Predictive Maintenance Simplified

VERO PRIMARY BATTERY SENSOR MODULE (PB-SM) OPERATION MANUAL

VERO-VTH-01 Operation Manual

Revision History

Revision	Document Number	Date	Approval
A	710-006 OM	30JUN2022	Shawn Nichols
B - Added optional mounts	710-006 OM	2/3/2023	

Printed instructions can be made available by sending an email to customersucess@nikola.tech

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1 Product Overview

The AssetWatch, Inc.VERO-VTH-01, also known as the Vero Primary Battery Sensor Module (PB-SM), is a self-contained, maintenance-free, wireless vibration and thermal sensor designed to transduce acceleration and temperature of the surface to which it is attached. It transmits the collected data via a Bluetooth Low Energy (BLE) radio and can be configured through the same communication link. The VERO-VTH-01 is ideally suited for indoor industrial applications and may be used where explosive gases and vapors are present. It is a critical component of the AssetWatch Condition Monitoring Platform known as AssetWatch™.

2 Introduction

2.1 Purpose and Outline of Manual

The purpose of this instruction manual is to provide a product description and practical and important information on the safe use, installation, maintenance and troubleshooting of the VERO-VTH-01 Primary Battery Sensor Module (PB-SM).

This manual consists of seven sections that should be read and understood prior to the deployment of the PB-SM. It is extremely important that the messages contained in these sections are followed closely.

The three sections are provided for reference and understanding of this product and this instruction manual. They are:

1. **Product Overview**
2. **Introduction**
4. **Detailed Product Description**

Particular attention should be paid to the four product application sections, especially limitations of use in some hazardous locations (HazLoc), and to the noted warnings and cautionary notes. These sections are as follows:

3. **Safety**
5. **Installation Instructions**
6. **Maintenance**
7. **Troubleshooting**

2.2 Limited warranty

AssetWatch warrants that it will perform all Services in accordance with generally accepted practices within its industry and that the Services will meet the requirements set forth in any applicable SOW. Customer shall notify Nikola of any breach of this warranty no later than thirty (30) days after delivery of the applicable Services. CUSTOMER'S EXCLUSIVE REMEDY AND NIKOLA'S ENTIRE LIABLITY UNDER THIS WARRANTY WILL BE FOR NIKOLA TO RE-PERFORM ANY NON-CONFORMING PORTION OF THE SERVICES, OR IF NIKOLA CANNOT SO REMEDY THE BREACH, TO REFUND TO CUSTOMER THE PORTION OF THE FEES ATTRIBUTABLE TO SUCH NON-CONFORMING PORTION OF THE SERVICES. NIKOLA DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMIT, THE IMPLIED WARRANTIES OF MERCHANTABILITY, TITLE AND FITNESS FOR A PARTICULAR PURPOSES, AND DOES NOT

GUARANTEE THAT THE USER PLATFORM CANNOT BE COMPROMISED, WILL BE ERROR FREE AND WILL NEVER BE INTERRUPTED.

3 Safety

3.1 Symbols

3.1.1 ISO General Warning

The ISO 7010 –0434B (2004-01) (triangle with an exclamation point) shown below is used on the product label to alert the user to refer to more documentation before proceeding with the installation and operation of this device.

This manual also uses this icon to highlight warnings and cautionary notes, especially associated with the PB-SM usage in potentially explosive environments.

3.1.2 ETL Mark

The Electrical Testing Labs Mark (ETL Mark) denotes that the VERO-VTH-01 has been tested and certified by ETL for its safety, quality, and performance.

Specifically, the VERO-VTH-01 compliant to industry standards for safety in ordinary locations, as well as certain hazardous locations, as indicated by Intertek's control number ETL22CA104869912X, noted in compliance report 104869912DAL and summarized in this manual.

3.1.3 FCC Mark

The FCC Mark connotes that the VERO-VTH-01 complies with part 15 of the FCC Rules.

A Supplier's Declaration of Conformity (SDoC) and supporting documentation are available upon request.

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4 Regulations for Ordinary Locations

The VERO-VTH-01 was evaluated against the following standards and levels of performance (where appropriate) for ordinary locations.

