



FIELD OPS REMOTE TRACKER USER MANUAL

Release Date: August 11, 2023

Table of Contents

1	COPYRIGHT & WARRANTY INFORMATION	1
2	INTRODUCTION	2
3	SPECIFICATIONS.....	3
3.1	Characteristics & Requirements	3
3.2	Mechanical Drawings.....	5
4	FORT EVALUATION AS AN APNT SYSTEM.....	6
4.1	Kit Contents.....	6
4.2	Quick Start.....	6
4.3	Charging	9
4.4	Mobile App Pairing.....	9
4.5	Start Tracking	12
4.6	Speech Recognition.....	14
4.7	Gyro Stabilization.....	15
4.8	Secure Module on Body.....	15
4.9	Start Walking.....	16
4.10	Stop Continually Adaptive Nav Service.....	18
4.11	CAN Settings.....	20
4.12	Multiple FORT Devices	22
4.13	Export Log	26
4.14	LED Indications.....	26
4.15	High Speed Data Logging	27
4.16	Configuration Tab	28
4.17	Output and Logs Tab.....	29
5	REVISION BLOCK.....	35

List of Figures

Figure 3-1: FORT PCA Mechanical Drawing	5
Figure 4-1: FORT unit and provided cable	6
Figure 4-2: FORT Module with the arrow at top	7
Figure 4-3: Blue circle.....	8
Figure 4-4: App Icon	10
Figure 4-5: Allow Bluetooth access.....	10
Figure 4-6: Pairing FORT Module to the mobile device.....	11
Figure 4-7: Services	12
Figure 4-8: Allow app to use your location	13
Figure 4-9: Speech Recognition Pop Up.....	14
Figure 4-10: FORT module in recommended position.....	16
Figure 4-11: Starting point created with “Add Start” button	17
Figure 4-12: Smaller or no blue circle is better.....	18
Figure 4-13: Continually Adaptive Nav service tracking outdoors and indoors ...	19
Figure 4-14: Settings in Continually Adaptive Nav Services – Default CAN-GPS Fusion	20
Figure 4-15: Advanced Settings in Continually Adaptive Nav Services	22
Figure 4-16: Extra FORT Devices	22
Figure 4-17: List of Available Extra FORT Devices.....	23
Figure 4-18: List of Connected and Available Extra FORT Devices	24
Figure 4-19: List of Paths for Extra FORT Devices	25
Figure 4-20: Setting Device Position for Extra FORT Devices	25
Figure 4-21 Example Path with Extra FORT Devices	26
Figure 4-22: Services	28
Figure 4-23: Configuration tab.....	28
Figure 4-24: Output and Logs tab	29
Figure 4-25: Selected Logs settings within Output and Logs tab	30
Figure 4-26: Positive & Negative Roll and Pitch Definition	31
Figure 4-27: Firmware Upgrade section	32
Figure 4-28: Calibration Section.....	33
Figure 4-29: Gradient Detector Settings.....	34

List of Tables

Table 3-1: Performance Specifications ¹	3
Table 3-2: Absolute Maximum Ratings	4
Table 3-3: Electrical Requirements	4
Table 3-4: I/O Characteristics.....	4
Table 3-5: Environmental Requirements	4
Table 3-6: Mechanical Characteristics	5
Table 4-1: FORT LED indicators	26

1 Copyright & Warranty Information

© Copyright Protonex LLC dba PNI Sensor, 2023.

All Rights Reserved. Reproduction, adaptation, or translation without prior written permission is prohibited, except as allowed under copyright laws. For the most recent version of this manual, visit our website at www.pnicorp.com.

PNI Sensor
2331 Circadian Way
Santa Rosa, CA 95407, USA
Tel: (707) 566-2260

Warranty and Limitation of Liability. PNI Sensor ("PNI") manufactures its FORT products ("Products") from parts and components that are new or equivalent to new in performance. PNI warrants that each Product to be delivered hereunder, if properly used, will, for one year following the date of shipment unless a different warranty time period for such Product is specified: (i) in PNI's Price List in effect at time of order acceptance; or (ii) on PNI's web site (www.pnicorp.com) at time of order acceptance, be free from defects in material and workmanship and will operate in accordance with PNI's published specifications and documentation for the Product in effect at time of order. PNI will make no changes that significantly affect form, fit, or function of the Product without written notice to the OEM, however, PNI may at any time, without such notice, make minor changes to specifications or manufacturing processes that do not affect the form, fit, or function of the Product. This warranty will be void if the Products' serial number, or other identification marks have been defaced, damaged, or removed. This warranty does not cover wear and tear due to normal use, or damage to the Product as the result of improper usage, neglect of care, alteration, accident, or unauthorized repair.

THE ABOVE WARRANTY IS IN LIEU OF ANY OTHER WARRANTY, WHETHER EXPRESS, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE. PNI NEITHER ASSUMES NOR AUTHORIZES ANY PERSON TO ASSUME FOR IT ANY OTHER LIABILITY.

If any Product furnished hereunder fails to conform to the above warranty, OEM's sole and exclusive remedy and PNI's sole and exclusive liability will be, at PNI's option, to repair, replace, or credit OEM's account with an amount equal to the price paid for any such Product which fails during the applicable warranty period provided that (i) OEM promptly notifies PNI in writing that such Product is defective and furnishes an explanation of the deficiency; (ii) such Product is returned to PNI's service facility at OEM's risk and expense; and (iii) PNI is satisfied that claimed deficiencies exist and were not caused by accident, misuse, neglect, alteration, repair, improper installation, or improper testing. If a Product is defective, transportation charges for the return of the Product to OEM within the United States and Canada will be paid by PNI. For all other locations, the warranty excludes all costs of shipping, customs clearance, and other related charges. PNI will have a reasonable time to make repairs or to replace the Product or to credit OEM's account. PNI warrants any such repaired or replacement Product to be free from defects in material and workmanship on the same terms as the Product originally purchased.

Except for the breach of warranty remedies set forth herein, or for personal injury, PNI shall have no liability for any indirect or speculative damages (including, but not limited to, consequential, incidental, punitive and special damages) relating to the use of or inability to use this Product, whether arising out of contract, negligence, tort, or under any warranty theory, or for infringement of any other party's intellectual property rights, irrespective of whether PNI had advance notice of the possibility of any such damages, including, but not limited to, loss of use, revenue or profit. In no event shall PNI's total liability for all claims regarding a Product exceed the price paid for the Product. PNI neither assumes nor authorizes any person to assume for it any other liabilities.

Some states and provinces do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may have other rights that vary by state or province.

2 Introduction

Thank you for purchasing PNI's Field Ops Remote Tracker (FORT) module. The FORT employs proprietary Edge AI, algorithms and Machine Learning (AI/ML) to accurately track dismounted soldiers, even when GPS is contested. FORT is a self-contained sensor-based tracking module that does not rely on cameras or RF beacons that can be occluded. The FORT uses only inertial sensors, and PNI's algorithms to determine a Soldier's location. FORT cannot be spoofed, jammed, or otherwise disabled or fooled by external sources.

The provided phone app provides an interface and some additional processing power but is not a required component for a fully deployed system. The BLE (Bluetooth Low Energy) phone connection and battery power are only provided for convenience of evaluation and are not required for full system implementation. Only the FORT module and End User Device (EUD) is required for a full solution.

PNI Sensor has invested IR&D over the last 9 years in developing inertial tracking algorithms that solely employ consumer-grade MEMS inertial sensors in combination with our high performance RM3100 magnetometers. Hence, the FORT module is a self-contained low SWaP-C tracking unit that can be body worn and deliver fine-resolution, step-resolution tracking in GPS-denied or compromised environments.



3 Specifications

3.1 Characteristics & Requirements

Table 3-1: Performance Specifications¹

Parameter			Value
Tracking / APNT Mode	Position	Accuracy ²	1% distance traveled
		Maximum time without reference (GPS) for 1% Accuracy	30 min

Footnotes:

1. Specifications are typical unless otherwise noted, and subject to change.
2. Assumes rigidly worn on a person (not shifting in a pocket), but no other walking constraints (forward, backwards, sideways, etc. are ok).

Table 3-2: Absolute Maximum Ratings

Parameter	Minimum	Maximum	Units
Supply Voltage	-0.3	+5.5	VDC
DC Input Voltage – USBDP and USBDM	-0.5	3.63	V
Storage Temperature	-40	+85	°C

CAUTION:

Stresses beyond those listed above may cause permanent damage to the device. These are stress ratings only. Operation of the device at these or other conditions beyond those indicated in the operational sections of the specifications is not implied.

