

Application Note

*Improving Asset Tracking Through
Untethered Dead Reckoning
with FOX3-3G-DR*



Intellectual Property

© 2019 Lantronix, Inc. All rights reserved. No part of the contents of this publication may be transmitted or reproduced in any form or by any means without the written permission of Lantronix.

Lantronix is a registered trademark of Lantronix, Inc. in the United States and other countries.

Patented: www.lantronix.com/legal/patents/; additional patents pending.

All trademarks and trade names are the property of their respective holders.

Contacts

Lantronix, Inc.

7535 Irvine Center Drive, Suite 100

Irvine, CA 92618, USA

Toll Free: 800-526-8766

Phone: 949-453-3990

Fax: 949-453-3995

Technical Support

Online: www.lantronix.com/support

Sales Offices

For a current list of our domestic and international sales offices, go to the Lantronix web site at www.lantronix.com/about/contact

Disclaimer

All information contained herein is provided "AS IS." Lantronix undertakes no obligation to update the information in this publication. Lantronix does not make, and specifically disclaims, all warranties of any kind (express, implied or otherwise) regarding title, non-infringement, fitness, quality, accuracy, completeness, usefulness, suitability or performance of the information provided herein. Lantronix shall have no liability whatsoever to any user for any damages, losses and causes of action (whether in contract or in tort or otherwise) in connection with the user's access or usage of any of the information or content contained herein. The information and specifications contained in this document are subject to change without notice.

Revision History

Date	Rev.	Comments
July 2018	1.0.0	Initial version.
December 2018	1.0.1	FOX3-3G-DR must be used with the external antenna ANT-14
October 2019	A	Initial Lantronix document. Added Lantronix document part number, logo, contact information, and links.

For the latest revision of this product document, please check our online documentation at www.lantronix.com/support/documentation.

Table of Contents

1. Introduction	5
1.1 What is Untethered Dead Reckoning?	5
1.2 What is needed to get started with FOX3-3G-DR?	6
1.3 Hardware setup.....	6
1.3.1 Connecting a FOX3-3G-BLE device to your PC	6
1.3.2 Installing the Workbench software and loading the configuration into the device	7
1.3.3 Installing the device in the vehicle using either CA70 or CA31.....	8
1.3.4 Mounting the FOX3-3G-DR in a vehicle and start device calibration	8
2. Documentation	10
1.4 Additional documentation & software tools	10
1.5 References.....	10

1. INTRODUCTION

This is a technical guide to the workings of the FOX3-3G-DR with Untethered Dead Reckoning (DR) technology.

1.1 What is Untethered Dead Reckoning?

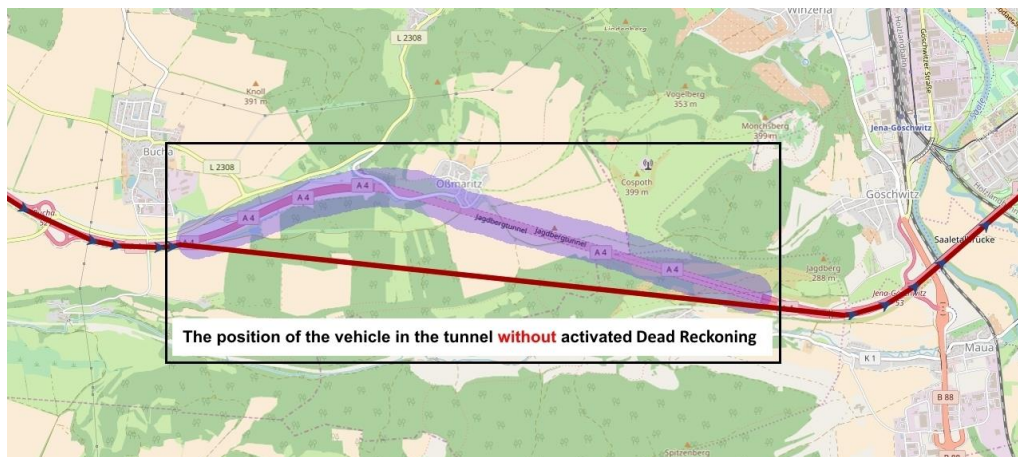
Vehicle telematics (tracking) devices with built-in GNSS receivers perform best when they have a clear, un-interrupted view of the sky and receive uninterrupted GNSS signals. Any degradation in GNSS signal quality can significantly affect the accuracy and tracking performances of the device. The signal quality can be affected by many different factors where GNSS signals are partial or completely blocked or reflected, such as in urban canyons, tunnels, underpasses, multi-level roads or parking garages.

