



FORT EVALUATION GUIDE (iOS)

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1. INTRODUCTION

The Field Ops Remote Tracking (FORT) Evaluation Kit showcases PNI's Continually Adaptive Navigation (CAN) technology to accurately track soldiers even when GPS is unavailable. Unlike other inertial tracking technologies, PNI's CAN location tracking algorithms determines the direction of the soldier's path of travel *independent* of the soldier's body pose or any device to body-frame offsets. For example, the FORT will continue to track a soldier's location even if they are walking backwards or sideways.

PNI Sensor has invested IR&D over the last 7 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-by-step tracking and location in GPS-denied or compromised environments.



2. OVERVIEW

2.1 Evaluation Kit Contents



Figure 1 Evaluation kit contents

Clockwise from top:

1. Field Ops Remote Tracking (FORT Module) – Part number 14573
2. Wireless Charger bracket design – Part number 14540
3. Micro USB charging cable

2.2 Quick Start

Note: Detailed steps shown in next sections

1. Charge FORT module using its wireless charger – a full charge will take about an hour. Make sure to slide the module with the arrow towards the USB connector.



Figure 2 Slide FORT Module with the arrow on the module pointed towards the USB Charger

2. Remove module from charger bracket and set it 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 FORT with CAN App and press the green Start Scan button.
4. Select the module you would like to connect to.

- Gyro bias learning will start when device is connected to the mobile app. It is important to keep the module still for 30 seconds after it makes a BLE (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 BLE to the mobile phone, you will be brought to a 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 BLE to the mobile app to ensure correct initial gyro bias learning.
 8. Secure module on body 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@pnisensor.zendesk.com if your application will not have any GPS access.
 10. FORT with CAN App uses Google 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.

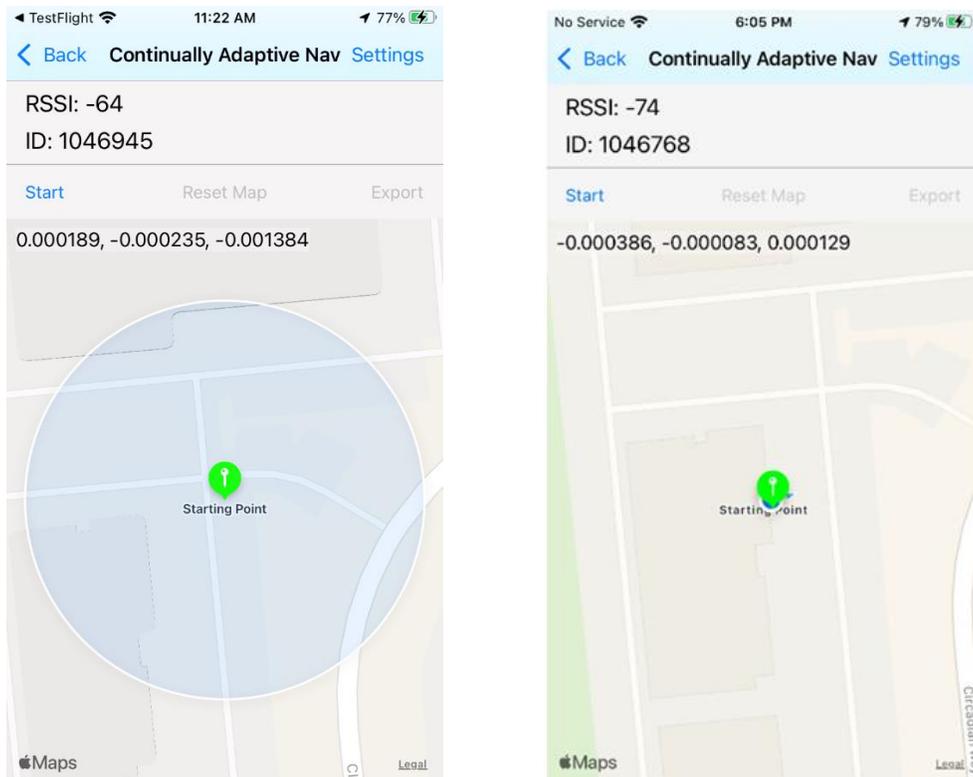


Figure 3 Blue circle around the location pin indicates uncertainty in your location using the iPhone's GPS. The smaller the circle, the more accurate your location pin. For best results, acquire a good GPS location without any blue circle.

