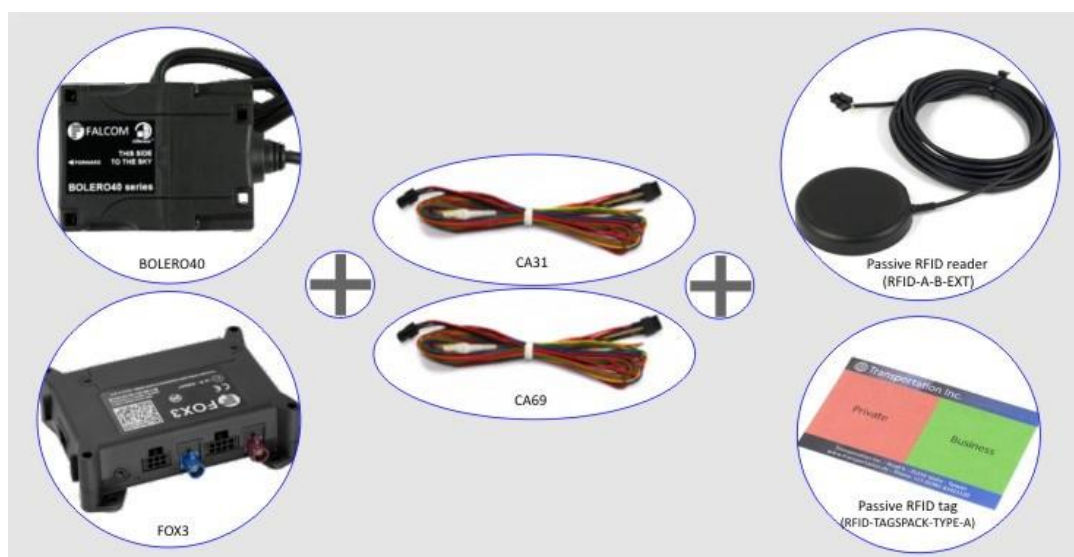# Application Note

Communication of Passive RFID Reader and FOX3 Series Via Serial Link

Intellectual Property

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

Revision History

Date	Rev.	Comments
April 2009	1.0.0	Initial version.
April 2009	1.0.1	Replaced Figure 2 and added a note. Changed settings for Serial0 port from $PFAL,MSG.Mode.SERIAL0=0,C to $PFAL,MSG.Mode.SERIAL0=40,C - allowing execution of PFAL commands "$PFAL,MSG.Send.(Raw)Serial0,<protocols>,<"text">" and a Note added as well. Corrected dynamic entry from &(Sys.eSerialData0) to &(SerialData0).
February 2010	1.0.2	Added chapter 1.3, "RFID Reader - Technical data (Lantronix accessory product)" - The new RFID reader supports ISO14443 type A/B. Added chapter 1.5.1.1.5, "How to use the RFID reader with only one Tag ID ". Added configuration $PFAL,Cnf.Set,DEVICE.COMM.BINEVENT="0x44,0x30",0D,e[i] in chapter 1.5.1.1.6 Sets filters for incoming data on the Serial Port 0.
May 2012	1.0.3	Corrected PFAL command in AL10, page 8.
June 2012	1.0.4	Replaced Figure 2 by a new one.
February 2013	1.0.5	Added "Attention" in chapter 1.5.1.1.5 - RFID readers will be programmed with a new firmware. With this firmware you can use the same TAG without sending the binary code for clearing the RFID buffer.
October 2014	1.0.6	Lantronix Offers only one RFID Reader that is compatible with all Lantronix AVL products. The RFID Reader supply voltages ranges from +5 to +12 VDC. The cable designation changed from KA to CA.
June 2018	1.0.7	Added FOX3-2G/3G/4G series and BOLERO40 series Added HEX- commands to configure the RFID reader Removed STEPPIII, BOLERO-LT2
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

This document describes the integration of passive RFID reader and transponder (Tag) with a FOX3-2G/3G/4G or BOLERO40 series device and, in particular how to read the passive RFID Tags and evaluate their identifiers in an appropriate way.

