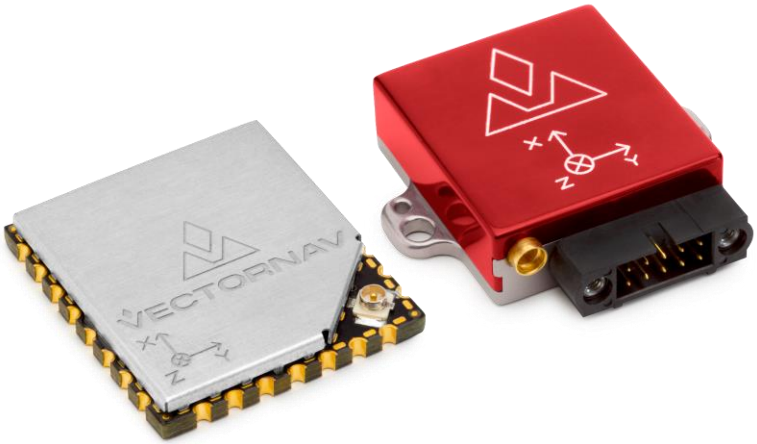
VN-200 Development Kit

Quick Start Guide



VECTORNAV
Embedded Navigation Solutions

Thank you for purchasing the VN-200 Development Kit from VectorNav Technologies. This Quick Start Guide will assist you in getting the VN-200 configured and operational. It will also introduce some common operations performed with the sensor. For more detailed information please refer to the VN-200 User Manual, a copy of which is provided with the Development Kit and is also available online at www.vectornav.com/support.

Please do not hesitate to give us a call at +1.512.772.3615 or email us at support@vectornav.com if there are any questions we can answer or if we can be of any assistance.

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VN-200 Introduction

The VN-200 is a miniature, surface-mount, high-performance GPS-Aided Inertial Navigation System (GPS/INS). Incorporating the latest solid-state MEMS sensor technology, the VN-200 combines a set of 3-axis accelerometers, 3-axis gyros, 3-axis magnetometer, a barometric pressure sensor, a 50-channel L1 GPS receiver, as well as a 32-bit processor into a miniature surface-mount or standalone module. The VN-200 couples measurements from the onboard GPS module with measurements from the onboard inertial sensors to provide position, velocity, and attitude estimates of higher accuracies and with better dynamic performance than a standalone GPS module or Attitude Heading Reference System (AHRS).

VN-200 Installation

Mounting the VN-200

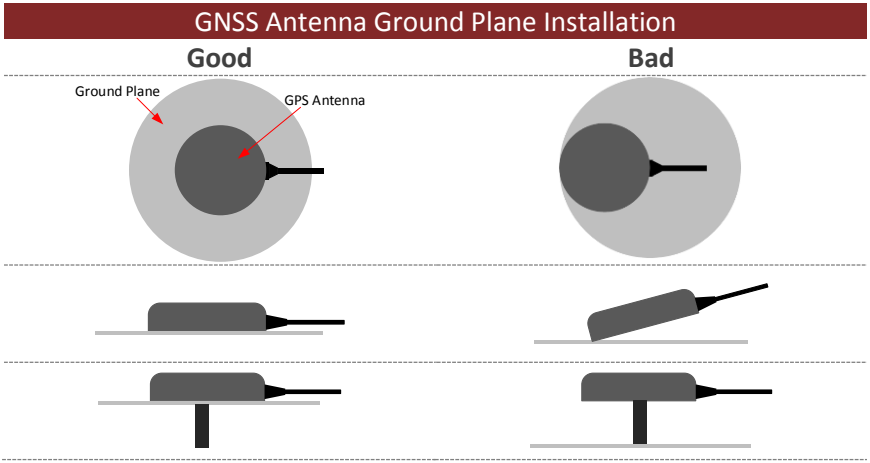
You may mount the VN-200 to the vehicle or platform **in any orientation**. If the VN-200 axes do not align with the desired vehicle or platform axes then a Reference Frame Rotation will be required to remap the attitude, angular rates, acceleration, and other data to the desired frame (see page 9).

When installing the VN-200 to a vehicle or other platform, ensure that:

- The VN-200 is **rigidly mounted** with respect to the GNSS antenna
- The VN-200 is **rigidly mounted** to the aircraft, vehicle or other platform.
    - Vibration dampeners or flexible mounts can degrade the VN-200 performance and are not recommended.
- All harnesses are properly secured and strain-relieved to avoid stress entering the VN-200 from the cabling.
- Great care is taken when connecting the GNSS antenna, as the connector can sustain limited side loads and connecting cycles

Ground Planes

To prevent multipath ensure that the GNSS Antennas are mounted directly to a ground plane. Below are good and bad ground plane installation examples.