Dead Reckoning is a centuries old concept originally used by sailors to calculate their position based on how far and in what direction they have travelled from a last known location, typically the last harbor ¹⁾.

Combining multi-GNSS (GPS, GLONASS, BeiDou, Galileo) with the Untethered Dead Reckoning technology improves position accuracy in such areas. Integration of the **Untethered Dead Reckoning (DR)** solution into the FOX3-3G-DR vehicle telematics device improves position accuracy in these areas with poor GNSS signal conditions and continues tracking where GNSS signals are partial blocked or reflected and during GNSS signal interruptions. The figure below shows the live data received from a FOX3-3G-DR, installed in a vehicle, on the D2Sphere platform during a drive test in a tunnel. This figure shows that even in worst case scenarios where GPS signals are completely blocked, the **Untethered Dead Reckoning** delivers higher accuracy in device positions.



This figure below shows device positions (GNSS data) in a tunnel with disabled **Untethered Dead Reckoning** function where GPS signals are completely blocked.



Applications with FOX3-3G-DR device include service vehicles from the airports, port facilities, car-sharing, fire departments, fleet management and stolen vehicle tracking that require accurate positioning at all times. Upon signal interruption (e.g. in cities with high rise buildings and narrow streets), **Untethered Dead Reckoning** lets you continue monitoring of vehicles.

1.2 What is needed to get started with FOX3-3G-DR?

To get started with FOX3-3G-DR, the following should be available:

1. **FOX3-2G/3G/4G** control-box (included in the promotion kit) that is needed to connect the device to a PC and perform device configuration for the first time
2. **ANT-14**, a GSM/UMTS/WCDMA/LTE and GPS/GLONASS combined antenna
3. **B1-Back-up battery**: It is a mandatory accessory as the device needs to be always powered to keep the calibration for Untethered Dead Reckoning.
Note: The DR calibration will be maintained so long power is applied on the FOX3-3G-DR (external power supply and internal battery) even when the FOX3-3G-DR goes in sleep mode.
4. **CA70** or **CA31** for in-vehicle installation:
 - **CA70** - Main port basic installation cable, with 2x4pin connector and 3 x open ended wires, can be used to power the device and activate low power modes with wake up reason "IGN";
 - **CA31** - Main port extended installation cable with 2x4pin connector and 6 x open ends as well as 2x2pin UCOM connector can be used to power the device, activate low power modes with wake up reason "IGN", monitor the state of inputs/outputs, connect a serial device (e.g. a passive or active RFID reader) to the 1st RS-232 serial (8pin connector) port of the FOX3-3G-BLE
5. **Device configuration**: The device should be configured for using **Untethered Dead Reckoning** function.
6. **Workbench software**: It is needed to load the configuration into the FOX3-3G-DR device
7. **Device calibration**: The device needs to be calibrated before using the **Untethered Dead Reckoning** function and this calibration remains available as long as the device is powered. If the external power gets disconnected, the device should automatically switch to the backup battery.
8. **Power source** from +12 to +32 VDC (e.g. 12 VDC in your vehicle) und the back-up battery.

1.3 Hardware setup

This chapter explains how to connect and get started with FOX3-3G-DR. Follow this four step process to get started with DR:

1. Connect the FOX3-3G-DR device to your PC with the help of the Control-box or USB cable.
2. Install Workbench software and load the configuration in section 1.3.2.1 into a FOX3-3G-DR device.
3. Mount the device in the vehicle and start the device calibration and testing.

1.3.1 Connecting a FOX3-3G-BLE device to your PC

To connect the FOX3-3G-DR device to your PC either use the Control-box (included in the promotion kit) or a USB cable* (*USB 2.0 Cable A-Male to Mini-B-5pin-Male*), connect it to the USB port on the device and install the USB driver. The USB driver can be downloaded from our website:

<https://www.lantronix.com/support/>.

* Please note that, when using the USB cable for device configuration you have to apply extra power to the FOX3-2G/3G/4G series via CA31.

If you are going to use the Control-box for connection of FOX3-3G-DR device to a PC, go to our website <https://www.lantronix.com/products/fox3-series/> and download the document "**FOX3/-3G PROMOTION-KIT Getting Started**" – then refer to the chapter 3.1.2 in that document.

