



**CSL CS101 EPC Class 1 Gen 2 RFID  
Handheld Reader  
User's Manual**

**Version 2.0.1**

*CSL: The One-Stop-Shop for RFID Solutions*

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## 2 FCC and IC Statement

### **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.

### **IC Notice (Industry Canada):**

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.

## 3 Introduction

### 3.1 CS101 Handheld RFID Reader

The CS101 handheld RFID reader is a ruggedized reader designed from the drawing board to have **extremely long read range and high read rate** – in that it is designed to replace fixed reader in many applications where fixed reader is a non-portable and therefore non-viable option. In fact it is nicknamed “Fixed Reader in Your Hand”. CS101 is a product that arises out of popular requests for applications such as:

1. Dock Door applications where the handheld reader is used to complement fixed reader when tags are not 100% read by the fixed reader.
2. Loading Bay applications where the fixed reader is not allowed because there is no place to put a permanent reader stand.
3. Warehouse applications where the handheld is used to do long read range inventory of all the shelves – apparently not a good idea to use a fixed reader and move it around up and down.
4. Special applications where long read range is a MUST because the operator does not want to go near the tagged item, example police inspecting the electronic license plate of a suspect vehicle with a suspicious driver inside.
5. Retail shop inventory applications where high read rate is most useful – workers can go home earlier!!

### 3.2 How to Use this Manual

This manual provides a comprehensive introduction to the CSL CS101 EPC Class1 Gen 2 handheld RFID reader (chapter 2), Installation Guide (chapter 3), Quick Start Guide (chapter 4), Applications Interface (chapter 5), CSL Demo Programs (chapter 6), Software Development Environment (chapter 7), PC Side Demo Program (chapter 8) and Usage Tips for CS101 (chapter 9).

Some other information such as RFID Cook Book (chapter 10), RFID Best Practices (chapter 11) and RFID Use Cases (chapter 12) are also provided for reference.

## 3.3 Product Package

### 3.3.1 Basic Package Content

The reader package contains:

- Handheld reader
- Charger with power adapter and country specific power cord
- Batteries – 2 pieces
- Wrist strap
- Shoulder strap
- User Manual (from CSL website:  
<http://www.convergence.com.hk/downloads-support-2/cs101/>)

### 3.3.2 Unpacking Instructions

Unpacking of the reader is very simple. Just open up the box and take out the content to a table. **The charger should be connected and the 2 batteries charged for a minimum of 10 hours before first use.**

## 3.4 Product Specification



Figure 3-1 CS101 Reader

### Features:

- ISO 18000-6C and EPCglobal Class 1 Gen 2 UHF RFID protocol compliant including dense reader mode
- Ultra long read range – peak at 8 meters open space with DogBone tags. (CS101-H-2 Version)
- Ultra high read rate – peak at 400 tags/sec. (Non-Dense Reader Mode)  
150 tags/sec. (Dense Reader Mode)
- Choices of vertical linear polarization antenna and horizontal linear polarization antenna for different application scenarios
- Sophisticated data handling for efficient management of large streams of tag data.
- Highly configurable buffering and tag filtering modes to eliminate the redundant tag data so as to reduce wireless LAN traffic and server loading
- 400 kbps tag-to-reader data rate profile
- Robust performance in dense-reader environments
- Excellent in transmit and receive mode – generates a different combination of unique reader-to-tag command rate, tag-to-reader backscatter rate, modulation format, and backscatter type
- Configurable parameters offer maximum throughput and optimal performance
- Supports all Gen 2 commands, including write, lock and kill

**Specifications:**

<b>Physical Characteristics:</b>	Length: 19.7 cm; Width: 12.2 cm; Height: 22.3 cm; Weight: 1 Kg
<b>Environment:</b>	Operating Temp: -20 <sup>0</sup> C to 50 <sup>0</sup> C Storage Temp: -40 <sup>0</sup> C to 75 <sup>0</sup> C Humidity: 5% to 95% non-condensing Enclosure: IP-65
<b>Antenna:</b>	Linear with excellent polarization diversity Choice of: Vertical Linear Polarized Antenna Horizontal Linear Polarized Antenna Circular Polarized Antenna
<b>Power:</b>	14.8 Volt, 1250 mAh Lithium Polymer battery
<b>RFID Frequency Ranges:</b>	865 – 868MHz, 902 – 928MHz
<b>Interfaces</b>	Wi Fi 802.11b/g with WPA/WPA2 Configurable to use fixed IP address or DHCP USB 2.0 Maximum 32GB SD card storage (SD and SDHC)
<b>Operating System:</b>	WinCE Professional 5.0
<b>Maximum Tag Read Rate:</b>	400 tags/sec. (non-DRM)
<b>Maximum Speed of Tag:</b>	660 ft/min
<b>Accessories:</b>	Charger, batteries, wrist strap, shoulder strap
<b>Order Code:</b>	N=1: 865-868 MHz (Europe) & 865-867 MHz (India), N=2: 902-928 MHz (USA), N=4: 922-928 MHz (Taiwan), N=7: 920-925 MHz (China, Australia, Malaysia, Hong Kong etc.), N=8: 915-922 MHz (Japan)
<b>Restrictions on Use:</b>	Approvals, features and parameters may vary depending on country legislation and may change without notice

# 4 Hardware Installation

## 4.1 Devices

### 4.1.1 Reader

The CSL CS101 handheld RFID Reader is an EPCglobal Class 1 Gen 2 handheld reader product.



Figure 4-1 CS101 Reader Front View

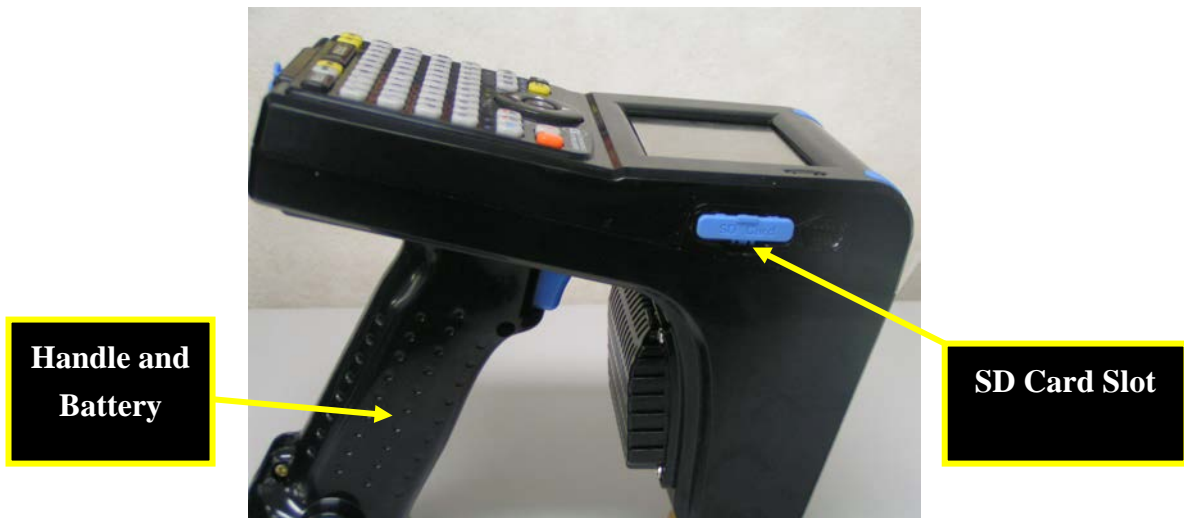
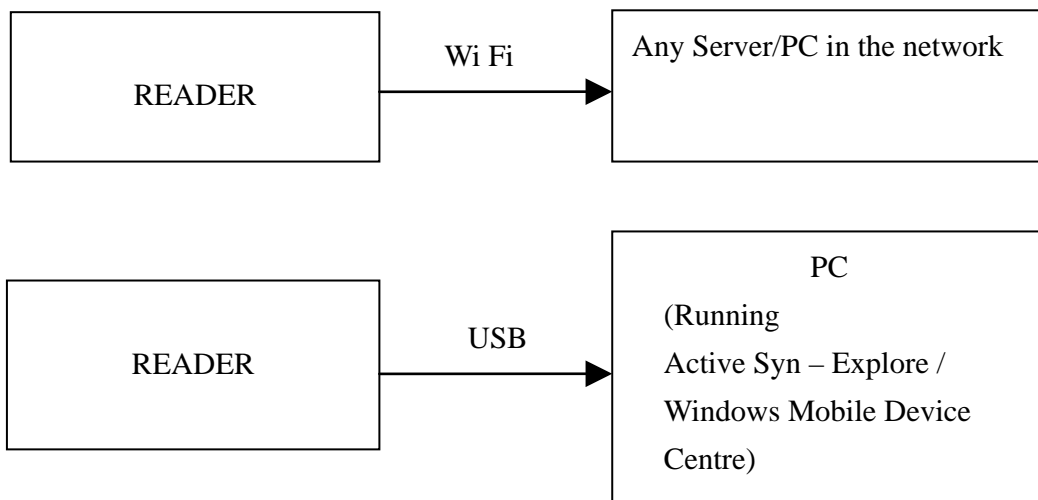


Figure 4-2 CS101 Reader Side View



Figure 4-3 CS101 Reader Plan View

The reader is connected to the network via Wi Fi. The reader can have a static IP address or can obtain an IP address using DHCP. Normally, a static IP address is more convenient to use because it does not change when the reader reboots, but the user has to make sure there is no collision with other network devices in the network. If the reader is configured to be DHCP, then a separate discovery program that runs on the PC side can help the user find all readers in the same local area network.



## 4.1.2 Charger



Figure 4-4 CS101 Charger with AC Adaptor

**Note:** If the battery goes into the over-current protection by shorting the battery terminals, the battery will not output the voltage until the battery is put into CS101 charger cradle to trigger the battery to release the status of over-current protection.

## 4.2 Power Up Sequence

The reader can be turned on to run RFID operation in a most simple manner:

1. Insert battery into the handle of the handheld reader with the metal contact inward. Also, make sure it is in the correct direction in terms of front and back. If the front-back direction is reversed, the battery cannot go in – in that case do not force it in, just reverse the battery and it should slide in effortlessly. Then use the cap to hold the battery firmly.
2. Press the power button on the upper right corner of the keypad continuously until LCD screen display appears.
3. Wait till WinCE screen shows up.
4. On the WinCE screen, there is an application called “**CS101 Callback Demo...**”. Double click it to start the application.
5. After that, the screen will enter the application selection page and you can start reading and writing tags, inventory of tags, search of tags, etc.

## 4.3 Usage Recommendation

### 4.3.1 Strap: Wrist Strap and Shoulder Strap

The wrist strap and shoulder strap should be attached to the handheld reader to allow additional weight support during use.

### 4.3.2 IO Connection

The IO connector consists of one USB connector (mini-USB) with dedicated cable that come with the reader.



Figure 4-5 IO Interface

### 4.3.3 Do's & Don'ts when using CS101 Handheld Reader

User should pay attention when using CS101 RFID Reader.

1. Do not turn on the reader operating (read/write tags) and leave it unattended.
2. Do not connect to Linksys access point since a firmware bug was found on one of the Linksys AP model. (In our laboratory test, we found a potential Wi-Fi connection problem in the “[Linksys WRT54G WiFi router firmware version v7.00.X](#)”. Thus, it is not compatible with the CS101 hand held reader.)
3. Do not use the reader close to metal sheet or materials with high RF reflection capacity.



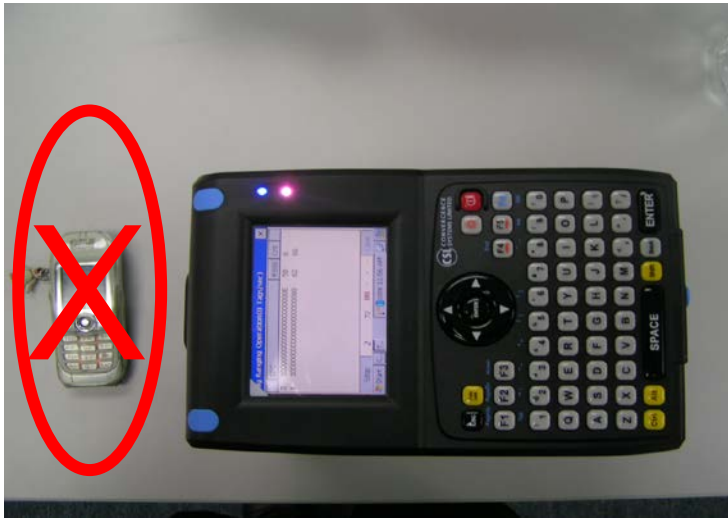
**Reader antenna too close to metal**

4. Do not use the reader to read tags within very short distance



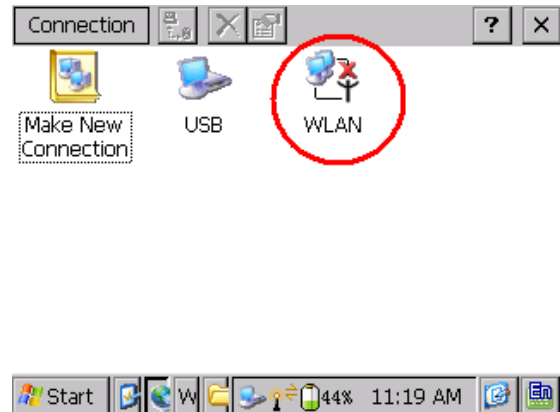
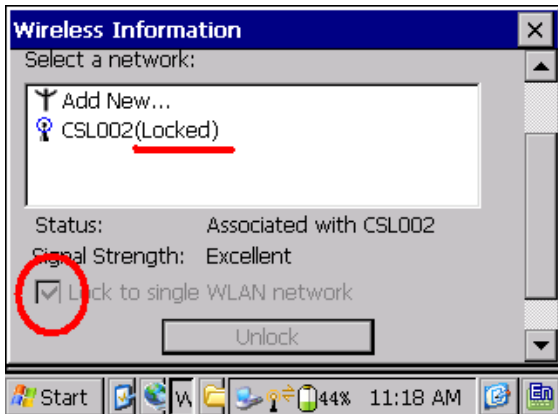
**Reader antenna too close to the tag**

- 5. Do not let devices with strong RF radiation close to the reader. e.g mobile phone

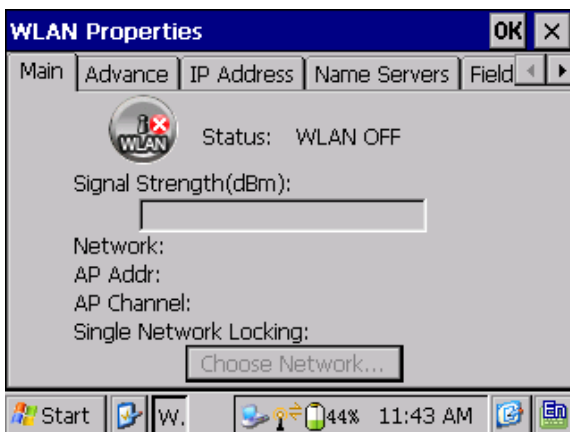


**Reader antenna too close to the mobile phone items**

- 6. Do configure the Wi-Fi settings of handheld reader to be either disabled or locked with an access point.



The reader is locked to an access point



The reader Wi-Fi function is disabled

7. Do keep certain distance between reader and the tagged items



## 4.4 Verification and Validation

The reader comes with standard demo application. Double click the icon “CS101 Callback Demo” to start.



Figure 4-6 WinCE Screen

The main menu will be shown on screen.

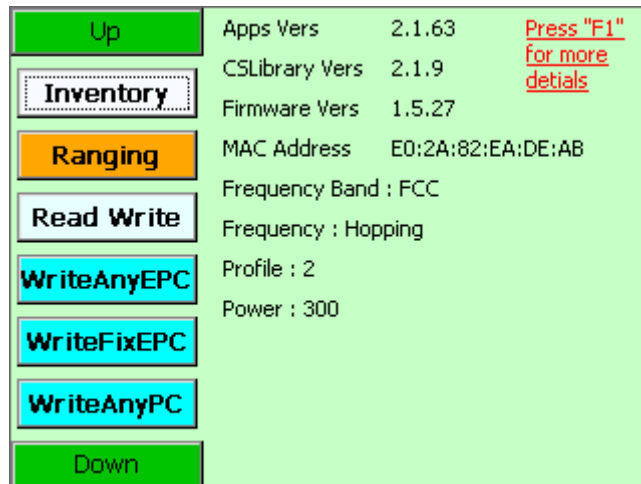


Figure 4-7 Main Menu

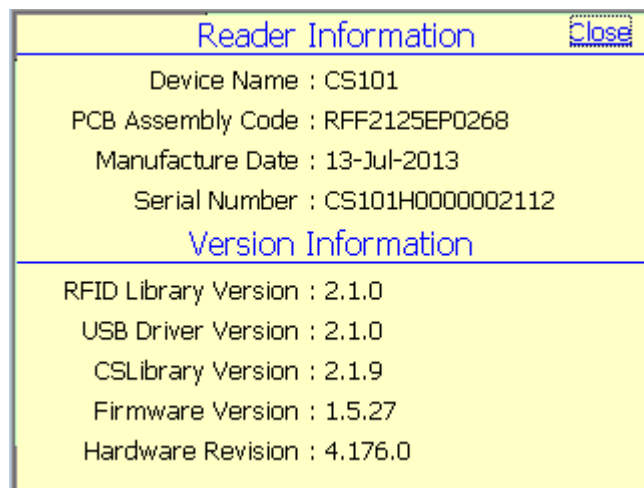
The current reader configuration and version information are shown on the main menu of the Callback 2.0 Demo Program as shown in figure 4-7, it is a fast and convenient way to review

the reader setting, e.g. firmware version, country code and antenna power output etc. Whenever the reader is stayed in the idle state (not during reading or writing the tags), you can press the function key “F1” to display the reader information.

**“F1”  
Function Key**



**Figure 4-8 Keyboard**



**Figure 4-9 Reader Information**

To read tags, click the “Inventory” or “Ranging” button and then click “Start”:

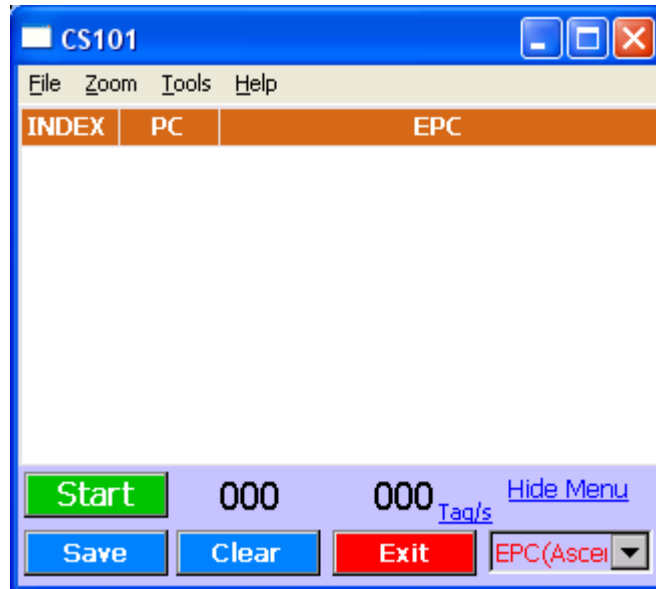


Figure 4-10 Tag Inventory Operation

Take the sample tags and put them in front of the handheld reader, all the tag's EPC within the read range of the reader will be read by handheld reader:

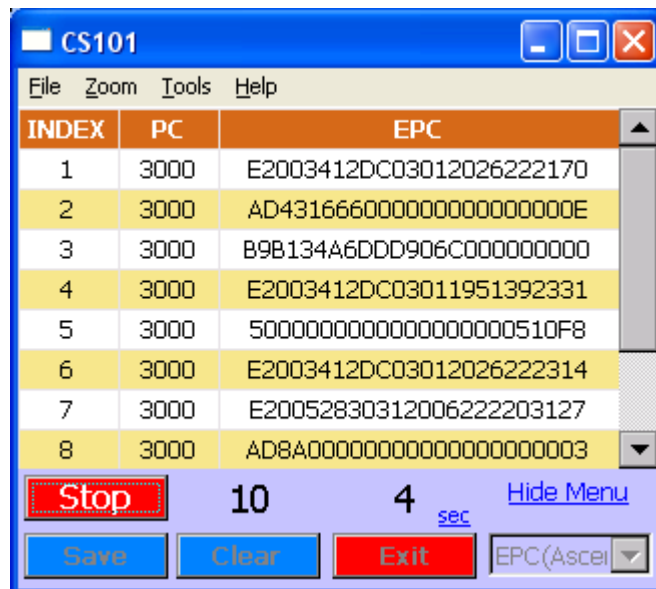


Figure 4-11 Tag Inventory – Listing

## 4.5 Cautions

**The default IP address of handheld reader is configured as DHCP. To change this IP address, please go to System Configuration page by clicking the “System Config” button of the demo application to do that.**

## 5 Software Installation

### 5.1 Software Content of Shipment Package

The CSL Reader software package can be downloaded from the CSL website (<http://www.convergence.com.hk>) > “Downloads & Support” area.

#### For General User

<b>1.</b>	<b>User's Manual</b>
<b>2.</b>	<b>Demo Applications (Installer)</b> <ul style="list-style-type: none"> <li>- CS101 .NET Demo App on WinCE OS with User Interface</li> <li>- UDP Server Demo Program on Windows OS using Command Prompt</li> <li>- CS101 Barcode and SnapShot Demo App on WinCE OS with User Interface</li> <li>- CS101 VB Demo App on WinCE OS with User Interface</li> </ul>
<b>3.</b>	<b>Special Notes</b> <ul style="list-style-type: none"> <li>- Restore CS101 OS to Factory Default Setting</li> <li>- CS101 Demo Operation Guidelines – BAP ID Card Tags</li> <li>- CS101 Demo Operation Guidelines – Cold Chain Tags</li> <li>- CS101 Barcode and Snapshot DemoApp Guideline</li> </ul>
<b>4.</b>	<b>Firmware, Upgrade Tool and Guideline</b> <ul style="list-style-type: none"> <li>- Firmware Upgrade Procedure</li> <li>- Firmware Upgrade Tool</li> <li>- Firmware for RFID Processor</li> </ul>

**For Developer**

<b>1.</b>	<b>User's Manual</b>
<b>2.</b>	<b>Demo Applications (SDK)</b> <ul style="list-style-type: none"> <li>- <b>CS101 .NET API Demo Build on WinCE OS with User Interface</b></li> <li>- <b>CS101 Java API Demo Build on WinCE OS with User Interface</b></li> <li>- <b>UDP Server Demo Build on Windows OS using Command Prompt</b></li> <li>- <b>CS101 Barcode Demo Build on WinCE OS with User Interface</b></li> <li>- <b>CS101 VB Demo Build on WinCE OS with User Interface</b></li> </ul>
<b>3.</b>	<b>Reference Manual</b> <ul style="list-style-type: none"> <li>- <b>C# Unified API Reference Manual</b></li> <li>- <b>Low Level API Manual</b></li> </ul>
<b>4.</b>	<b>Special Notes</b> <ul style="list-style-type: none"> <li>- <b>Restore CS101 OS to Factory Default Setting</b></li> <li>- <b>CS101 Demo Operation Guidelines – BAP ID Card Tags</b></li> <li>- <b>CS101 Demo Operation Guidelines – Cold Chain Tags</b></li> <li>- <b>CS101 Barcode DemoApp Guideline</b></li> </ul>
<b>5.</b>	<b>Firmware, Upgrade Tool and Guideline</b> <ul style="list-style-type: none"> <li>- <b>Firmware Upgrade Procedure</b></li> <li>- <b>Firmware Upgrade Tool</b></li> <li>- <b>Firmware for RFID Processor</b></li> </ul>

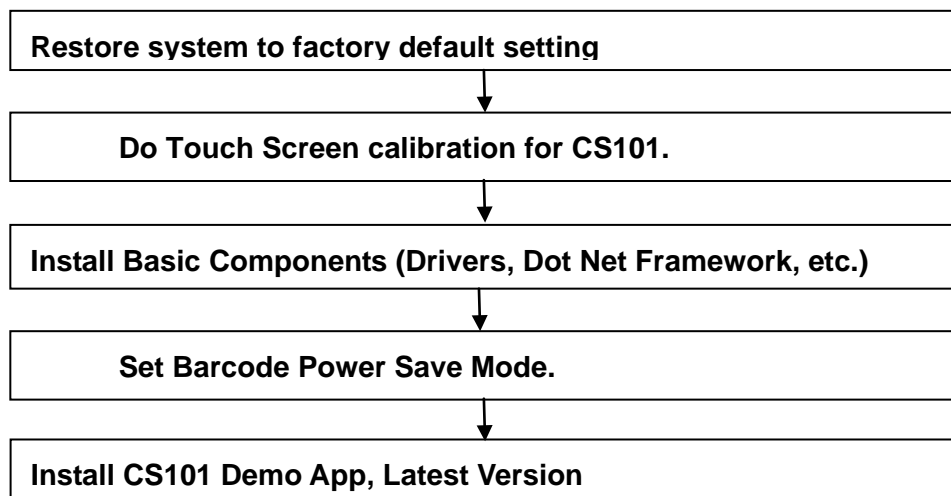
## 5.2 Restore CS101 OS to Factory Default Setting

This section provides guidelines to the user to restore the software to factory default in the CSL CS101 Reader. The following areas will be covered in this section:

- Restore of the Windows CE OS on CS101
- Installation of the CS101 Basic Components Installers
- Installation of demo application

### 5.2.1 Restore CS101 OS to Factory Default Setting Overview

The flow diagram below shows the priority of firmware upgrade steps starting from device application and default setting file. **User MUST follow the sequence below to restore Win CE OS to Factory Default Setting. DO NOT FORGET ANY STEP.**



## 5.2.2 Restore CS101 OS to Factory Default Setting Procedure

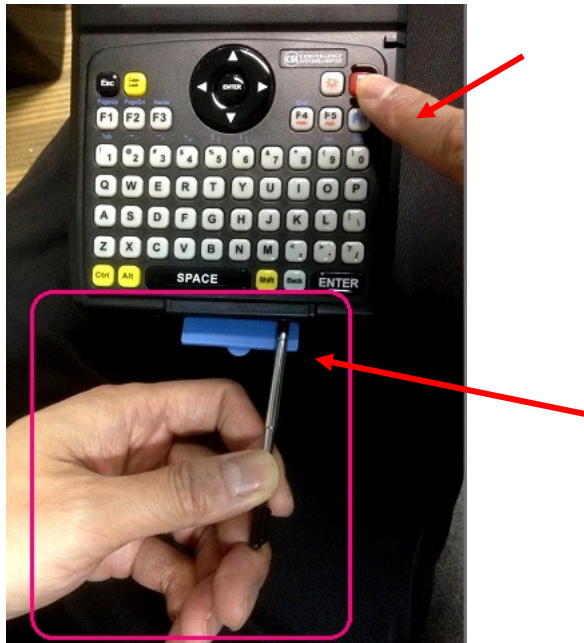
1. Use a **fully charged battery** to power on CS101



2. Press and keep holding the **“Power”** key for **1 second**



3. **WHILE holding the “Power” key**, press “Reset” key **simultaneously** for **5 seconds**.



4. After that, **ONLY** release the “Reset” key, leaving the Power key still pressed by finger. Keep holding the key **and wait until warning box is seen (after 5 seconds)**.



5. After warning box (Restore system to factory default) is seen, release the “Power” key. Press **[Yes]** to continue.



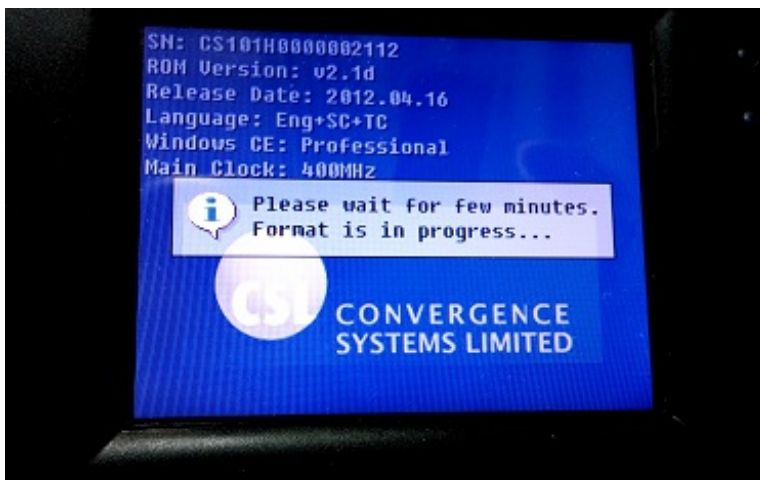
6. Press **[Yes]** when reconfirmation box appears.



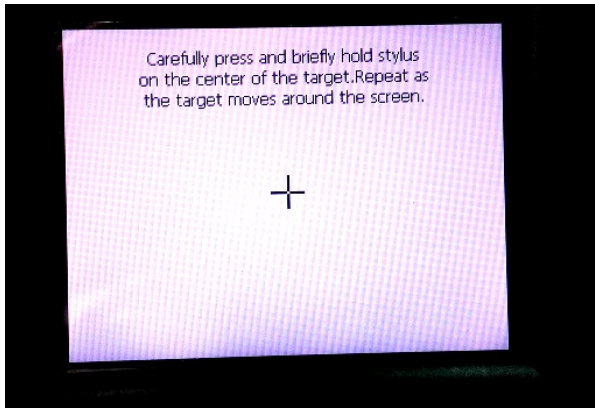
7. Press **[OK]** button to confirm the System ROM formatting.



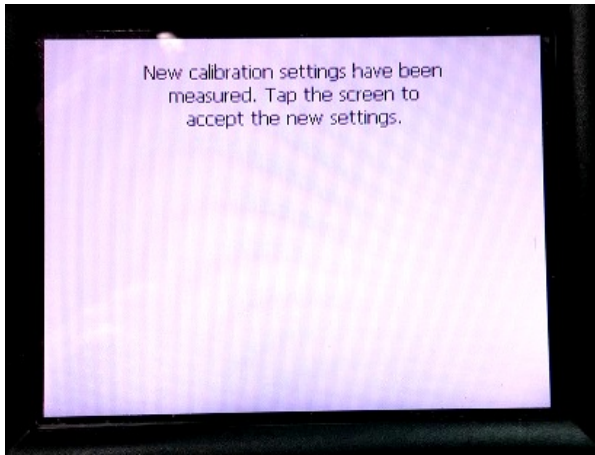
8. Wait until System ROM formatting process is finished.



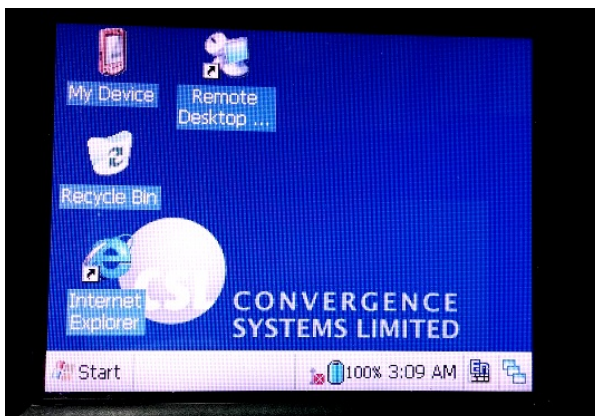
9. It will then automatically go to a touch screen calibration screen.  
Use the Pen CS101 provided to do the Calibration.



10. Tap the screen to confirm the calibration settings.



11. After the 1st Touch Screen calibration for CS101, wait until CS101 enters Win CE.

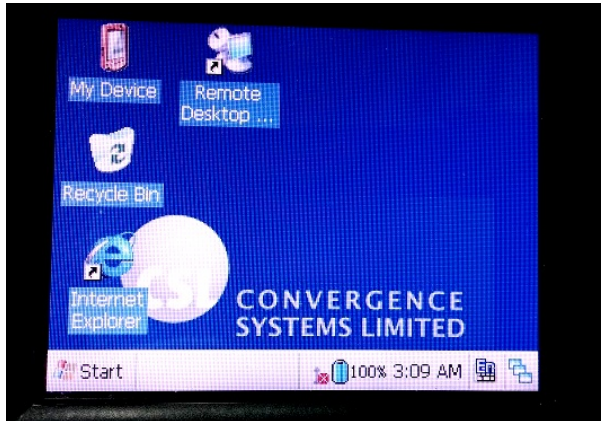


12. Please go to **Section 4 to Install Basic Components** for CS101.

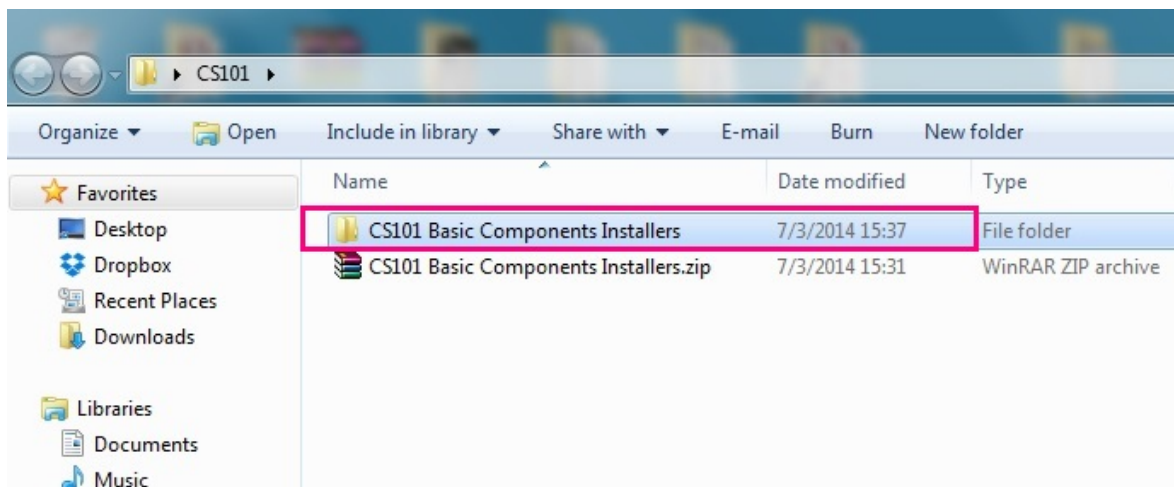
### 5.2.3 Install Basic Components

Just upgrading the WinCE OS is not enough. The user needs to install the internal USB driver connecting the host processor to the RFID module inside, Dot Net Framework, Demo App, etc.

1. After the Win CE OS is upgraded, wait until CS101 enter Win CE.



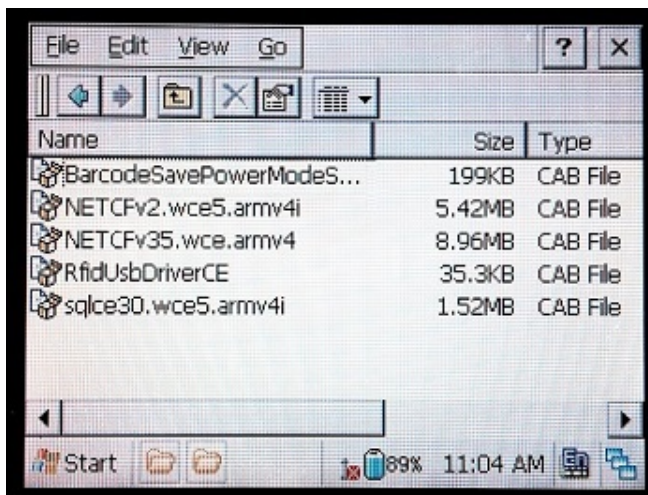
2. Unzip the package **CS101 Basic Components Installers.zip** (provided by CSL) in PC to a directory.
3. Copy the complete directory **CS101 Basic Components Installers** from PC to CS101 via SD card or USB connection (For USB connection, you need to run ActiveSync or Windows Mobile Device Center) .



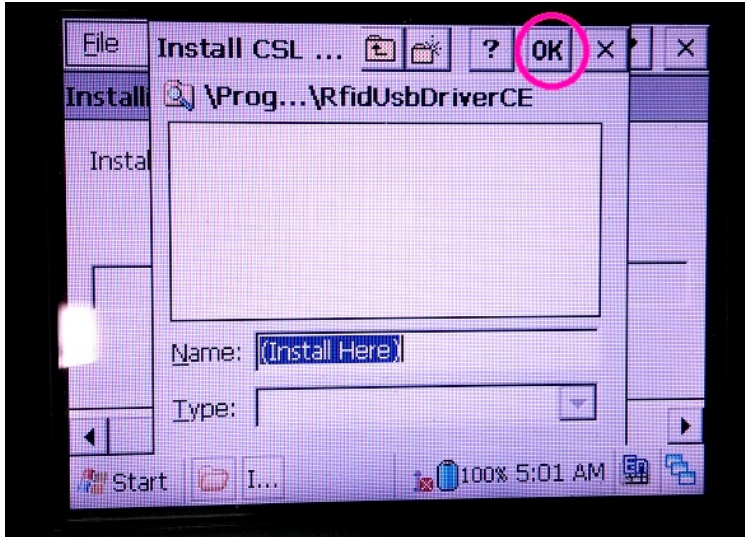
4. Open the folder inside CS101 Win CE.



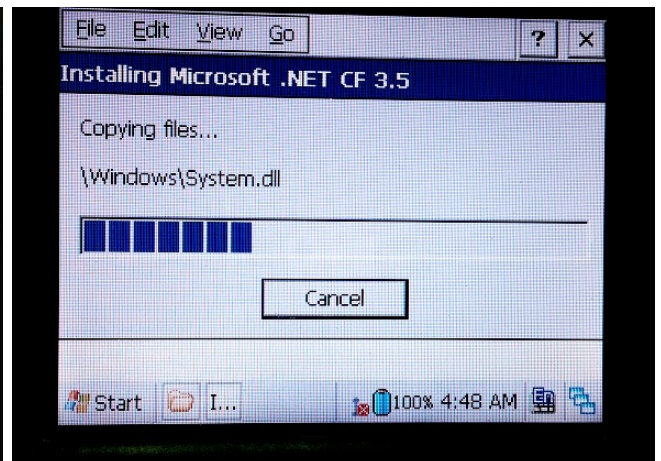
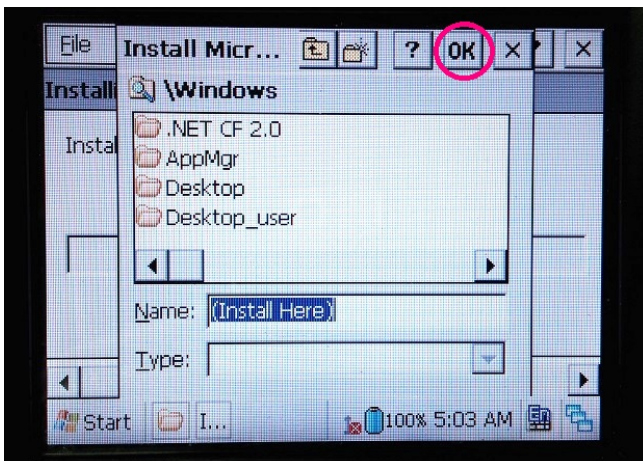
5. Check the files in “CS101 Basic Components Installers”. They are [RfidUsbDriverCE.cab](#), [NETCFv2.wce5.armv4i.cab](#), [NETCFv35.wce.armv4.cab](#), [BarcodeSavePowerModeSetup21-Oct-2009.CAB](#) and [sqlce30.wce5.armv4i.cab](#).



- Starting from [RfidUsbDriverCE.cab](#), double click the cab files to install the files. A file location will pop up. Simply press "OK" to install the component to the default directory provided.



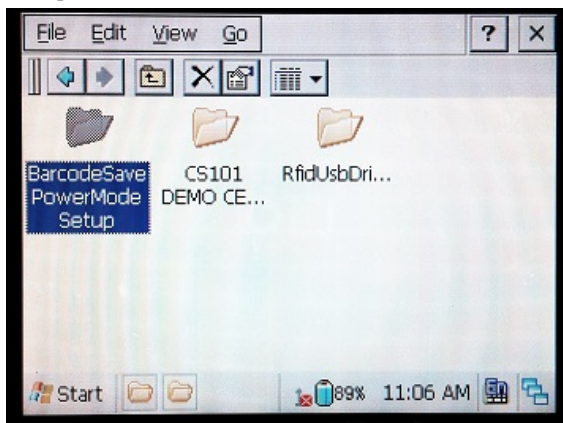
- After [RfidUsbDriverCE](#) is installed, install the other components: [NETCFv2.wce5.armv4i.cab](#), [NETCFv35.wce.armv4.cab](#), [BarcodeSavePowerModeSetup21-Oct-2009.CAB](#) and [sqlce30.wce5.armv4i.cab](#) to the default directories provided in sequence.



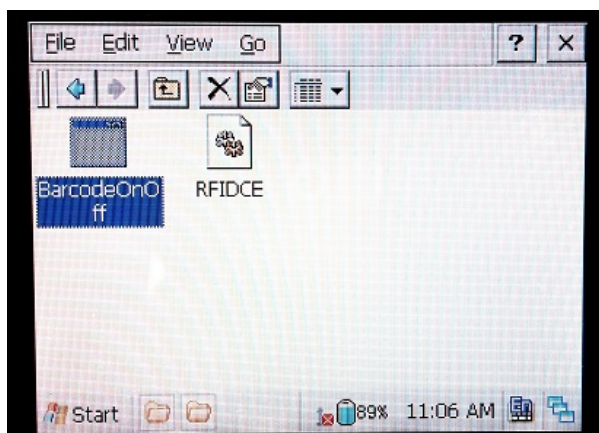
- 8. After CS101 Basic Components installed, the **Barcode Power Save Mode** should be set before use. Enter CS101 **Program Files**.



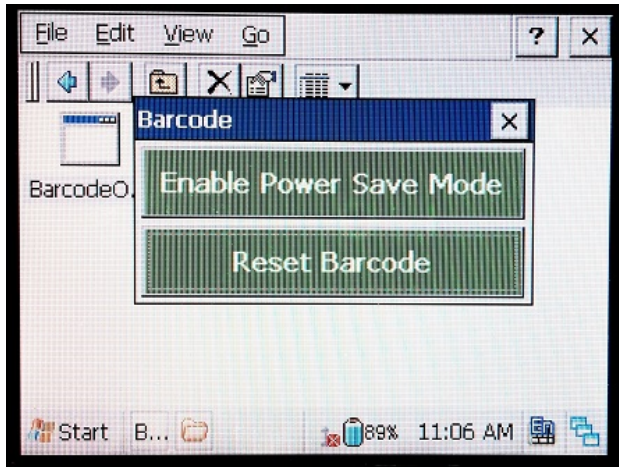
- 9. In **Program Files**, enter **BarcodeSavePowerMode Setup**.



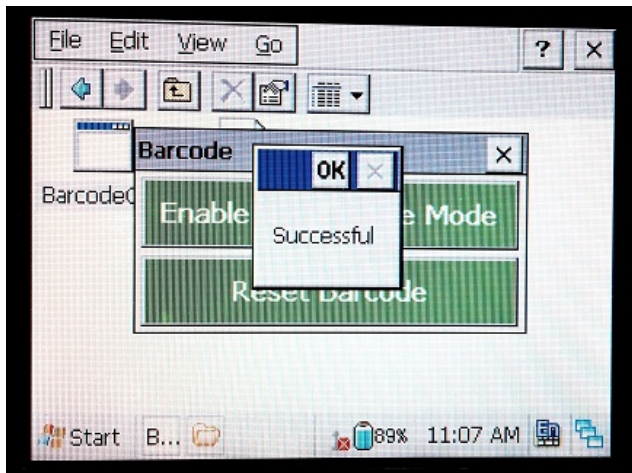
- 10. Run the program **BarcodeOnOff.exe**



11. Press **“Enable Power Save Mode”**.



12. Press **OK** when **“Successful”** is prompt. Then exit this program by pressing the **“x”** button on the upper right corner of the Barcode application window.



13. User can go to **Section 5** to install the latest **CS101 Demo App**.

## 5.2.4 Install CS101 Demo App

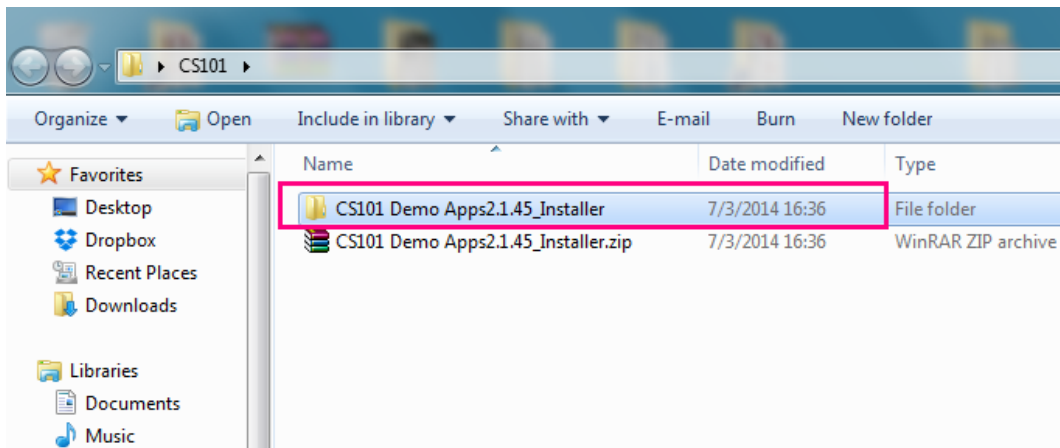
After installation of Basic Components for CS101, the user can install latest CSL CS101 Demo App from CSL website

(<http://www.convergence.com.hk/download-support-installer-cs101-demo-app/>) to enable the CSL RFID handheld reader features.

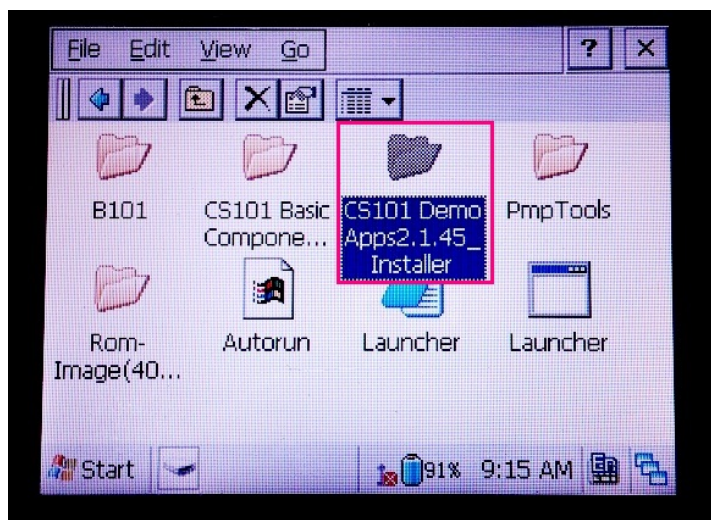
1. Here we use version 2.1.45 as example.

Unzip the package **CS101 Demo Apps2.1.45\_Installer.zip** (provided by CSL) in PC.

