



**GEM3NFC**  
Hardware Manual  
Version 1.0  
August 31, 2020



**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
0.3	April 13, 2020	Added UART connection note, added power consumption data for different modes
1.0	August 31, 2020	Added current consumption information and I2C interface details

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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 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

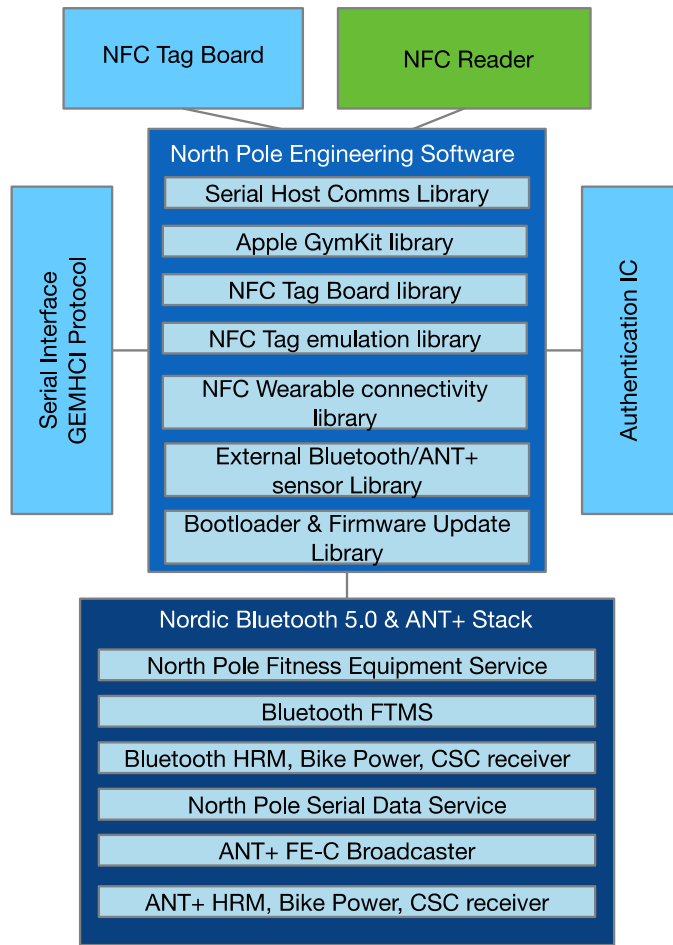
- -95 dBm sensitivity
- TX Power-20 to +8dBm in 4dB steps
- 240m line of sight range @ +8dBm
- 15 mA peak TX @ 8dB, 6.2mA @ 0dBm
- 4.6 mA peak RX
- 1dB dB RSSI resolution
- ARM® Cortex™M4F 32 bit processor running at 64MHz
- 1MB embedded flash memory and 256 kB RAM
- Serial Host Interface
- I2C Interface
- 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.

# Specification

## Specification Summary

Category	Feature	Implementation
RF	Bluetooth	5.0 Single Mode Peripheral and Central
	ANT+	Broadcaster and receiver
	Frequency	2.402-2.480 GHz
	Maximum Transmit Power	+2dBm
	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
	I2C Interface	I2C Master – 400Kbps
FW Upgrade	North Pole Engineering Firmware	Over the air SWD interface UART Interface
Control Protocol	GEMHCI	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

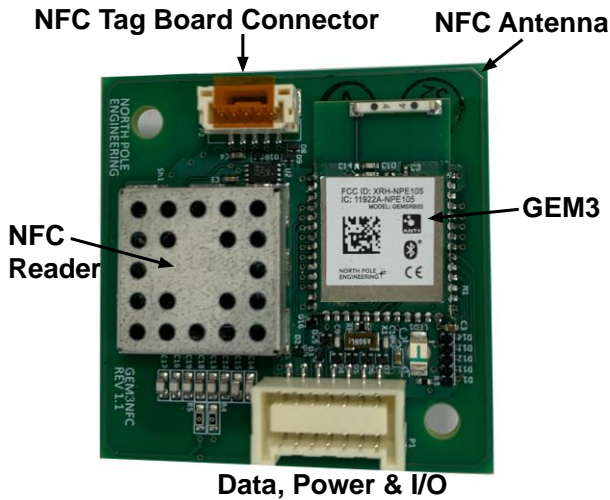


Software Diagram

## GEM3NFC Overview

### Overview

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



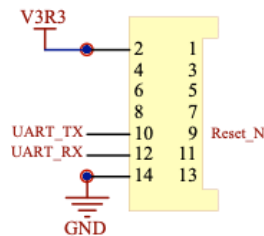
### Data, power, & I/O connector

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.

NOTE: External connection to the UART TX and UART RX lines should be connected as shown below. Connect host MCU TX to pin 10 (TX) on GEM3NFC module and host MCU RX to pin 12 (RX) on GEM3NFC module.

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.

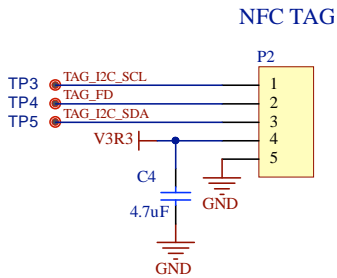
Data, power, and I/O connections:





## NFC Tag Board Connection

The GEM3NFC module includes an additional connector to support connection of an NFC tag board using I2C communications. Pinout of the I2C interface is shown below:



## NFC Reader

The GEM3NFC module incorporates an NFC reader chip allowing for decoding of compatible NFC tags for user identification for example. In addition, the NFC reader also supports NFC type 4 tag emulation for tap to pair support with compatible Android and iOS applications.