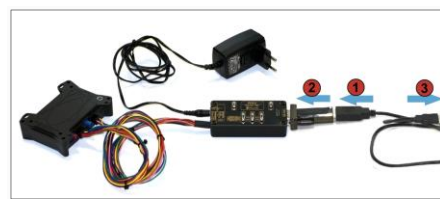


Figure 1: Use the Control-box for connection of a FOX3-2G/3G/4G series device to a PC

1.3.2 Installing the Workbench software and loading the configuration into the device

To be able to communicate with the FOX3-3G-DR device and load configuration onto the device, you need to install the **Workbench** software. Go to the following link to download it: <https://www.lantronix.com/products/workbench/>

System requirements for using the Workbench software:

- PC with 700 megahertz or higher processor Intel Pentium II or compatible processor recommended,
- 512 megabytes (MB) of RAM or higher recommended (512MB minimum supported; may limit performance and some features),
- 90 megabytes (MB) of hard disk space available (recommended 2 gigabytes),
- Keyboard and Mouse.

After downloading the Workbench software, double click on the file to install it. An install shield will guide you through the installation. Integrated online help can be found once the installation is completed.

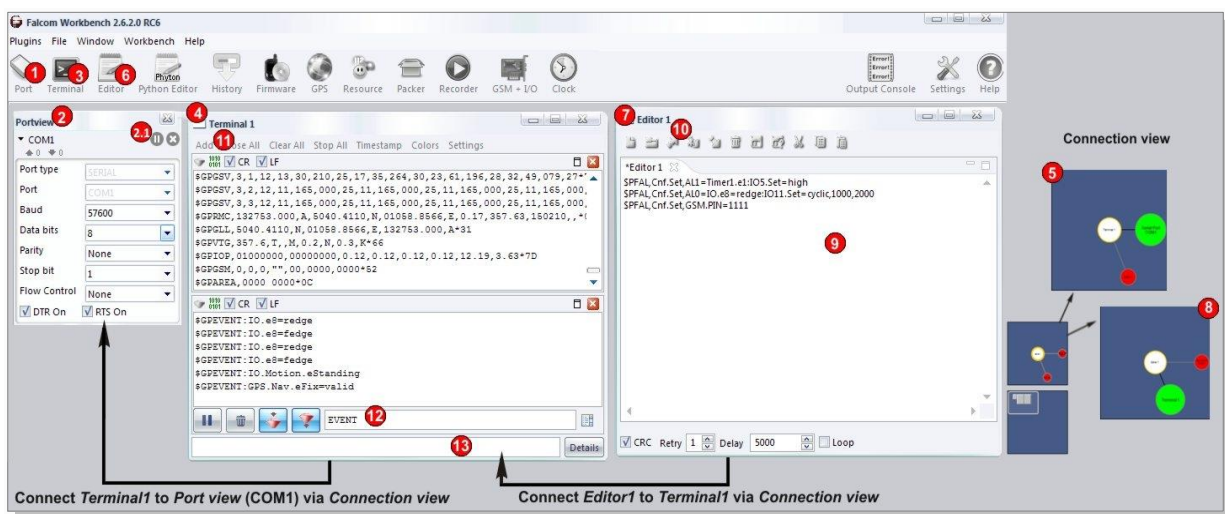


Figure 2: Workbench software

- After completing the installation, double-click on **Workbench.exe** to start it. Open a new **COM Port** from the Toolbar (1), on the **COM Port view** (2), choose the port where FOX3-2G/3G/4G is connected (go to Device Manager > Ports > USB Serial Port (COMxx), where xx is the COM port to use), define the port settings (115200 bps, 8 Data bits, No Parity bit, 1 Stop bit, None Flow control) and finally, click the connect (play) icon (2.1) to open that COM port. You can also get an online help in HTML format if you click the "Help" button on the upper-right hand corner.
- Open a new **Console** from the Toolbar (3), click on the **Console1** (4), then go to **Connection view** and click on **COMPort** (5).
- Open a new **Editor** from the Toolbar (6), click on the **Editor1** (7), then go to **Connection view** and click on **Console1** (8).
- To load the configuration or send commands to the FOX3-3G-DR device, type them in the **Editor** (9), then click on **Start sending configuration** (10) or double-click with the left mouse key on each configuration line individually, in the **Editor** (9).
- Now, copy the configuration lines (in green) from the table in chapter 1.3.2.1 and past them in the **Editor** (9) and perform the step 4, above.