2. Copy the complete directory **CS101 Demo Apps2.1.45\_Installer** from PC to CS101 via SD card or USB connection.

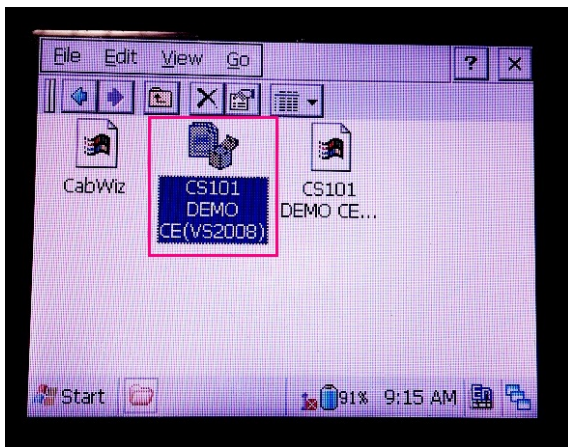


3. Open the folder in CS101 Win CE.

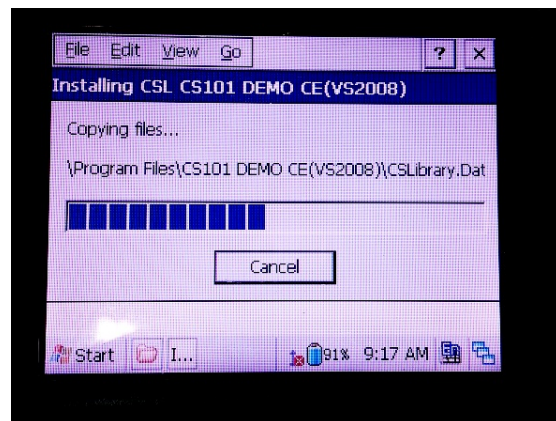
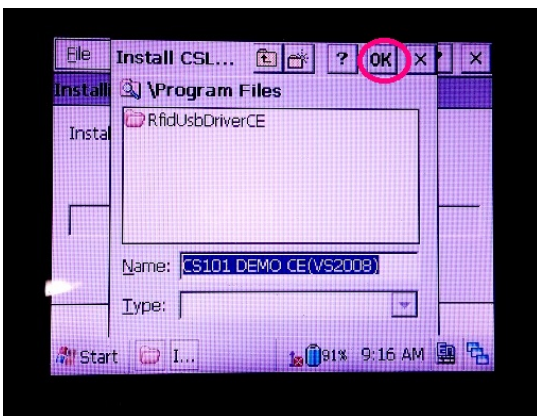


4. Check the files in “CS101 Demo Apps2.1.45\_Installer”.

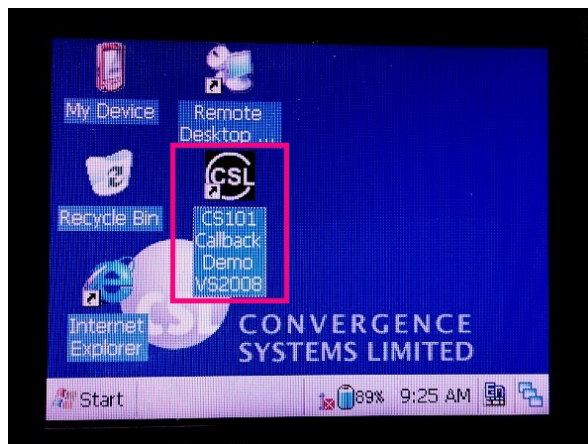
Choose “CS101 Demo CE(VS2008)”.



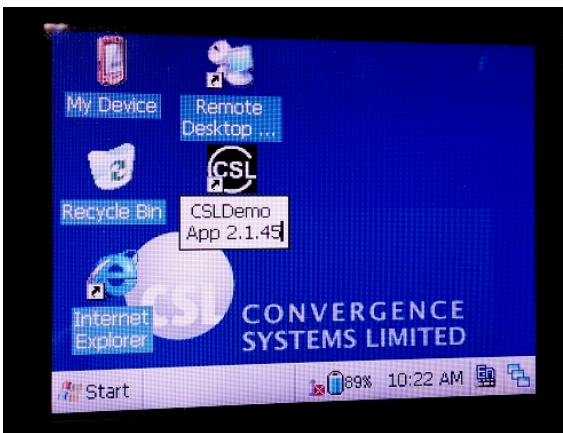
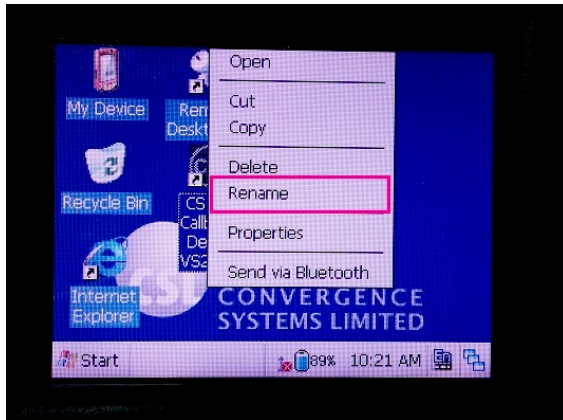
5. Double click the cab file to install the file “CS101 Demo CE(VS2008)”. Press “OK” to install the Demo App to the default directory provided.



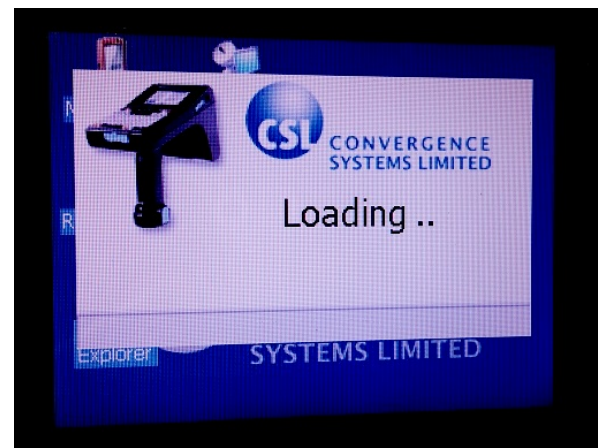
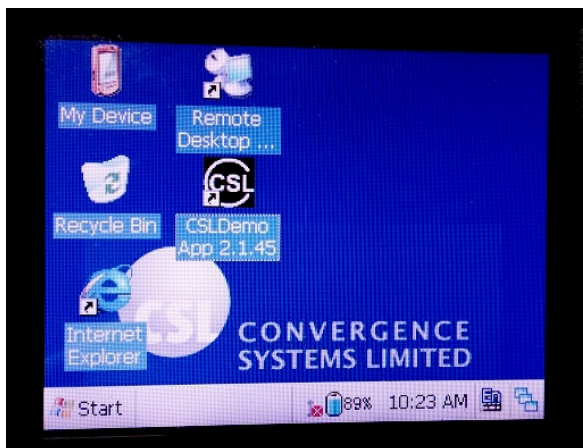
6. After “CS101 Demo CE(VS2008)” is installed, a shortcut is created automatically at desktop.



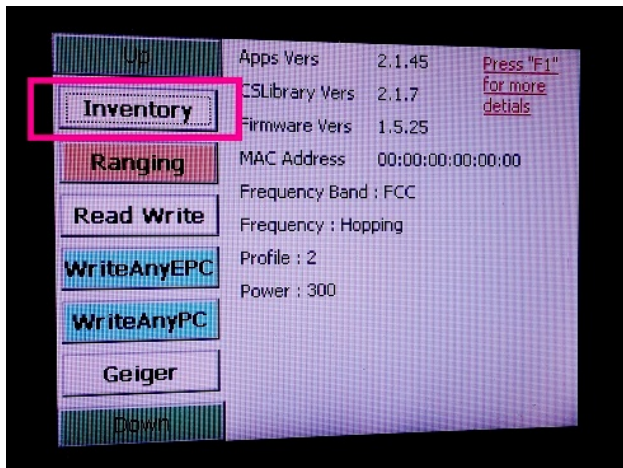
7. Click and hold the shortcut of Demo App. Choose “Rename” to rename the file.



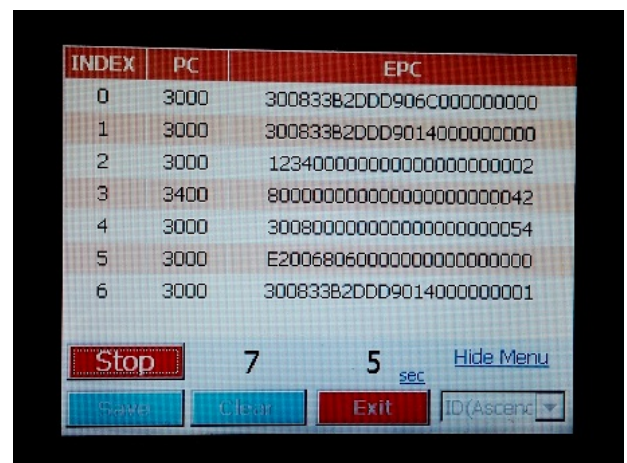
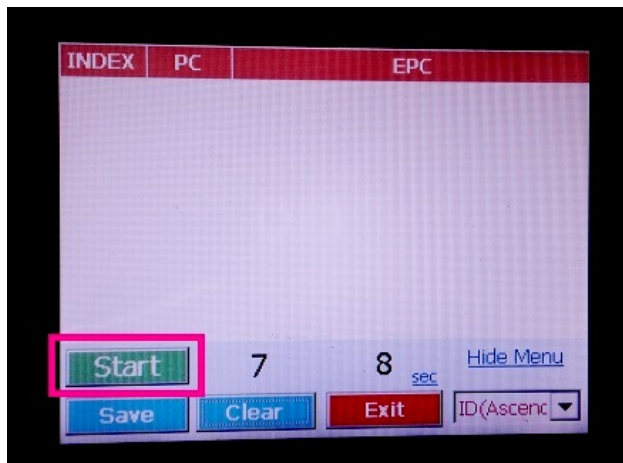
8. Double Click to run the renamed Demo App.



9. In the main menu, choose **“Inventory”**



10. Click **“Start”** to run **Inventory**



## 6 Quick Start

### 6.1 Start the Callback Demo Program

- Press the power button to power up the reader.
- Click the CS101 Callback Demo Program icon on the desktop to run the demo program.

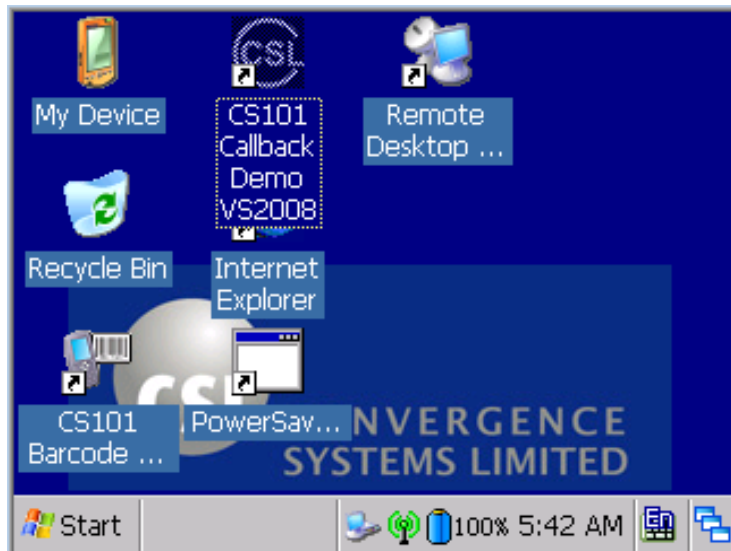


Figure 5-1 CS101 Screen

## 6.2 Main Menu

User can press [Up] and [Down] to choose to enter the operation and configuration of CS101. User can press [Exit] to quit the Demo Program.

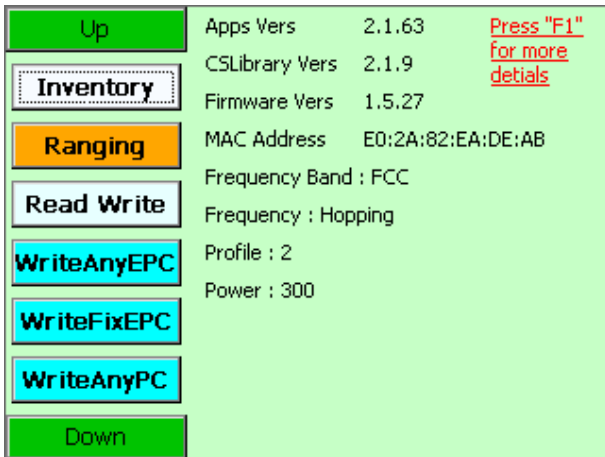


Figure 5-3A Main Menu

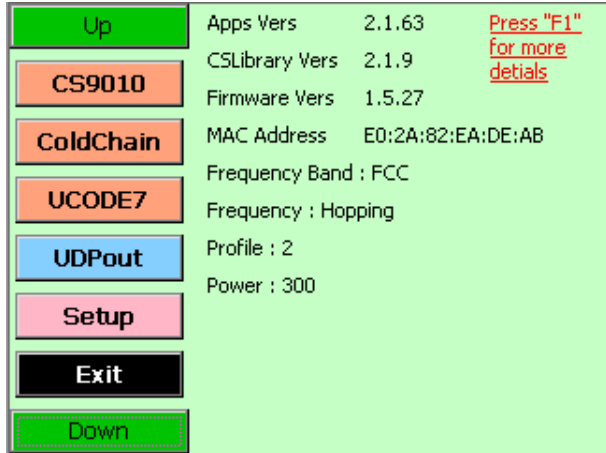


Figure 5-2B Main Menu

## 6.3 Setup

“Setup” allows user to set basic properties of the handheld reader, such as the Gen2 parameter settings, link profile, transmit power and barcode configuration, etc.

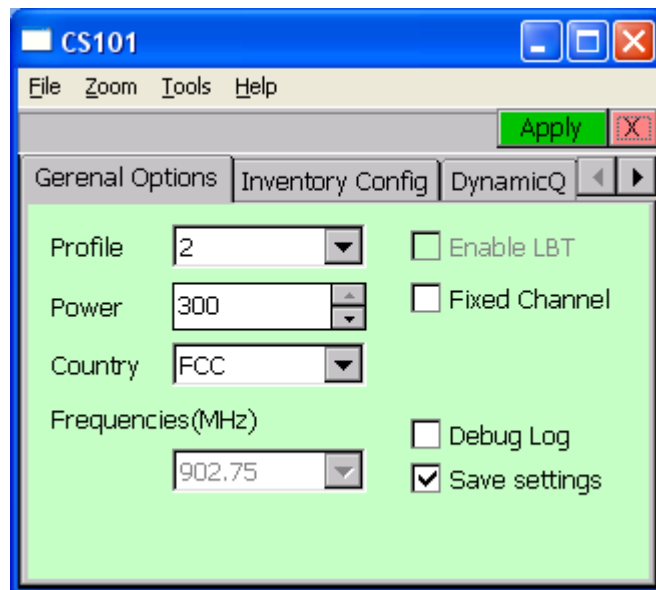
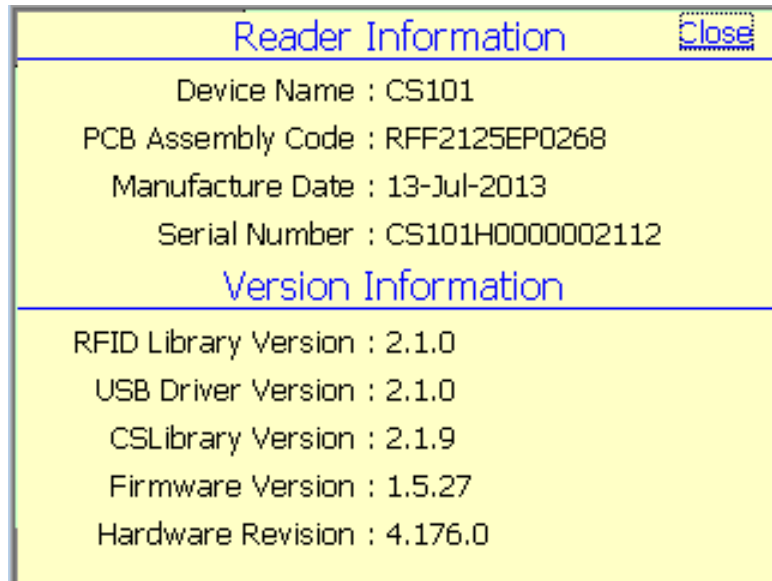


Figure 5-3 Setup Screen

## 6.4 Reader Information

You can check the current reader configuration in the “Reader Information”. Whenever the reader is stayed in the idle state (not during reading or writing the tags), you can press the function key “F1” to display the reader configuration information, it is convenient to review the reader information.



**Figure 5-4 Reader Information**

## 6.5 Tag Inventory

Tag inventory provides an efficient way to read and count all tags at a time. In tag inventory, a duplicate filter is implemented to filter out the tags with same EPC ID, hence the tags with same EPC ID will not be displayed on the screen more than once. The function is most useful for warehouse inventory or whatever kind of inventory where you want to know the unique tags in the environment.

Besides the EPC ID, you can also read the PC (Protocol Control) field of the tags.

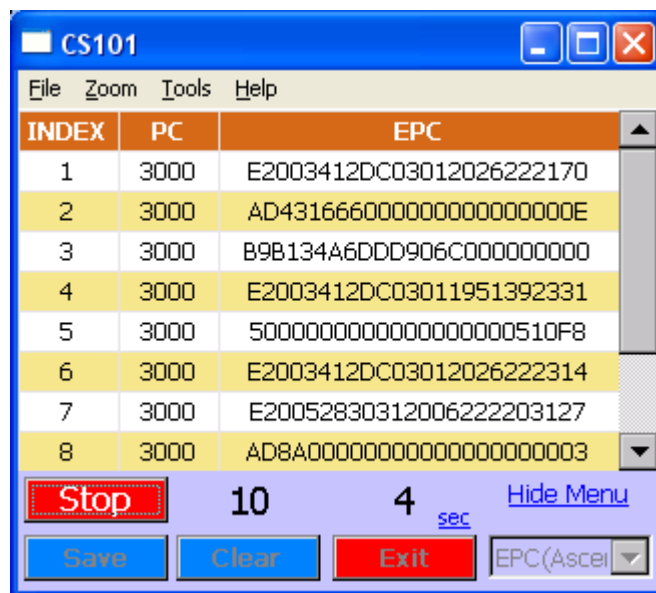


Figure 5-5 Tag Inventory Operation



## 6.7 Setting Up the Language on CS101

CS101 supports different language including English, Simplified Chinese, Traditional Chinese and Japanese (for CS101-3 Japan reader only). This language setting can be changed on the operating system.

Go to “Regional Settings” by clicking Start” → “Settings” → “Control Panel”



Figure 5-5 Regional Settings

In “Regional and Language Settings”, select the “Language” tag



Figure 5-6 Language in Regional Settings

Select the language on the pull-down list and click “OK” button. The reader will reboot automatically and the new language setting will be effective after the reboot.



**Figure 5-7 Select Japanese language on CS101-3 reader**

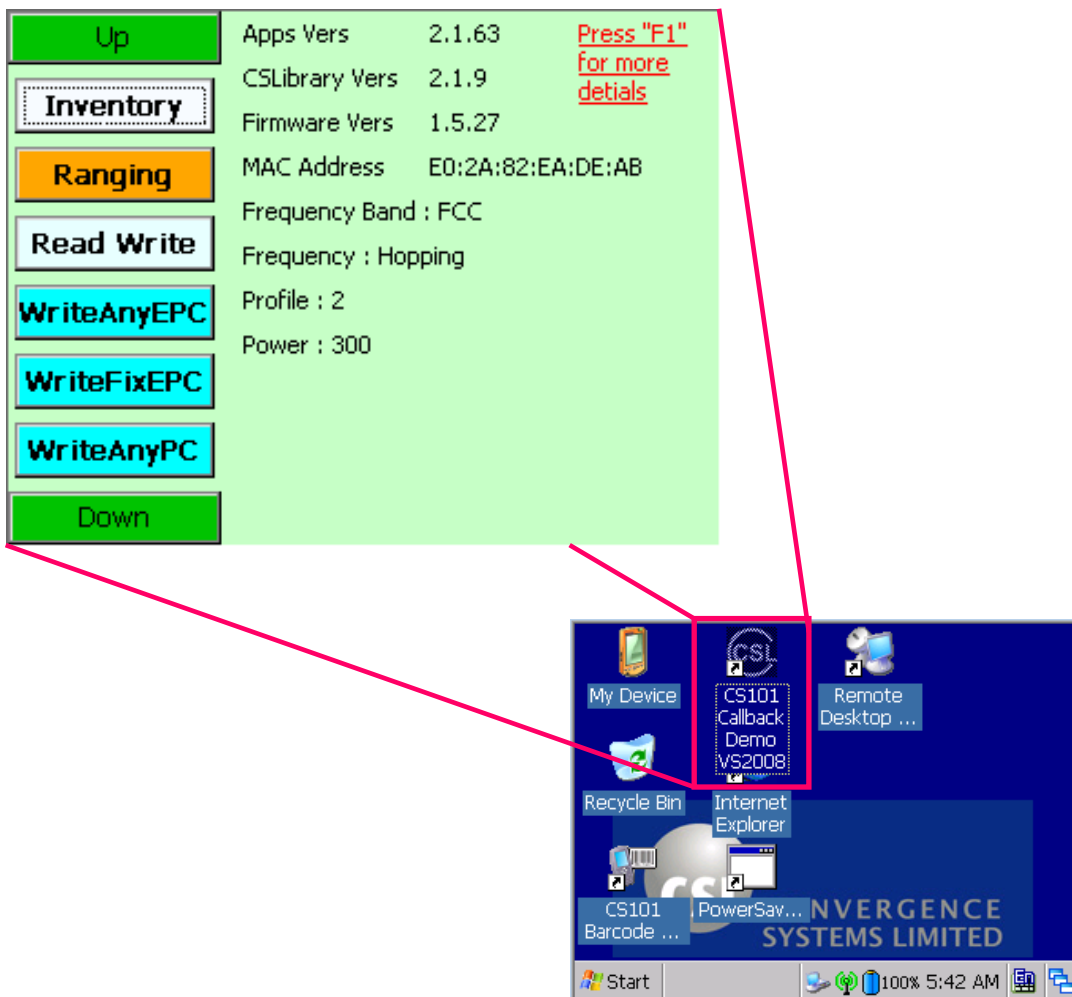
# 7 CS101 .NET Demo Application

## 7.1 Introduction

The CS101 WinCE screen contains a short cut called CS101 .NET DemoApp. Please double click that short cut to start the application. You are recommended to use this new DemoApp for testing or refer it for software development. For Demo Application API programming details, please refer to the document “CS101 Callback-based API 2.0 Programmer’s Manual”.

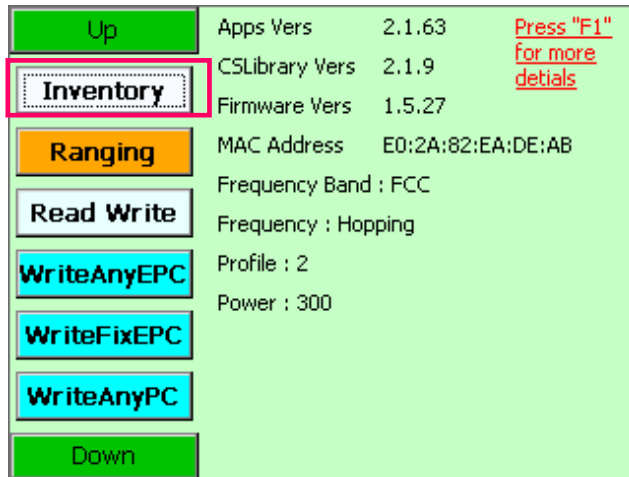
## 7.2 Main Menu

In main menu of the CS101 .NET Demo App, the configuration information of the reader is shown and you can select the various functions.

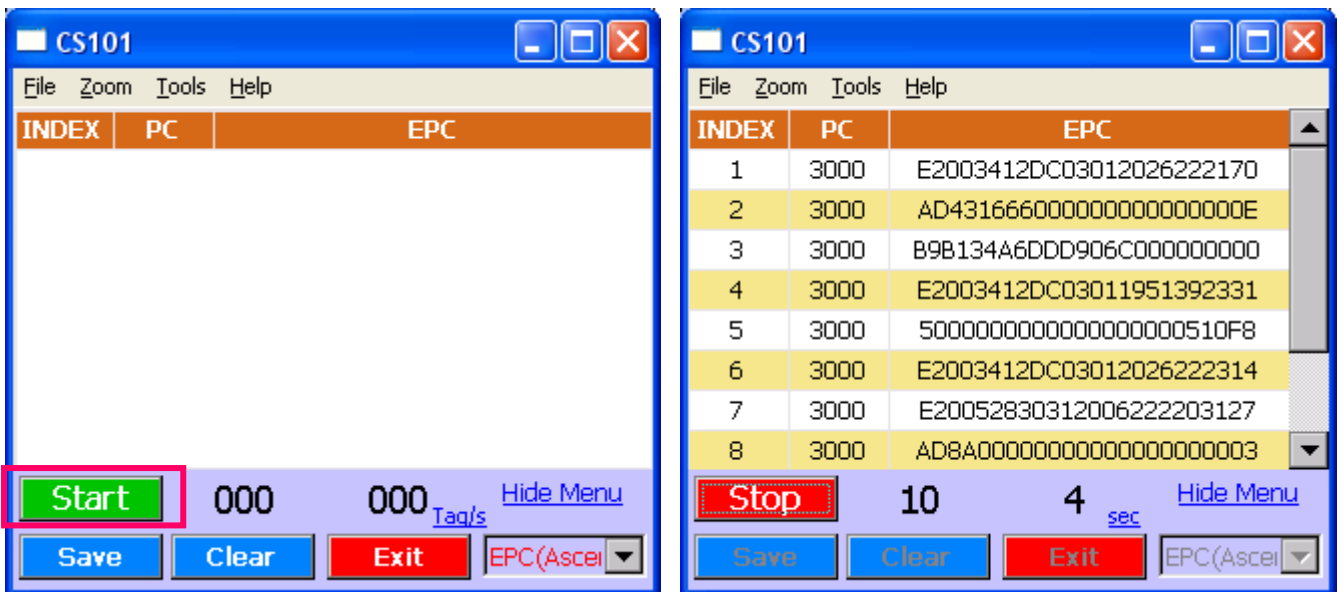


### 7.3 Inventory

This page demonstrates the tag inventory function (TAG\_INVENTORY) for reading tags continuously with the RSSI value and read count displayed.

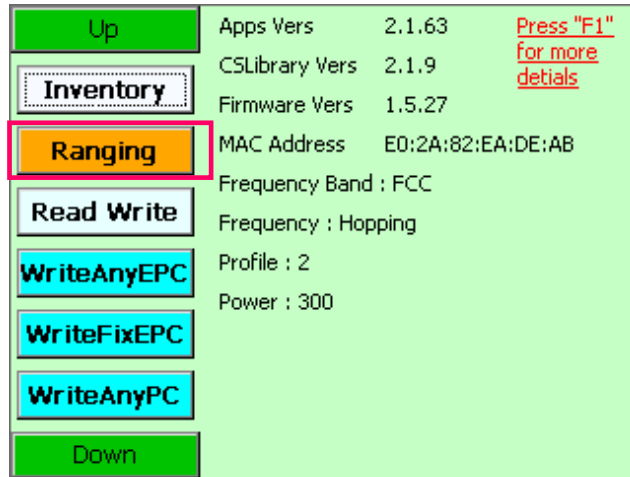


Click the "Start" button to start reading tags.

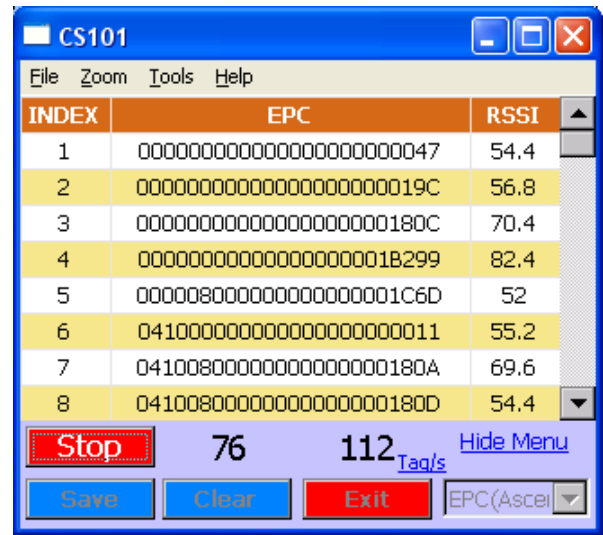
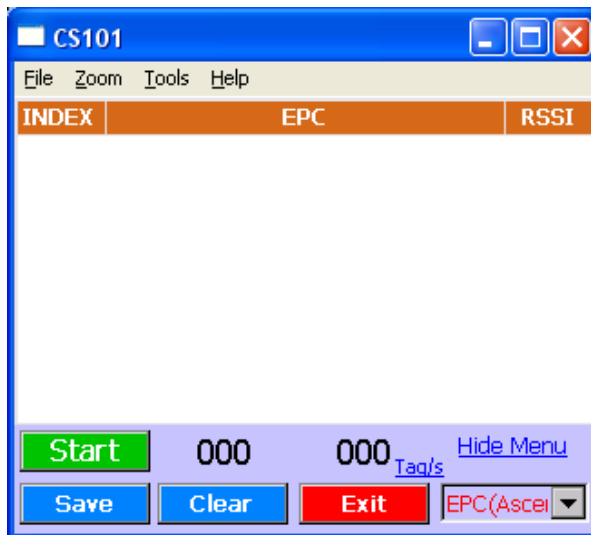


## 7.4 Ranging

This page demonstrates the function of reading tags by the TAG\_RANGING API function. It reads tags continuously with the RSSI value and read count displayed.

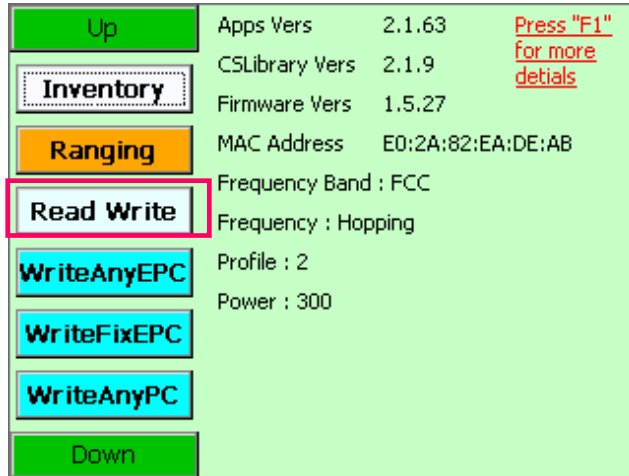


Click the “Start” button to start reading tags.

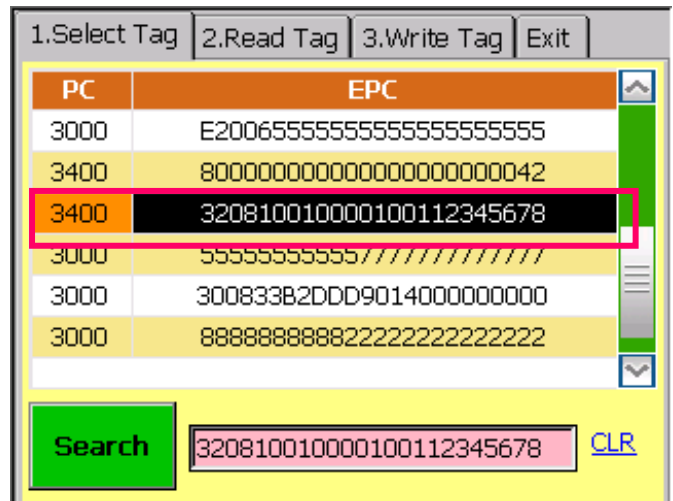
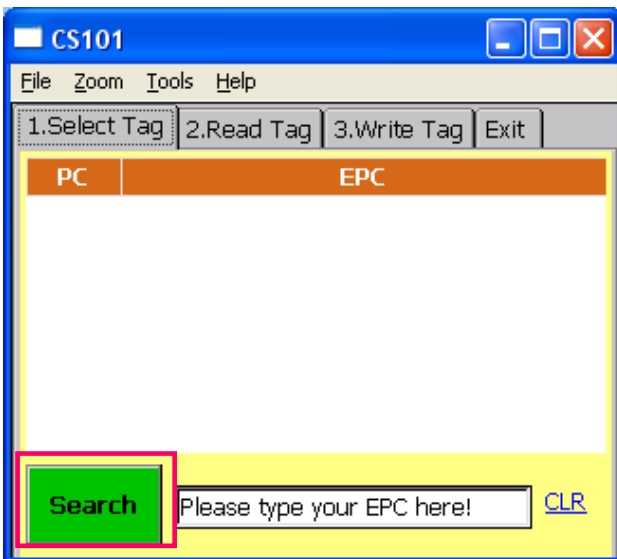


## 7.5 Read / Write

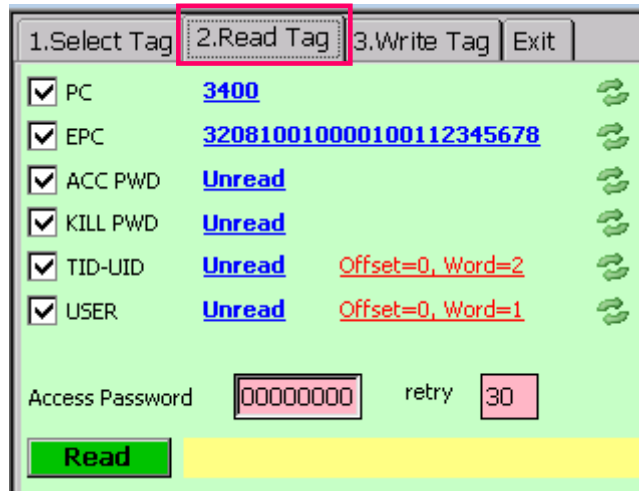
This page demonstrates the function of reading and writing different memory banks of a selected tag.



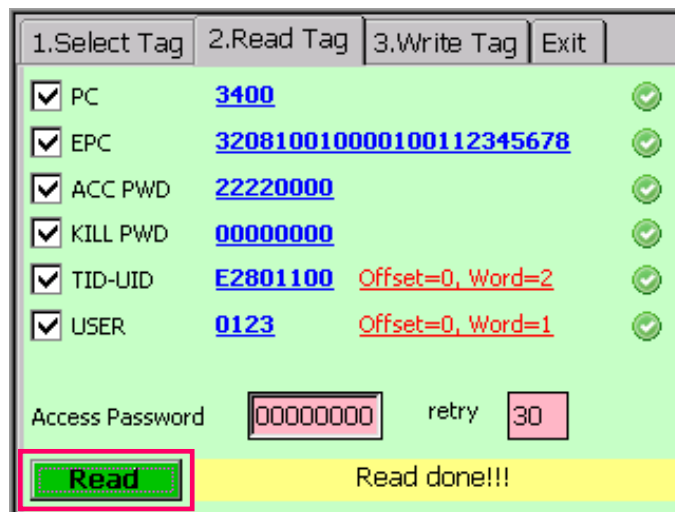
Click on the “Search” button to scan for and select the tag you want to access.  
Select the tag on the list



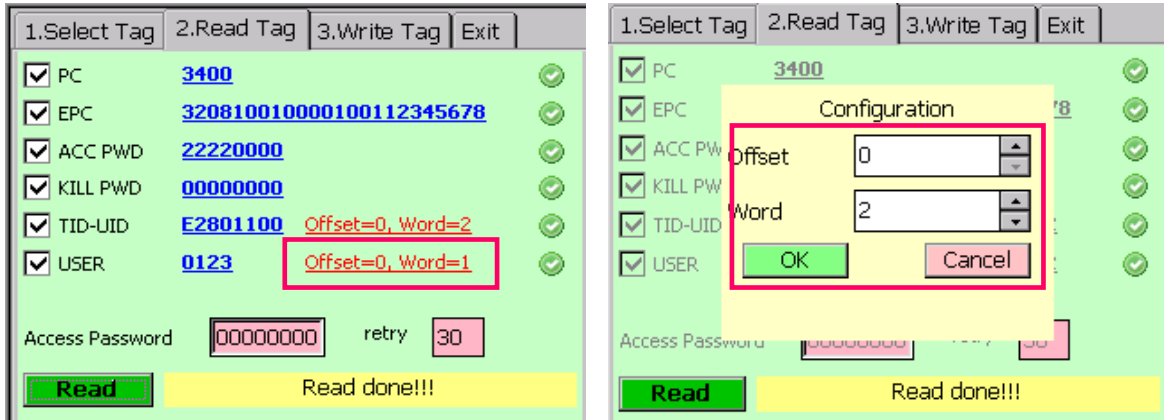
**Read the tag:** After the tag is selected, you can click the “2. Read Tag” tab to read the memory banks of this tag.



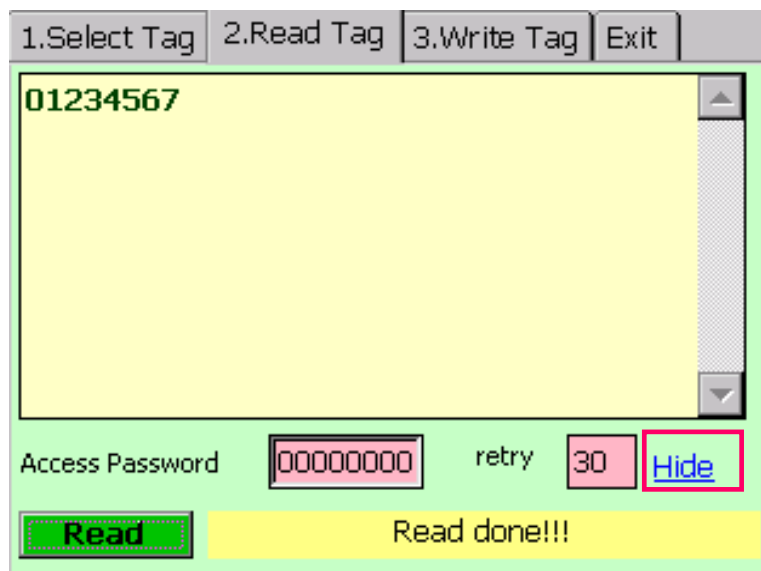
Click on the “Read” button to read all the memory banks

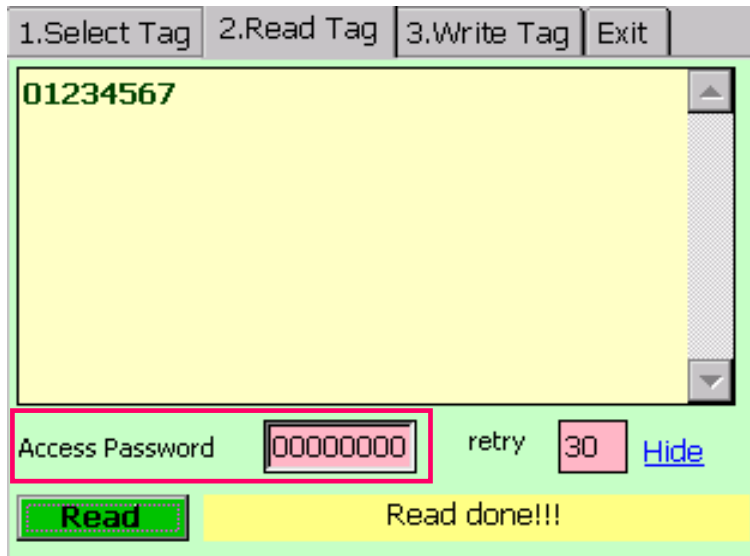


For the “User Memory” bank, you could also change the offset word and length of words you want to read. After entering the [**Offset=0, Word=1**] (in terms of words), user can configure the offset value of User Bank and number of Data Words to be read. Press [**OK**] to confirm.



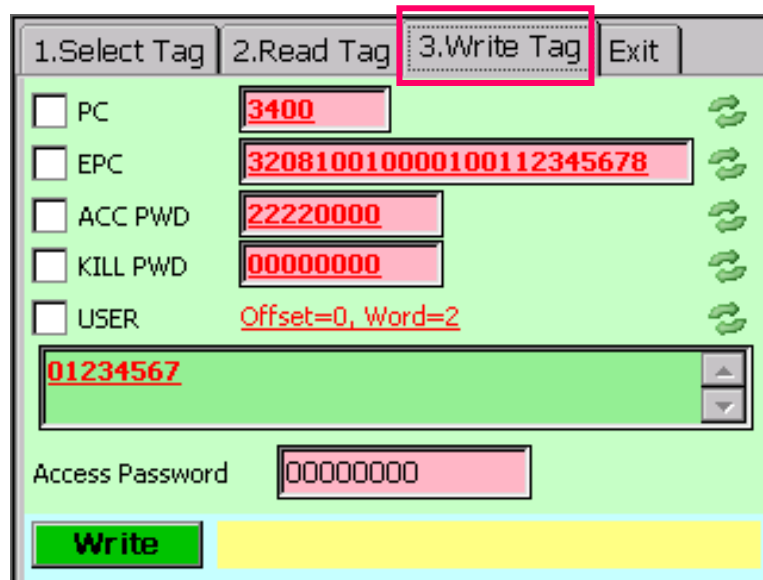
If the data in user memory read is displayed on screen, click the link [**Hide**] to return to the previous menu.





If the memory bank is locked, input the access password in “Access Password” field to read the tag data.

**Write the tag:** Click on the “3.Write Tag” tab on the top to write data on the selected tag memory banks.



Tick the checkbox(es) of the memory bank(s) you want to write. Input the new data of that field(s) and then click the **[Write]** button to write the new data.

The screenshot shows the '3. Write Tag' menu with the following fields and values:

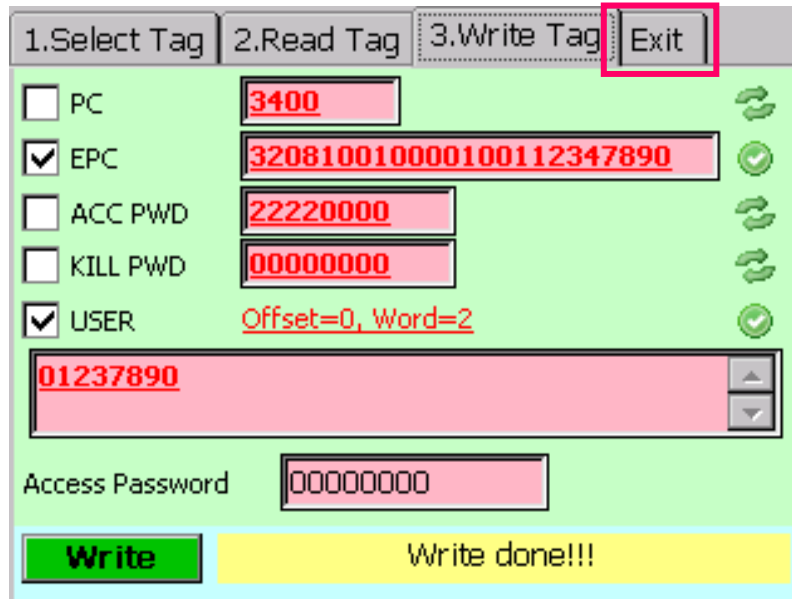
- 1.Select Tag | 2.Read Tag | 3.Write Tag | Exit
- PC | 3400
- EPC | 320810010000100112347890
- ACC PWD | 22220000
- KILL PWD | 00000000
- USER | Offset=0, Word=2
- 01237890
- Access Password | 00000000
- Write** button

The screenshot shows the '3. Write Tag' menu with the following fields and values:

- 1.Select Tag | 2.Read Tag | 3.Write Tag | Exit
- PC | 3400
- EPC | 320810010000100112347890
- ACC PWD | 22220000
- KILL PWD | 00000000
- USER | Offset=0, Word=2
- 01237890
- Access Password | 00000000
- Write** button

If the memory bank is locked, input the access password in **[Access Password]** field to write the tag.

**Exit Read/Write:** To exit this Read/Write function, click the **[Exit]** tab.

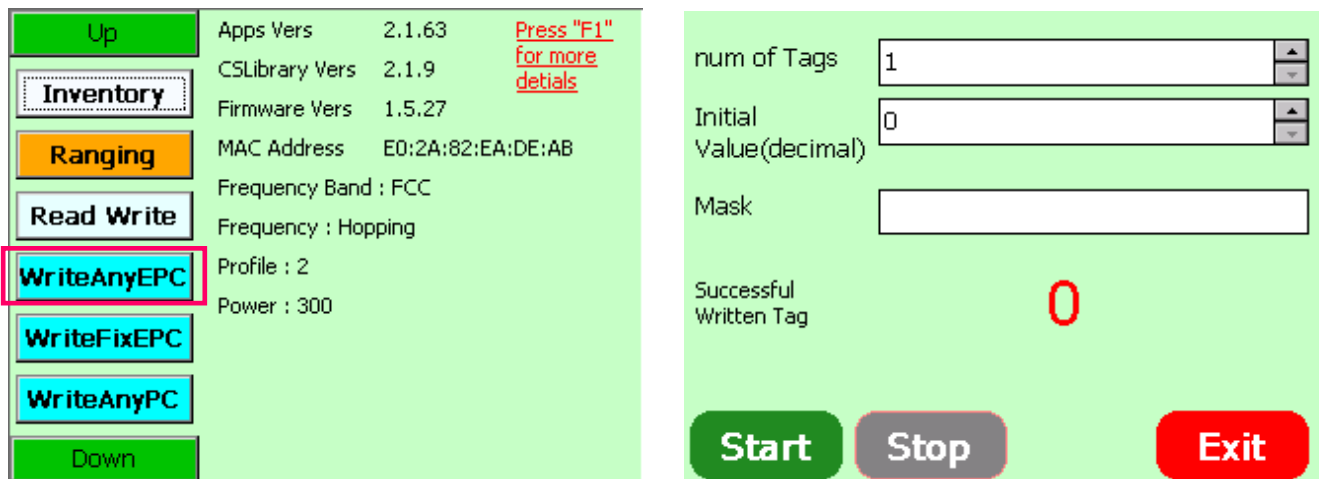


## 7.6 Write EPC and PC

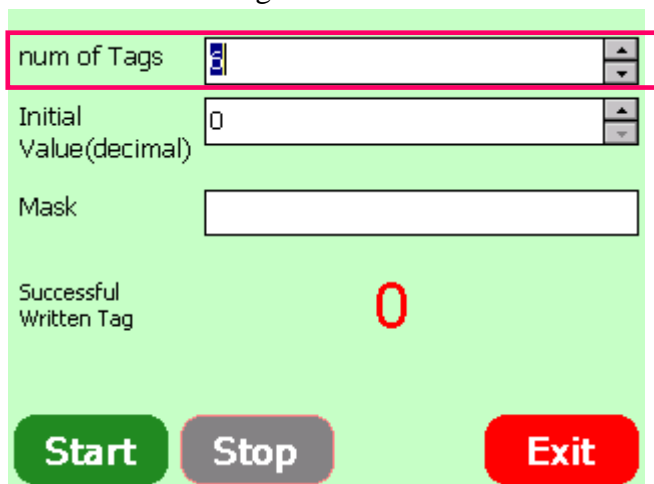
CS101 can write EPC and PC data to the Tag with EPC and PC ID specified.

### 7.6.1 Write Any EPC

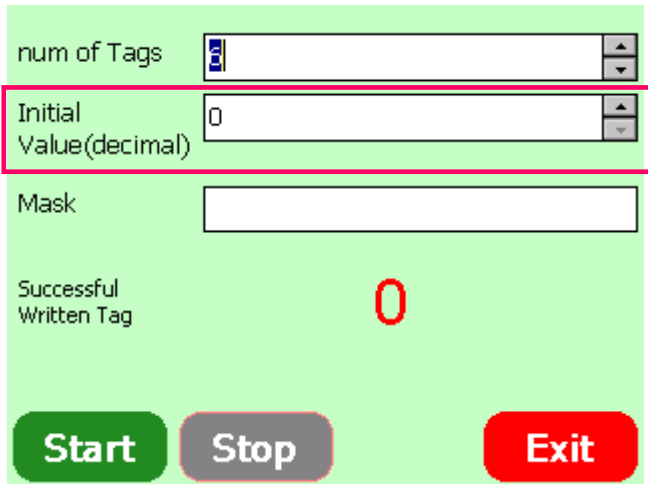
1. Choose [WriteAnyEPC] in the menu.



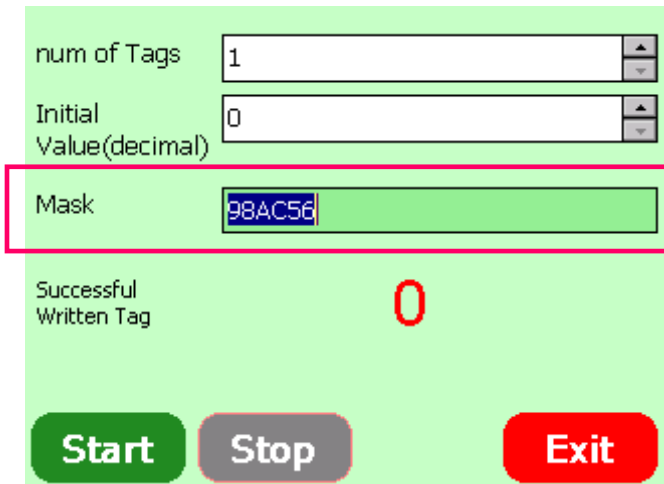
2. Set the number of tags to be written.



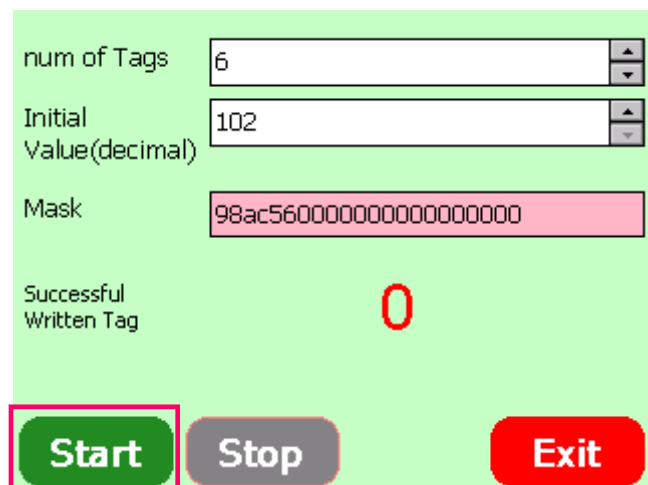
3. Set the initial value to be written.