3.2.1 Product Safety Standards

ANSI/UL 61010-1
CSA C22.2 No.61010-1:

3.2.2 Electromagnetic Compatibility Standards

FCC Part 15
RSS-247 issue 2: 2017
RSS-Gen issue 5, Amendment 1: 2019
EN 61326-1: 2013
EN 61000-6-2: 2007
ETSI EN 301 489-1 v2.2.3 (2019)
ETSI EN 301 489-3 v2.1.1 (2019)
ETSI EN 301 489-17 v3.2.4 (2020)
EN 61000-4-3:2006+A1:2008+A2: 2010
Stress levels: 10 V/m for 80-1000 MHz
3 V/m for 1400-2700 MHz
EN 61000-4-2:
Stress level
EN 61000-4-8
Stress level
European Directive: R&TTE

3.2.3 Other Standards

IEC 60529
IP64
European Directive: RoHS

4.1 Conformance to Regulations for Ordinary Locations

4.1.1 Supplier Information

AssetWatch is headquartered at 60 Collegeview Rd, Westerville, OH 43081.

4.1.2 Electrical Ratings

The VERO-VTH-01 is rated for a nominal voltage of 3.6V and a max current of 0.25A.

4.1.3 United States and Canada

4.1.3.1 BM833 Federal Communications Commission (FCC) Statement

The VERO-VTH-01 may contain a Fanstel Corporation model BM833 BLE module and is labeled as:

Contains FCC ID: X8WBM833

This device also complies with part 15 of the FCC Rules, and its 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.

The PB-SM has been tested and verified that it complies FCC Part 15 Subpart B limits for unintentional radiators.

4.1.3.2 BM833 Industry Canada (IC) Statement

The VERO-VTH-01 may contain a Fanstel model BM833 BLE module, a license-exempt transmitter/receiver that complies with Innovation, Science and Economic Development Canada's license-exempt RSS. This module has been approved by Industry Canada, and when employed in the product, the label states:

Contains IC ID: 4100A-BM833

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 my cause undesired operation of the device.

Cet appareil contient des émetteurs/récepteurs exempts de licence qui sont conformes au RSS exemptés de licence d'Innovation, Sciences et Développement économique Canada. L'opération est sourmise aux deux conditions suivantes:

(1) Cet appareil ne doit pas causerd'interférences
(2) Cet appareil doit accepter toute interférence, y compris les interférences pouvant provoquer un fonctionnement indésirable de l'appareil.

4.1.3.3 ETL Mark C/US

The ETL Mark C/US is proof of product compliance to North American safety standards. Authorities Having Jurisdiction (AHJs) and code officials across the United States, Canada, and other countries whose safety standards align with the US and/or Canada accept the ETL Listed Mark as proof of product compliance to published industry standards.

4.1.3.4 Other Relevant Product Compliance Information

The Tadiran model TL-5955 lithium cell used to power the PB-SM is an Underwriters Laboratories (UL) recognized component, MH 12193. The battery is soldered directly to the printed circuit board. The positive side of the battery is toward the base (i.e. bottom of the device). The battery must never be replaced in the field. If the battery voltage is low, it must be returned to AssetWatch for service. To start the return process, please send an email to customersucess@nikola.tech.

4.1.3.4.1 Ingress Protection

VERO-VTH-01 has been tested and verified to ingress protection ratings of IP64.

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5 Regulations for potentially explosive atmospheres

ANSI/UL 60079-0

ANSI/UL 60079-11

CSA C22.2 No. 60079-0

CSA C22.2 No. 60079-11:

IEC 60529

IP64

5.1 Approvals for potentially explosive atmospheres

Hazardous Locations marking for North America and Canada:
Class I, Zone 0 AEX ia IIC T4 GA
Class I, Division 1, Groups A, B, C, D, T4
Ex ia IIC T4 Ga
-40°C ≤ Ta ≤ +65°C

5.2 Special Conditions of use in potentially explosive atmospheres

⚠ WARNING – POTENTIAL ELECTROSTATIC CHARGING HAZARD
AVERTISSEMENT – DANGER POTENTIEL DE CHARGES ÉLECTROSTATIQUES

The equipment utilizes external non-metallic materials which pose a potential electrostatic charging hazard. Refer to section 6.4 in this manual for details on the mitigation of electrostatic charging. Do not use or install in high charge areas.