11. While in Continually Adaptive Nav 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.”
12. Start walking - Start in open sky and walk for one minute outdoors.
 13. 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.
 14. At the end of walk press “Stop”.
 15. Export JSON log for data analysis and for Playback of the run.
 - DOM Playback mode can recreate the run.
 16. 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.
 - Saved log files enables our support teams to answer any questions you may have about your results.

3. DETAILED STEPS

3.1 Charging

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

To charge the module, slide the FORT module into the wireless charger and apply power to the charger using the micro-USB connector. Make sure the small arrow on top of the FORT module points towards the USB charger as in Figure 2 when sliding it onto the charger. The LED will blink green to indicate that it is charging. 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. If the LED stays red when first attached to the charger, double check that the arrow on the module is pointing towards the USB cable.

Note: In this prototype version of the FORT module hardware, there is no battery charge level indicator. If the battery is nearly full, the charger LED may blink red and not turn green. This is a function of the charger IC which we are not able to change at this time. The battery will charge even with the blinking red LED, keep it in the charger for an hour to guarantee a full charge.

3.2 Mobile App Pairing

The FORT with CAN Eval iOS application will be provided via TestFlight which can be found on the Apple App Store. An invitation link to the FORT with CAN Eval 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@pnisensor.zendesk.com



Figure 4 - App Icon

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

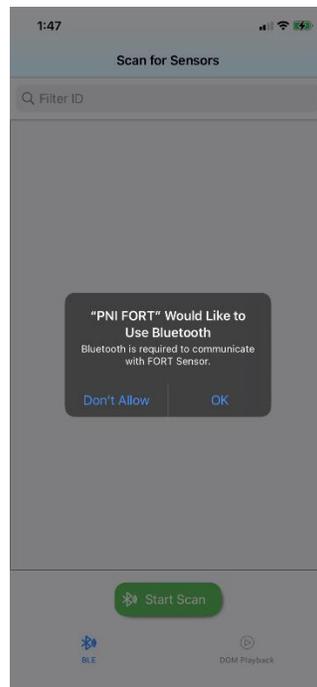


Figure 5 Allow Bluetooth access

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

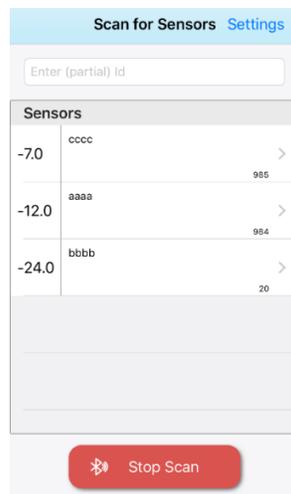
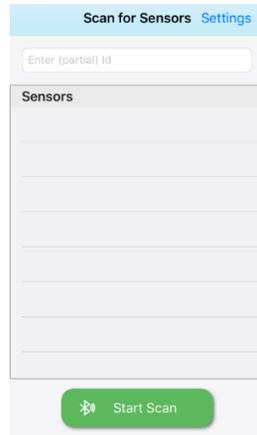


Figure 6 – Pairing FORT Module to the mobile device

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



Figure 7 – Services

3.3 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 FORT with CAN App, go to your Settings on your iPhone.

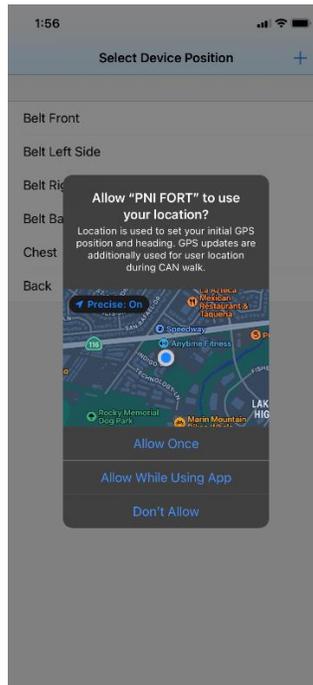


Figure 8 - Allow App to use your location notification

The FORT with CAN 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 to 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@pnisensor.zendesk.com if your application will not have any GPS access.