4. Set the Mask value for the tags to be written.

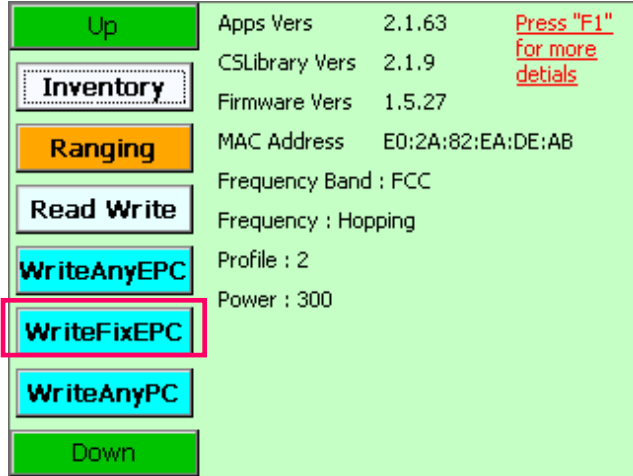


5. Press [Start] to start new EPC value writes to the tags.

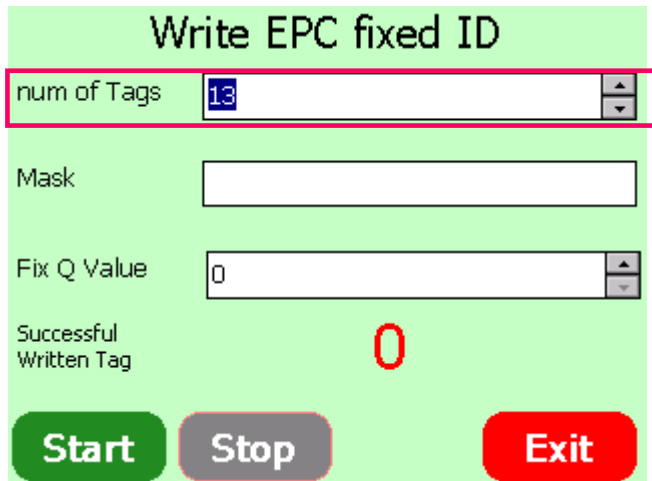


## 7.6.2 Write Fix EPC

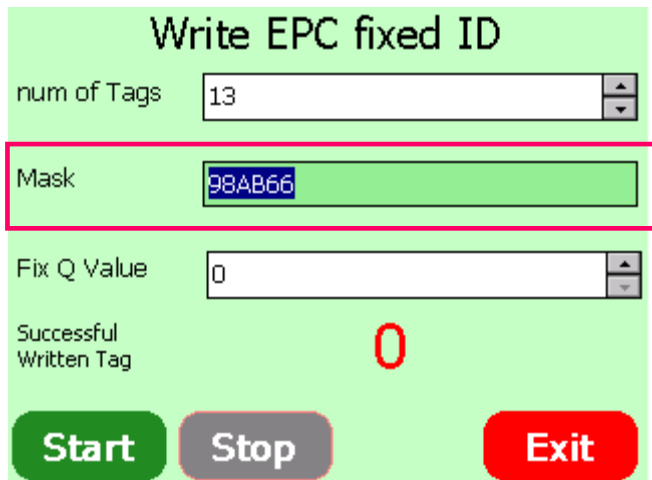
1. Choose [WriteFixEPC] in the menu.



2. Set the number of tags to be written.



3. Set the Mask value for the tags to be written.



- 4. Input the Fix Q Value for the tags.

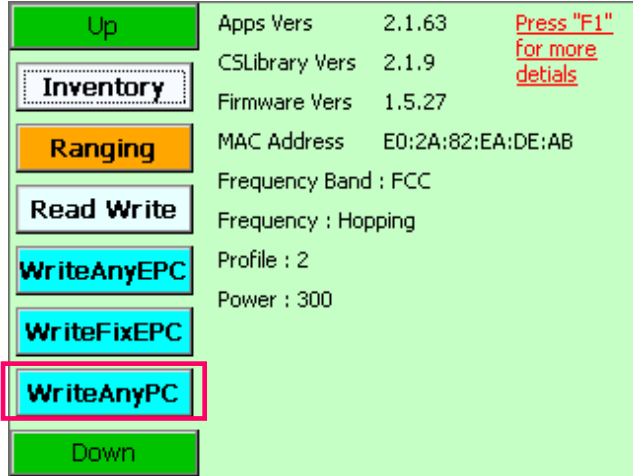
The screenshot shows the 'Write EPC fixed ID' menu. It features a light green background with the title 'Write EPC fixed ID' at the top. Below the title are three input fields: 'num of Tags' with the value '13', 'Mask' with the value '98AB660000000000000000000000', and 'Fix Q Value' with the value '7'. The 'Fix Q Value' field is highlighted with a red rectangular border. Below these fields, the text 'Successful Written Tag' is followed by a large red '0'. At the bottom, there are three buttons: a green 'Start' button, a grey 'Stop' button, and a red 'Exit' button.

- 5. Press [Start] to start new EPC value writes to the tags.

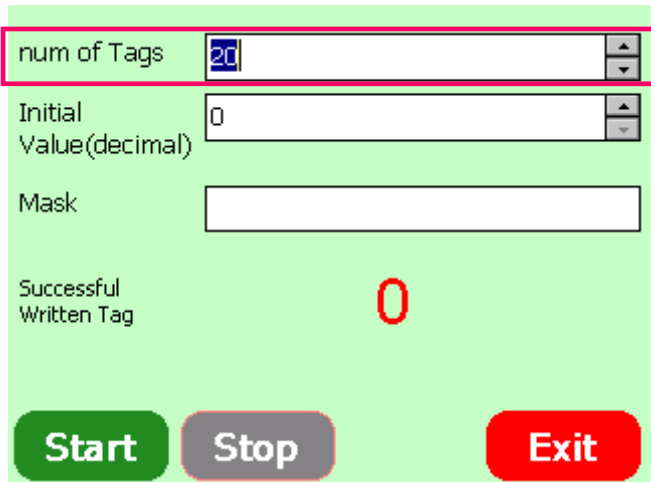
This screenshot is identical to the previous one, showing the 'Write EPC fixed ID' menu with the same values in the input fields. However, in this image, the green 'Start' button at the bottom left is highlighted with a red rectangular border.

### 7.6.3 Write Any PC

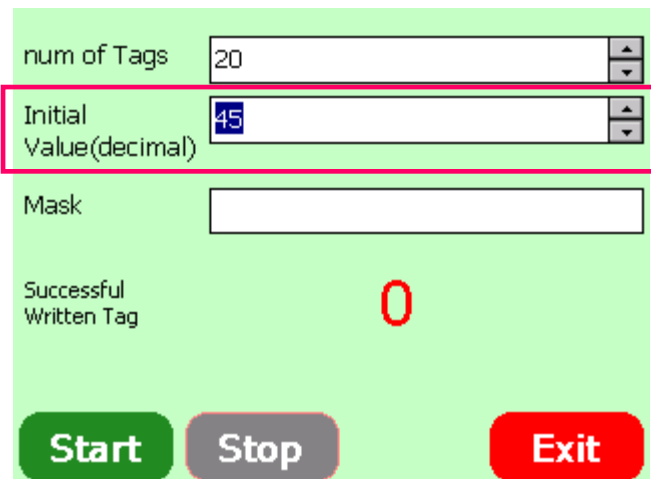
1. Choose [WriteAnyPC] in the menu.



2. Set the number of tags to be written.



3. Input the Initial value for the tags.



- 4. Set the Mask value for the tags to be written.

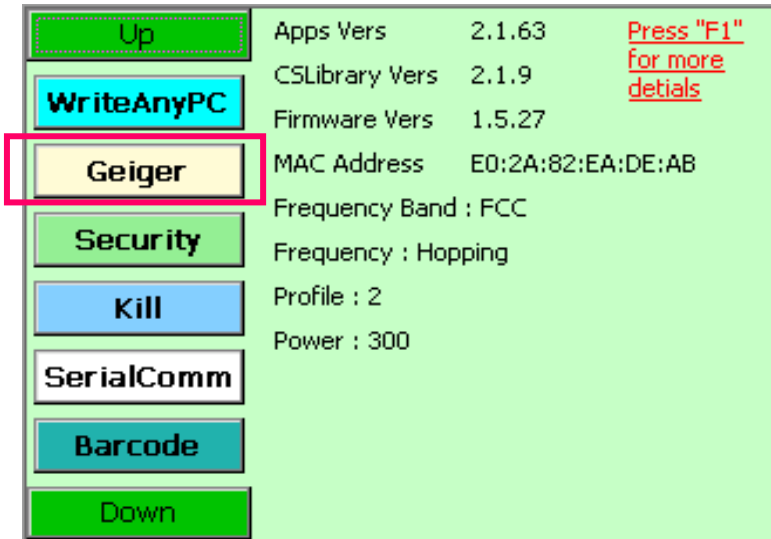
The screenshot shows a menu titled "Write EPC fixed ID" with a light green background. It contains three input fields: "num of Tags" with the value 20, "Initial Value(decimal)" with the value 45, and "Mask" with the value 7788AB333300000000000000. The "Mask" field is highlighted with a red rectangular border. Below the fields, the text "Successful Written Tag" is followed by a large red "0". At the bottom, there are three buttons: "Start" (green), "Stop" (grey), and "Exit" (red).

- 5. Press [Start] to start new PC value writes to the tags.

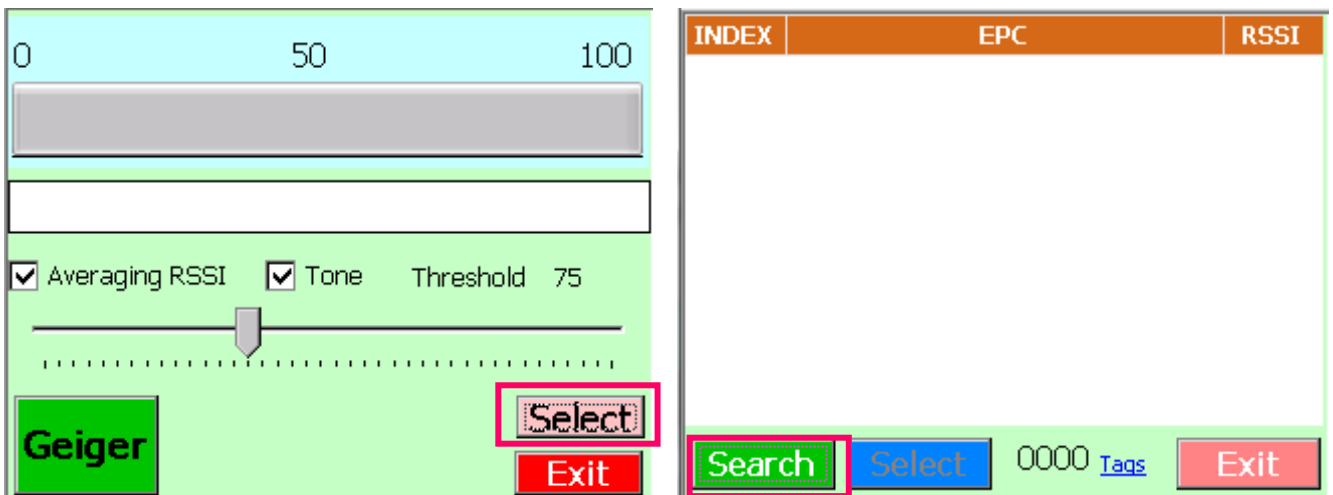
The screenshot shows the same "Write EPC fixed ID" menu. The "num of Tags" field now has the value 13, and the "Mask" field has the value 98AB6600000000000000000000. The "Fix Q Value" field has the value 7. The "Successful Written Tag" text is still followed by a large red "0". The "Start" button at the bottom left is highlighted with a red rectangular border.

## 7.7 Geiger Counter Search

This page demonstrates the Geiger counter tag search mode. Input the EPC ID of the tag (or partial of the EPC ID) you want to search and then click the “Geiger” button.



User should choose the tag before using Geiger Search. Press [Select] button and then click [Search] to check



Press **[Stop]** to stop the search. Click the target tag in the list and press **[Select]**.

INDEX	EPC	RSSI
0	300833B2DDD906C00000DDDD	59.2
1	55555555557777777777	52.8
2	22226666666666666655555555	53.6
3	E200655555555555555555555	58.4
4	320810010000100112347890	63.2
5	888888888822222222222222	57.6
6	18731BAE	49.6
7	800000000000000000000042	57.6
8	555566663C00000012095F18	59.2

16 Tags

**Stop** **Select** **Exit**

INDEX	EPC	RSSI
0	300833B2DDD906C00000DDDD	59.2
1	55555555557777777777	52.8
2	22226666666666666655555555	53.6
3	E200655555555555555555555	58.4
4	320810010000100112347890	63.2
5	888888888822222222222222	57.6
6	18731BAE	49.6
7	800000000000000000000042	57.6
8	555566663C00000012095F18	59.2

21 Tags

**Search** **Select** **Exit**

Press **[Geiger]** to start the Geiger Search.

When the tag is seen, it shows the RSSI value with the beep sound effect.

Press **[Stop]** and **[Exit]** after use.

0 50 100

320810010000100112347890

Averaging RSSI  Tone Threshold 75

**Geiger** **Select** **Exit**

0 50 100

320810010000100112347890

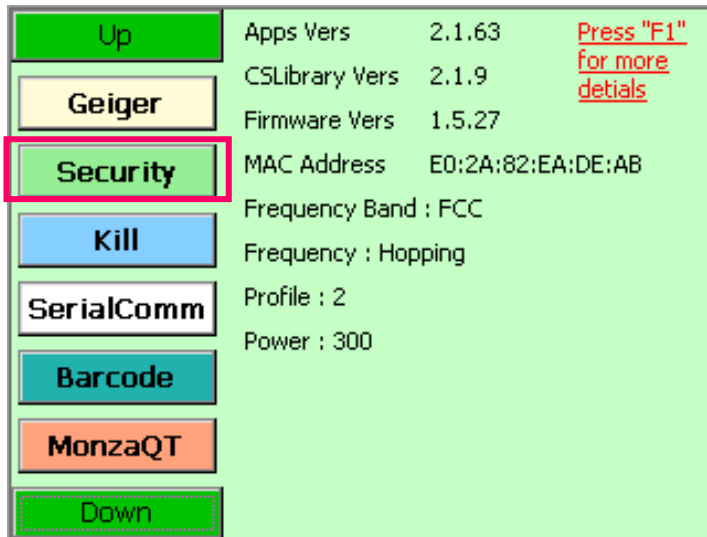
Averaging RSSI  Tone Threshold 75

**Stop** **Select** **Exit**

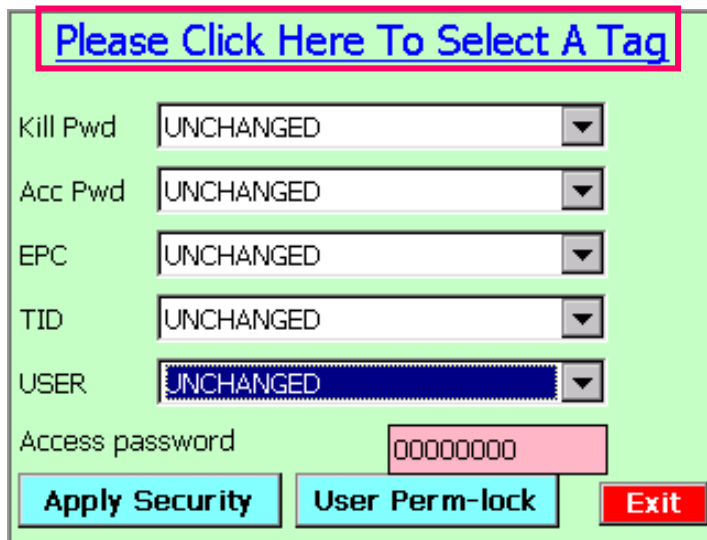
60

## 7.8 Tag Security

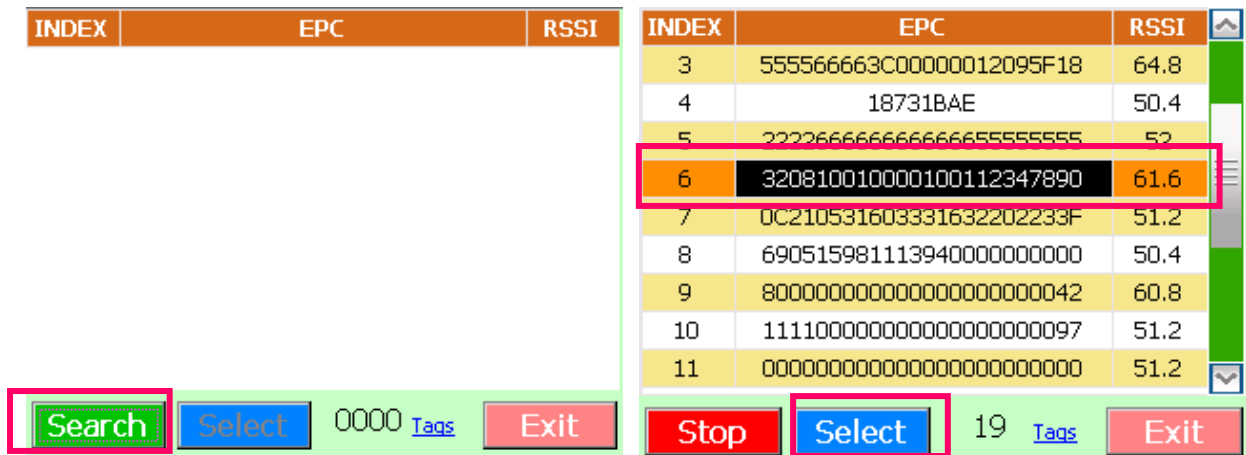
This page demonstrates the tag security operations (lock and unlock).



Click the link [[Please Click Here To Select A Tag](#)] to scan for the tag

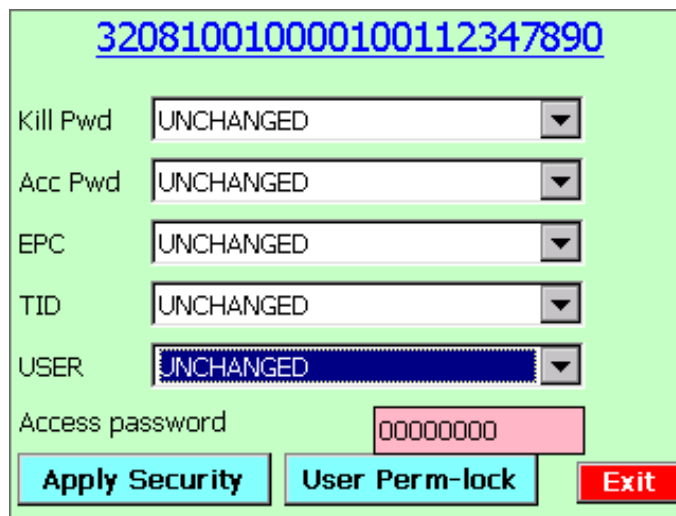


When user presses **[Search]** the searched tags will be displayed.  
 Select the tag you want to apply security and click **[Select]** button.



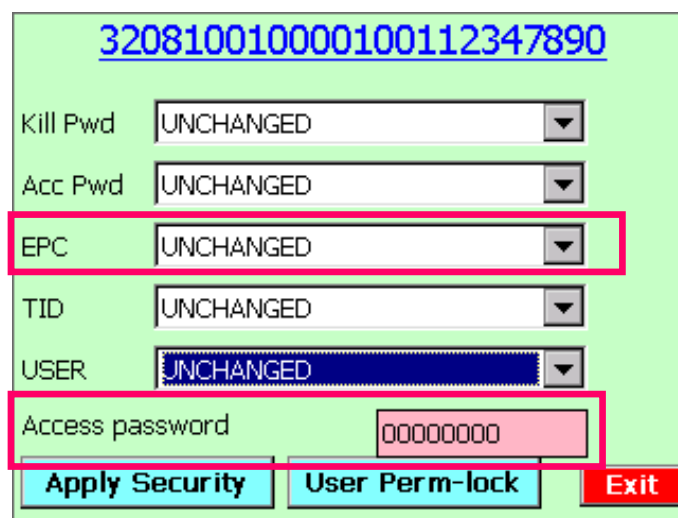
After the tag is selected, select the security you want to apply on each memory bank.  
 For Kill Password (Kill Pwd) and Access Password (Acc Pwd) banks:

- UNLOCK: Unlock the bank – allow user to read and write it without access password
- PERM\_UNLOCK: Permanently unlock the bank – allow user to read and write it forever without access password (cannot lock it again)
- LOCK: Lock the bank – cannot read and write the tag, need access password to unlock it
- PERM\_LOCK: Permanently lock the bank – cannot read and write the tag forever (cannot unlock it again)
- UNCHANGED: Keep the existing security state



For EPC and User Memory (USER) banks:

- UNLOCK: Unlock the bank – allow user to write it without access password
- PERM\_UNLOCK: Permanently unlock the bank – allow user to write it forever without access password (cannot lock it again)
- LOCK: Lock the bank – cannot write the tag, need access password to unlock it
- PERM\_LOCK: Permanently lock the bank – cannot write the tag forever (cannot unlock it again)
- UNCHANGED: Keep the existing security state



320810010000100112347890

Kill Pwd UNCHANGED

Acc Pwd UNCHANGED

EPC UNCHANGED

TID UNCHANGED

USER UNCHANGED

Access password 00000000

Apply Security User Perm-lock Exit

After the security state is selected, enter the access password in “Access Password” field. If the access password field of the tag is “00000000”, that means no password is set on the tag and it could not be locked. Please write the access password on the tag in “Read/Write” function first.

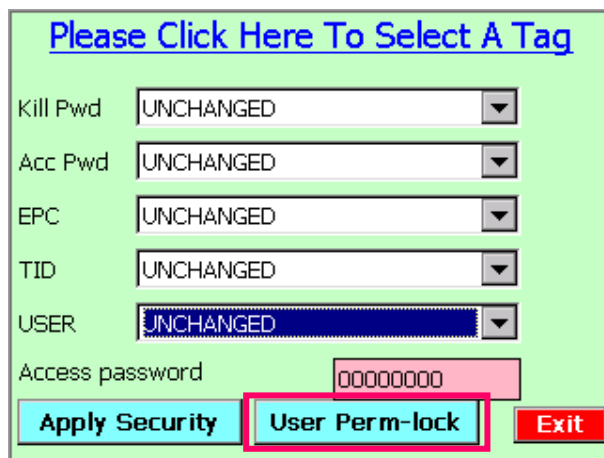
Click the [**Apply Security**] button to set the security on the tag’s memory bank(s).

**User Perm-lock**

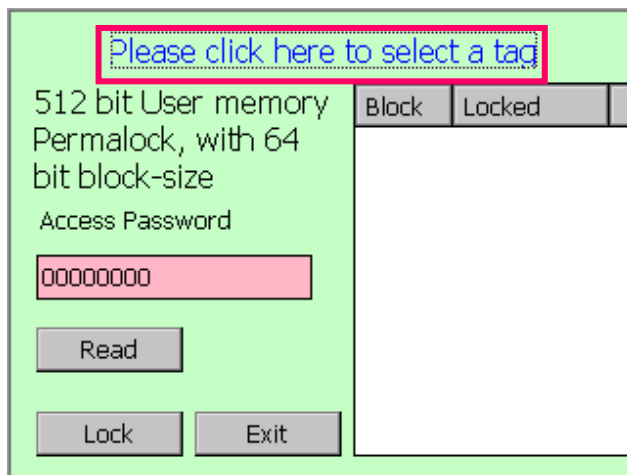
In Tag Security, the “User Perm-lock” function is used for block-level (64 bits) Perma-lock of tag’s user memory. This function is only applicable for new tag that is compliant with the EPC Class 1 Gen 2 Tag Specification v1.2. Moreover, this function is only support on CS101 with firmware version 1.3.68 or above.

To perma-lock the 64-bits block of user memory:

- 1) Click [**User Perm-lock**] button to enter the block perma-lock page.



- 2) Click link [**Please click here to select a tag**] to scan and select the tag you want to lock



3) Search and Select the target tag.

INDEX	EPC	RSSI
3	555566663C00000012095F18	64.8
4	18731BAE	50.4
5	222266666666666655555555	52
6	320810010000100112347890	61.6
7	0C210531603331632202233F	51.2
8	690515981113940000000000	50.4
9	800000000000000000000042	60.8
10	111100000000000000000097	51.2
11	000000000000000000000000	51.2

0000 Tags

19 Tags

4) Enter the correct Access Password of the tag

320810010000100112347890

512 bit User memory  
Permalock, with 64  
bit block-size

Access Password

00000000

Read

Lock Exit

Block	Locked

5) Click [Read] button to read the status of each block (64 bits) of the user memory

320810010000100112347890

512 bit User memory  
Permalock, with 64  
bit block-size

Access Password

00000000

Read

Lock Exit

Block	Locked

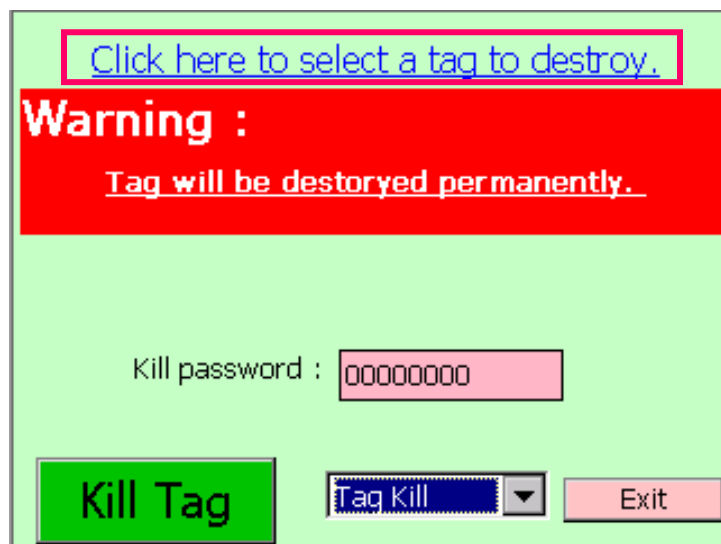
- 6) In order to change the lock status of a block, right-click on the block you want to lock and select "Permalock" on the pull-down list.
- 7) Make sure the correct Access Password is entered and then click "Lock" button to perma-lock the block(s)
- 8) The blocks permalock status will be changed.

## 7.9 Kill

This page demonstrates the Kill Tag operation.



Click the link "[Click here to select a tag to destroy](#)" to scan and select the tag

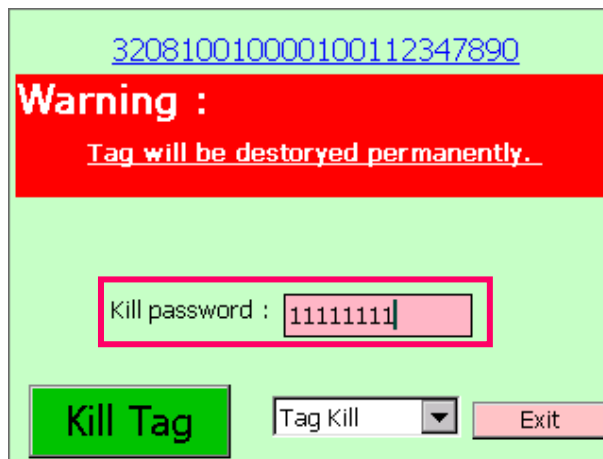


INDEX	EPC	RSSI
3	555566663C000000012095F18	64.8
4	18731BAE	50.4
5	222266666666666655555555	52
6	320810010000100112347890	61.6
7	0C210531603331632202233F	51.2
8	690515981113940000000000	50.4
9	800000000000000000000042	60.8
10	111100000000000000000097	51.2
11	000000000000000000000000	51.2

<b>Search</b>	Select	0000 Tags	Exit
Stop	Select	19 Tags	Exit

After the tag is selected, enter the kill password of the tag as below. If the kill password of the tag is set as “00000000”, that means no password is set on the tag and it could not be killed. Please write the password on the tag in “Read/Write” function first.



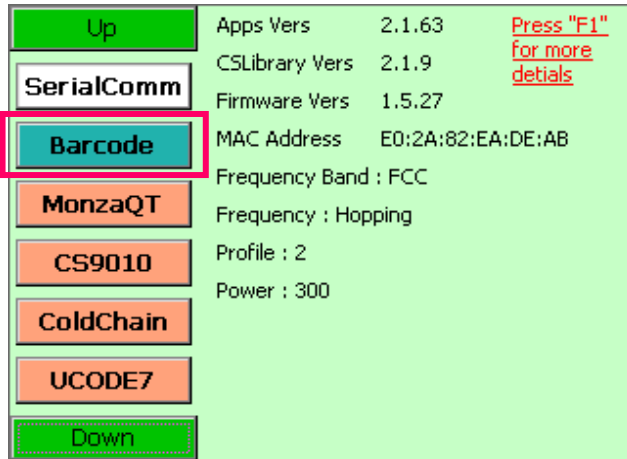
After that, click the [Kill Tag] button to kill the tag.



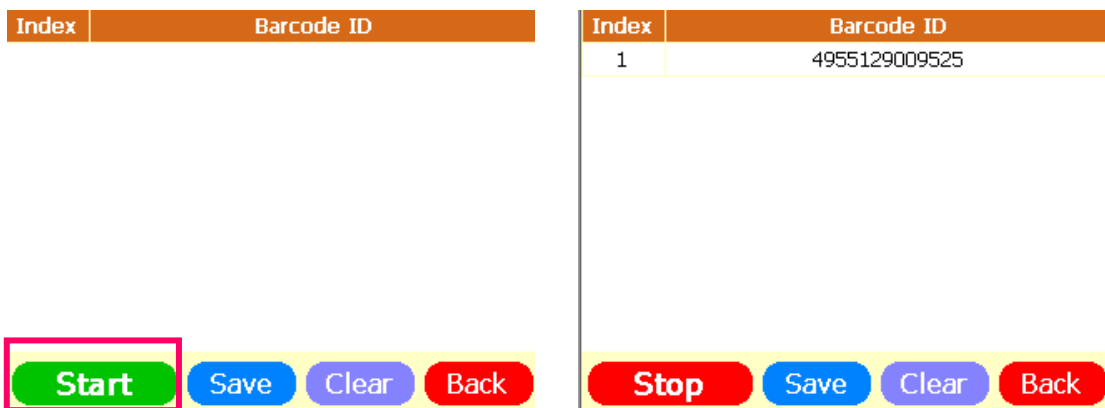
There are 4 options: [Tag Kill], [Disable Permlock], [Disable User Memory], [Unlock all banks].

## 7.10 Barcode

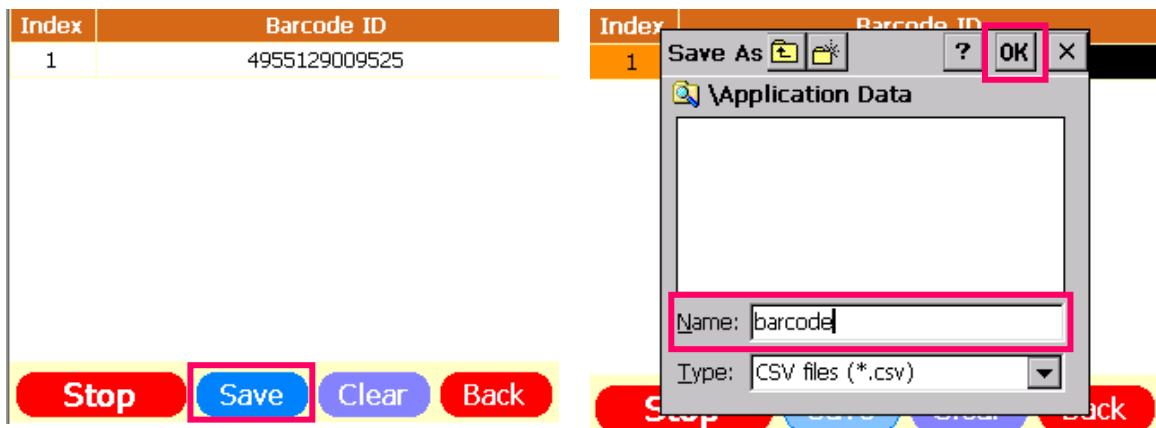
This page demonstrates the barcode scanning function of the reader, both 1-D and 2-D barcodes.



Click the “Start” button or press the trigger key to start reading barcode.



The Barcode ID record can be saved as CSV file.

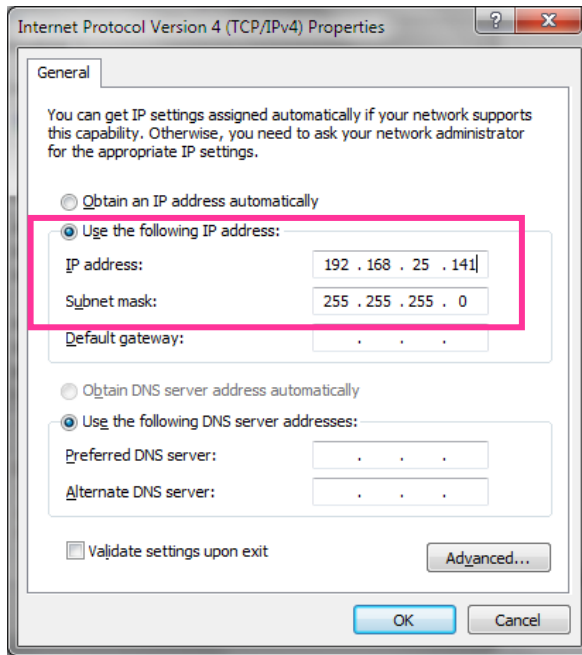


## 7.11 UDPout

CS101 can pass the received tag data to PC real time using **UDPout** mode.

1. To begin, the PC with Port Forwarding IP address in the intranet is required.

In “**Internet Protocol Version 4 (TCP/IPv4) Properties**”, set the PC IP address to fixed IP address which Port Forwarding is available.



2. Go to CSL website and find “Download & Support”

(<http://www.convergence.com.hk/downloads-support-2/cs101/>)

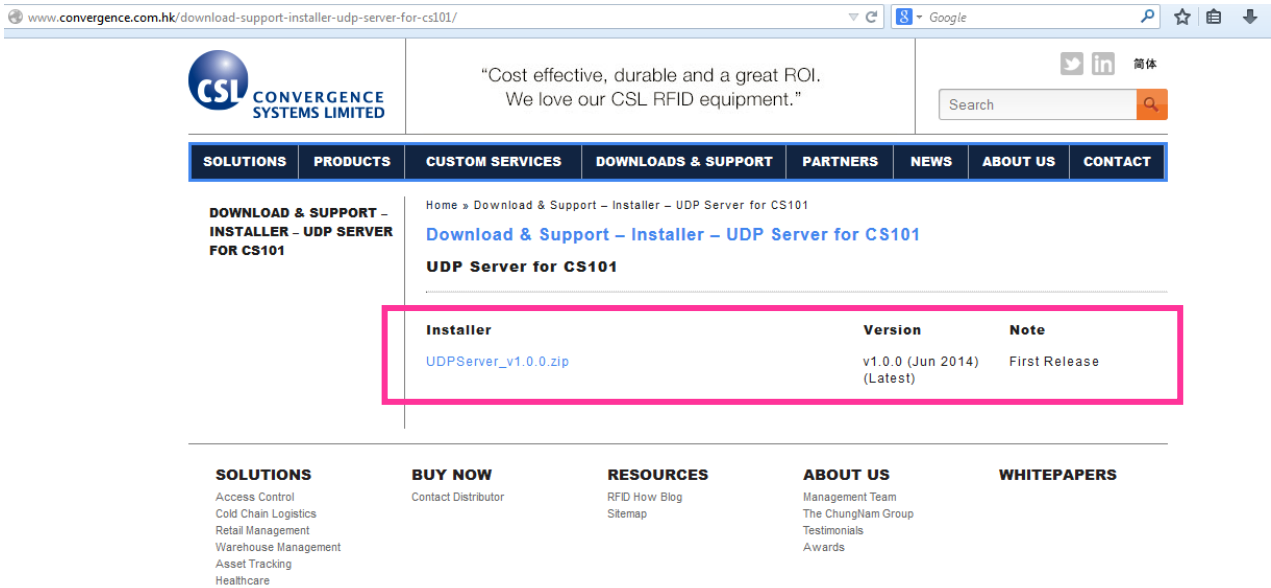
In the section **Demo App**, choose “**UDP Server Demo Program on Window OS ....**”

Installer	Latest Version	Remark
<a href="#">CS101 .NET Demo App on WinCE OS with User Interface</a>	v2.1.63 (Aug 2014)	CS101 .NET Demo App
<a href="#">UDP Server Demo Program on Windows OS using Command Prompt</a>	v1.0.0 (Jun 2014)	UDP Server Demo Program
<a href="#">CS101 Barcode and Snapshot Demo App on WinCE OS with User Interface</a>	v1.0.0 (Jun 2014)	CS101 Barcode and Snapshot Demo in C#.NET
<a href="#">CS101 VB Demo App on WinCE OS with User Interface</a>	v1.0.3 (Jun 2014)	CS101 Demo in VB .NET

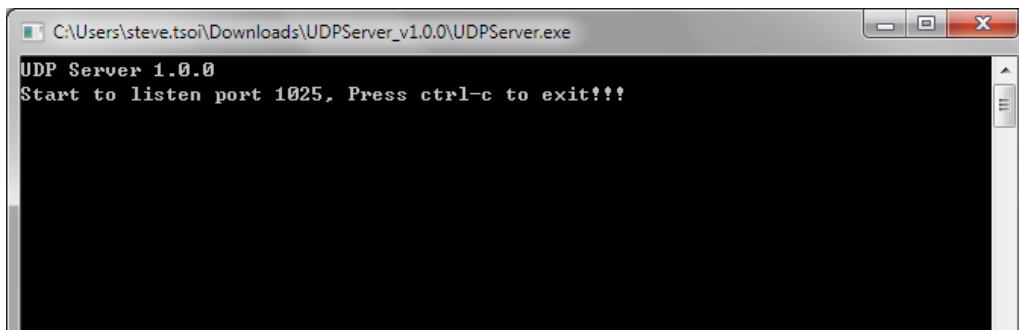
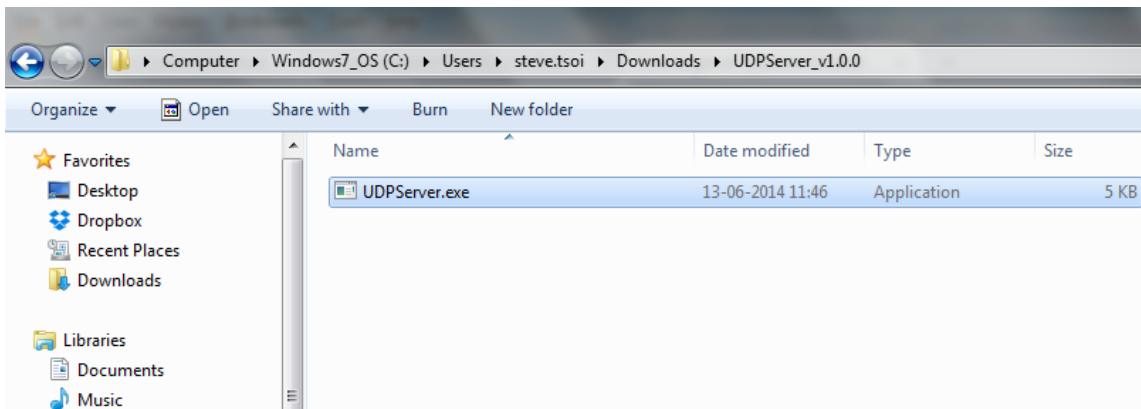
  

Files	Latest Version	Note
<a href="#">Restore CS101 OS to Factory Default Setting</a>	v1.2.1 (Apr 2014)	Guidelines to restore CS101 OS to Factory Default Setting

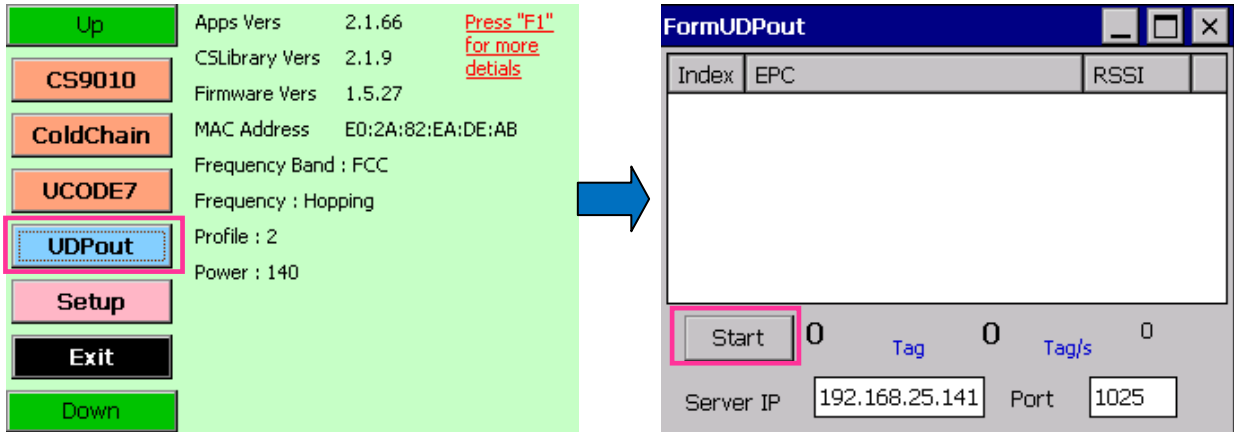
3. Download and unzip the latest version **UDPServer\_vX.X.X.zip**



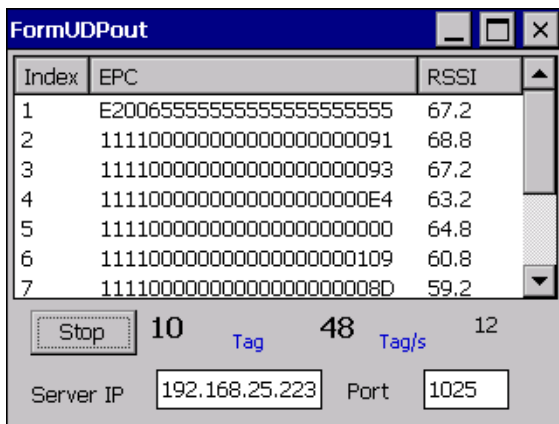
4. In the unzipped folder “UDPServer\_vX.X.X”, Run “UDPServer.exe”.



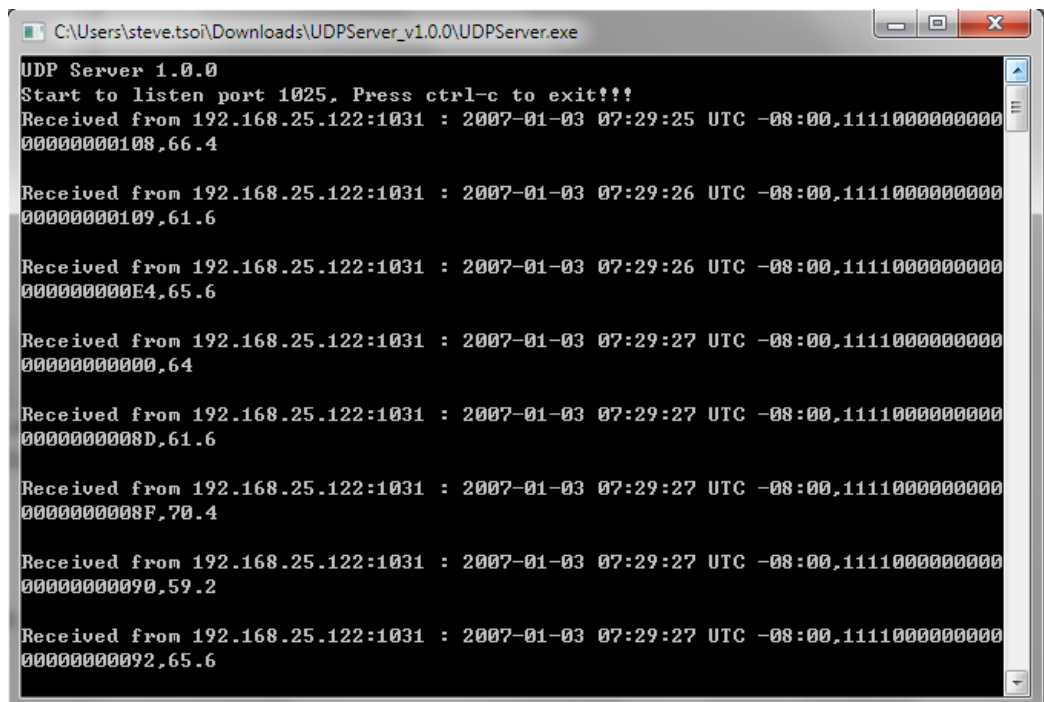
- Check with the CS101 reader. Choose “**UDPout**” mode.  
Press [**Start**] in the form “**FormUDPout**”.



- The tag data is listed out in CS101 and also displayed in the PC UDP Server Demo Program.

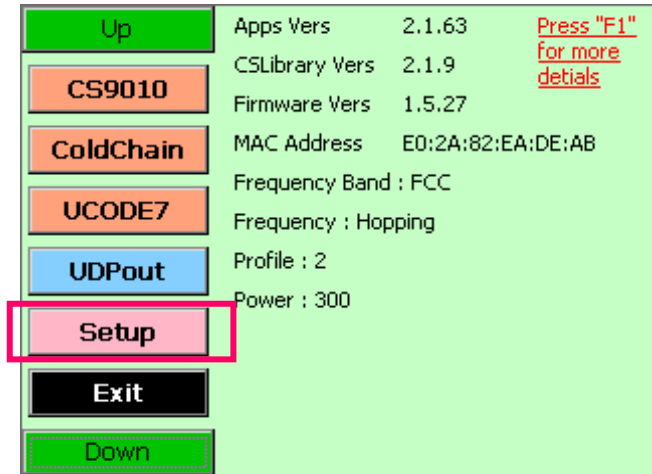


PC UDP Server Demo Program



## 7.12 Setup

This “Setup” page allows the user to perform basic configuration on the reader.



For more information about the Gen 2 parameters, please refer also refer to the EPC Class 1 Gen 2 Specifications.

## General Options

In “General Options”, you could configure the reader’s link profile, power and frequency settings.

**Profile** – default setting is profile 2

**Power** – output power, display value = power x 10 (e.g. 300 = 30dBm)

**Country** – Select the corresponding country the reader operates in

**Enable LBT** – Listen-before-talk option, available for CS203-3 (TELEC) Japanese reader only

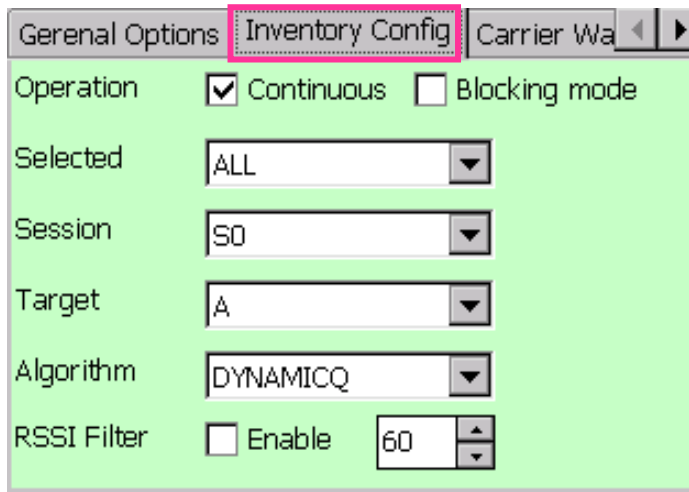
**Fixed Channel** – Option for selecting fixed frequency channel

**Frequencies (MHz)** – Select the channel for fixed frequency channel operation

**Debug Log** – Check this box for generating debug log

**Save settings** – Check this box for saving the settings

## Inventory Config



General Options	Inventory Config	Carrier Wa
Operation	<input checked="" type="checkbox"/> Continuous <input type="checkbox"/> Blocking mode	
Selected	ALL	
Session	S0	
Target	A	
Algorithm	DYNAMICQ	
RSSI Filter	<input type="checkbox"/> Enable 60	

The page allows user to configure the Gen 2 parameters settings for custom inventory operation.

