal Communication Commission (FCC) Radiation Exposure Statement:	18
FCC Labeling Requirements.....	18
FCC Warning:.....	19
Industry Canada (IC) Warning:	20
CE.....	22
Bluetooth Qualification.....	23
Ordering Details	23
Further Assistance	23

Wahoo GEMNFC Hardware Manual

Overview and Key Features

The GEMNFC module is been designed to allow OEMs to easily add Bluetooth, ANT+, Apple GymKit, and NFC reader connectivity in their product offering. The GEMNFC module incorporates Wahoo's GEMSAFE and 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 GEMNFC module is based on Nordic Semiconductor's nRF52832 multiprotocol 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 GEMNFC module offers a serial host interface and has a maximum transmit power of +4dBm, and a sensitivity of -96dBm. This manual is intended to assist with hardware integration of the GEMNFC module into a given design. Details on Wahoo's GEMHCI and GEMSAFE protocol software can be found at www.wahoogym.com.

Features

- -96 dBm sensitivity
- TX Power-20 to +4dBm in 4dB steps
- 100m line of sight range
- 5.3 mA peak TX @ 0dB
- 5.4 mA peak RX
- 1dB dB RSSI resolution
- ARM® Cortex™M4F 32 bit processor running at 64MHz
- 512 kB embedded flash memory and 64 kB RAM
- Serial Host Interface
- AES HW encryption
- FCC, CE, IC certified
- Integrated Antenna
- RoHS compliant
- Bluetooth End Product Listed
- Integrated GEMHCI and GEMSAFE software
- ANT+ FE profile
- ANT+ HRM scanning and connection
- Integrated Apple GymKit support
- Integrated NFC reader support

Specification

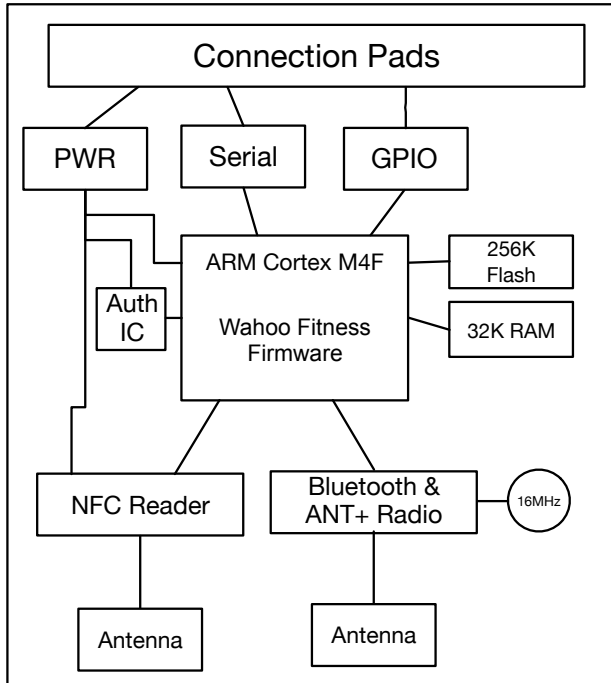
Specification Summary

Category	Feature	Implementation
RF	Bluetooth	4.1 Single Mode Peripheral
	ANT+	Broadcast
	Frequency	2.402-2.480 GHz
	Maximum Transmit Power	+4dBm
	Minimum Transmit Power	-20dBm
	Receive Sensitivity	-96dBm
	Range	up to 100m 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
	GPIO	Link Indicator
	GPIO	Pairing Button
FW Upgrade	Wahoo Firmware	Over the air Via JTAG interface
Control Protocol	GEMHCI	binary command interface
	GEMSAFE	CSAFE serial protocol
Supply Voltage	Min	x.xV
	Max	x.xV
	Recommended	5.0V
Power Consumption		Less than 50mA peak
Physical		
Environmental		-40 to +85C