- Antennas shipped with the development kit have a manufacturer recommended 100 mm diameter ground plane included
- There is **no** requirement for ground planes to be electrically grounded
- Ground planes can be any thin piece of metal (even foil)

Mounting the GPS Antenna

The VN-200 requires connection to an active GPS antenna, mounted with a clear view of the sky.

In order for the GNSS Compass to function optimally both antennas **must**:

- have clear view of the sky
- have a ground plane installed directly underneath the antenna or be mounted on large metal surface
- be mounted as flat as possible, minimize pitch/roll to < 10°

VN-200 Start Up Sequence

Mode: 0 (NotTracking)
No Fix Acquired

Time: 0 sec
The VN-200 is operating as an AHRS. Using the on-board magnetometer for coarse heading estimation

Mode: 1 (Aligning)
3D Fix Acquired

Time: +30 sec
GPS Fix acquired. Local magnetic declination applied. VN-200 still operating as AHRS.

Mode: 1 (Aligning)
3D Fix Acquired

The VN-200 needs to exceed 5 m/s for more than 1 second to start dynamic alignment

Mode: 1 (Aligning)
3D Fix Acquired

During dynamic alignment accel and GPS data are correlated to produce yaw estimate. Typically take 60 seconds of sufficient motion to complete alignment.

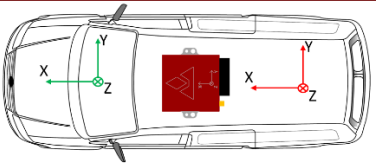
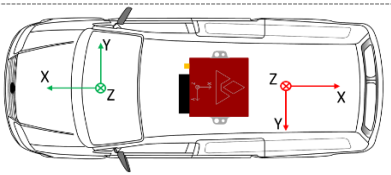
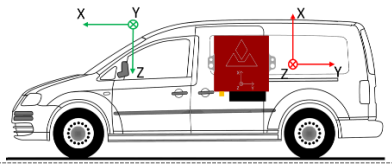
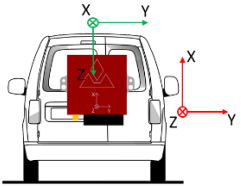
Mode: 2 (Tracking)
3D Fix Acquired

VN-200 Heading uncertainty is now below 2 degrees. Sensor operating within specification.

VN-200 Setup

Reference Frame Rotation

The VN-200 may be mounted in **any** orientation on the vehicle or platform. The Refence Frame Rotation is a 3 x 3 rigid rotation matrix that will map the sensor axes to the vehicle axes, this will enable the VN-200 to output attitude, angular rates, acceleration, and other data in the vehicle reference frame.

Sensor Orientation	Reference Frame Rotation
	$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$
	$\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$
	$\begin{bmatrix} 0 & -1 & 0 \\ 0 & 0 & 1 \\ -1 & 0 & 0 \end{bmatrix}$
	$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix}$
 Vehicle Frame	 Sensor Frame

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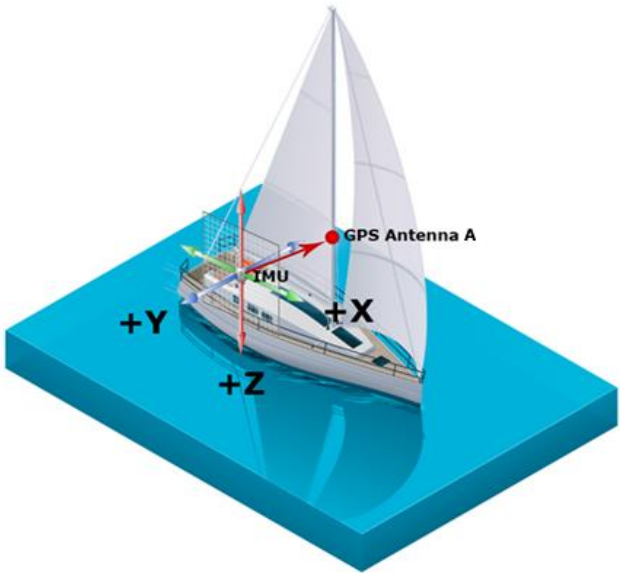
GPS Antenna A Offset

By default, the VN-200 assumes that GPS Antenna A is mounted within 10 centimeters of the VN-200 module itself. If GPS Antenna A is mounted farther away than 10 centimeters in any direction then the GPS Antenna A Offset Register must be specified to properly account for the relative motion of the antenna with respect to the IMU. The VN-200 defines the Antenna A offset as the distance from the VN-200 to Antenna A in the X, Y, & Z directions defined by the Sensor Frame.