**Operation:** operate in continuous or non-continuous reading (Continuous or Blocking mode)

**Selected:** use select flag or not (ALL, ON, OFF, UNKNOWN)

**Session:** the session number of this reader (S0, S1, S2, S3, UNKNOWN), readers nearby should be configured in different session number

**Target:** the target flag for this reader (A, B, UNKNOWN)

**Algorithm:** the inventory algorithm (FixedQ, DynamicQ, DynamicQ\_Adjust, DynamicQ\_Thresh)

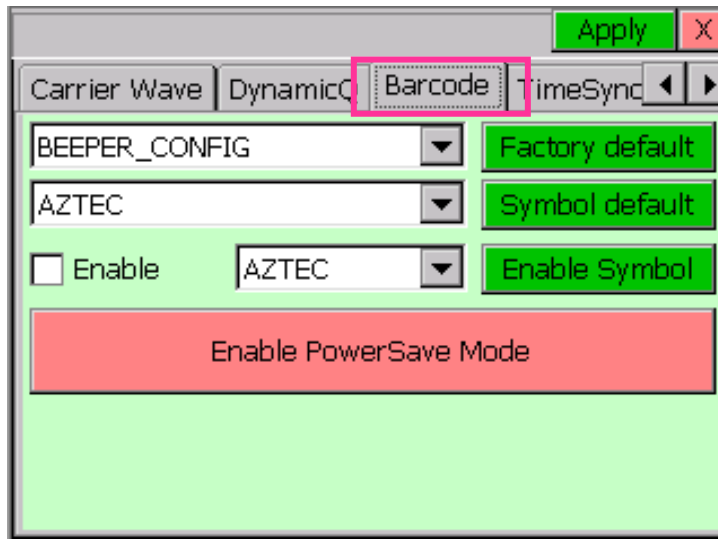
## DynamicQ

Carrier Wave	DynamicQ	Barcode	TimeSync	◀	▶
StartQValue	7				
MinQValue	0				
MaxQueryRep	0				
Retry	0				
MaxQValue	15				
Toggle	<input checked="" type="checkbox"/>				

This page allows setting of the Q parameter when using Dynamic Q algorithms.

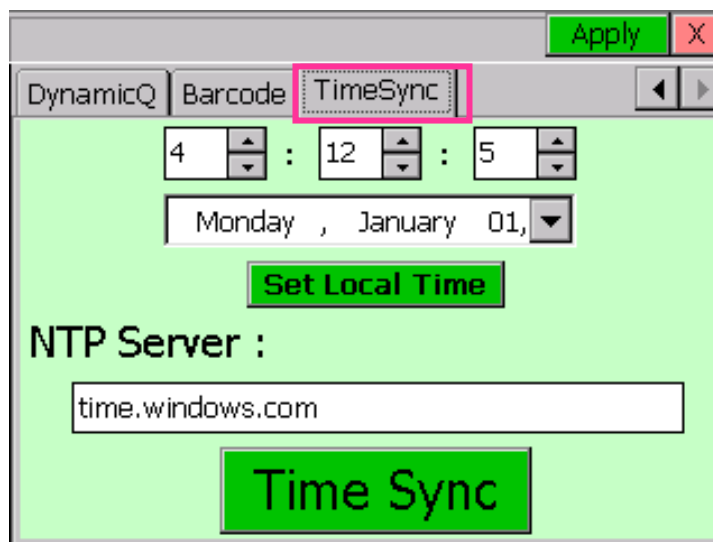
Barcode

This page is used for configuring the barcode scanner.



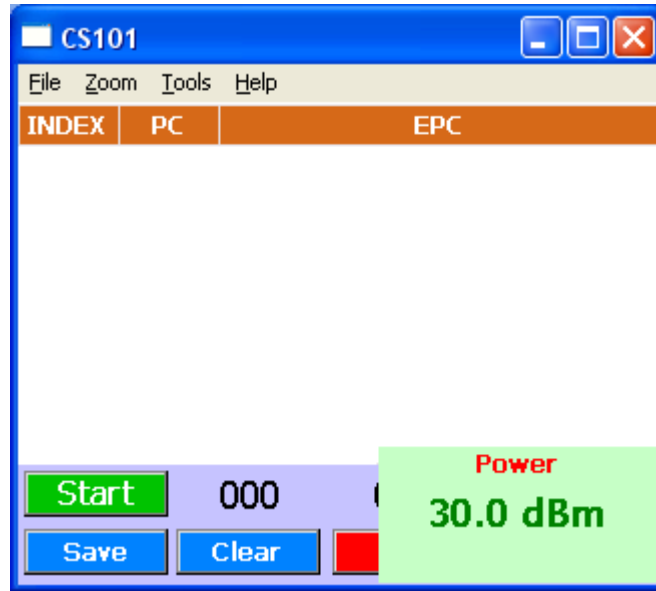
TimeSync

This page is used for entering the NTP server for time synchronization.

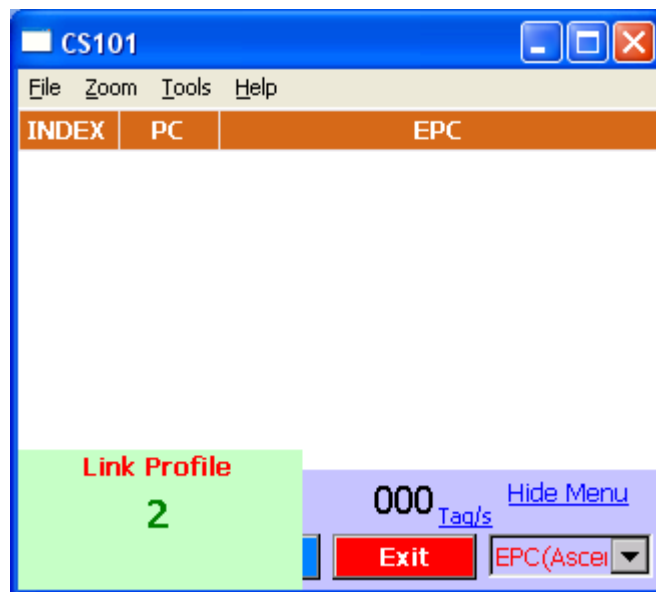


## 7.13 Changing Output Power and Link Profile

User can press the <F4> and <F5> keys on the reader to change the output power of the reader before press **[Start]** to run inventory mode.



For changing the Link Profile, user can press the <F2> and <F3> keys on the reader before press **[Start]** to run inventory mode.



# 8 Reader Configuration

## 8.1 Reader Configuration Overview

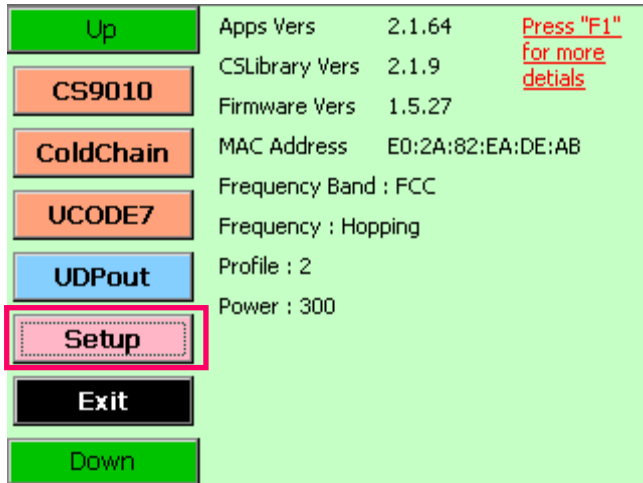
The diagram below shows the configuration components of CS01 RFID reader.



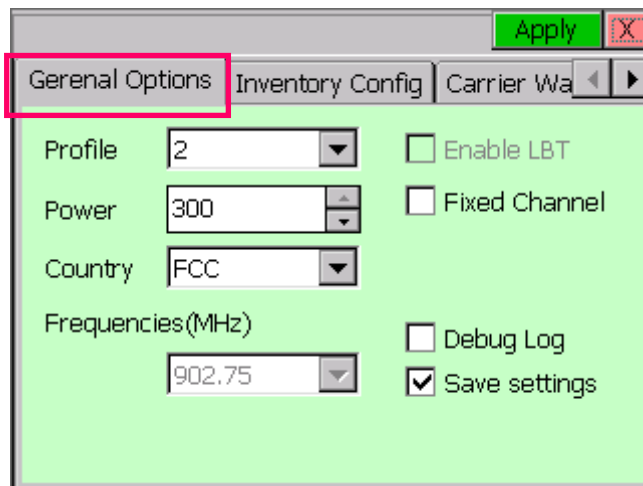
## 8.2 Power Level

User can set the power of CSL RFID Reader up to **maximum 30 dBm** using CS101 .NET Demo App.

To set up power level of the CSL RFID Reader, press **“Setup”** button in the Main Menu.

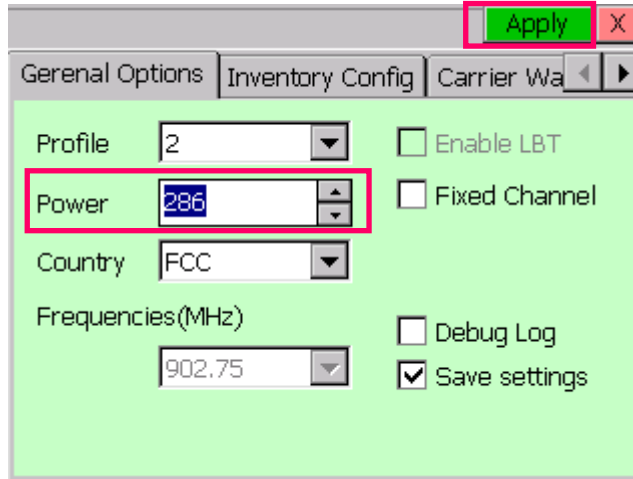


In **Setup**, choose the tab **“General Options”**



User can change the power level by changing the value in the field **“Power”**.

Press **“Apply”** button at the top right corner to confirm.



**Please note that Antenna port output power is set in 0.1dBm. The default value is 300, which is equal to 30dBm.**

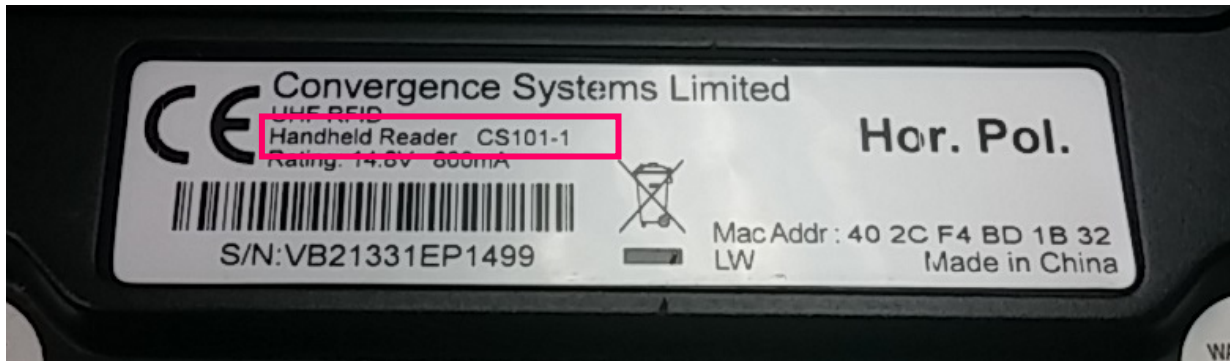
### 8.3 Country, Frequency and Fixed Channel

CSL RFID Reader can be used in different region and countries worldwide based on EPCglobal “**Regulatory status for using RFID in the UHF spectrum**”

Country / Region	Frequency	Certification
USA	902MHz ~ 928MHz	(FCC)
Europe	865MHz ~ 868MHz	(CE)
China	920MHz ~ 925MHz	(SRRC)
Japan	915MHz ~ 922MHz	(TELEC)
Australia	920MHz ~ 926MHz	(C-TICK)
India	865MHz ~ 867MHz	-
South Africa	915MHz ~ 919MHz 865MHz ~ 868MHz	(ICASA)
Taiwan	922MHz ~ 928MHz	(NCC)
Hong Kong	920MHz ~ 925MHz	(OFTA)
Malaysia	919MHz ~ 923MHz	(SIRIM)
Singapore	920MHz ~ 925MHz	(FCC)

Please refer to the document “**Regulatory status for using RFID in the UHF spectrum**” and the Order Code of CSL RFID Reader to set the Country, Frequency and Fixed Channel.

The Order Code is **printed at the rear panel of the CS101 RFID Reader.**



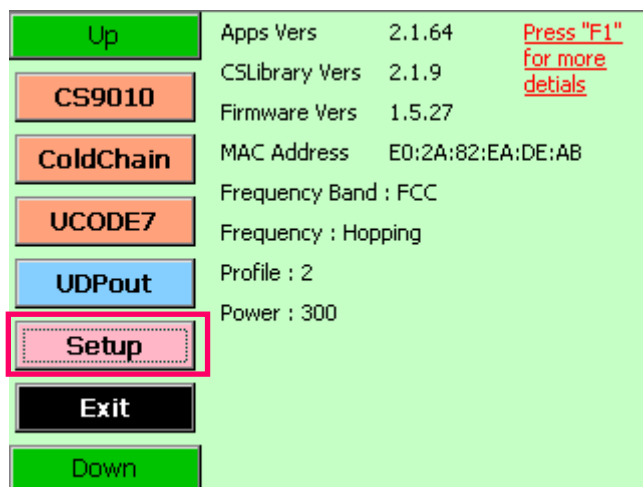
The format of Order Code is shown as follow:

CS101: CS101-**N**, where **N**:

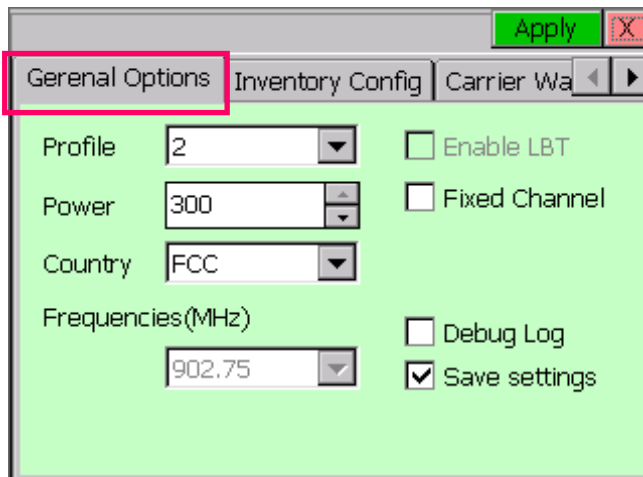
- N=1: 865-868 MHz (Europe) & 865-867 MHz (India)**
- N=2: 902-928 MHz (USA)**
- N=4: 922-928 MHz (Taiwan)**
- N=7: 920-925 MHz (China, Australia, Malaysia, Hong Kong etc)**
- N=8: 915-922 MHz (Japan)**

User can set the Country, Frequency and Fixed Channel of CSL RFID Reader using .NET Demo App.

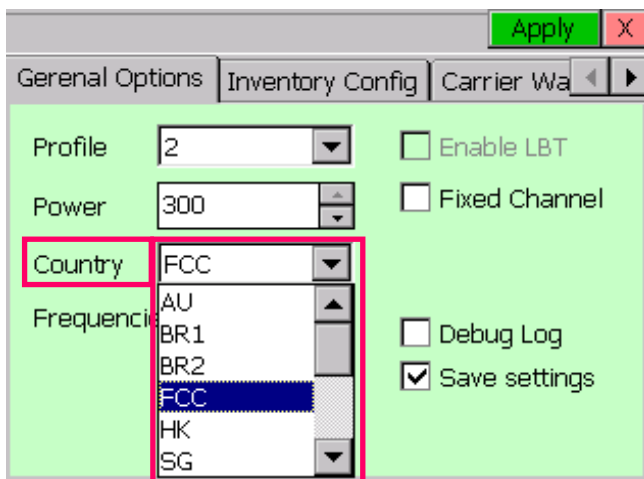
To set up Country, Frequency and Fixed Channel of the CSL RFID Reader, press “**Setup**” button in the Main Menu



In **Setup**, choose the tab “**General Options**”

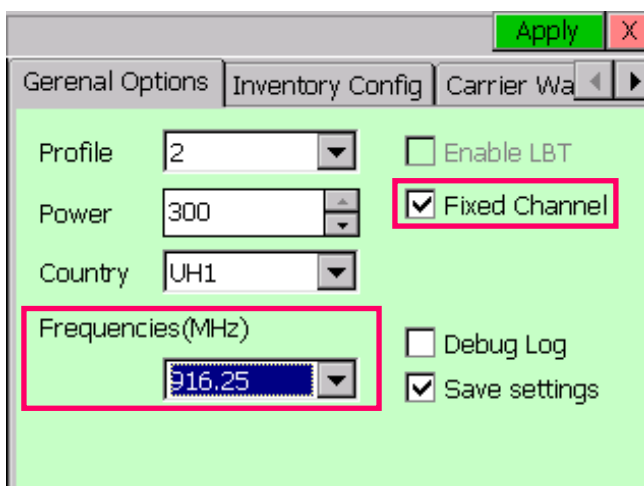


Choose the country / region in the field “**Country**”

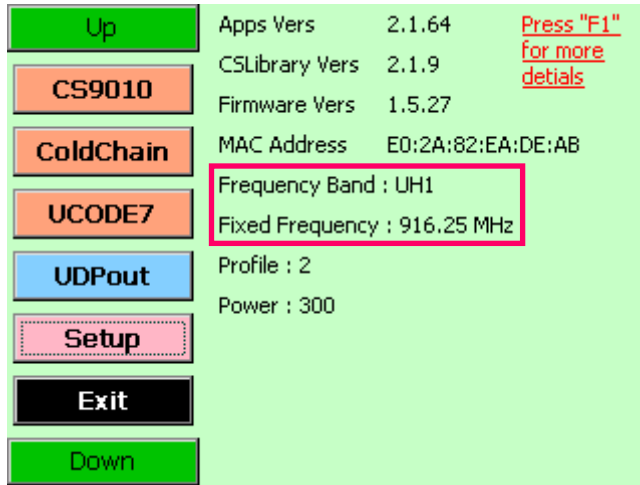


If user wants to operate the Reader in **one frequency channel**, tick the checkbox “**Fixed Channel**” and select the frequency in the field “**Frequencies(MHz)**”

Click “**Apply**” at the top right corner when the setting is confirmed.



The updated configuration can be checked in the Main Menu of Demo App.



## 8.4 RSSI Filter

The RSSI (Received Signal Strength Indicator) value is an indicator of signal strength from an RFID tag to an RFID reader.

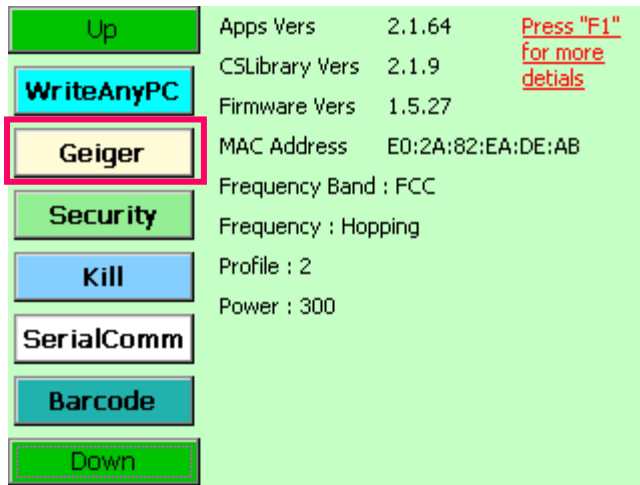
Normally RSSI can be used in

- Estimating the distance between an RFID tag and an RFID reader. The higher the RSSI value, the closer the RFID tag is to the reader. (The environment is analyzed and taken into consideration.)
- Identifying the movement direction of an RFID tag. (As the RFID tag moves closer to the RFID reader, the RSSI value increases. When the RFID tag moves away from the RFID reader, the signal gets weaker)
- Setting optimal reading and writing conditions. (RSSI value can be used to analyze the tag reading and writing conditions. The optimal condition is to be able to use as little power as possible for achieving a strong enough signal to perform the RFID actions)
- Analyzing and optimizing the environment.
- Locating lost tags. (Geiger search: Many retail and supply chain operations require a "locate tag" application. The RSSI value can be used for guiding the user closer and closer to the target)

By applying RSSI filters only tags within a certain distance are registered. RFID reading and writing conditions can be optimized for specific applications.

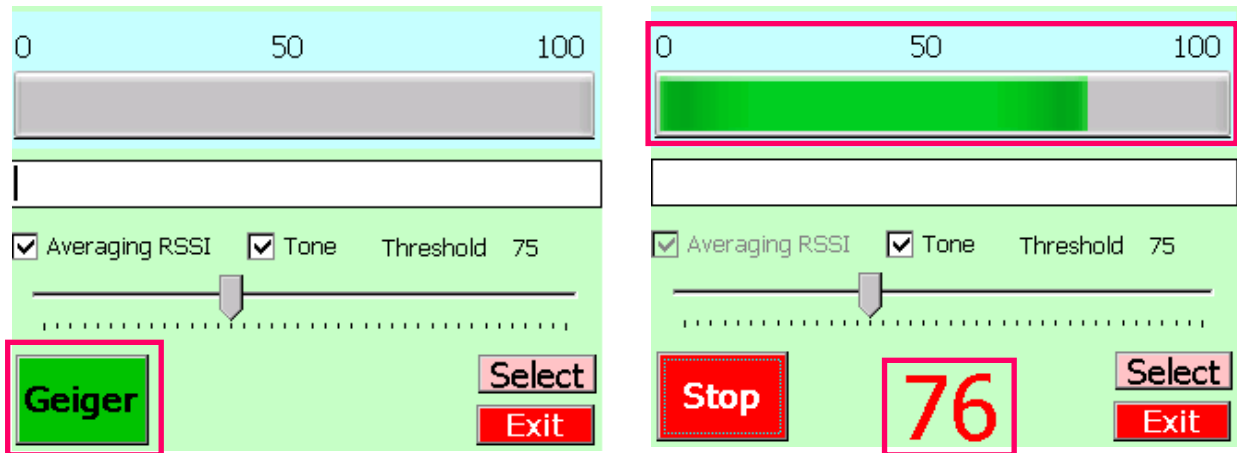
To obtain the threshold value, user can use Geiger to get the RSSI value range of using a tag located at a distance from the CSL RFID reader.

In Demo App, press “Geiger” in the Main Menu.

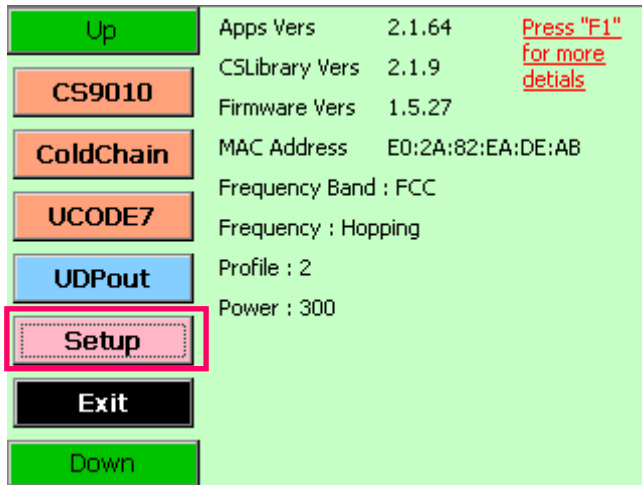


Place the tag in front of reader antenna for distance estimation.

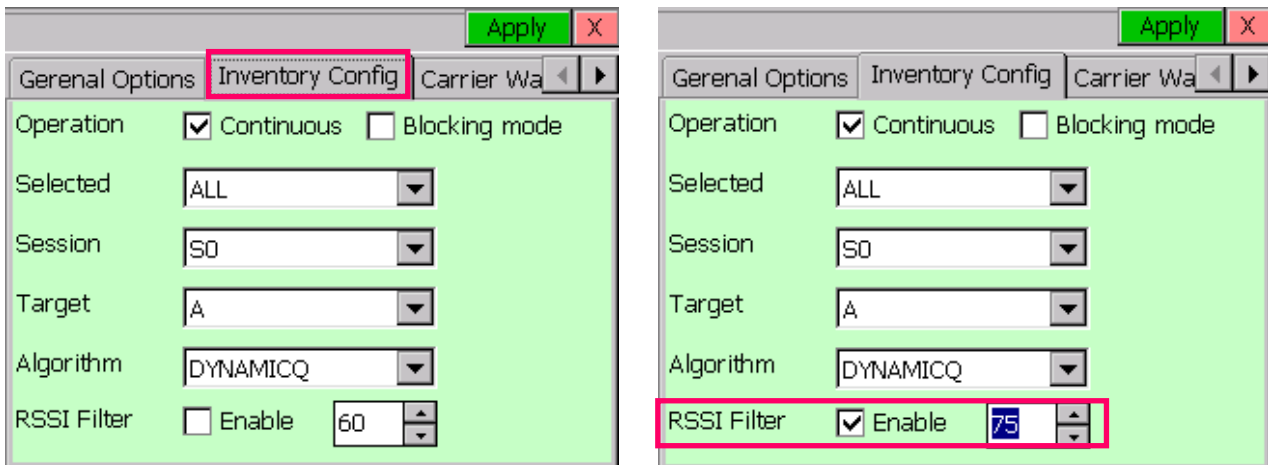
In the GeigerSearchForm, press “Geiger”, user can check the range of RSSI value.



Go to the Main Menu. Press **“Setup”** in the Main Menu.



Click on **“Inventory Config”**, tick the checkbox **“Enable”** and set the RSSI threshold value in the field **“RSSI filter”**. The filter will ignore tags with RSSI value less than the threshold set.



Click **“Apply”** at the top right corner to confirm the setting.

## 8.5 Link Profile

Different modulation profile of RFID reader (Interrogator) and the Tag can be selected by the user for different situation.

User should refer to the document **EPC Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz** by EPCglobal when setting Link Profile.

The default setting is profile 2. It is also the recommended setting for most of the common applications. In CS101-3 (Japan) and CS101-1 (ETSI) readers, only profiles 0, 2, 3 and 5 are selectable. (Profile 0 is also not advised for CS101-3 Japanese reader).

Profile	0	1	2	3	4	5
R-T Modulation	DSB-ASK	DSB-ASK	PR-ASK	PR-ASK	DSB-ASK	DSB-ASK
Tari (µs)	25.00	12.5	25.00	25.00	6.25	25.00
R-T speed (kbps)	40	80	40	40	160	40
PIE	2 : 1	2 : 1	1.5 : 1	1.5 : 1	1.5 : 1	1.5 : 1
Pulse Width (µs)	12.50	6.25	12.50	12.50	3.13	12.50
T-R LF (kbps)	40	160	250	300	400	250
T-R Modulation	FM0	Miller-2	Miller-4	Miller-4	FM0	Miller-2
Divide Ratio	8	8	64 / 3	64 / 3	8	64 / 3
T-R Data Rate (kbps)	40	80	62.5	75	400	125

DSB-ASK                    Double-sideband amplitude shift-keying

PR-ASK                    Phase-reversal amplitude shift keying

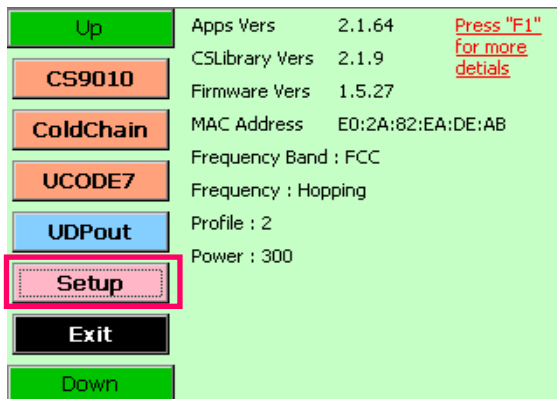
R-T Modulation        Interrogator-to-Tag modulation

T-R Modulation        Tag-to-Interrogator modulation

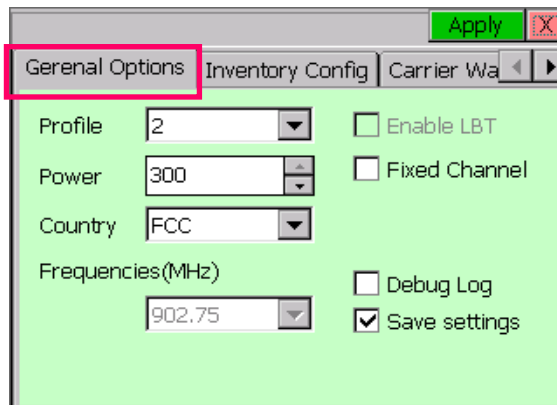
Tari Reference time interval for a data-0 in Interrogator-to-Tag signaling. The mnemonic "Tari" derives from the ISO/IEC 18000-6 (part A) specification, in which Tari is an abbreviation for Type A Reference Interval.

User can set the Link Profile of CSL RFID Reader using .NET Demo App.

To set up Link Profile of the CS101 RFID Reader, press “**Setup**” button in the Main Menu.

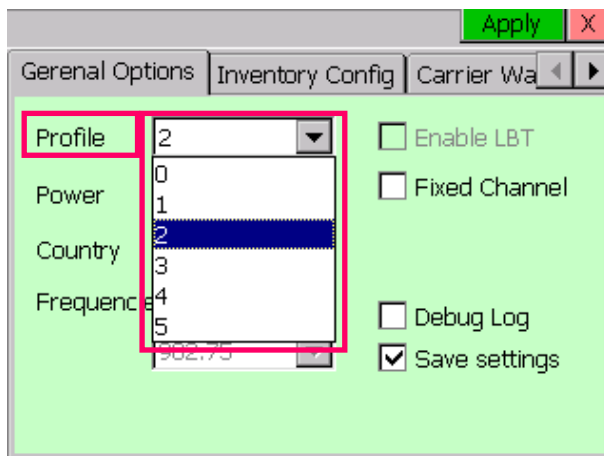


In **Setup**, choose the tab “**General Options**”



User can change the Link Profile by changing the value in the field “**Profile**”.

Press “**Apply**” button at the top right corner to confirm.



## 8.6 Target and Toggle A / B Flag

There are 2 meanings for **Target** in the standard of **EPC Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz** by EPCglobal. One of them is the parameter of RFID protocol **Inventory – Select** Command, which indicates whether the Select command modifies a Tag's Selected (SL) flag or its inventoried flag.

Another **Target** is the parameter of RFID protocol **Inventory – Query** Command, which selects whether Tags whose inventoried flag is **A or B** participate in the inventor round. Tags may change their inventoried from A to B (or vice versa) as a result of being singulated.

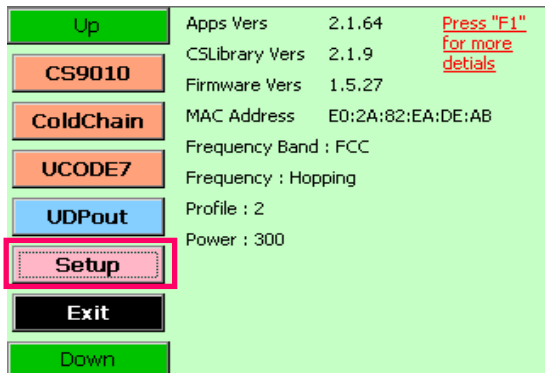
In CSL RFID Reader Read / Write configuration, **Target** is the parameter of RFID protocol **Inventory – Query** Command. The options for Query Command in the field **Target** are "A", "B" and "Unknown". User can set the Target of CS101 Reader using .NET Demo App.

Inventory contains a designation of the tags with which flag is to be inventoried. User can define it to be Flag A, or Flag B. There is also a parameter toggle, if user set it to "on", i.e. toggle, then in continuous inventory it will inventory Flag A in the first round, then Flag B in the next round, and so on. If user set it to "off", then it will keep on inventorying the same flag.

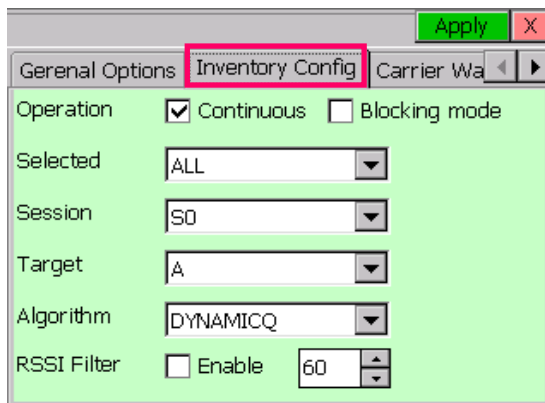
So the usual trick is to set inventory to read Flag A, and toggle to off. Then it will keep on reading Flag A tags. Those that have been read will become flag B and it will not respond to an inventory of Flag A tags. This will the crowded situation will improve as reader read more and more tags, leaving only those who have not been read yet (hence still in flag A state) to respond with no jamming by others.

When the tag is booted up (powered up) at the first time, it has Flag A. After it is inventoried, it will become Flag B for certain period of time depending on the persistence selection. Please check **EPCGlobal** specs in detail.

To set up **Target** of the CS101 Reader, press **“Setup”** button in the Main Menu.

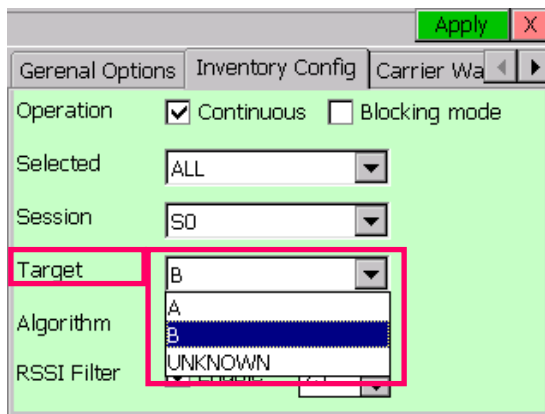


Choose the tab **“Inventory Config”**.



Check the field **“Target”** in the tab, user can choose A / B / UNKNOWN.

Press **“Apply”** button at the top right corner to confirm.



## 8.7 Session and Tag Selection

Session is an inventory process comprising a reader and an associated Tag population. A reader chooses one of four sessions and inventories Tags within that session. The reader and associated Tag population operate in one and only one session for the duration of an inventory round. For each session, Tags maintain a corresponding inventoried flag. Sessions allow Tags to keep track of their inventoried status separately for each of four possible time-interleaved inventory processes, using an independent inventoried flag for each process.

## 8.8 Slot-Count Parameter Q

RFID Protocol **Inventory - Query** Command contains a **Slot-Counter Parameter Q**.

When participating Tags receive a Query, they pick a pseudo-random value in the range  $(0, 2^Q-1)$  and load this value into their slot counter. Tag which picks a zero transition to the reply state replies immediately. Tags which pick a nonzero value transition to the arbitrate state await a QueryAdjust or a QueryRep command to decrement the value in its slot counter. Tags reply when the value in their slot counter (i.e. their slot) is zero. Since Q is an integer in the range  $(0, 15)$ , the corresponding Tag-response probabilities range from  $2^0 = 1$  to  $2^{-15} = 0.0000305$ .

It is usually recommended to set a Q-value that have the corresponding number of slots larger than the exact maximum number of Tags to be read by the reader. For example, if there are 40 tags to be read by the reader, the Q-value is configured to 6, in which  $2^Q = 2^6 = 64 > 40$ .

## 8.9 Inventory Algorithm: Fix Q and Dynamic Q Algorithm

In CS101 readers, it consists of two main inventory algorithms (Fixed Q Algorithm and Dynamic Q Algorithm). The variable Q algorithms differ in their mechanism for adjusting the Q values at the end of each round. It also provides routines for the four tag access functions (read, write, kill and lock).

### Fixed Q Algorithm

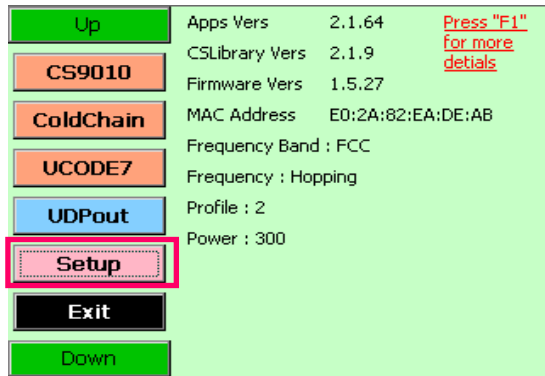
This algorithm runs all inventory rounds with a single Q value. In this algorithm an inventory cycle consists of one or more rounds, each of which will attempt to read every slot. The number of slots to search is given by  $2^Q$ . For example, a Q of 7 will cause the algorithm to search 128 slots on each round. One word of caution, if the time it takes to run the round is greater than the frequency hop time (and the session is 0) or **antenna dwell time (The duration time of each antenna port in ms)**, the round will never complete.

### Dynamic Q Algorithm

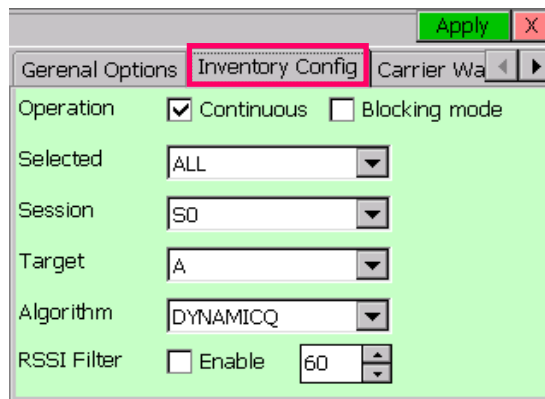
In this algorithm, the value of Q is dynamically adjusted based on the periodic evaluation of the relative frequency of **RN16 (16-bit random or pseudo-random number)** timeouts versus EPC timeouts. Each round is comprised of a Query and up to MaxReps QueryReps. The value of Q for the subsequent round is determined by the results of the current round. If the number of RN16 timeouts is greater than the number of EPC timeouts multiplied by thresHi, Q is decremented (presumed empty slots outnumber presumed collisions). If the number of RN16 timeouts is less than the number of EPC time outs times thresLo, Q is incremented (presumed collisions outnumber presumed empty slots). If the number of RN16 time outs falls between those two values, Q remains unchanged.

An inventory cycle is comprised of one or more inventory rounds, and is terminated when a round is executed with Q = 0 and no tags read.

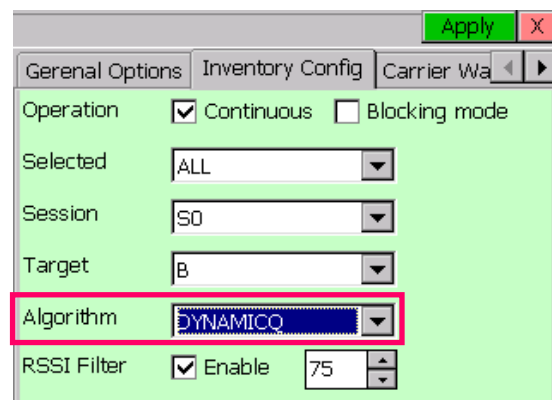
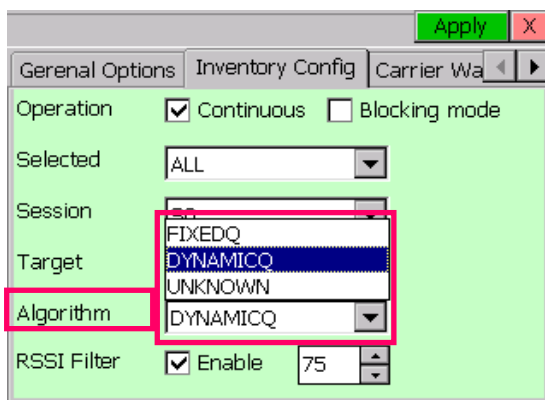
To set up Q Algorithm of the CS101 Reader, press **“Setup”** button in the Main Menu.



Click on the tab **“Inventory Config”**.

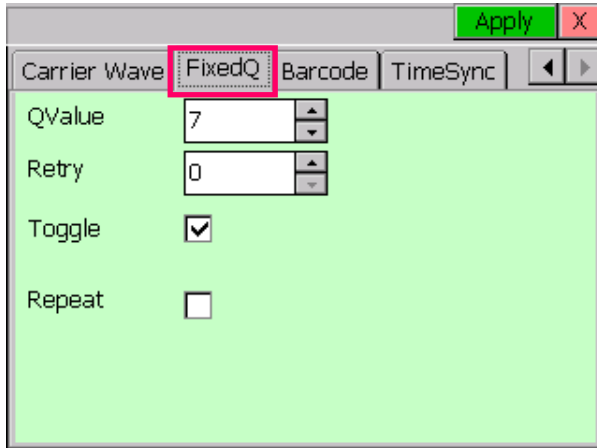


In the field **“Algorithm”**, choose **“FIXEDQ”** for Fixed Q Algorithm, **“DYNAMICQ”** for Dynamic Q Algorithm.



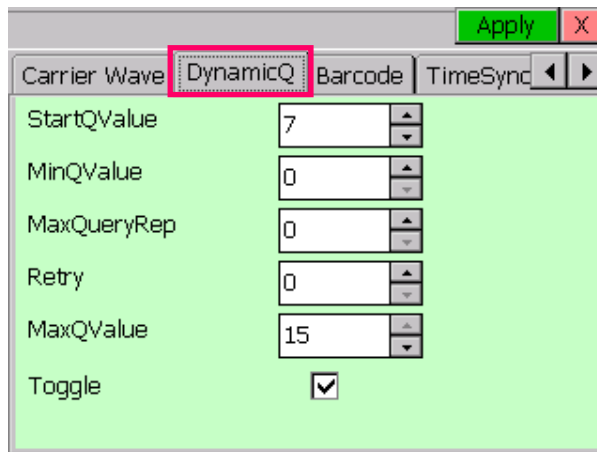
If **“FIXEDQ”** is chosen, user can go to the tab **“FixedQ”** and set the value of Q in the field **“Q Value”**

Press **“Apply”** button at the top right corner to confirm.



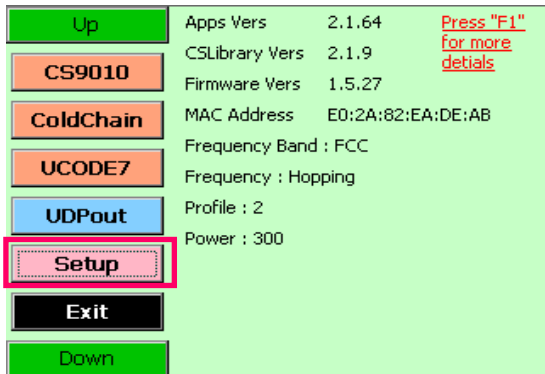
If **“DYNAMICQ”** is chosen, user can go to the tab **“DynamicQ”** and set the value of Start Q in the field **“StartQValue”**.

Press **“Apply”** button at the top right corner to confirm.

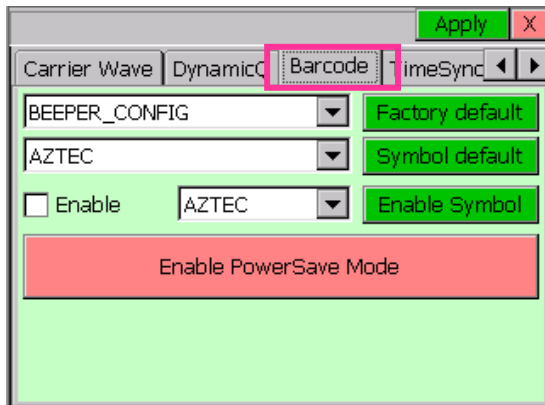


## 8.10 Barcode

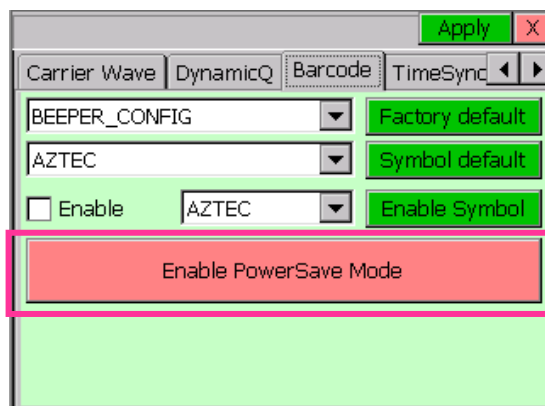
To set up Barcode of the CS101 Reader, press **“Setup”** button in the Main Menu.



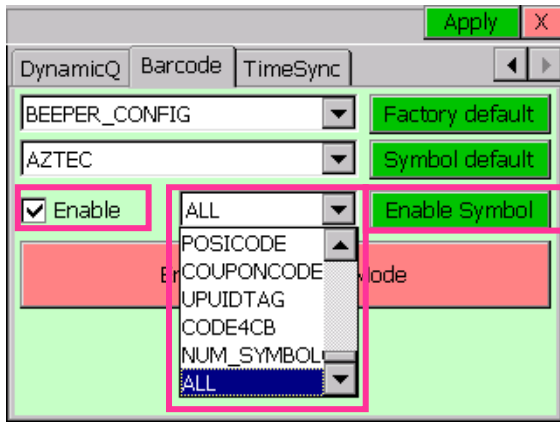
Click on the tab **“Barcode”**.



The **“Enable PowerSave Mode”** button is used for setting the barcode module to power save mode.

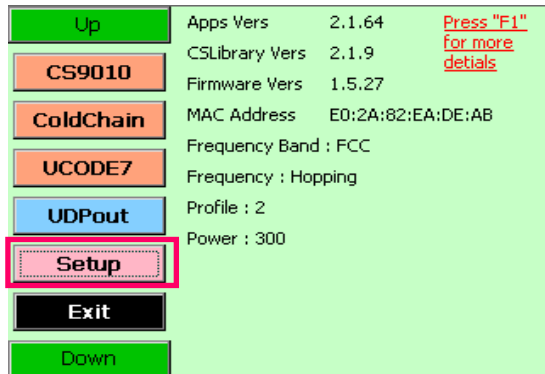


For setting up the barcode format you want to scan, check the “Enable” box, select the Barcode format (e.g. “ALL”) and then click “Enable Symbol” button.



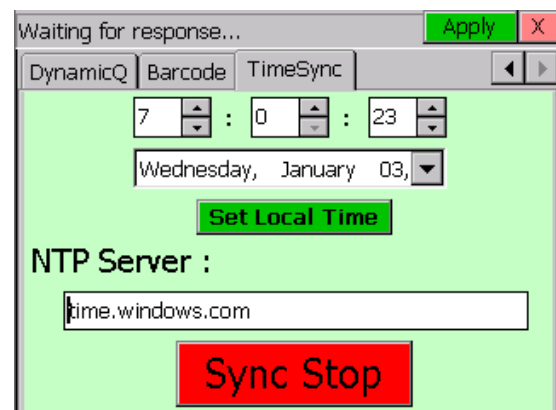
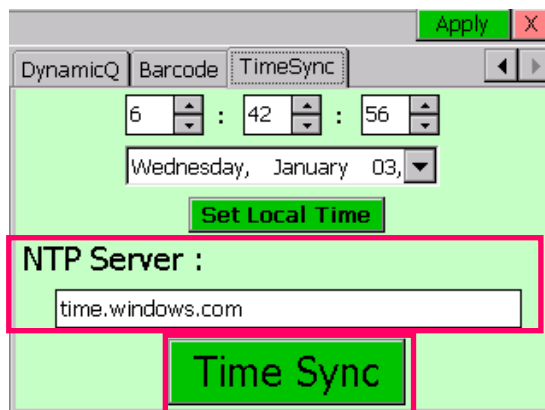
## 8.11 Time Synchronization

To set up Time Synchronization, press “**Setup**” button in the Main Menu.



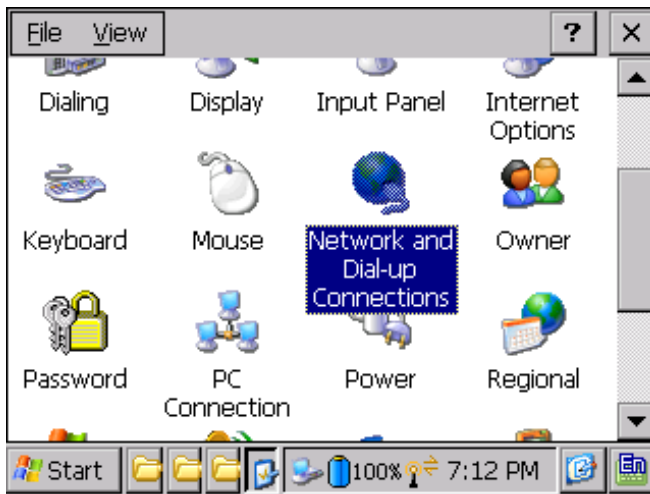
Click on the tab “**TimeSync**”. User can input the address in the field **NTP Server** and press “**Time Sync**” to synchronize the time.