Please note that, the configuration examples given in this document can be used for both the FOX3-2G/3G/4G and BOLERO40 series. The BOLERO40 series and FOX3-2G/3G-LITE devices support only one serial port, which has the index "0" in the firmware. If you are going to use one of these device series with Lantronix RFID reader, you have to modify the configuration examples below and change the index of the serial port to "0". Additionally, the "SERIAL-PORT" is a Premium-feature for BOLERO40 series and you need to order and activate it before use.

1.1   What is a passive RFID and how does it work?

Radio frequency identification, or RFID, is a generic term for technologies that use radio waves to automatically identify items, such as goods, package delivery, people or other objects. In principle an RFID system consists of at least three components, two Tags and one Reader. The Tag is the backbone of the RFID system since it contains the data that identify the items. The reader produces a weak high frequency over an antenna electromagnetic field. If a Tag passes within this magnetic field, the Tag gets once operating energy from the reader and sends out contactless its identifier *(in the form of a unique serial number)* to identify itself. The reader receives this identifier *(from here on this identifier will be referred to "ID")* and then sends it as is through its serial line to the connected vehicle telematics device. If the Tag leaves the HF-field of reader, its chip becomes again inactive.

Basically there are two variants of RFID Tag technology:

Passive Tags: Such transponders do not have any internal power source and their energy source is radiated by the reader which powers up the transponder within the reading zone. The maximum reading zone on such systems is usually not to long (only some *centimetres*).

Active Tags: Such transponders have their own battery and thus have a longer reading zone than passive transponders. For more details about active Tags, go to our website https://www.lantronix.com/resources/app-notes/ and download the document "AppNotes_FOX3_3G_with_ELA_Active_Reader.pdf"

There are systems with 125kHz, 134kHz, 13.56MHz, 433MHz, 868MHz, 915MHz, 2.45GHz which have naturally different read characteristics and ranges.

1.2   Technical data of RFID-A-B-EXT – Lantronix Passive RFID Reader

The main features of RFID-A-B-EXT passive RFID reader:

✓ Supports ISO/IEC 14443 A / MIFARE® mode
✓ Supports all layers of the ISO/IEC 14443 B communication scheme
✓ Uses ISO/IEC 14443-4 and/or ISO/IEC 14443 B transport protocols, anticollision implemented
✓ Operating distance for communication to a ISO/IEC 14443A / MIFARE® up to 50 mm
✓ Supports MIFARE® Classic authentication and encryption
✓ Operating frequency: 13.56 MHz
✓ Operating voltage: 12 to 32 VDC;
✓ Magnetic field strength (H) 7.5 A/m (Ampere per meter) maximum, as defined in ISO/IEC 14443-2
✓ Cable length: 5 meter
✓ Reader dimensions: 70 mm (diameter) x 13 mm (high)
✓ Connector type: 4-pin double row MOLEX connector for connecting to the cable CA31 or CA69

✓ Default communication settings: 38400 bps baud rate, 8 data bits, no parity, 1 stop bit
✓ Provides audio feedback when passing the transponder (Tag) within HF-field of the reader.
✓ Power consumption: 40 mA @ 12 VDC (Standby)

1.3 What is needed to get started with FOX3-2G/3G/4G series and passive RFID system?

The following devices and cables should be available to operate with a passive RFID reader and FOX3-2G/3G/4G series:

1. **FOX3-2G/3G/4G** series with its control-box (included in the promotion kit) that is needed to connect the device to a PC and perform the device configuration.
2. **RFID-A-B-EXT** reader with 5 m cable,
3. **CA31** - Main port extended installation cable with 2x4pin connector and open ends as well a 2x2pin UCOM connector for connecting RFID readers to the main port (8pin with 1st RS-232) of the FOX3. This can be provided by Lantronix. Contact technical support.
4. Or **CA69** - Accessory port extended cable with 2x4pin connector and open ends as well a 2x2pin UCOM connector for connecting RFID readers to the accessory port (6pin with 2st RS-232) of the FOX3. This can be provided by Lantronix. Contact technical support.
5. One or more transponders/tags (**RFID-TAG-TYPE-A**),
6. **Workbench software** to load the configuration into the FOX3 device
7. Power source from +12 to +32 VDC

1.4 Hardware setup

This chapter explains how to connect and get started with RFID reader and FOX3-2G/3G/4G series. Follow this four-step process to get started with RFID reader:

1. Connect a FOX3-2G/3G/4G series device to your PC with the help of Control-box.
2. Install the Workbench software and load the configuration into a FOX3 device.
3. Interface RFID reader with a FOX3 series device and power them up using the cable CA31 or CA69.
4. Start testing the device configuration for RFID reader.