To configure the GPS Antenna A Offset, use *Register ID 57* to input the X, Y, & Z position of Antenna A with respect to the VN-200.



If the Reference Frame Rotation is implemented, then the Antenna A offset must be specified in the X, Y, & Z directions of the Vehicle Frame as defined by the Reference Frame Rotation matrix.

Configuring the VN-200 in Control Center

All VN-200 configuration registers can be set within Control Center using the various dropdown items in the Config Registers View and stored in non-volatile memory using the Write Settings command. The VN-200 will automatically startup in the configuration that was set when a Write Settings command was issued. A Restore Factory Settings command will reset the configuration to the default settings.

A copy of the Control Center GUI is included on the CD in the VN-200 Development Kit. Please also regularly check our website for the latest version of the software.

http://www.vectornav.com/support/downloads

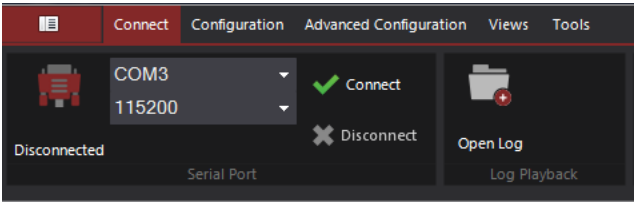
The following steps provide an example of how to connect to the VN-200, configure the VN-200 output data, input the GNSS Compass measurements, and view the VN-200 INS Status message through startup and operation.

Some INS Filter configuration settings require a Reset command after issuing a Write Settings command before taking effect.

Connecting to the VN-200

When first working with the VN-200, we recommend connecting the sensor to a PC running our Control Center GUI to gain familiarity with the available configuration options and features.

1. Attach the USB or Serial Adapter Cable to the VN-200 using the cable tool provided in the Development Kit. For the VN-200 Development Board, you can connect and power the sensor through USB1 (J2 connector) or alternatively use the USB2 (J3) for power and the DB-9 (J4) for communication.



2. Connect to the VN-200 by selecting the correct COM port and baudrate and clicking on the Connect button. The default baudrate for the VN-200 is 115200.

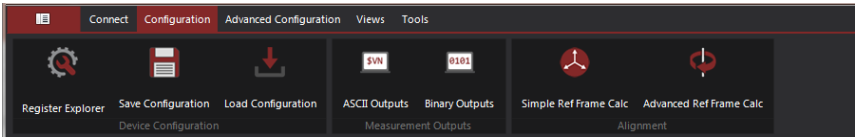
The VN-200 can pull up to 100mA of current when the GNSS antenna is connected. Ensure USB port compatibility prior to use.

Reference Frame Rotation Configuration

As mentioned earlier, the VN-200 can be mounted in any orientation. In order to align the output axes with that of the vehicle frame you need to configure the Reference Frame Rotation. The changes can be input by either using the:

1. Simple Ref Frame Calc Tool
2. Advanced Ref Frame Cal Tool
3. Reference Frame Rotation Register located in:
   Config Registers -> IMU -> Reference Frame Rotation

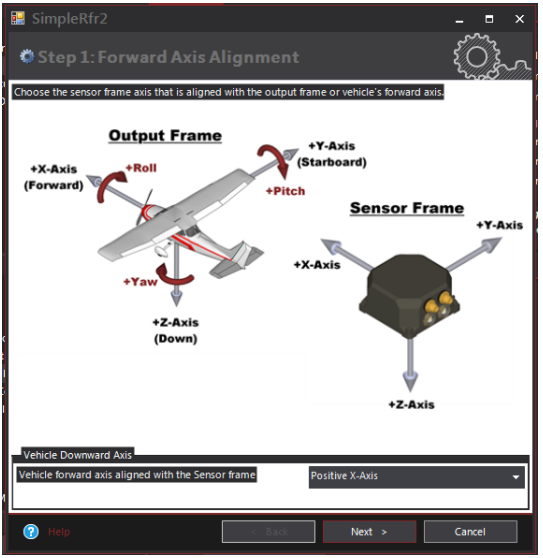
The simplest tool to use for the RFR configuration is the Simple Ref Frame Calc tool that can be found under the Configuration menu item.