## 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

## Power Consumption

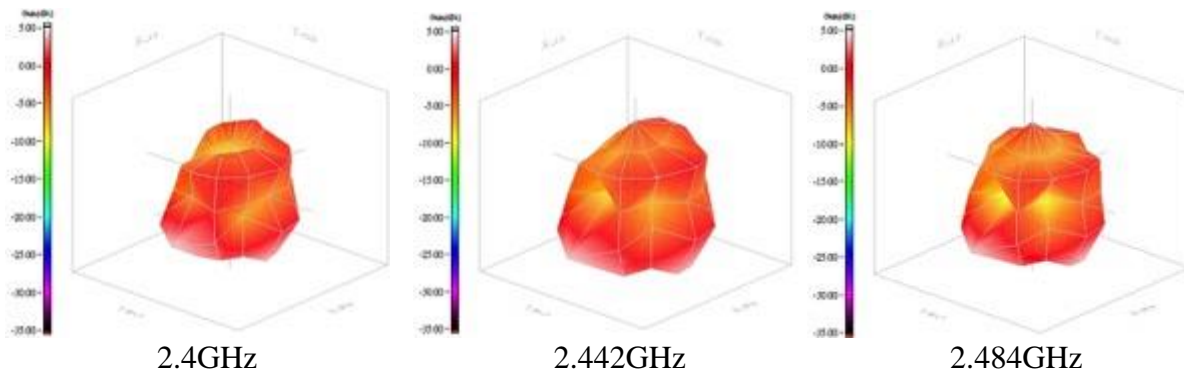
Power Mode	Average (mA)	Peak (mA)
Standby	0.890	1
NFC Polling	7	135
NFC Read & Connection	37	228
Watch Connected	2	14
BLE Only	1.5	7
ANT+ Only	1	4

## 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.

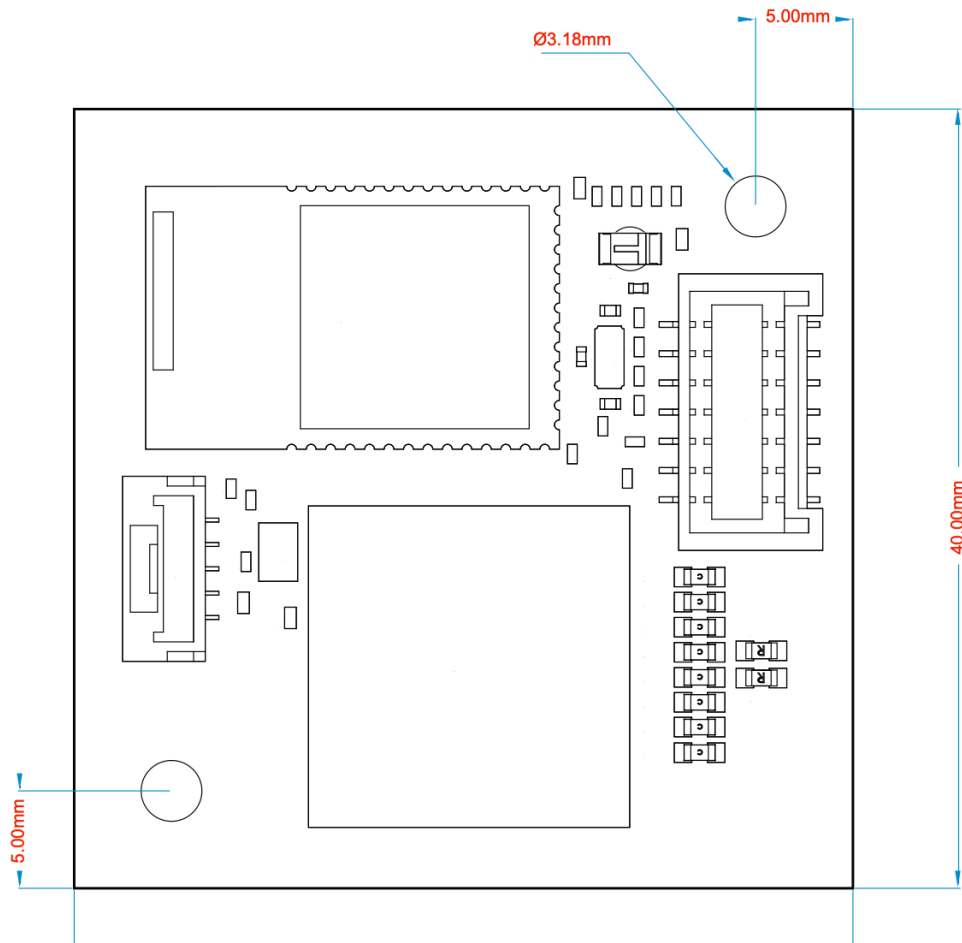


### Antenna Performance

	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 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) $\mu$ s	(64/13.56) $\mu$ s	(32/13.56) $\mu$ 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) $\mu$ s	(64/13.56) $\mu$ s	(32/13.56) $\mu$ s
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 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: "  
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

## 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](http://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](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
GEMNFC0301	100 pieces		100	100

### Further Assistance

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

NORTH POLE ENGINEERING  
221 North 1<sup>st</sup> Street, Suite 310  
Minneapolis, MN 55401  
Telephone: 1-612-305-0440  
Email: [sales@npe-inc.com](mailto:sales@npe-inc.com)  
[www.npe-inc.com](http://www.npe-inc.com)