Table 3-3: Electrical Requirements

Parameter		Value
Supply Voltage		4.5 to 5.5 VDC
Current Draw	Charging	140 mA Max
	Charged State	<1mA

Table 3-4: I/O Characteristics

Parameter	Value
Communication Interface	USB Virtual Comm Port
Communication Protocol	PNI Binary
Communication Rate	38400 baud

Further communication protocol information can be obtained by contacting support@pnicorp.com

Table 3-5: Environmental Requirements

Parameter	Value
Operating Temperature ¹	-40C to +85C
Storage Temperature	-40C to +85C

Footnote:

1. To meet performance specifications across this range, recalibration will be necessary as the temperature varies.

Table 3-6: Mechanical Characteristics

Parameter	Value
Dimensions (l x w x h)	30.0 x 50.7 x 15.35 mm
Weight	22 grams
Connector	USB Micro

3.2 Mechanical Drawings

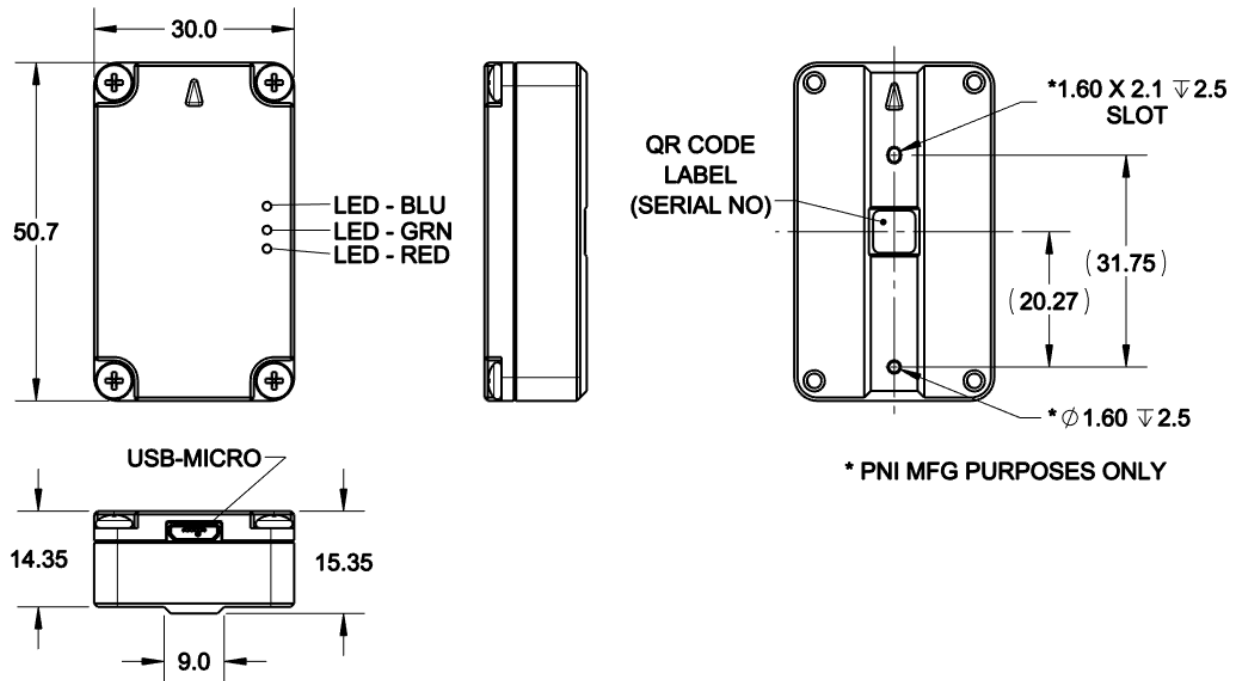


Figure 3-1: FORT PCA Mechanical Drawing

4 FORT Evaluation as an APNT System

- Ensure the FORT unit is charged.
 - It may take an hour or more to fully charge a unit when depleted.
- Evaluate and test the FORT unit using the provided application.

4.1 Kit Contents



Figure 4-1: FORT unit and provided cable and belt

1. Field Ops Remote Tracking (FORT Module) – Part number 14649
2. Micro USB charging cable
3. Tactical Belt for mounting
4. iOS “PNI FORT” application can be received by contacting support@pnicorp.com so that users can be set up with the TestFlight application. An iPhone and Apple ID will be required in order to download the PNI FORT application.

4.2 Quick Start

Note: Detailed steps shown in next sections

1. Charge FORT module using a micro-USB cable – a full charge will take about an hour.
Note that the micro-USB port on the module is on the opposite side of the arrow.



Figure 4-2: FORT Module with the arrow at top

2. Set module down on a stable surface such as a table.
 - The FORT module has a gyroscope. The gyroscope bias is continuously learned and setting the module down on a stable surface will allow a quick learning of the initial gyroscope bias.
 - Keep it stable and still while performing the next steps.
3. Launch iOS PNI FORT App and press the green Start Scan button.
4. Select the module to which you would like to connect.
 - Gyro bias learning will start when the device is connected to the mobile app. It is important to keep the module still for 30 seconds after it makes a Bluetooth connection to the mobile app.
 - If you only have one module, only one device will appear in the selection.
 - Each module is identified by a unique serial number.
 - Serial number can be found on the sticker on the module.
5. Once the module is connected via Bluetooth to the mobile phone, you will be brought to the Services page of the App.
6. Choose Continually Adaptive Nav Service
7. Make sure the module has been kept on a stable surface for at least 30 seconds from connecting via Bluetooth to the mobile app to ensure correct initial gyro bias learning.
8. Secure module on torso (arms or legs not recommended) so it is stable and does not move.
9. For best results, start the test in open sky where an accurate initial location can be determined using the iPhone's GPS. Starting in open sky with good GPS will automate user step scaling and starting location. Contact our FAE Team at support@pnicorp.com if your application will not have any GPS access.

10. PNI FORT App uses Apple maps for display purposes. When a good GPS location is acquired, there will be no “blue circle” around the location pin. Good GPS acquisition could take some time and/or you may need to move away from buildings or trees to acquire a good GPS location.

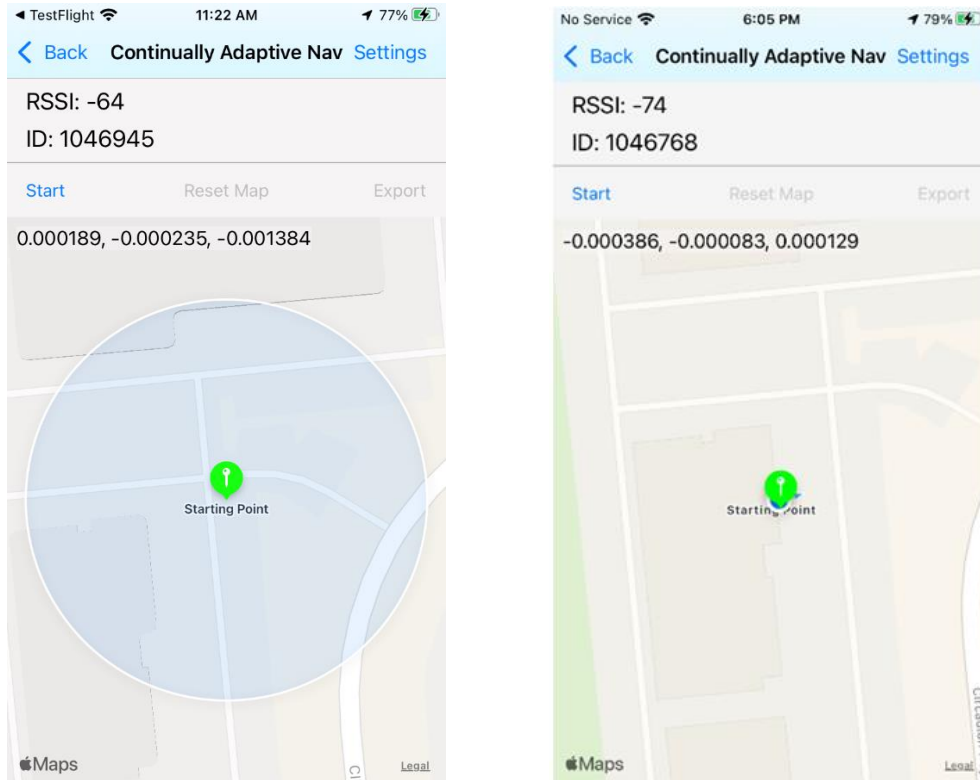


Figure 4-3: Blue circle

The blue circle around the location pin indicates uncertainty in your location using the iPhone's GPS. The smaller the circle, the more accurate your location pin. For best results, acquire a good initial GPS location without any blue circle or a blue circle with the smallest radius possible.