- Fixed Installation

- Special Ambient Temperature Range is specified as such: -40°C ≤ Ta ≤ +65°C

- This product has a capacitance average of 6.4 pF on the screw, 6.67 pF on the magnetic attachment to Base (inner), 6.83 pF on the magnetic attachment to Base (outer), and 6.03 pF on the base which are in excess of 3pF and may pose electrostatic charging hazard. All metal parts of product must be connected to the ground through < 1GΩ impedance or the user must determine the suitability for the specific application.

-The VERO-VTH-01 is designed for Indoor use only when in a potentially explosive atmosphere.

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6 Detailed Product Description

The Vero Primary Battery Sensor Module (PB-SM) is designed to work in conjunction with Nikola Lab's cloud-based Condition Monitoring Platform AssetWatch(TM)™. **Error! Reference source not found.** below shows the Vero PB-SM.

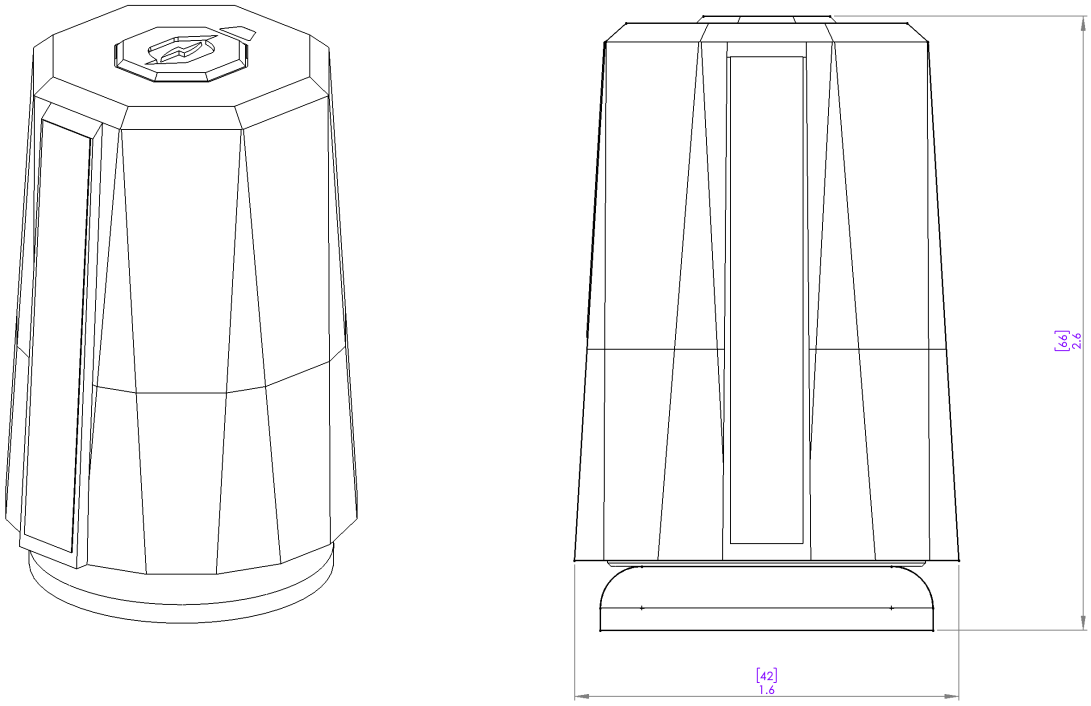

Figure 1: ***VERO PRIMARY BATTERY SENSORS MODULE (MODEL VERO-VTH-01)***

Marking Information will include the following:

- AssetWatch LLC
- Model number: VERO-VTH-01
- Serial Number (S/N): each unit is identified by a unique serial number located on the label. The S/N may be used to determine date of manufacture (upon request).
- Intertek/cETLus Marking & ETL22CA104869912X
- Cl I, Div 1, Groups A, B, C & D, T4
- Cl 1, Zn 0 AEx ia IIC T4 Ga

The model number VERO-VTH-01 sensor is designed to measure vibration and temperature for industrial rotating equipment like motors, fans, pumps, compressors, etc. The vibration and temperature readings are sent wirelessly, via Bluetooth Low Energy (BLE), to a Vero Hub, which translates the BLE signal to Wi-Fi and sends it to the cloud. The mechanical housing is sealed against environmental factors such as intense water spray and heavy dust/fiber accumulation. The high energy

cell coupled with low energy usage electronics assures long field life without the need to replace or recharge the battery.