Press “**Apply**” to confirm.

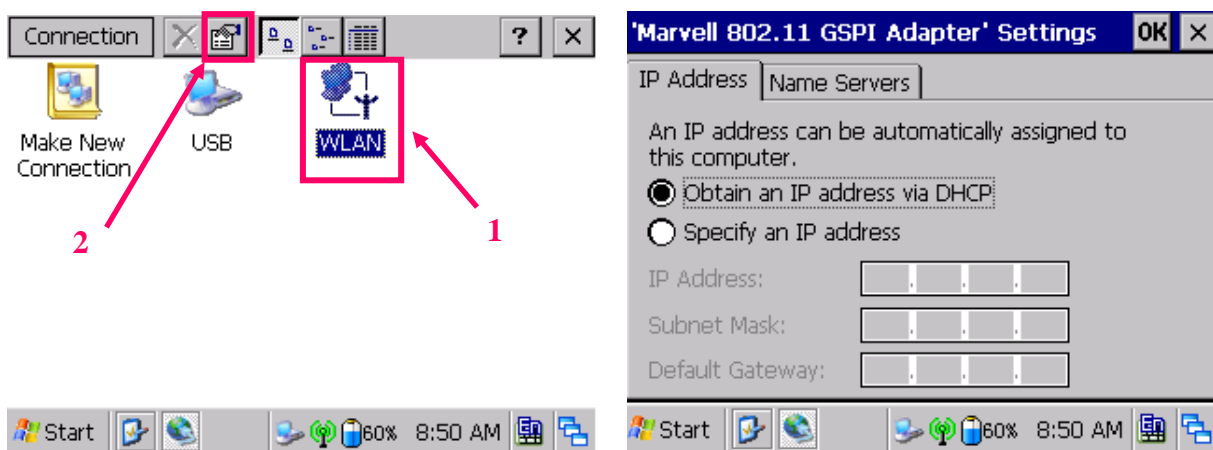


## 8.12 WiFi Configuration

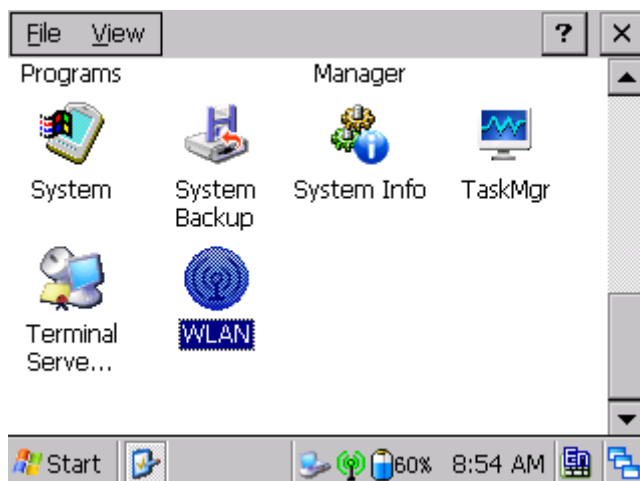
1. Go to “Control Panel” and choose “Network and Dial-up Connections”



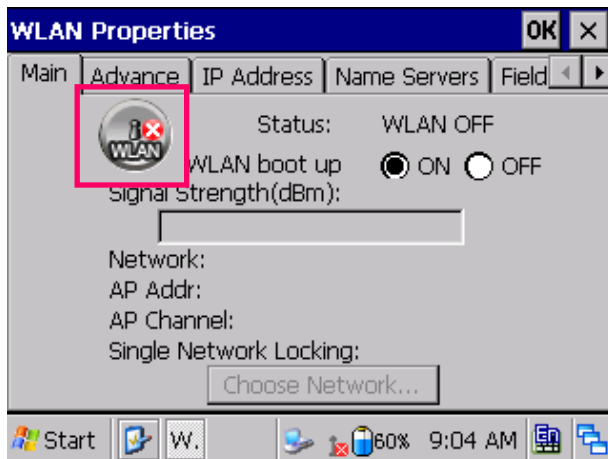
2. User can set the properties for CS101 WiFi network.



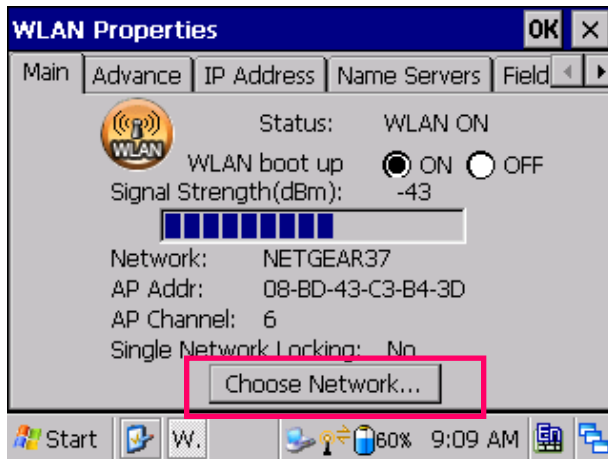
3. Go back to the “Control Panel” and then click WLAN icon.



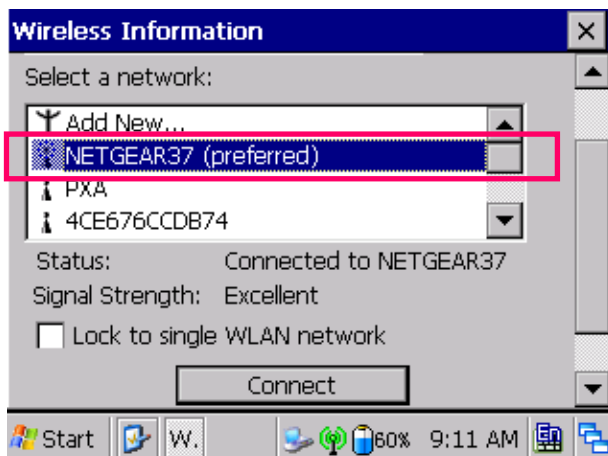
4. Enable or disable the WLAN settings can set here by toggling the icon



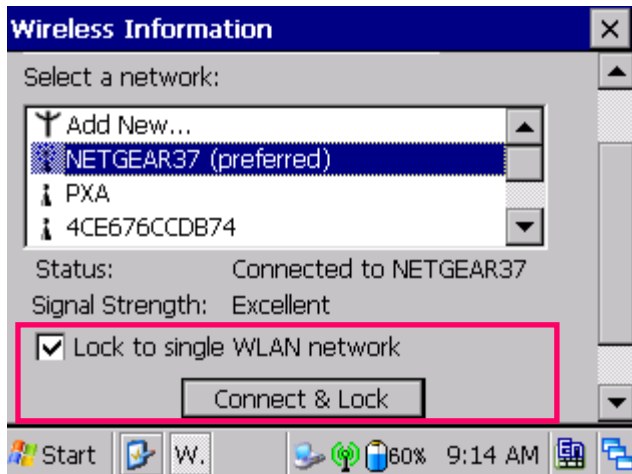
5. Click "Choose Network..."



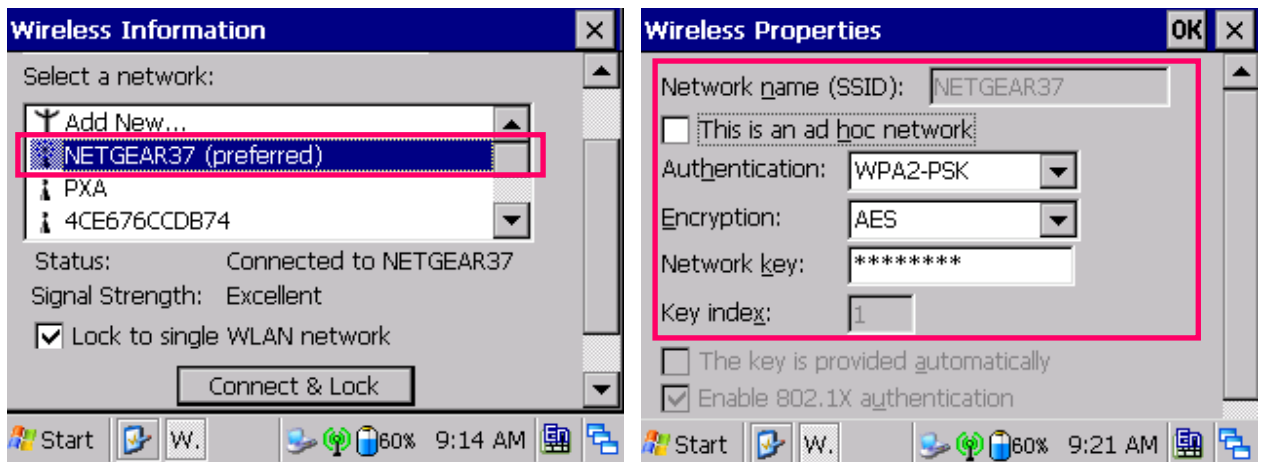
6. Select the available access point



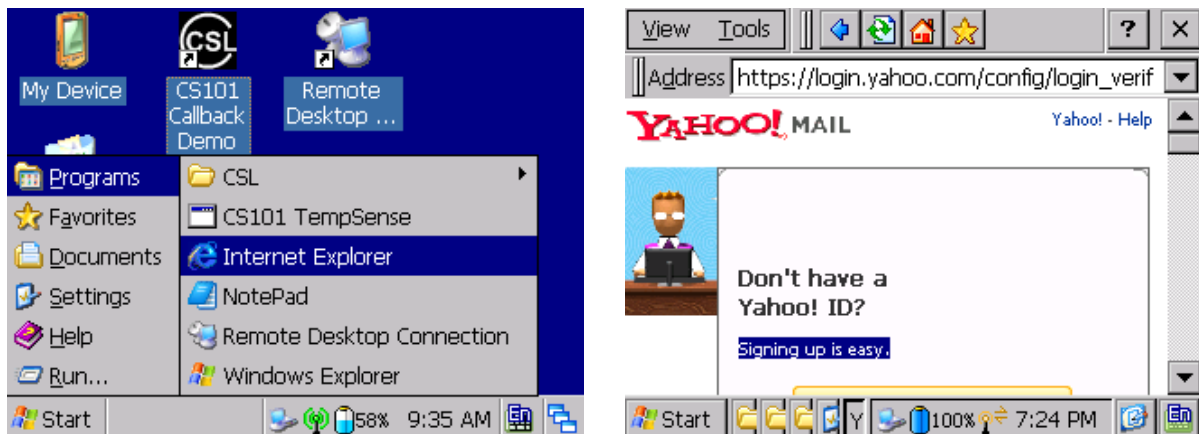
7. Click “Connect & Lock”



8. User can double click the access point in the list and configure the wireless properties if necessary.



9. The wireless LAN is configured, and you can try to connect to the Internet by using “Internet Explorer” if the access point is connected to the Internet.



## 9 Software Development Kit

The CSL CS101 handheld reader software development kit provides the following components for quick and easy application development:

1. Software specifications
2. Block diagrams
3. Application Programming Interface (API) definitions
4. Application scenarios with program source codes
5. Unit test plan and results
6. Build environment
7. Debug methods

## 9.1 Software Specifications

The overall software architecture consists of CS101 RFID Libraries on the WinCE OS inside the handheld reader, CS101 Demonstration Application (which consists of a whole series of applications, such as tag read, tag write, tag inventory, tag search, tag authentication, tag commissioning, barcode scanning, RFID configuration, system configuration, database file manipulation, network database file transfer, etc.), CS101 Keep Alive Monitor, all of the above inside the handheld device; and then also CS101 Server Side Database Administration Application, which resides on the WinXP server side.

### 9.1.1 CS101 RFID Libraries

The CS101 RFID Libraries consists of 3 parts:

1. RfidSp
2. PosSp
3. ClsSys Util

These calls are designed to be called by C# applications with the PInvoke (Platform Invoke) method.

### 9.1.2 CS101 Demonstration Application

The CS101 Demonstration Application is a comprehensive C# demonstration program that demonstrates how to write an application on the CS101 platform. It offers all possible RFID related and barcode related functionalities. The purpose is to give a good Out-Of-Box OOB experience to the system integrator. The functions include:

1. Tag Read
2. Tag Write
3. Tag Inventory
4. Tag Ranging
5. Tag Search
6. Tag Commissioning
7. Tag Authentication

8. Database Management
9. RFID Configuration
10. Scan Barcode
11. Tag Security
12. System Configuration
13. Factory Defaults

### **9.1.3 CS101 Keep Alive Monitor**

CS101 Keep Alive Monitor is an independent application that is turned on during WinCE boot up to monitor health situations, including:

1. Battery Monitoring and Alert
2. Memory (RAM) Monitoring and Alert
3. Disk Space (Internal Flash) Monitoring and Alert
4. Disk Space (SD Card) Monitoring and Alert
5. SD Card Physical Action Monitoring and Alert (insertion and ejection)
6. Network Condition Monitoring and Alert
7. Automatic Files Backup

### **9.1.4 CS101 Server Side Application**

The CS101 Server Side Application handles collection of tag data and converting them to typical formats.

## 9.2 Build Environment

The build environment consists of tools and the corresponding configurations of the Visual Studio. It is expected that the system integrator or the software system programming house will be developing the applications on Visual Studio. With this tool, typically he has to write programs on the handheld and also on the PC. The following 14 steps are needed to set up the build environment.

**The following Build Environment is tested and suggested for CS101 developers:**

1. **Operating System:** Microsoft Windows 7 installed.
2. **Microsoft Visual Studio 2008 Professional Edition**
3. **Microsoft .Net Compact Framework 3.5 (It is included during VS2008 setup)**
4. **Install SP1 patch for .Net Framework 2.0**  
<http://www.microsoft.com/downloads/details.aspx?familyid=79bc3b77-e02c-4ad3-aacf-a7633f706ba5&displaylang=en&tm>
5. **Window Mobile Device Centre for Remote Debugging**  
Enables remote debugging on handheld reader via USB (Free Download)  
<http://support.microsoft.com/kb/931937>

**Optional software package:**

1. **Microsoft SQL Server Management Studio Express Edition (Free download from Microsoft)**
2. **Microsoft Windows CE 5.0 SDK (Free download from Microsoft)**
3. **Microsoft SQL Server 2005 Compact Edition SDK (Free download from Microsoft)**

# 10 CS101 Demo Operation with Special Purpose RFID Tags

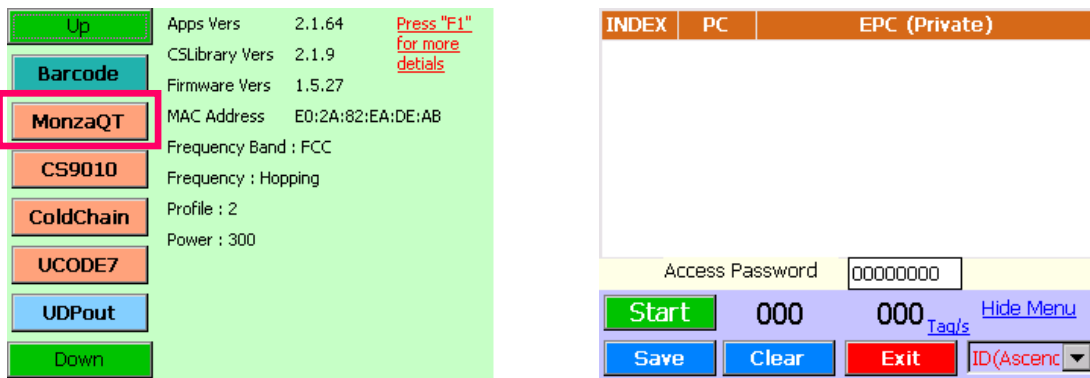
The CSL CS101 handheld reader can work with CSL Special Purpose RFID Tags – Monza4QT, UCODE7, BAP ID Card Tag and Cold Chain Tag.

BAP ID Card Tag is used for long read range detection and Cold Chain Tag is used for temperature monitoring and data logging.

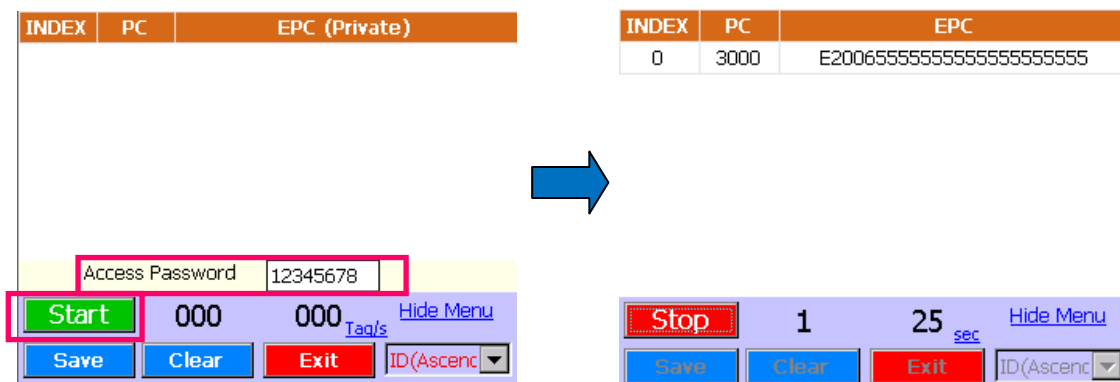
## 10.1 CS101 Demo Operation with Monza4QT Tag

User can use Monza4QT Mode to check the Private Mode Data in Monza4QT Tag.

1. In the main menu, choose “**Monza4QT**”.

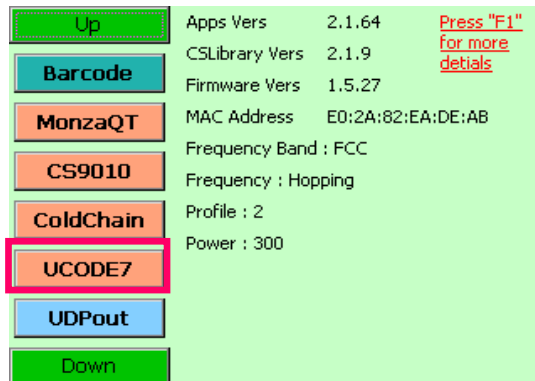


2. Input the “**Access Password**” for Private Mode Data. Press “**Start**” to begin.

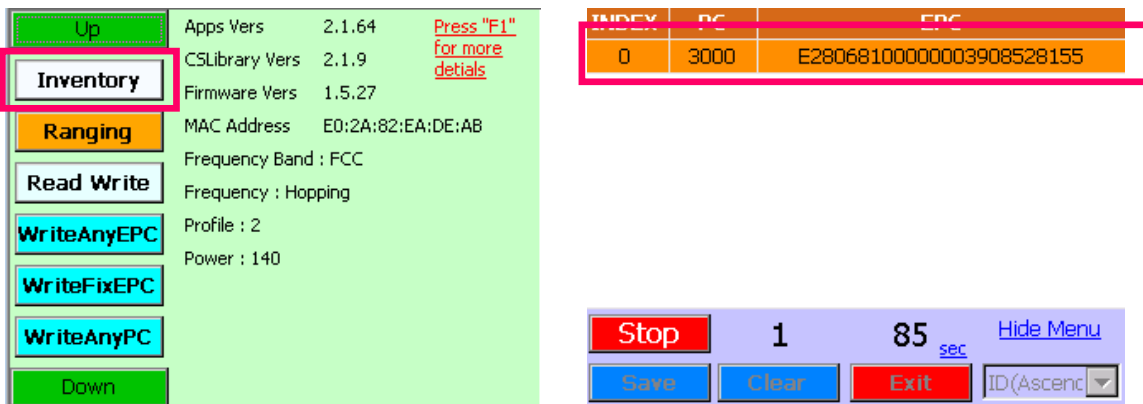


## 10.2 CS101 Demo Operation with UCODE7 Tag

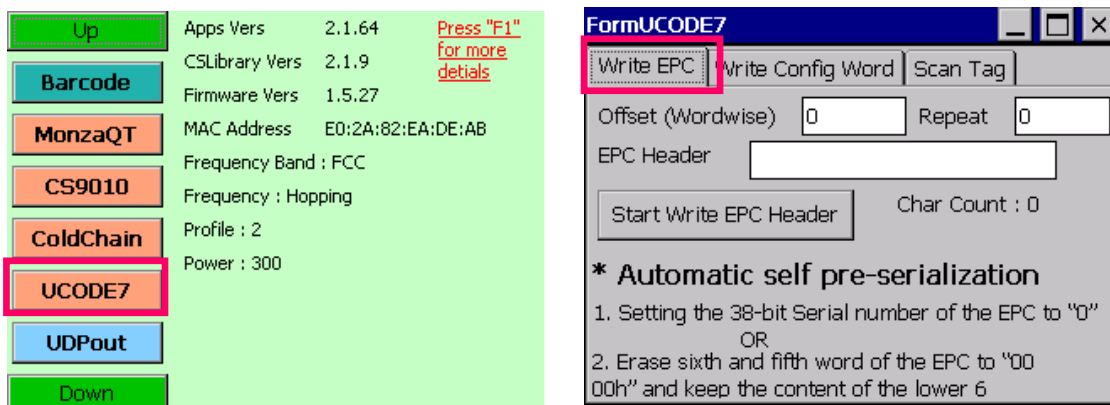
User can use “UCODE7” mode in CS101 reader to change the EPC of the UCODE7 tag CS6321. The maximum backscatter strength and PSF alarm flag can also be set of UCODE7 can also be set using CS101 reader.



1. To begin, user can check the EPC ID of the UCODE7 tag using Inventory mode.



2. In the main menu, select “UCODE7” and choose the tab “Write EPC”



- To write new value to EPC data bank of the tag, set the “**Offset**” (EPC data bank offset in words), “**Repeat**” (repeat for write error) and “**EPC Header**” (new EPC value). Press “**Start Write EPC Header**” to confirm and CS101 will write the new EPC value to the UCODE7 tag.

FormUCODE7

Write EPC Write Config Word Scan Tag

Offset (Wordwise) 2 Repeat 3

EPC Header 34567890

Start Write EPC Header Char Count : 8

**\* Automatic self pre-serialization**

- Setting the 38-bit Serial number of the EPC to "0"
- OR
- Erase sixth and fifth word of the EPC to "00 00h" and keep the content of the lower 6

FormUCODE7

Write EPC Write Config Word Scan Tag

Offset (Wordwise) 2 Repeat 3

EPC Header 34567890

Start Write EPC Header Char Count : 8

**\* Automatic self pre-serialization**

- Setting the 38-bit Serial number of the EPC to "0"
- OR
- Erase sixth and fifth word of the EPC to "00 00h" and keep the content of the lower 6

- Return to the main menu and go to Inventory Mode again. The EPC ID of the UCODE7 tag is updated with new value.

Up

Inventory

Ranging

Read Write

WriteAnyEPC

WriteFixEPC

WriteAnyPC

Down

Apps Vers 2.1.64 Press "F1" for more details

CSLibrary Vers 2.1.9

Firmware Vers 1.5.27

MAC Address E0:2A:82:EA:DE:AB

Frequency Band : FCC

Frequency : Hopping

Profile : 2

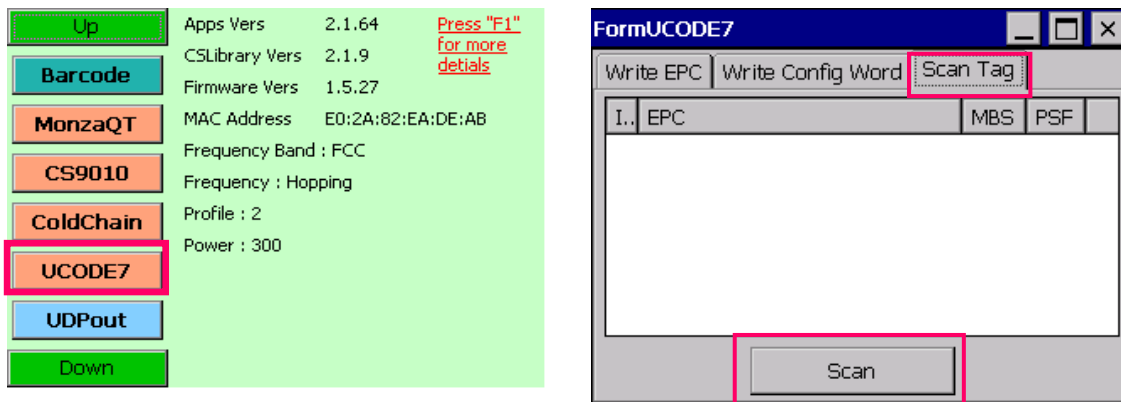
Power : 140

INDEX	PC	EPC
0	3000	E28068103456789008528155

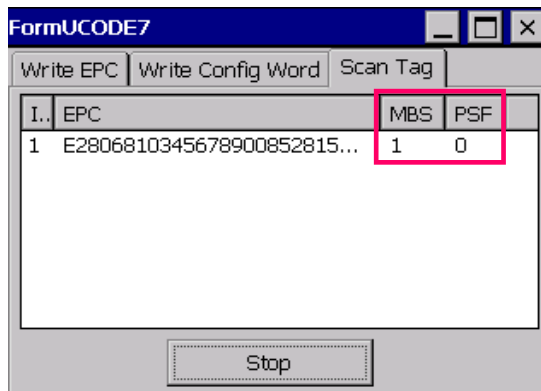
Stop 1 6 sec Hide Menu

Save Clear Exit ID(Ascend)

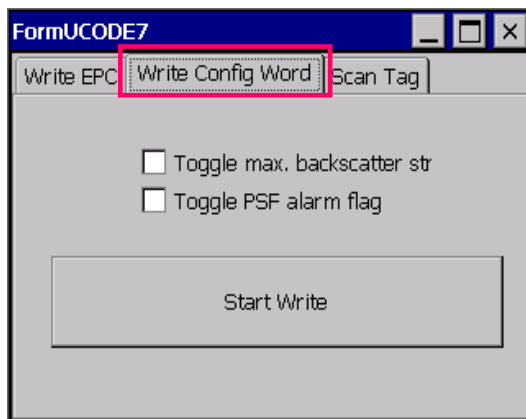
5. User can also configure **the maximum backscatter strength** and **the PSF alarm flag** in the UCODE7. To begin, go to the tab “**Scan Tag**” and press “**Scan**” to check the status of the tag.



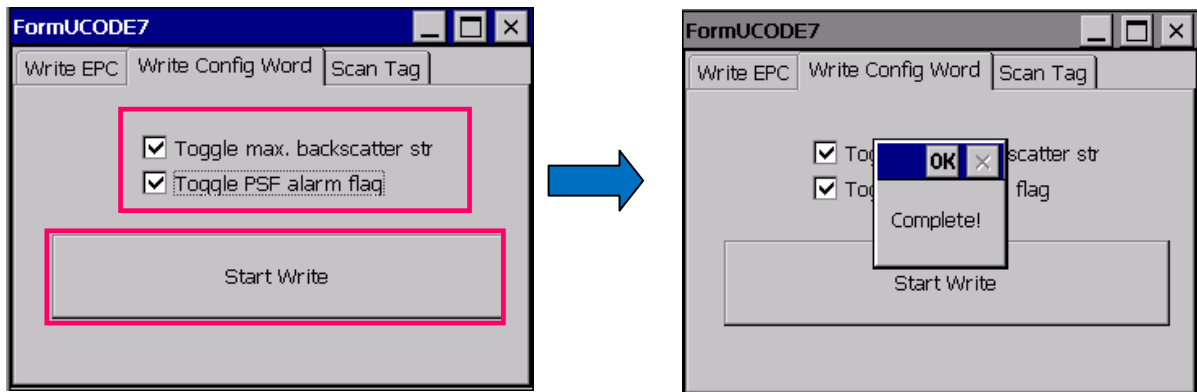
6. Move the tag in front of the CS101 reader. User can check the status of **maximum backscatter strength (MBS)** and **PSF alarm flag (PSF)** in the UCODE7.



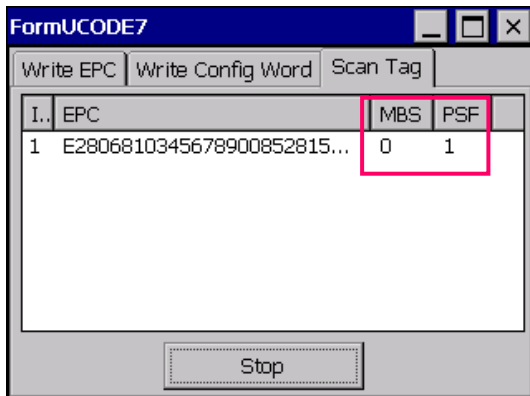
7. Next, go to the tab “**Write Config Word**”.



8. Set the checkboxes to toggle the setting. Press “**Start Write**” to confirm.

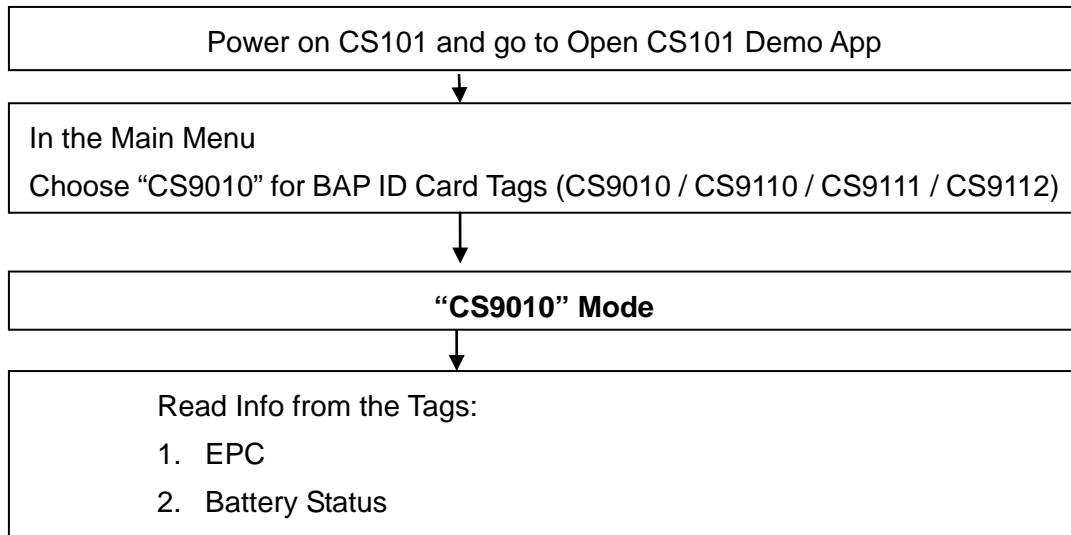


9. Go to the tab “**Scan Tag**” again and press “**Scan**”. The status of the tag is updated.



### 10.3 CS101 Demo Operation with BAP ID Card Tag

The flow diagram below shows the operation steps:



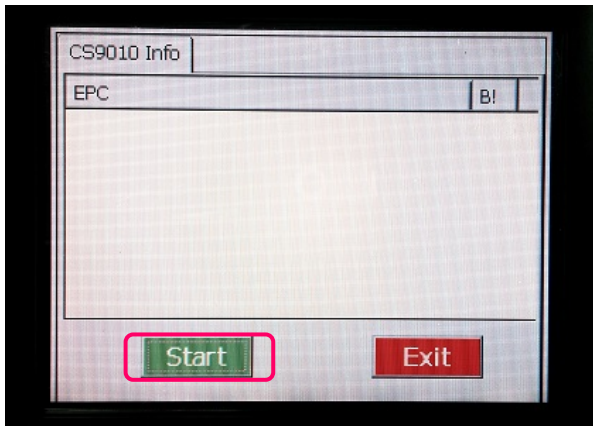
User can use “CS9010” Mode in CS101 Demo App to check EPC and Battery status of BAP ID Card Tags when before use.

1. In the Main Menu of Demo App, Press Down until “CS9010” is found.
2. Choose “CS9010”.

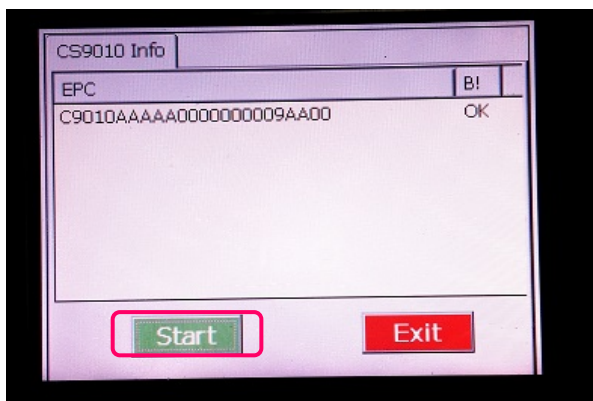


3. Put the BAP ID Card Tag in front of CS101 reader.

4. Press **Start** to run the application.



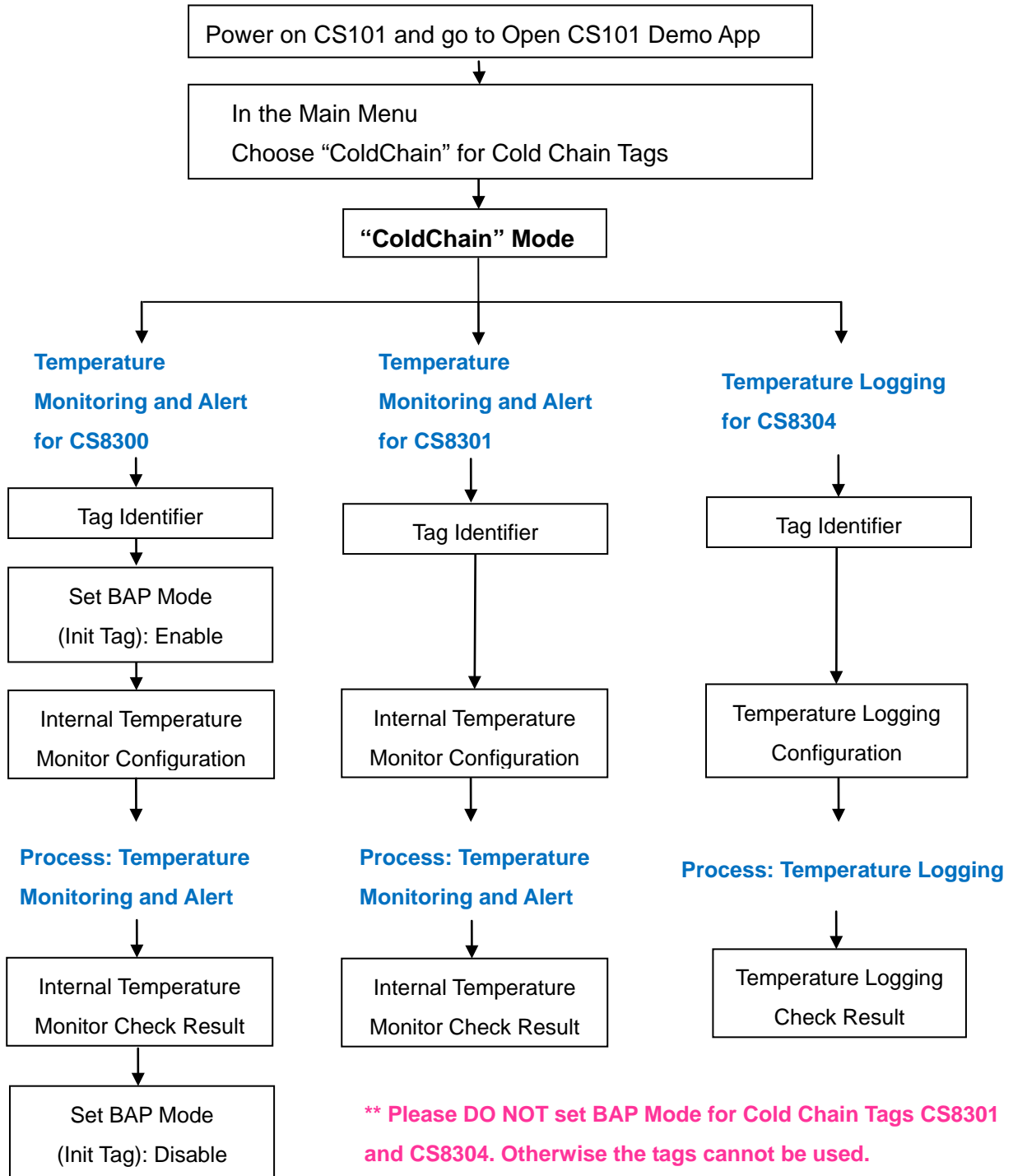
5. The EPC and Battery Status (B!) can be checked. The BAP ID Card Tag can be read in long read range if **OK** is checked in the field **B!**.



6. If **OK** is not available in the field **B!**, this is end of battery life for the BAP ID Card Tag. Please contact CSL and order a new one.

## 10.4 CS101 Demo Operation with Cold Chain Tag

The flow diagram below shows the operation steps:

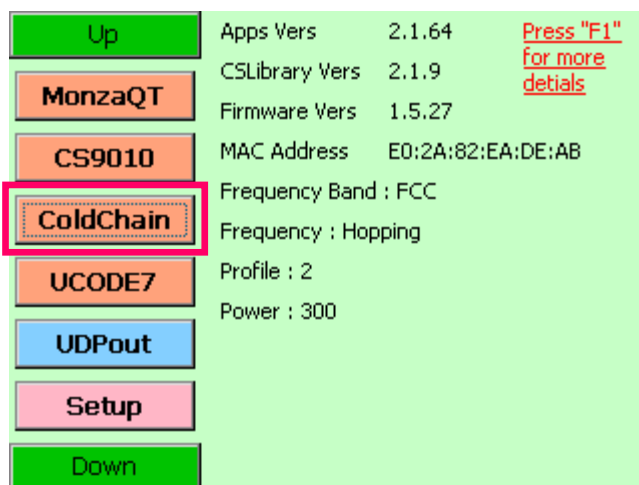


## 10.4.1 Temperature Alert in “ColdChain” Mode for Cold Chain Tags CS8300

User can use “ColdChain” mode in CS101 and the Cold Chain tag CS8300 to do monitor temperature surrounding and alert when the temperature reaches the limit set by user.

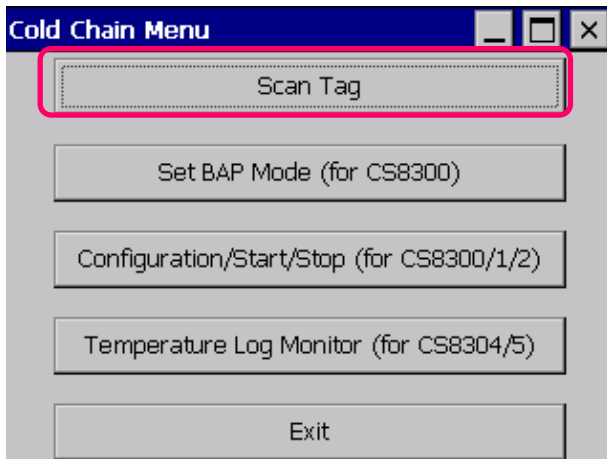
Basically user has to set Temperature Monitor Start Time, Sampling Rate and Temperature Threshold to alert before use.

1. In the Main Menu of Demo App, Press green button “**Down**” until “**ColdChain**” is found.
2. Choose “**ColdChain**”.

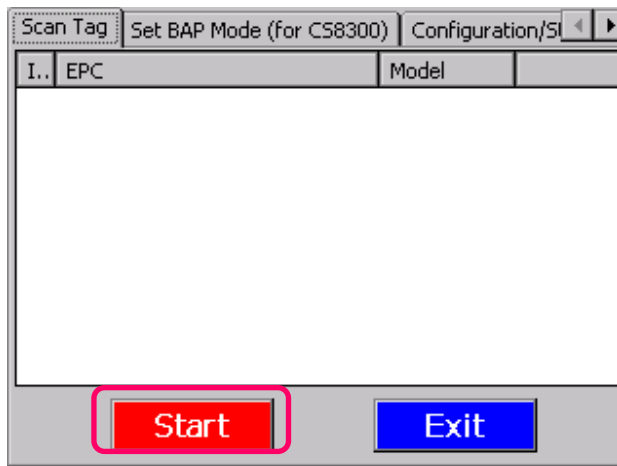


3. Put the ColdChain CS8300 Tag at a distance of at least 30 cm in front of CS101 reader.

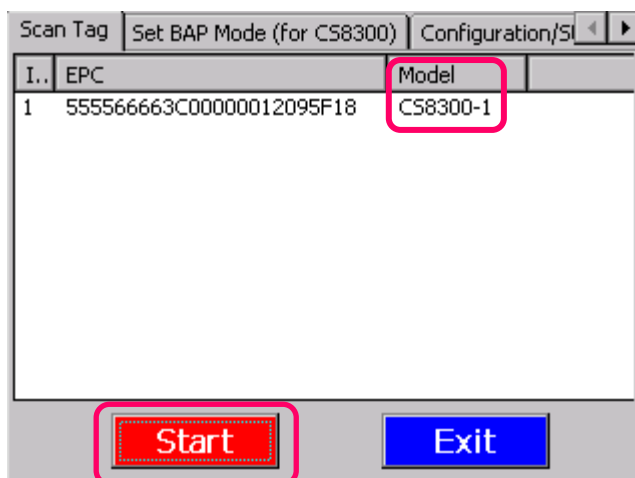
4. In the Cold Chain Menu, choose **“Scan Tag”**.



5. In the tab **“Scan Tag”**, press **“Start”** to scan the target Cold Chain Tag (CS8300).

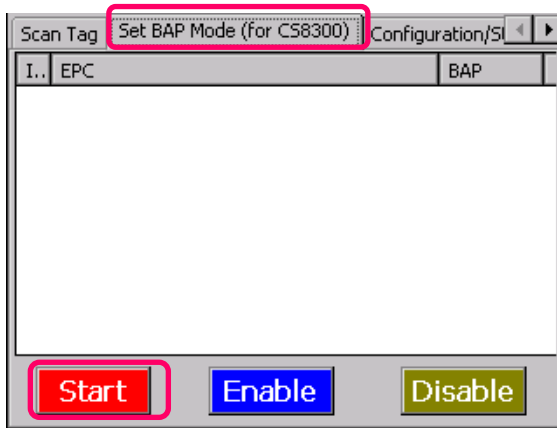


6. Press **“Stop”** to stop scanning. Check the tag model **“CS8300-X”** in the field **“Model”**. If the tag model is not what you want, then look for the correct model.



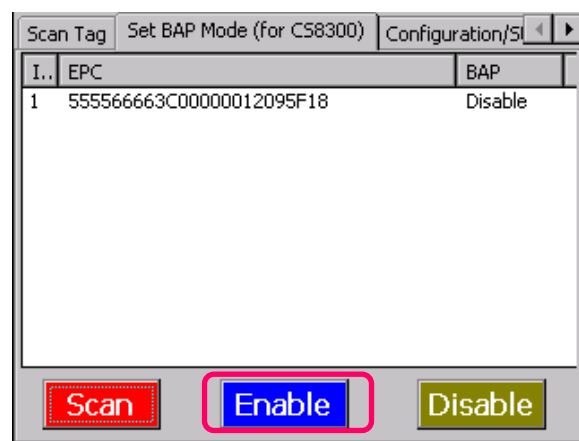
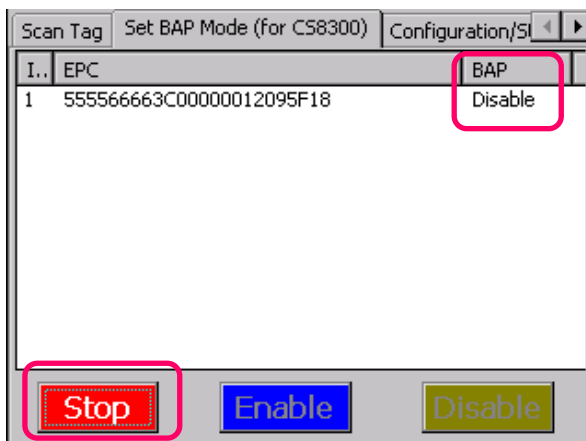
- For CS8300, when receiving card from factory (first use), user has to set its BAP mode to “Enable” state before use. The card’s BAP mode is disabled ex-factory to conserve battery life. This is only done for CS8300. For CS8301 and CS8304, the BAP mode is always enabled, even from factory.

Go to tab “Set BAP Mode (for CS8300)”, press “Start” to check BAP state of the target tag.

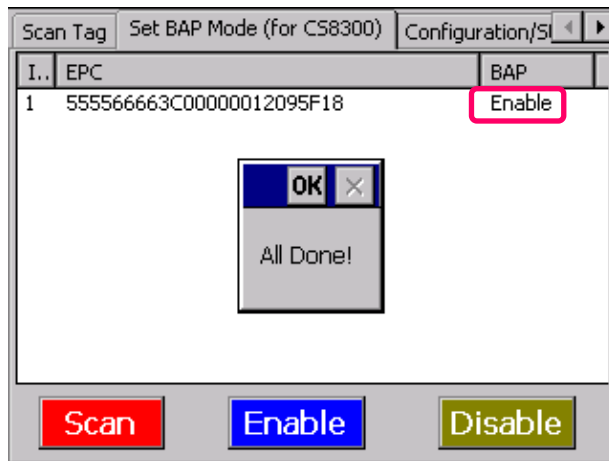


- You would see, ex-factory, “Disable” setting in the field “BAP”.

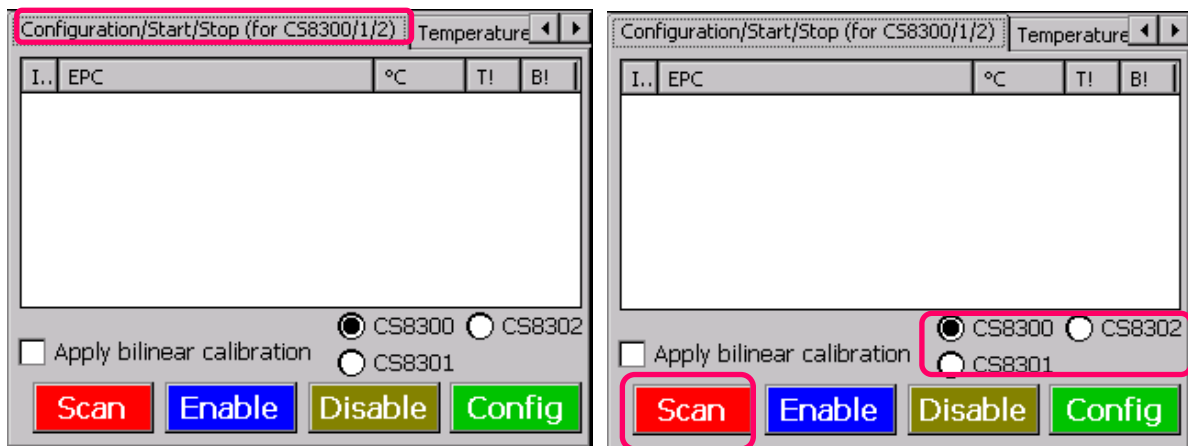
Press “Stop” and then press “Enable” to set the target Tag to BAP enable.



