CS108 RFID Sled Handheld Reader
User Manual

CSL: The One-Stop-Shop for RFID Solutions

1 Contents

2 Regulatory Regions

CS108 is offered as various models, using the format of CS108-N where N is of various values, each covering one or more different regulatory regions.

For example, CS108-2 covers the regulatory region of FCC, which includes USA, Canada, Mexico and other Latin America Countries that use the FCC frequency range.

The following is a model table with N as index, for CS108-N, and the corresponding frequency band and regulatory regions:

N=1:	865-868 MHz for Europe ETSI, Russia, Mid-East countries, 865-867 MHz for India
N=2:	902-928 MHz, FCC, for USA, Canada and Mexico. Hopping frequencies locked
N=2 AS:	920-926 MHz, Australia. Hopping frequencies locked
N=2 NZ:	921.5-928 MHz, New Zealand. Hopping frequencies locked
N=2 OFCA:	920-925 MHz, Hong Kong. Hopping frequencies locked
N=2 RW:	920-928 MHz, Rest of the World, e.g. Philippines, Brazil, Peru, Uruguay, and any other countries that use sub or partial sections of the FCC frequency range
N=4:	922-928 MHz, Taiwan
N=7:	920-925 MHz, China
N=8:	916.7-920.9 MHz, Japan
N=9:	915-921 MHz, Europe Upper Band

Some regulatory regions require the CS108 User Manual to contain some statement. Here are those statements.

2.1 FCC Statement and IC Statement

FCC STATEMENT

1. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any interference received, including interference that may cause

undesired operation.

2. Changes or modifications not expressly approved by the party responsible for compliance could

void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-Consult the dealer or an experienced radio/TV technician for help

IC STATEMENT

IC Notice to Canadian Users

This device complies with industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

(1) This device may not cause harmful interference

(2) This device must accept any interference received, including interference that may cause undesired operation of the device.

This device complies with RSS-247 of industry Canada. Operation is subject to the condition that this

device does not cause harmful interference.

This Class B digital apparatus complies with Canadian ICES-003(Cet appareil numérique de classe B est conforme à la norme NMB-003 du Canada).

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 5mm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

2.2 European CE

In Europe, 865-868 MHz band is allowed in all countries. The upper band of 915-921 MHz is however only ratified in a subset of the EU countries.

2.3 Hong Kong OFCA

Hong Kong Government requires the frequency of operation to be limited to within the frequency band allocated in Hong Kong: 920-925 MHz.

2.4 Australia AS

Australia Government requires the frequency of operation to be limited to within the frequency band allocated in Hong Kong: 920-926 MHz.

2.5 New Zealand NZ

New Zealand Government requires the frequency of operation to be limited to within the frequency band allocated in Hong Kong: 921.5-928 MHz.

3 Introduction

3.1 CS108 RFID Sled Handheld Reader

The CS108 RFID sled handheld reader is designed to work with an off-the-shelf smart phone (such as an iPhone or Android phone) or laptop/tablet via a Bluetooth Low Energy (Bluetooth 4.0/4.1/4.2) connection, where the application on the smart phone/laptop/tablet would control the CS108 reader to perform RFID tag reading or barcode scanning. The tag data is collected in the smart phone or laptop/tablet and can then be manipulated or transferred to other locations on the Internet Cloud for further processing.

Below photo shows the smart phone and CS108 working together during operation:

Note: The Smart phone App directly searches and pairs with CS108. There is no need to first pair with the CS108 via the normal Bluetooth Device connection page of the OS. Therefore, install the App on your smart device first and then search and connect the CS108 from inside the App.

The CS108 can be controlled via Bluetooth 4.0/4.1/4.2 from a laptop or tablet. Below is an example where it is accessed from a tablet running Linux Operating System:

The CS108 can also be controlled via its USB connection by a PC (tethered). In this case, the Bluetooth connection is not used. The control commands enter via the USB cable. The application is on the PC.

Photo below shows the CS108 handheld reader connected via USB cable to (and controlled by) a PC.

In summary, the following, are the various host platforms and connections combinations. (BLE is Bluetooth Low Energy, including Bluetooth 4.0, 4.1, 4.2)

Host Platform	**Interface Physical Media**	**Protocol of Host Platform**
Apple iPhone	Air	Bluetooth 4.0 or 4.1 or 4.2
Apple iPad	Air	Bluetooth 4.0 or 4.1 or 4.2
Apple iPod Touch	Air	Bluetooth 4.0 or 4.1
Android Phone	Air	Bluetooth 4.0 or 4.1 or 4.2
Android Tablet	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows 10* Laptop with BLE	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows 10* Tablet with BLE	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows 10* Mobile Phone	Air	Bluetooth 4.0 or 4.1 or 4.2
Linux PC or Laptop or Tablet	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows PC or Laptop	USB cable	USB
Linux PC or Laptop	USB cable	USB
Android Phone with OTG	OTG USB cable	USB
Android Tablet with OTG	OTG USB cable	USB

*Note that for Microsoft Windows OS platforms, to connect, using Bluetooth Low Energy (BLE), it needs to be Windows 10 (or later) because the BLE native driver is only available beginning with Windows 10.

3.2 Product Packaging

3.2.1 Package Contents

The reader package contains 5 items:

1)	CS108:	Sled Handheld RFID Reader
2)	CS108USBCtoACable:	USB cable, USB Type C to Type A, 1 pc
3)	CS108B:	Battery, 3400 mAh, 1 pc
4)	CS108QSG:	Quick Start Guide
5)	CS108RG	Regulatory Guide

3.3 Product Specifications

Figure 3-1 CS108 Reader

Features:

- ISO 18000-6C – EPC Global Class 1 Gen 2 UHF RFID protocol compliant including dense reader mode
- Ultra-long read range – Best in Class up to 18 meters for Monza R6 Dogbone tag (read range dependent on tag model, tag IC, reader antenna and environmental conditions)
- Robust performance in dense-reading environments
- Multiple reader modes (link profiles) with different reader to tag data rate and tag-to-reader backscatter rate, modulation format, and backscatter type for different business scenario and physical environment.
- Highly Configurable for maximum throughput and optimal performance
- Supports all Gen 2 commands, including Write, Lock and Kill

Specifications:

Physical Characteristics:	Length: 16.1 cm (6.3”); Width: 9.0 cm (3.5”); Height: 16.1 cm (6.3”); Weight: 650 grams (22.9oz) Weight includes battery
Environment:	Operating Temp: -20^{0}C to 50^{0}C (-4^{0}F to + 122^{0}F) Storage Temp: -40^{0}C to 85^{0}C (-40^{0}F to + 185^{0}F) Humidity: 5% to 95% non-condensing Enclosure: IP-54
Antenna:	2.7 dBi Gain internal patch antenna
RF Power:	Internal conducted power 0 - 30 dBm in 0.1 dB increments.
EIRP Power:	32.7 dBm
RFID Frequency Ranges:	902-928 MHz band and subset 865-868 MHz band and subset
Interfaces	Bluetooth 4.0 (BLE) USB
Accessories:	USB cable
Restrictions on Use:	Approvals, features and parameters may vary depending on country legislation and may change without notice

3.4 Product Accessories

There are 3 accessories for the CS108 RFID sled handheld reader:

1) CS108 Spare Battery

   Each CS108 comes with 1 battery in the product shipment box. Additional batteries are available for purchase. P/N: CS108B

2) CS108 USB C to A Cable

   Each CS108 comes with 1 cable in the product shipment box. Additional cbles are available for purchase. P/N: CS108USBCtoACable.

3) CS108C Charger

   A dual slot external battery charger is available for charging additional spare CS108 batteries. P/N: CS108C

4 Getting Started

4.1 Introduction

This chapter explains how to set up CS108 for the first time.

4.2 Unpacking

Open the box, removing all protective plastic bags and save the shipping container for later storage or shipment.

Check that the following items are in the box:

1. CS108 RFID Sled Handheld Reader
2. CS108B 3400 mAh battery
3. USB Type C to Type A cable
4. Quick Start Guide
5. Regulatory Guide

4.3 Features

The CSL CS108 RFID sled handheld Reader is an EPC Global Class 1 Gen 2 compliant product.

Below is the front view of the CS108 reader. The 2D barcode module is located at the top. The RFID reader module is in the front, with a forward facing embedded patch antenna..

Figure 4-1 CS108 Reader Front View

Below is the left side view of the CS108 reader. There are 5 LEDs on this side, from left to right, respectively:

1) RFID Power On
2) Status
3) Barcode Power On
4) Charging
5) External Power connected

On the sled handle, there is a trigger used by the operator to start and stop the reading of RFID tags or barcodes.

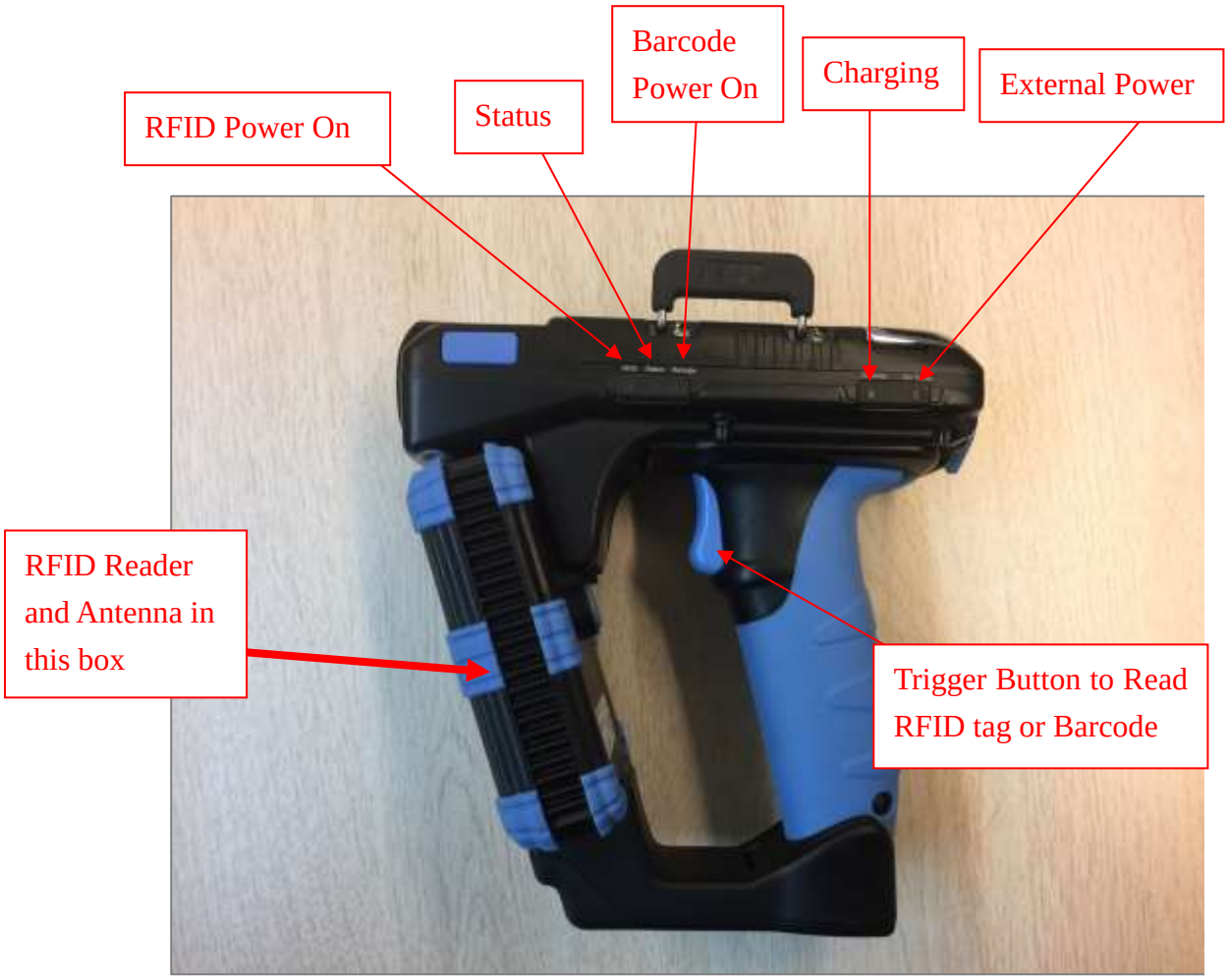


Figure 4-2 CS108 Reader Left Side View

Below is a view of the right side of the CS108 reader. There are 2 combination button/LED on this side.

The right button/LED is for the main power and the LED lights up **GREEN** meaning power is on. Press the button continuously for 3 seconds, then release to power on (must release before it powers on). To power off when the reader is on, press the button continuously for 3 seconds, then release the button to power off.

The left button/LED is for the Bluetooth pairing, and the LED lights up BLUE meaning Bluetooth is connected. When first powered up, the Bluetooth LED will automatically start flashing indicating it is now discoverable by a smart device nearby. From the Application on the smart device, one can then connect to the CS108. After connection, the LED will stop blinking and remain lit.

At any time, to stop the Bluetooth connection, press the Bluetooth button continuously for 3 seconds until the LED turns off. To restart the Bluetooth and pair with a device, press the button continuously until the Bluetooth LED starts flashing and reconnect via the application.

Figure 4-3 CS108 Reader Right Side View

Below is the rear view of the CS108 reader. Here the USB Type C socket is on the left, allowing the user to connect the CS108 to a PC for control, or to a USB power source to recharge the battery inside the CS108. On the right side is the Reset button, at this time it has not been activated to cause a factory reset on the unit.

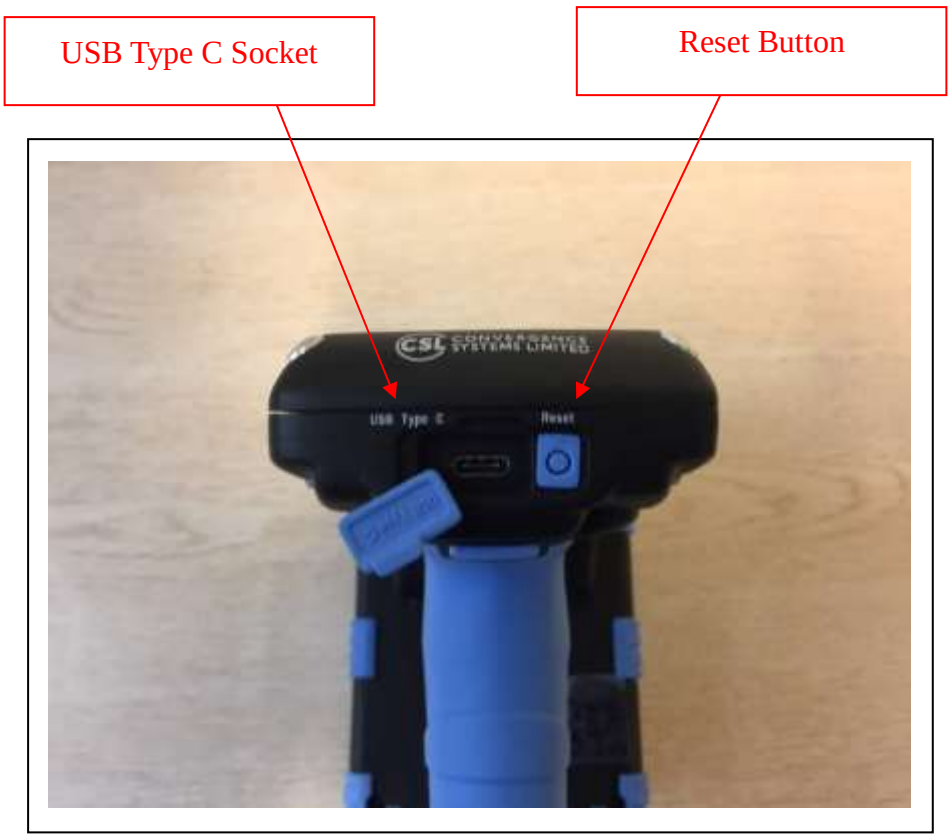
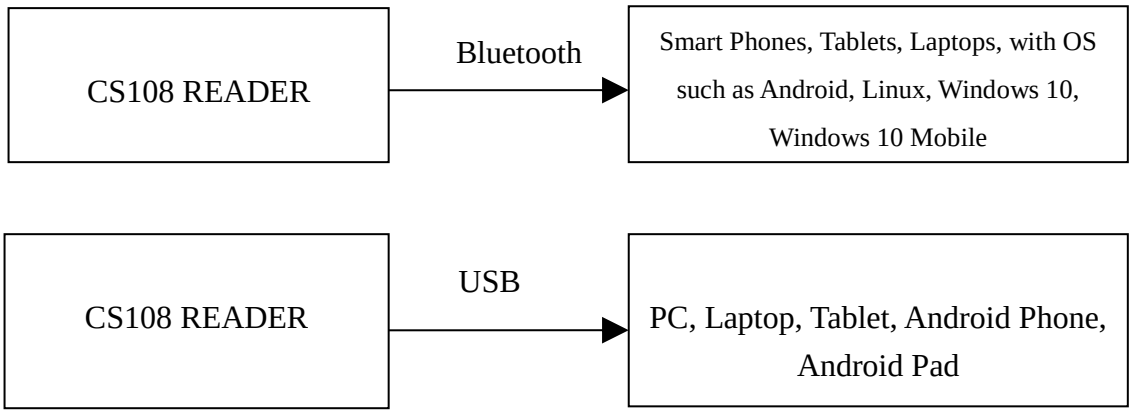


Figure 4-4 CS108 Reader Rear Side View

One can connect the CS108 to either a smart phone or other smart device, including laptop PC via Bluetooth for control and data collection, or to a PC via USB cable for control and data collection.



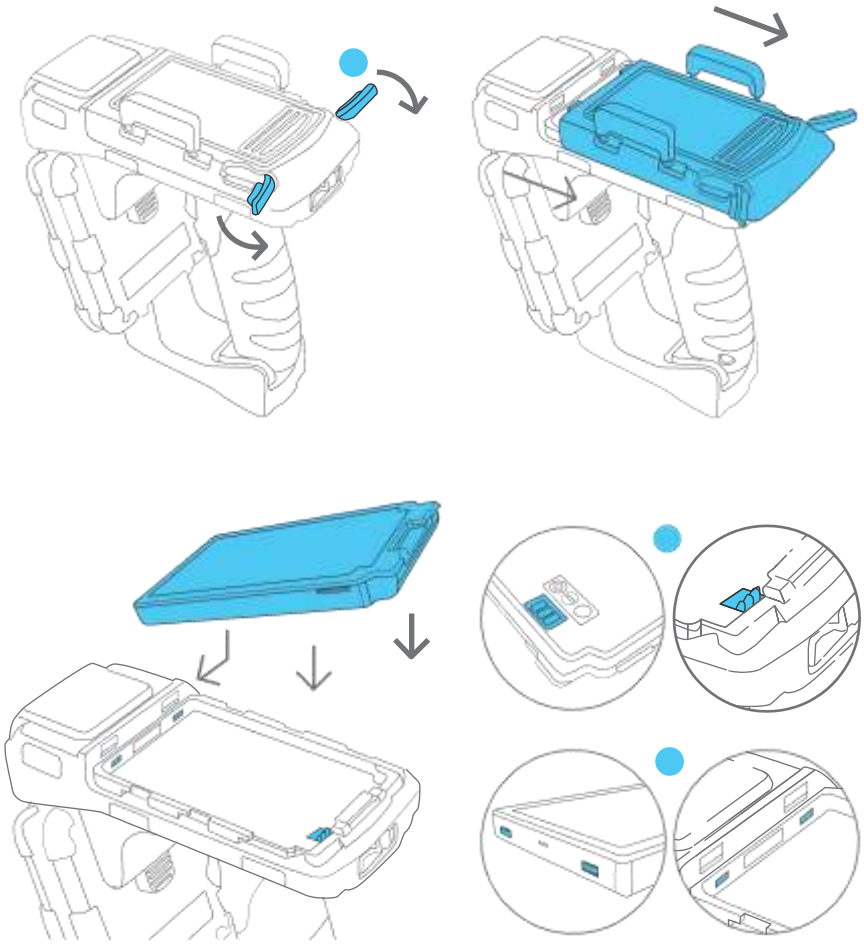
4.4 Setting up CS108

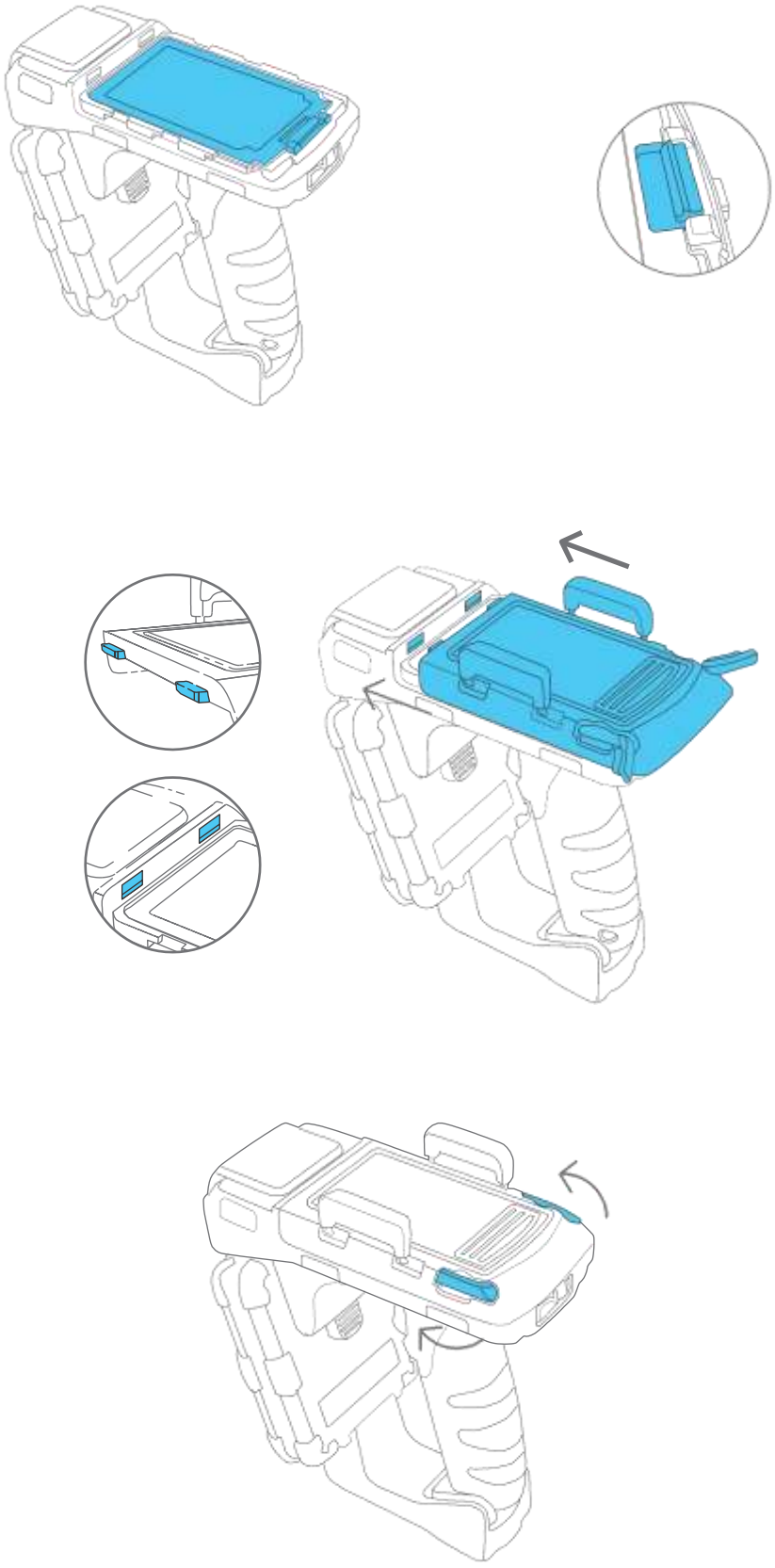
To use the CS108 for the first time, carry out the steps described in the following sections.

4.5 Installing the battery

To install the battery,

1. Rotate the two silver latches at the back of the top cover.
2. Slide back the cover.
3. Install the battery by inserting the front battery teeth in the corresponding slots at the front of the battery compartment and aligning the copper connectors at the bottom right section of the battery with its counter-connectors. Snap it in place making sure it is underneath the blue locking mechanism.
4. Slide the cover back into place.
5. Rotate the two silver latches until fully closed.



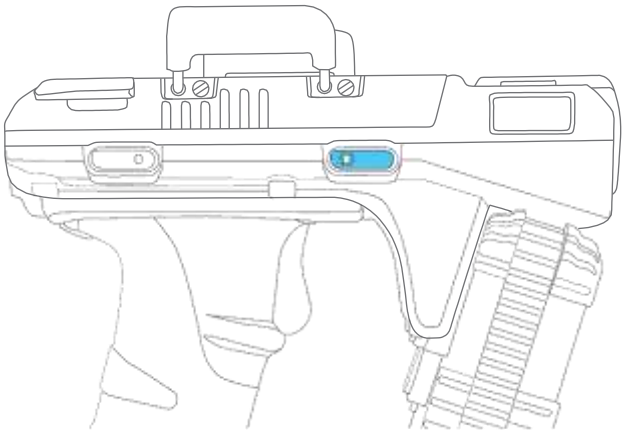


4.6 Removing the battery

1. Rotate fully backwards the two silver latches at the back of the top cover.
2. Slide back the cover.
3. Press down on the blue locking mechanism at the back to pop out the battery.

4.7 Power Up the Reader

1. Make sure the battery is inserted properly and is charged..
2. Press the power button on the right side of the reader continuously for 3 seconds then release.
3. After you release the button, the Green Power LED will light up and the Blue Bluetooth LED will begin a slow blink.
4. The reader is now turned on and ready for Bluetooth pairing.



4.8 Bluetooth Pairing with Mobile Devices

1. When you power up the CS108 reader, the Bluetooth LED will automatically flash blue, meaning it is now discoverable by smart devices nearby. **NOTE:** the CS108 uses only the Bluetooth Low Energy protocol, therefore smart devices must have Bluetooth 4.0/4.1/4.2 to be able to connect to the CS108.
2. With the Bluetooth LED flashing, you can search, discover and connect the CS108 to the CSL Demo App or customer written app. **NOTE** that you can only connect to the CS108 via the CSL Demo App or customer written application. You cannot connect the CS108 Bluetooth via the standard Bluetooth pairing function of the OS of the smart device.

4.9 Charging the CS108

4.9.1 Direct Charging CS108

The CS108 can be directly charged by inserting a USB cable with the following plugs:

1) USB Type C plug on one side
2) USB Type A plug on the other side
3) The above Type A plug connecting to a USB charger with the traditional Type A socket. The charger can be 1A or 2A.