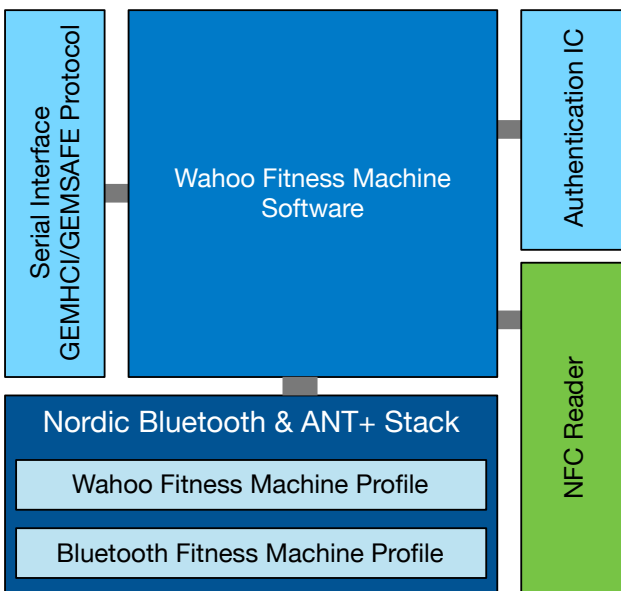
Approvals		FCC, IC, CE, Bluetooth EPL
-----------	--	----------------------------