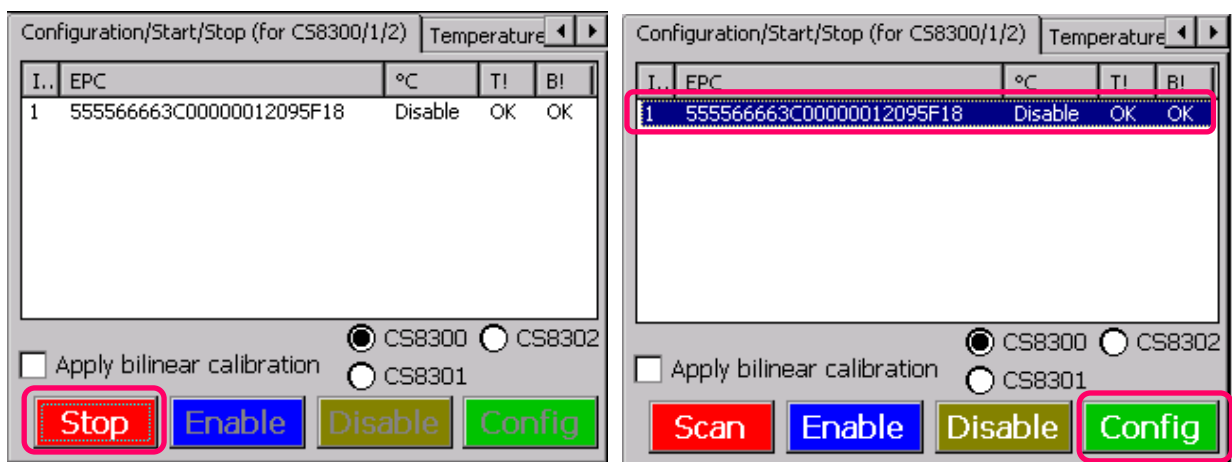
9. The target BAP ID card Tag is now enable. Press “OK” to continue



10. Go to “Configuration/Start/Stop ...”, Ensure the option “CS8300” is chosen and press “Scan” to scan target Tag.



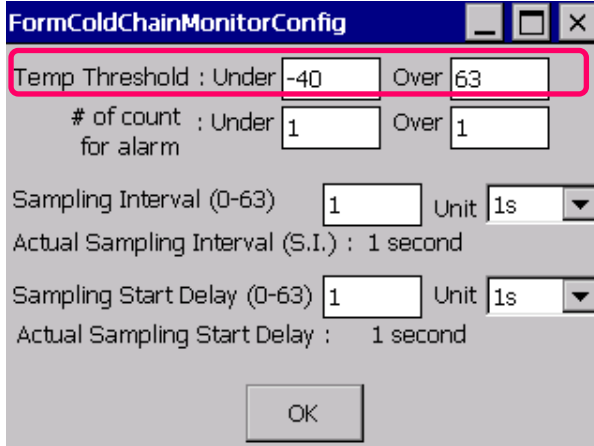
11. Press “Stop”, Select the target Tag and press “Config”.



12. In the form “**FormColdChainMonitorConfig**”, set Temp Threshold in **Celsius**.

In the field “**Under**”, input the lower temperature limit.

In the field “**Over**”, input the upper temperature limit.



The screenshot shows a dialog box titled "FormColdChainMonitorConfig" with the following fields and values:

Temp Threshold : Under	-40	Over	63
# of count : Under for alarm	1	Over	1
Sampling Interval (0-63)	1	Unit	1s
Actual Sampling Interval (S.I.) : 1 second			
Sampling Start Delay (0-63)	1	Unit	1s
Actual Sampling Start Delay : 1 second			

An "OK" button is located at the bottom center of the dialog box.

13. Set the sampling rate for the temperature monitoring and alert process in the field **“Sampling Interval (0-63)”**.

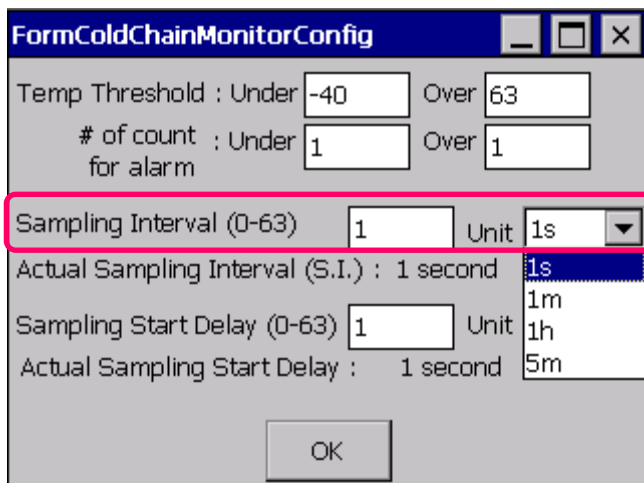
Please ensure that the values range from 0 to 63.

To set the sampling rate to 1 second, choose **“1s”** in dropdown list in the field **“Unit”** and input **“1”**.

To set the sampling rate to 8 minutes, choose **“1m”** in dropdown list in the field **“Unit”** and input **“8”**.

To set the sampling rate to 2 hours, choose **“1h”** in dropdown list in the field **“Unit”** and input **“2”**.

To set the sampling rate to 5 hour 15 minutes (which is equal to 315 minutes), choose **“5m”** in dropdown list in the field **“Unit”** and input **“63”**.



14. In the field “**Sampling Start Delay (0-63)**”, set the time for the target tag to start temperature monitoring and alert process after the tag is configured and enabled.

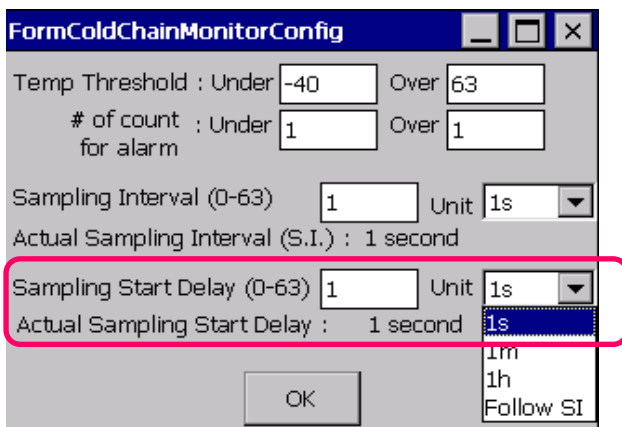
Please ensure that the values range from 0 to 63 in the field “**Value**”.

To set target tag start temperature monitoring after 1 second, choose “**1s**” in dropdown list in the field “**Unit**” and input “**1**”.

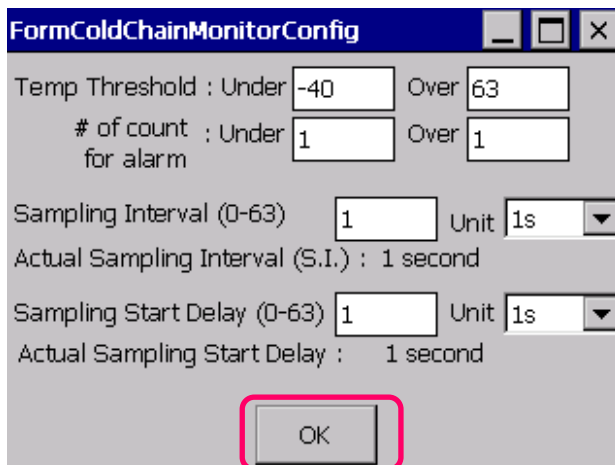
To set target tag start temperature monitoring after 3 minutes, choose “**1m**” in dropdown list in the field “**Unit**” and input “**3**”.

To set target tag start temperature monitoring after 8 sampling intervals defined by user, choose “**Follow SI**” in dropdown list in the field “**Unit**” and input “**8**”.

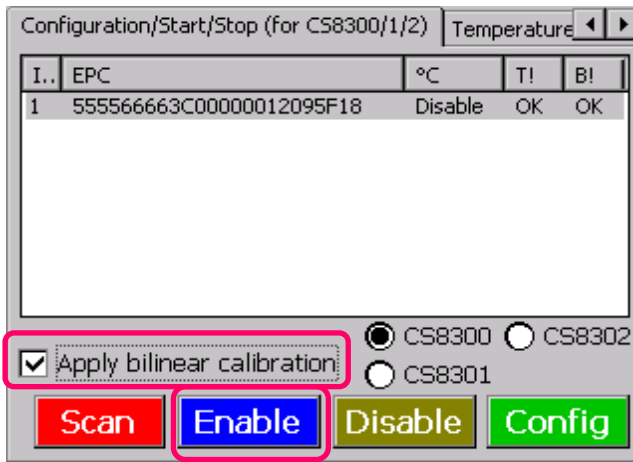
(User has to set the “**Sampling Interval (0-63)**” when choosing this option)



15. Press “**OK**” to confirm the configuration

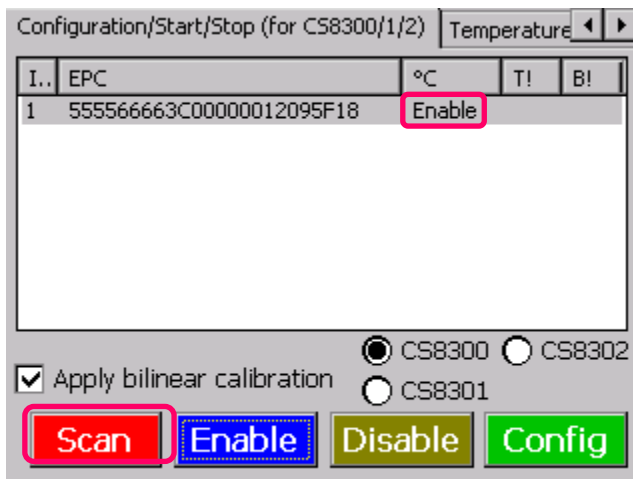


16. Remember to tick the checkbox “**Apply bilinear calibration**” and press “**Enable**”.

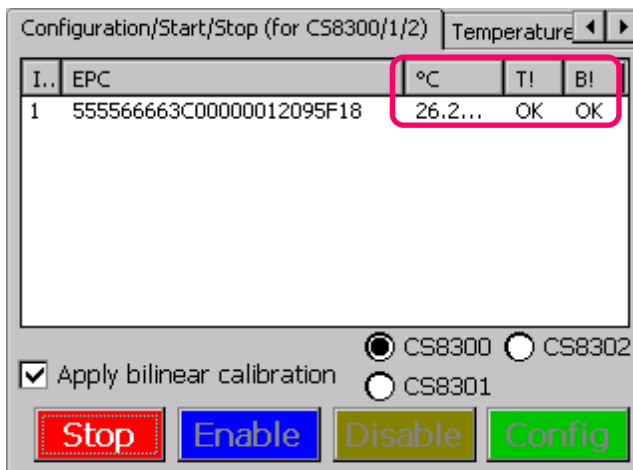


17. Make sure the target tag is in **Enable** state before the process start.

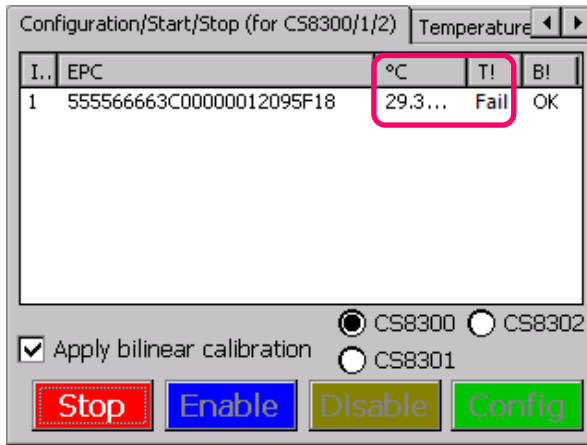
When press “**Scan**”, the Temperature Monitor and Alert process will start according to the time set in **Sampling Start Delay**.



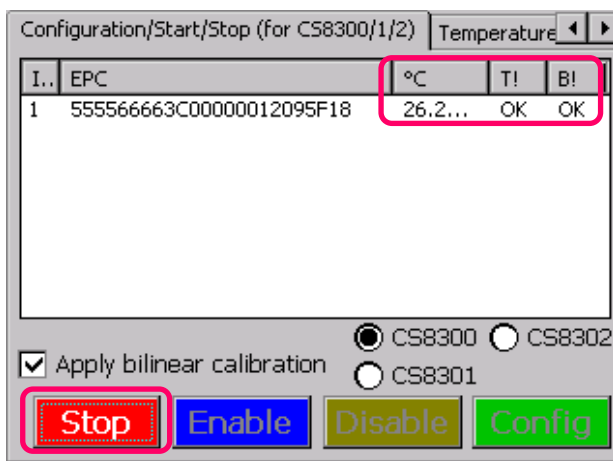
18. The Temperature (°C), Temperature Alert Status (T!) and Battery Status (B!) are monitored in the screen in the sampling rate the user defined.



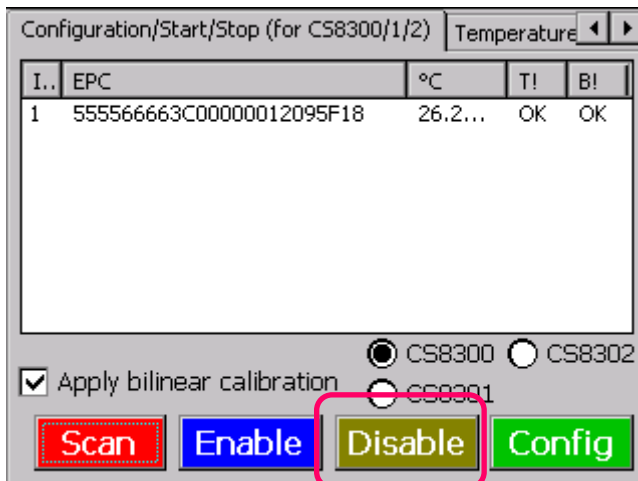
19. If the surrounding temperature reaches the configured temperature limit, Temperature Alert Status (T!) is changed to **Failed**.



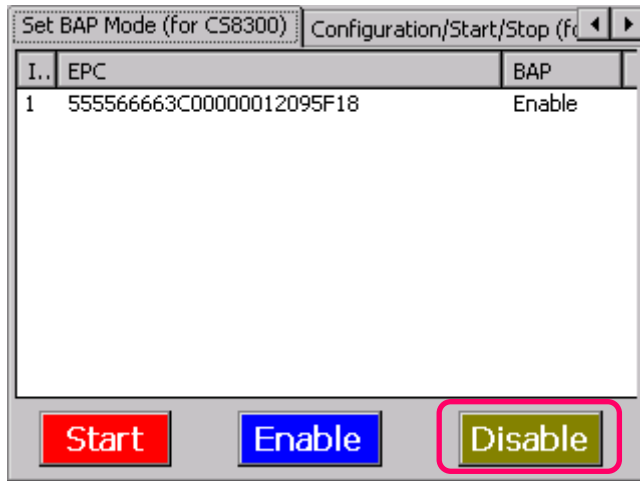
20. When the user want to end the temperature monitoring process, press **“Stop”** to stop the process.



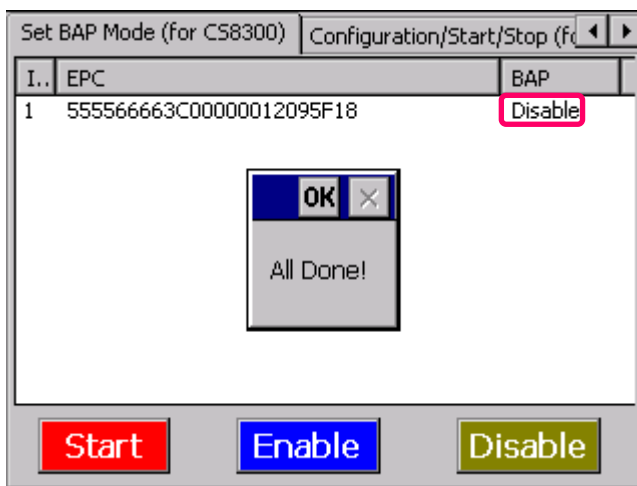
21. User has to disable the Tag again to save battery power. Press **“Disable”** in the tab **“Configuration/Start/Stop ... ”**. The **Red LED** in the Tag will turn **ON** if the value in the field **“T!”** is **“Fail”**.



22. Go to tab “Set BAP Mode (for CS8300)”, press “Disable”.



23. The state of BAP is changed to **Disable** with prompt message. Press “OK” to continue.



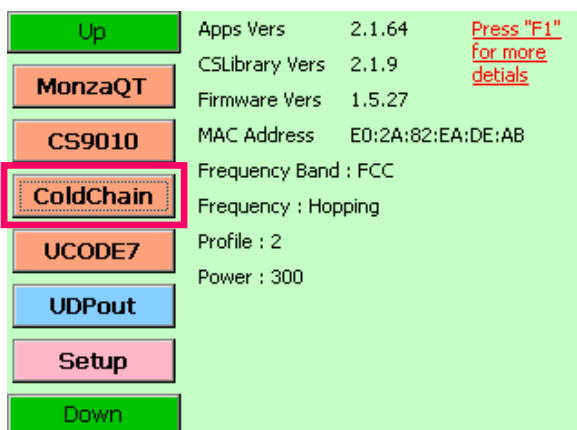
24. Choose the tab **Exit** to close the application.

## 10.4.2 Temperature Alert in “ColdChain” Mode for Cold Chain Tags CS8301

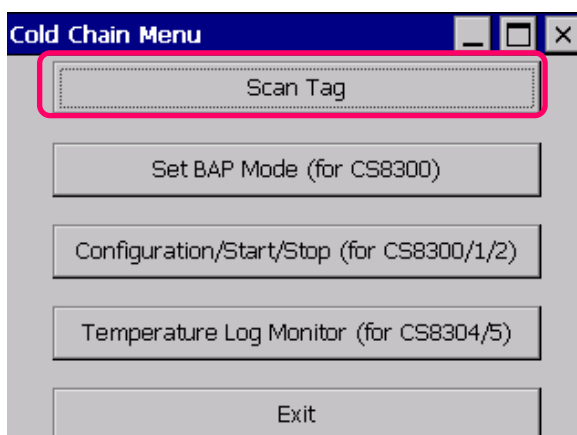
User can use “ColdChain” mode in CS101 and the Cold Chain tags CS8301 to do monitor temperature surrounding and alert when the temperature reaches the limit set by user.

Basically user has to set Temperature Monitor Start Time, Sampling Rate and Temperature Threshold to alert before use.

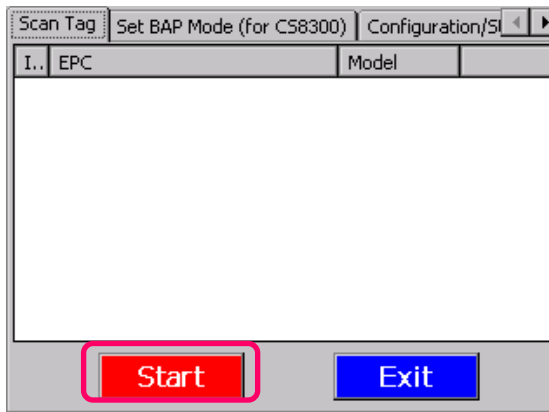
1. In the Main Menu of Demo App, Press “**Down**” until “**ColdChain**” is found.
2. Choose “**ColdChain**”.



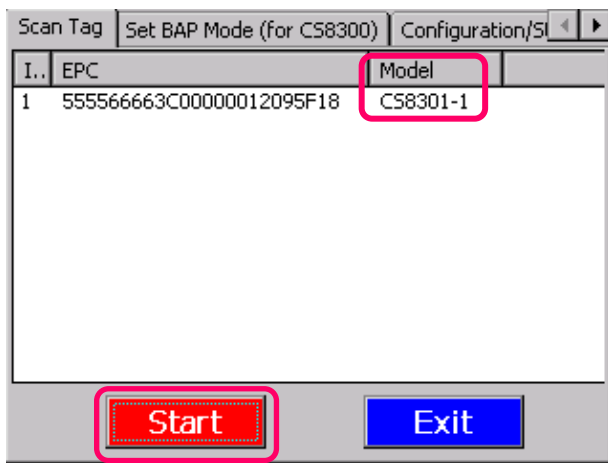
3. Put the ColdChain CS8301 Tag at a distance of 30 cm in front of CS101 reader.
4. In the Cold Chain Menu, choose “**Scan Tag**”.



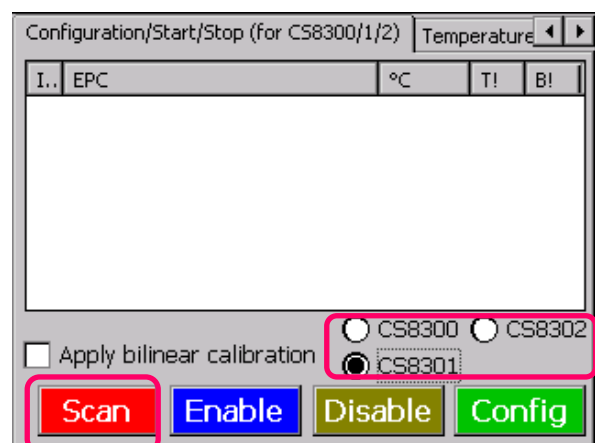
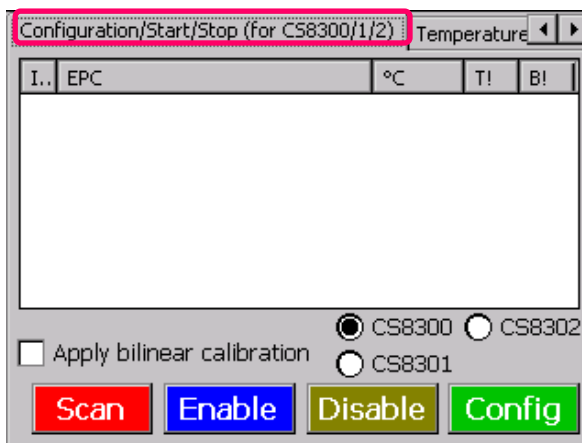
- In the tab “**Scan Tag**”, press “**Start**” to scan the target Cold Chain Tag (CS8301).



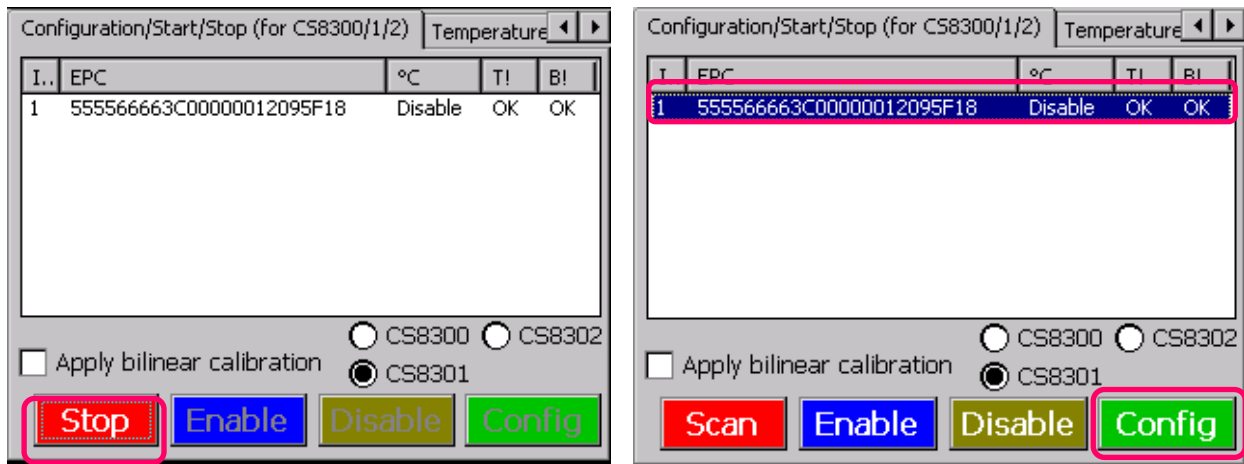
- Press “**Stop**” to stop scanning. Check the tag model “**CS8301-X**” in the field “**Model**”. If the tag model is not “**CS8301-X**”, find a new tag of this model.



- Go to “**Configuration/Start/Stop ...**”, Ensure the option “**CS8301**” is chosen and press “**Scan**” to scan target Tag.



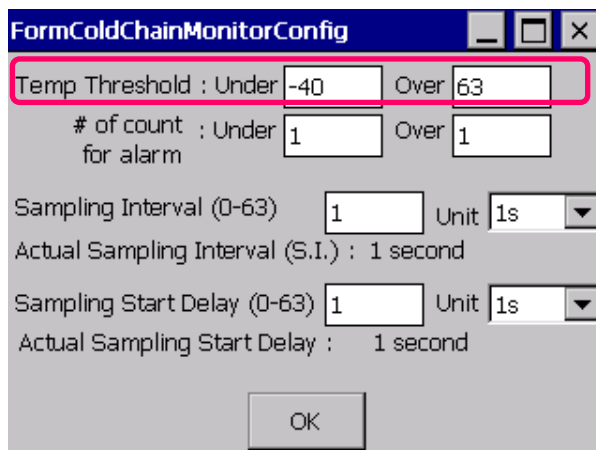
8. Press “**Stop**”, Select the target **Tag** and press “**Config**”.



9. In the form “**FormColdChainMonitorConfig**”, set Temp Threshold in **Celsius**.

In the field “**Under**”, input the lower temperature limit.

In the field “**Over**”, input the upper temperature limit.



10. Set the sampling rate for the temperature monitoring and alert process in the field **“Sampling Interval (0-63)”**.

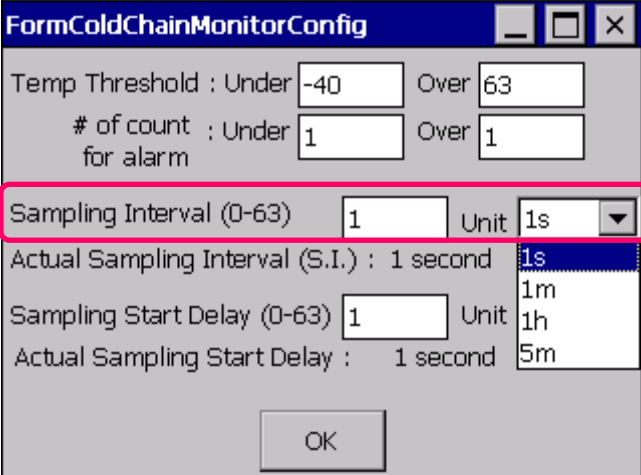
Please ensure that the values range from **0 to 63**.

To set the sampling rate to **1** second, choose **“1s”** in dropdown list in the field **“Unit”** and input **“1”**.

To set the sampling rate to **8** minutes, choose **“1m”** in dropdown list in the field **“Unit”** and input **“8”**.

To set the sampling rate to **2** hours, choose **“1h”** in dropdown list in the field **“Unit”** and input **“2”**.

To set the sampling rate to **5 hour 15 minutes (which is equal to 315 minutes)**, choose **“5m”** in dropdown list in the field **“Unit”** and input **“63”**.



FormColdChainMonitorConfig

Temp Threshold : Under -40 Over 63

# of count : Under 1 Over 1  
for alarm

Sampling Interval (0-63) 1 Unit 1s

Actual Sampling Interval (S.I.) : 1 second

Sampling Start Delay (0-63) 1 Unit 1h

Actual Sampling Start Delay : 1 second 5m

OK

11. In the field “**Sampling Start Delay (0-63)**”, set the time for the target tag to start temperature monitoring and alert process after the tag is configured and enabled.

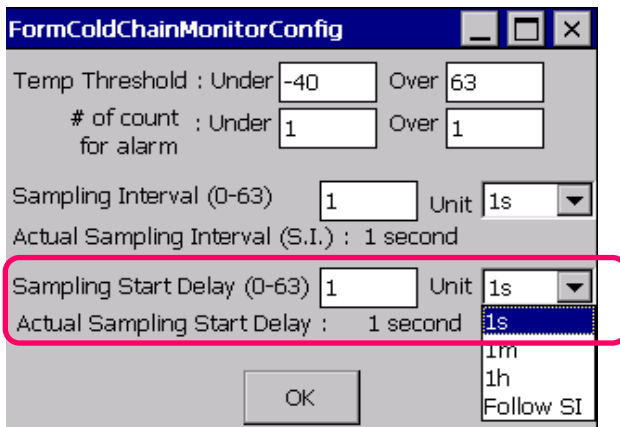
Please ensure that the values range from **0 to 63** in the field “**Value**”.

To set target tag start temperature monitoring after **1** second, choose “**1s**” in dropdown list in the field “**Unit**” and input “**1**”.

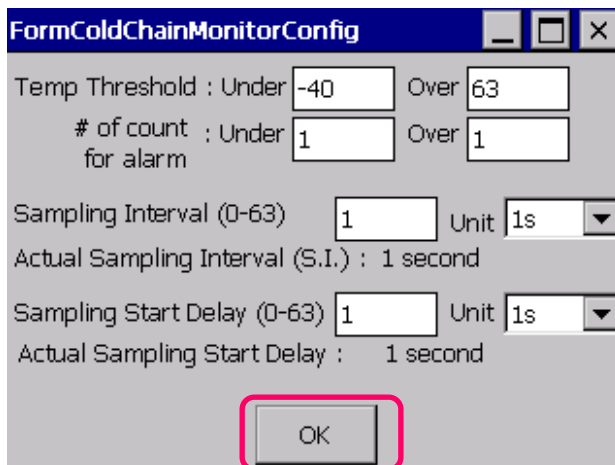
To set target tag start temperature monitoring after **3** minutes, choose “**1m**” in dropdown list in the field “**Unit**” and input “**3**”.

To set target tag start temperature monitoring after **8** sampling intervals defined by user, choose “**Follow SI**” in dropdown list in the field “**Unit**” and input “**8**”.

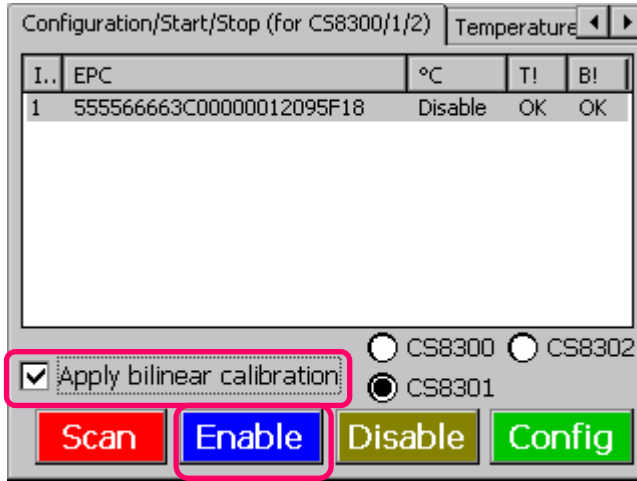
(User has to set the “**Sampling Interval (0-63)**” when choosing this option)



12. Press “**OK**” to confirm the configuration

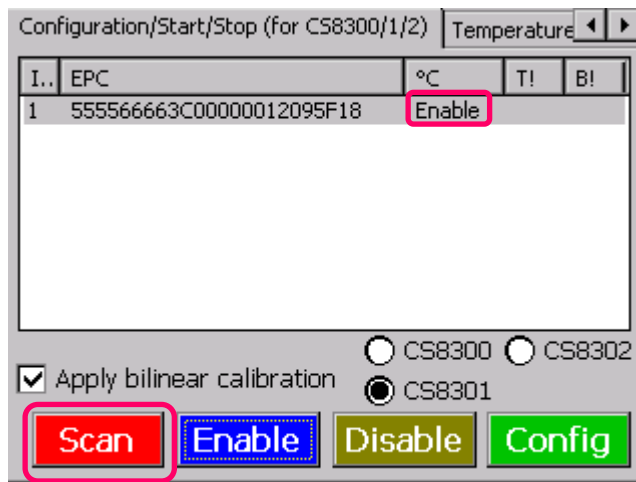


13. Remember to tick the checkbox “**Apply bilinear calibration**” and press “**Enable**”.

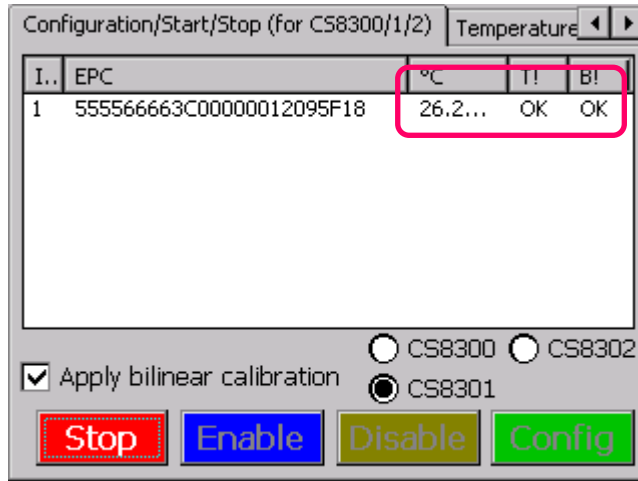


14. Make sure the target tag is in **Enable** state before the process start.

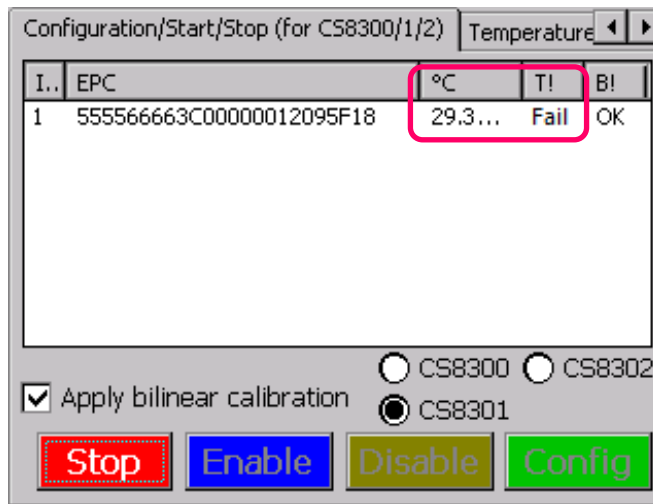
When press “**Scan**”, the Temperature Monitor and Alert process will start according to the time set in **Sampling Start Delay**.



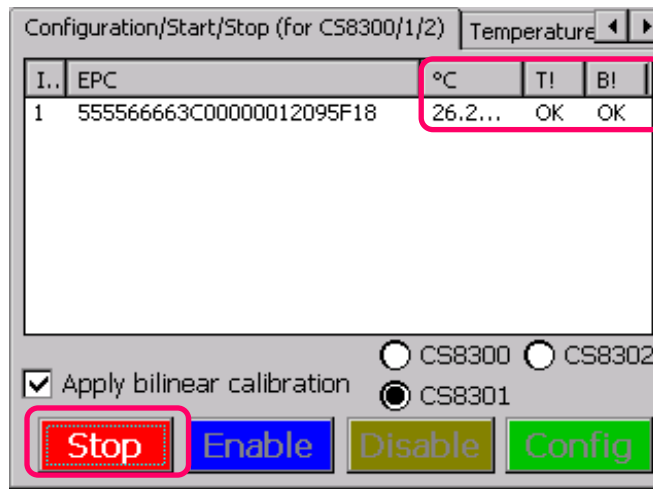
15. The Temperature (**°C**), Temperature Alert Status (**T!**) and Battery Status (**B!**) are monitored in the screen in the sampling rate the user defined.



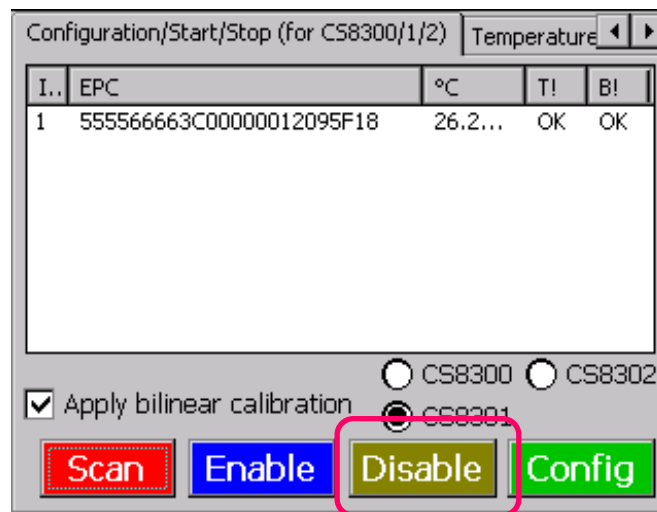
16. If the surrounding temperature reaches the configured temperature limit, Temperature Alert Status (**T!**) is changed to **Failed**.



17. When the user want to end the temperature monitoring process, press **“Stop”** to stop the process.



18. User has to disable the Tag again. Press **“Disable”** in the tab **“Configuration/Start/Stop ...”**. The **Red LED** in the Tag will turn **ON** if the value in the field **“T!”** is **“Fail”**.

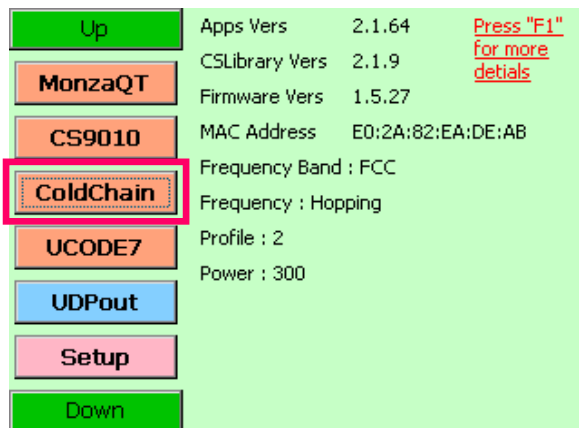


19. Choose the tab **Exit** to close the application.

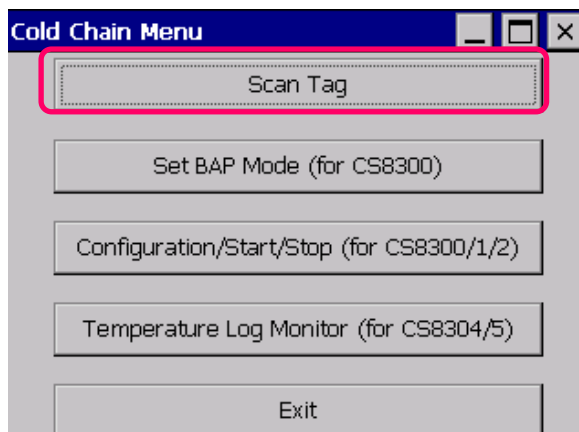
### 10.4.3 Temperature Logging in “ColdChain” Mode for Cold Chain Tags CS8304

User can use “ColdChain” mode in CS101 RFID reader and enable Temperature Data Logging for the Cold Chain tag CS8304. The temperature data is recorded in Celsius with date and time.

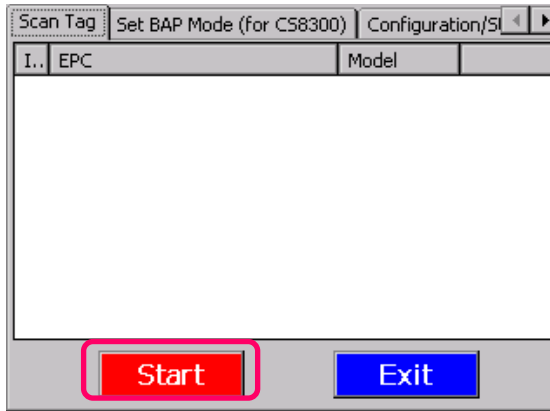
1. In the Main Menu of Demo App, Press “**Down**” until “**ColdChain**” is found.
2. Choose “**ColdChain**”.



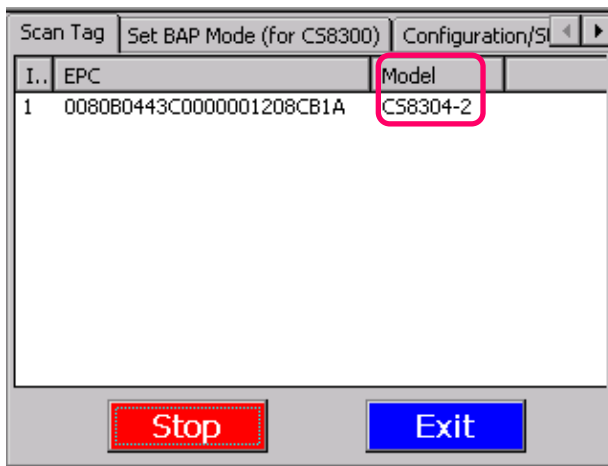
3. Put the ColdChain (CS8304) Tag at a distance of 30 cm in front of CS101 reader.
4. In the Cold Chain Menu, choose “**Scan Tag**”.



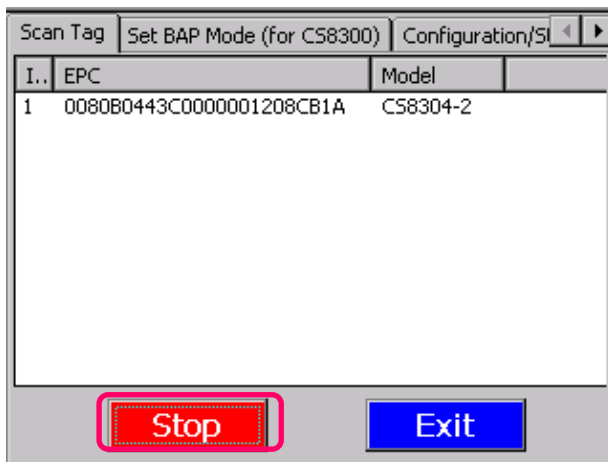
5. In the tab “**Scan Tag**”, press “**Start**” to scan the target Cold Chain Tag (CS8304).



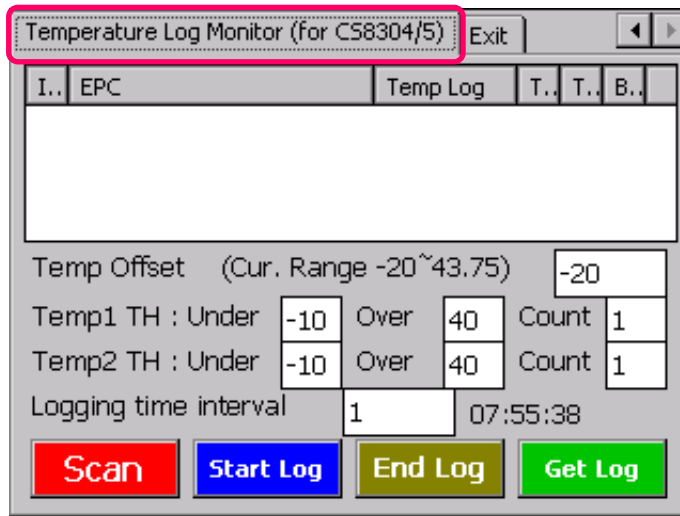
6. Check the tag model “**CS8304-X**” in the field “**Model**”. If the tag model is not “**CS8304-X**”, find a new tag of this model.



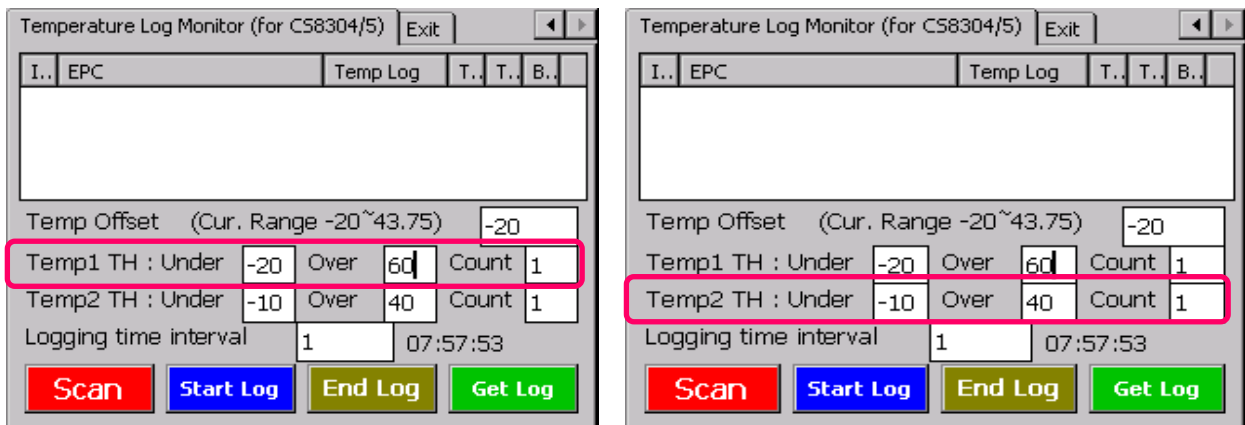
7. Press “**Stop**” to stop scanning.



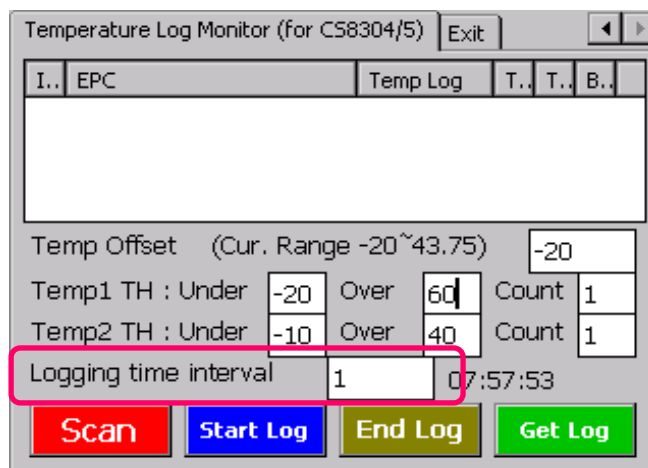
8. **DO NOT** change the enable state in **BAP Mode for CS8304**. Go to tab “Temperature Log Monitor (CS8304/5)” directly.



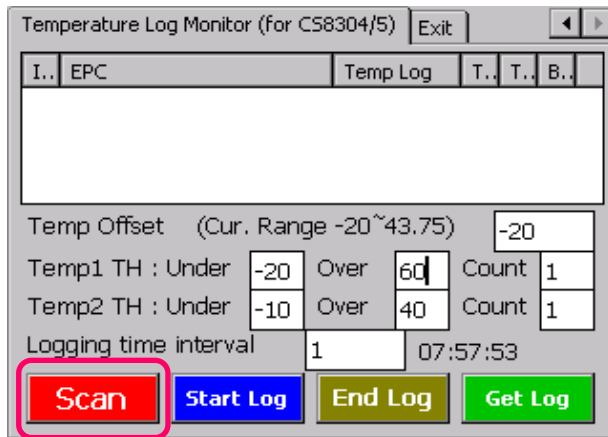
9. User can set at most 2 sets Temperature data record lower and upper limit (in Celsius) in the field “Temp1 TH”, “Temp2 TH”



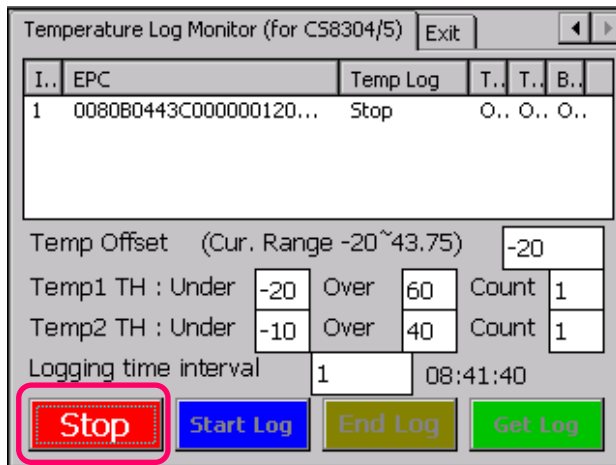
10. Set the logging time interval (in second) in the field “Logging time interval”



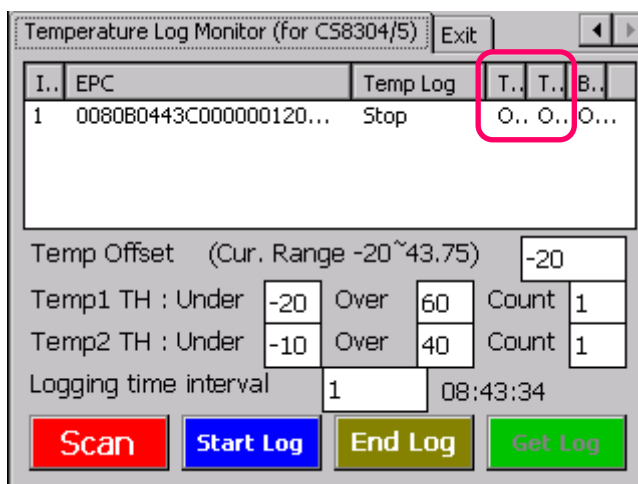
11. Press **“Scan”** and check the target tag EPC. Press **“Stop”** when the tag is found.



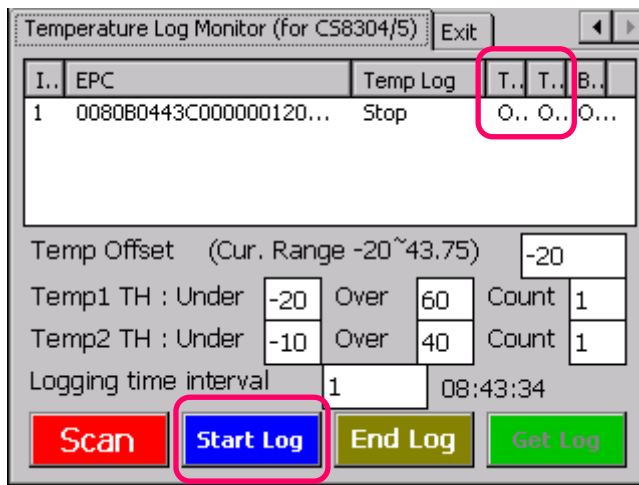
12. Press **“Stop”** when the tag is found.