Error! Reference source not found. below illustrates how the Nikola Vero components work together to create a safe and secure environment for our customer's data. First, the PB-SMs communicate to the hub using Bluetooth™ Low Energy (BLE). The BLE protocol is based on the version 4.2 standard and adheres to those security requirements. The Hubs communicate via Wi-Fi (802.11 standards using common security protocols to connect to a cellular hotspot (i.e. Cradlepoint). The Cradlepoint uses cellular/LTE technology to send data directly to the Nikola AssetWatch™ cloud without ever touching a customer IT network.

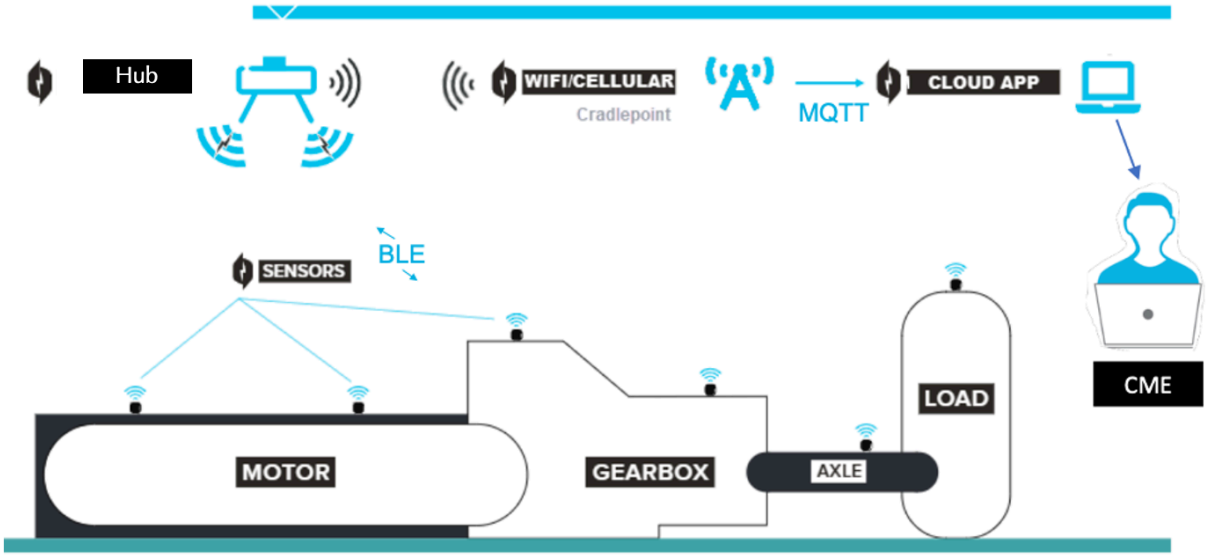

Figure 2: Typical Nikola Lab's Vero Communications Overview (No Customer Network Needed)

The Nikola Vero PB-SM monitors the health of customer equipment through the use of accelerometers and temperature sensors. The acceleration and temperature data are sent eight times (typically) per day using MQTT. Each MQTT packet is approximately 100kB of non-customer identifiable raw vibration data and is encrypted in-transit by using TLS. TLS is used to ensure the confidentiality of the application's MQTT protocol. Once the data hits the broker, it's within our secured AWS cloud infrastructure using AWS best practices and standards to ensure security. This data is not accessible or shared outside of the Nikola network except for our cloud application AssetWatch™ and APIs which are also deployed within the same AWS cloud infrastructure.