Hardware Specifications

Block Diagrams



Hardware Block Diagram

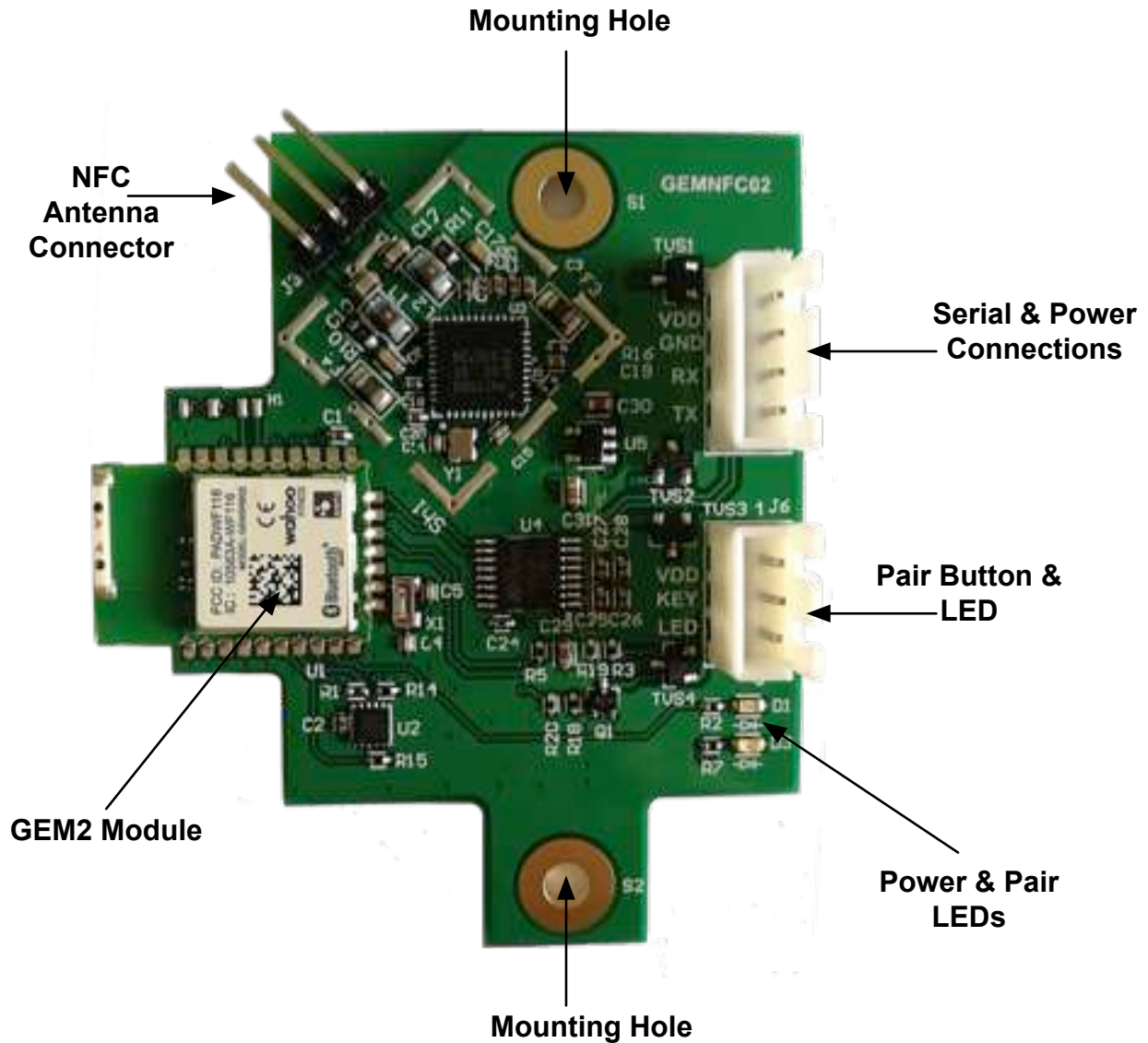


Software Diagram

GEMNFC Overview

Overview

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



Serial Host and power connector

The Serial Host and power connector provides a means to connect a supply voltage of 5V to the GEMNFC board as well as Transmit and Receive lines for serial communications between the GEMNFC board and the fitness equipment console MCU. The GEMNFC serial lines are 5V tolerant and operate at 115.2Kbps.

Power LED

The green power LED indicates when the GEMNFC is powered.

Link LED

The orange link LED indicates when the GEMNFC is advertising by blinking at a 1Hz rate and continually illuminated when a Bluetooth connection has been established.

Pair/LED connector

The Pair/LED connector provides facilities for connection to external circuitry for the Pair/Advertising Indicator GPIO and the Pair button GPIO of the GEMNFC module. This interface includes a VDD connection point in addition to the I/O lines for the pair button input and LED output line.

Mounting holes

The GEMNFC mounting holes provide a convenient method of mounting the GEMNFC within fitness equipment.

NFC Antenna Connector

The GEMNFC antenna connector provides a simple method of connecting the GEMNFC's NFC antenna to the GEMNFC module.

Specifications

Operating Parameters

Parameter	Min	Typical	Max
Supply Voltage	-0.3V	5.0V	+5.8V
Operating Temperature @ 3.3V	-40C		+85C
Serial Interface	x.x	5.0V	X.x

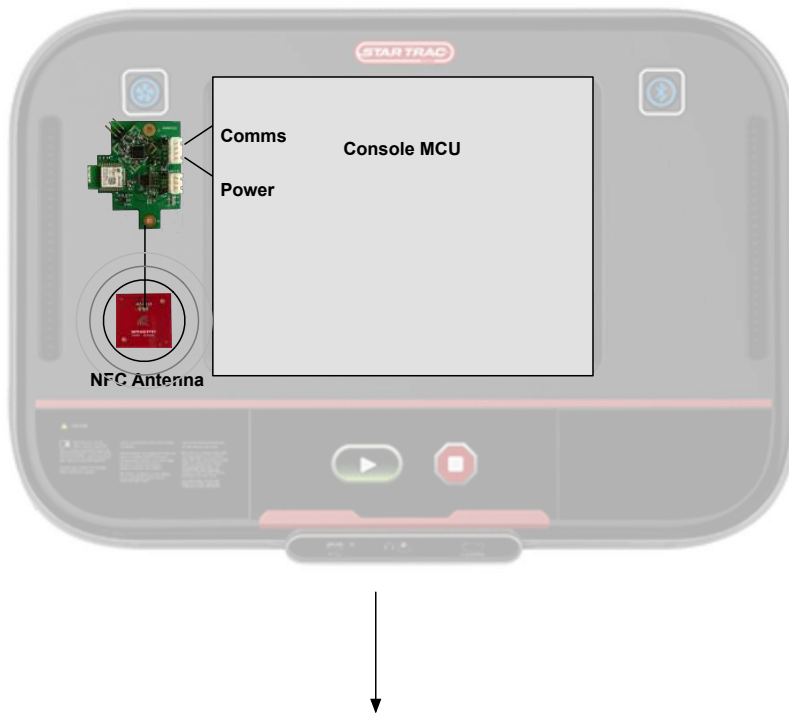
Operating Modes

GymKit Connection

The GEMNFC 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 GEMNFC’s antenna has been located.