2 LEDs will light up:

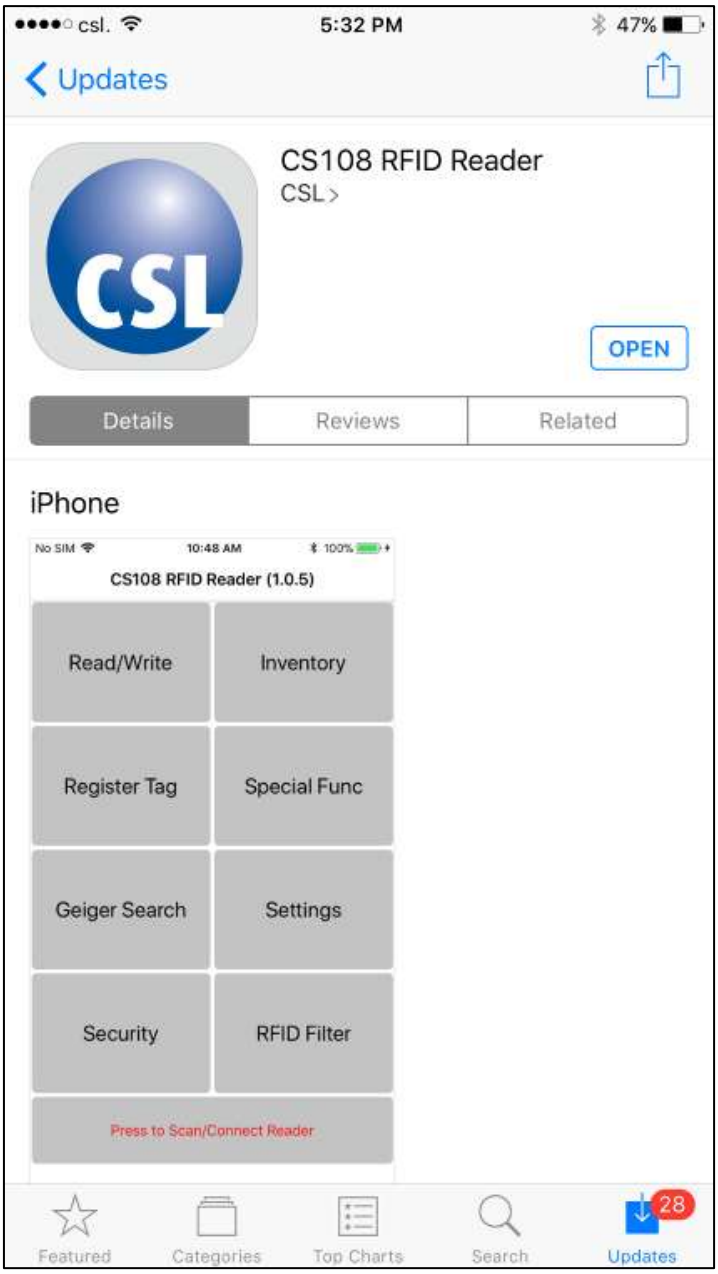
1) "Ext. Power" LED: **Green** LED. Whenever the CS108 is connected to an external power supply, this **Green** LED will light up.
2) "Charging" LED: Red LED. When the battery is heavily drained, this red LED will be bright. When the battery is completely recharged, this red LED will be very dim. Do not be alarmed if you connect the USB cable and this LED is very dim. It just means the battery is fully charged

4.9.2 Charging CS108B battery using an external charger CS108C

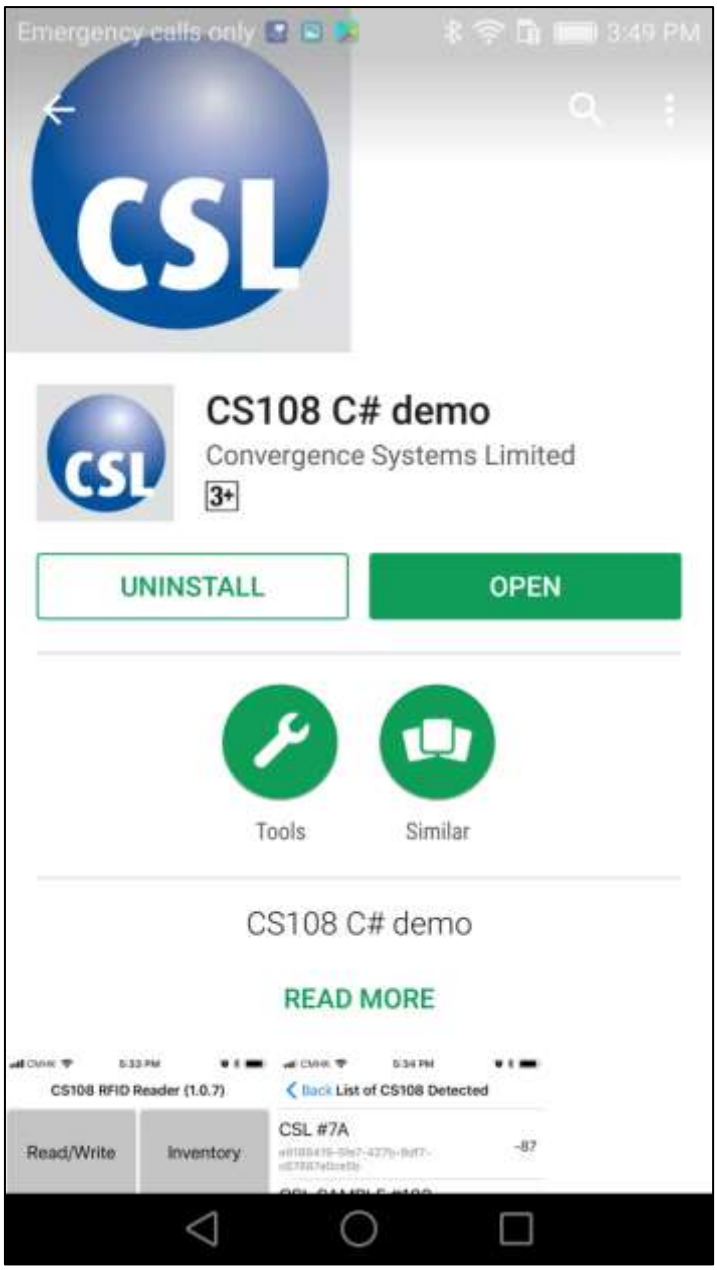
For intensive operations, one can purchase the optional CS108C external charger. With this charger, you can charge 2 CS108B batteries simultaneously:

4.10 Downloading Application Software

To download the C# Demo application software for iPhone, please go to the Apple App Store and search for “cs108 rfid reader”.

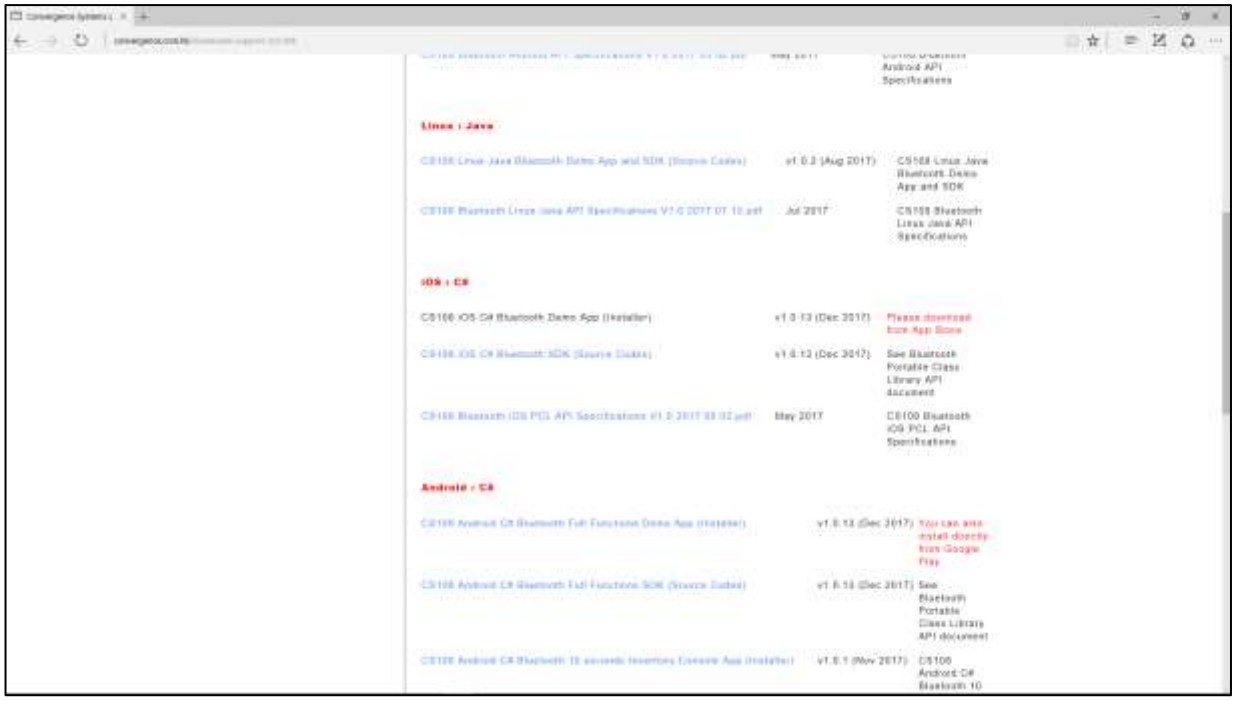


To download the C# Android App, please go to Google Play to download:



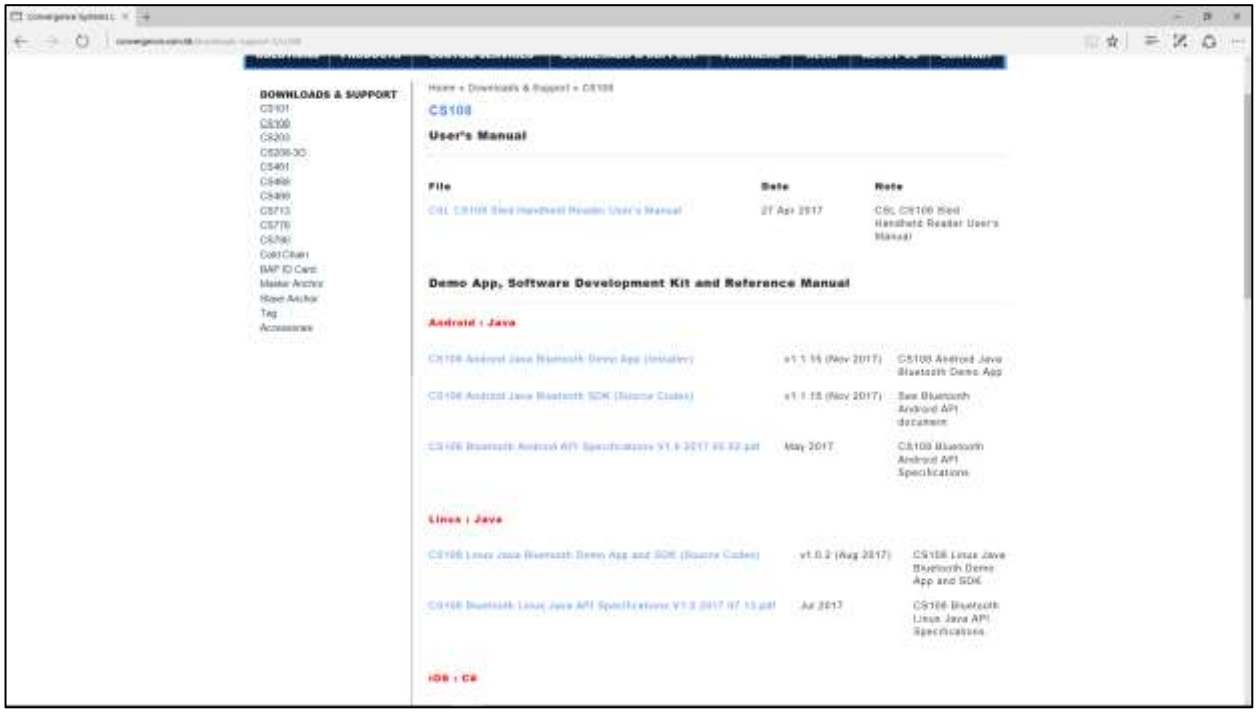
To download Android Java App, please go to Google Play to download.

For Linux and Windows App, please go to www.convergence.com.hk “Downloads and Support” then “CS108 Sled Handheld” to download the respective software and documentation.



4.11 Downloading Application Software Source Codes

For developers who need to download source codes and modify those for their own use, they can go to the Downloads & Support section of www.convergence.com.hk and then choose the reader CS108 Sled Handheld. There you can download all the source codes, reference manuals and other information for use.



4.12 Trigger Button vs Touch Screen Usage

Using a Demo App provided by Convergence Systems Limited, one can start and stop an RFID inventory or Barcode Reading using either the Start/Stop button inside the CSL Demo App via the LCD touch screen of the smart device, or use the Trigger on the sled handle.

In the CSL Demo Apps, pressing the trigger initiates a **continuous** RFID or Barcode scanning process. One can then terminate this process upon releasing of the trigger. You need to press the Trigger and KEEP PRESSING, for the reader to be continuously reading RFID tags or scanning barcodes, depending which reading mode you are in. The moment you release the trigger, the RFID inventory or barcode scanning will stop.

If you do not use the Trigger, you can use the Start/Stop button on the CSL Demo App via the LCD touch screen of your smart device. When you press the Start button, the CSL Demo App will start continuous RFID inventory or barcode reading. To stop, just press on the Stop button.

5 Introduction

5.1 Software Applications

The CS108 offers standard demo applications with source codes freely downloadable from Convergence website (www.convergence.com.hk) for iPhone, iPAD, Android Phone, Android Tablet, Linux Tablet and Windows 10 PC/laptop. For iPhone and iPAD, you can install the application from Apple's App Store. The source code for iPhone and iPAD are available from www.convergence.com.hk For Android phone and tablet, you can directly download the .apk install file and also source codes from www.convergence.com.hk. You can also download the Android Demo App directly from Google Play. You can download the Linux and Windows 10 App, installer and source codes from www.convergence.com.hk

Host Platform	Interface Physical Media	Protocol of Host Platform
Apple iPhone	Air	Bluetooth 4.0 or 4.1 or 4.2
Apple iPad	Air	Bluetooth 4.0 or 4.1 or 4.2
Apple iPod Touch	Air	Bluetooth 4.0 or 4.1
Android Phone	Air	Bluetooth 4.0 or 4.1 or 4.2
Android Tablet	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows 10* Laptop with BLE	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows 10* Tablet with BLE	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows 10* Mobile Phone	Air	Bluetooth 4.0 or 4.1 or 4.2
Linux PC or Laptop or Tablet	Air	Bluetooth 4.0 or 4.1 or 4.2
Windows PC or Laptop	USB cable	USB
Linux PC or Laptop	USB cable	USB
Android Phone with OTG	OTG USB cable	USB
Android Tablet with OTG	OTG USB cable	USB

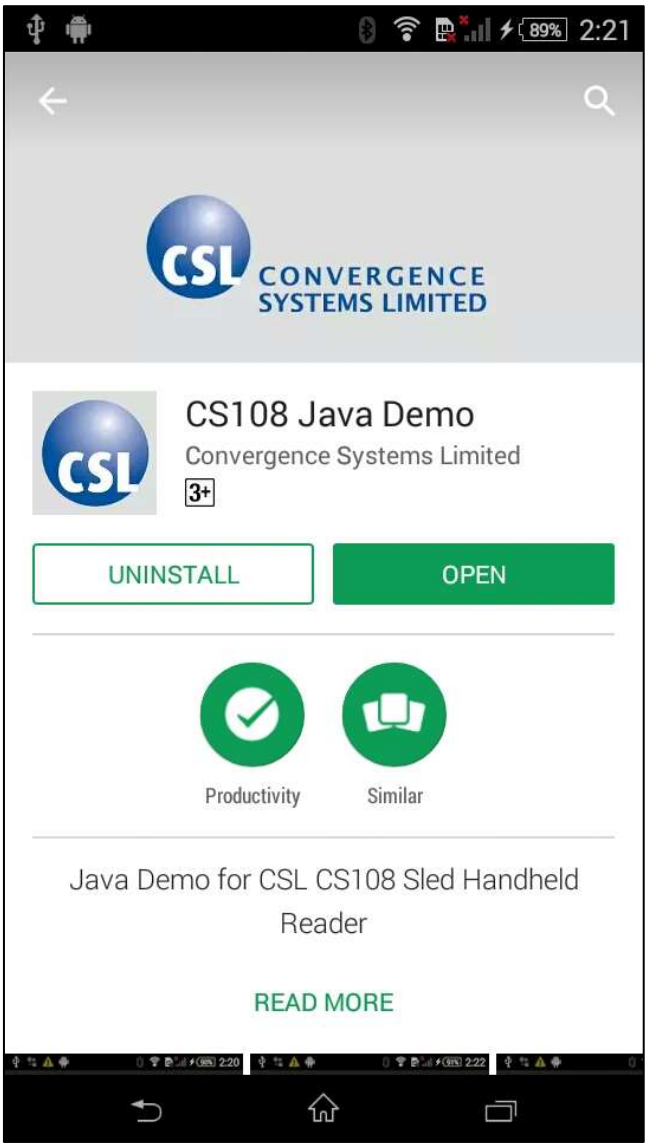
5.1.1 DEMO JAVA SOFTWARE FOR ANDROID

5.1.1.1 Installing the Demo Android Java Software

There are 2 ways to install the Demo Android Java App:

1) Install directly from Google Play
2) Download the APK from Convergence website.

5.1.1.1.1 Installing from Google Play

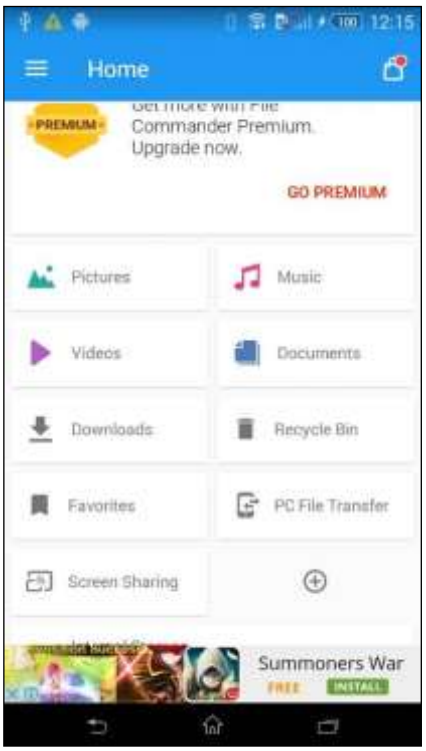


5.1.1.1.2 Download APK from CSL website

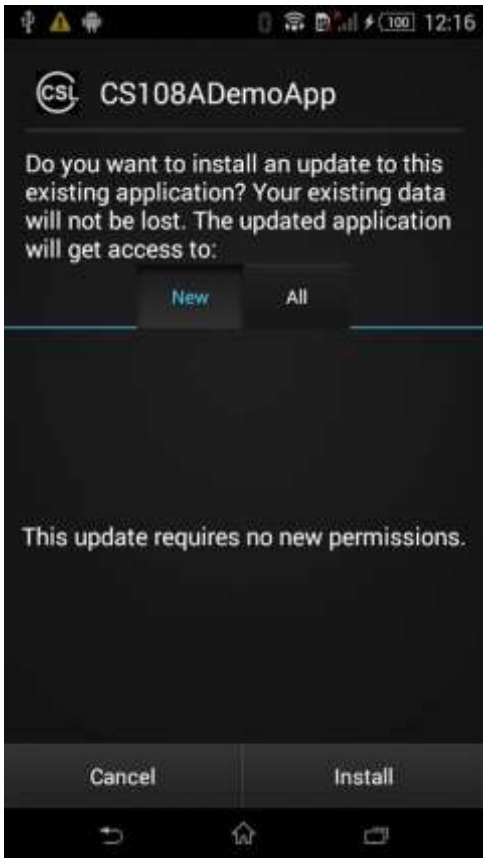
Download the APK from Convergence website. Save the .apk file to the Download folder.

You can directly download that to your Android phone as long as your Android phone is connected to the Internet.

See below:



Select and press the APK and start the installation process:



Once installed, start the App and you should see the following:

5.1.1.2 Starting the Android Java Demo Software

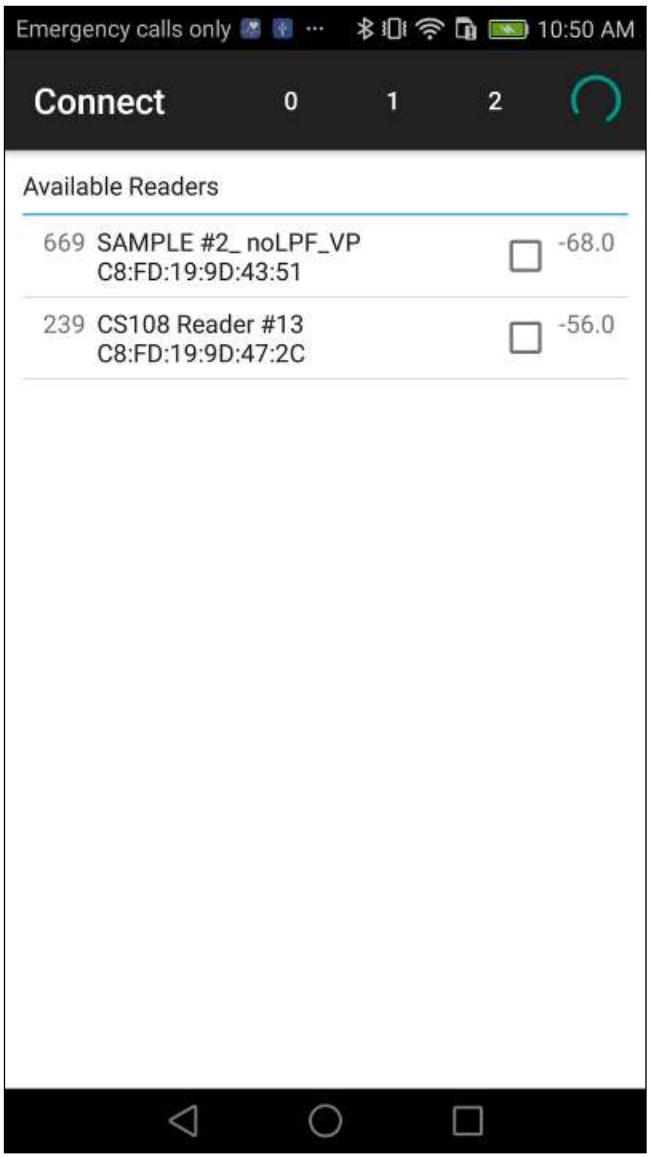
The CS108 Android Java Demo App icon should appear on your Android device screen as "CS108ADemo"

Open the Android Java Demo App and you should see the following screen:

5.1.1.3 Searching and Connecting to (Pairing with) the CS108

To start searching and connecting to (pairing with) a CS108 nearby, press the Connect button at the bottom of the menu. Please make sure that you have powered ON the CS108 you are trying to connect with and the blue Bluetooth LED is blinking. Also make sure the Bluetooth on your Android phone is turned on.

After a few seconds, you should see on the Demo App screen all the CS108 units nearby available for pairing.



Select the one you want to connect to by pressing on the row of the screen corresponding to the reader you want to connect with.

After that you should see the check box to the right of the reader name ticked. Press on the screen again to connect to the chosen reader. If you have multiple CS108 readers they should be set to different names. (see Settings)

5.1.1.4 Settings

Once connected to the reader, set up the reader's parameters in the Settings page:

The Settings/Operation menu, has configuration for the Regulatory Region, Frequency Order, Fixed Channel, Power, Tag Population, Q (override), Session, Target, Query Algorithm, and Reader Mode/ Link Profile

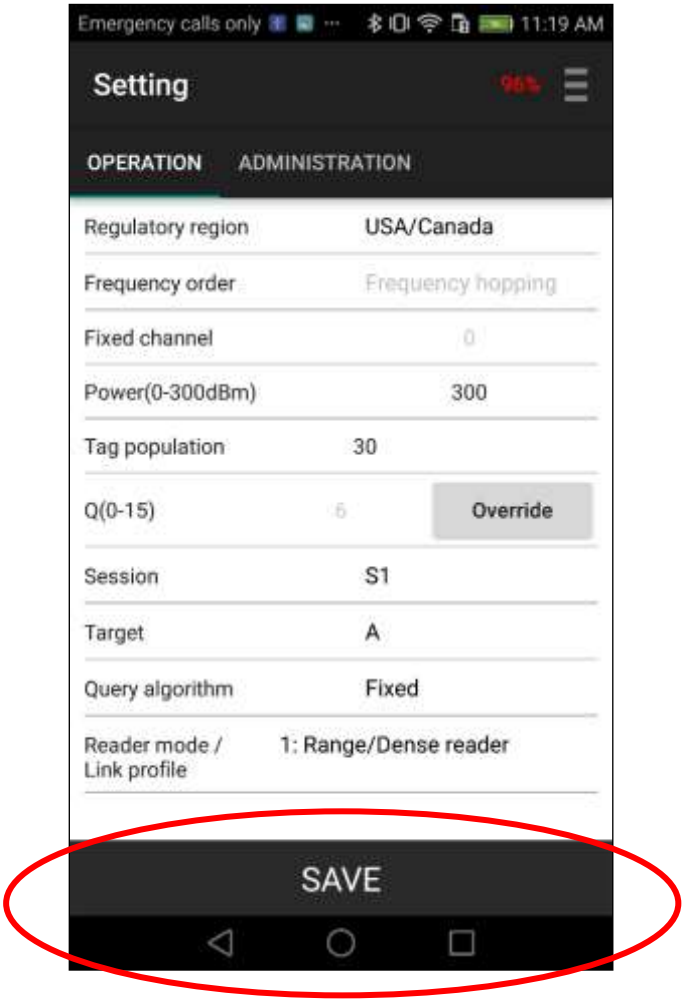
Please refer to Appendix B, C, D, E, F, for the definitions and uses of Reader Modes/Link Profiles, Sessions, Tag Population and Q, Query Algorithms, and Target.

Note that it is strongly recommended for the user to select a Tag Population that is close to the number of RFID tags the reader will see while reading directly in front of it. If inventorying a warehouse consisting of a large tag population, say 2000, do not set 2000 as the Tag Population, as the reader cannot "see" all 2000 tags at once. Instead set the Tag Population to 50, 100, etc….. The default is 30.

The Power is default set to 300, meaning 30 dBm (1 Watt). This is the internal conducted power before it enters the antenna. The antenna gain is 2.7 dBi. Depending on environment, a lower power may get better read results. Experiment with different power settings to see

which one provides best results.

After making changes to the Settings page you must press the SAVE button to apply the changes.



5.1.1.5 RFID Inventory

To do an inventory of RFID tags, select the “Inventory” button:

Press the Start button or Press the Trigger to start the inventory and then the ID(s) of the RFID tags will be listed as shown below. The first column is the number of reads of that tag ID, second column is the RFID tag EPC ID, the last column is the RSSI of the tag. On the upper right, you can also see the current battery level in red font.

A high frequency tone will be heard when a new RFID tag is read and a low frequency tone will be heard when a tag is read again.

A summary of tags read appears at the bottom of the screen: number of Unique Tags, Total Number of Tags Read, Read Rate, and Run Time.

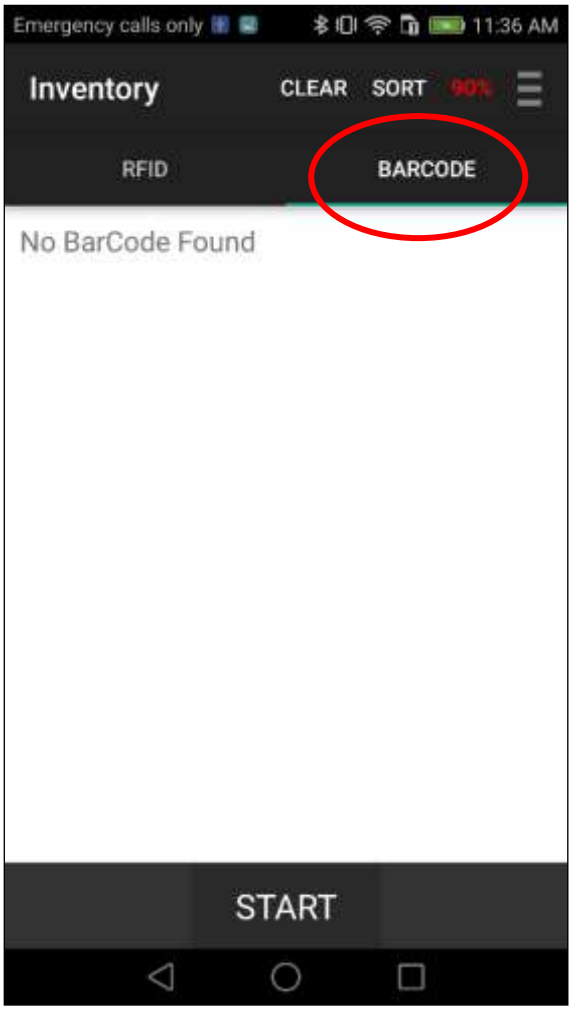
At any point, if you want to stop reading, just press the Stop button or release the Trigger.

If you stop inventory and start again, the previous list will remain and new tags are added at the top of the list. If you want to start a new list, press the Clear button at the bottom to clear the list.

5.1.1.6 Barcode Inventory

To scan a Barcode press the Inventory button:

Then press the BARCODE SCAN button on the upper right hand of the screen:



Press the START button on the touch screen or Pull the Trigger. The red LED of the barcode reader will light to help you aim the CS108 barcode scanner to the barcode. A focused circular aiming dot will appear. This indicates the optimal reading distance between the CS108 and the barcode.

Once the barcode is read, you can press the Stop button or release the Trigger.

5.1.1.7 RFID Read and Write memory banks

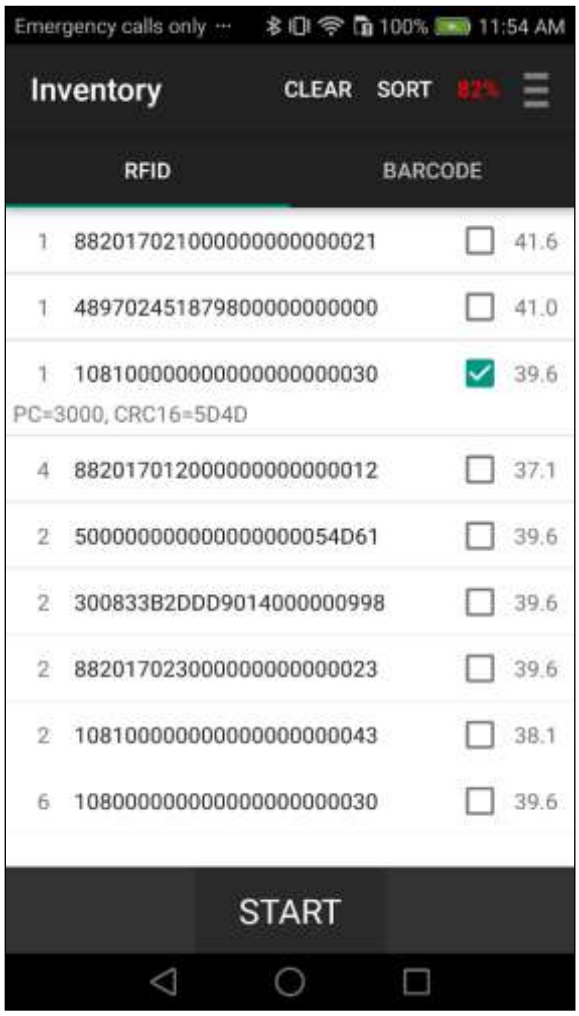
To read and write specific memory banks of an RFID tag. Press the Read/Write button:

The screen below appears displaying Bank 0 (Reserved), Bank 1 (EPC), Bank 2 (TID Memory) and Bank 3 (User Memory) of the EPC tag. Select at least one bank to read or write. Note that Bank 2, TID bank, can only be read and cannot be written, as defined by EPC Global Standard.