The PB-SM contains a triaxial accelerometer and temperature sensors with the following parameters:

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Triaxial Accelerometer

- Mechanical response: (-3dB): 8.2kHz (x), 8.5kHz (y), 5.6kHz(z)
- Measurements: up to +/-64g, 16-bit @ 25.6kHz sample rate

Temperature Sensor

- Operating Range: -40°C to +125°C (-40°F to +257°F)
- Accuracy of +/-1°C

Mechanical Specifications

- Height: 2.4" [107mm]
- Diameter:1.6" [41mm]
- Weight: 5.8 oz. [108g]
- Mounting Provisions:
    - Magnet (100 lbs. +/- 10% pull force)
    - Magnet with ferrous strike plate (for mounting to non-ferrous substrates)
    - Threaded stud rigid coupling (¼-28 stud threaded in customer asset)
    - Epoxy mounted stud rigid coupling (¼-28 stud on machined epoxy mount)

6.1 Normal Installations Instructions

6.1.1 Inspection

Inspect for cracks and damage.

6.1.2 Pre-Install Assumptions

- The facility has already been created in AssetWatch(TM)™ and has been linked in SalesForce.
- Install team knows locations and names of customer assets and has determined mounting locations for hardware to be installed.
- Cradlepoints have a SIM card installed and Wi-Fi SSID & password are configured.
- Hubs have Wi-Fi SSID & password configured.
- In AssetWatch(TM)™the following has been completed.
    - 'Facility Status' has been set to 'Live Customer'.
    - 'Facility-wide 15m hub diagnostics' has been enabled.
    - Hubs and Cradlepoints have been assigned to the facility.
- To ensure connectivity to all devices being installed, it is recommended to install hardware for each area in the following order: Cradlepoint, hub, PB-SM.
    - For detailed instructions on Cradlepoint and Hub installations and troubleshooting, please refer to the Hub Operation Manual

6.1.3 PB-SM Installation

1. From the 'Facility Layout' tab, click the 'Add/Edit Monitoring Points' button next to the asset and fill in all the needed information.
2. Mount the PB-SM to the customer asset using the included magnet or one of the optional mounting methods below:
    a. Standard mount: Simply place the PB-SM on the desired location using the supplied 100 lbs pull force magnet. Surface should be dry, clean and firmly fixed to the asset. Figure 3 shows a typical installation. PN:SN label faces in axial direction, parallel to shaft.

Figure 3: Typical PB-SM Installation with supplied magnet

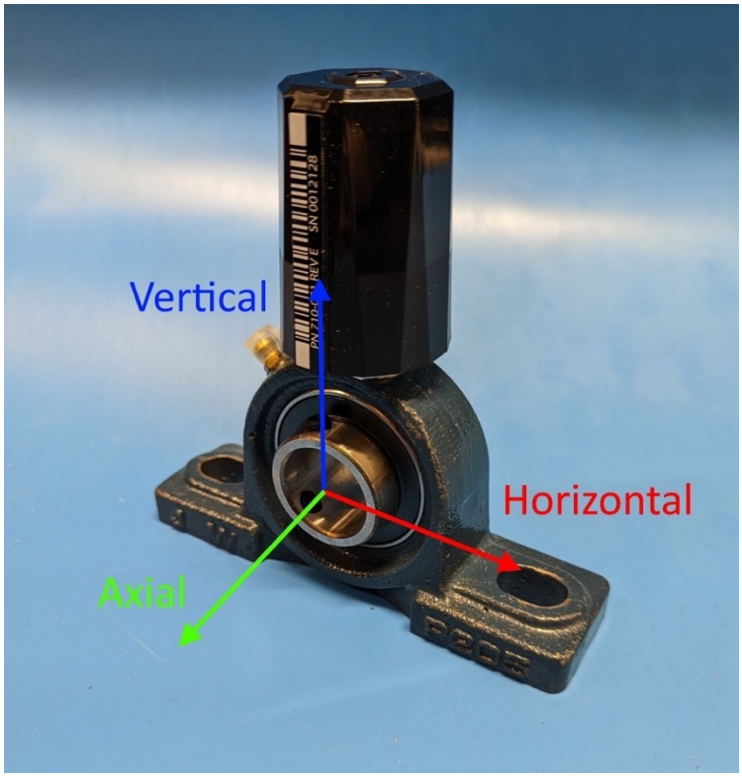

Figure 4: Example of PB-SM showing orientation of the device

b. Optional Mount: Magnet with ferrous strike plate

(Pictures of epoxied strike plate and magnet mounted PBSM on strike plate)

For customer assets with non-ferrous housings, an optional ferrous strike plate may be mounted to the housing with Loctite multi-material epoxy AA330 and activator SF 7387.