The GEMNFC 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 GEMNFC 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 GEMNFC for GymKit Applications:



Fitness equipment is idle awaiting connection from Watch.



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



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





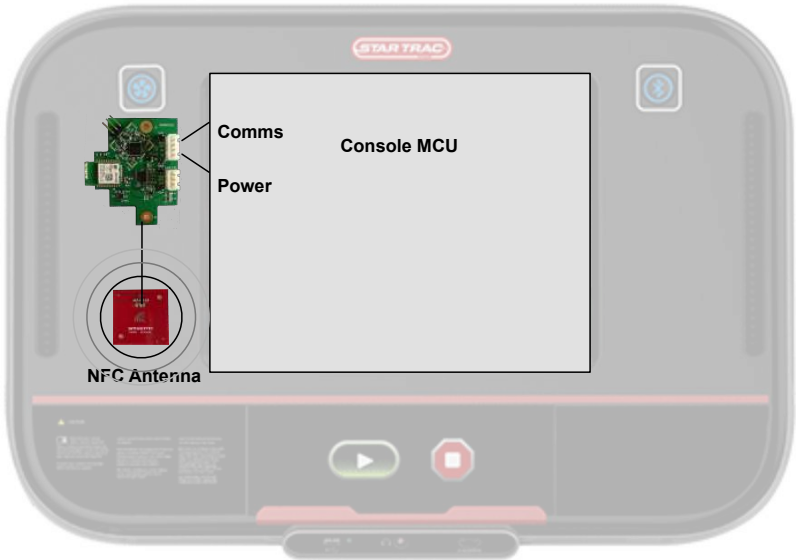
User begins workout. GEMNFC relays data from fitness equipment to Watch using Bluetooth fitness machine service. GEMNFC receives HR and Calorie data from Watch using GymKit service.

Smartphone Connection

The GEMNFC module when integrated into a fitness equipment device can pair with a mobile device with a compatible application such as Wahoo RunFit using Bluetooth low energy.

The GEMNFC module will broadcast it's 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. T

The following diagrams outlines the operating flow for using the GEMNFC for GymKit Applications:



GEMNFC is idle awaiting connection from Watch or app through a Bluetooth connection.



User initiates Bluetooth pairing through the console user interface.





User confirms connection and GEMNFC establishes a Bluetooth link with the smart device.



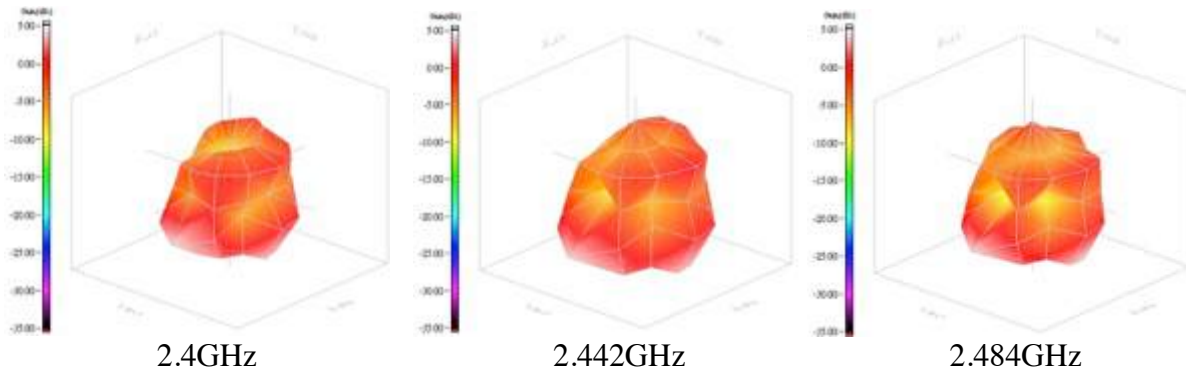
User begins workout. GEMNFC relays workout data from fitness equipment to smart device app using Bluetooth fitness machine service. GEMNFC receives HR data from connected HRM. GEMNFC sends received HR data to fitness equipment console for display.