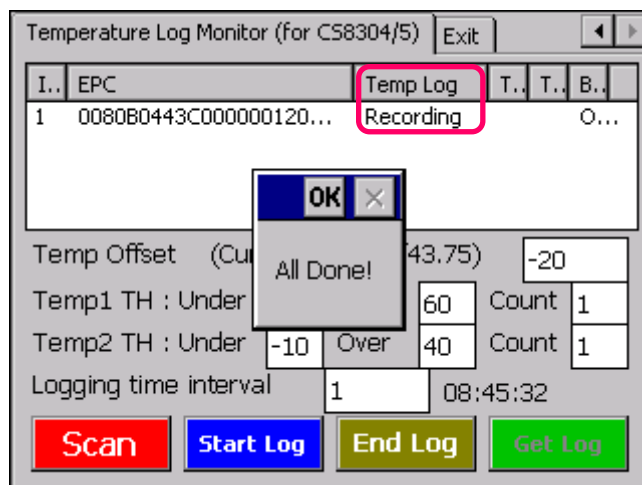
13. Check the field **“T!”** is in **“OK”** state before use. If not, please order a new tag from CSL.



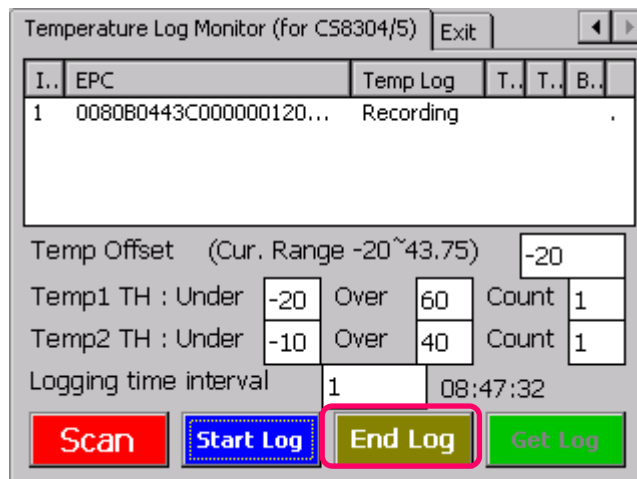
14. The default value in the field “Temp Log” is “Stop”. Press “Start Log” to enable the temperature data logging process.



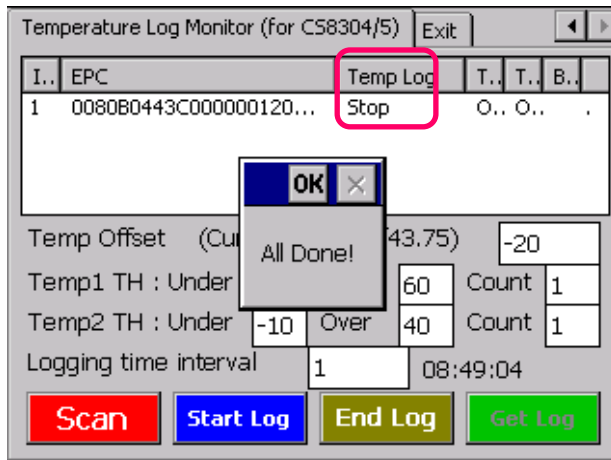
15. When the temperature data logging process starts, the state in the field “Temp Log” is changed to “Recording”. Press “OK” to continue.



16. To stop the temperature data logging process, press “End Log” to stop the process.

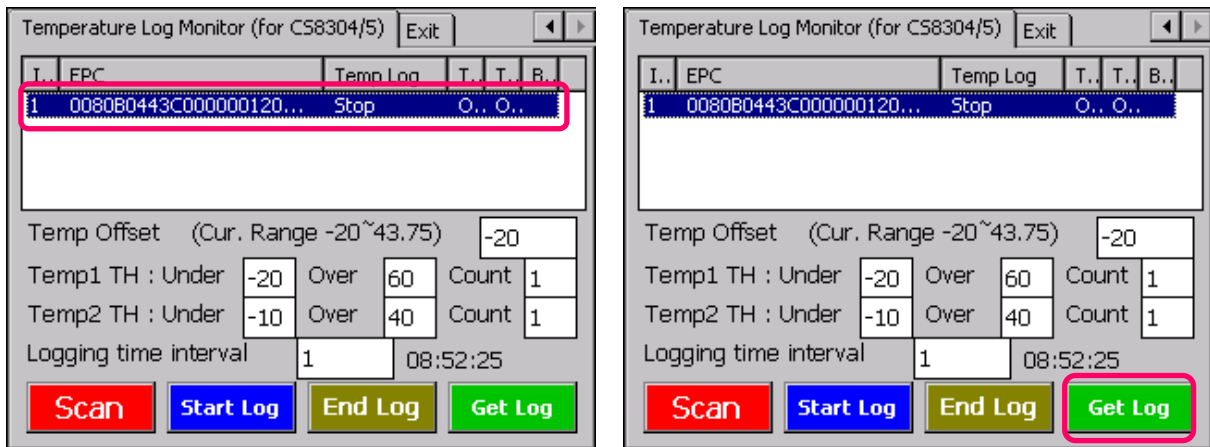


17. When the temperature data logging process stops, the field “Temp Log” is changed to “Stop”. Press “OK” to continue.

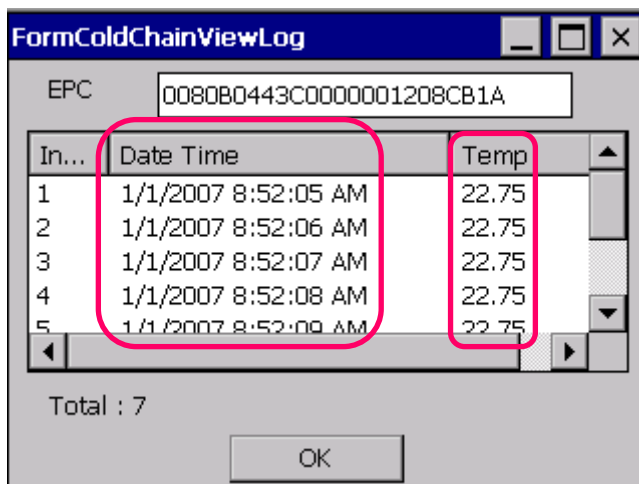


18. User can check the temperature log data recorded by the target Tag.

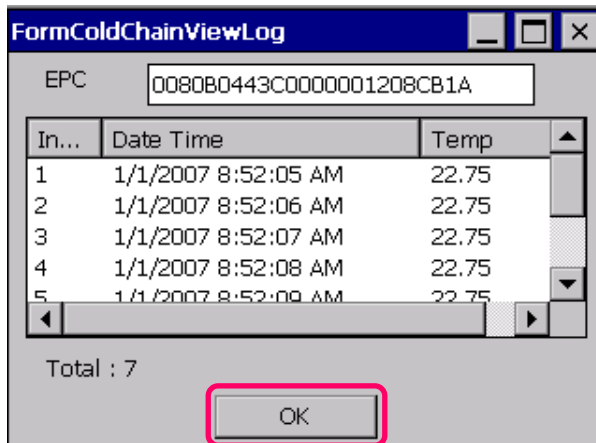
Select the target Tag in the list and press “Get Log”.



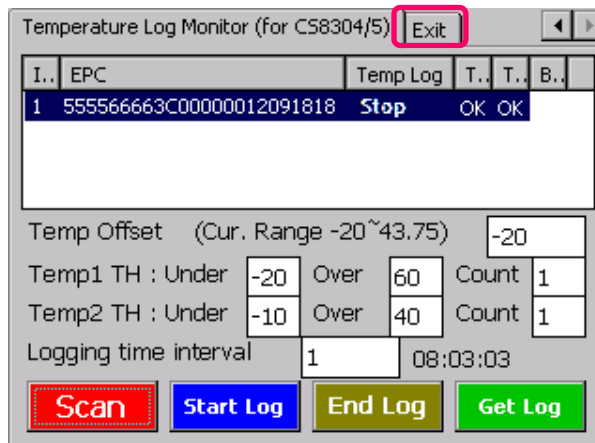
19. The form “FormColdChainViewLog” is shown. User can scroll down and check the record including date, time (Date Time) and temperature (Temp).



20. User can press "OK" to exit.



21. To exit the application, choose the tab **Exit**.



# 11 CS101 Demo Application Software Upgrade

## 11.1 Demo Application Upgrade

User can visit the CSL website (<http://www.convergence.com.hk>) > Downloads & Support > CS101 to find the latest release software for upgrade of CS101 Reader.

The screenshot shows the website interface for CSL Convergence Systems Limited. At the top, there is a navigation bar with links for SOLUTIONS, PRODUCTS, CUSTOM SERVICES, DOWNLOADS & SUPPORT, PARTNERS, NEWS, ABOUT US, and CONTACT. The main content area is titled 'CS101' and provides links for 'Download and Support for General User' and 'Download and Support for Developer'. Below this, there is a section for 'For General User' with a link to the 'User's Manual'. A table lists the manual file, date (26 Jun 2014), and note. Another section titled 'Demo App' contains a table with columns for 'Installer', 'Latest Version', and 'Remark', listing two demo applications: 'CS101 .NET Demo App on WinCE OS with User Interface' (v2.1.63, Aug 2014) and 'UDP Server Demo Program on Windows OS using Command Prompt' (v1.0.0, Jun 2014).

## 11.2 PC Demo Application Upgrade - For User

1. In the section “Demo App”, check the latest version of Demo Application and download it.

**Demo App**

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Installer	Latest Version	Remark
<a href="#">CS101 .NET Demo App on WinCE OS with User Interface</a>	v2.1.63 (Aug 2014)	CS101 .NET Demo App
<a href="#">UDP Server Demo Program on Windows OS using Command Prompt</a>	v1.0.0 (Jun 2014)	UDP Server Demo Program
<a href="#">CS101 Barcode and SnapShot Demo App on WinCE OS with User Interface</a>	v1.0.0 (Jun 2014)	CS101 Barcode and SnapShot Demo in C# .NET
<a href="#">CS101 VB Demo App on WinCE OS with User Interface</a>	v1.0.3 (Jun 2014)	CS101 Demo in VB .NET

**Special Notes**

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Files	Latest Version	Note
<a href="#">Restore CS101 OS to Factory Default Setting</a>	v1.2.1 (Apr 2014)	Guidelines to restore CS101 OS to Factory Default Setting



“CSL is a leader in identification products and focus on providing excellence.”




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**DOWNLOAD & SUPPORT –  
INSTALLER – CS101 DEMO  
APP**

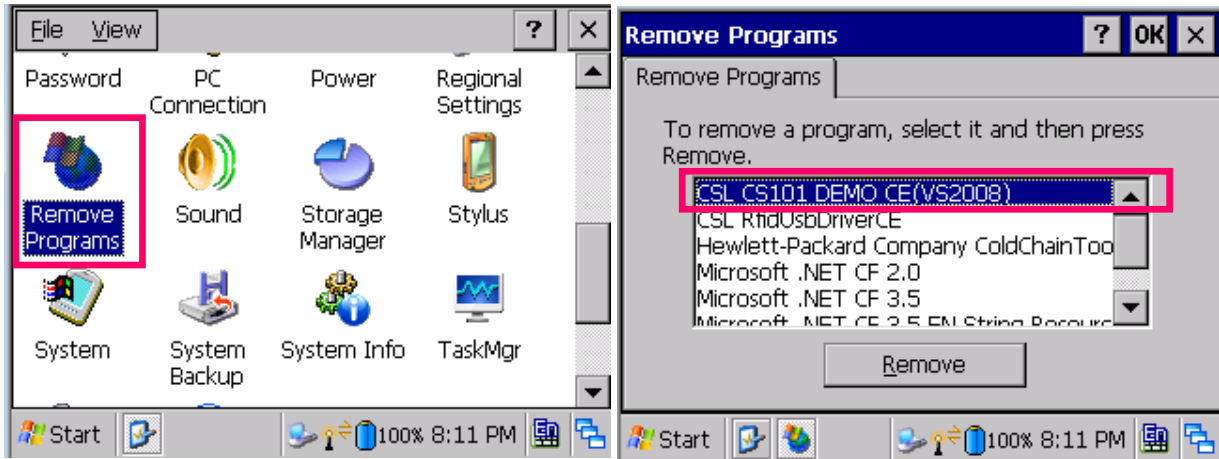
Home » Download & Support – Installer – CS101 Demo App

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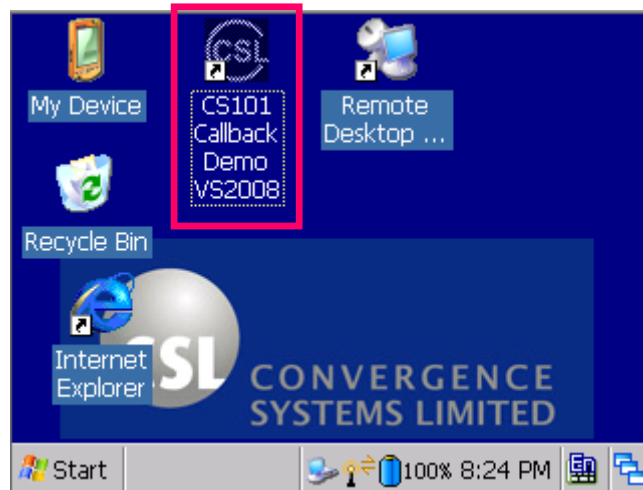
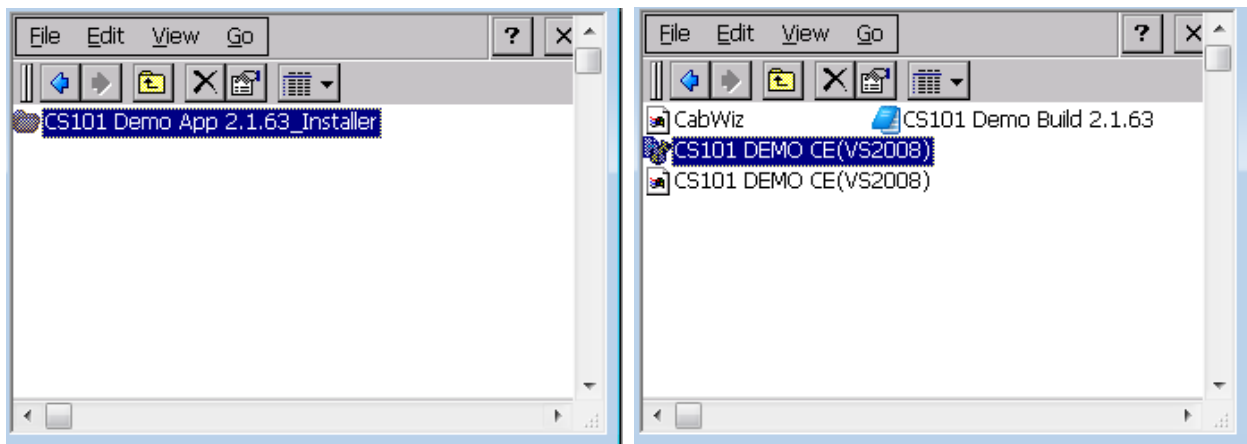
**CS101 .NET Demo App**

Installer	Version	Note
<a href="#">CS101 Demo App 2.1.63_Installer.zip</a>	v2.1.63 (Aug 2014) (Latest)	CSLibrary 2.1.9.0 <a href="#">Release Note</a>
<a href="#">CS101 Demo App 2.1.61_Installer.zip</a>	v2.1.61 (Jul 2014)	CSLibrary 2.1.9.0 <a href="#">Release Note</a>

2. Uninstall the original Demo App previous installed in CS101 Reader.



3. Unzip and copy the downloaded Demo App to CS101 from PC via USB or SD card. Double click and install Demo App.



## 11.3 PC Demo Application Upgrade - For Developer

1. In the section “Software Development Kit”, check the latest version of SDK and download it.

**For Developer**

**Software Development Kit**

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<b>SDK</b>	<b>Latest Version</b>	<b>Remark</b>
<a href="#">CS101 .NET API Demo Build on WinCE OS with User Interface</a>	v2.1.63 (Aug 2014)	C# over C++ SDK with libraries included
<a href="#">CS101 Java API Demo Build on WinCE OS with User Interface</a>	22 Feb 2010	<a href="#">Guidelines for Building CS101 Java Demo App using NetBeans</a>
<a href="#">UDP Server Demo Build on Windows OS using Command Prompt</a>	v1.0.0 (Aug 2014)	UDP Server Demo Build in C# .NET
<a href="#">CS101 Barcode Demo Build on WinCE OS with User Interface</a>	v1.0.0 (Jun 2014)	CS101 Barcode Demo Build in C# .NET
<a href="#">CS101 VB Demo Build on WinCE OS with User Interface</a>	v1.0.3 (Jun 2014)	CS101 Demo Build in VB .NET

**Special Notes**

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<b>Files</b>	<b>Latest Version</b>	<b>Note</b>
<a href="#">Restore CS101 OS to Factory Default Setting</a>	v1.2.1 (Apr 2014)	Guidelines to restore CS101 WinCE OS to Factory Default Setting



“CSL handles harsh outdoor conditions and rough handling in oil and gas industry.”




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**DOWNLOAD & SUPPORT – SDK – CS101 .NET DEMO BUILD**

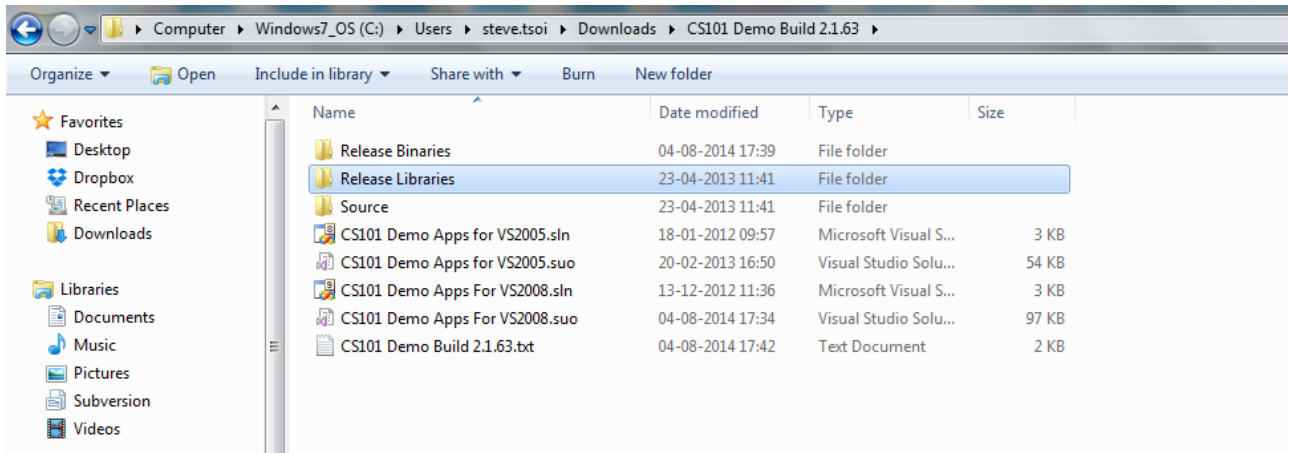
Home » Download & Support – SDK – CS101 .NET Demo Build

**Download & Support – SDK – CS101 .NET Demo Build**

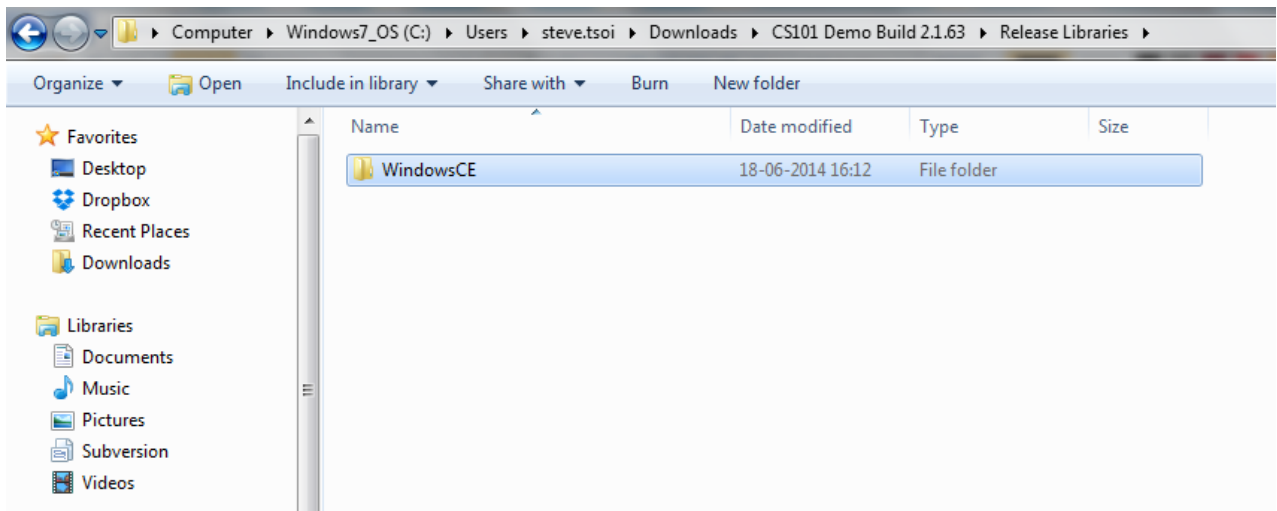
**CS101 .NET Demo Build**

<b>SDK</b>	<b>Version</b>	<b>Note</b>
<a href="#">CS101 Demo Build 2.1.63.zip</a>	v2.1.63 (Aug 2014) (Latest)	<a href="#">CSLibrary 2.1.9.0 Release Note</a>
<a href="#">CS101 Demo Build 2.1.61.zip</a>	v2.1.61 (Jul 2014)	<a href="#">CSLibrary 2.1.9.0 Release Note</a>

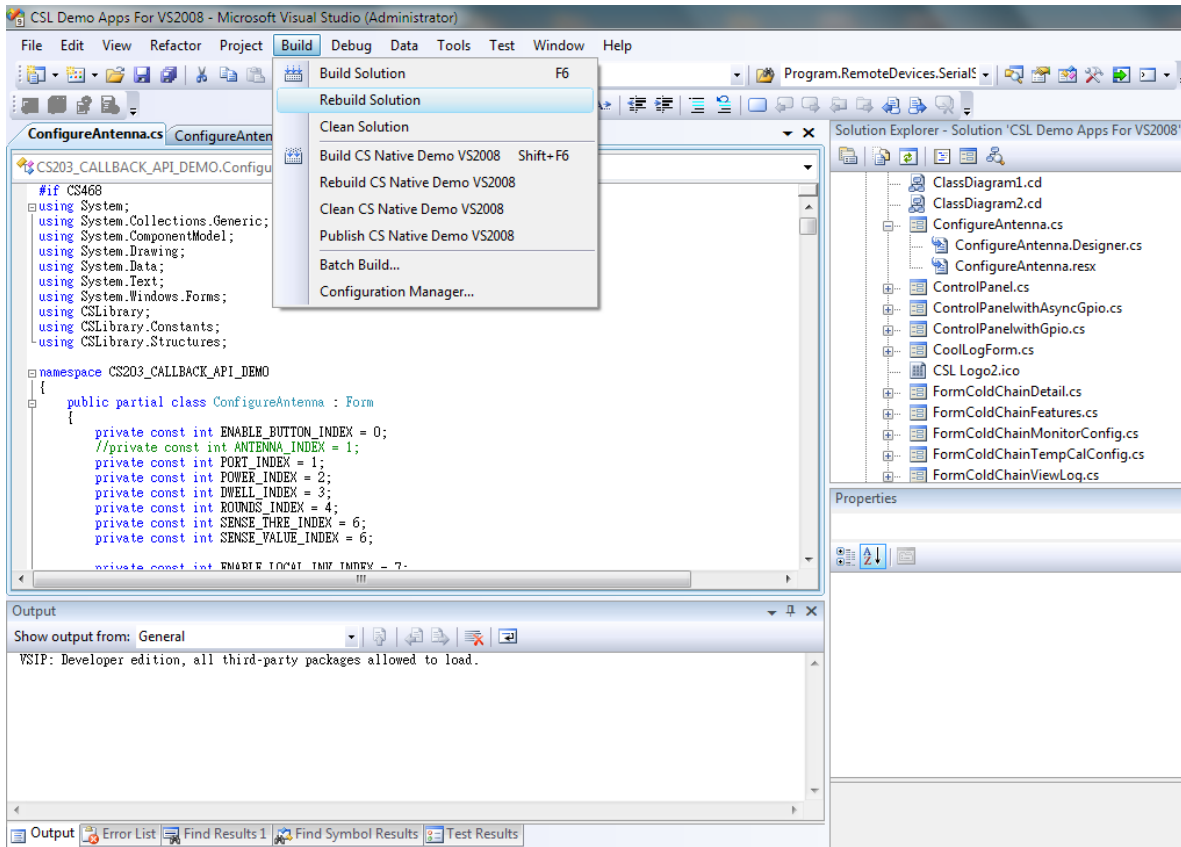
2. Unzip and check the “Release Libraries”.



3. Copy the SDK Library folder inside the folder “Release Libraries” and replace the folders in “Release Libraries” in current Developer’s project.



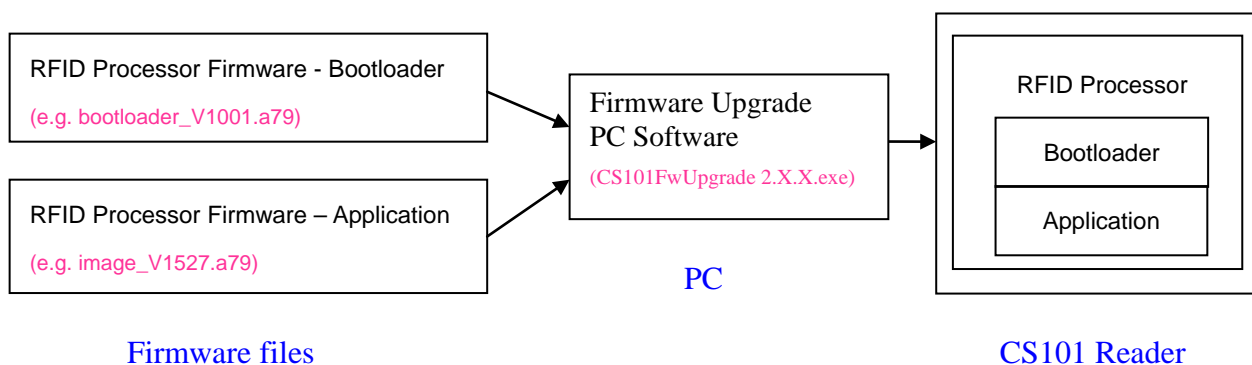
4. Open the Developer's project in Microsoft Visual Studio. Rebuild the project with latest SDK libraries.



## 12 CS101 Firmware Upgrade

### 12.1 Firmware Upgrade Procedure Overview

CSL CS101 Readers have 1 RFID Processor for RFID application. The application firmware can be upgradable via Firmware Upgrade software provided (CS101FwUpgrade 2.X.X.exe).

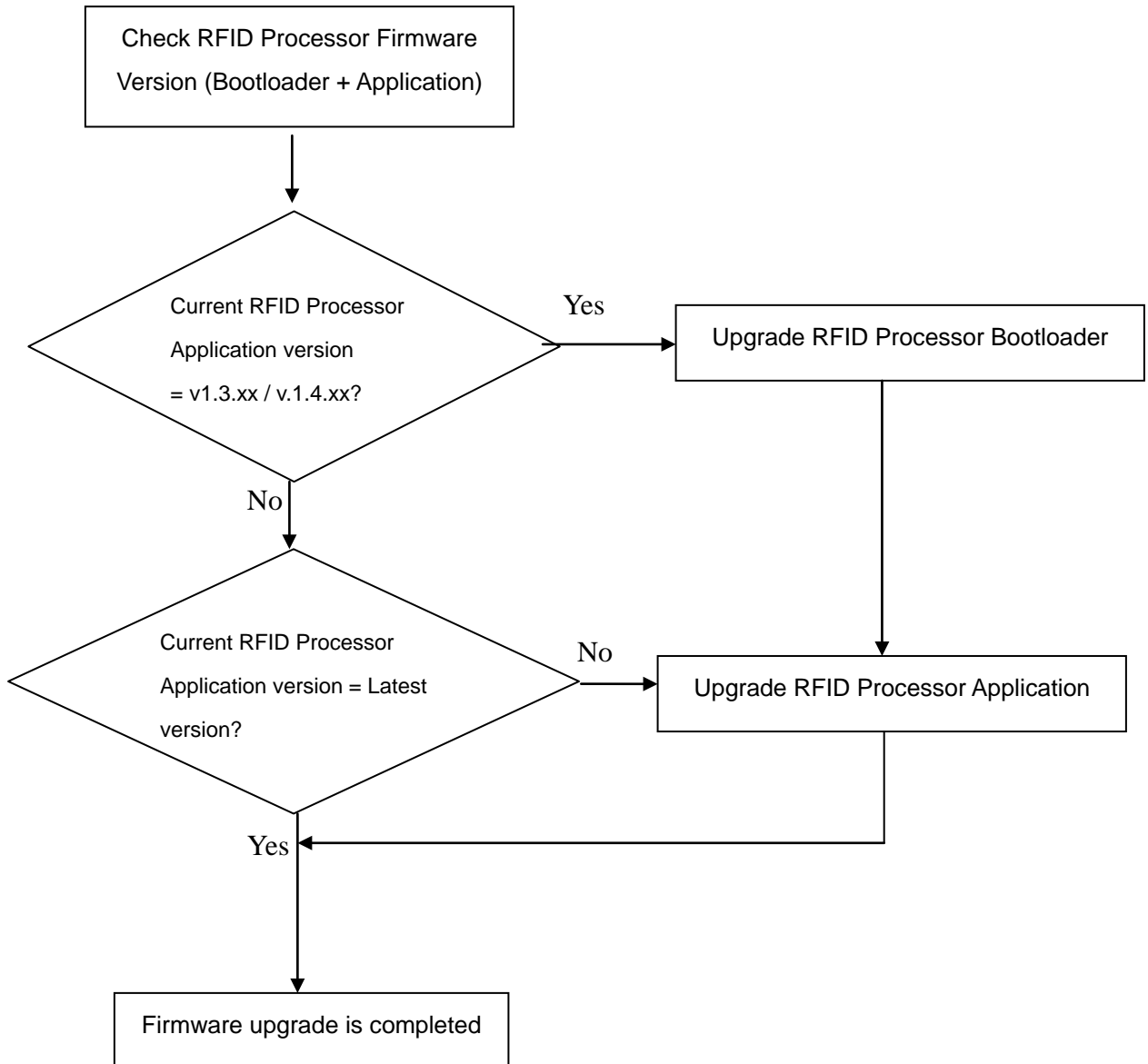


The Firmware Compatibility Table shows that current CSL CS101 reader with RFID Application version 1.3.xx and v1.4.xx do not include RFID Bootloader. Therefore if user wants to do firmware upgrade of RFID Application from **v1.3.xx / v1.4.xx** to **v1.5.xx**, user must install the RFID Bootloader to the reader before upgrading the RFID Application to the latest version (v1.5.xx or after).

RFID App	RFID Bootloader
v1.3.xx	No Bootloader
v1.4.xx	No Bootloader
v1.5.xx	v1.0.1 / v1.0.0

#### Firmware version for RFID Reader CS101

## The flow diagram for Firmware Upgrade procedure

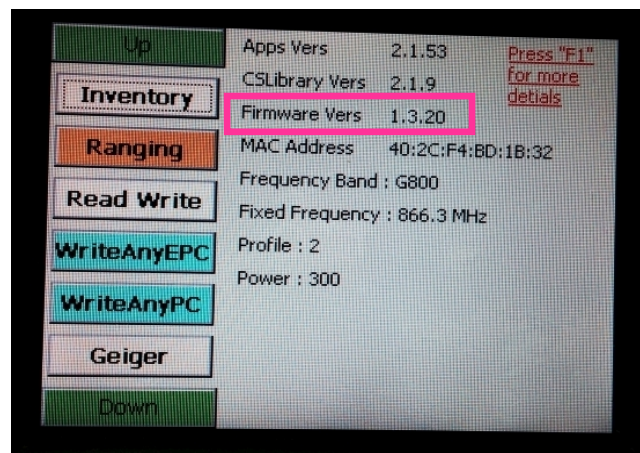


**Before doing firmware upgrade, please ensure YOU HAVE A FULLY CHARGED BATTERY INSERTED AND MAKE SURE THE BATTERY COVER IS SECURELY ATTACHED. DURING UPGRADE, YOU MUST NOT POWER OFF CS101 DURING THE FIRMWARE UPGRADE PROCESS.**

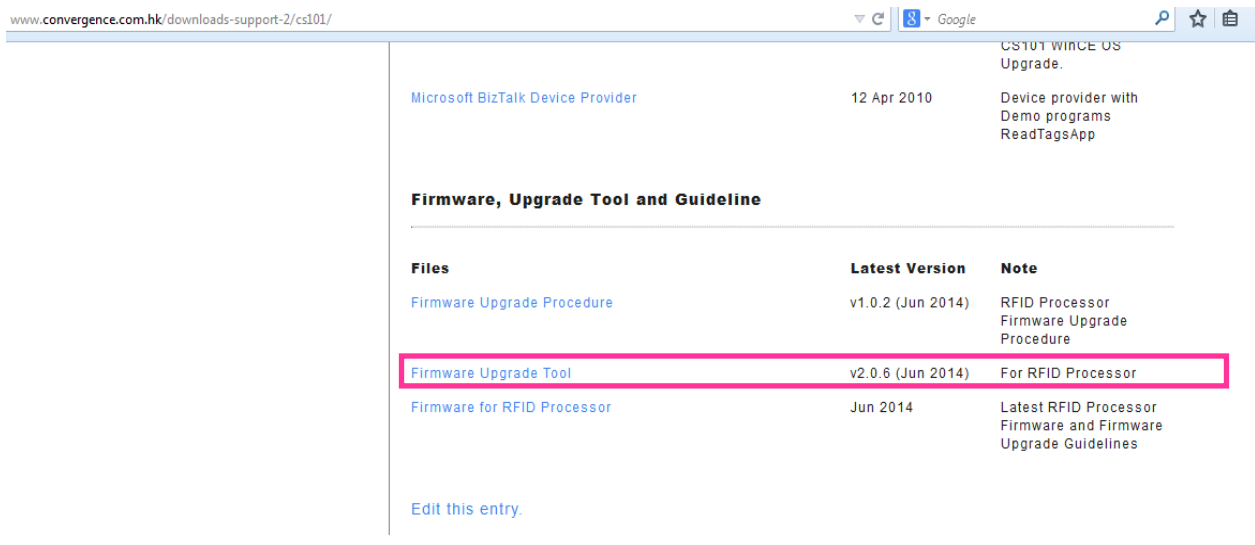
## 12.2 RFID Processor Firmware Upgrade Procedure

### 12.2.1 Procedure for CSL reader with RFID Processor App version 1.3.xx or 1.4.xx

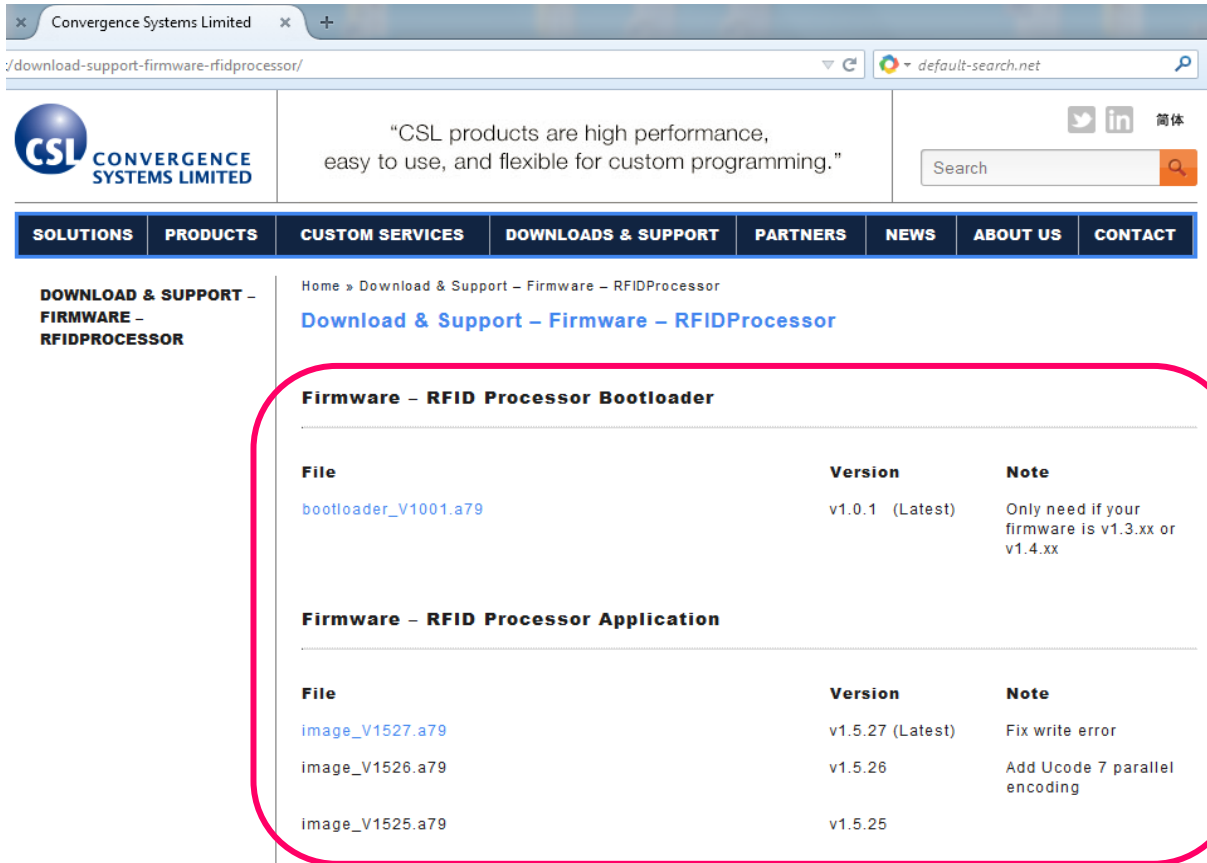
1. User must check the RFID Firmware version before doing RFID Firmware upgrade. **If the RFID Firmware Vers is 1.5.xx, please refer to section “3.2 Procedure for CSL reader with RFID Firmware App 1.5.xx”.**



2. Please download the latest Firmware Upgrade tool from CSL website (Downloads and Support for CS101). The latest version is "**CS101FwUpgrade 2.0.6.zip**".



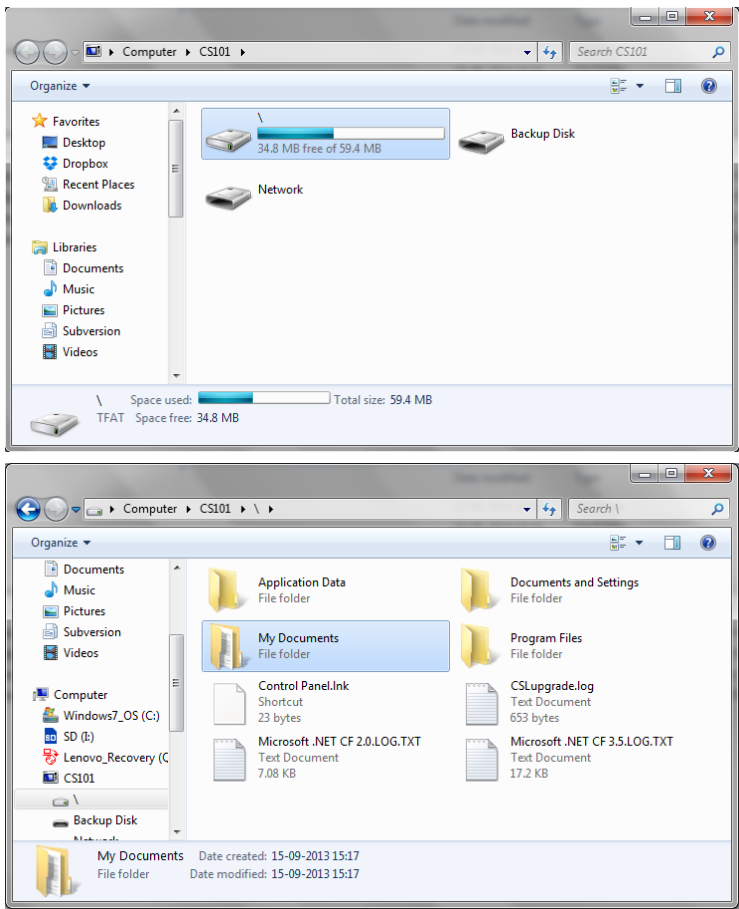
- Download the latest RFID Processor bootloader (**bootloader\_V1001.a79**) and firmware (**image\_V1527.a79 in this example**) from “Firmware - RFID Processor Bootloader” and “Firmware - RFID Processor Application”.



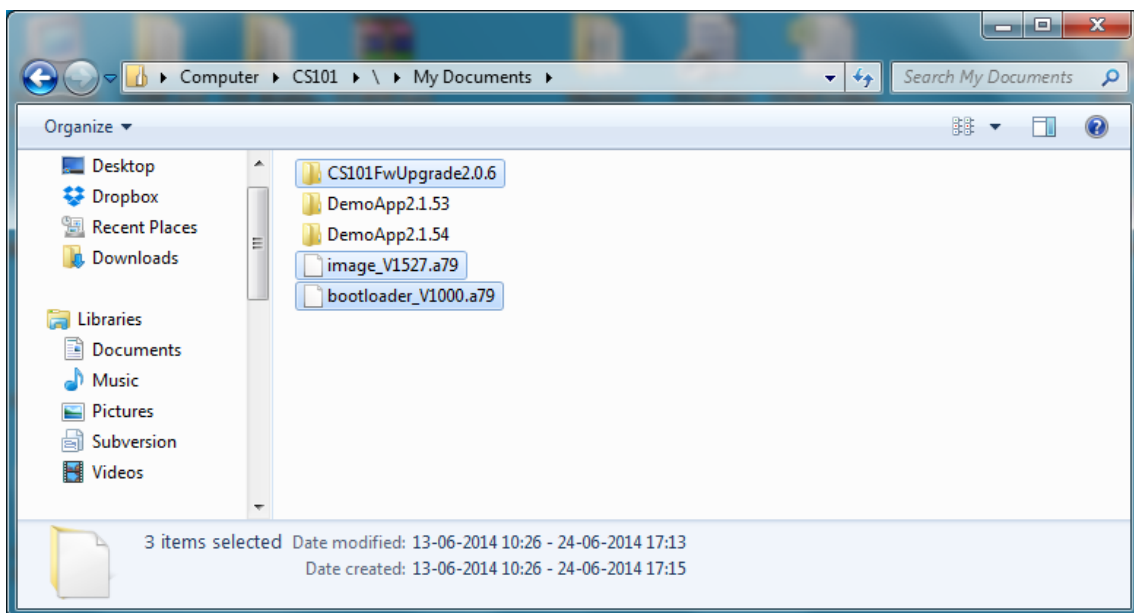
- Connect CS101 to PC via USB provided.



5. In the PC, go to directory “Computer” > “CS101” > “\” > “My Documents”



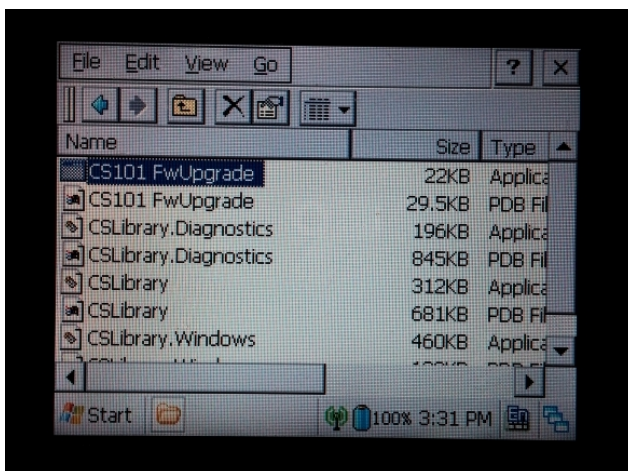
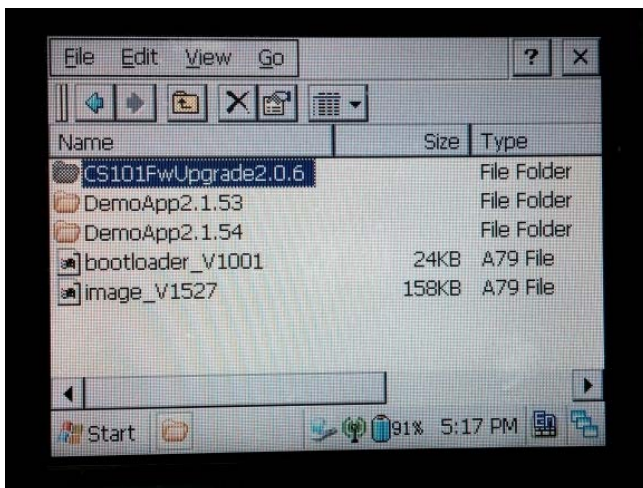
6. Unzip downloaded "CS101FwUpgrade 2.0.6.zip". Copy the unzipped folder "CS101FwUpgrade 2.0.6" together with the Bootloader image ("bootloader\_V1001.a79") and the latest RFID Processor Firmware ("image\_V1527.a79" in this example) to the directory "My Documents".



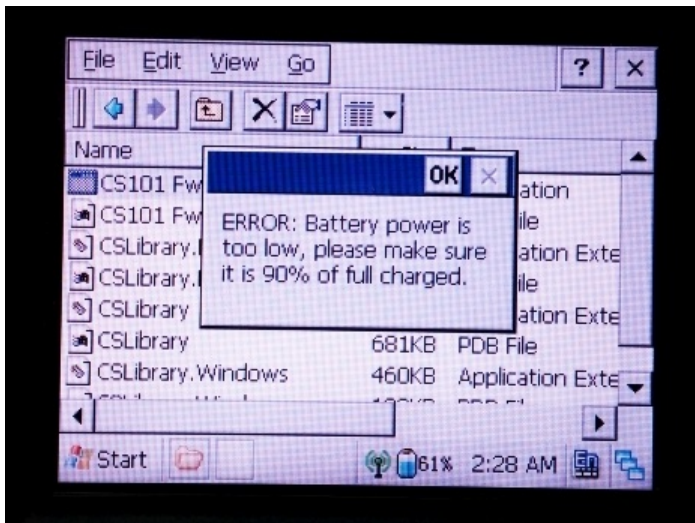
- In CS101 screen, go to directory “My Device” > “My Documents” > “CS101FwUpgrade2.0.6”.

Run “CS101 FwUpgrade.exe”

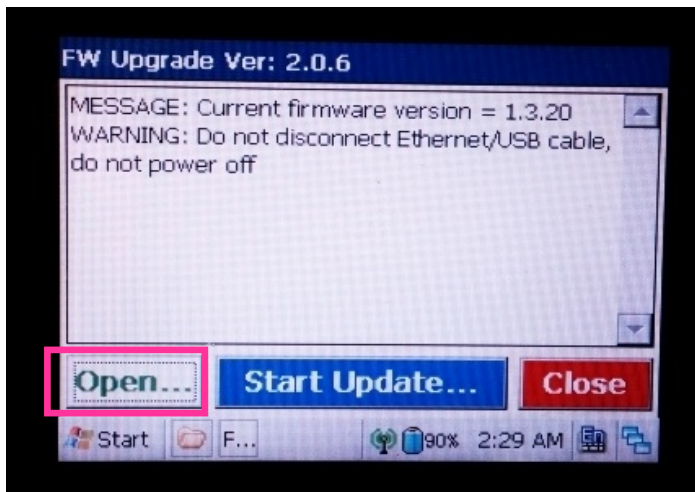
Please run the exe file by double clicking the file within this directory only.