Figure 6: Loctite AA330 and SF 7387

i. Follow manufacturer instructions for surface preparation and use of Loctite AA330 and activator for an adequate bond
ii. Unsure no epoxy is present on the magnet side of the strike plate. Sensor magnet should contact the strike plate flat over it's entire surface.
iii. Use a ferrous, zinc plated or galvanized steel strike plate of at least 0.04" [1mm] thickness and at least 1.5" [38.1mm] in diameter.
iv. Mcmaster-Carr P/N 91090A116 (Nikola P/N) is a suitable strike plate for this purpose:

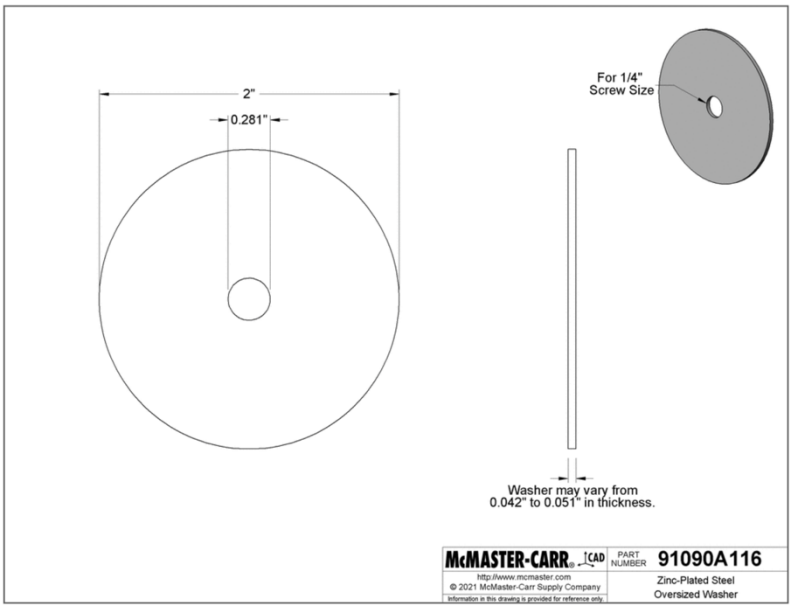

Figure 7: Optional epoxy mounted ferrous strike plate

c. Optional Mount: Threaded stud rigid coupling

(Pictures of threaded stud protruding from asset and PBSM mounted on threaded stud)

For customers who require a direct threaded connection to the asset, the magnet may be bypassed with a ¼-28 stainless steel threaded stud mounted directly into the threaded hole in the PB-SM base.

i. ¼-28 threaded stud should engage a metal substrate of the asset housing to a depth of at least ¼"
ii. ¼-28 threaded stud should protrude from the asset at least 3/16" [4.5mm] and not more than 3/8" [9.5mm]. Mcmaster-Carr P/N 92311A560 (Nikola P/N) is a suitable threaded stud for rigid coupling