1.4.1 Connecting a FOX3-2G/3G/4G series device to your PC

To connect a FOX3-2G/3G/4G series device to your PC use either 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 also to apply extra power to the FOX3-2G/3G/4G series.

If you are going to use the Control-box for connection of a FOX3-2G/3G/4G series 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.
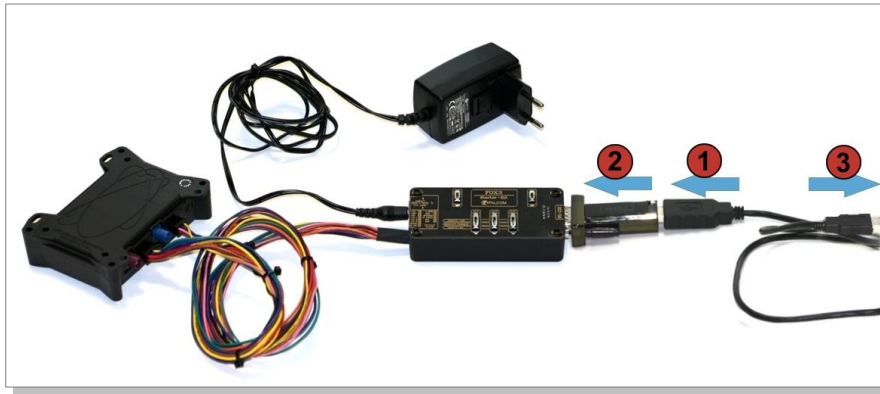
Figure 1: Use the Control-box for connection of a FOX3-2G/3G/4G series device to a PC

1.4.2 Installing the Lantronix Workbench software and loading the configuration into the device

To be able to communicate with a FOX3 device and load a configuration into the device, you need to install the **Workbench** software. Go to this link and to download it: https://www.lantronix.com/products/workbench/.

System requirements for using the Workbench software:

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

After downloading the Workbench software, double click that file to install it. An install shield will guide you through the installation. An integrated online help can be found after the installation completes.
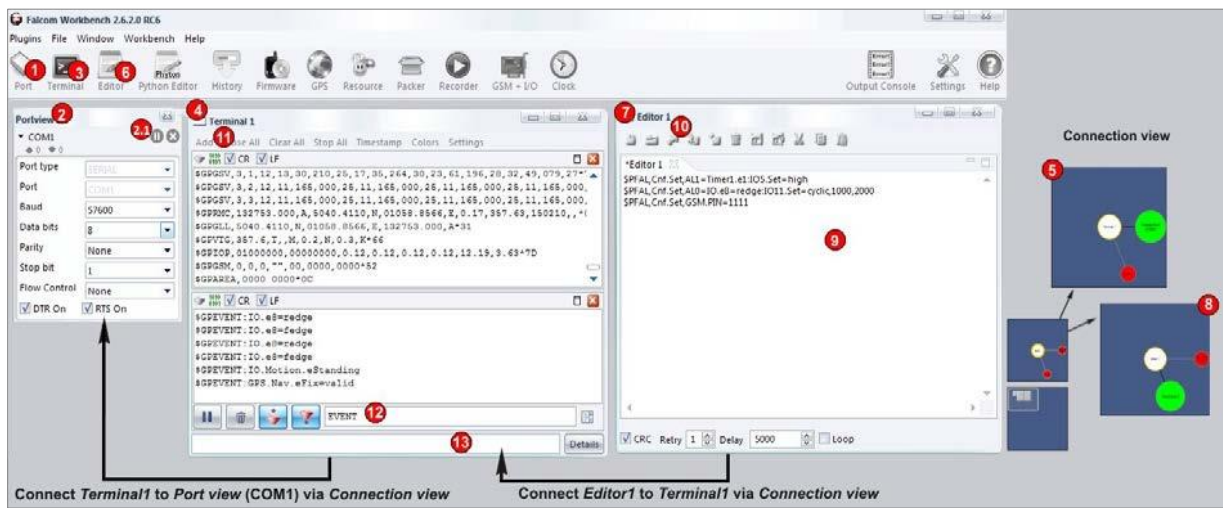
Figure 2: Lantronix Workbench software