10. While in Continually Adaptive Nav (CAN) Service with a screen view of a map and good GPS acquisition of your starting point, select “Start” at the top left corner of the map.
- After hitting “Start”, wait about 3 seconds before walking. This allows the module to learn its orientation in relationship to the user's body.
 - Once started, “Start” will toggle to “Stop.”
11. Start walking - Start in open sky and walk for one minute outdoors.
12. Once a good starting location and automatic user initial stride length is learned (one minute with good GPS), move from outdoors to indoors and back outdoors for testing.
13. At the end of the walk press “Stop”.
14. Export JSON log for data analysis and for Playback of the run.
- CAN Playback mode can recreate the run.
15. Once you leave Continually Adaptive Nav Service page, the tracking run will be erased.

- Export your log before you exit Continually Adaptive Nav if you'd like to save your results.
- Saving log files enables our support teams to answer any questions you may have about your results.

4.3 Charging

The FORT module can be used in continuous mode connected via BLE to the iPhone for 4 hours. After 2-3 hours of use, we recommend charging the module before further testing.

To charge the module, connect the FORT module to a USB power source, using the micro USB cable. Please note that the micro USB port on the module is on the opposite side of the arrow. A red LED will light up on the bottom of the charger and when charging is complete, the LED will turn solid green. To fully charge the battery from low battery condition, will take about an hour.

4.4 Mobile App Pairing

The PNI FORT Evaluation iOS application will be provided via TestFlight which can be found on the Apple App Store. An invitation link to the PNI FORT iOS app will be made available by PNI's Field Application Engineer (FAE) team. If you did not receive your invitation to the app, please request access through support@pnicorp.com

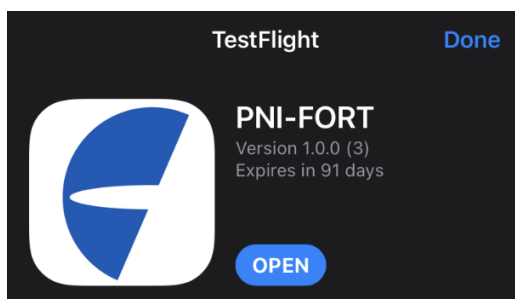




Figure 4-4: App Icon

Launch the app and ensure Bluetooth is enabled for the app.

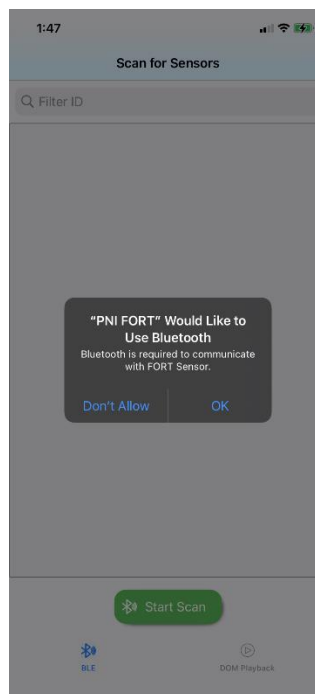


Figure 4-5: Allow Bluetooth access

Press “Start Scan” button on the bottom of the screen. All available FORT modules will be displayed. Choose the module to which you would like to pair.

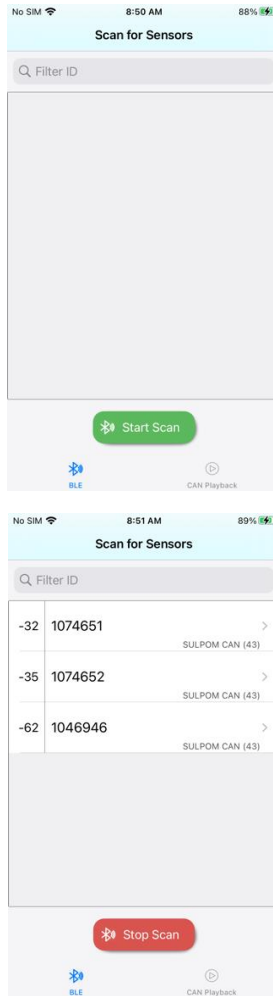


Figure 4-6: Pairing FORT Module to the mobile device

Once paired, the app will bring you to the Services page.

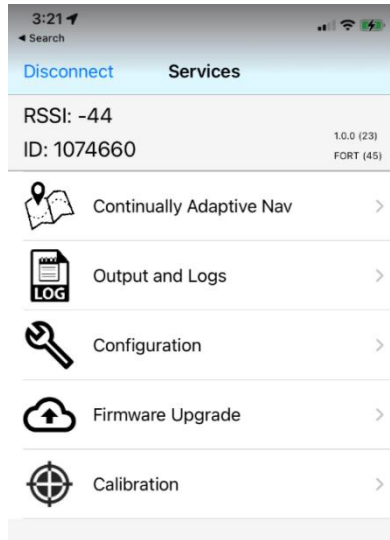


Figure 4-7: Services

4.5 Start Tracking

From the Services page choose **Continually Adaptive Nav**. The first screen will open the maps page and request user permission to allow the app to use your location. In order to see your live tracking on a map, you will need to choose “Allow while Using App” or “Allow Once”. To change location access by the PNI FORT App, go to your Settings on your iPhone.

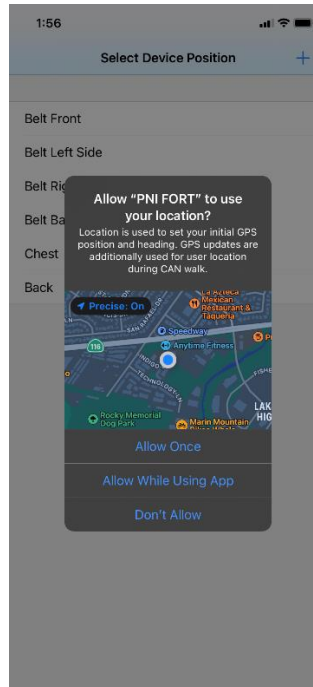


Figure 4-8: Allow app to use your location

The PNI FORT tracks the user and traces the user's path using only inertial sensors. Hence an initial location input is needed for the module to provide continuous location. Assuming an application where a user moves from outdoors where GPS is available indoors or from open sky to tree cover or canyons, the default settings of the app have been configured to use the phone's GPS to acquire the user's starting point location. The phone's GPS will also be used to automatically learn a user's stride length for accurate scaling of the user's traced path.

Starting in open sky with GPS will automate user step scaling and starting location. Contact our FAE Team at support@pnicorp.com if your application will not have any GPS access.

The app setting is defaulted to display the CAN-GPS Fusion path in black. This path is the output from FORT where reliable GPS signals are used to learn the user's stride and correct any accumulated errors in the inertial tracking. Unlike GPS only tracking, CAN-GPS Fusion will accurately track even when GPS is inaccurate or unavailable. Furthermore, the FORT module tracks the user's path with step-level resolution versus an interpolation between two GPS positions.

4.6 Speech Recognition

The app has the ability to listen to the user's speech for specific commands. This feature is enabled by default. When visiting the CAN service, you will be prompted to allow the app access to speed recognition.