1.3.2.1 Loading configuration into the device

After connecting the device to your PC/Laptop and stating the workbench software, copy the configuration (in green) given in table below and paste it into the Editor of Workbench (see section above). Finally send it to the connected FOX3-3G-DR device. After sending this configuration to the device, install your device in the vehicle using CA70 or CA31 and start the device calibration.

<pre>\$PFAL,Cnf.Set,DEVICE.GPS.AUTOCORRECT=off,5.0,27,10,10,50 \$PFAL,Cnf.Set,DEVICE.GPS.TIMEOUT=0,30 \$PFAL,GPS.NAV.GNSS=GPS,GLONASS,BEIDOU \$PFAL,Cnf.Set,DEVICE.GPS.CFG=4,fast,0,0,1,1 \$PFAL,Cnf.Set,DEVICE.BAT.CHARGEMODE=auto \$PFAL,Cnf.Set,DEVICE.BAT.MODE=auto</pre>
To switch between internal and external antennas on the FOX3-3G-DR send/store these alarms (AL90 , AL91) to the device.
<pre>\$PFAL,CNF.Set,AL90=GPS.eExtAntPlugged:GSM.SetExternalAntenna \$PFAL,CNF.Set,AL91=GPS.eExtAntUnplugged:GSM.SetInternalAntenna</pre>
How to send the device positions to your server. The alarms (AL) below do the following: AL0 = Device loads the saved position of slot <0> to the position slot <0> on start up. AL1 = Starts a cyclic timer with 5 seconds time out when device has got a valid fix. AL2 = Stops the cyclic timer when device has lost that fix. AL3 = Device saves the current position into the position slot <0> and sends the RMC protocol to the connected remote server on every timer event only if the distance travelled from the position slot <0> is greater than 200 m. AL3 = Device saves the current position into the position slot <0> before shutdown.
<pre>\$PFAL,CNF.Set,AL0=SYS.Device.eStart:GPS.Nav.Position0=load0 \$PFAL,CNF.Set,AL1=GPS.Nav.eFix=valid:SYS.Timer0.start=cyclic,5000 \$PFAL,CNF.Set,AL2=GPS.Nav.eFix=invalid:SYS.Timer0.stop \$PFAL,CNF.Set,AL3=SYS.Timer.e0&GPS.Nav.Position.s0>200:GPS.Nav.Position0=current&TCP.Client.Send,08,"device position" \$PFAL,CNF.Set,AL4=SYS.Device.eShutdown:GPS.Nav.Position0=save0</pre>

Table 1: Untethered Dead Reckoning related configuration.

1.3.3 Installing the device in the vehicle using either CA70 or CA31

After the device has been successfully configured, connect the ANT-14 external antenna and then apply power to the device using either cable CA70 or CA31. To apply power, plug in the 8pin connector of one of these cables to the 8pin connector of the FOX3-3G-DR device. Finally, connect the power pins (wires at the end of the used cable - IN+, GND - refer to the package insert of the device) of the used cable to an external power source ranging from +12 to +32 VDC (e.g. 12 VDC in your vehicle). FOX3-3G-DR must be always powered from an external power source (12, 24VDC) and backed up from the B1 battery (accessory for FOX3-2G/3G/4G series).

1.3.4 Mounting the FOX3-3G-DR in a vehicle and start device calibration

The FOX3-3G-DR should be firmly attached to the car body (on a horizontal plane) to avoid any movement or vibration with a moving tolerance of +/-2mm. Often it is enough to use strong double sided tape or Velcro tape glued to the bottom of the FOX3-3G-DR casing for the attachment. The FOX3-3G-DR must be secured against any change in position and particularly orientation with respect to the vehicle frame.

The FOX3-3G-DR must always be used with the external antenna ANT-14. The installation of the GNSS antenna is crucial to the quality of the data received from GNSS satellites and the calibration of Untethered Dead Reckoning. Any metal close to a GNSS antenna can disturb the signal in an unpredictable way due to interference from reflections of weak GNSS signals. The external antenna should be installed on the place in the vehicle with good GNSS signals reception and get quickly a GNSS fix.