Enter a Tag Pattern to select a specific tag for Read/Write operations.

If you do not input anything, in the Tag Pattern input box, (see circle) the reader will read whatever tag it sees. You can input a string of hex number to select the specific tag. The whole EPC ID, or a partial string can be entered for the pattern; the remaining being wild card.

Alternatively, a Tag Pattern for a Read/Write operation can be selected from the Inventory page. Select a tag by pressing the line of the tag desired, and it will be highlighted.



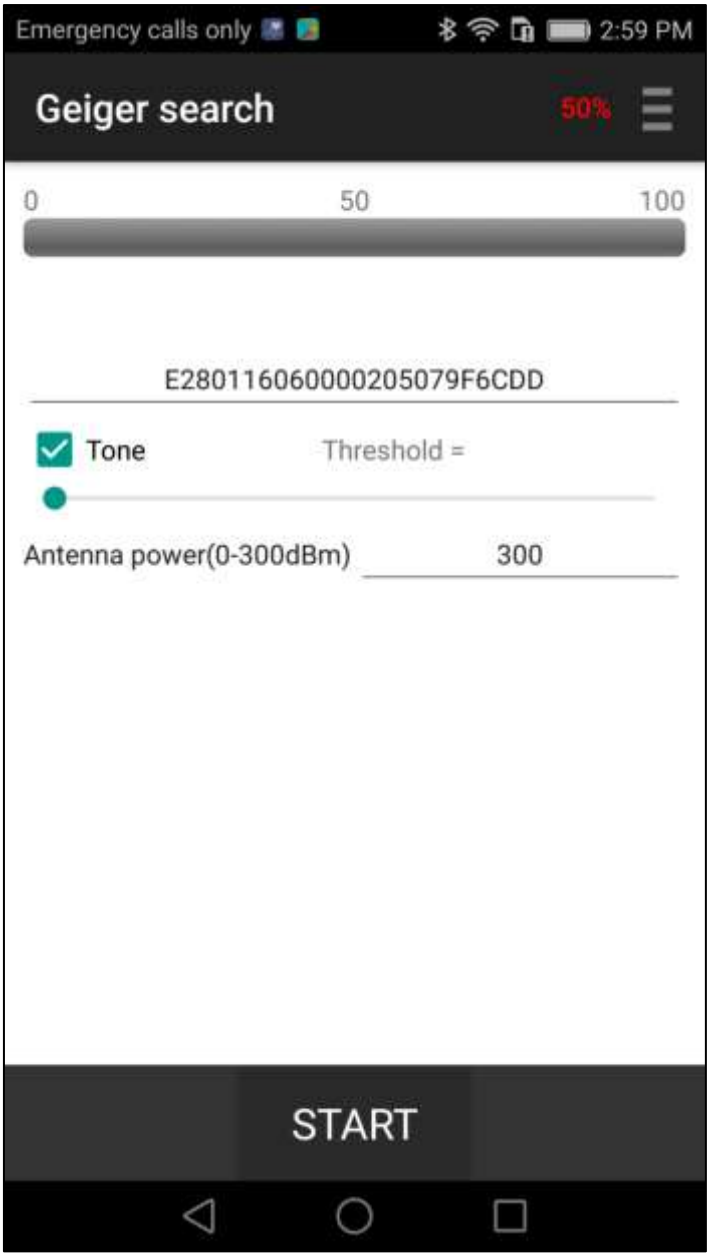
Return to the Main Menu and select the Read/Write function. The selected Tag ID will be displayed in the Tag Pattern field.

You can now Read or Write any specific memory banks.

5.1.1.8 Geiger Search

A tag search is done with the Geiger Search function:

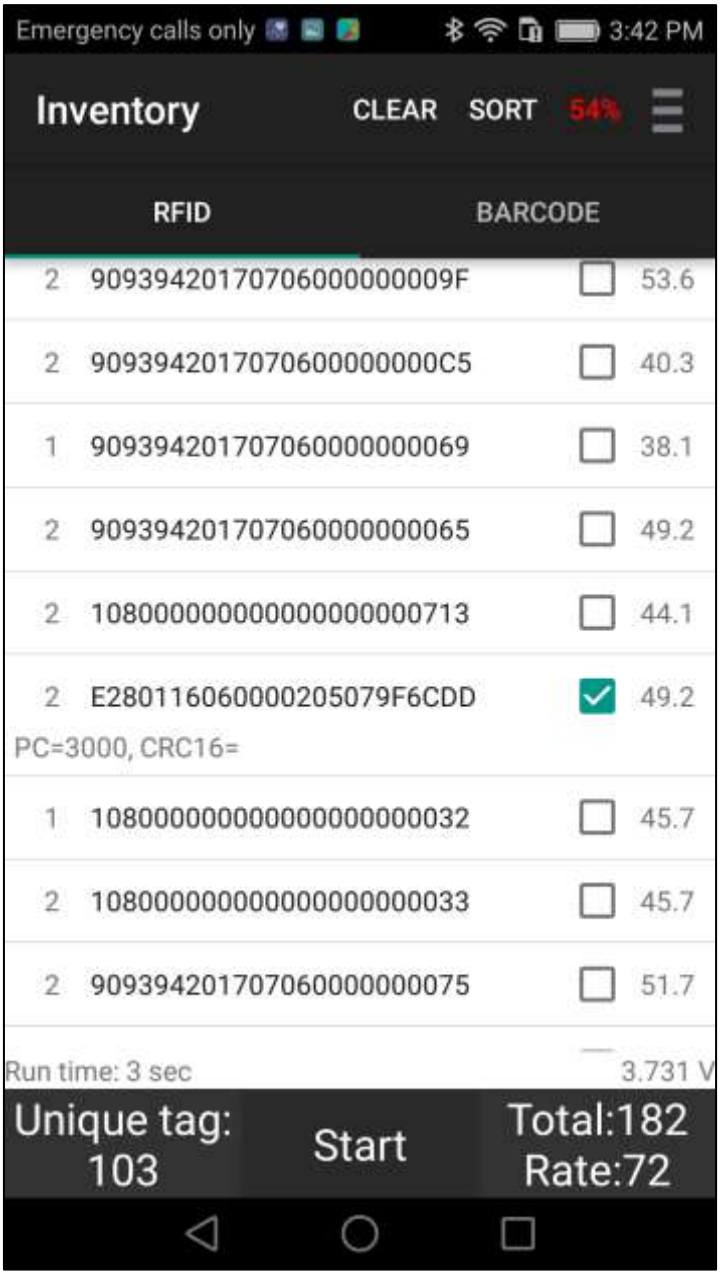
Select a tag from the Inventory function or manually enter the tag ID to be searched.



Press Start. Continuous reading will begin showing the RSSI, as well as, a beeping a tone if the Tone box is selected. The Threshold can be adjusted to limit the tone.

The tag can now be searched for using the beeping sound. If the Tone box is enabled, it will become faster and faster as the RSSI increases. When you are really close to the tag a long beep will replace the tone.

Another way to home in on a tag is to first do an inventory of the whole area, without knowing the exact location of the tag. Then select the tag with the ID you are looking for by selecting that line.



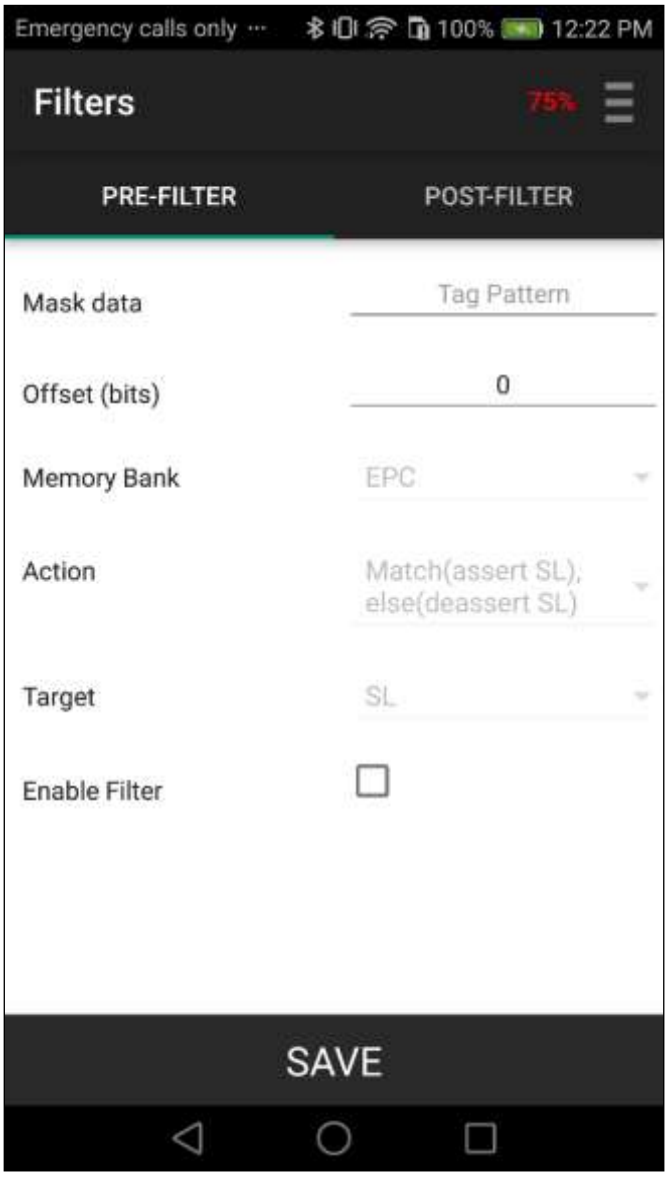
Then, return to Main Menu and enter the Geiger Search function, the ID will already be in the Input field, and you can start the Geiger Search:

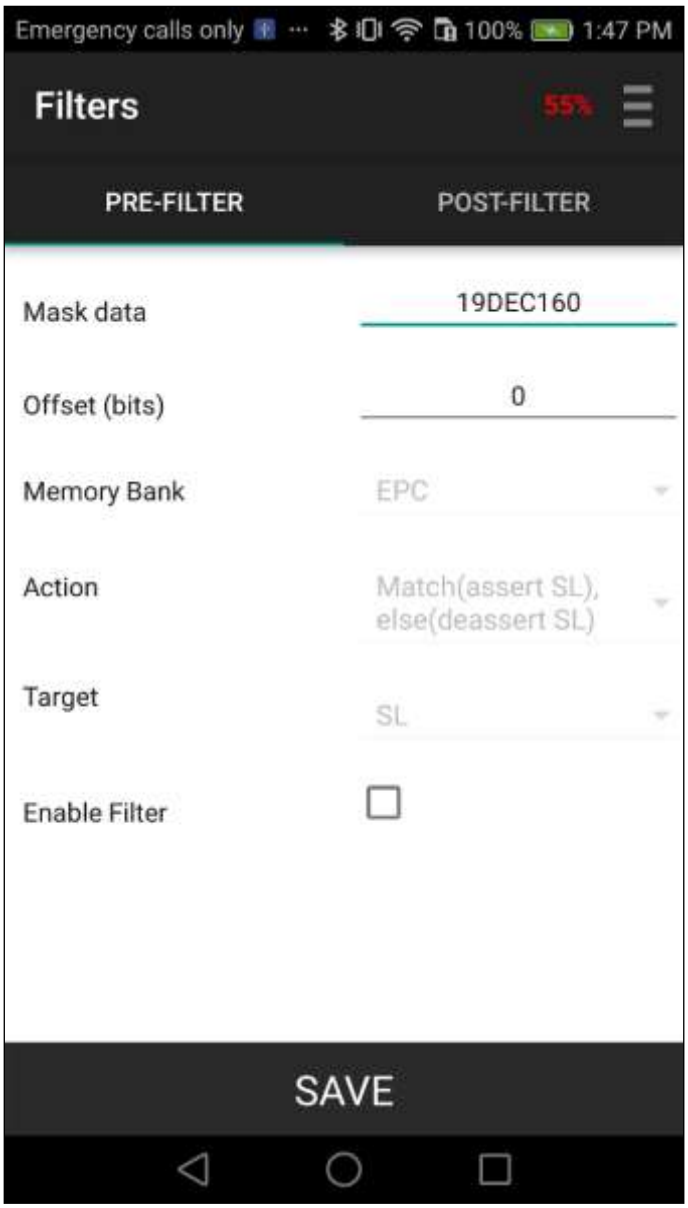
To stop, press the Stop button, and the search will end.

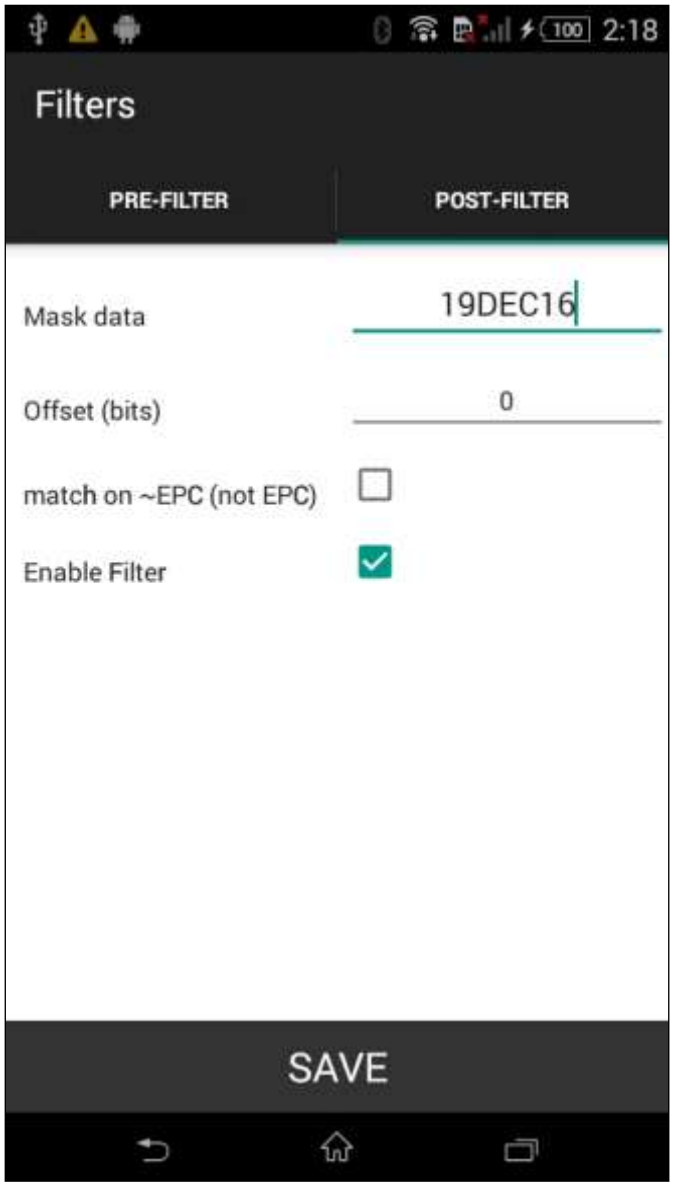
5.1.1.9 Filter: Pre Filter

A Pre-Filter, i.e. a select filter, to have only a certain group of tags respond to the reader's query can be added. To implement this, select the Filters function:

On the Pre-Filter page, enter the Tag Pattern used to filter the desired tag(s) population. The tag pattern does not need to be from the beginning of the EPC bank. An Offset can be entered, the default offset is 0. After entering the data, check the Enable filter box and then press the SAVE button.



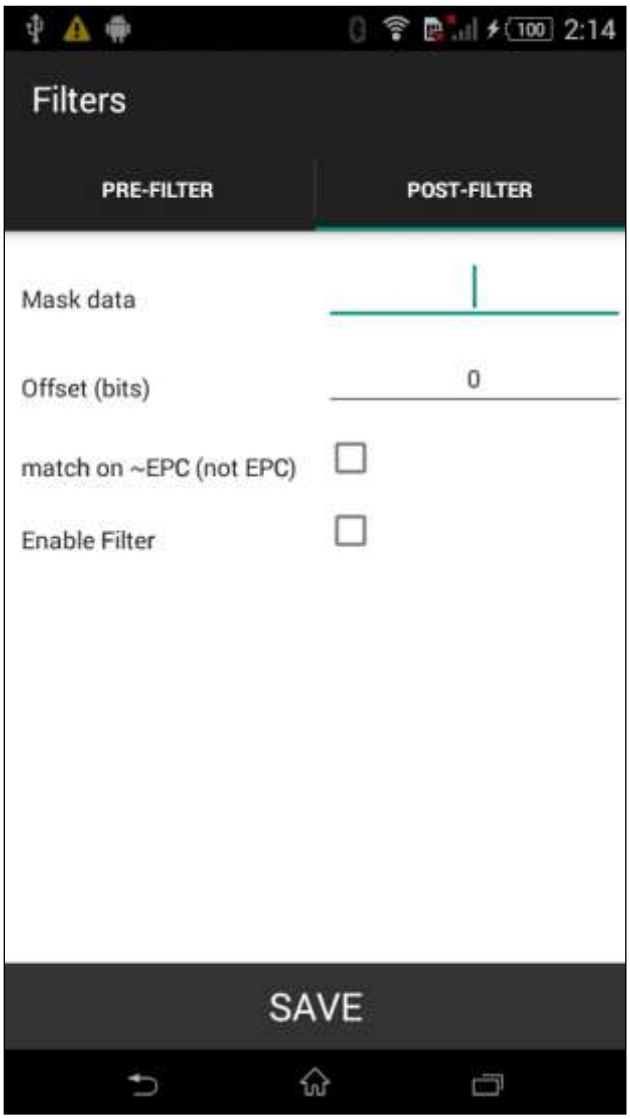


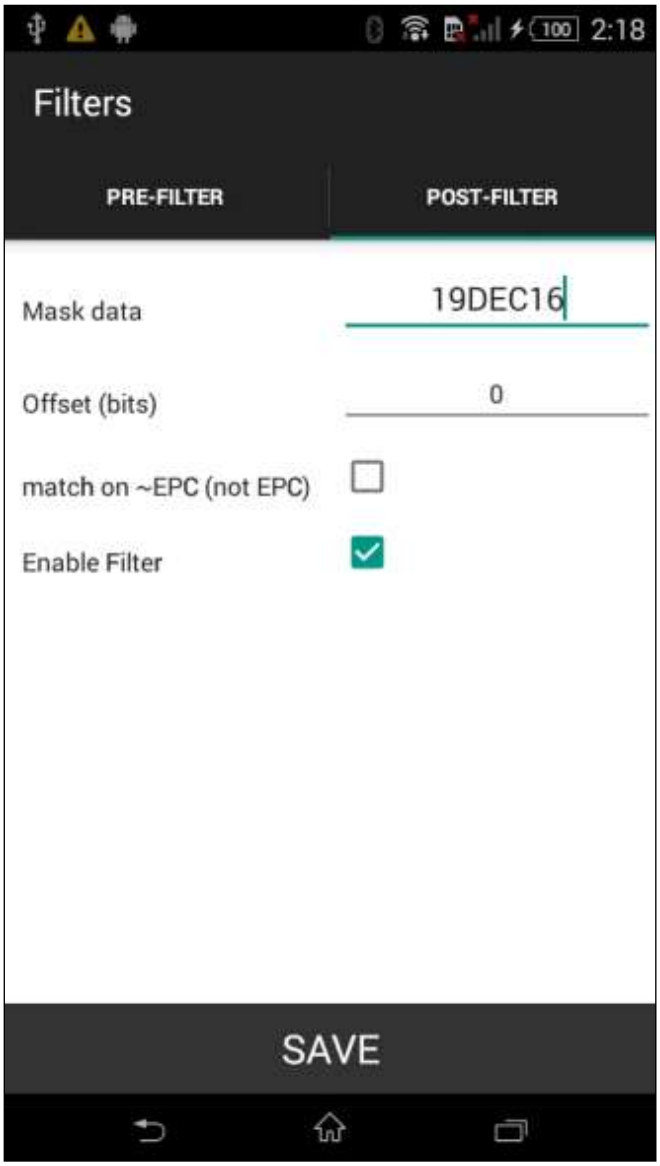


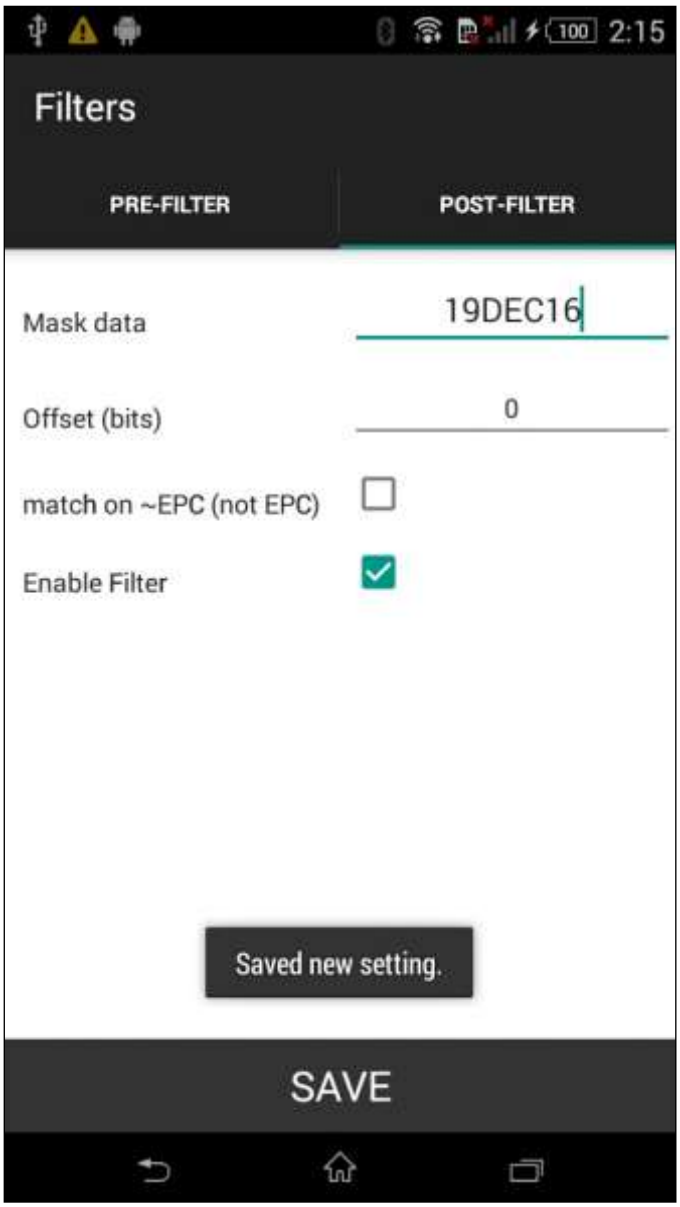
5.1.1.10 Filter: Post Filter

Inventoried tags can be further selected using the Post Filter:

On the Post-Filter page, enter the Tag Pattern used to filter the desired tag(s) population. The tag pattern does not need to be from the beginning of the EPC bank. An Offset can be entered, the default offset is 0. After entering the data, check the Enable filter box and then press the SAVE button.



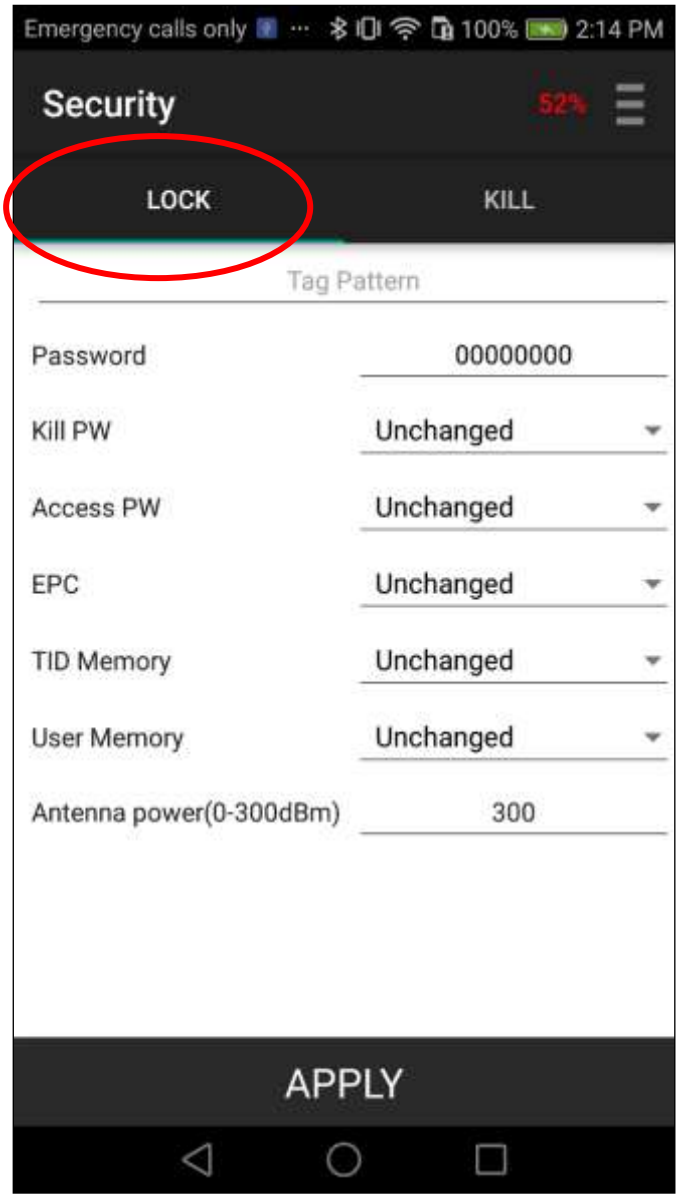




5.1.1.11 Security

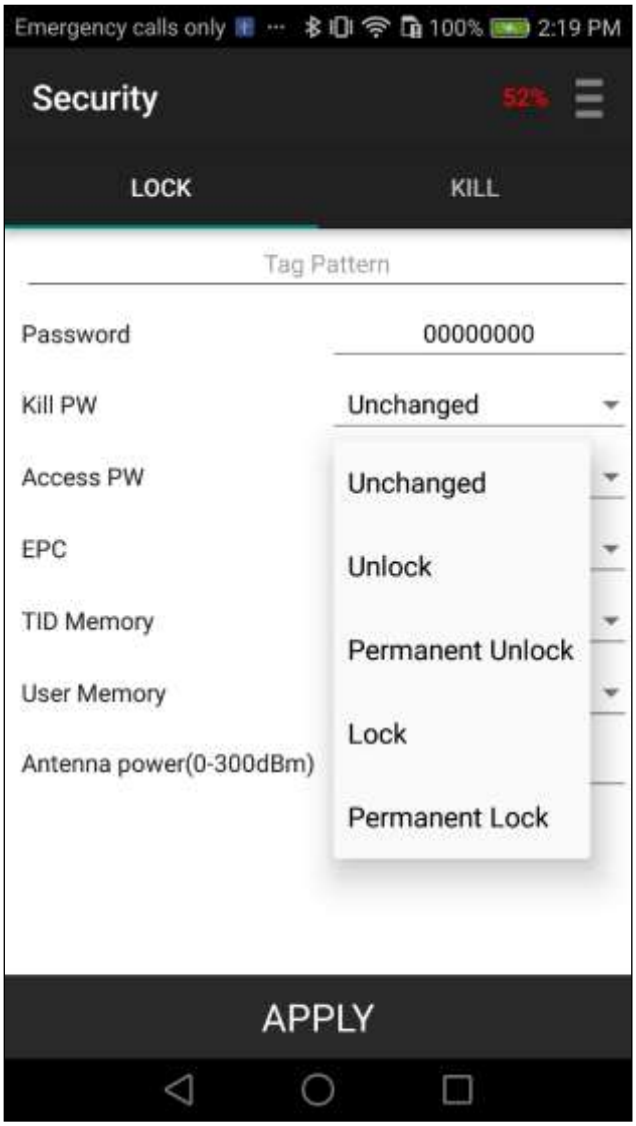
Security features, such as Locking or Killing can be added to the EPC of tags. To enable these features, go to Security page:

You can either Lock or Kill a tag. Here is the procedure for locking a tag:

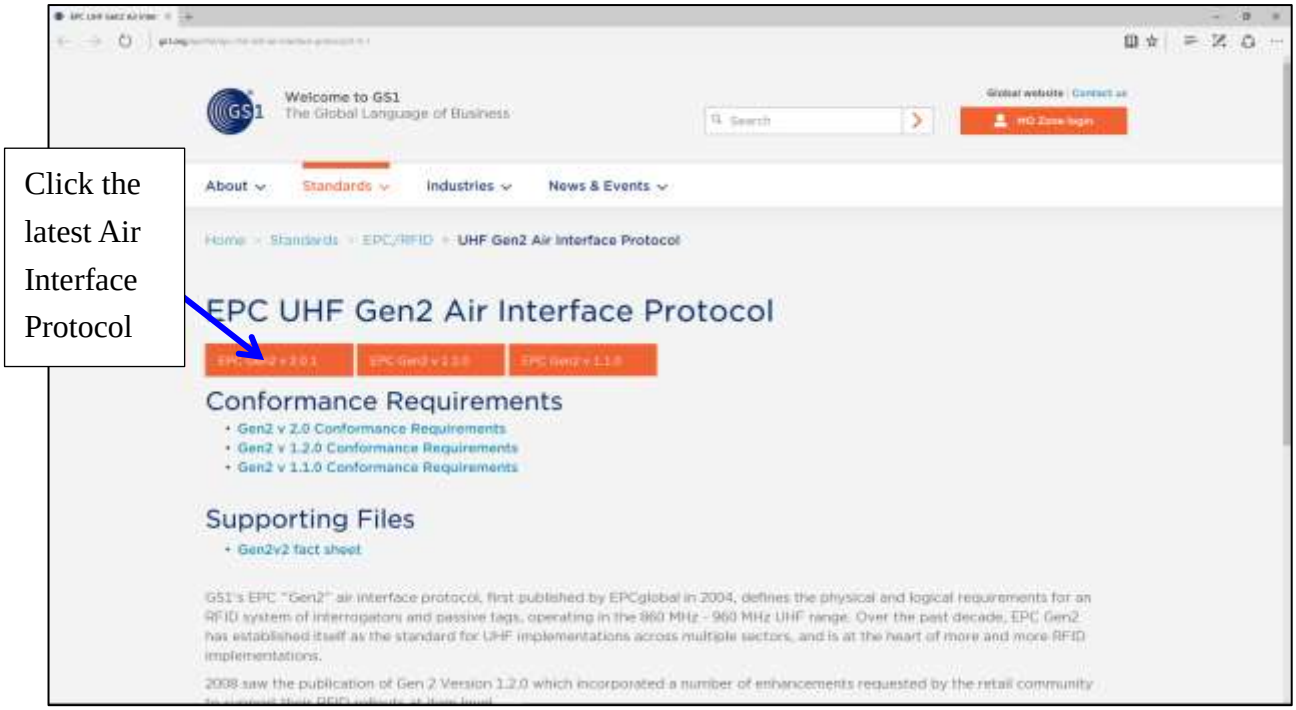


For locking a tag there are 5 possible actions to choose from,

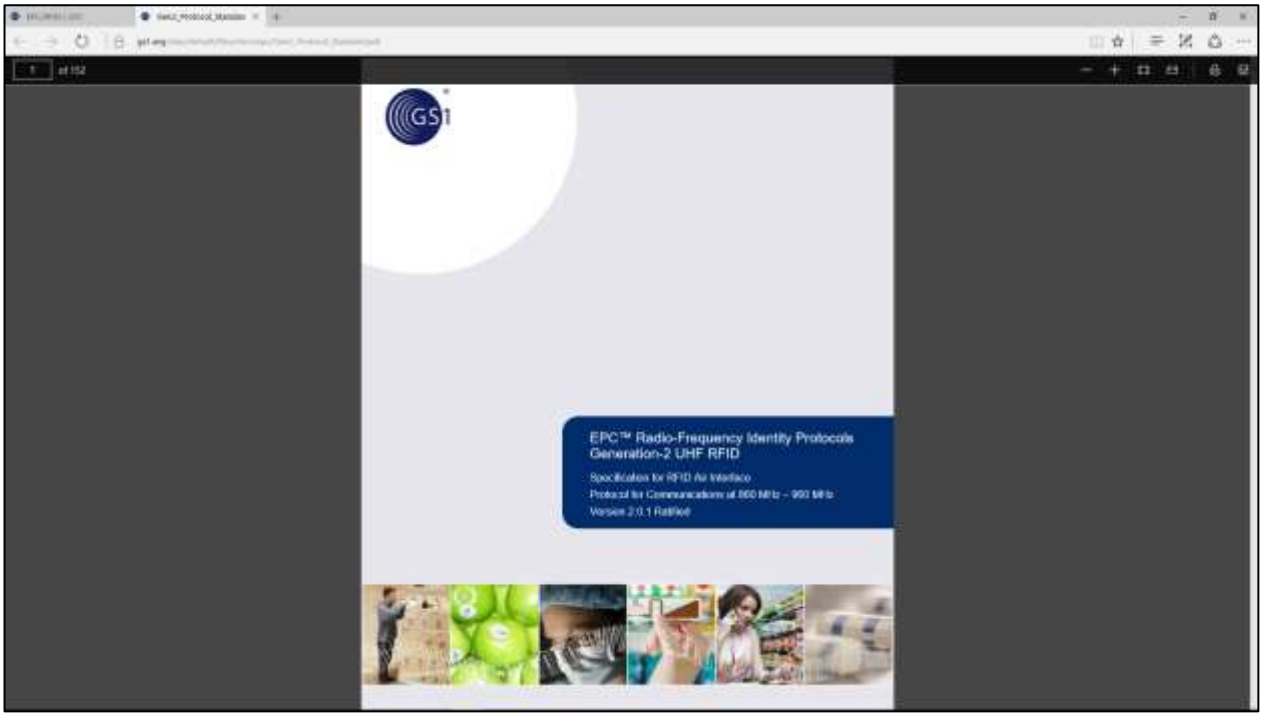
1) Unchanged (no action)
2) Unlock
3) Permanent Unlock
4) Lock
5) Permanent Lock



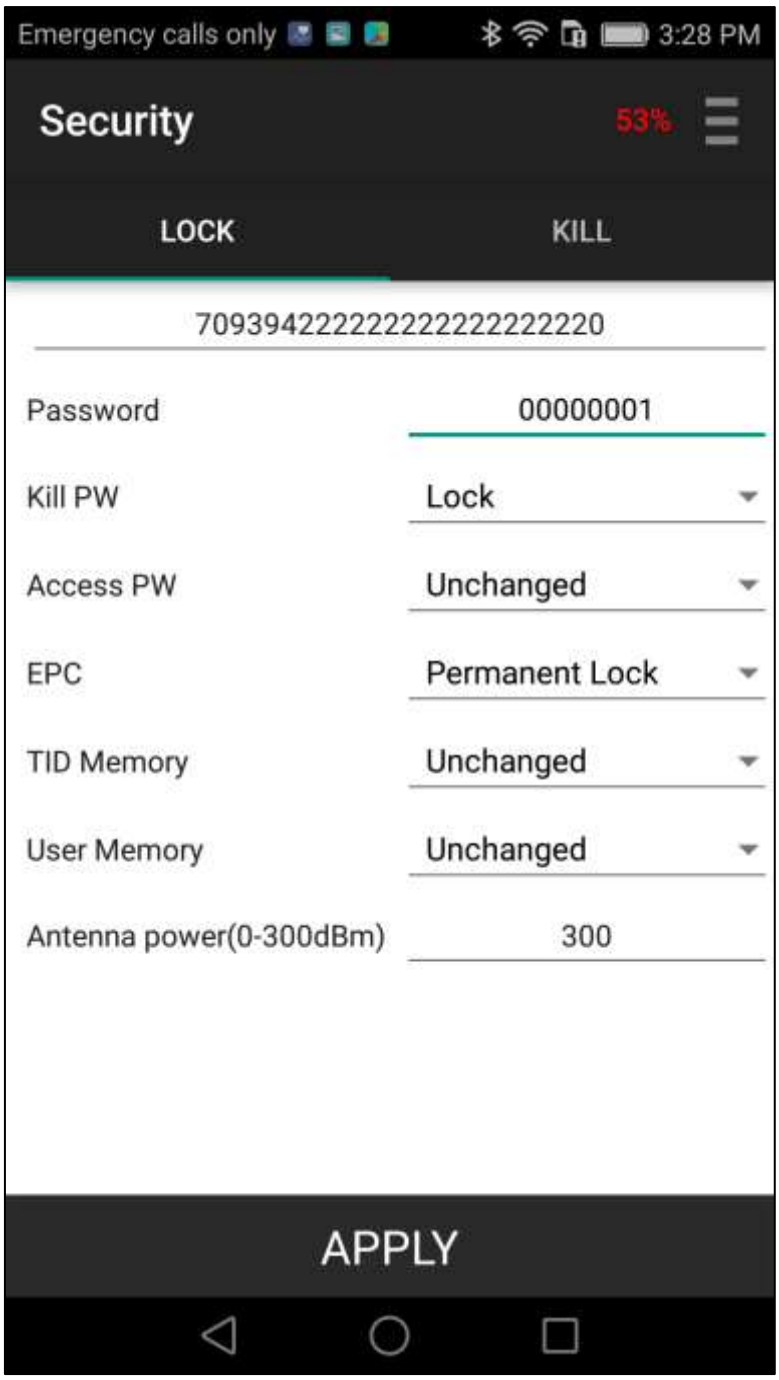
You can lock, unlock, permanently lock, and permanently unlock a memory bank of the tag. The detailed definitions of these 4 operations can be found in the EPC Global standards document which can be found at the EPC Global website: https://www.gs1.org/epcrfid/epc-rfid-uhf-air-interface-protocol/2-0-1. On the page, press the button showing the latest air interface protocol and download the pdf file. More details can be found on Appendix G.



Click the latest Air Interface Protocol

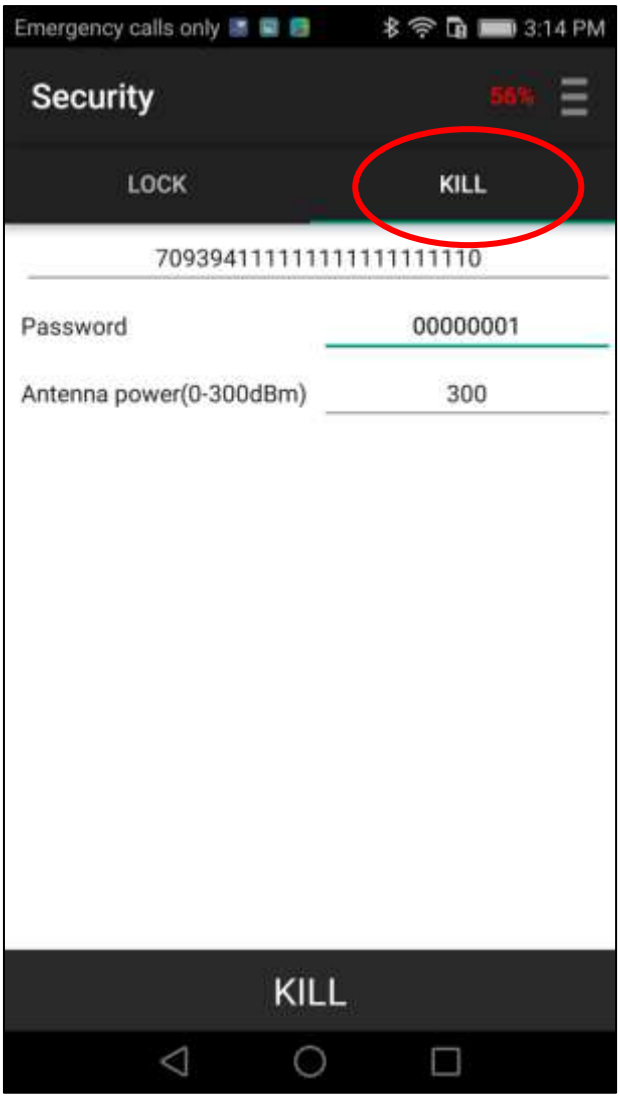


After a successful operation, the following screen is diplayed.



Reminder: The Lock password must be non-zero for you to be able to implement any security action. This is an EPC Global Standards definition and requirement.

Pressing KILL at the top of the screen presents the feature for killing a tag. Note it asks you to enter the Kill password immediately:



After entering the correct password, press KILL button at the bottom of the screen, the tag will be killed. During the process, the word “KILL” will be changed to “KILLING”, and , if successful, a “Success” message will pop up above the bar.

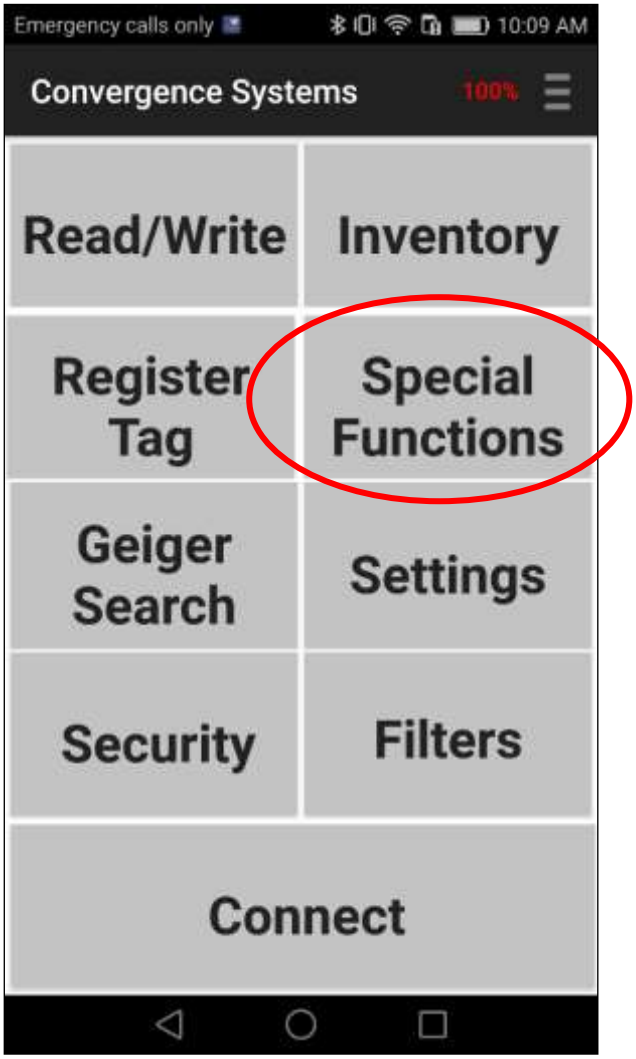
Reminder: The Kill password must be non-zero for you to be able to implement any security action. This is an EPC Global Standard definition and requirement.

5.1.1.12 Register Tag

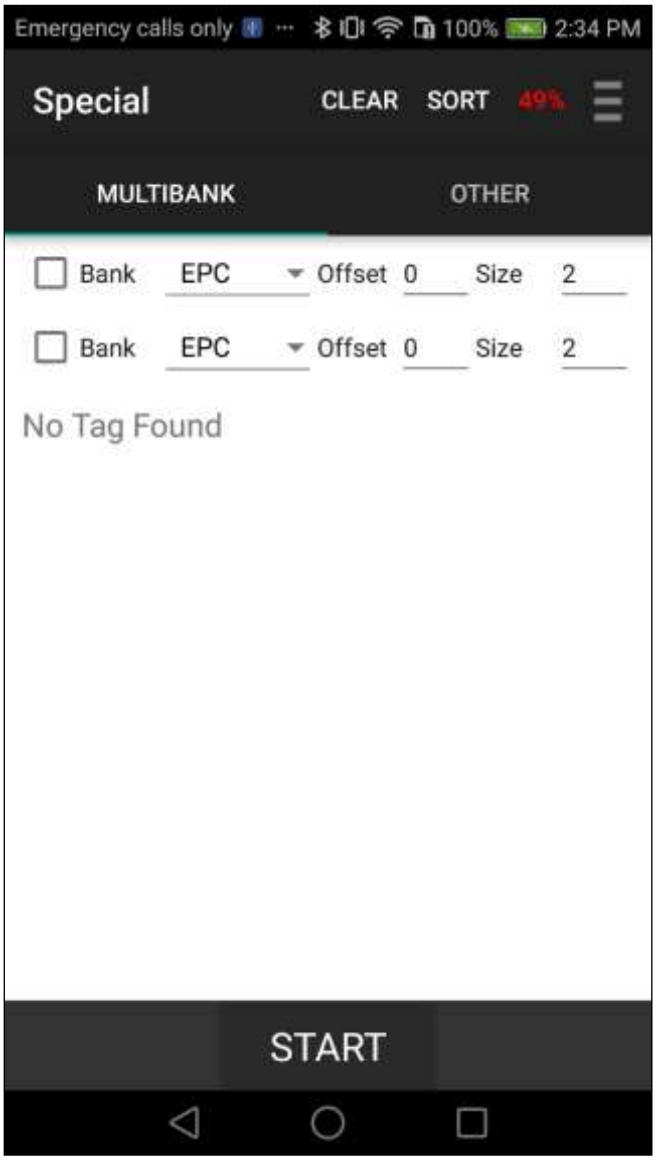
Register Tag is a section of the CS108 Demo Application page allowing the user to scan a barcode, and then write that information into a specific memory bank of an RFID tag. That information is often saved in a certain section of the EPC memory bank, or in the USER memory bank. This section allows you to select which memory bank and which offset location to write that information to. Moreover, it allows you to set a tag mask so that it would only write to tags with a certain tag pattern.

5.1.1.13 Special Functions

This section of the CS108 Demo Application offers user some additional special functions available with the CS108.



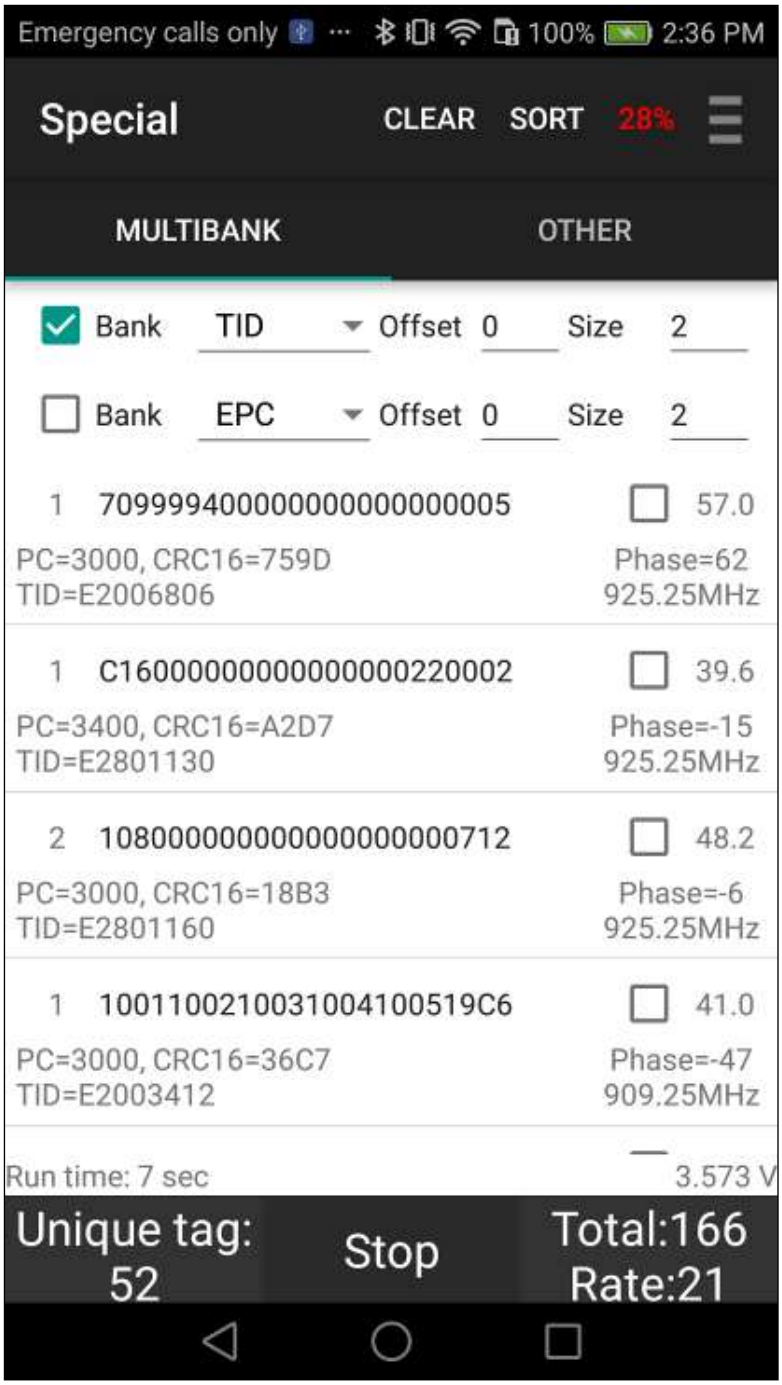
Multibank inventory is a special function that allows the RFID inventory of multiple tag memory banks at the same time.



Select the bank, offset and size (in words) that you want to inventory. You can choose up to 2 extra banks.

Now you can press the START button:

You will now see the RFID tags' EPC bank, TID bank, as well as the phase and frequency channel of reading:

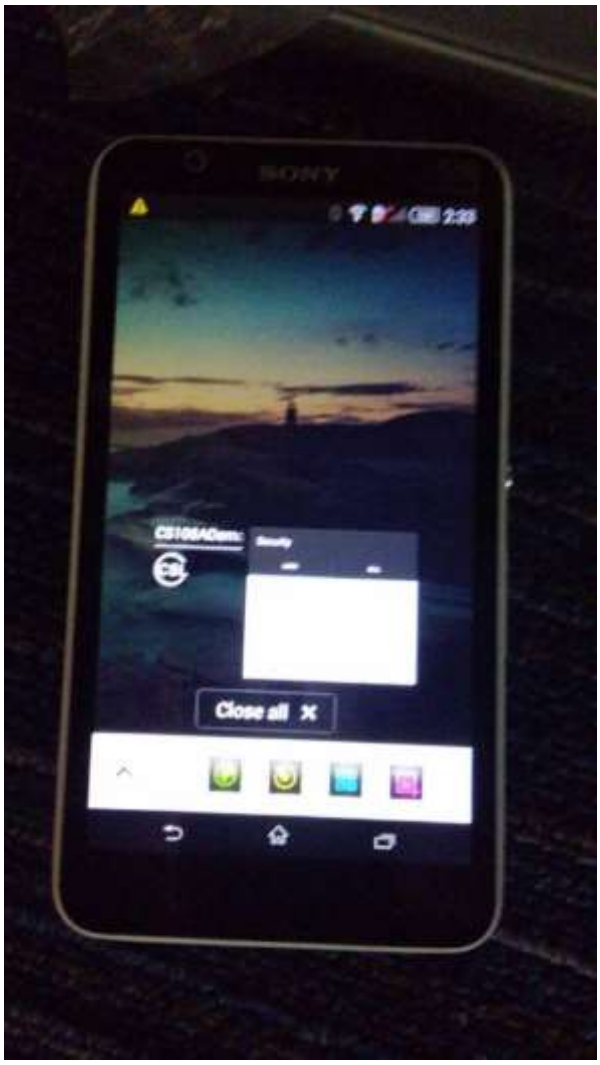


5.1.1.14 Exiting the Software

By pressing the Home button, middle CIRCLE icon on the LCD touch screen at the bottom, one can exit the software. Note that using this method for exiting the demo application does not completely stop the application, the application is placed in a sleep mode.

5.1.1.15 Truly Exiting the Software

To truly exit the software, press the SQUARE button, and then you will see the following screen:



At this point, you can truly exit the software by pressing the ‘X’ to close the app.

5.1.1.16 Source Codes

Source code for this application, tools and manuals are available on Convergence Systems Limited website:

www.convergence.com.hk

5.1.2 DEMO C# SOFTWARE FOR iPHONE and Android

5.1.2.1 Installing the iPhone and Android Software

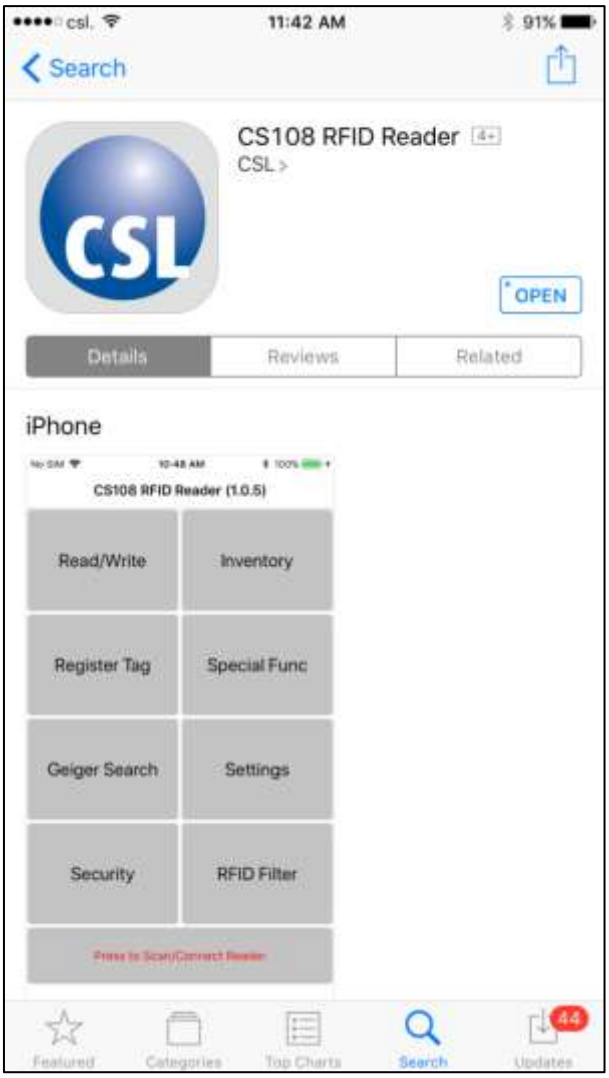
The C# code applies to both the iPhone and Android phone. The same code can be deployed to multiple platforms. This is a powerful development in the world of smart phone Apps. Visual Studio 2017 was used to compile the applications.

The iPhone version App can be installed from the Apple App Store.
The Android version App can be installed from Google Play.

The Android software can also be installed by downloading the APK file from the CSL website.

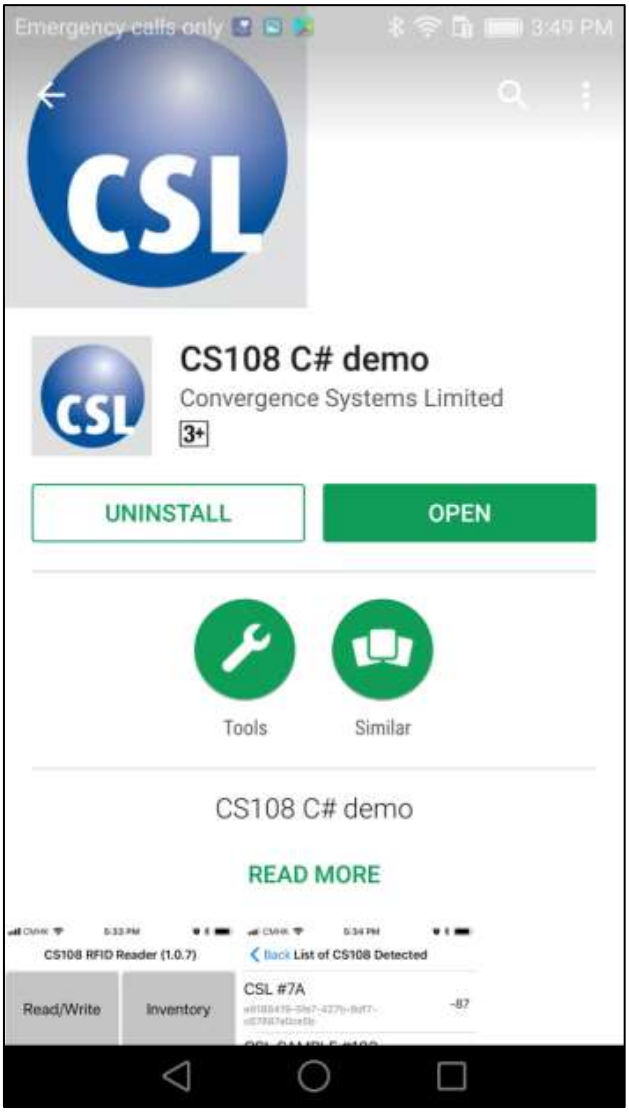
5.1.2.1.1 Installing iPhone App from App Store

The released CS108 C# iPhone App can be installed from the Apple's App Store:



5.1.2.1.2 Installing Android App from Google Play

The CS108 C# Android App can be installed from Google Play:



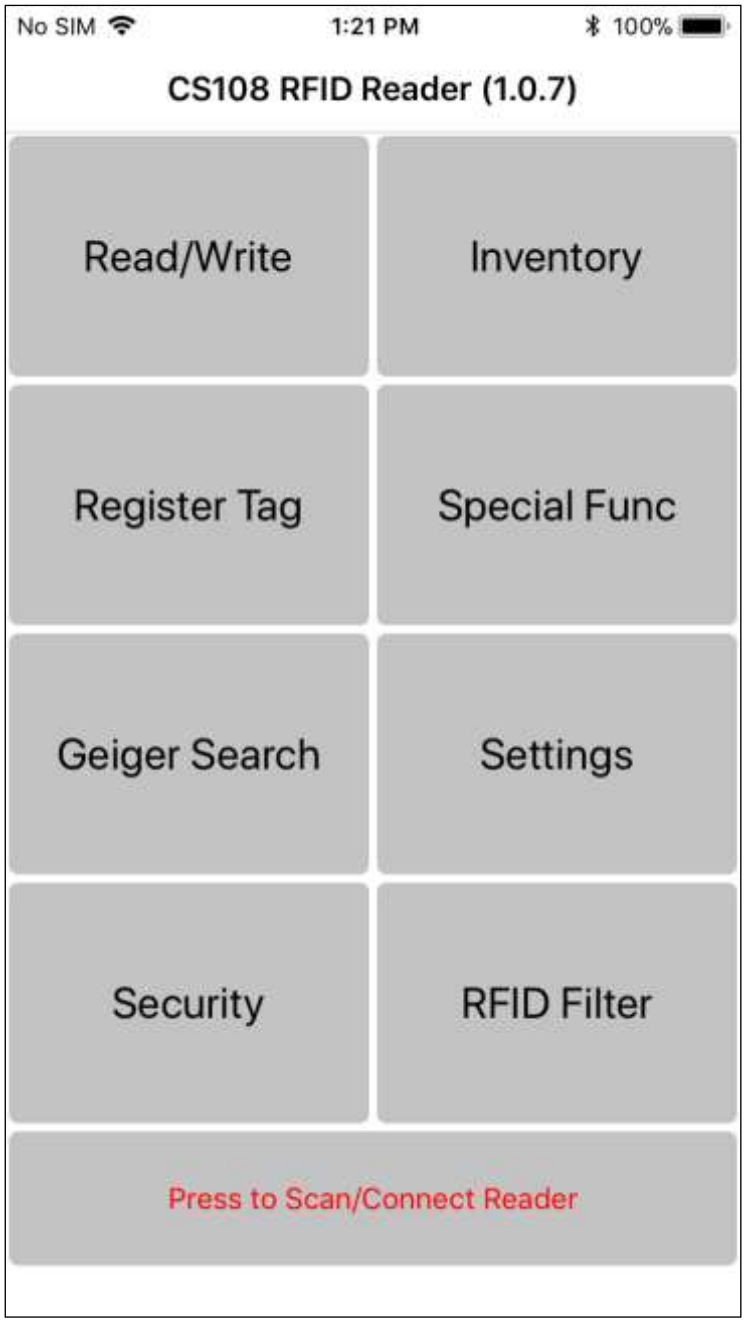
The CS108 C# Android App can also be installed by downloading the APK installer from the CSL website and then copied to the Android phone for installation.