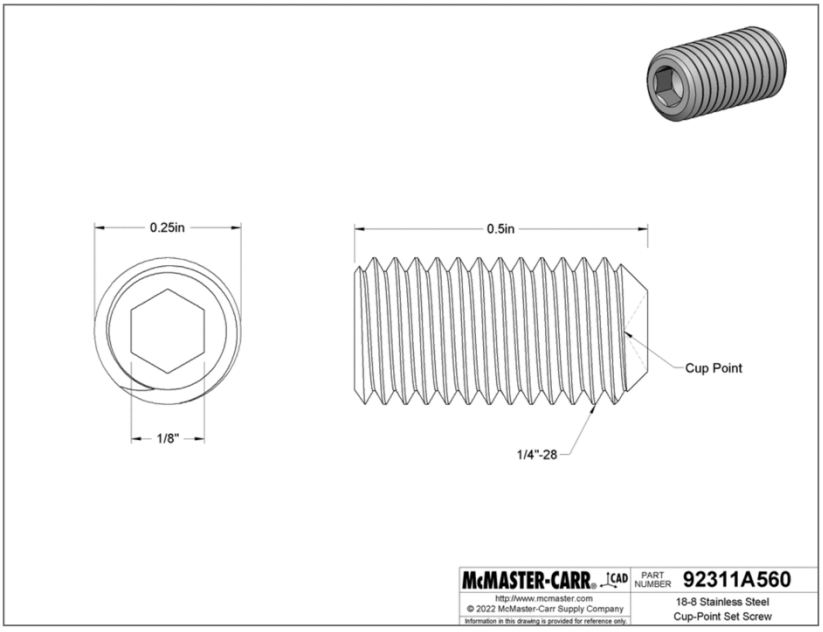

Figure 8: Threaded stud for rigid coupling to PB-SM

iii. Unthread the magnet screw from the PB-SM using an impact driver and #1 Phillips tip (This will require significant torque to remove the screw)
iv. Use metal ring shims to set the height of the PB-SM so the PN:SN label faces in axial direction, parallel to shaft when fully engaged on the stud. Use a torque of at least 1 ft-lb. [1.4 N-m] to ensure at least 90 lbs [41kg] of axial force in the rigid coupling. Mcmaster-Carr 90902A225 (Nikola P/N) is a suitable metal ring shim for rigid coupling

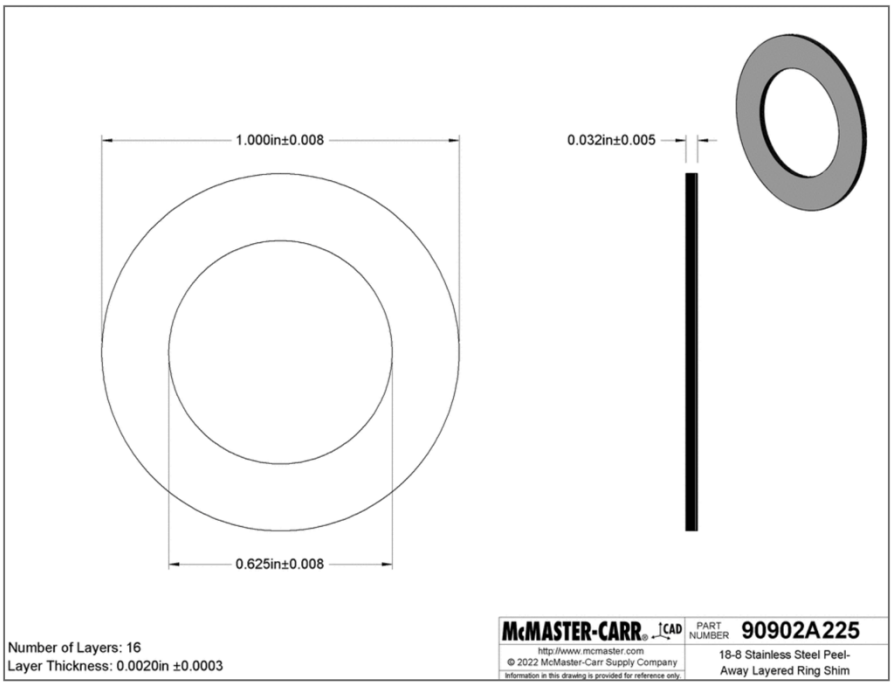

Figure 9: Ring shim for rigid coupling with threaded stud

v. Use Loctite 242 (Blue) on both sides of threaded stud, into the asset and into the PB-SM base.

3. After installation, press button to provision PB-SM.
    a. Press button until there are two quick green flashes.
    b. The LED will periodically blink blue when in provisioning mode.
4. Wait for PB-SM to finish provisioning.
    a. Once a hub has provisioned a PB-SM, the LED on the PB-SM may blink green again as it goes into normal mode.
    b. Once in normal mode the PB-SM LED will remain off.
5. Take photo of the mounted PB-SM and upload to AssetWatch™ in one of the following ways.
    a. Send a text message to 1-614-412-3720.
    b. From the 'Facility Layout' tab, click the 'Edit Asset' button and use the photo tab.

6.1.4 Verification

1. Verify all sensors are online and have sent data to AssetWatch™.
2. Contact Customer Success team and let them know the install is complete!

6.1.5 Additional Resources

- For details about the hardware interfaces mentioned in this guide, refer to the Version 2.0 Hardware Interfaces document.
- Cradlepoint devices can be managed online with NetCloud at cradlepoint.com.
- If you need to configure the Wi-Fi credentials on a hub, refer to the Version 2.0 Soft AP Guide.