Figure 3: Install the device in a vehicle with connectors facing the opposite driving direction

Installation recommendations and device calibration:

- Install the device in a vehicle with the side "THIS SIDE TO SKY" facing up to the sky and the connectors facing the opposite driving direction.
- Install the ANT-14 antenna in the vehicle with good GNSS signals reception and to get faster the GNSS fix.
- Set-up an initial calibration of Untethered Dead Reckoning function as follows:
 - a. After installing the device in the vehicle and power it up, wait for the device to get a valid GNSS fix before driving off.
 - b. Drive for a few minutes (approx. 3 kilometers).
 - c. The driving should include a left and right turn, a stop and a short backward drive.

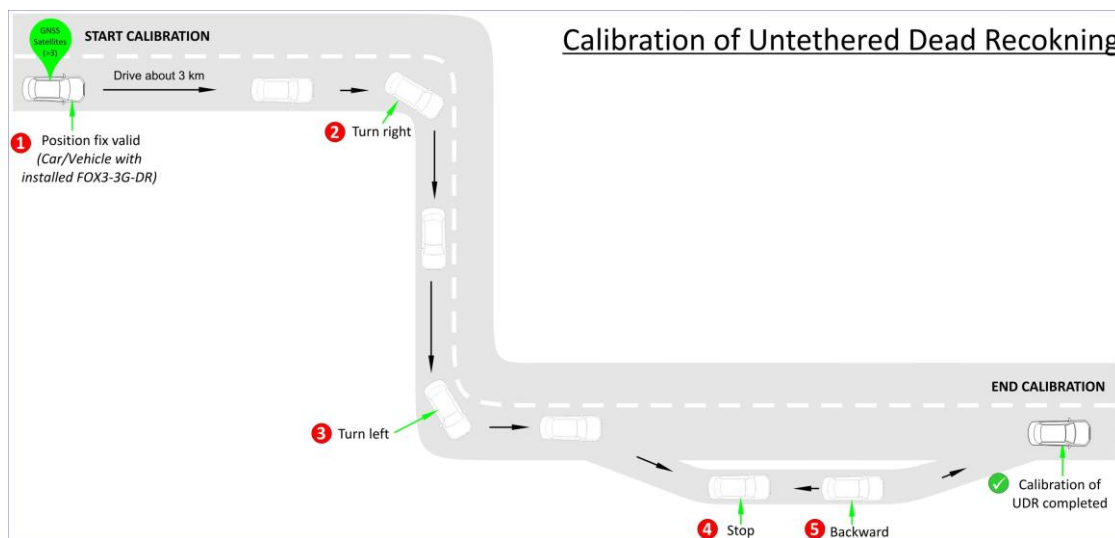


Figure 4: Calibration of Untethered Dead Reckoning in FOX3-3G-DR

If you would like to know the position fix status before starting and during the driving calibration, then you need to store/load both alarms (AL5) into the device and you will get via SMS on your phone the device GPS fix status and the number of satellites used.

```
$PFAL,CNF.Set,AL5=GPS.Nav.eFix=valid:GSM.SMS.Send,"enter your phone number",08,"FIX Valid; SATS &(SatsUsed)"
```

```
$PFAL,CNF.Set,AL6=GPS.Nav.eFix=invalid:GSM.SMS.Send,"enter your phone number",08,"FIX Invalid; SATS &(SatsUsed)"
```

- After initial set-up the device remains calibrated as long as the external power is applied AND the recommended the internal backup battery is attached.

Now you are ready to use the device with Untethered Dead Reckoning function, which will be automatically activated in location with bad or even no GNSS signals.

Note: When the calibration data is lost due to an interruption in the power supply, change of the installation angle or installation position of FOX3-3G-DR, you need to calibrate the FOX3-3G-DR again.

2. DOCUMENTATION

1.4 Additional documentation & software tools

If this application note does not cover all the information you need to setup, refer to the additional documents listed below, which can be found on the [Product Index](#) or [Application Notes](#) pages.

Filename	Description
AVL_PFAL_Configuration_Command_Set.pdf	Lists and describes all PFAL commands supported by the AVL devices.
FOX3_3G_4G_HardwareManual.pdf	Contains instructions for safety and operation of the FOX3/-3G device.
AppNotes_AVL_Installation_Guide.pdf	Provides all the necessary information about installing the Lantronix products properly and safely.
Workbench Software	Description
Lantronix Workbench	Lantronix Workbench configuration tool (Windows XP, Windows Vista, Windows 7)

1.5 References

¹⁾ For more details about the u-blox Untethered Dead Reckoning, please refer to this link:

- [u-blox' 3D Dead Reckoning for Vehicle Applications](#)