1. After completing the installation, double-click the **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 "**Help**" button on the upper-right corner.
2. Open a new **Console** from the Toolbar **(3)**, click on the **Console1 (4)**, then go to **Connection view** and click on **COMPort (5).**

---

3. Open a new **Editor** from the Toolbar **(6)**, click on the **Editor1 (7)**, then go to **Connection view** and click on **Console1 (8).**
4. To load the configuration or send commands to a FOX3-2G/3G/4G series device, type them on the **Editor (9)** and then click on **Start sending configuration (10)** or double-click with left mouse each configuration line on the **Editor (9)** individually.
5. Now, copy one of the configuration lines from one of the tables below and past them in the **Editor (9)** and perform the step 4 above.

Please note that, when loading the configuration with specific tag IDs shown in the examples below, please change first the ID of your tag in the alarms (AL) and then send them to the device. Do not send the alarms (AL) with the existing example IDs to the device. The alarms will not be triggered.

a) **Reading Tags ID and sending them over TCP to your server**

The example below demonstrates how to send the Tags ID to a TCP server. To send the ID read from a Tag together with the actual date, time and position to an internet server, then the configuration can be defined as follows:

Erase UART buffer	$PFAL,CNF.Set,AL1=SYS.Device.eStart:MSG.Send.RawSerial0,0,"start"&MSG.Send.RawSerial1,0,"start"
When using CA31 cable for connection	
All Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData0:TCP.Client.Send,8,"tag.id &(SerialData0)"
Specific Tag ID	$PFAL,CNF.Set,AL3=Sys.eSerialData0="0A0B0C0D01020402":TCP.Client.Send,8,"tag.id &(SerialData0)"
When using CA69 cable for connection	
All Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData1:TCP.Client.Send,8,"tag.id &(SerialData1)"
Specific Tag ID	$PFAL,CNF.Set,AL3=Sys.eSerialData1="0A0B0C0D01020402":TCP.Client.Send,8,"tag.id &(SerialData1)"

b) **Reading Tags ID and storing them into the Flash (history)**

Besides sending the read ID from a Tag from first serial port to the second one, it is also possible to store such IDs *(or specific one)* inside the device and read it out later. If the Tags ID should only be stored in history, then the configuration can be defined as follows:

Erase UART buffer	$PFAL,CNF.Set,AL1=SYS.Device.eStart:MSG.Send.RawSerial0,0,"start"&MSG.Send.RawSerial1,0,"start"
When using CA31 cable for connection	
All Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData0:GPS.History.Write,8,"tag.id &(SerialData0)"
Specific Tag ID	$PFAL,CNF.Set,AL3=Sys.eSerialData0="0A0B0C0D01020402":GPS.History.Write,8,"tag.id &(SerialData0)"
When using CA69 cable for connection	
All Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData1:GPS.History.Write,8,"tag.id &(SerialData1)"
Specific Tag ID	$PFAL,CNF.Set,AL3=Sys.eSerialData1="0A0B0C0D01020402":GPS.History.Write,8,"tag.id &(SerialData1)"

c) **Evaluating the Tag ID to open/close/activate something using a digital output**

The following configuration demonstrates how to control an LED indicator (e.g. Output 1) using the IDs of Tags. This configuration requires, two Tags, one reader that is connected to a Lantronix device via cable CA31. You can also use specific Tag IDs to turn on or off the LEDs on the RFID reader itself. For example, when the Tag with ID (e.g. D00218A765FBD301) is passed over the reader, the red LED on the RFID reader itself goes on and when the tag with ID (D00218A765FBD302) is passed, the red LED goes off. For more details about the hex-command for RFID reader, refer to chapter 1.5.