The app setting is defaulted to display the DOM-GPS Fusion path in purple. This path acquires its starting point and calculates the user’s stride length using GPS inputs. Unlike GPS only tracking, DOM-GPS Fusion will accurately track even when GPS is hard to acquire or unavailable. Furthermore, the DOM DST module tracks the user’s path with step-level resolution versus an interpolation between two GPS positions.

3.4 Gyro Stabilization

The FORT Module uses 3-axis magnetic sensors, 3-axis gyroscope and 3-axis accelerometer for GPS denied inertial tracking. Gyroscope bias learning is important to achieving tracking accuracy and hence the FORT Module should be placed on a stable surface such as a table for at least 30 seconds at the beginning of a walk, and after every 20 minutes of walking to allow gyro bias learning.

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

3.5 Secure Module on Body

Secure the FORT Module tightly to the user's body; for example, on the loop of a tactical vest as shown in figure 8. The module should not be allowed to swing or bounce around.

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. This may require the phone to be held closer to the module for maintaining the Bluetooth connection.



Figure 9 - FORT Module in recommended position

Unlike other inertial trackers, the FORT module will track accurately, independent of positioning on the body. Hence testing can be done with the module secured to a belt or inside a pant pocket where it will be secured in one orientation. We do not recommend the module to be wrist worn. Arm swing motion correction algorithms are not optimized in the CAN algorithms.

Weapon or head mounted locations could work but 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.

3.6 Start Walking

Tracking can be viewed live on the FORT with CAN 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. Once you have a good GPS acquisition of your start location, 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"
2. Start walking
 - Preferably start in open sky away from buildings or tree cover
 - Walk outdoors
3. 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@pnisensor.zendesk.com if your application will not have any GPS access.
4. FORT with CAN app uses Google 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.