GEMNFC 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 GEMNFC module edge.

Antenna Characteristics

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

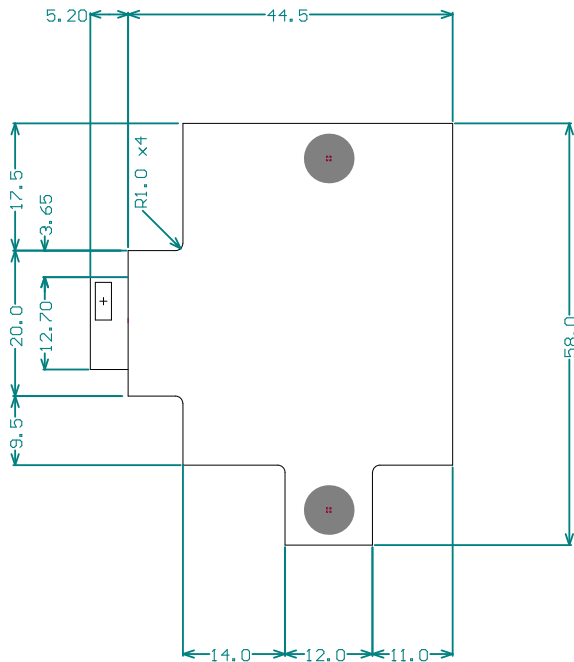


Antenna Performance

	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 GEMNFC to Console MCU

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

The GEMNFC serial interface has a TX line and RX line that are 5V tolerant and operate at 115.2Kpbs.

GEMNFC Host Protocol

The GEMNFC supports both Wahoo's GEMHCI and GEMSAFE protocols for communication between the GEMNFC board and the console MCU using the GEMNFC module's serial host connection connection. The both protocols support a port speed of 115.2Kbps.

The GEMHCI protocol is a binary protocol and is used to configure the GEMNFC operation as well as pass fitness equipment related data to the GEMNFC 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 GEMNFC module.

Details of the GEMHCI protocol are provided in the GEMHCI reference manual. Please contact Wahoo for the latest version of the GEMHCI reference manual.

The GEMSAFE protocol is a command-oriented protocol built around the fitness industry's CSAFE protocol. The GEMSAFE protocol is used to configure GEMNFC operation as well as communicate fitness equipment related data to the GEMNFC for broadcasting to connected applications using its Bluetooth/ANT+ radio. The GEMSAFE 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 GEMNFC module.

Details of the GEMSAFE protocol are provided in the GEMSAFE reference manual. Please contact Wahoo for the latest version of the GEMSAFE reference manual.

NFC Reader T4T card mode operation

ISO/IEC 1444A 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 \rightarrow 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 \rightarrow 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) μ s	(64/13.56) μ s	(32/13.56) μ s
PCD \rightarrow 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 \rightarrow 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 GEMNFC module has modular approval for the United States and Canada. To ensure compliance when using the GEMNFC 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 GEMNFC 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: PADWF125
 IC:10563A-WF125

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 GEMNFC 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 UNDESIRE 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.

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: "
GEMNFC Module Contient des IC: 10563A-WFXXX"

CE

The GEMNFC 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 GEMNFC 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

Wahoo Fitness 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: Wahoo Fitness LLC
 90 W. Wieuca Road Suite 110
 Atlanta, GA 30342
 +1(877) 978-1112

Date: XXXX
Authorized Person: James Halter
Signature:

Bluetooth Qualification

The GEMNFC module has been listed with the Bluetooth Special Interest Group (SIG) as a qualified an End Product. The Wahoo Fitness Declaration ID is: DID XXXXX

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 over 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 Blueooth 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
GEMNFC0206	100 pieces	TBD	100	100

Further Assistance

Please contact Wahoo Fitness at 1-877-978-1112 or via email at info@wahoofitness.com if additional help is needed.

Wahoo

90 W. Wieuca Road N.E. Suite 110
Atlanta, GA 30342
Telephone: 1-877-978-1112
Email: support@wahoofitness.com
www.wahoofitness.com