Erase UART buffer	$PFAL,CNF.Set,AL1=SYS.Device.eStart:MSG.Send.RawSerial0,0,"start"&MSG.Send.RawSerial1,0,"start"
When using CA31 cable for connection	

Specific Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData0="D00218A765FBD301":TCP.Client.Send,8,"tag.id &(SerialData0)"&MSG.Send.RawSerial0,0,"&(bin=0x01,0x35)"
	$PFAL,CNF.Set,AL3=Sys.eSerialData0="D00218A765FBD302":TCP.Client.Send,8,"tag.id &(SerialData0)"&MSG.Send.RawSerial0,0,"&(bin=0x01,0x36)"
When using CA69 cable for connection	
Specific Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData1="D00218A765FBD301":TCP.Client.Send,8,"tag.id &(SerialData1)"&MSG.Send.RawSerial1,0,"&(bin=0x01,0x35)"
	$PFAL,CNF.Set,AL3=Sys.eSerialData1="D00218A765FBD302":TCP.Client.Send,8,"tag.id &(SerialData1)"&MSG.Send.RawSerial1,0,"&(bin=0x01,0x36)"

If desired to use an output port instead of LED, for example to keyless lock/unlock doors of a vehicle for access management or activate a buzzer, fist replace the commands "*IO12.Set=high*" and "*IO12.Set=low*" from AL2 and AL3 below by "*IO5.Set=hpulse,500*" and "*IO5.Set=hpulse,500*" accordingly and then load the modified configuration to the device. Additionally to the device configuration, you need to connect also the IO2 (PIN4) and IO3 (PIN5) in the main port of the FOX3-2G/3G/4G series to the vehicle' door contacts.

To lock the door of your vehicle pass the tag with ID (e.g. D00218A765FBD301) over the reader installed on the vehicle' windscreen and to unlock pass the tag with ID (e.g. D00218A765FBD302) over the reader.

Erase UART buffer	$PFAL,CNF.Set,AL1=SYS.Device.eStart:MSG.Send.RawSerial0,0,"start"&MSG.Send.RawSerial1,0,"start"
When using CA31 cable for connection	
Specific Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData0="D00218A765FBD301":TCP.Client.Send,8,"door.open &(SerialData0)"&IO12.Set=high [IO5.Set=hpulse,500]
	$PFAL,CNF.Set,AL3=Sys.eSerialData0="D00218A765FBD302":TCP.Client.Send,8,"door.close &(SerialData0)"&IO12.Set=low [IO6.Set=hpulse,500]
When using CA69 cable for connection	
Specific Tags ID	$PFAL,CNF.Set,AL2=Sys.eSerialData1="D00218A765FBD301":TCP.Client.Send,8,"door.open &(SerialData1)"&IO12.Set=high [IO5.Set=hpulse,500]
	$PFAL,CNF.Set,AL3=Sys.eSerialData1="D00218A765FBD302":TCP.Client.Send,8,"door.close &(SerialData1)"&IO12.Set=low [IO6.Set=hpulse,500]

6. Finally, copy also the configuration settings below and past them in the **Editor (9)** and then click on either **Start sending configuration (10)** or double click with left mouse each configuration line on the **Editor (9)** individually. The configuration below only adjusts the settings on the device serial port where the reader is connected to.

Command mode	$PFAL,MSG.Mode.SERIAL0=40,C

In the command mode, the protocols and debug information are periodically output on the serial port of the device and the device listens to PFAL commands the user can send. Because the RFID reader will be connected serially to the device, all outputs messages on this port should be switched off, otherwise the outgoing messages to the reader may be misinterpreted.

Parameter   Parameter description for command mode=40,C

40:   Except the commands "$PFAL,MSG.Send.(Raw)Serial0,<prot>,<"text">"
outgoing messages from the device' serial port to RFID reader are switched off.

 C: Sets the selected serial port into the command mode. This mode allows the device to
generate also events when receiving data on that serial port.

Note: After sending this command to the device, the output of data on this port is blocked. The default setting of the serial port is "**PFAL,MSG.Mode.SERIAL0=7F,C**".