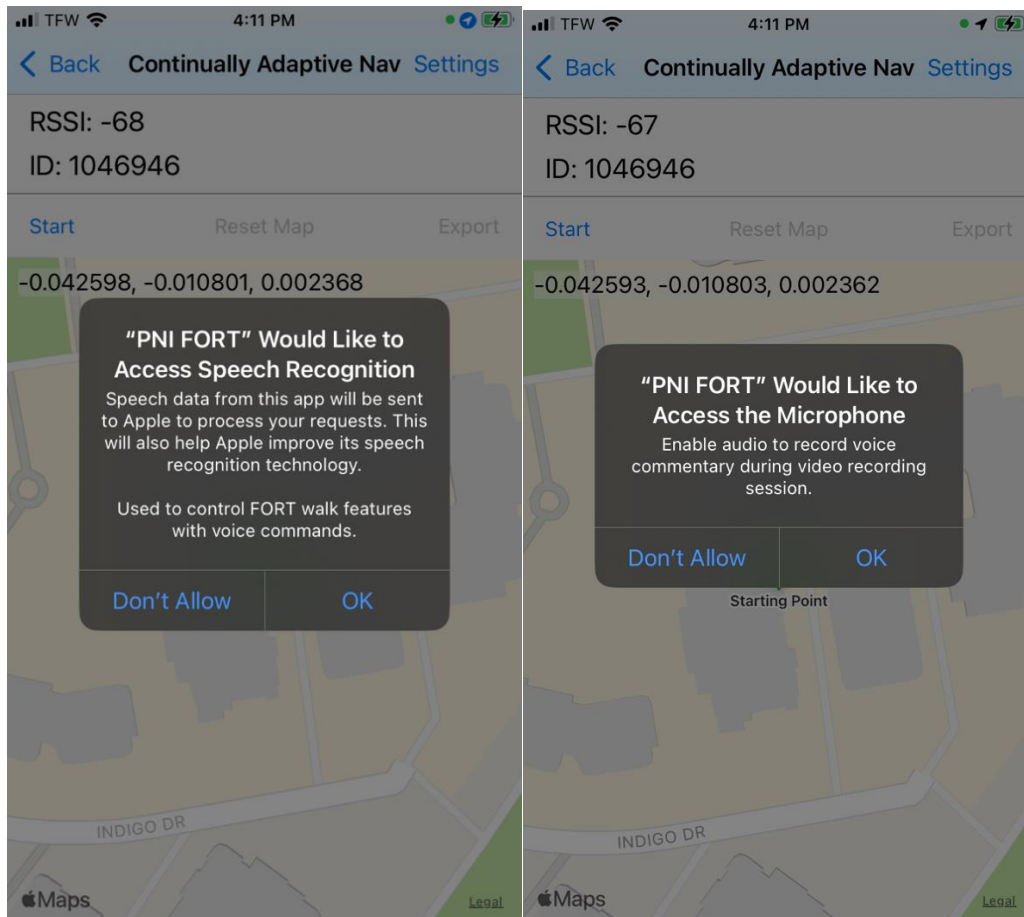


Figure 4-9: Speech Recognition Pop Up

You will also be asked to allow microphone access.

If you do not wish to use this feature, then feel free to tap “Don’t Allow”. These can be allowed later by opening the “Settings” app, selecting “PNI-FORT”, and then enabling the relevant settings.

When enabled, the app will listen for the following phrases:

- “Start FORT Walk”: This will start the walk if the walk is not already started.
- “Stop FORT Walk”: This will stop the walk if a walk is in progress.
- “GPS fusion On”: GPS Fusion will be enabled.
- “GPS fusion Off”: GPS Fusion will be disabled.
- “Map Zoom In”: The map will zoom in.
- “Map Zoom Out”: The map will zoom out.

You can also turn this setting off and on from CAN Service -> Settings -> Voice Commands.

4.7 Gyro Stabilization

The FORT Module uses 3-axis magnetic sensors, 3-axis gyroscope and 3-axis accelerometer for GPS denied tracking. Gyroscope bias learning is important to achieving tracking accuracy and hence the FORT Module should be placed on a stable surface (while the unit is connected via BLE) such as a table for at least 30 seconds at the beginning of a walk, and after every 20-30 minutes of walking to maintain 1% accuracy.

Background, automatic gyro bias learning using the magnetic sensors is one of the technology developments planned for future releases of this product.

4.8 Secure Module on Body

Important: Secure the FORT Module tightly to the user's torso, from the waist up; for example, on the loop of a tactical vest, or on the belt as securely as possible as shown in figure 4-9. For optimal accuracy the module should not be allowed to swing or bounce around. The specific location itself does not matter too much, so long as the FORT unit does not move, shift regularly and is secure when walking. However, we do not recommend the module to be wrist worn or in a pant pocket. Arm or leg swing motion correction algorithms are not optimized in the FORT at this time.

Although FORT rejects magnetic anomalies, for best performance, it is recommended to keep the unit about a foot away from magnetic devices such as weapons, cell phones or large metal buckles. In figure 4-10, the tactical belt nylon strap is a better holder than the belt loop as the unit can move or fall out, but both could be acceptable if used correctly. Figure 4-10 also shows the FORT mounted in a Tactical Belt which comes with the FORT evaluation kit.

Weapon or head mounted locations are still being tested and results may vary. Please first evaluate the FORT module secured to the body as recommended above. We welcome you to test the module on different parts of the body. Please remember to include the module's location on the body and how it was attached to that location with any data logs you share with us.

Once the FORT module is secured to your body, place the iPhone and the module in close enough vicinity to maintain a good, constant Bluetooth connection. It should be noted that as the iPhone battery is depleted, the Bluetooth signal can get weaker which may require the phone to be held closer to the module to maintaining good Bluetooth connection.



Figure 4-10: FORT module in recommended position

4.9 Start Walking

Tracking can be viewed live on the PNI FORT iPhone app with the Continually Adaptive Nav Service once the module is connected via Bluetooth to the mobile phone.

1. In Continually Adaptive Nav view, there will be a view of a map and your phone's start location pin. If outside, the system will use GPS to determine the starting point. If user is inside or otherwise does not have good enough starting information, it will be necessary to manually input the starting point. To do this, first change the manual start point setting (see section 4.10). Then use the button in the bottom right corner "Add Start" to select the start point on Apple maps.

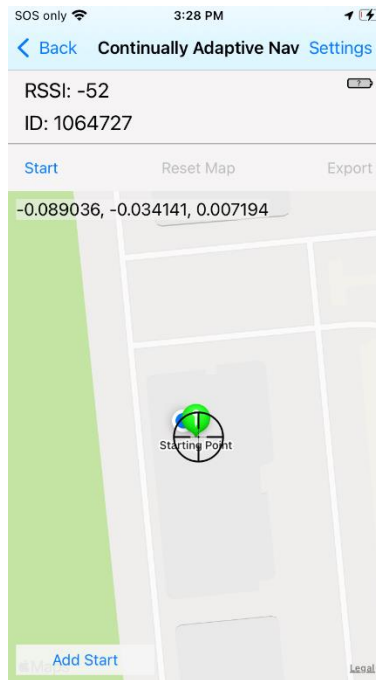


Figure 4-11: Starting point created with "Add Start" button

2. Once the starting position is accurate, select "Start" at the top left corner of the map.
 - After hitting "Start", wait about 3 seconds before walking. During these 3 seconds, the module will determine its orientation on the body. There can be errors if the user does not wait 3 seconds before walking.
 - Once started, "Start" will toggle to "Stop."
3. Start walking.
 - Preferably start in open sky away from buildings or tree cover.
 - Walk outdoors initially.
4. For best results start the test in open sky where an accurate initial location can be determined using the iPhone's GPS. Starting in open sky with GPS will automate user step scaling and starting location. Contact our FAE Team at support@pnicorp.com if your application will not have any GPS access.
5. PNIFORT app uses Apple maps. When a good GPS location is acquired, there will be no "blue circle" around the location pin. Good GPS acquisition could take some time and/or you may need to move away from buildings or trees to acquire a good GPS location.