5.1.2.2 Starting the iPhone Software

Since the User Interface is the same for C# Demo App on iPhone and Android, here we will only focus on the iPhone version:

With the CS108 App for iPhone installed, you will see the following icon on your iPhone:

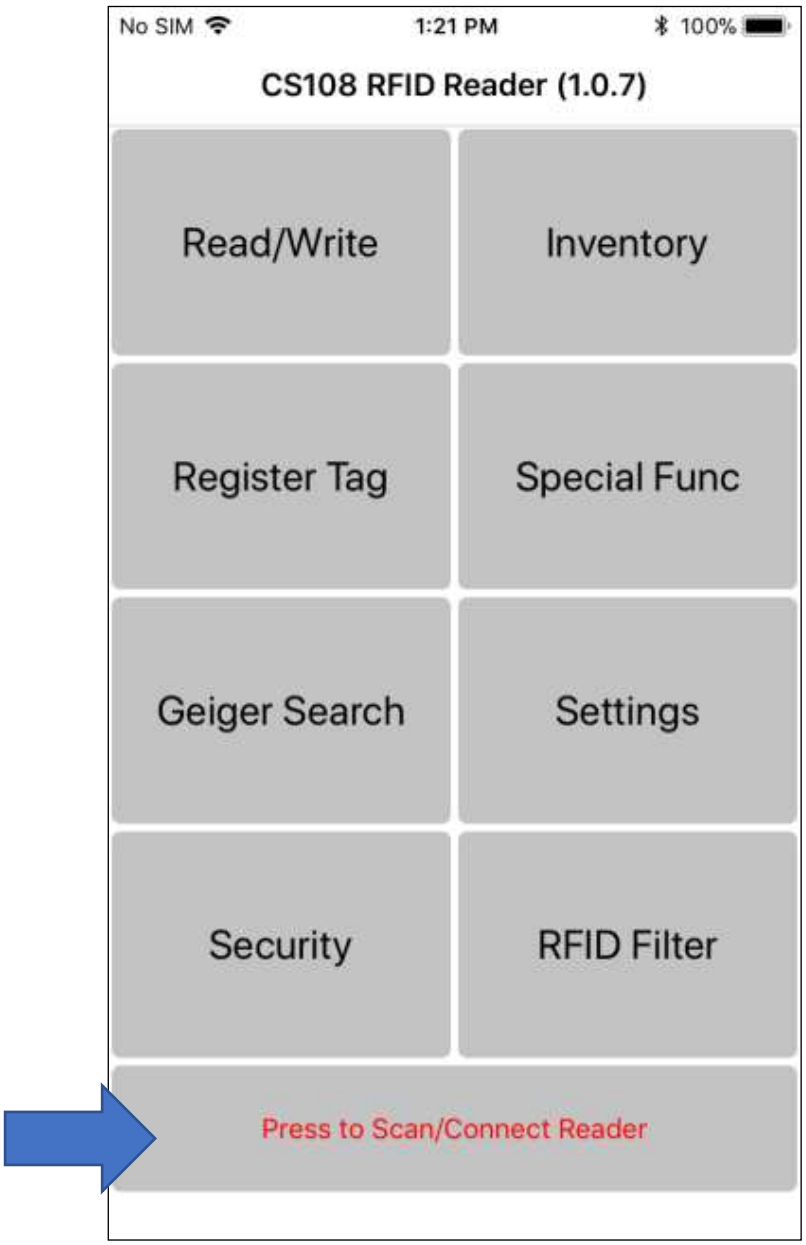
Press the icon to start the CS108 iPhone App.



5.1.2.3 Main Menu

The Main Menu will launch when you start the CS108 iPhone App. There are 8 function buttons and 1 connection button. The text color on the connection button indicates whether a CS108 reader is connected (blue text) or disconnected (red text).

To connect, press the button with text “Press to Scan/Connect Reader” to begin searching and making a connection to CS108 reader.

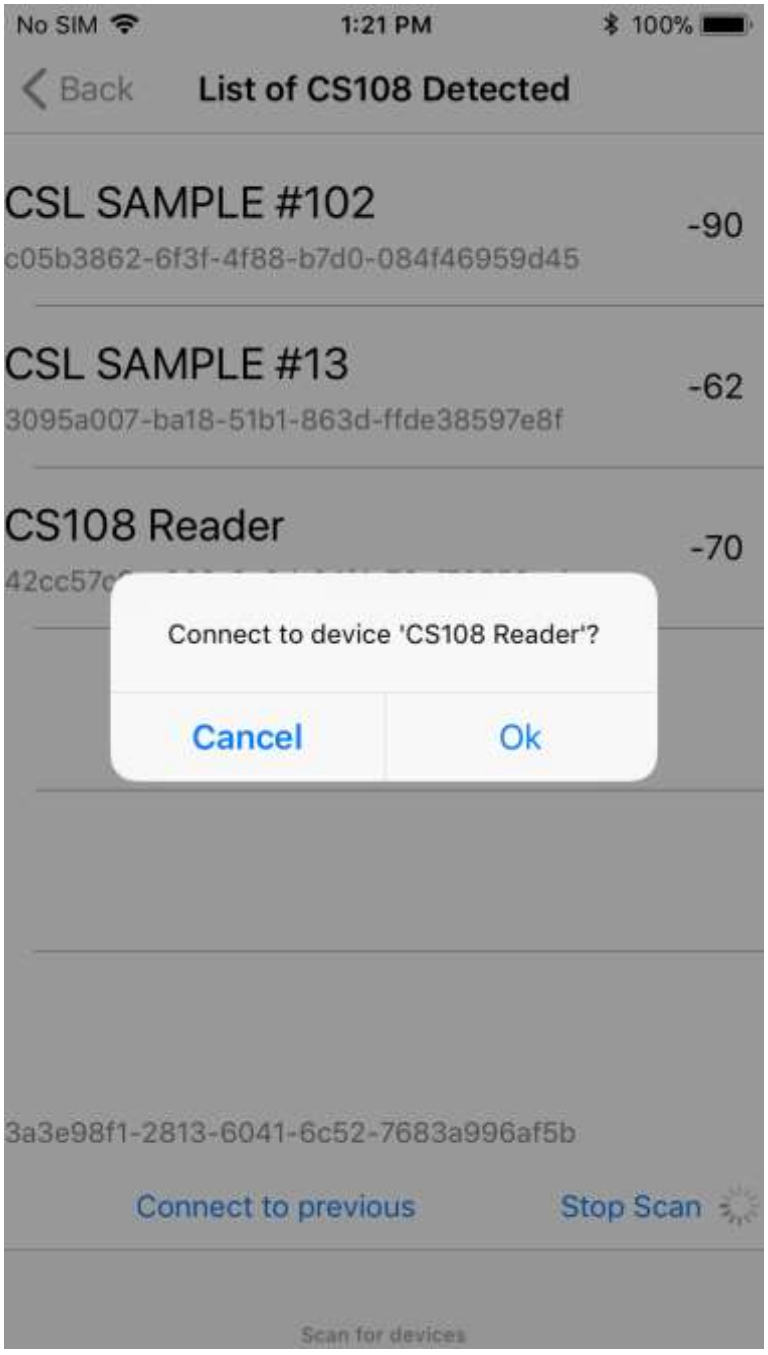


5.1.2.4 Searching and Connecting to CS108 (Pairing)

The search and connect screen will search for CS108s nearby and list them. Please make sure the CS108 Blue LED Bluetooth button is flashing, meaning the CS108 is ready for discovery by the iPhone. **Note: the system Bluetooth device connection is not used to make the CS108 connection on an iPhone OS. The CS108 Application provides this functionality.**

You can refresh the search process by swiping DOWNWARD and then releasing

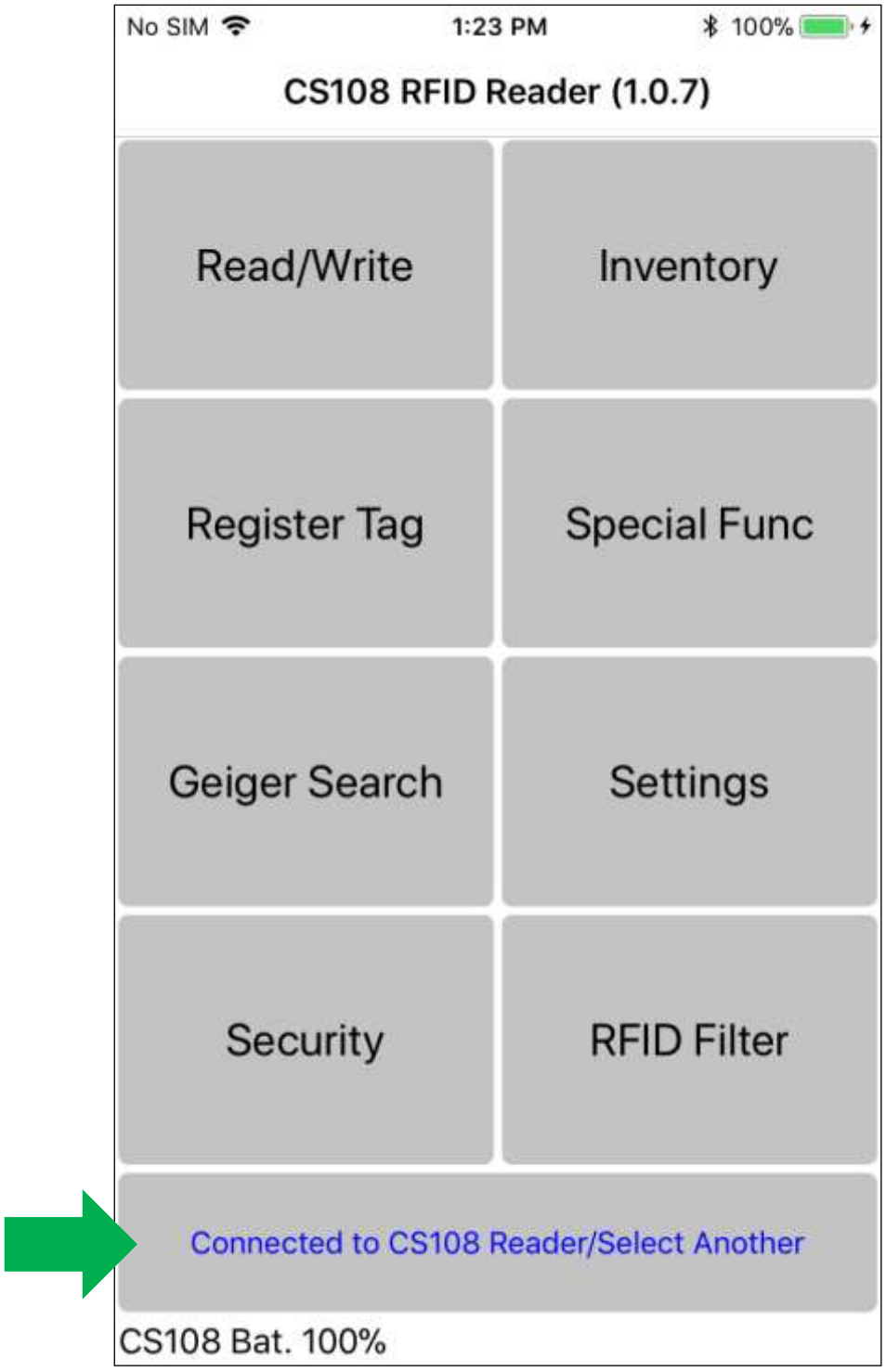
Once you select a particular reader by pressing your finger onto that selection, then a pop up window will ask you if you want to connect to that reader. Press “Ok” to connect.



After that, the software will automatically return to main menu screen of the application.

***Note** the Reader Name is very useful to distinguish between various readers on the screen. To change name, go to Settings > Administration and edit the Reader Name field. For help see section 5.1.2.5 Settings.

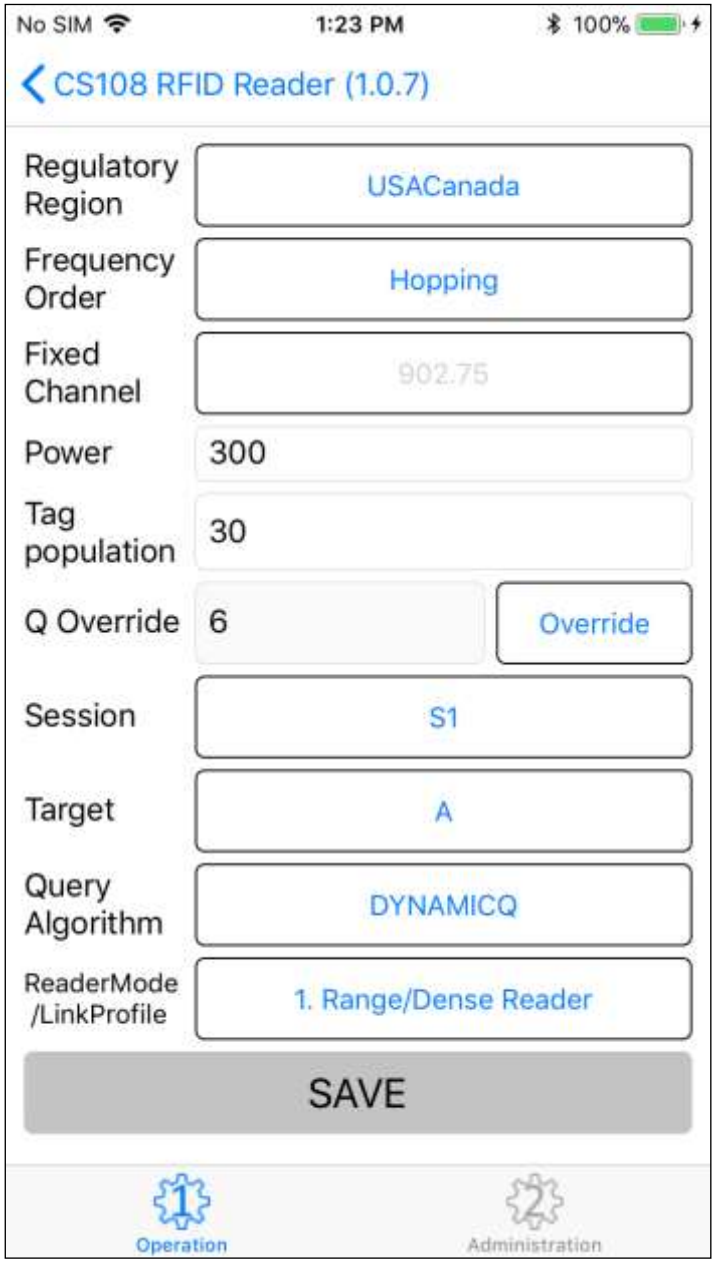
After successfully connecting a CS108, the red text in the connection button will change to blue text and shows the connected reader name.



5.1.2.5 Settings

After connecting, the Settings page allows you to edit the RFID operation parameters and administration parameters.

Operation Settings:

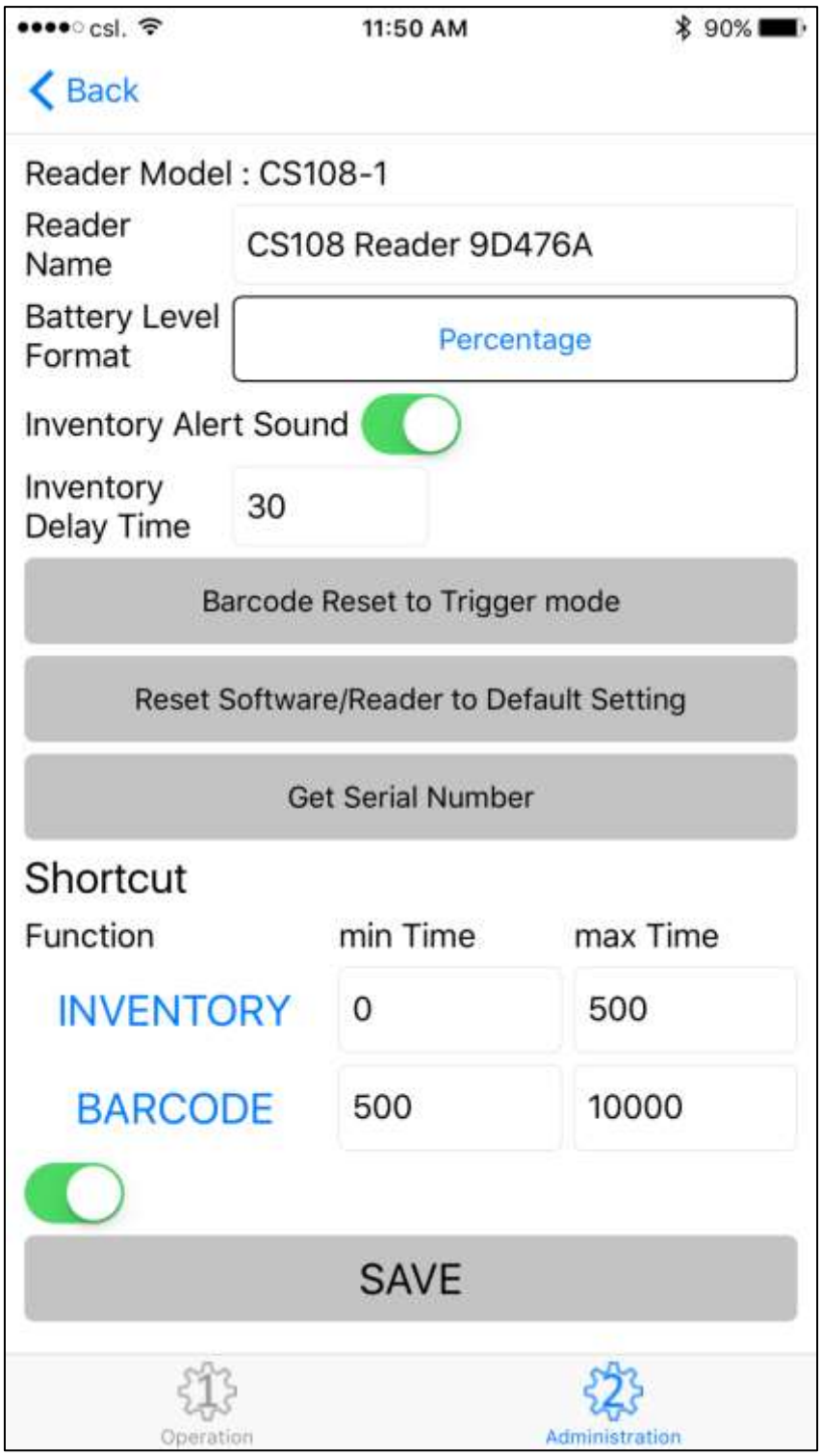


1. Regulatory Region is the specific area/country where the unit is to be used.
2. Frequency Order is how the frequency channels are to be traversed: Hopping, Fixed or Agile.

3. Fixed Channel is the specific frequency channel to be used when Frequency Order is set to Fixed.
4. Power is the conducted power entering the antenna, the value is 10 times the dBm value desired. For example, 300 means 30 dBm. i.e. (300/10) dBm.
5. Tag Population is the approximate number of tags to be typically inventoried.
6. The Q Override value is automatically set when you enter the Tag Population value. This value can be overwritten by pressing the "Override" button and editing the Q value. To return to the default value, press 'Reset' Appendix D describes this in detail.
7. Session is the EPC defined session for querying the tags. For detailed explanations of Session please refer to Appendix C.
8. Target is the EPC defined query target of the tag status flag, A, B, or A/B Toggle. For a detailed explanation of Target. Please refer to Appendix F
9. Query Algorithm is either DynamicQ or FixedQ. A detailed explanation is found in Appendix E.
10. Reader Mode or Link Profile is either 0, 1, 2, or 3. Detailed explanation is found in Appendix B.

After changing parameters, press "SAVE" button. A beep will confirm the successful save.

Administration Settings:



1. Reader Model is the model of the reader, for example, CS108-1 for 865-868 MHz band or CS108-2 for 902-928MHz
2. Reader Name is an editable name for the reader. You can change the name of the reader for

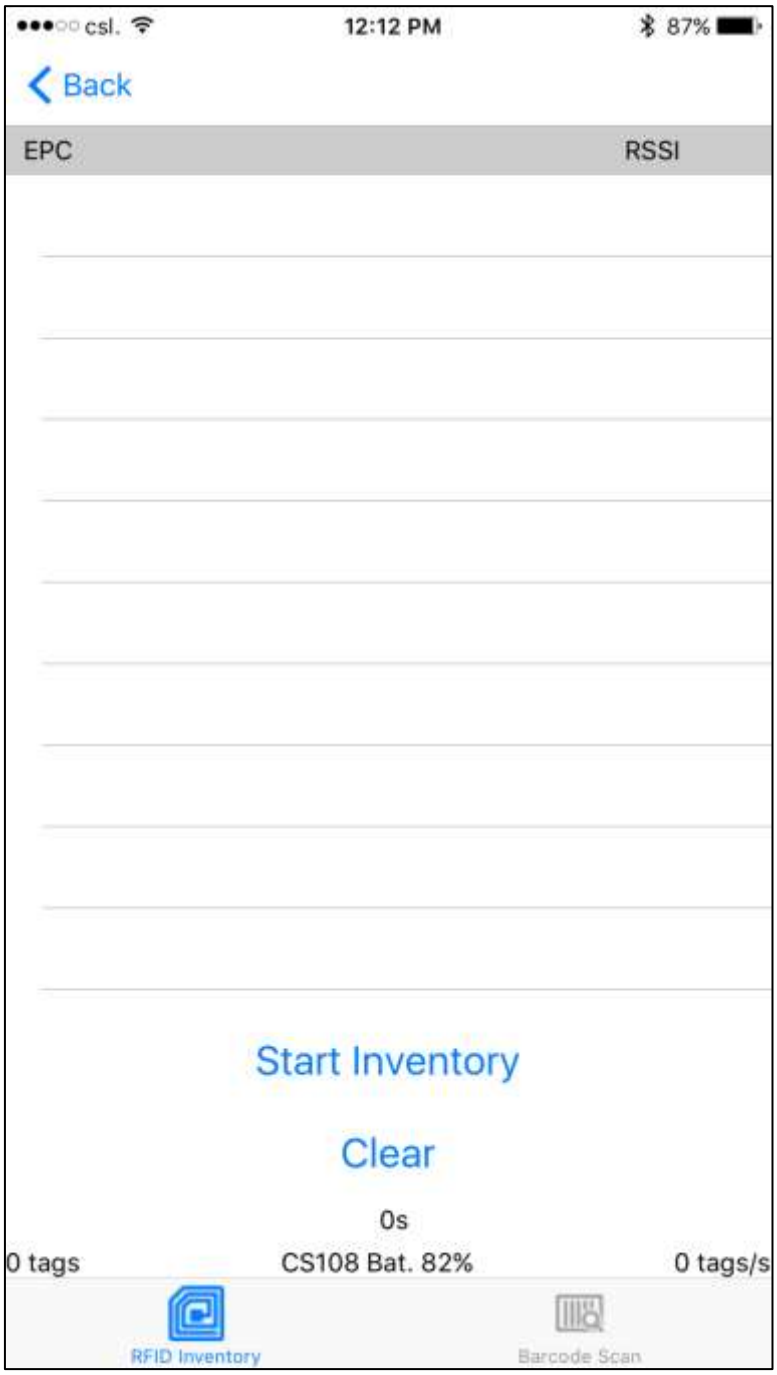
easier management at sites where you have multiple CS108 units. After the name is changed, you need to power off and power on the CS108 for the name to be effective.

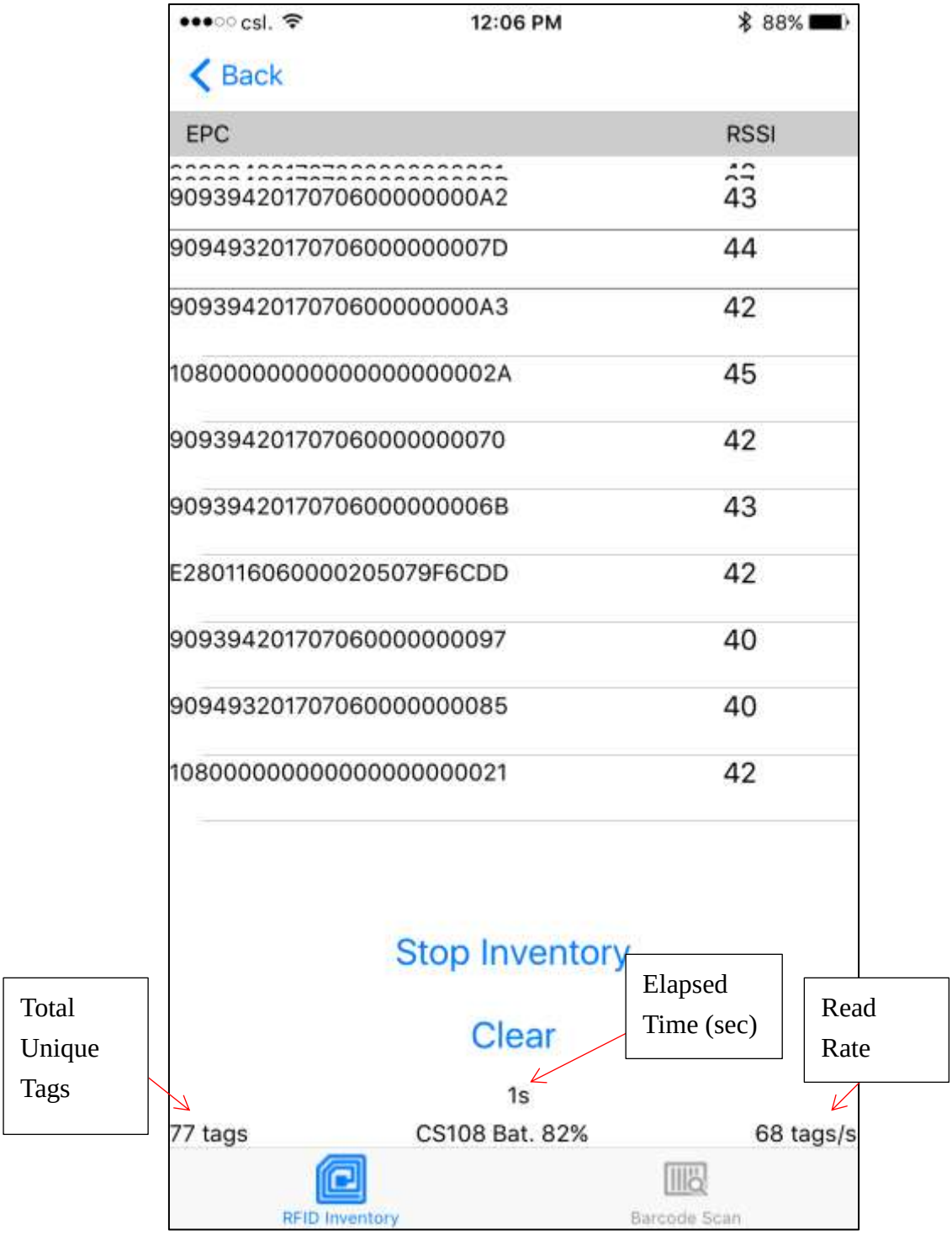
3. Battery Level Format defines how you want to view the battery level, either in absolute voltage or in percentage.
4. Inventory Alert Sound enables or disables the sound during inventory. During inventory, there are 2 different pitches of sound: high pitch means a new unique tag has been read. Low pitch means a tag that has been read before has been read again. Also, the rate of beeping is proportional to the rate of tag reads received.
5. Inventory Delay Time is an internal data control. Do not change.
6. Barcode Reset to Continuous Mode is a special function button to reset the barcode to continuous mode. This button may need to be pressed after firmware upgrades and is an artifact of this being Demo software for both users and developers. If the barcode has been inadvertently set to trigger mode, this button resets it.
7. Reset Software/Reader to Default Setting is a special function button to reset the configuration setting to the default values.
8. Get Serial Number gets the Product Serial Number. It is also on the paper label on the back of the reader.
9. Shortcut defines the short cut sled trigger timing. The values are in msec. This is short cut method to select either RFID inventory or barcode reader. When the user is in the main page already, then this short cut trigger control will work. In this default setting, if the user continuously presses the trigger for 0 to 500 msec and then releases it, he will jump to the RFID inventory page. If he keeps on pressing the trigger past 500 msec and releases it before 10,000 msec (10 seconds), then he will jump to the barcode reading page. The Min and Max value ranges are 0 and 30,000 msec (30 seconds).
10. The Save Button MUST be pressed to make value changes effective.