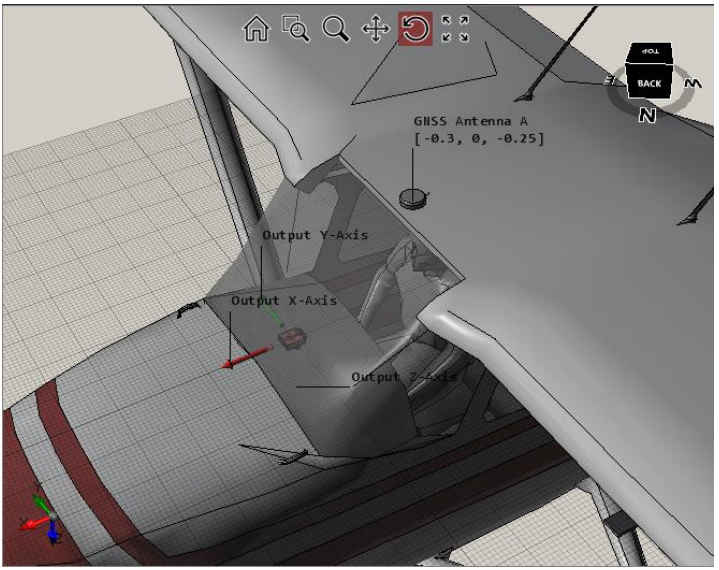
The Simple Ref Frame Calc will step you through aligning the VN-200 axes with the vehicle axes. There are three (3) steps:

a. What axis of the VN-200 aligns with the forward axis of the vehicle?
b. What axis of the VN-200 aligns with the downward axis of the vehicle?
c. Click Finish to write the new RFR to the sensor and reset

The RFR will only take affect after a reset. Ensure that you issue Write Settings to save the configuration for the next power up.



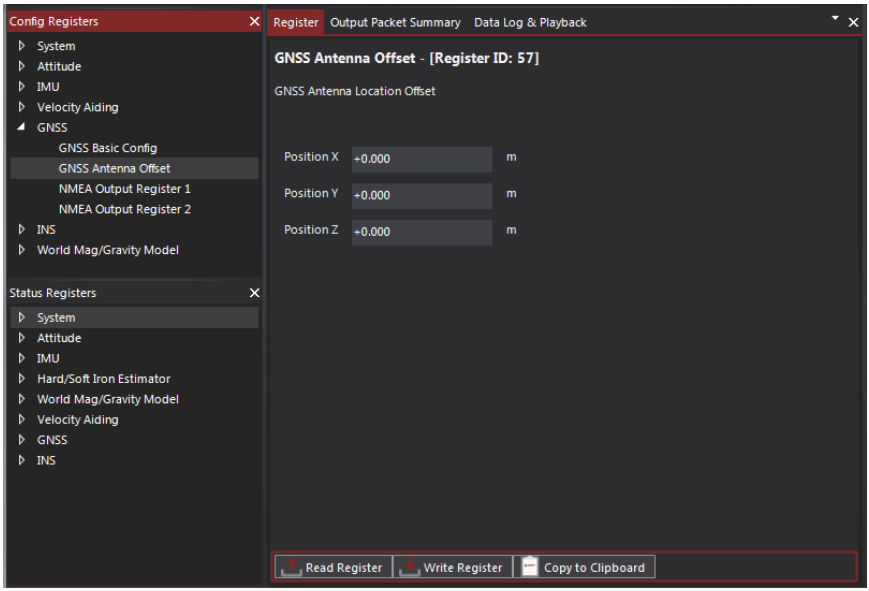
Use the 3D View to confirm the orientation of the VN-200 matches your physical installation.



Antenna A Offset Configuration

Input the X, Y, & Z GNSS Antenna A Offset measurements by expanding the *GNSS Antenna A Offset item* under *Config Registers -> GNSS.*

Click the Write Register button in order to write the new configuration to the sensor.