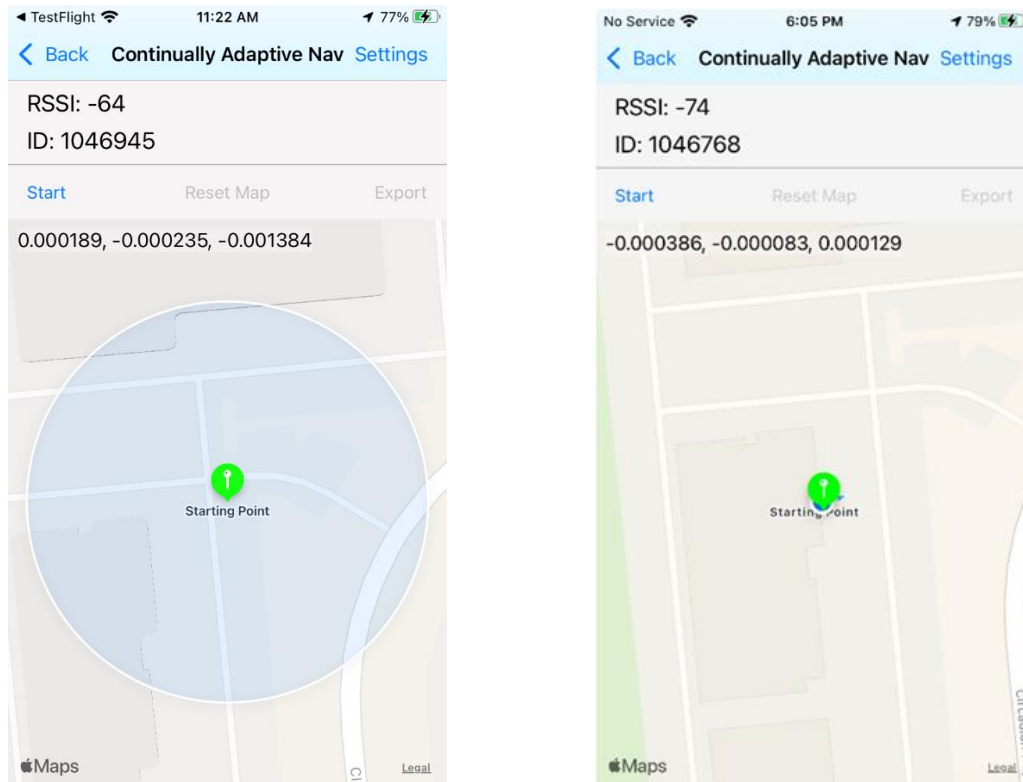


Figure 4-12: Smaller or no blue circle is better

6. Continue walking outdoors for about 1 minute to allow for a good initial location and automatic stride length learning.
7. Test by walking outdoors, indoors, in areas where GPS signal is weak or not available to test the FORT module and algorithm capabilities.
8. At end of walk press “Stop” Continually Adaptive Nav service.

In the Continually Adaptive Nav Service, The CAN algorithms track and trace the user’s path when walking forwards, backwards and even when walking side to side.

CAN algorithms are currently not optimized for running and may not track accurately. Crawling and other dynamic motion have limited support in the current algorithms but can be developed in the future according to customer requirements.

4.10 Stop Continually Adaptive Nav Service

At end of walk, press “Stop”.

It is important to note that once you leave the Continually Adaptive Nav Service page, by hitting the back button, the app will not save the map or the log files. If you’d like to save the run, take a screen shot and save the session log by selecting “Export” on the right top corner of the map. This will allow you to play back the run in Playback mode detailed in the Playback Section. We recommend you export your test results if you have any questions about your run. The logs will be needed by our support team to properly answer your questions.

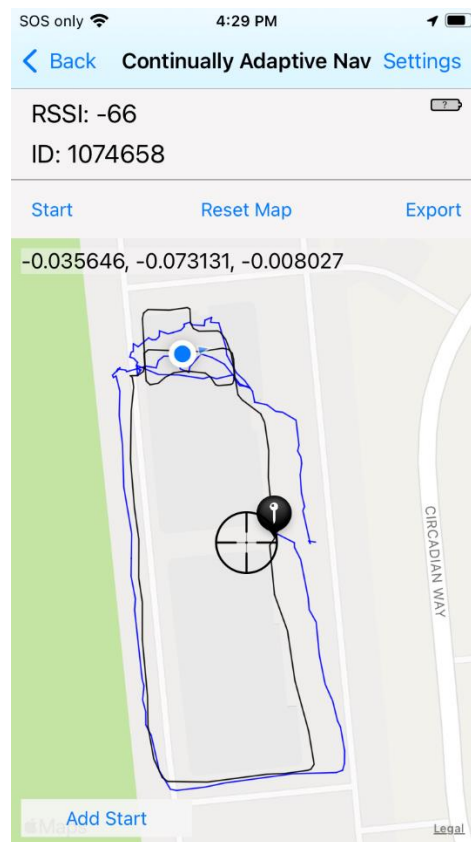


Figure 4-13: Continually Adaptive Nav service tracking outdoors and indoors

Figure above shows a sample run with both the CAN-GPS Fusion (black) and GPS (blue) paths. Tracking was started outdoors and moved indoors to PNI offices. Notice the black path continues to track accurately indoors while GPS indoors is not able to track properly.

The default trace shown on the map in Continually Adaptive Nav Services is the CAN-GPS Fusion in black. User can choose to also show GPS-only path which will be displayed in blue. The default view is CAN-GPS Fusion path only.

If indoors, under tree canopy or in urban canyons, GPS may not be accurate. If FORT is powered up for the first time in these types of situations, you can enable “Manual Point Entry” in Settings, and then use the “Add Start” button to manually locate your start point on the map. If you have any questions, please contact our FAE team at support@pnicorp.com for additional information.

4.11 CAN Settings

The settings tab in the continually adaptive nav section allows users to adjust performance and parameters when taking data and performing walks.

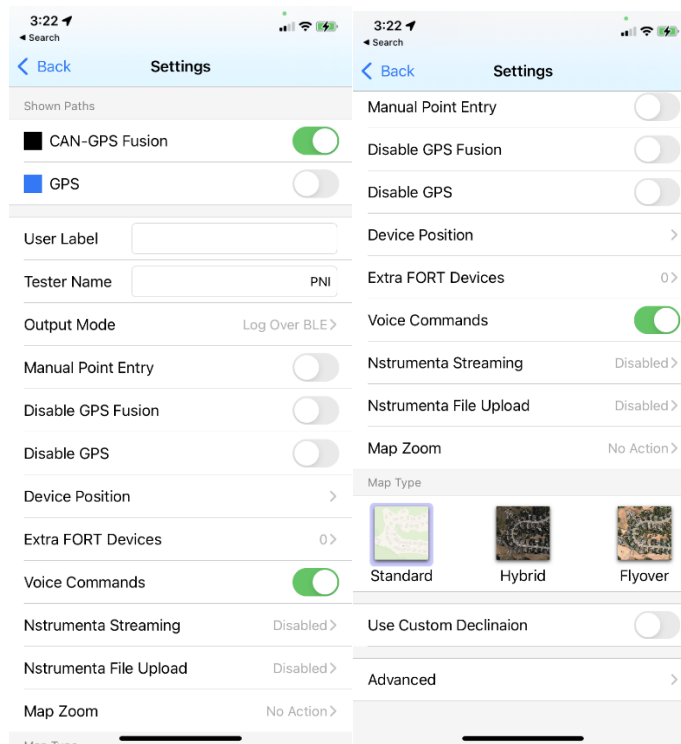


Figure 4-14: Settings in Continually Adaptive Nav Services – Default CAN-GPS Fusion

CAN-GPS Fusion (default ON) - toggles the display of APNT fusion tracking results.

GPS (default OFF) - toggles on and off the display of GPS data.

User label and **Tester Name** are both labels for logging data and tracking the walker.

Output mode (default=Log High Speed to Flash) - Controls if all data should go over BLE or if some data should go over BLE with the rest going to high-speed flash.

Manual point entry (default=OFF) - A value of 'on' requires the user to select a starting position prior to walk start. It also allows the user to place waypoints mid walk.

Disable GPS (default=OFF) - Turning this on will shut down Location services completely.

Disable GPS Fusion (default=OFF) - Turning this on will remove Location services from the fusion path but will still log GPS data in the background for the JSON log.

Device Position (default=Null) - This does not affect fusion and is merely useful for truth-data labelling. When giving logs to PNI customer service, this field might help with debugging.

Extra FORT Devices (default=0) – See next section for more information.

Voice Commands (default=ON) – Turning this on will enable speech recognition for specific commands. See section 4.6 for more information.

Nstrumenta Streaming (default=Disabled) - Allow streaming walk from app in real time. This is primarily useful when receiving or sending data to PNI. URL/API Key fields are empty by default and auto Connect is OFF by default.

Nstrumenta File Upload (default=Disabled) - Allow uploading json/video to Nstrumenta when Exporting. This is primarily useful when receiving support from PNI or transferring data to PNI. URL/API Key fields are empty by default and are different than Nstrumenta streaming.