5.1.2.6 RFID Inventory

From the Main Menu press the Inventory button to go to the demo Inventory screen. At the bottom of the screen you can select RFID Inventory or Barcode Scan,

RFID Inventory is the default. Press the sled trigger or press Start on the application screen. The RFID tags read will be displayed as shown in the second image below.





A high frequency tone will be heard when a new RFID tag is read and a low frequency tone will be heard when a tag is read again. NOTE: Make sure the sound part of the iPhone is not muted and the volume is not set too low.

A summary of tags read appears at the bottom of the screen: Total Unique Tags, Read Rate, and Elapse Time.

If you stop inventory and start again, the previous list will remain and new tags are added to it at the top. If you want to start a new list, then you can press the Clear button to clear the list.

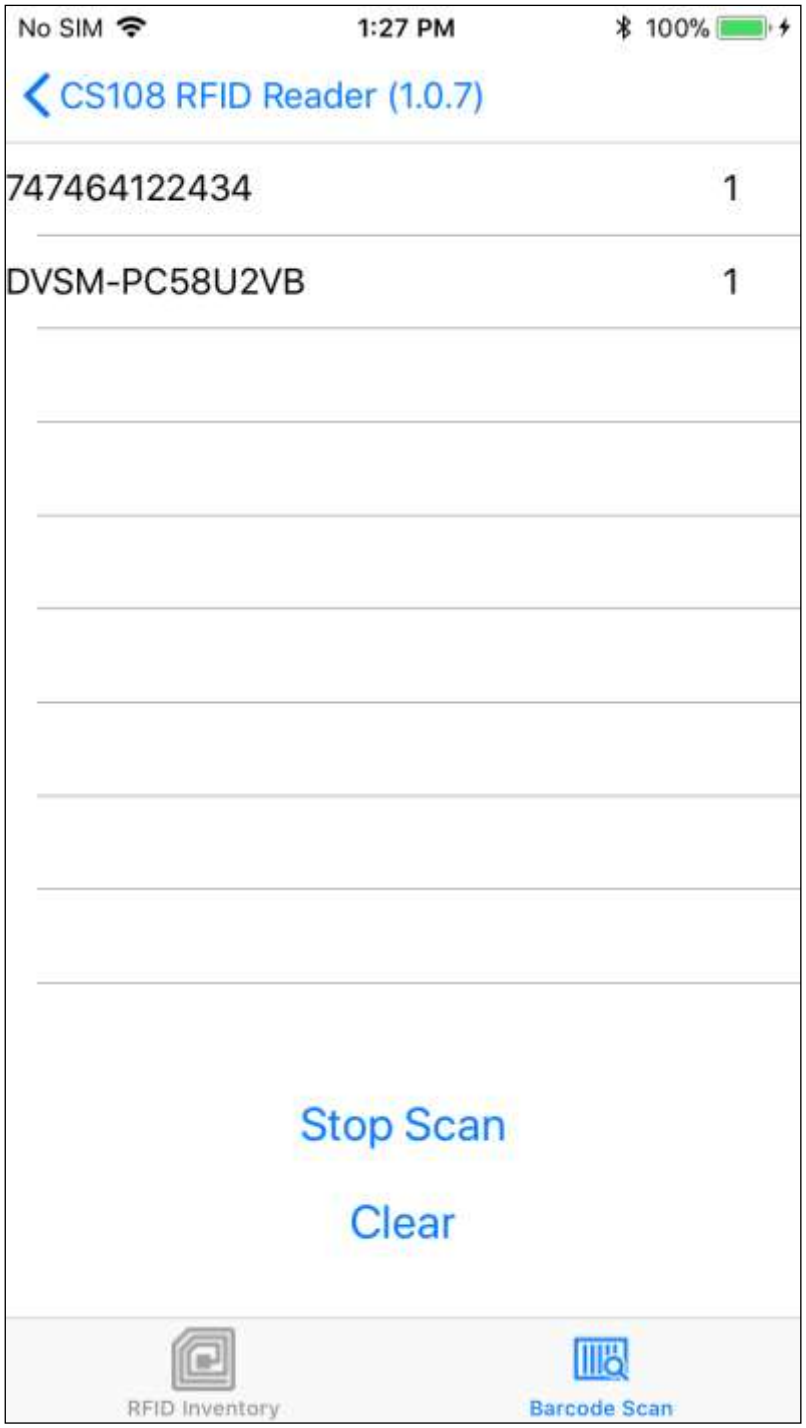
5.1.2.7 Barcode Inventory

To inventory Barcodes, select Barcode Scan at the bottom of the screen.

Pull the sled trigger or press Start on the application screen to activate the scanner.

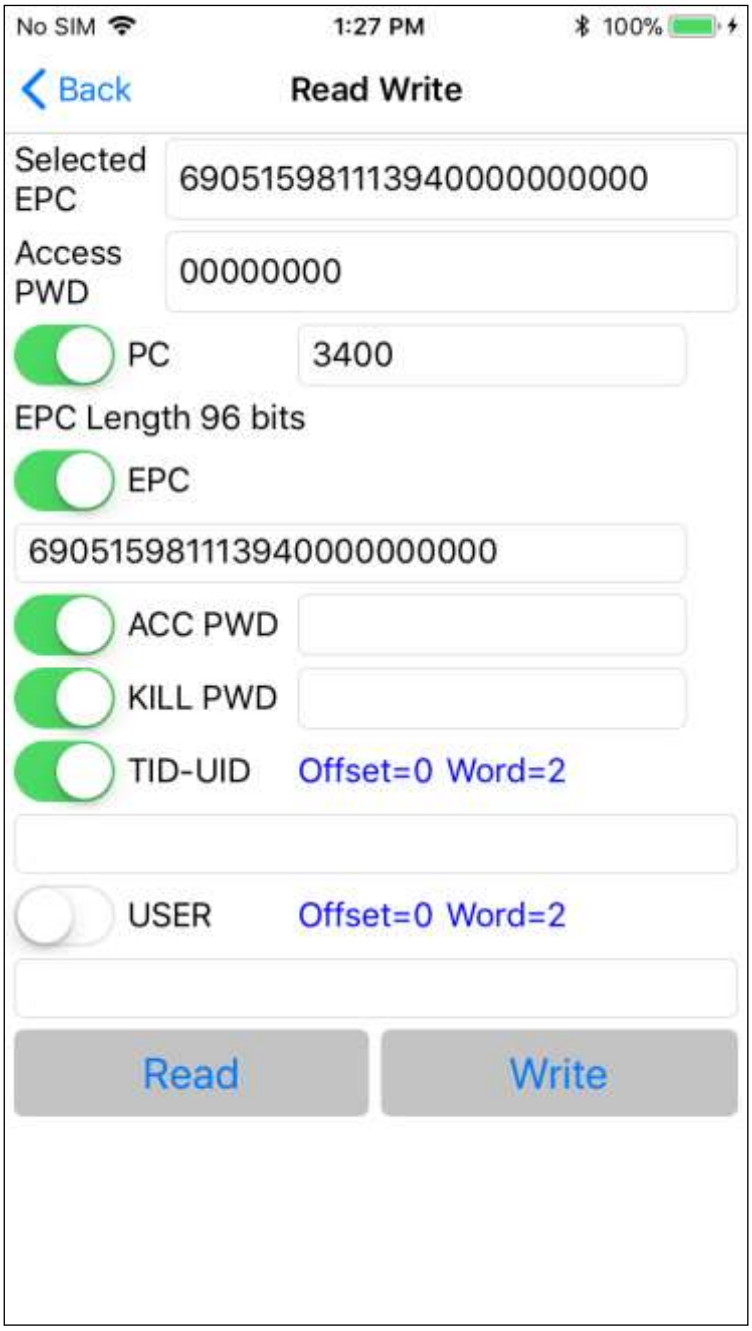
There is a registration/target dot to aim the scanner. A high tone will be heard when a new Barcode is scanned and a low tone will be heard when a barcode is read again.

Previous scans can be cleared by pressing the Clear text button on the screen.

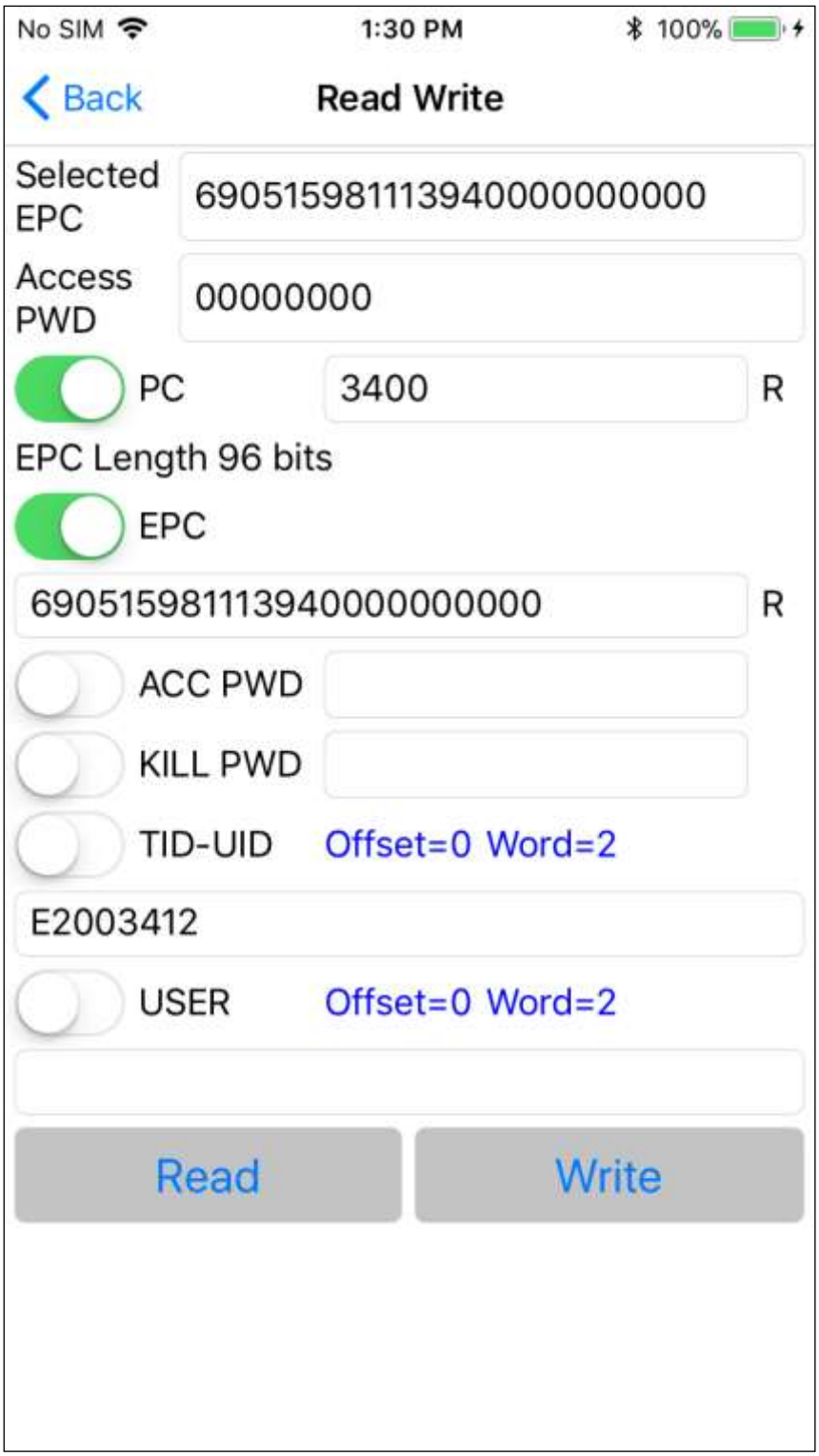


5.1.2.8 RFID Read and Write memory banks

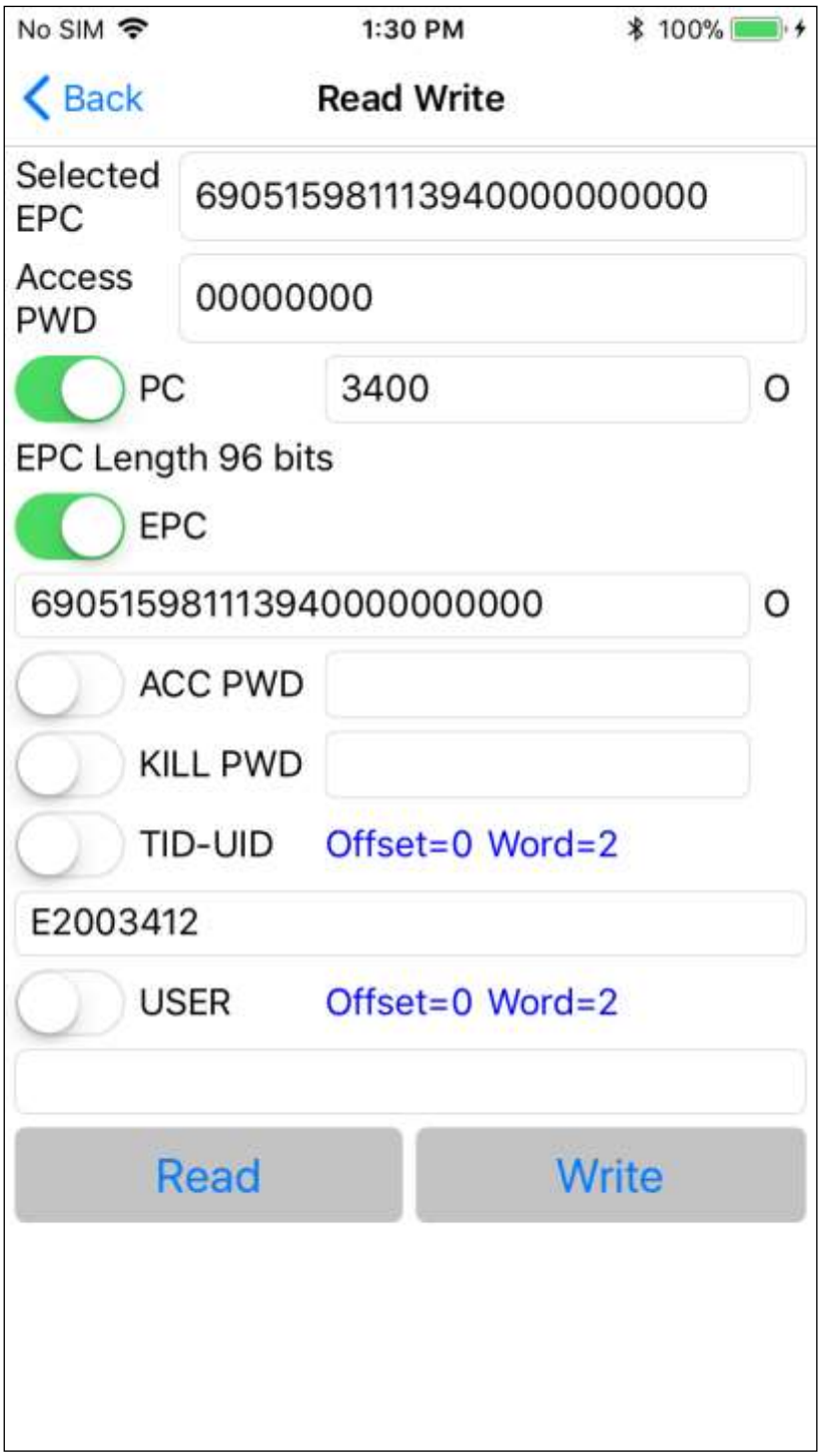
The Read / Write functions allows read/write of specific memory bank inside an RFID tag. You should be knowledgeable about these functions prior to using them.

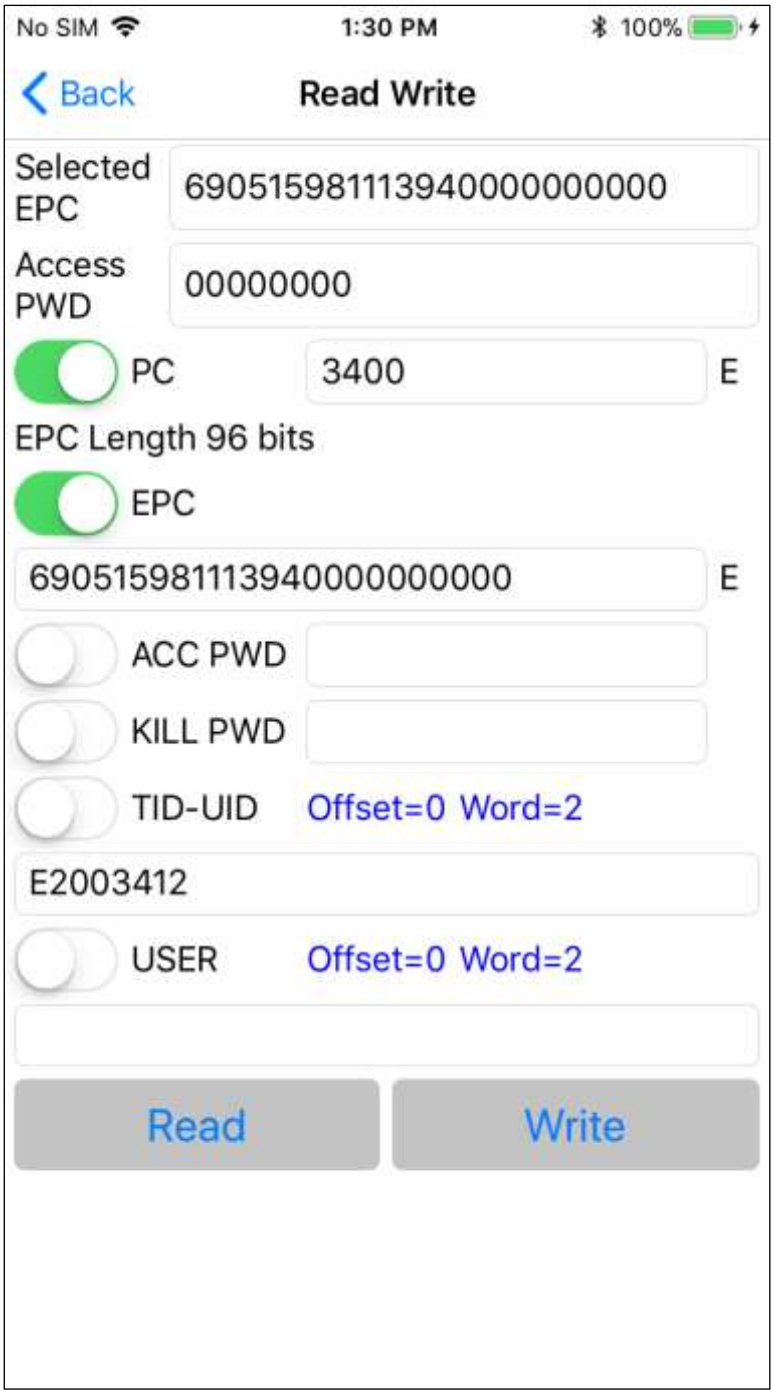


When reading and writing, the status character "R"eading or "W"riting will be displayed on the right hand side of the screen.



At the end of the operation, you can see result "O"K or "E"rror on the right hand side:

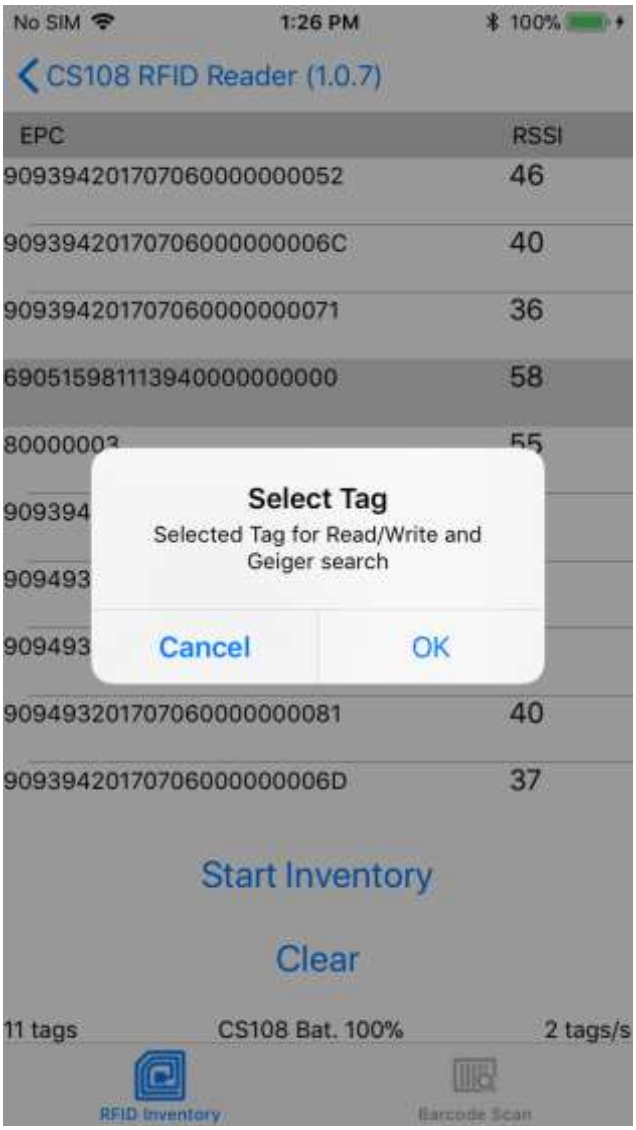




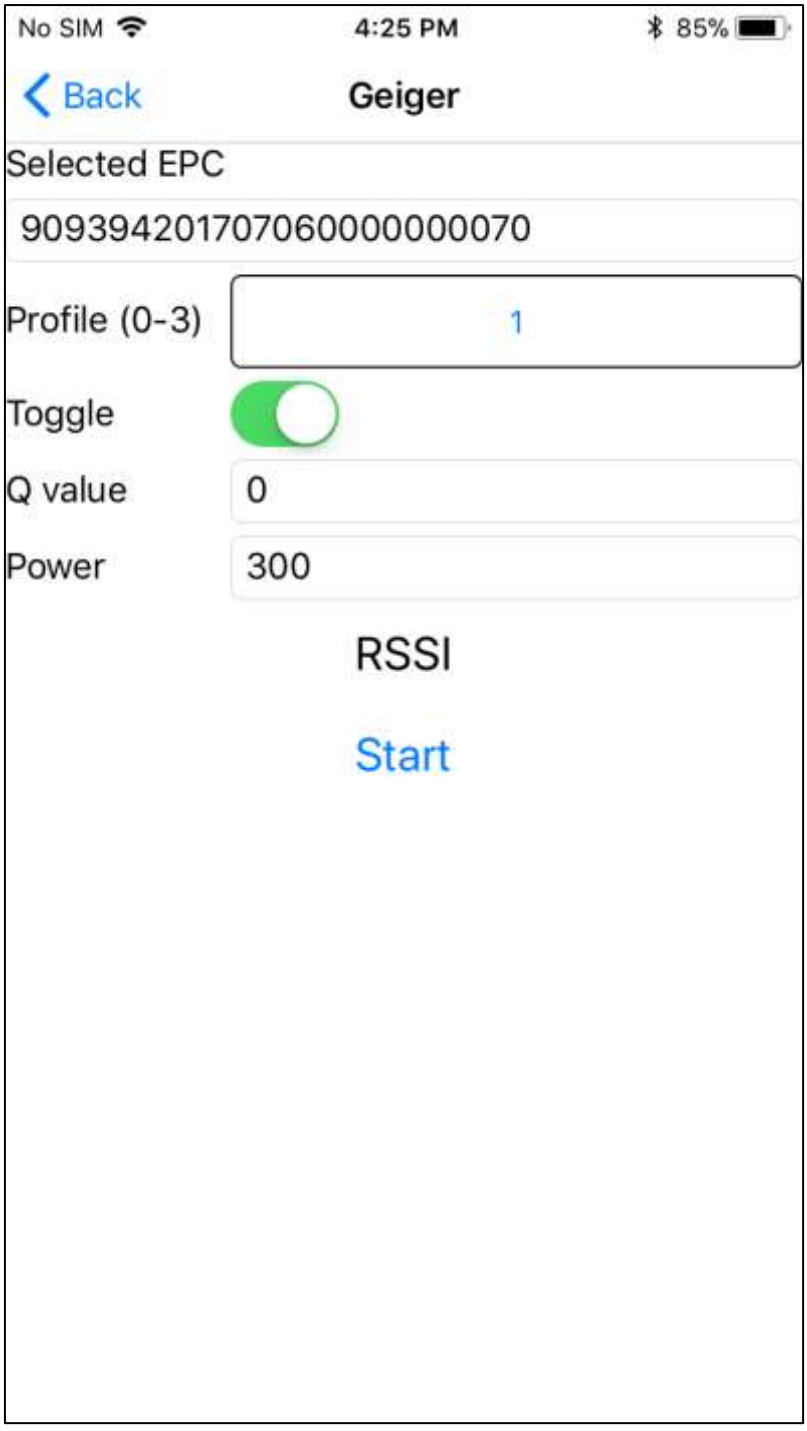
5.1.2.9 Geiger Search

The Geiger Search function enables ‘searching for’ and ‘homing in on’ a tag. .

First, go to the Inventory page and inventory the tag, then select that tag. A pop up window asks if you want to select that tag for subsequent Read/Write operation or Geiger Search operation. Press OK.



Now return to Main Menu (Swipe from left) and then enter the Geiger Search menu. The tag ID will already be displayed. Press Start to begin Geiger Search.



You can also directly type in the tag ID into the Selected EPC box.

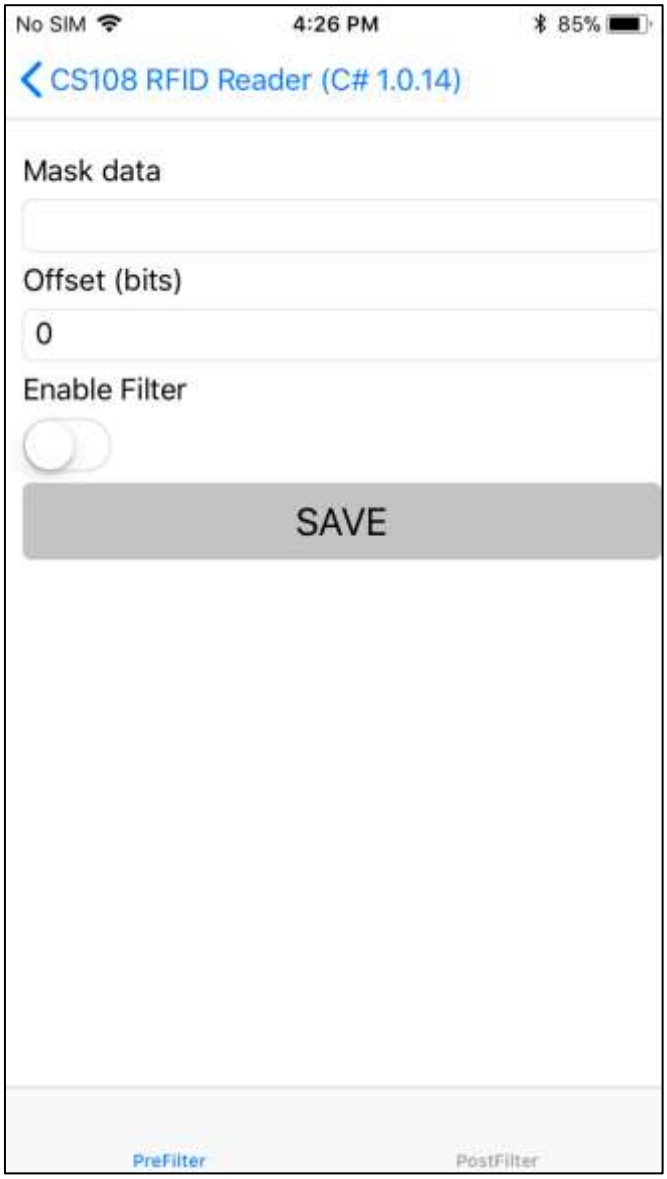
After pressing the “Start” button, you can see the RSSI and hear an audible beep when the tag is within range. The beep will become faster as you get closer to the tag. When you are very close to the tag, the beep becomes very long.