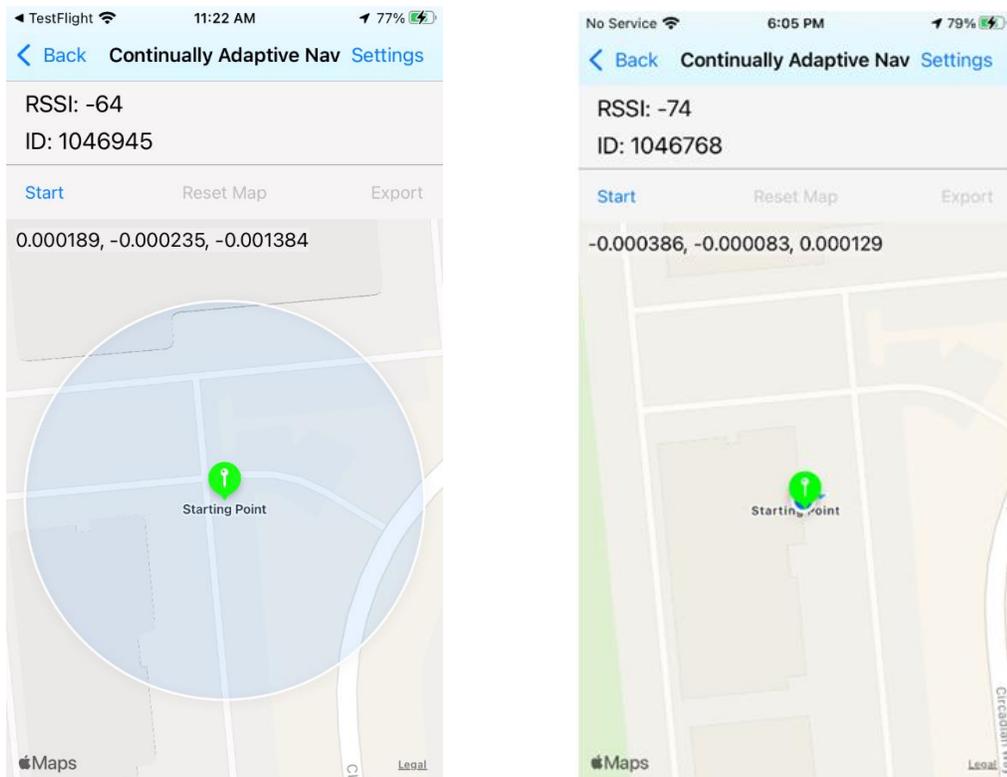


Figure 10 Blue circle around the location pin indicates uncertainty in your location using the iPhone's GPS. The smaller the circle, the more accurate your location pin. For best results, acquire a good GPS location without any blue circle.

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

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

Although the CAN algorithms include running, due to the processor processing power limitations of the current FORT module running will 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.

3.7 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 or the BLE scan icon, 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.

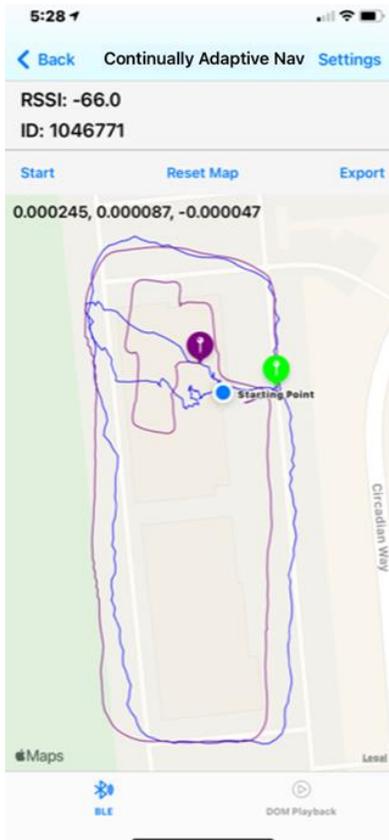


Figure 11 - Stop Continually Adaptive Nav service tracking outdoors and indoors
Purple line DOM-GPS fusion path, Blue line GPS only

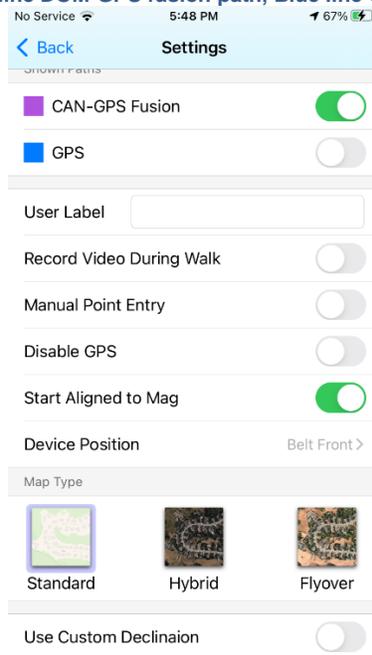


Figure 12 Settings in Continually Adaptive Nav Services – Default DOM-GPS Fusion

The default trace shown on the map in Continually Adaptive Nav Services is the DOM-GPS Fusion in purple.

User can choose to also show GPS-only path which will be displayed in blue and DOM DST with NO GPS fusion or GPS learned step count in black. The default view is DOM-GPS Fusion path only, additional traces need to be selected in Continually Adaptive Nav Services Setting before starting the tracking.

If indoors, under tree canopy or in urban canyons, there will be GPS errors. If starting the Continually Adaptive Nav Service in these types of situations, please contact our FAE team at support@pnisensor.zendesk.com for additional information.

Figure 10 shows a sample run with both the DOM-GPS Fusion (purple) and GPS (blue) paths. Tracking was started outdoors and moved indoors to PNI offices. Notice the purple path continues to track accurately indoor while GPS indoors is not able to track properly.

3.8 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@pnisensor.zendesk.com. Please detail the location of the module on the evaluator's body when sharing the logs. The JSON file contains the phones GPS coordinates along with the FORT Module's computed path.