Map Zoom (default=No Action) – Setting this option to “Follow” will cause the map to pan to the user’s location as the walk is done. Setting this option to “Full Path” will cause the map to pan and zoom out so the entire path is visible as the walk is done. “No Action” will not cause the map to do anything during the walk.

Map Type (default=Standard) - user preference of map / view.

Use Custom Declination (default=OFF) - Allows use if iPhone mags aren't working or report an incorrect declination. Manual declination default is 0.

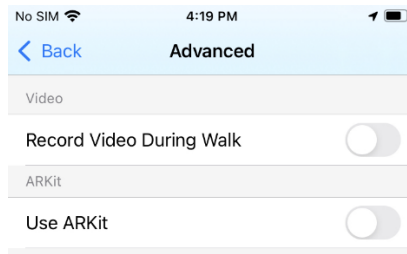


Figure 4-15: Advanced Settings in Continually Adaptive Nav Services

Record Video During Walk and **Use ARKit** (default=ON) - are useful when providing data to PNI Support. These are additional video sources that can be logged for use later.

4.12 Multiple FORT Devices

The app can now connect to two additional FORT devices from CAN Service -> Settings (for a total of 3 units at once).

Tap on CAN Service -> Settings -> Extra FORT Devices

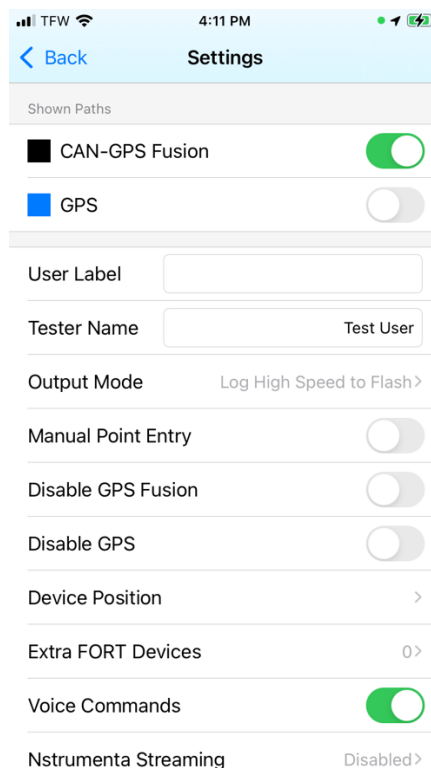


Figure 4-16: Extra FORT Devices

Tap on a FORT device under section “Available” to connect to it.

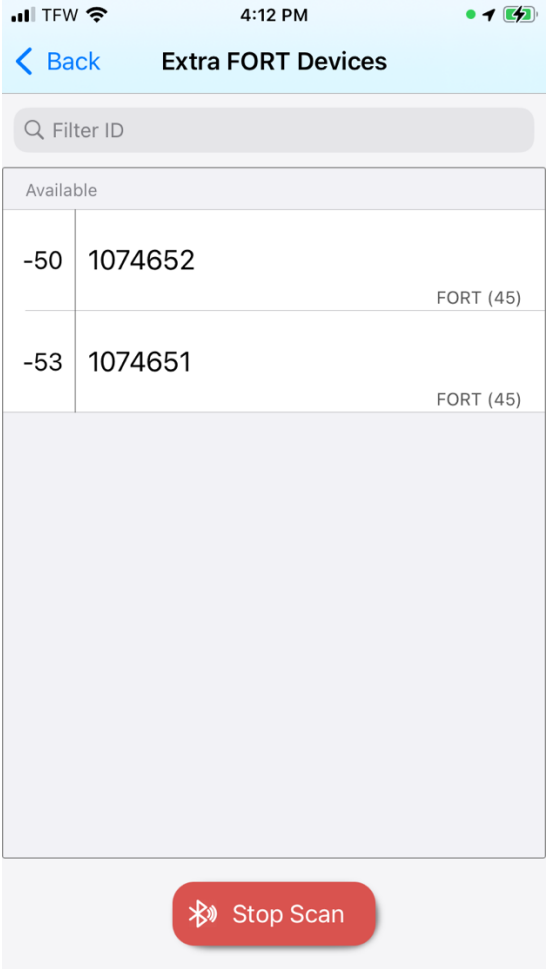


Figure 4-17: List of Available Extra FORT Devices

Once connected, the FORT device will be moved under section “Connected”. Tapping on it while it is under section “Connected” will disconnect the unit.

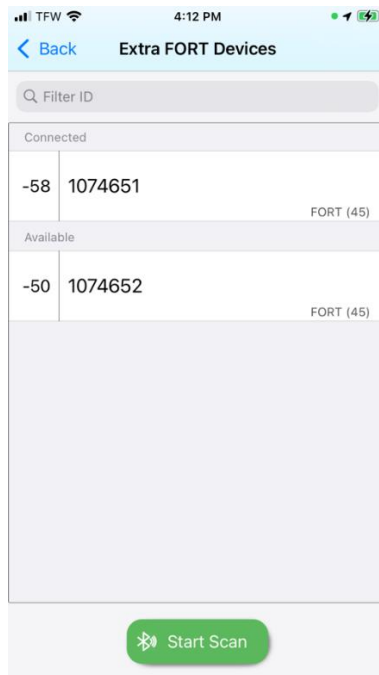


Figure 4-18: List of Connected and Available Extra FORT Devices

To toggle which paths are shown for multiple units, go to CAN Settings → Shown Paths → CAN-GPS Fusion and tap on it. Each fusion path will be shown with its serial number ID and color.

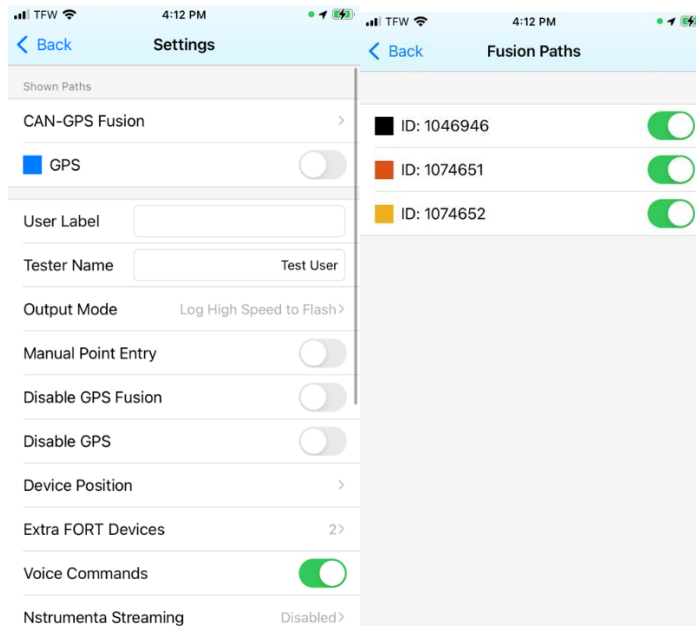


Figure 4-19: List of Paths for Extra FORT Devices

It is possible to set a device position for each unit. Go to CAN Service → Settings → Device Position. To expand a section for a FORT device, tap on it.

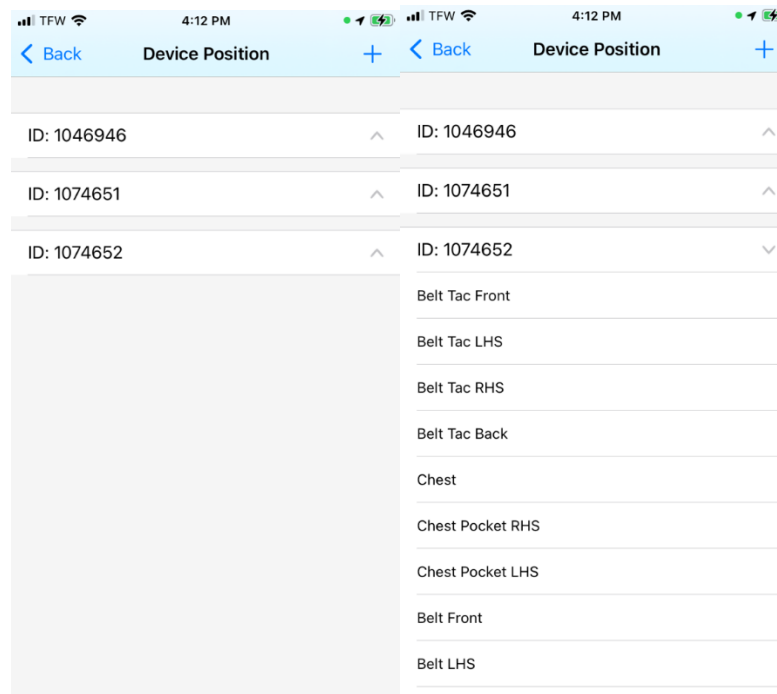


Figure 4-20: Setting Device Position for Extra FORT Devices

When performing a walk with multiple units, all FORT device results will be shown on the map. When finished, a JSON log will be available to export per connected FORT device.