Press ‘Stop’ to exit the Geiger Counter function.

5.1.2.10 RFID Filter: Pre Filter

The RFID Filter function includes 2 types of filter: pre-filter and post-filter. When you enter the Filter page, on the bottom you can choose to enable either the pre-filter or the post-filter, or both together.

Pre-filter creates a pre-filter Tag Pattern that will be used to “select” the tags that you want to display in the Inventory page. The tag pattern can be offset and doesn’t need to be from the beginning of the EPC bank. The default offset is 0, edit the value in the field. After completing all fields, set the Enable switch and press the SAVE button.



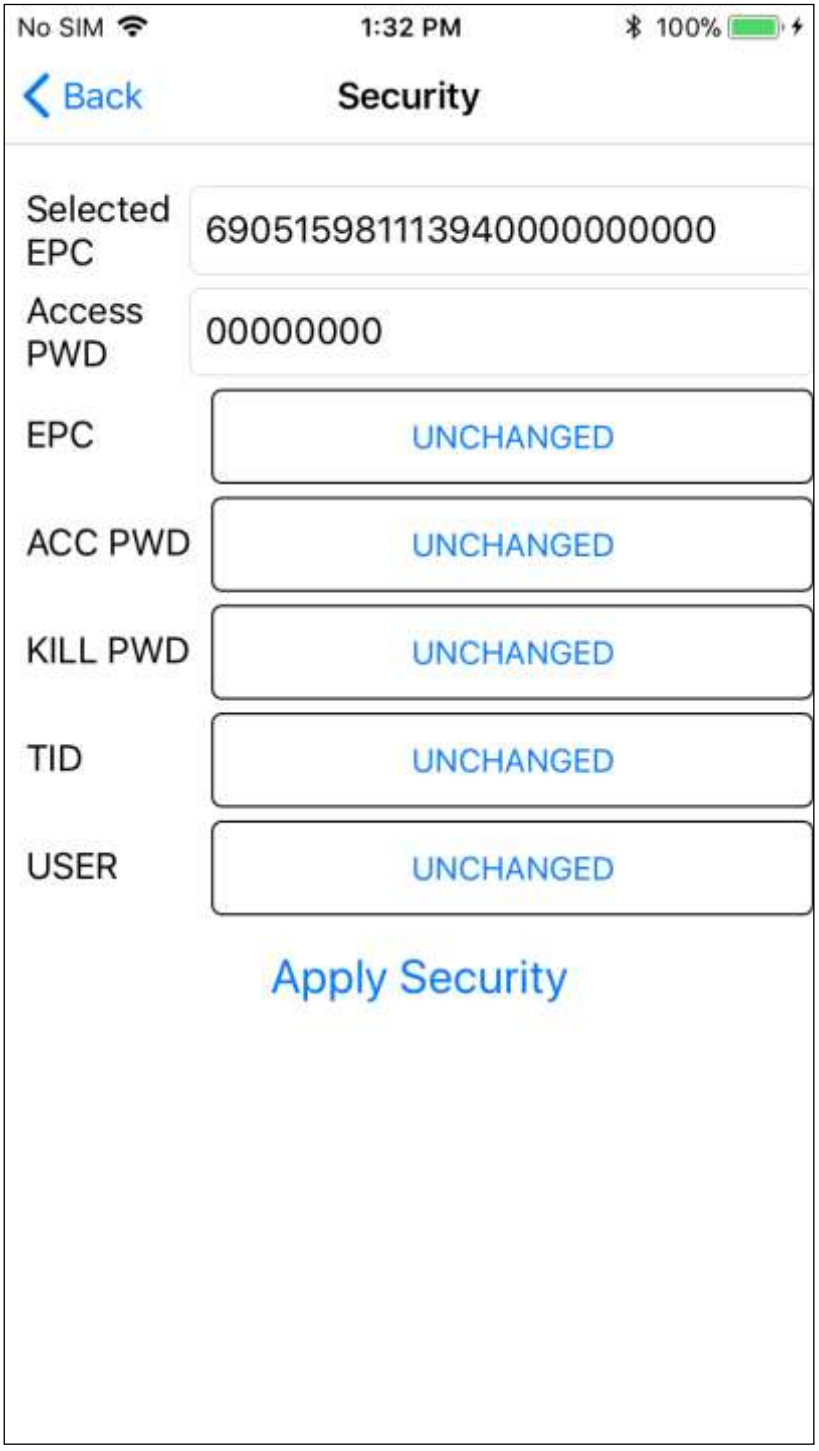
5.1.2.11 RFID Filter: Post Filter

Post Filter contains parameters for filtering AFTER the tags are inventoried by the reader:

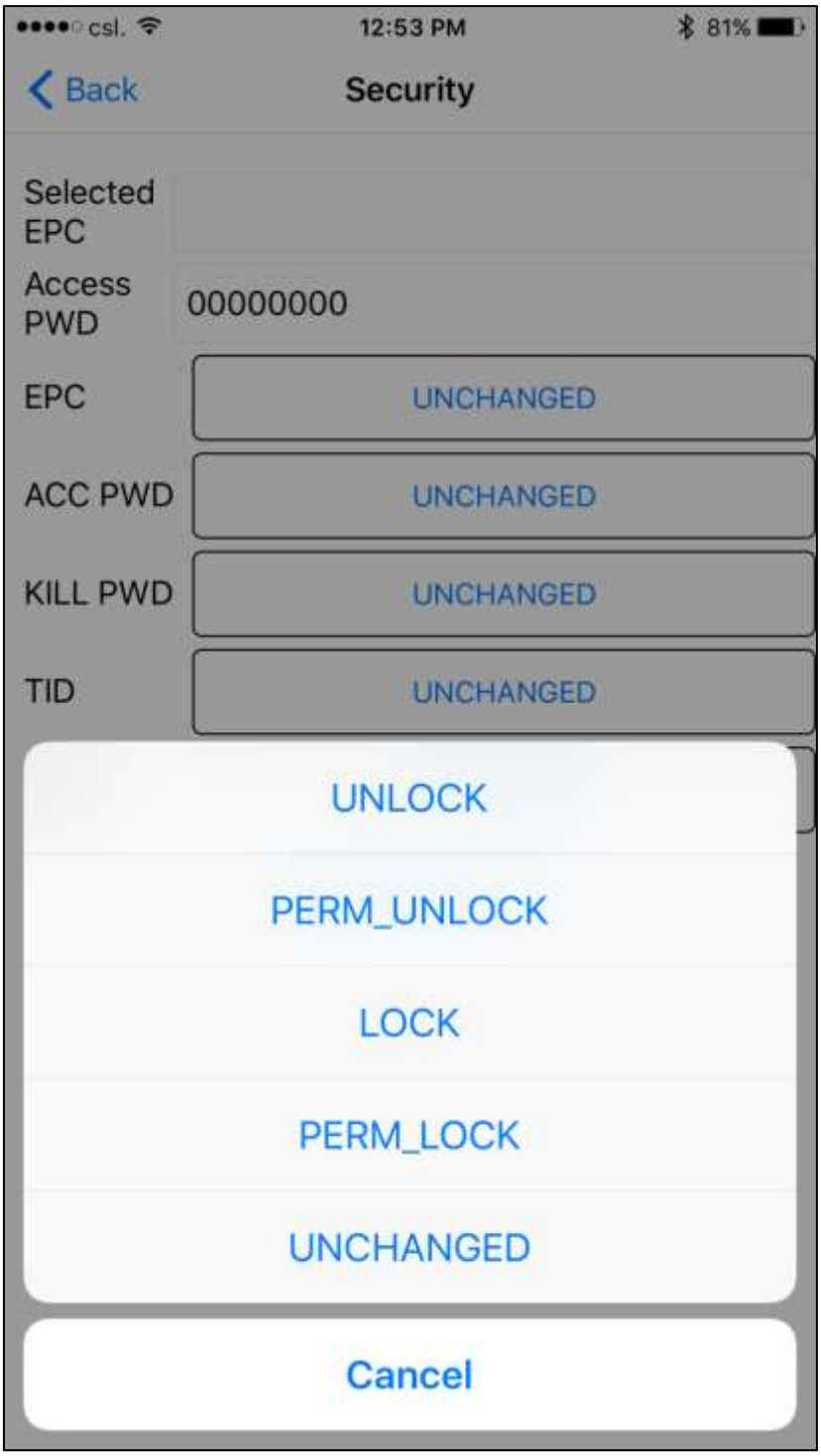
It is possible to implement both the pre-filter and post-filter functions together.

5.1.2.12 Security

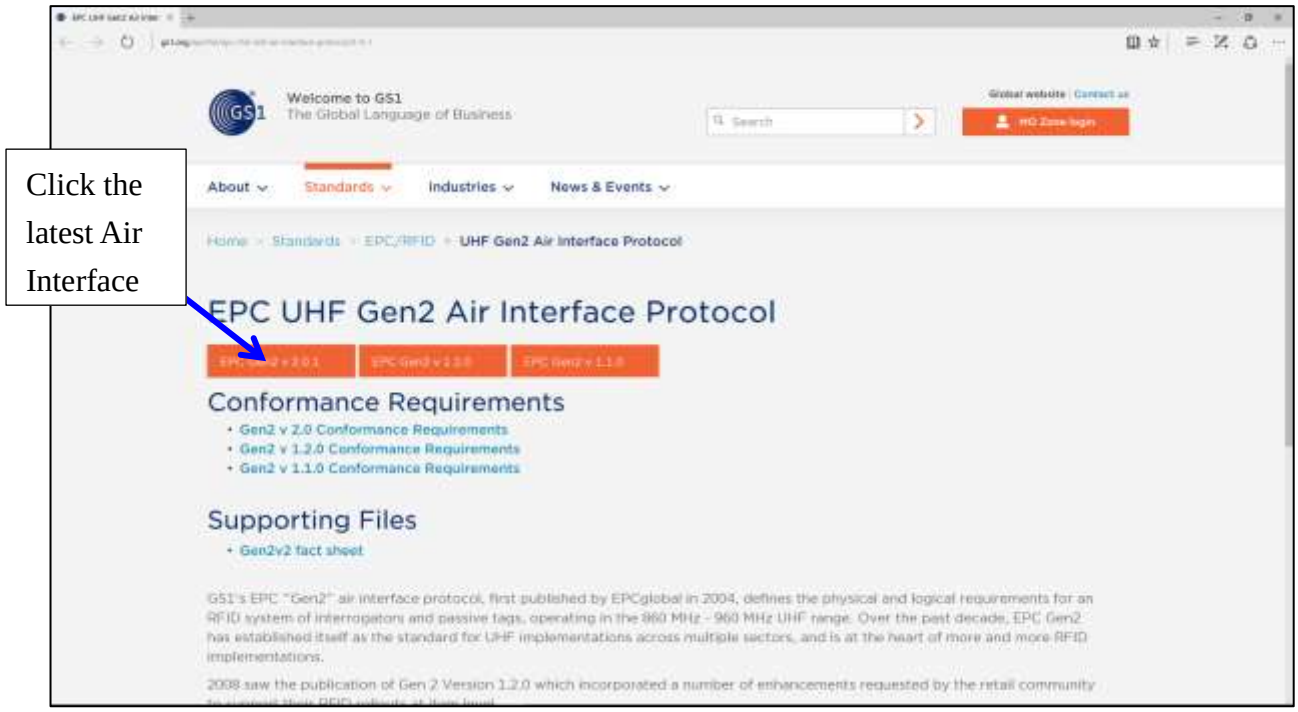
Security involves implementing memory lock on certain banks of the tag. You need to be careful administrating a lock function to a tag. If you lock a memory bank and forget the password to unlock it, then the specific part of the memory cannot be read or written anymore.

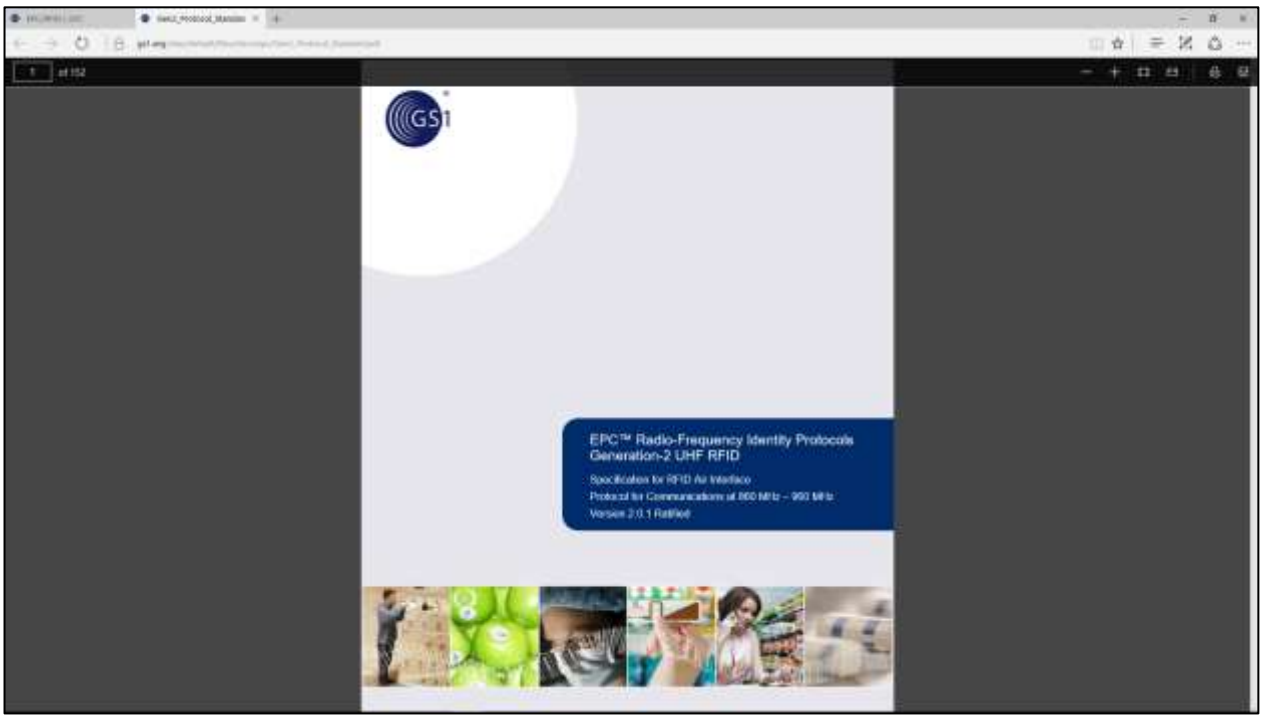


Touching the select box with the “UNCHANGED” text will display 5 choices on the screen: UNLOCK, PERM_UNLOCK, LOCK, PERM_LOCK, UNCHANGED. These are the 5 actions you can choose for each of the memory banks inside the RFID tag.

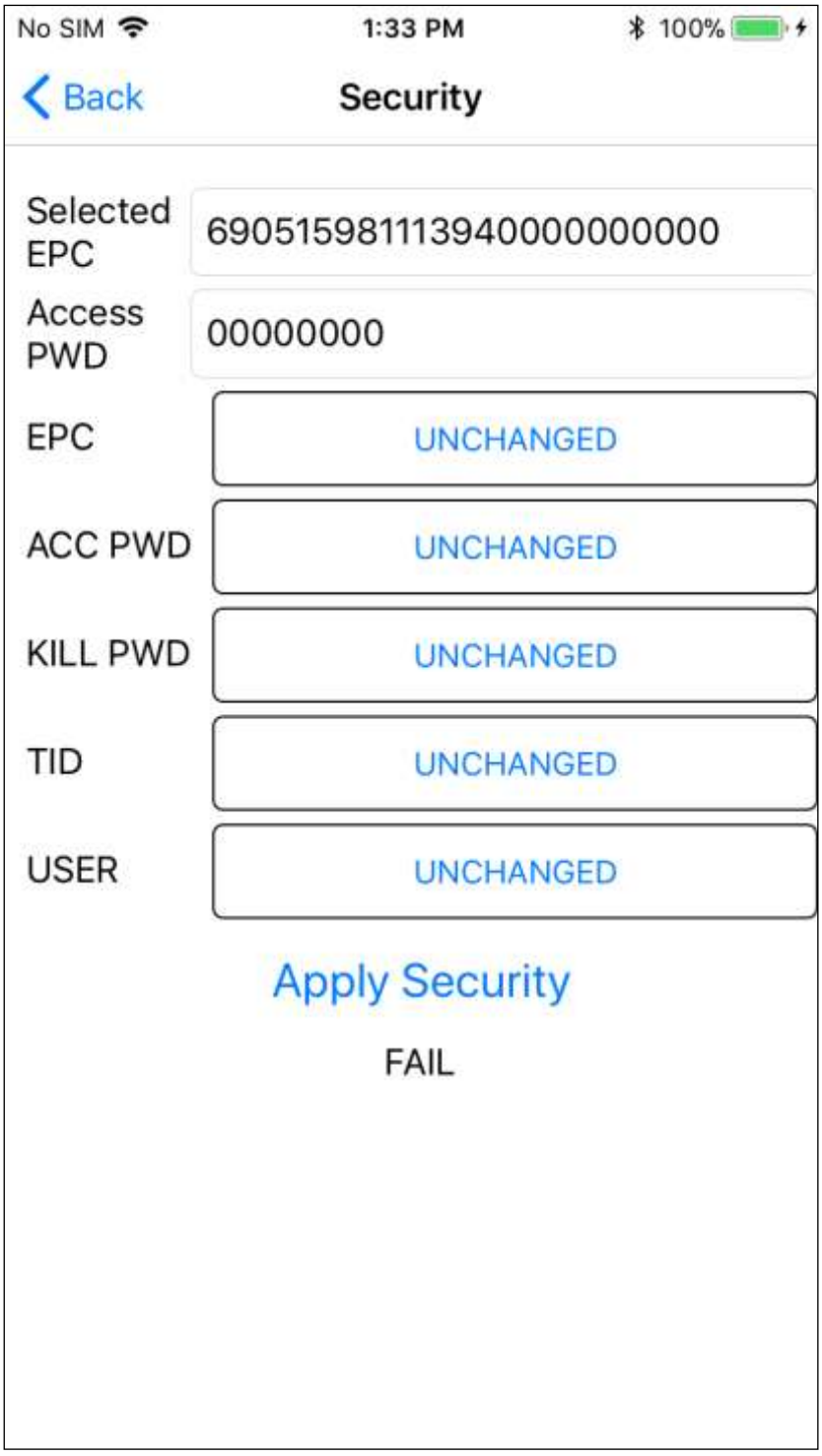


You can lock, unlock, permanently lock, and permanently unlock a memory bank of the tag. The detailed definitions of these 4 operations can be found in the EPC Global document which can be found on the EPC Global website: https://www.gs1.org/epcrfid/epc-rfid-uhf-air-interface-protocol/2-0-1. Once there, press the button showing the latest air interface protocol and ~~mouse~~ click to get the pdf file. More details can be found on Appendix G.





After Applying the changes the resulting Success or Fail message will be displayed on the bottom of the screen.

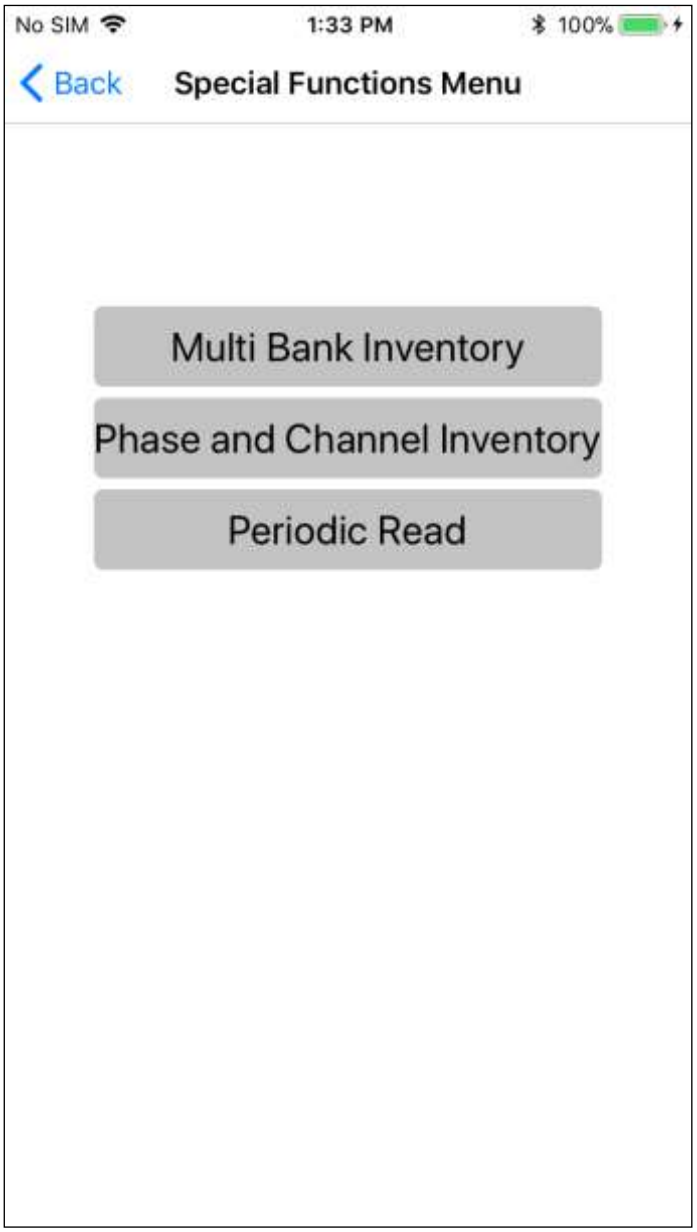


5.1.2.13 Register Tags

Register Tag is a section of the CS108 Demo Application page allowing the user to scan a barcode, and then write that information into a specific memory bank of an RFID tag. That information is often saved in a certain section of the EPC memory bank, or in the USER memory bank. This section allows you to select which memory bank and which offset location to write that information to. Moreover, it allows you to set a tag mask so that it would only write to tags with a certain tag pattern.

5.1.2.14 Special Functions

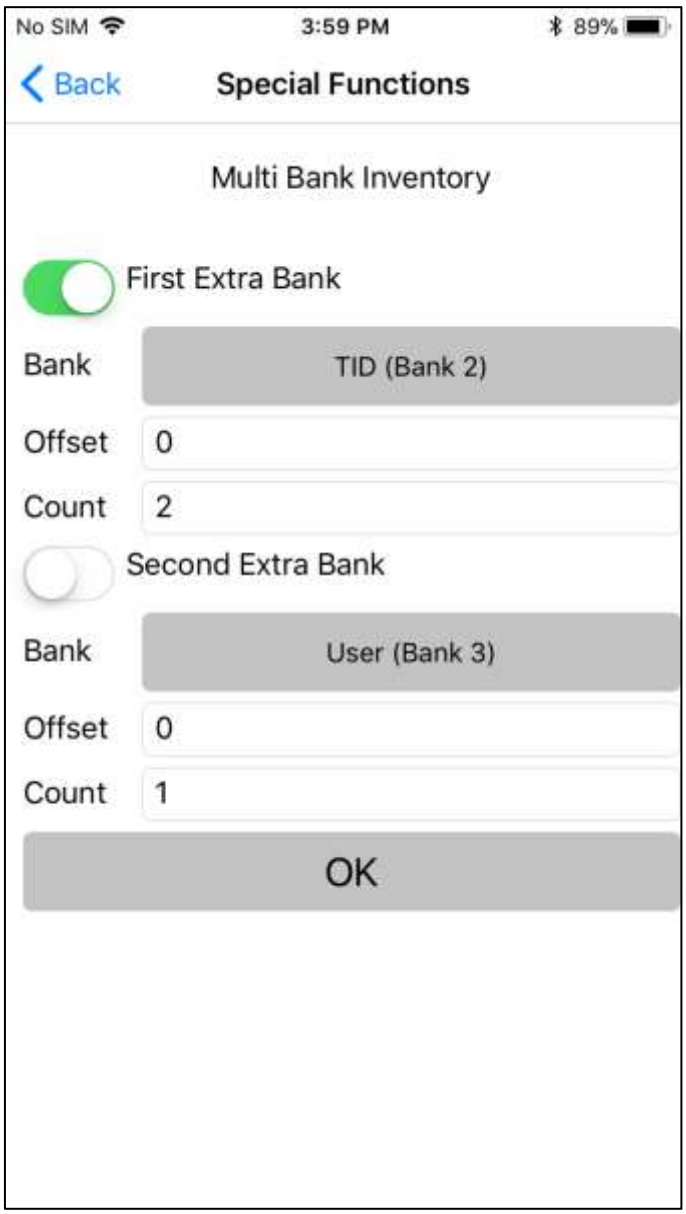
Special functions for specific application scenarios are provided in this page. Three special functions are available at this time. More will be added in the future.

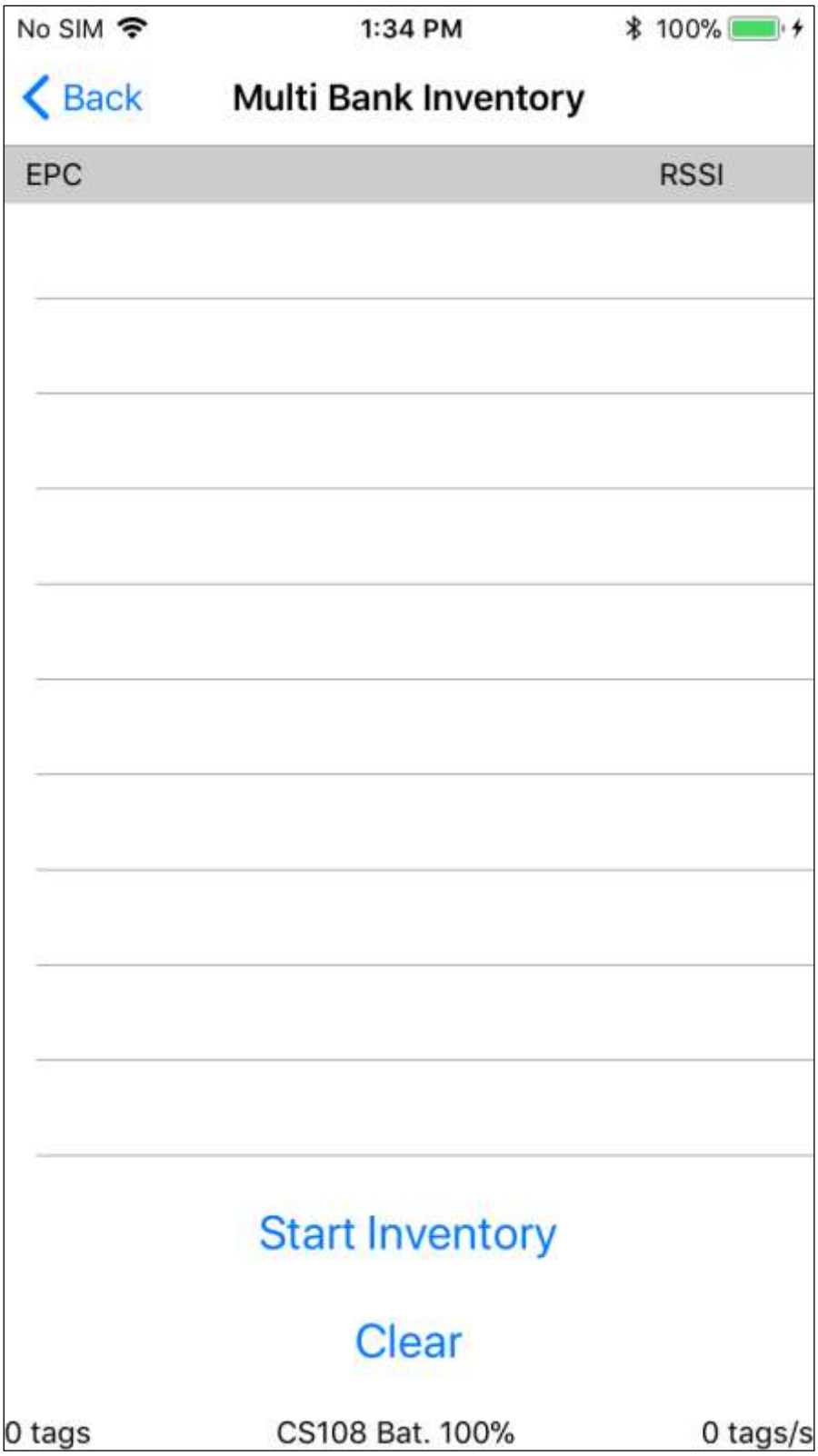


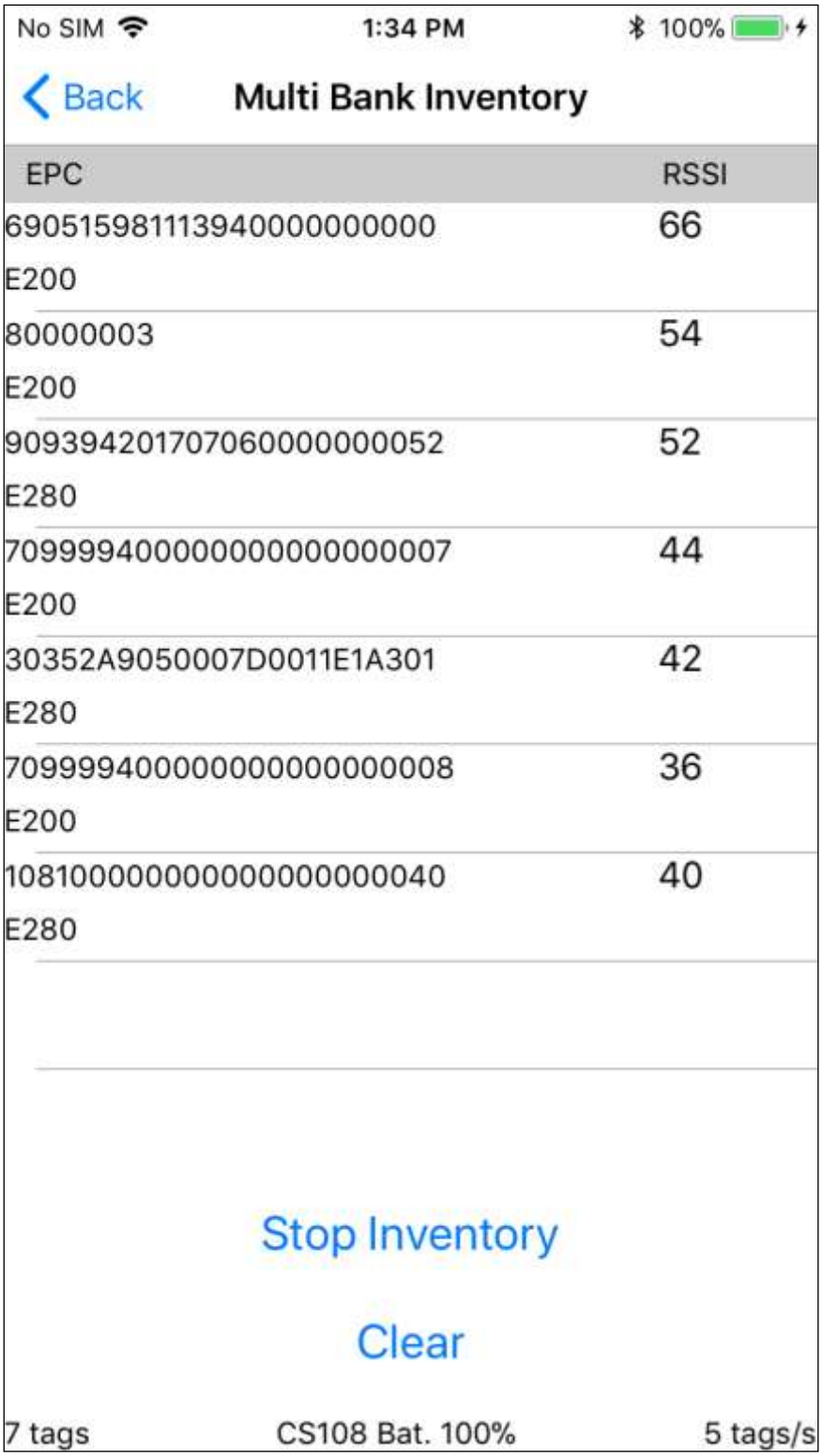
5.1.2.15 Multi Bank Inventory

This is a special feature. You can inventory one or two additional banks in inventory, as well as the EPC data.