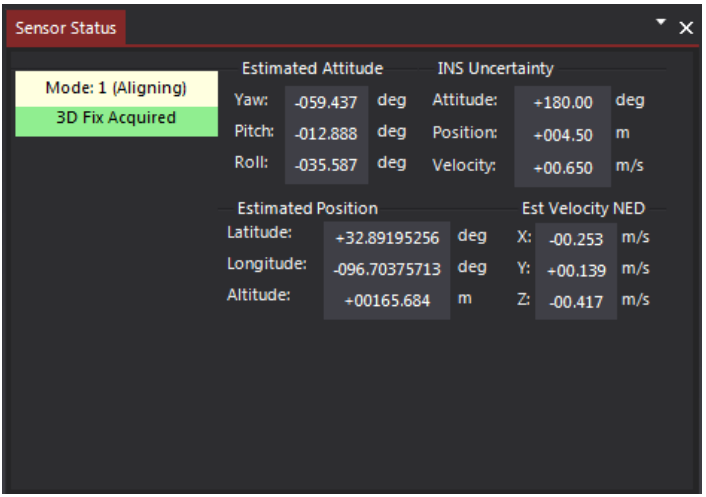
It is important to issue a Write Settings followed by a Reset command after inputting the GNSS Compass Baseline measurements to ensure the VN-200 initializes on the correct values. Right-click on Write Settings in the *Commands Window* and then click Execute Command. Next, right-click on Reset and then click Execute Command.

Monitoring VN-200 Startup

Control Center will poll the VN-200 and display the INS Mode, GNSSFix status flags in the Sensor Status window. It will also provide details of the number of satellites used from Position, Velocity and Timing (PVT) solution.

It is important to monitor these status messages during the startup sequence to ensure that the INS Filter initialize properly.

The Sensor Status window provides a comprehensive overview of the VN-200 status.



Trouble Shooting

1. The heading/yaw is incorrect or drifts when stationary

The VN-200 is experiencing magnetic interference.

- ☐ Move the sensor away from magnetic interference
- ☐ Do an HSI calibration to compensate for local interference

2. No GPS fix or position is jumping when stationary

Likely problem is poor GPS conditions, poor satellite visibility or multipath

- ☐ Ensure the GPS antenna has a clear view of the sky
- ☐ Move away from obstructions or large buildings
- ☐ Ensure antenna is mounted directly to ground plane

3. The VN-200 is not getting into INS Mode 2

The VN-200 will only dynamically align with sufficient motion.

- ☐ The vehicle/platform needs to exceed 5 m/s in order to dynamically align

4. INS Mode toggles when in high dynamic maneuvers

The Lever Arm, Antenna A offset, is likely incorrect.

- ☐ Check Antenna A Offset measurements are correct and in the correct reference frame

5. The VN-200 altitude is incorrect

The VN-200 reports altitude above ellipsoid (WGS84) and not above Mean Sea Level (MSL).

VN-200 Installation and Setup Checklist

Description	Yes/No
VN-200 Mounting	
Is the VN-200 rigidly mounted?	☐
Are the cables strain relieved?	☐
Do you need a reference frame rotation? $\begin{bmatrix} \_ & \_ & \_ \\ \_ & \_ & \_ \\ \_ & \_ & \_ \end{bmatrix}$	☐
GNSS Antenna Mounting	
Is the GPS antenna rigidly mounted?	☐
Is the antenna on a flat and level surface?	☐
Is the GPS Antenna mounted directly to a ground plane?	☐
Does the antenna have a clear view of the sky?	☐
Measurements	
Are the Antenna A Offset measurements in the ***Vehicle Frame*** ?	☐
X: Y: Z:	
VN-200 Setup	
Start Control Center	☐
Connect Control Center to VN-200	☐
Input Reference Frame Rotation into Control Center	☐
Input GNSS Antenna A Offsets (X, Y, & Z)	☐
Set COM Baudrate to: 115200	☐
Set Async Data Output Type to: INS LLA	☐
Set Async Data Output Frequency to: 40	☐
Write Settings to Sensor Memory	☐
VN-200 Startup Sequence	
Are you outside?	☐
Are you away from tall buildings?	☐
Do you have a clear view of the sky?	☐

Connect the VN-200 to Control Center	☐
Is GPS Fix: True	☐
Is INS Mode: 1	☐
Has your platform/vehicle exceed 5m/s	☐
Is INS Mode: 2	☐

Additional References

- VectorNav VN-200 User Manual (UM0004)

  www.vectornav.com/support/manuals

- VectorNav Development Tools
  - Control Center
  - C/C++ Library
  - .NET Library
  - Embedded Firmware Library
  - MATLAB Development Library
  - EAGLE PCB Parts Library

  www.vectornav.com/support/downloads

- Overview of Inertial Sensor Technology

  www.vectornav.com/support/library