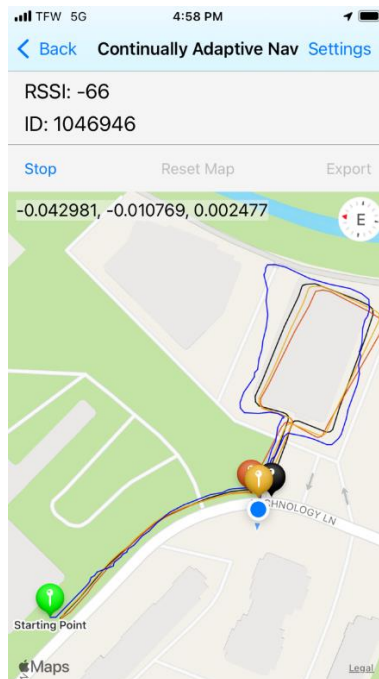


Figure 4-21 Example Path with Extra FORT Devices

4.13 Export Log

Press the Export button at the top of the map to export a JSON log of the walk. Logs can be shared along with feedback by emailing our FAE Team at support@pnicorp.com. Please detail the location of the module on the evaluator's body when sharing the logs. The JSON file contains the phone's GPS coordinates along with the FORT Module's computed path.

4.14 LED Indications

The FORT module has 3 colored LEDs built onto the PCB. These LEDs will turn on, turn off, or flash to indicate the status of the FORT module.

Table 4-1: FORT LED indicators

Red LED	• ON when charging
Green LED	• ON when system is running • ON when connected via BLE • OFF when system is in stop mode (low power)
Blue LED	• Flashing ○ BLE activity ○ Host interface activity ○ High speed data logging ○ Loading high speed data • ON ○ High Speed Playback to host interface

4.15 High Speed Data Logging

The FORT module supports high speed sensor datalog playback (uploading high speed raw sensor datalogs to PC or Mac), when the output mode is set to “high-speed logging to flash”. In order to take advantage of this, the please contact PNI Sensor for the Electron Application by emailing support@pnicorp.com.

To start high speed playback, this option will need to be enabled from the iOS application.

1. Go to “Output and Logs” or “Continually Adaptive Nav” to take a high-speed log (configured with output mode in either device.
2. Boot up electron app and plug in device to USB.
3. Select appropriate baud rate and the USB device and connect.
4. In iOS, go to “Output and Logs” and tap “HS Playback.”
5. Select desired entry(s) and tap “Start.”

Please note: to check the configured baud rate, go Configurations -> Advanced and scroll to the bottom. This must match what you set in the electron application or garbage data will be output.

4.16 Configuration Tab

In addition to the walking and APNT features that have been described previously, the PNI FORT app can also display raw, calibrated, and quaternion / YPR data from the FORT Attitude Heading Reference System (AHRS). For full AHRS details, and additional communications information contact support@pnicorp.com.

The “Output and Logs” tab and “Configuration” tab from the services menu both provide additional features not covered above.

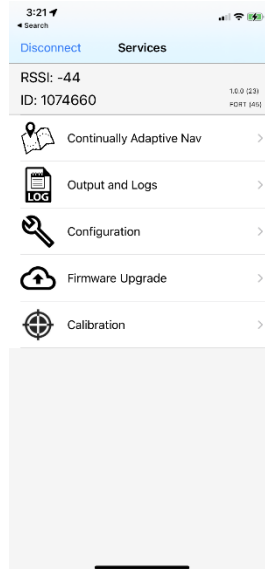


Figure 4-22: Services

The configuration tab can be used to make adjustments to the settings of the unit.



Figure 4-23: Configuration tab

Baud Rate: is used to select the baud rate for the FORT unit when plugged in. 38400 is recommended for normal serial port usage. 921600 is recommended for high-speed logs download and transfer.

Reset Ref: is used to set the 9-axis quaternion to align with the 6-axis (mag/accel only) quaternion, and is also used to learn a “clean” magnetic field. It is recommended to use this button whenever the user suspects they are in a clean magnetic field, or if significant drift or other issues are observed from the 9-axis quaternion. Further description can be found regarding "reset reference field" in section 7, and kResetRef in section 8 (parameter 110).

4.17 Output and Logs Tab

The "Output and Logs" section allows the user to see sensor data from the system (both physical and derived). This includes raw and calibrated data, as well as derived values such as quaternions and gyro bias.

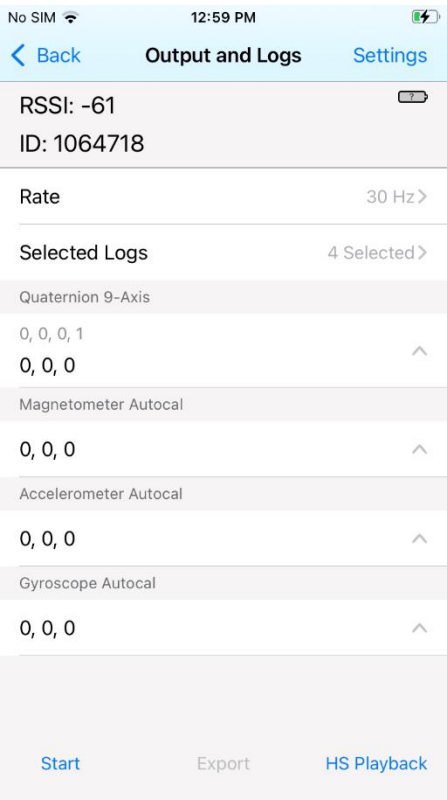


Figure 4-24: Output and Logs tab

Settings: Various settings including log over BLE or HS to flash; record video; and show sensor magnitude.

Rate: Selects the logging speed of data selected.

Start: button will begin logging the selected data sets. Pressing it will continue logging until the **Stop** button is depressed to end the log.

Export: button will save logged data, either to the local drive or cloud service of the user's choice.

Selected Logs: button will bring up a dialog to choose which sensor values are desired to be logged and saved.

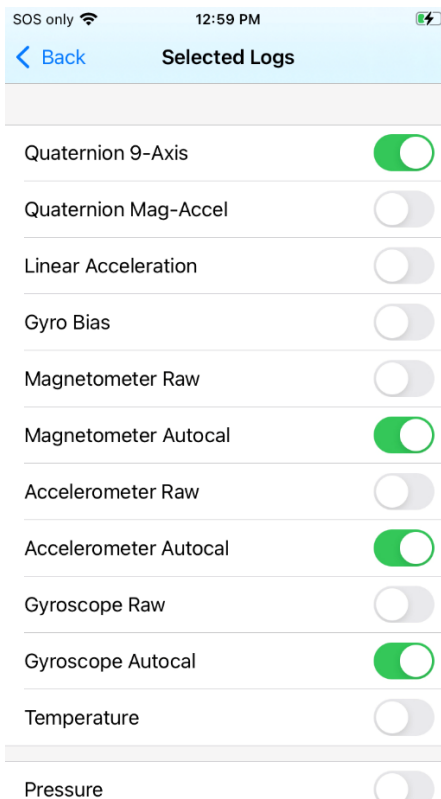


Figure 4-25: Selected Logs settings within Output and Logs tab

The **Quaternion 9-Axis** refers to the full AHRS quaternion output utilizing mag, accel, and gyroscope sensors; this may require occasional use of the reset ref command to work correctly. The 9-axis quaternion is less susceptible to magnetic fields, and it should reject most magnetic transient fields. In the app, this shows both the quaternion in gray, and the heading/pitch/roll

in black. Heading pitch roll is in NED coordinate frame and defined in the standard aircraft paradigm. See figure for NED coordinate definition.