Set baudrate	$PFAL,Cnf.Set,DEVICE.SERIAL0.BAUDRATE=38400

Description:	Default operation of serial ports of the FOX3-2G/3G/4G series devices is Command Mode using a serial baud rate of 115200 bps. The RFID reader communicates with other devices using fixed settings: 38400 bps baud rate, 8 data bits, no parity, 1 stop bit. Therefore, the serial interface (SER0) on the Lantronix device where the reader is going to be connected to should manually be changed from default (115200 bps) to 38400bps. To change it, use the command with settings above.

1.4.3 Interfacing RFID reader with a device and power them up with the help of either CA31 or CA69

To interface both devices use either cable CA31 or CA69. The cable CA31 has an 8pin connector that connects to the FOX3 main (8pin) port, a 4pin UCOM connector that provides an RS-232 interface (RX, XT) and power pins (IN+, GND) to communicate and power up the RFID reader device. At the end of CA31 there are also the power supply lines that need to be connected to an external power source ranging from +12 to +32 VDC (e.g. 12 VDC in your vehicle). The cable CA69 has an 6pin connector that connects to the FOX3 accessory (6pin) port, a 4pin UCOM connector that provides an RS-232 interface (RX, XT) and a power line (IN+) to communicate and power up the RFID reader device. At the end of CA69 there is also the power supply line that needs to be connected to an external power source ranging from +12 to +32 VDC (e.g. 12 VDC in your vehicle).
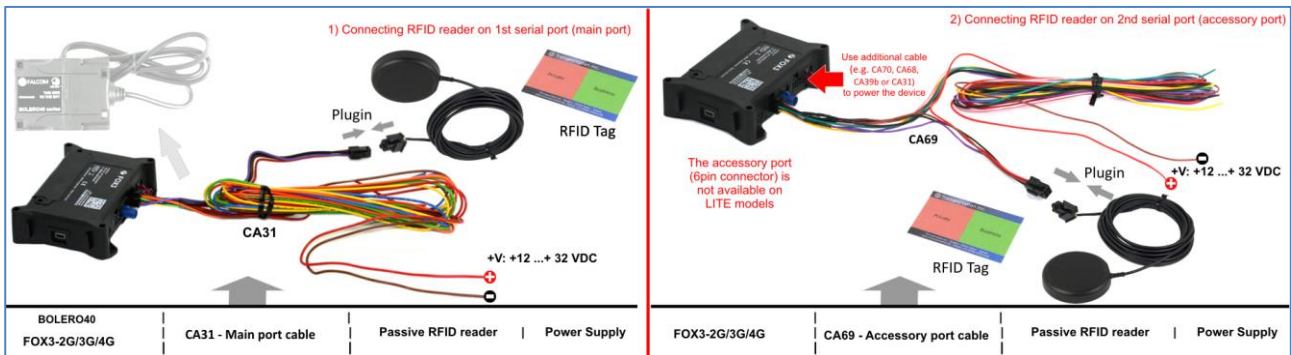

Figure 3: Connecting the RFID reader to a FOX3-2G/3G/4G series device

If you are using the cable CA31 to interface the RFID reader to a FOX3 device (see picture in section above), and connecting the power pins (V+ and GND) of this cable to a power source +12.00 to +32.00 VDC, the device and RFID reader will be powered up automatically.

If you are going to use the cable CA69 (see picture in section above) for interfacing the RFID reader with a FOX3 device, you have to use an additional cable (e.g. CA70, CA68, CA39b or CA31) to apply power to a FOX3 device. The RFID reader is then powered up when connecting the power pins (V+ and GND) of the cable CA69 to the power pins (V+ and GND) of the used cable for powering the device.

Note: When connecting the RFID reader to the cable CA31 or CA69, the lever and pitches on both 2x2 connectors should face the same direction before plugging in.