Select the bank, offset and count (in words: 1 word is 2 bytes; 1 byte is 8 bits; 1 byte can be represented by 2 hex numbers) that you want displayed in the inventory.

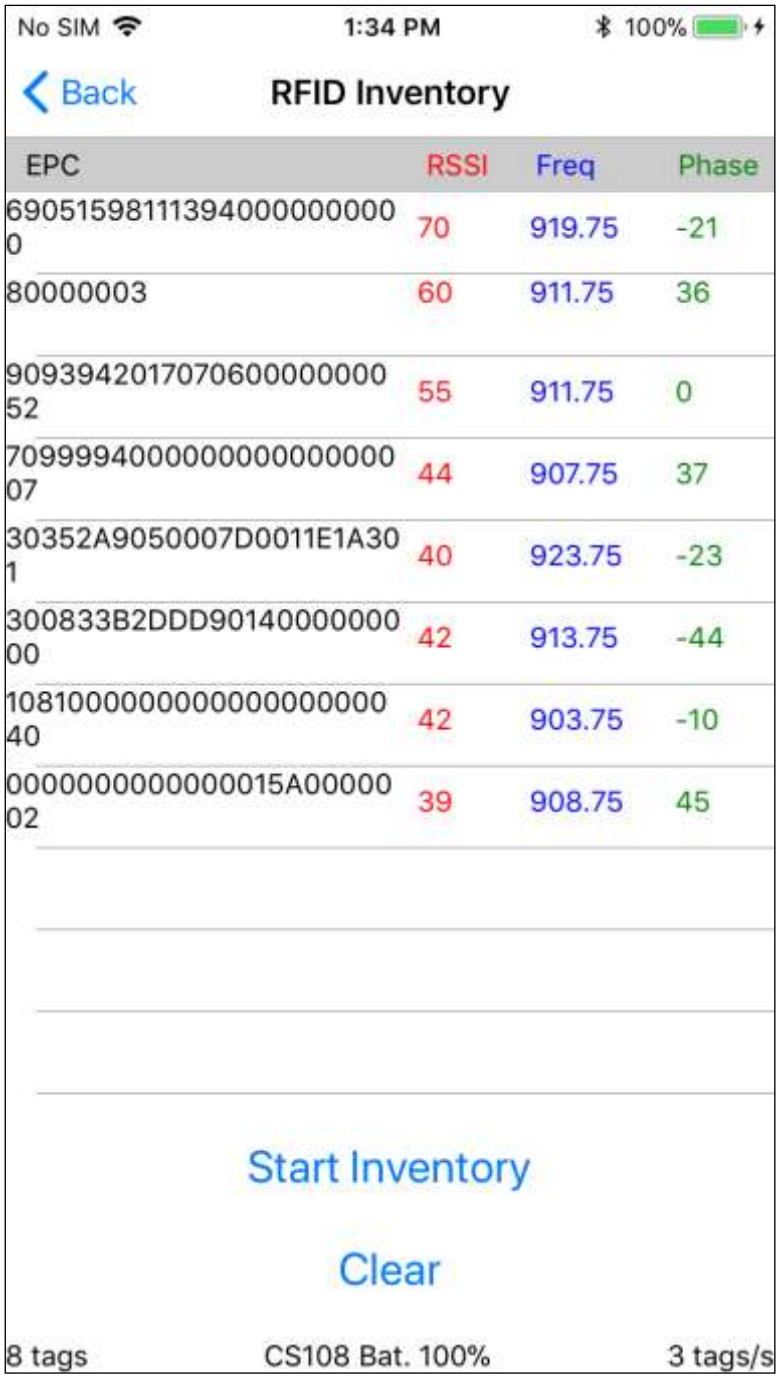






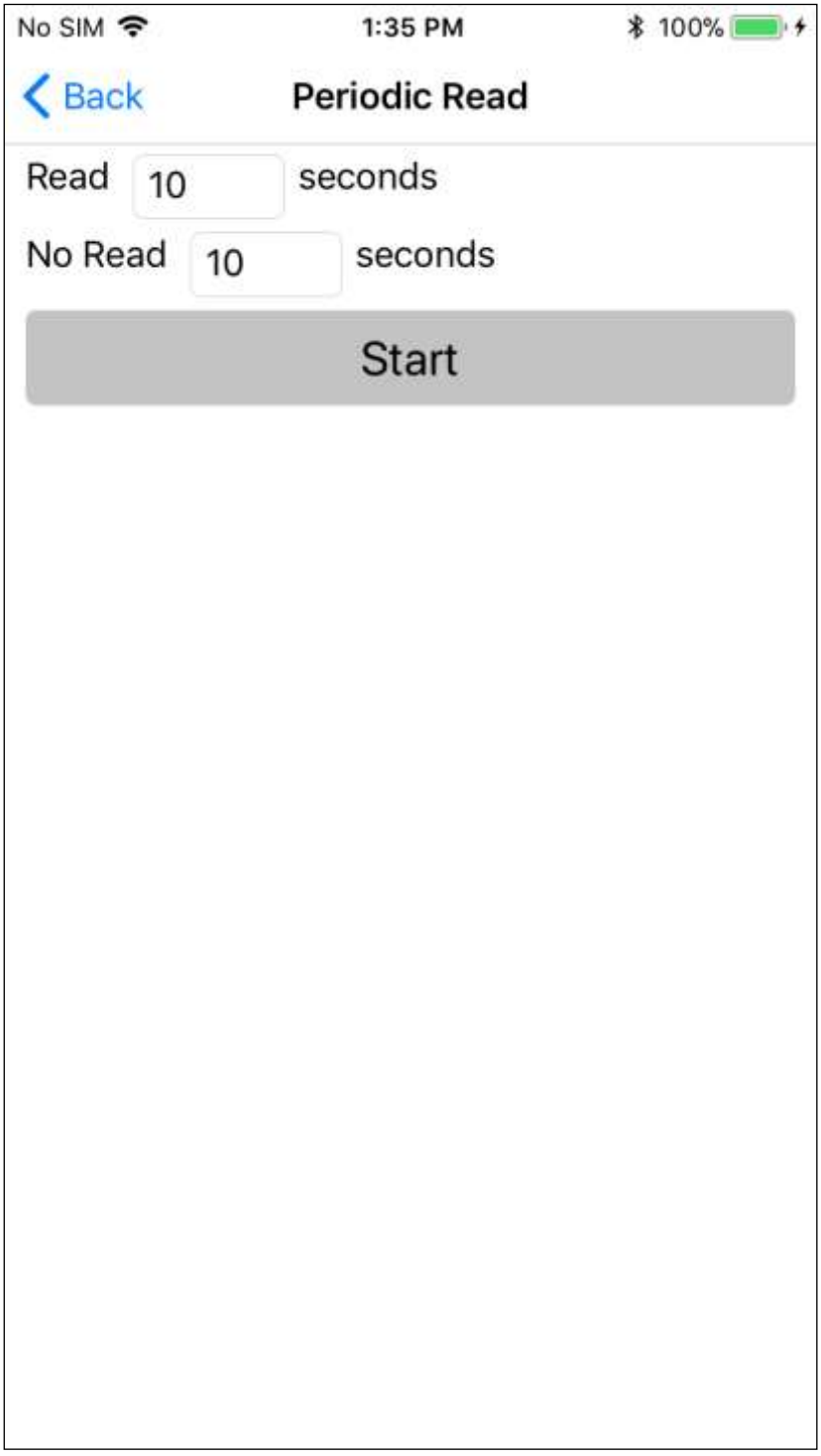
5.1.2.16 Phase and Channel Inventory

The page shows the inventory with RSSI, operation frequency and phase data.



5.1.2.17 Periodic Read

In some business scenarios, you do not do continuous reading but instead do a periodic reading of tags. You can set the read time and waiting time (no read). The Program will show you the battery level and tag rate per cycle.



5.1.2.18 Exiting the Software

The user can exit the software by simply pressing the Home button. However, this is only sending the App to the background. See the next section on how to exit the application.

5.1.2.19 Truly Exiting the Software

On the iPhone OS, when you press the iPhone Home button, the Application is not really closed, only moved into the background.
To fully exit the software, double click the Home button, and then the CS108 demo App will show as one of the Applications in the background, select the CS108 App and then use a finger to drag/swipe it upward and out of the phone to truly exit the software.

5.1.2.20 Source Codes

Source code for this demo application, other files and documents are available on Convergence Systems Limited website:

http://www.convergence.com.hk/downloads-support-2/cs108/

5.2 Software on a PC – connecting via USB

The CS108 can also be controlled via the USB cable. In this case the mobile phone is not required and Bluetooth is not turned on.

Below is the screen capture of an application on a PC controlling CS108. Everything is self-explanatory in the application:

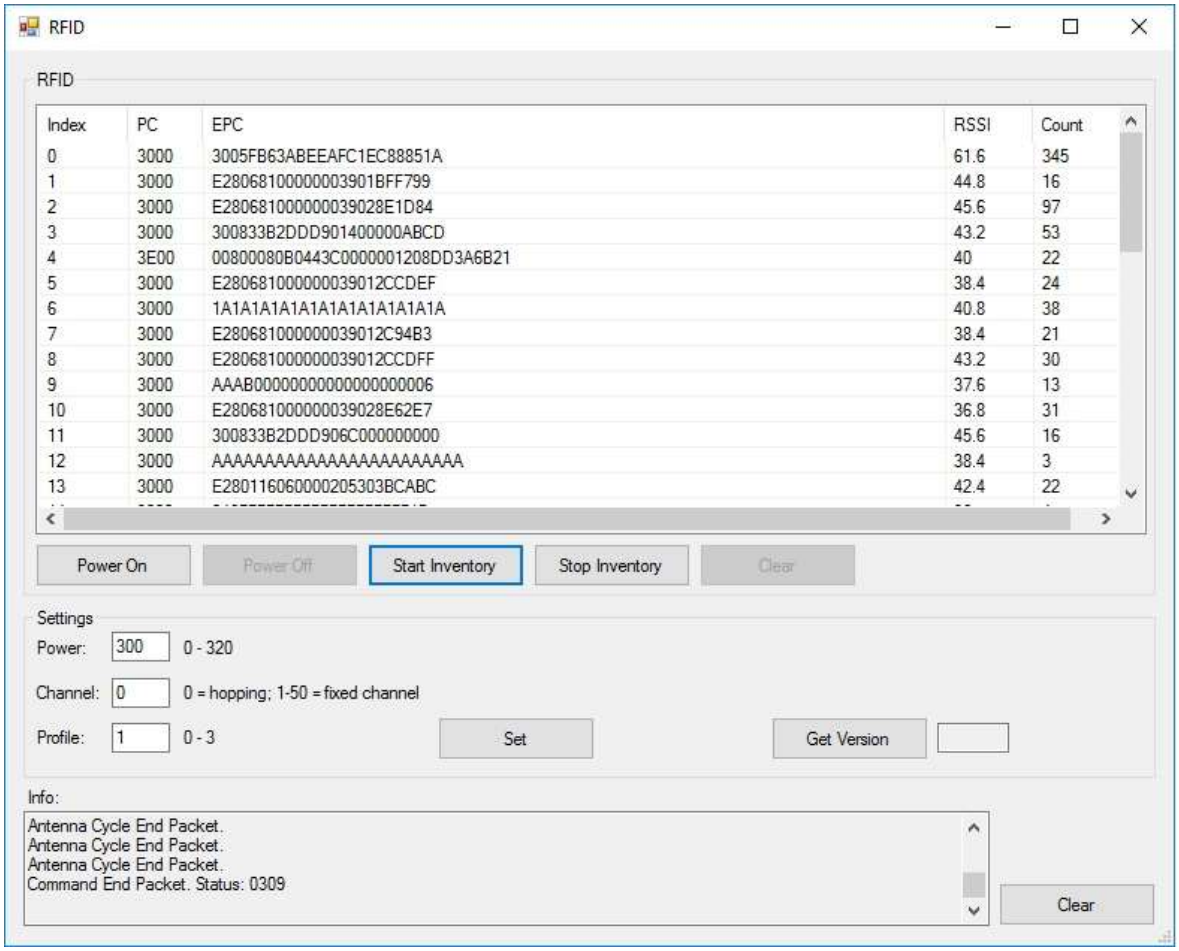


Figure 5-1 PC Application Screen – controlling CS108 via USB

Source code of the PC App for the CS108 is also available for download from Convergence website: www.convergence.com.hk

Appendix A. Federal Communications Commission Compliance

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Consult the dealer or an qualified radio/TV technician for assistance

FCC NOTICE:

To comply with FCC part 15 rules in the United States, the system must be professionally installed to ensure compliance with the Part 15 certification. It is the responsibility of the operator and professional installer to ensure that only certified systems are deployed in the United States. The use of the system in any other combination (such as co-located antennas transmitting the same information) is expressly forbidden.

This Class B digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

Note:
Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

Appendix B: Reader Modes (Link Profiles)

There are 4 link profiles in the CS108: 0, 1, 2, 3. Only 1 profile is active at any time in the CS108. The purpose of each link profile is explained below. These definitions correspond to different application or physical scenarios. The user should try out each profile to see which one gives best performance.

Reader Mode/ Link Profile	**0**	**1**	**2**	**3**
Definition	Best Multipath Fading Resistance	Longest Read Range, Dense Reader Mode	Read Range and Throughput, Dense Reader Mode	Maximum Throughput
R-T Modulation	DSB-ASK	PR-ASK	PR-ASK	DSB-ASK
Tari (μs)	25.00	25.00	25.00	6.25
X	1.00	0.50	0.50	0.50
PW (Pulse Width in usec)	12.50	12.50	12.50	3.13
RTcal (usec)	75.00	62.50	62.50	15.63
TRcal (usec)	200.00	85.33	71.11	20.00
DR (Divide Ratio)	8	64/3	64/3	8
T-R Modulation	FM0	Miller-4	Miller-4	FM0
TRExt	1	1	1	1
Link Frequency(LF) (KHz)	40	250	300	400
Data Rate (Kbps)	40	62.5	75	400

Appendix C: Sessions

Session is a concept of the EPC Global Standard to allow a tag to respond to multiple readers inventorying it at the same time, each using a different session number.

There are 4 possible sessions: S0, S1, S2, S3.

The user however has to be careful because these 4 sessions have different behaviors, notably how the tag flag "persists" in time. A tag, before being inventoried or when just after being powered on, has a flag of State A. When it is inventoried, the flag will go to State B. The tag flag will stay in State B until the tag powers off or the persistence time is up.

A reader can declare it only wants to inventory flag A, so that after a tag is inventoried and its flag gone to State B, it will no longer respond to further inventory rounds – until the end of the persistence time.

Now for S0, S1, S2 and S3, the persistence times are DIFFERENT! Because of that, one has to be very careful in choosing which session to use.

Session	**Tag Flags Persistence Time**
S0	Tag Energized: indefinite Tag Not Energized: none
S1	Tag Energized: 0.5 second < Persistence Time < 5 seconds Tag Not Energized: 0.5 second < Persistence Time < 5 seconds
S2	Tag Energized: indefinite Tag Not Energized: 2 seconds < Persistence Time
S3	Tag Energized: indefinite Tag Not Energized: 2 seconds < Persistence Time

Appendix D: Tag Population and Q

Tag Population is the RFID tag population that is to be inventoried. To be more precise, it is the population of tags that can be "seen" by the RFID reader.

Q is an EPC Global Standard concept related to the way a group of tags is inventoried. When a reader broadcasts its desire to inventory tags, it sends out a Q value. The tag will, based on that Q, calculate a certain number and define that as the number of repeated inventories the reader will do. Basically, the relationship of Inventory Repeats and Q is:

Inventory Repeats = 2^Q

The tag will then choose by random a certain number less than this Inventory Repeats. When the reader starts doing inventory, the tag will then respond at that repeat number.

In other words, the Inventory Repeats should correspond to Tag Population:

Tag Population = Inventory Repeats = 2^Q

For example, if there are 8 tags, then in theory the Q can be 3, and if each tag chooses a number different from that of the other 7 (miraculously, of course), then the 8 tags will be inventoried in an orderly manner in turn.

Of course this will never happen, as the tags will easily choose a number the same as that of another one, and a collision will occur.

Therefore, it is a normal practice to have a bigger Q, such as 4 in this case, so that the 8 tags would have a lower chance of choosing the same number.

Therefore, reversing the equation, ideally, we can have:

$Q = INTEGER(LOG_2(Tag\ Population))$

But in reality, we need some headroom, so that:

$Q = INTEGER(LOG_2(Tag\ Population \times 2)+1$

Appendix E: Query Algorithm

There are 2 types of Query Algorithm: Fixed Q and Dynamic Q.

For Fixed Q, the Q value does not change. In other words, the expected Tag Population does not change.

For Dynamic Q, the Q value changes adaptively: when there are a lot of inventory repeats where no tags respond, the reader will interpret that there are not that many RFID tags in the ~~front~~ environment, and hence it is more efficient to change the Q to a smaller value. When there are a lot of inventory repeats where the reader receives data but they do not satisfy checksum, meaning there is heavy collision, then the reader will interpret that there are too many RFID tags in the environment and hence it is better to increase the value of Q. Dynamic Q algorithm is a way to allow the RFID reader to adapt to different amount of RFID tags being seen by the reader. The idea is that if there are a smaller number of tags in the environment, then the Q can be reduced and the reader can collect all the tag data faster.

Appendix F: Target

Target ~~here actually~~ refers to the target flag that the reader wants to inventory. There are 2 possible flags of an RFID tag: State A and State B.

When an RFID tag is first powered up, it has a flag of State A. After it is inventoried, the state of the flag becomes State B.

The tag will only go back to State A if either it is powered off and powered on again, or if its persistence time has run up (See Appendix B).

For each round of inventory, the reader sends out a notification to the environment which tag flag state it wants to inventory. It can inventory State A, or it can inventory State A and State B alternatively from one round of inventory to the next round of inventory.

In theory, it is a good thing to inventory only State A. The reason being that those tags that have been inventoried should not respond again, and will hence quickly reduce the amount of collisions between tags. Generally in practice if you set inventory to State A only, the inventory of large amount of tags can be faster.

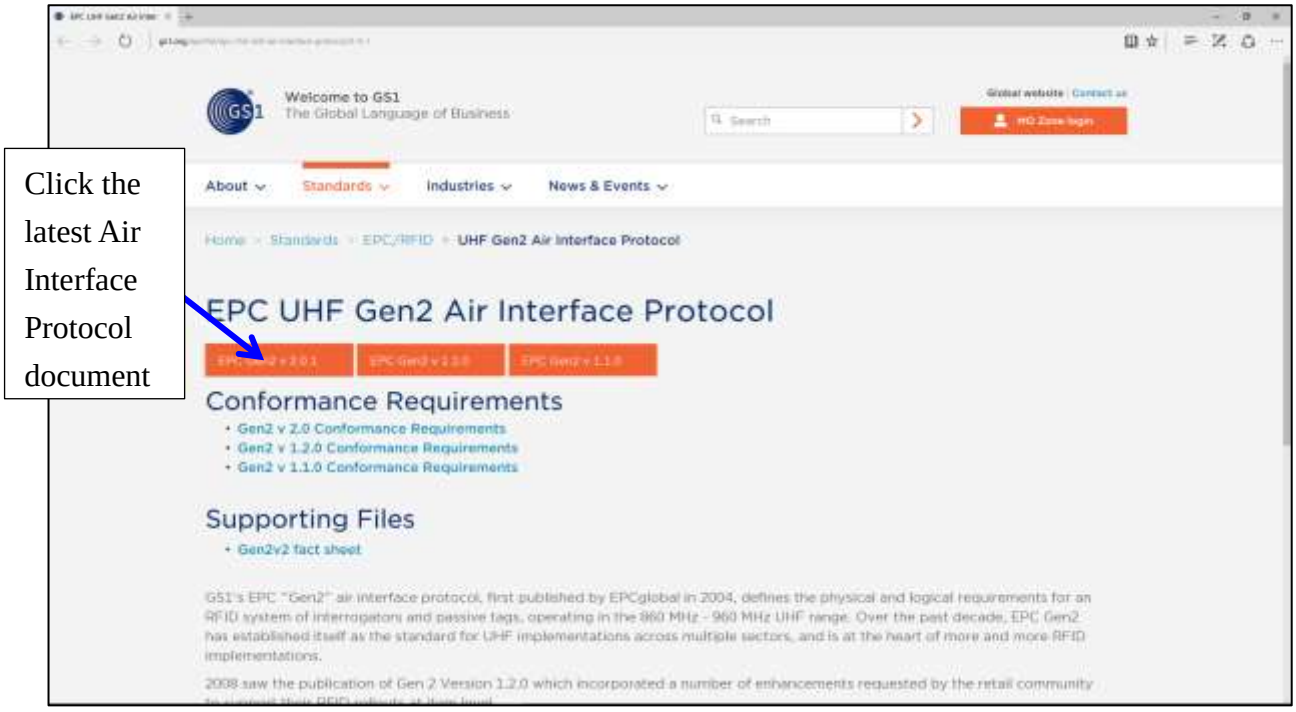
The only catch is that when a tag responds to the reader, it does not know another tag is colliding with it. It sends out the response and thinks it has done the job, hence transitioning to flag State B. So in such a case, the tag will not respond to further inventory queries by the reader, even though its response has been lost due to collisions. Because of that, sometimes the user will set the inventory to target State A in one inventory round, and then State B in the next round, and vice versa, and so on. This is called A/B Toggle or A & B Dual Target or simply Dual Target.

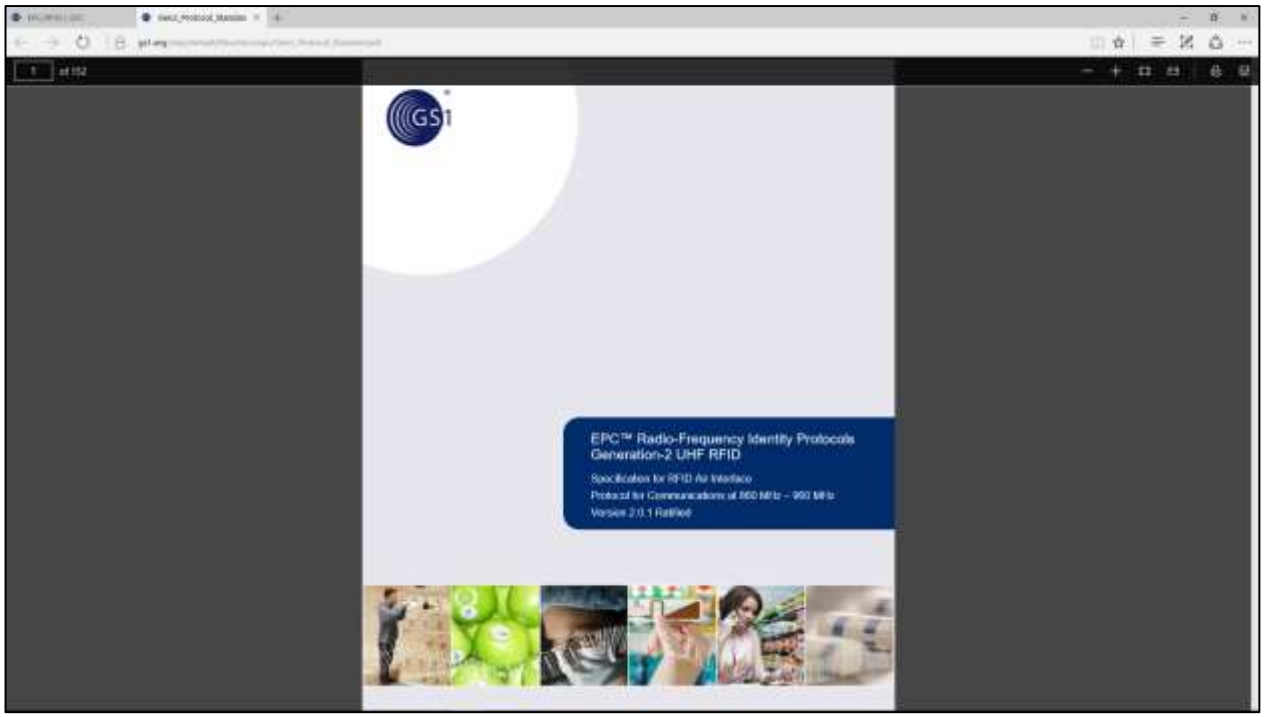
Appendix G: Security

There are 4 actions you can apply on the memory inside an RFID tag:

1) Lock
2) Unlock
3) Permanent Lock
4) Permanent Unlock

You can obtain an EPC Global document which can be downloaded from the EPC Global website that explains this:
https://www.gs1.org/epcrfid/epc-rfid-uhf-air-interface-protocol/2-0-1.
Once there, press the button showing the latest air interface protocol document and click on it to get the pdf file.





For the Access Password and Kill Password the security locking affects both reading and writing.

For the EPC memory bank and the User memory bank, the security locking affects only writing.

For the TID memory bank, since we are the user and not the manufacturing vendor, there is no security action that can be applied. It has been permanently unlocked in the factory and it cannot be changed.

Appendix H: Models & Regulatory Region

There are various models, denoted by the alphanumeric key to the right of the dash after the "CS108-", here denoted by "**N**". The applicable regulatory regions for each model are described below:

N=1:	865-868 MHz for Europe ETSI, Russia, Mid-East countries, 865-867 MHz for India
N=2:	902-928 MHz, FCC, for USA, Canada and Mexico. Hopping frequencies locked
N=2 AS:	920-926 MHz, Australia. Hopping frequencies locked
N=2 NZ:	921.5-928 MHz, New Zealand. Hopping frequencies locked
N=2 OFCA:	920-925 MHz, Hong Kong. Hopping frequencies locked
N=2 RW:	920-928 MHz, Rest of the World, e.g. Philippines, Brazil, Peru, Uruguay, etc.
N=4:	922-928 MHz, Taiwan
N=7:	920-925 MHz, China
N=8:	916.7-920.9 MHz, Japan
N=9:	915-921 MHz, Europe Upper Band

Appendix I: Technical Support

All technical support should be sent to the following email:

info@convergence.com.hk