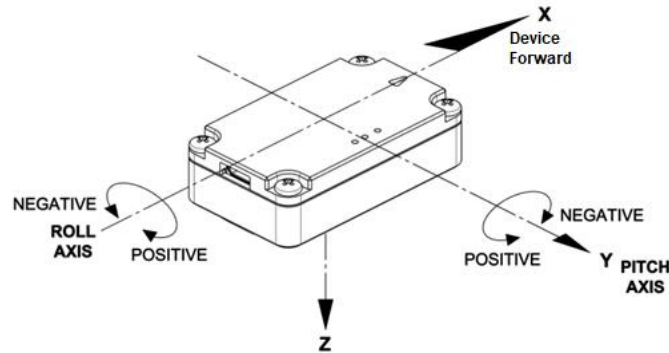


Figure 4-26: Positive & Negative Roll and Pitch Definition

The **Quaternion Mag-Accel** (6 axis quaternion) refers to the quaternion derived directly from the mag and accel calculation equations; this quaternion is susceptible to magnetic distortions and transients. The use of both 9 and 6 axis can provide insight into how magnetically clean a location is. Moving the system in a straight line and observing the mag-accel quaternion will also show significant changes in heading if there are distortions present. In the app this shows both the quaternion in gray, and the heading/pitch/roll in black. Heading pitch roll is in NED coordinate frame and defined in the standard aircraft paradigm.

Linear Acceleration is the calculated acceleration value with gravity acceleration subtracted. Units are in gravities.

Gyro Bias is the value being subtracted from the gyroscope to remove offset errors. These values should update regularly when the device is still. Checking that gyroscope bias updates regularly when still is an excellent way to debug system health. If gyro bias does not update regularly, a system **Reboot** (located in the Firmware Update tab) might help.

Magnetometer / Accelerometer / Gyroscope Raw are the raw sensor samples coming out of the RM3100 magnetometer and BMI088 IMU. These units are in counts and are provided for customers that wish to do their own analysis without PNI calibration additions. Approximate scaling from counts to scaled units from counts are the following: mag 0.02uT/count, accel 0.00018315 gravities/count, gyro 0.001065 radians/second/count.

Magnetometer / Accelerometer / Gyroscope Autocal are the fully system calibrated sensor data samples in 3 axes per sensor. This includes temperature, scale, offset, linearity, bias, and other calibration types. Magnetometers units are microTesla. Accelerometers units are gravities. Gyroscope units are radians per second.

Temperature: Is the temperature of the system in degrees Celsius. Note that this temperature value is provided internal to the sensors themselves and is primarily used for temperature calibration. Therefore, the temperature given may not be representative of the external system temperature, or even of the temperature inside of the housing.

Pressure: Is given directly from the internal pressure sensor. Units are hecto-Pascal (a change of 1 unit is equal to 100 Pascal).

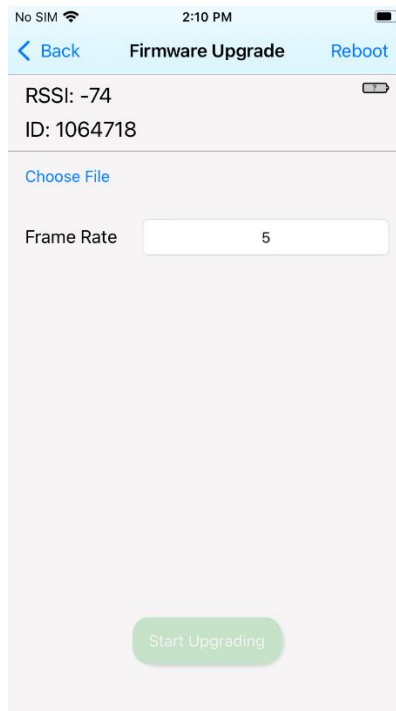


Figure 4-27: Firmware Upgrade section

The next tab is the firmware upgrade section. The **Choose File** dialog will allow users to select a firmware file given by PNI Sensor, and upgrade via BLE the FORT unit. The **Frame Rate** selector will change how quickly data is logged (higher values are faster). The **Reboot** button can be used to reset the unit; this is very useful in case of FORT errors, such as stoppages in gyro bias updating, spinning quaternions, connection issues, etc.

The final tab is the Calibration tab.

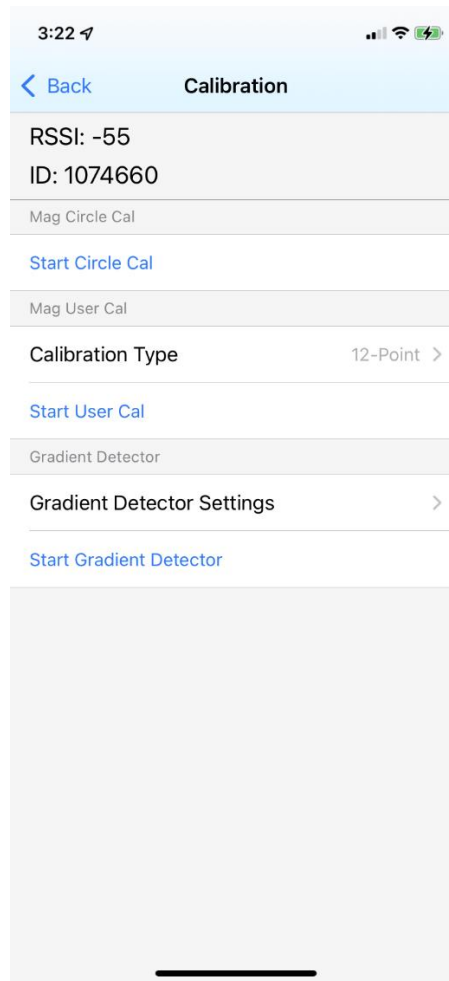


Figure 4-28: Calibration Section

Mag Circle Cal – Begins a quick calibration that compensates for magnetic residues on your body. Recommended to do a mag circle cal every time you mount the FORT to a different location. To perform a mag circle cal, the user will need to spin in a complete circle in a clean environment with the device mounted securely.

Mag User Cal (Default: 12-Point) – There is the possibility that the FORT's factory calibration coefficients have depreciated and are no longer valid which causes the data output to be less accurate. Normally the Mag circle calibration will solve this but in the case of doing a Mag Circle Cal and still acquiring inaccurate data, a Mag User Cal might be needed. The mag circle cal is a longer standard user calibration that provides more accurate compensation. The number of data equidistant calibration points is determined by the "Calibration Type" setting.

4-Point – Take a calibration data point at every 90 Degrees rotation with 0 pitch.

12-Point – Take calibration data point with +30 degrees pitch at every 60 degrees heading then -30 degrees pitch at the same 60 degrees heading points.

Gradient Detector – Use the FORT module to detect the gradient of the surrounding magnetic fields.

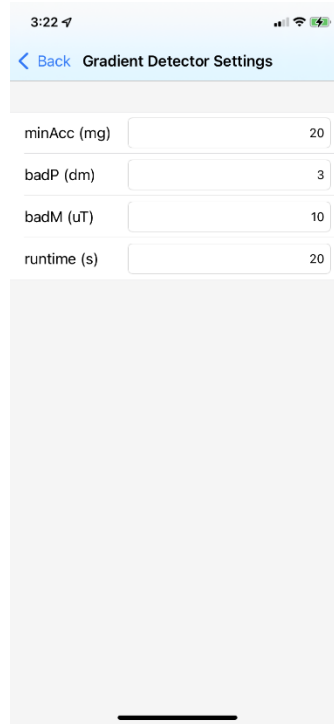


Figure 4-29: Gradient Detector Settings

minAcc (mg) (Default: 20): deadband for accel activity, linear acceleration values below this will be ignored. Recommend default ~20mg $\approx$ 0.2 m/s².

badP (dm) (Default: 3): how much movement is required for a sample to be successful. Currently requires 30cm = 3dm of movement.

badM (uT) (Default: 10): amount of mag change in earth frame that is acceptable to be “clean.” This is likely to need significant adjustment based on how clean we require the system to be and how accurate the earth frame mag ends up being; current setting 10uT.

runtime (s) (Default 20): how long the system runs before giving a report.

5 Revision Block

<u>Revision</u>	<u>Description of Change</u>	<u>Effective Date</u>	<u>Approval</u>
V1.0	Released	8/11/2023	JT
V1.1	Added information about Speech Detection, Extra FORT settings, Calibration tab, Tactical Belt	1/12/2024	HN