1.4.4 Testing the RFID reader with a FOX3-2G/3G/4G series device

This section describes how to test the configuration examples given in tables in the sections above. After loading one of the configuration examples above into one of the FOX3-2G/3G/4G series device and connecting the RFID reader to the device, just pass a RFID Tag within the magnetic field of the RFID reader (it is about 2-4 cm above the reader) to see how the configuration of **AL2** and **AL3** works. A sound will be hear when the RFID reader receives your tag ID. Log in into your server or our D2Sphere server and you will see the identifier of that tag ID (*tag.id* or *door.open/close*) together with its ID sent to the server. When loading the configuration with LED from the example **c)** above into your device, then the LED on device casing will go on and off corresponding the Tags passed over the reader.

If you would like to use other RFID Tags with our reader, then select only Tags that use chips like **SRIX512** or compatible, other chip types have different read characteristics (protocols) and frequency and cannot communicate with our RFID readers. The following are listed the key features for selecting compatible Tags:

- ✓ ISO 14443 B communication scheme
- ✓ ISO 14443 - 4 and 14443 B transport protocols
- ✓ ISO 14443 A MIFARE® mode
- ✓ 13.56MHz Carrier Frequency
- ✓ 847kHz Sub-carrier Frequency
- ✓ 106 kbit/s Data Transfer
- ✓ 8 bit Chip_ID based anti-collision system
- ✓ 64-bit Unique Identifier

1.5   Additional Hex commands to configure the RFID Reader

This chapter provides commands to configure the **RFID-A-B-EXT** RFID Reader for operation in a variety of applications.

Note: A signal ton will be generated on the Reader if the command you send is not allowed. To send these codes to the reader use this command *$PFAL,Msg.Send.RawSerial0,0,"&(bin=0x<HEX>,0x<HEX>)"*

<HEX>	Description of Hex commands
03 20 [freq] [len]	Detection tone configuration [freq] : Sets the frequency of the tone (1 byte, value range 0.. F) [len]: Sets the length of the tone (1 byte, value range 0.. F)
01 21	**Clear stored RFID** (for redetecting the same tag)
02 22 XX	**Set Timeout** for reading the same TAG in second max. 254 Sec. XX Timeout in seconds (default 02 22 01 for 1 second) For example: 02 22 03 (after 03 seconds the reader can read the same TAG again)
01 30	Play startup sound
01 33	Set LED0 (green) to high
01 34	Set LED0 (green) to low
01 35	Set LED1 (red) to high
01 36	Set LED1 (red) to low

02 50 xx	Set baud rate on the reader's serial port;
	xx =Sets the baud rate on the reader serial port, e.g.:
	          19 = 19200 bps
	          38 = 38400 bps
	          57 = 57600 bps
	For example:
	          02 50 19: Sets baud rate to 19200 bps
	          02 50 38: Sets baud rate to 38400 bps
	          02 50 57: Sets baud rate to 57600 bps

xx 51 $yy_1 \dots yy_n$	Set Header <xx> Defines the length of the ID header including the flag 52 (the value FF is not allowed) 52 It is the flag for the header chars $yy_1 \dots yy_n$ Defines the header value(s) in hex e.g. 10 02 FA 01. For example: To set the header to 10 02 FA 01 you have to specify 05 51 10 02 FA 01
01 51	Clear Header
xx 52 $yy_1 \dots yy_n$	Set Terminator <xx> Defines the length of the ID terminator including the flag 52 (the value FF is not allowed) 52 It is the flag for the terminator chars $yy_1 \dots yy_n$ Defines the terminator value(s) in hex e.g. 10 02 FA 01. For example: To set the terminator to 10 03 you have to specify 03 52 10 03

<HEX>	Description of Hex commands
01 52	Clear Terminator
02 53 XX	Set checksum XX Defines what characters of the header will be used for CRC calculation. Suppose you have set the header 1002FA01 and you want to calculate the CRC of the TAG starting from the 3rd character of the header then send 025303. 03 is the 3rd character of the header. 02 53 FF: This command means: No CRC To use all characters of the header for CRC calculation use this command: 02 53 01
01 54	Set the output mode in HEX
01 55	Set the output mode in ASCII

Table 3: Additional codes for configuration of RFID reader

2   DOCUMENTATION

2.1   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_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)

These PDF files are viewable and printable from Adobe Reader. If you do not have the Adobe Reader installed, you can download it from ***http://www.adobe.com***