6.2 Installation in Hazardous Locations

The steps for installing VERO-VTH-01 in a potentially explosive environment are the same as for ordinary locations but with the following precautions:

⚠ CAUTION – Ensure that the atmosphere where the PB-SM is to be installed contains no potentially explosive materials. The sudden striking of the magnet to the mounting surface could generate a metal-to-metal spark.

1 Maintenance

6.3 Maintenance free

There is no need to open device at any time. Nonetheless, the follow warning is provided:

⚠ WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT
AVERTISSEMENT – NE PAS OUVRIR EN CAS DE PRESENCE D'ATMOSPHERE EXPLOSIVE

6.4 Cleaning

⚠ CAUTION – Care must be taken when handling or cleaning the sensor module so there is no static charge build-up or discharge. Do not wipe off the PBSM with a dry cloth. Use only water damp cloth and allow to air dry for cleaning device.

6.5 Repair

To customers using the VERO-VTH-01:

Faulty devices or devices otherwise requiring repair should be returned immediately to AssetWatch. There are no user serviceable parts inside. Please send an email to customersucess@nikola.tech to get the return process and replacement service started

To repair facilities of the VERO-VTH-01:

⚠ WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY OF THIS DEVICE.
AVERTISSEMENT: LA SUBSTITUTION DES COMPOSANTS PEUT NUIRE À LA SÉCURITÉ INTRINSÈQUE

Use only identical or approved parts in the repair of this device.

7 Troubleshooting

7.1 Observed behaviors and what to do

The best way to tell if everything is operating correctly is to observe data reporting at regular intervals in the AssetWatch™ platform. The tables below describe the various LED colors and flash sequences for troubleshooting if data is not being displayed in AssetWatch™ or if things are not going well during the installation process.

7.1.1 Button Actions and LED Indicators

User Action	LED Response	PBSM Action
Press and hold button less than 1 second	Red Flash 2x	Goes back to Deep Sleep Mode
Press and hold button more than 1 second	Green Flash 2x	Initialize and Startup Mode begins
	Quick Blue Flashes: 2x every 5 seconds	Sensor successfully turned on and is provisioning
	2 Purple Flashes:	The Sensor Serial number is invalid
	2 Amber Flashes:	Temperature sensor hardware failure
	3 Amber Flashes:	Accelerometer sensor hardware failure
Confirmed PBSM working in AssetWatch	OFF	Normal Operation

7.1.2 Operational Modes

Deep Sleep Mode

- When the button is pressed for 1s, but no more than 3s, the red LED will turn on and the Deep Sleep mode will be primed
- The user must release the button when the red LED is on to enter Deep Sleep Mode
- Deep sleep mode is the lowest power option available where the only functionality needed is to wait for a button push to wake up the device

Provision Mode (Constant Advertising)

- A single button press for 500ms will wake the sensor from deep sleep (indicated by flashing green LED), and then it will check whether if it is an initial boot. If it is, the sensor will enter Provision Mode.
- In provision mode the sensor will not go to sleep between advertising events, allowing the hub to connect to it more easily.
- If a hub does not connect to the sensor within a 30-minute timeout, the device will flash the red LED and go back to Deep Sleep Mode
- If a hub does connect to sensor within the 30-minute timeout, it will provision the device and the device will then enter Normal Operation Mode after resetting.

Normal Operation Mode

- A single button press for 500ms will wake the sensor from deep sleep (indicated by flashing green LED), and then it will check whether if it is an initial boot. If it is the sensor will enter Normal Operating Mode.
- In Normal Operating Mode, the sensor will advertise once every ~30-60 seconds.

Erase Internal Flash

- When the button is pressed for 3s, but no more than 5s, the blue LED will turn on and the Erase Internal Flash mode will be primed. This will put the sensor into Provision Mode when it is turned on next time.
- The user must release the button when the blue LED is on to erase the internal flash
- After the internal flash is erased, the sensor will go to Deep Sleep mode.

Device Reset

- When the button is pressed for 7.5s, a hardware reset will occur

7.2 Instructions for returning to AssetWatch

If users have any problems with PB-SMs not working properly, please send an email to customersucess@nikola.tech to get the return process and replacement service started.