8. If the Battery Power is below 90% of fully charged, please replace the battery in CS101 with a fully charged battery.

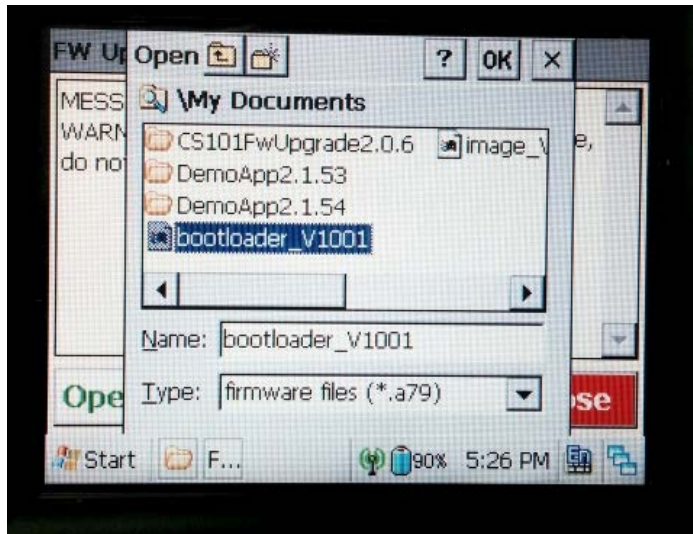


9. Check the current version of the firmware. Click **[Open]**.

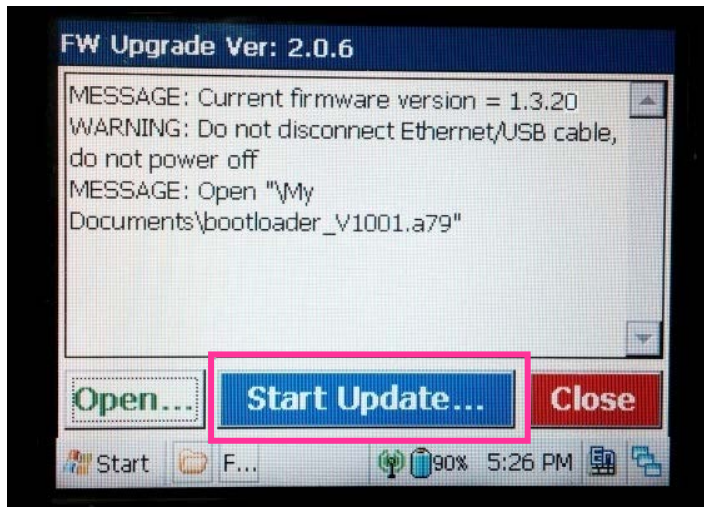


- Choose the RFID bootloader firmware file "**bootloader\_V1001.a79**".

Click **[OK]** to confirm.

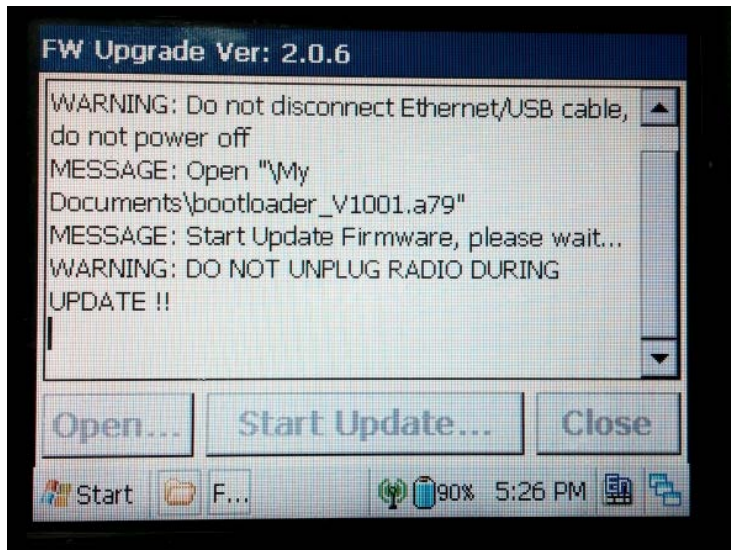


- Press **[Start Update]** to start firmware update process.

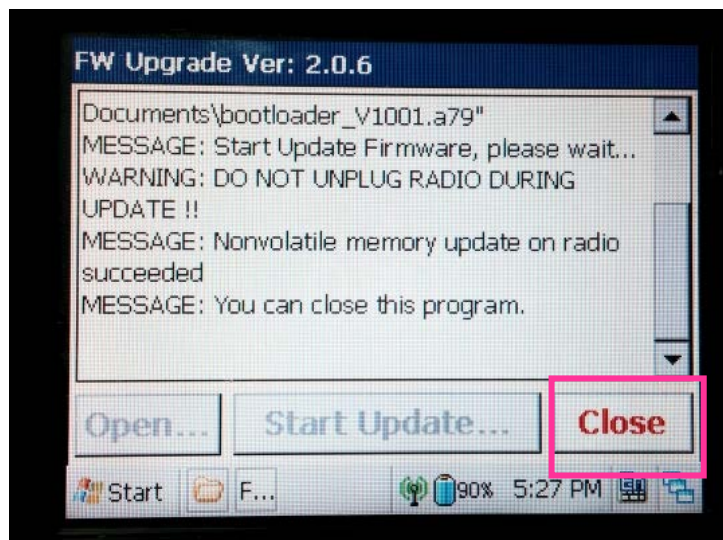


- Wait until the firmware update process is finished.

**DO NOT power off the reader during the process.**

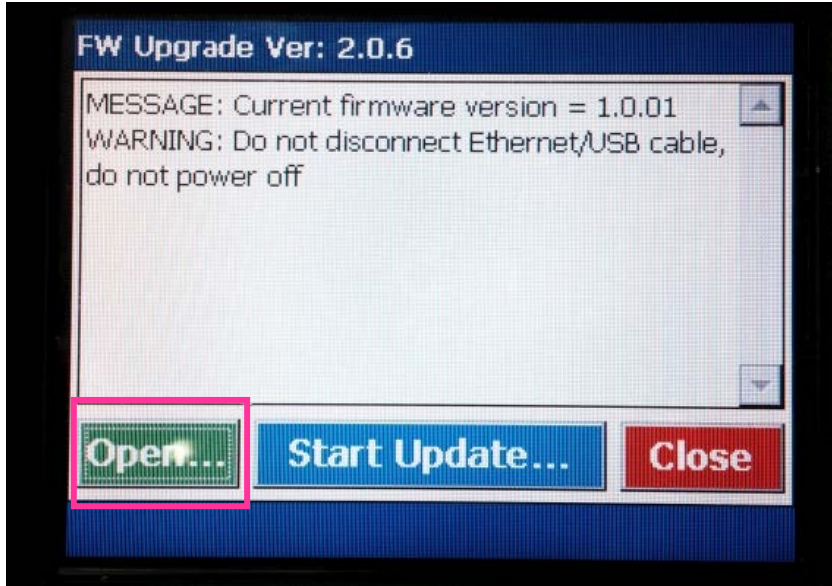


- At the end of the firmware update process, click [**Close**] to exit the Firmware Upgrade window.



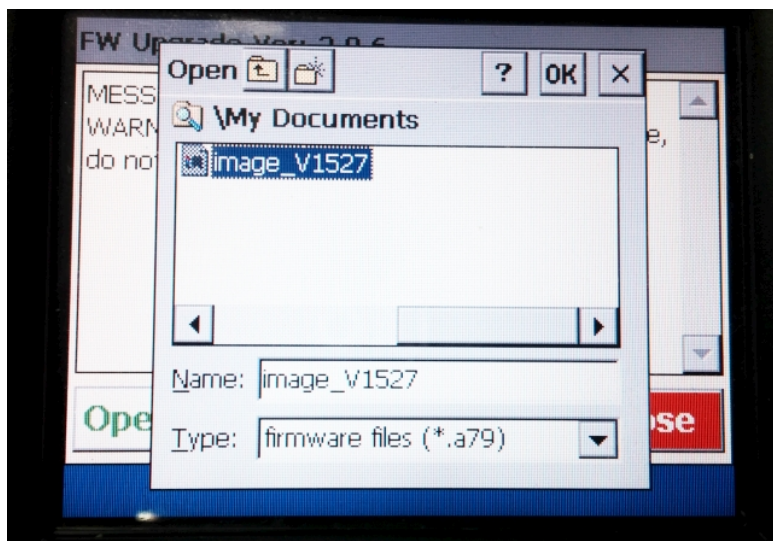
14. Check the current version of the firmware. If **Current firmware version = 1.0.01**, the bootloader is successfully installed in previous steps.

To continue, click **[Open]**.

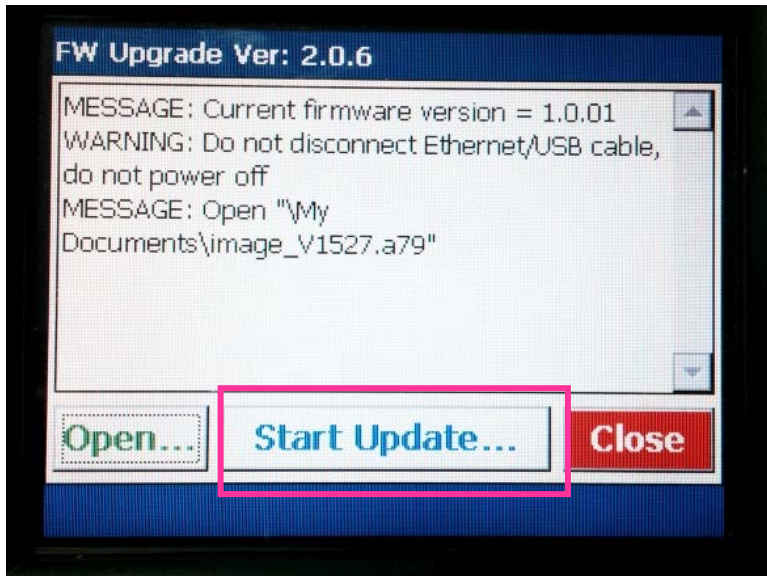


15. Choose the latest RFID Processor application file.

Click **[OK]** to confirm.

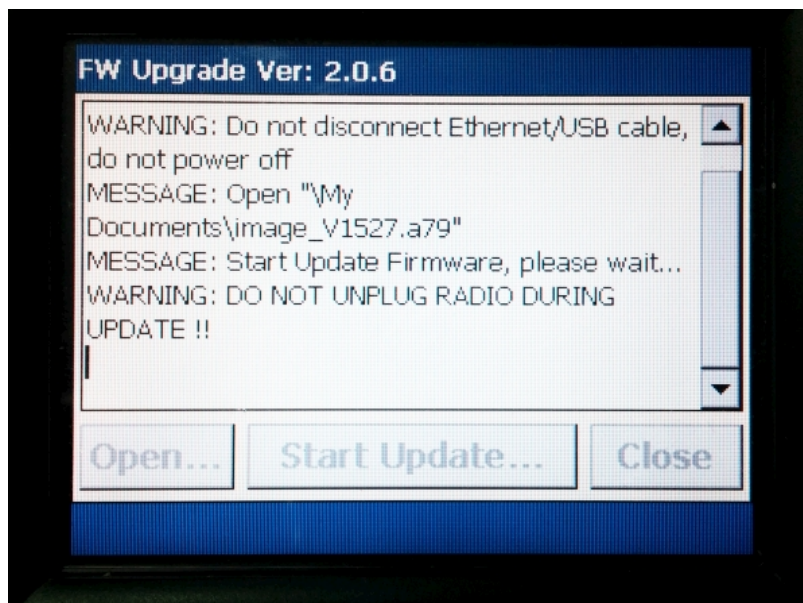


16. Press **[Start Update]** to start firmware upgrade process.

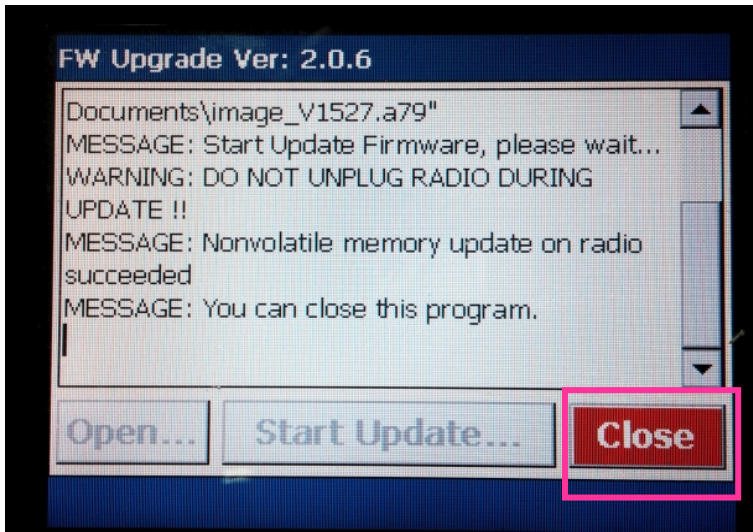


17. Wait until the firmware update process is finished.

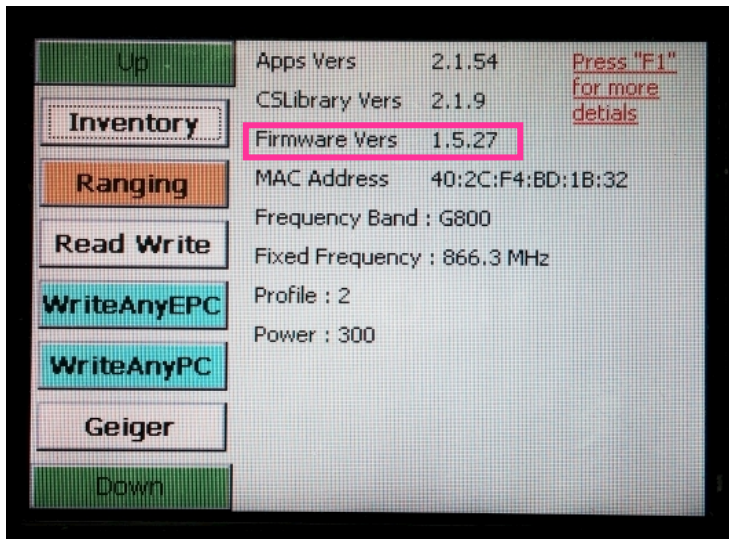
**DO NOT power off the reader during the process.**



18. At the end of the firmware update process, click **[Close]** to exit the Firmware Upgrade window.

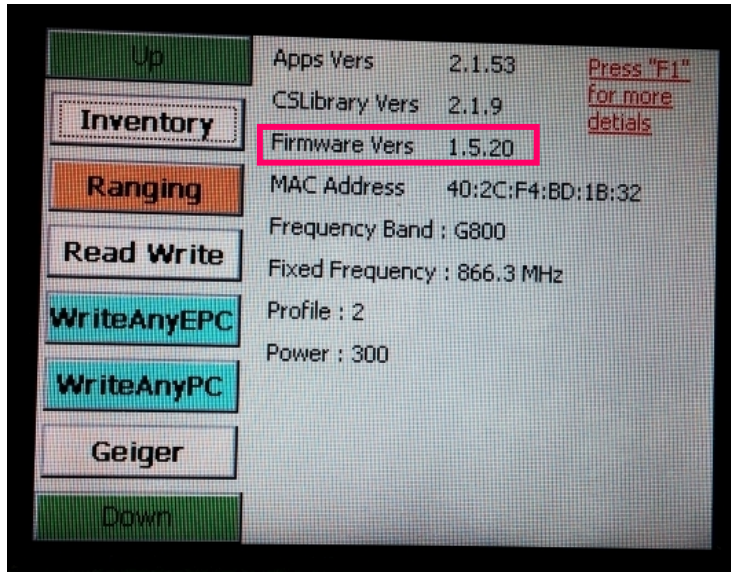


19. Open CSL CS101 Demo App. The updated firmware version can be checked.

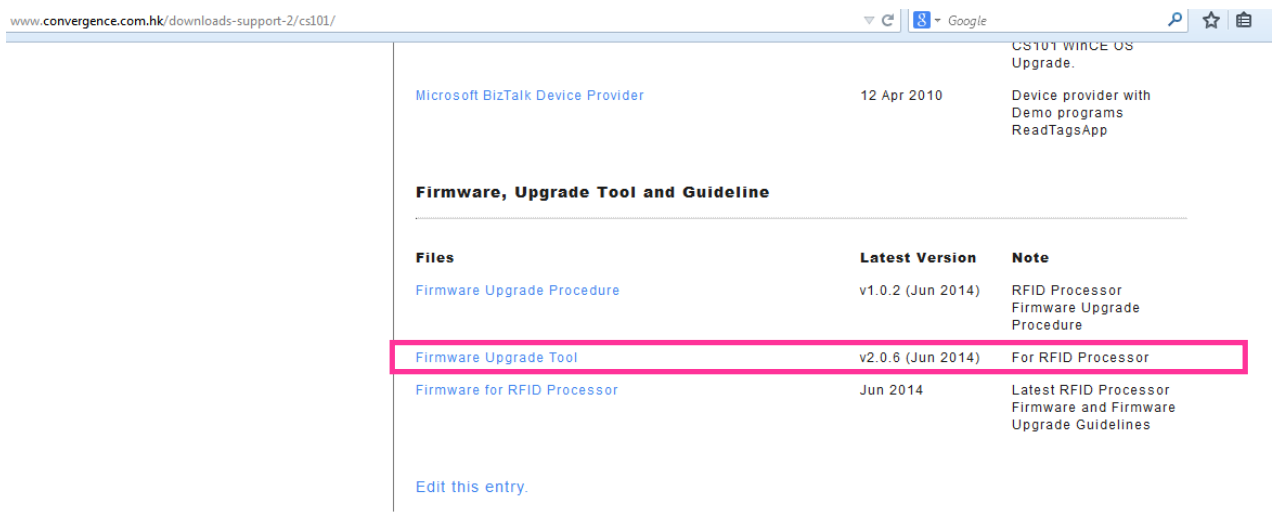


### 12.2.2 Procedure for CSL reader with RFID Processor App version 1.5.xx or after

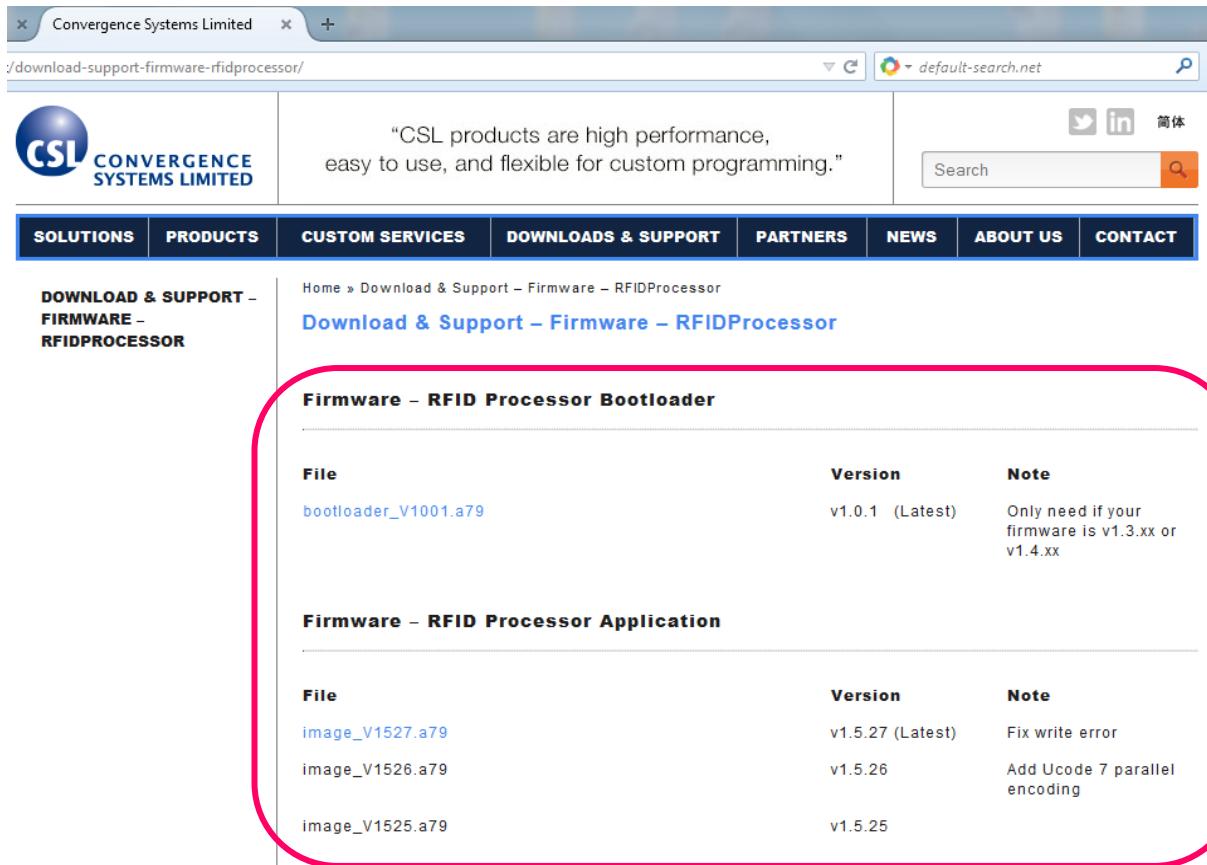
1. User must check the RFID Firmware version before doing RFID Firmware upgrade. **If the RFID Firmware Vers is 1.3.xx and 1.4.xx, please refer to section “4.1 Procedure for CSL reader with RFID App version 1.3.xx and 1.4.xx )”.**



2. Please download the latest Firmware Upgrade tool from CSL website (Downloads and Support for CS101). The latest version is "**CS101FwUpgrade 2.0.6.zip**".



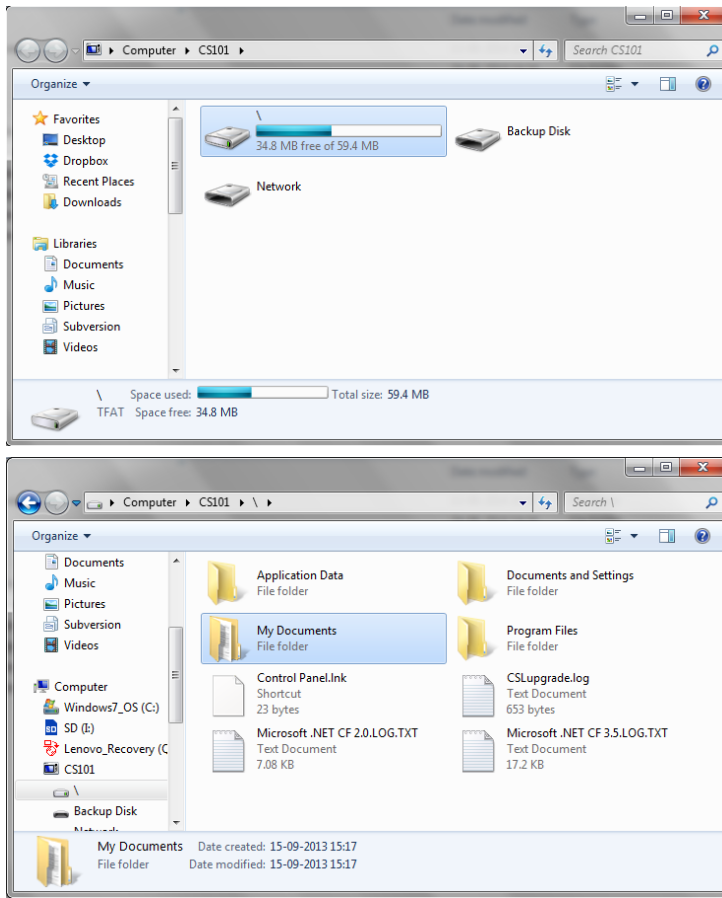
- Download the latest firmware (**image\_V1527.a79** in this example) from “Firmware - RFID Processor Application”.



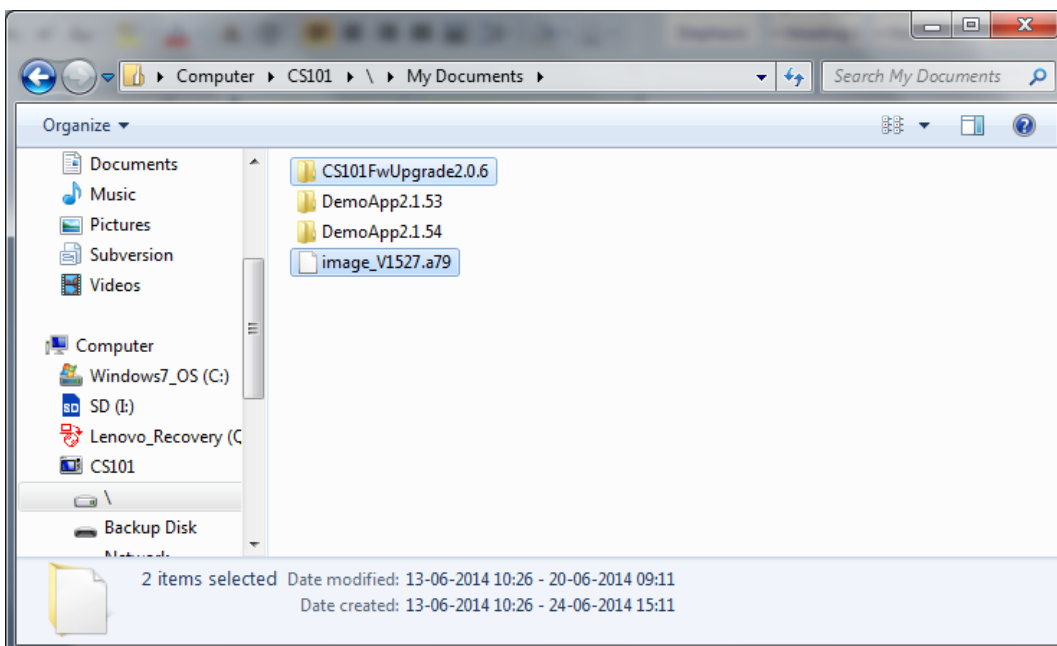
- Connect CS101 to PC via USB provided.



- In the PC, go to directory “**Computer**” > “**CS101**” > “**\**” > “**My Documents**”



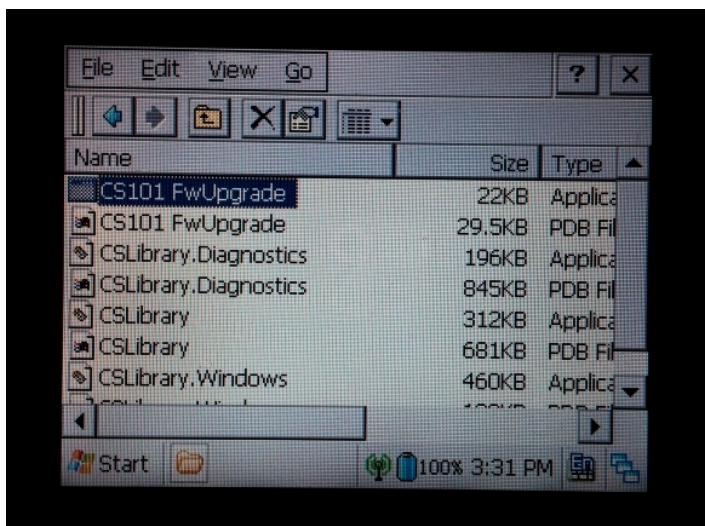
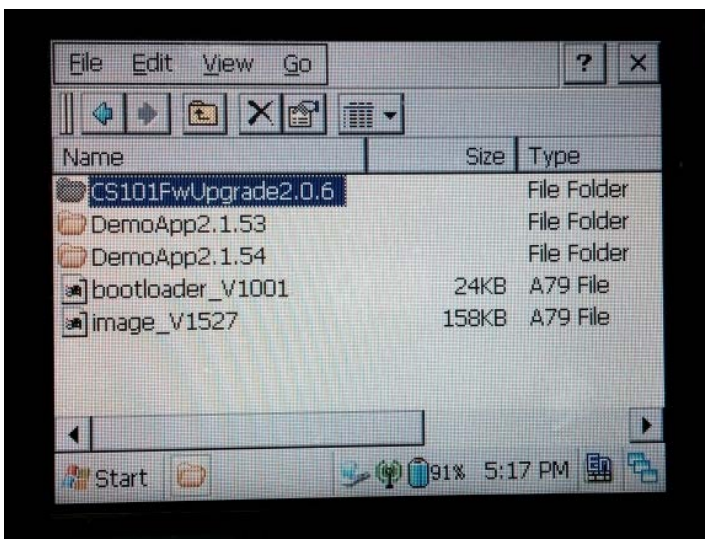
- Unzip downloaded “**CS101FwUpgrade 2.0.6.zip**”. Copy the unzipped folder “**CS101FwUpgrade 2.0.6**” together with the latest RFID Processor firmware (“**image\_V1527.a79**” in this example) to the directory “**My Documents**”.



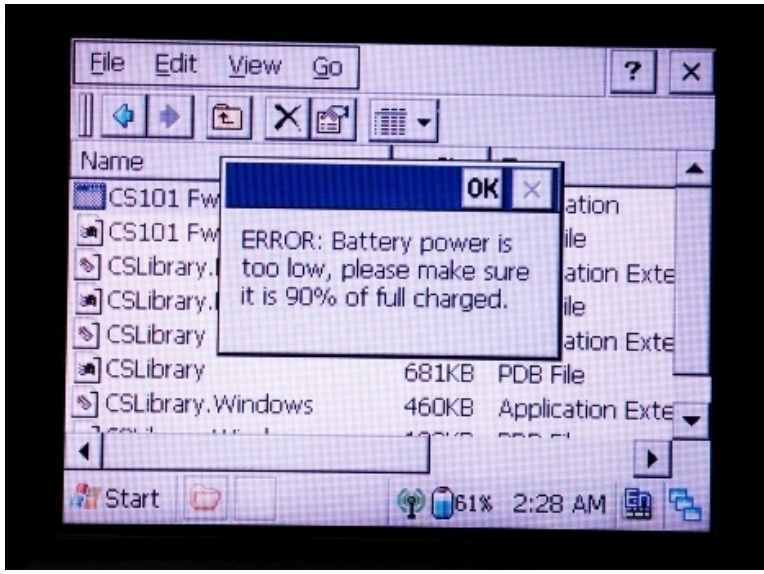
- In CS101 screen, go to directory **My Device” > “My Documents” > “CS101FwUpgrade2.0.6”**.

Run **“CS101 FwUpgrade.exe”**

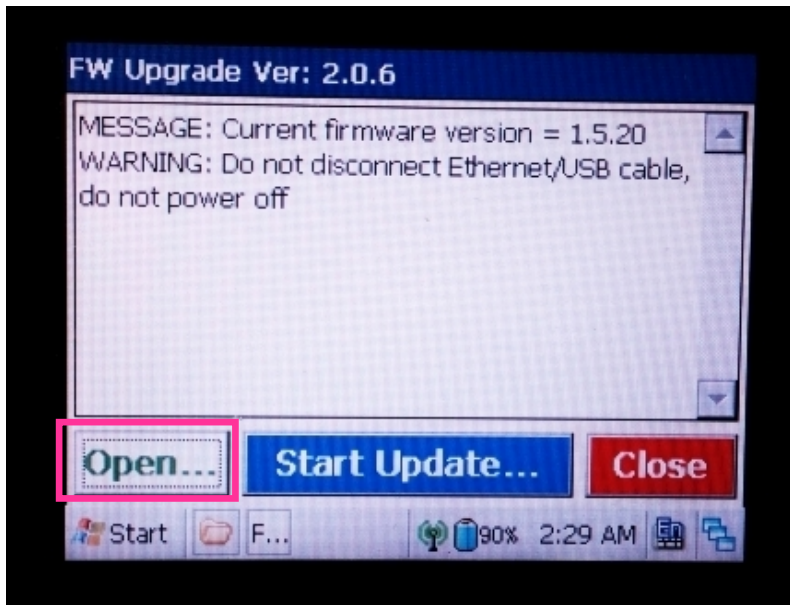
**Please run the exe file by double clicking the file within this directory only.**



- 8. If the Battery Power is below 90% of fully charged, please replace the battery in CS101 with a fully charged battery.

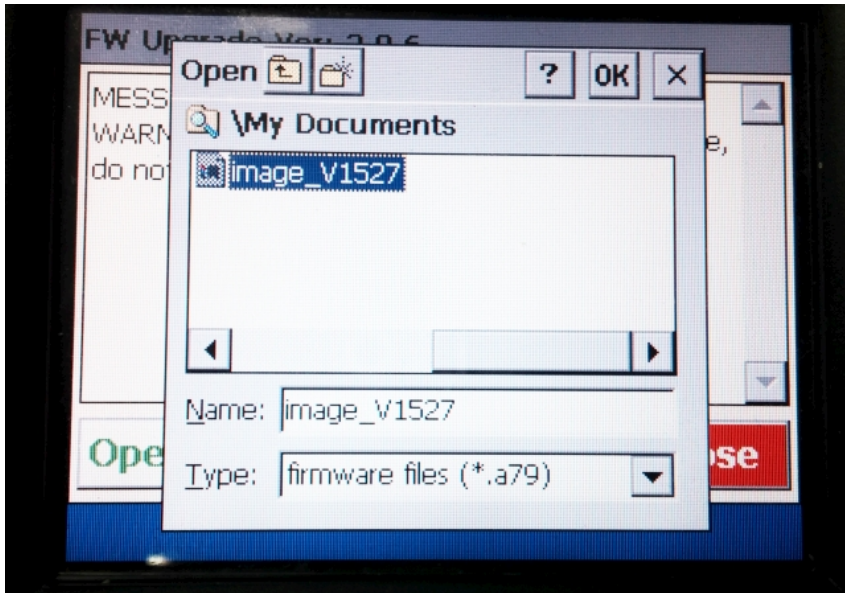


- 9. Check the current version of the firmware. Click **[Open]**.

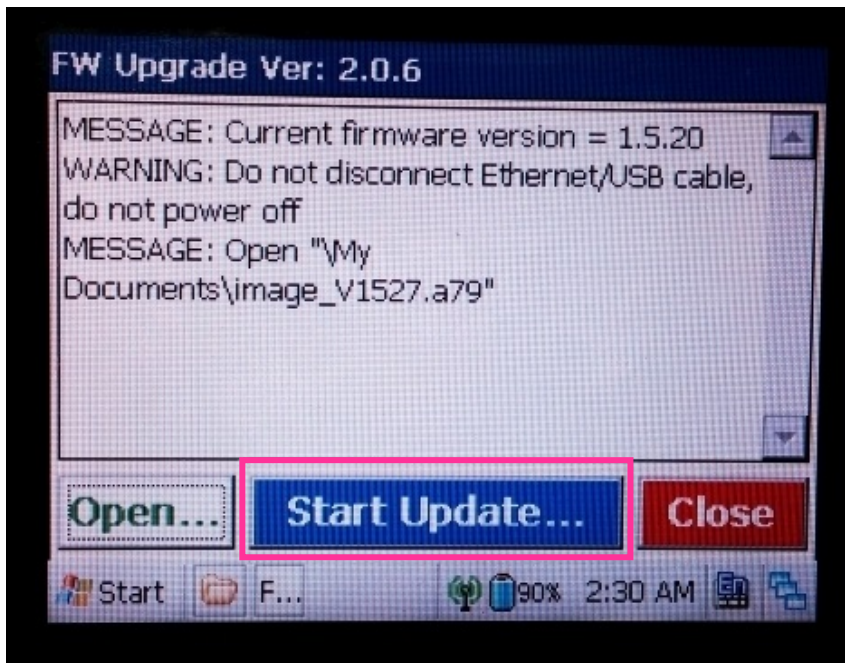


- Choose the latest RFID Processor application file.

Click **[OK]** to confirm.

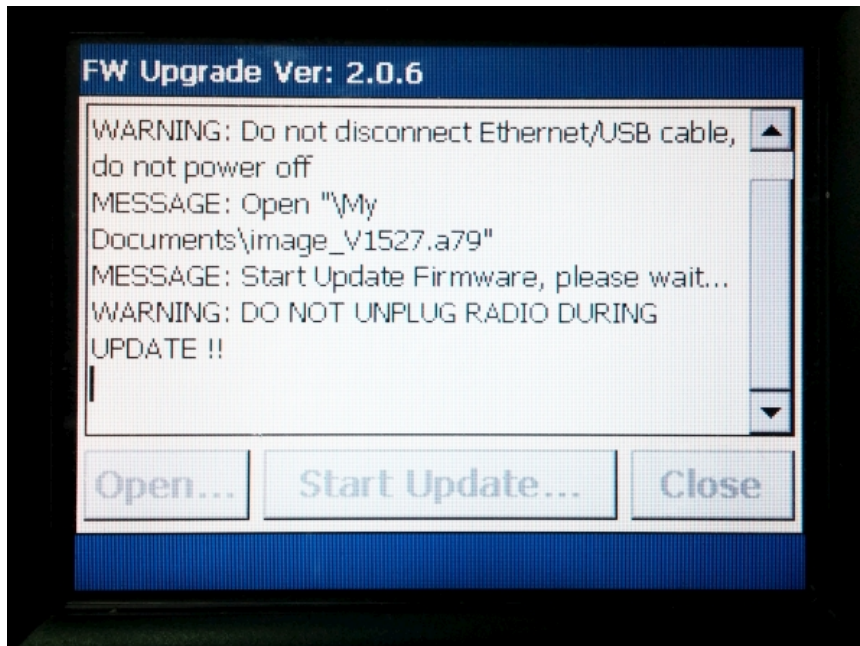


- Press **[Start Update]** to start firmware upgrade process.

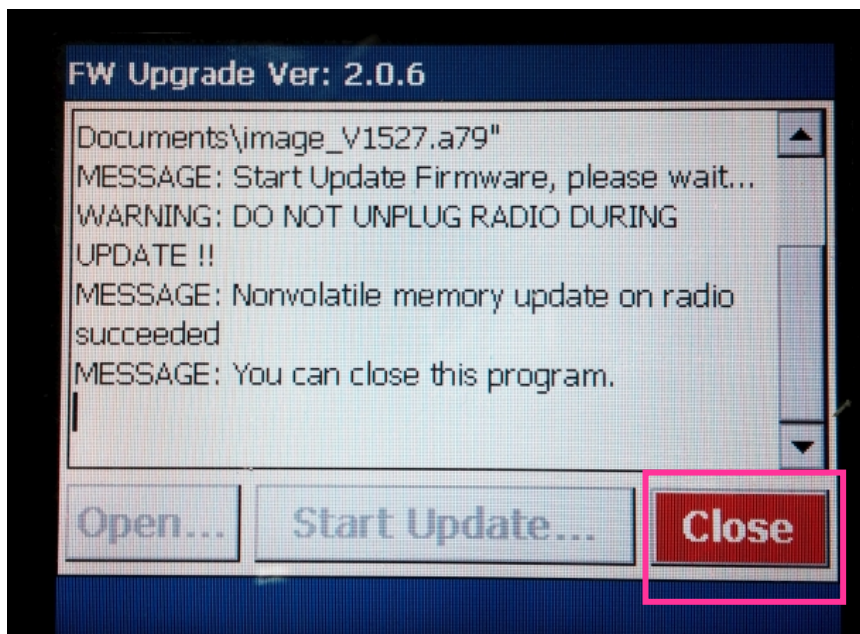


12. Wait until the firmware update process is finished.

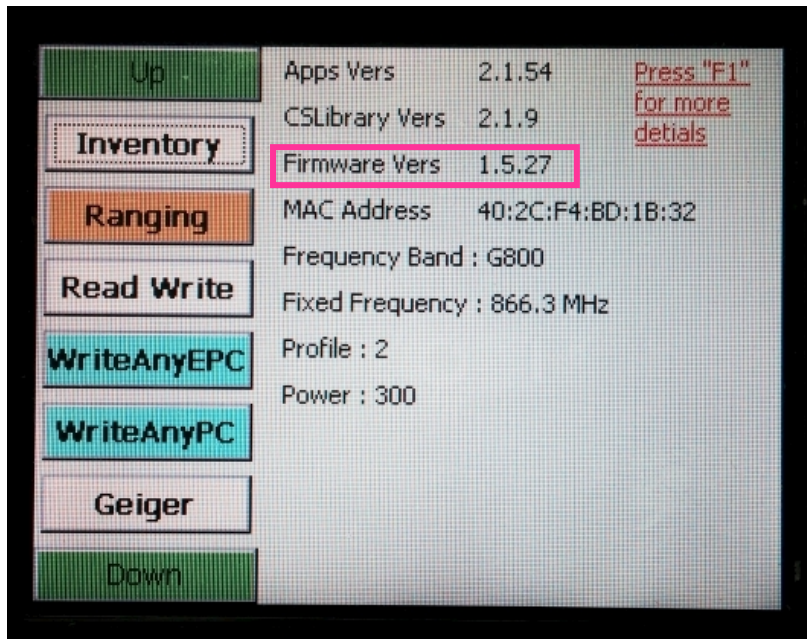
**DO NOT power off the reader during the process.**



13. At the end of the firmware update process, click **[Close]** to exit the Firmware Upgrade window.



14. Open CSL CS101 Demo App. The updated firmware version can be checked.



## **13 Usage Tips for CS101**

### **13.1 Introduction**

The objective of this chapter is to recommend the best practices of using the CSL CS101 Reader. The following areas will be covered in this document

- General usage
- Write tag
- Event and alert
- System

### **13.2 General Tips**

CS101 is designed to give long read range and high read rate operations for situations where a fixed reader may be inconvenient, or a fixed reader may lack the needed angular and distance flexibility, or a fixed reader design may require too many units whereas a handheld reader can be easily moved around for lower initial infrastructure cost.

### **13.3 System Tips**

The CS101 host processing unit is a basic PDA design utilizing WinCE operating system. Since this host processing unit is only 400 MHz clocked, one should not expect it to work as fast as a PC. A lot of consideration of system computation power and connection bandwidth must be taken in the most graceful manner.

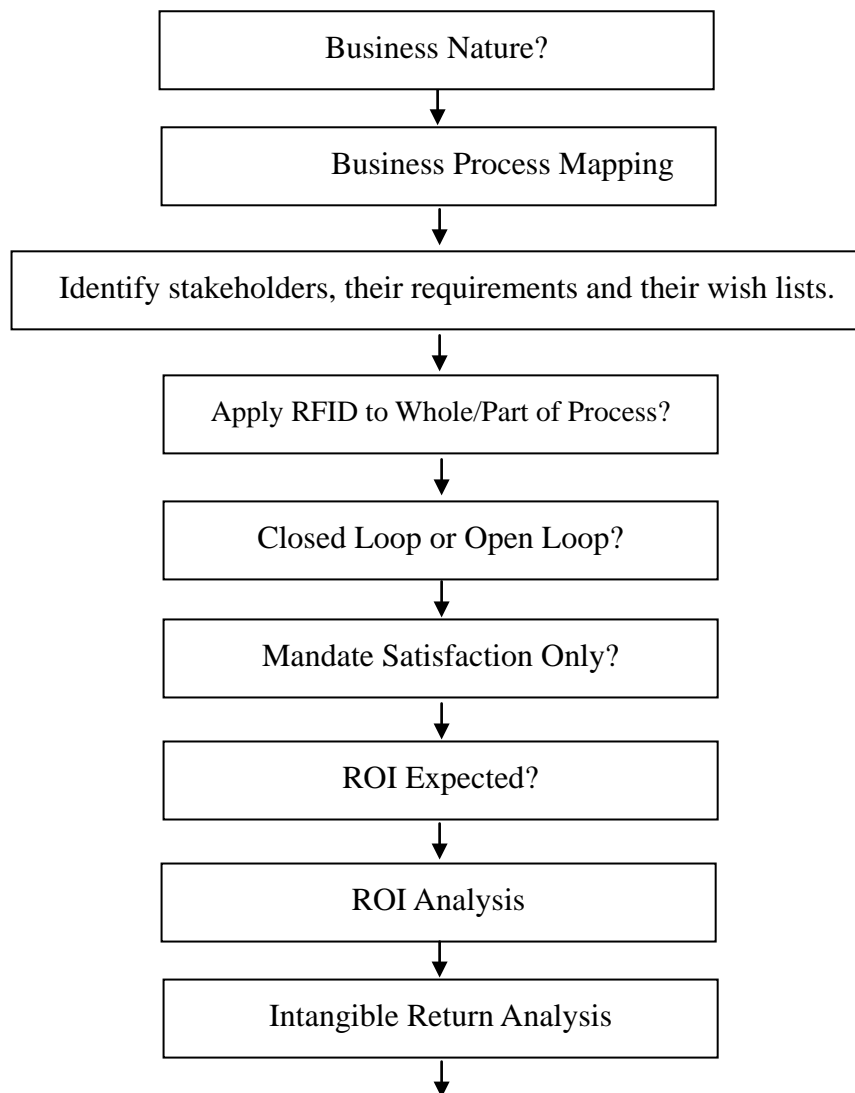
### **13.4 Write Tag Tips**

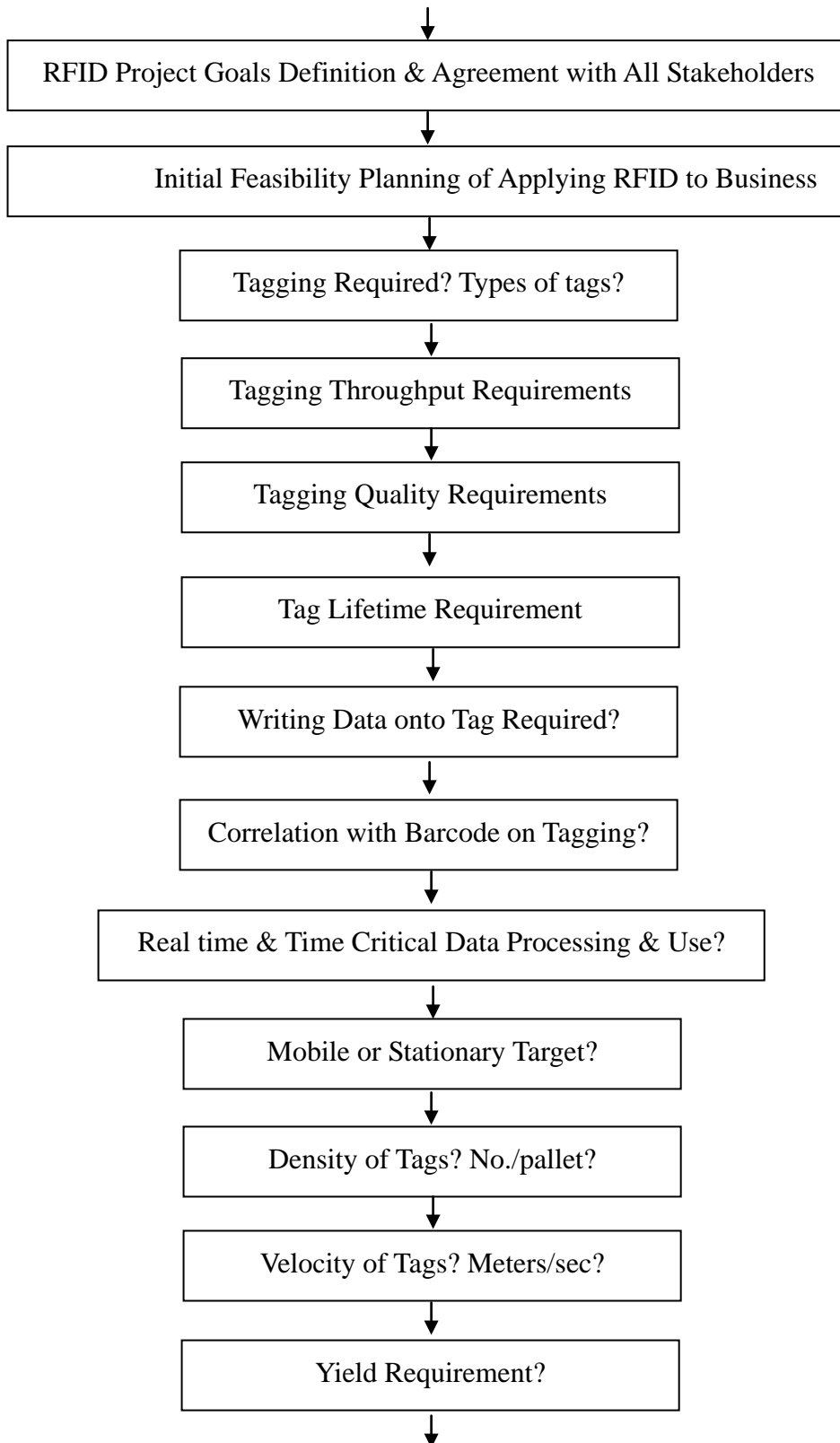
There are many ways to write tags using the EPC Gen2 protocol. Halt filter is among one of the tool to speed up the process. One should study the EPC Gen2 document intensively to understand the meaning of each parameter to enable the most efficient use of this technology. The more proficient a system integrator is on EPC Gen2 protocol, the more successful it can be.

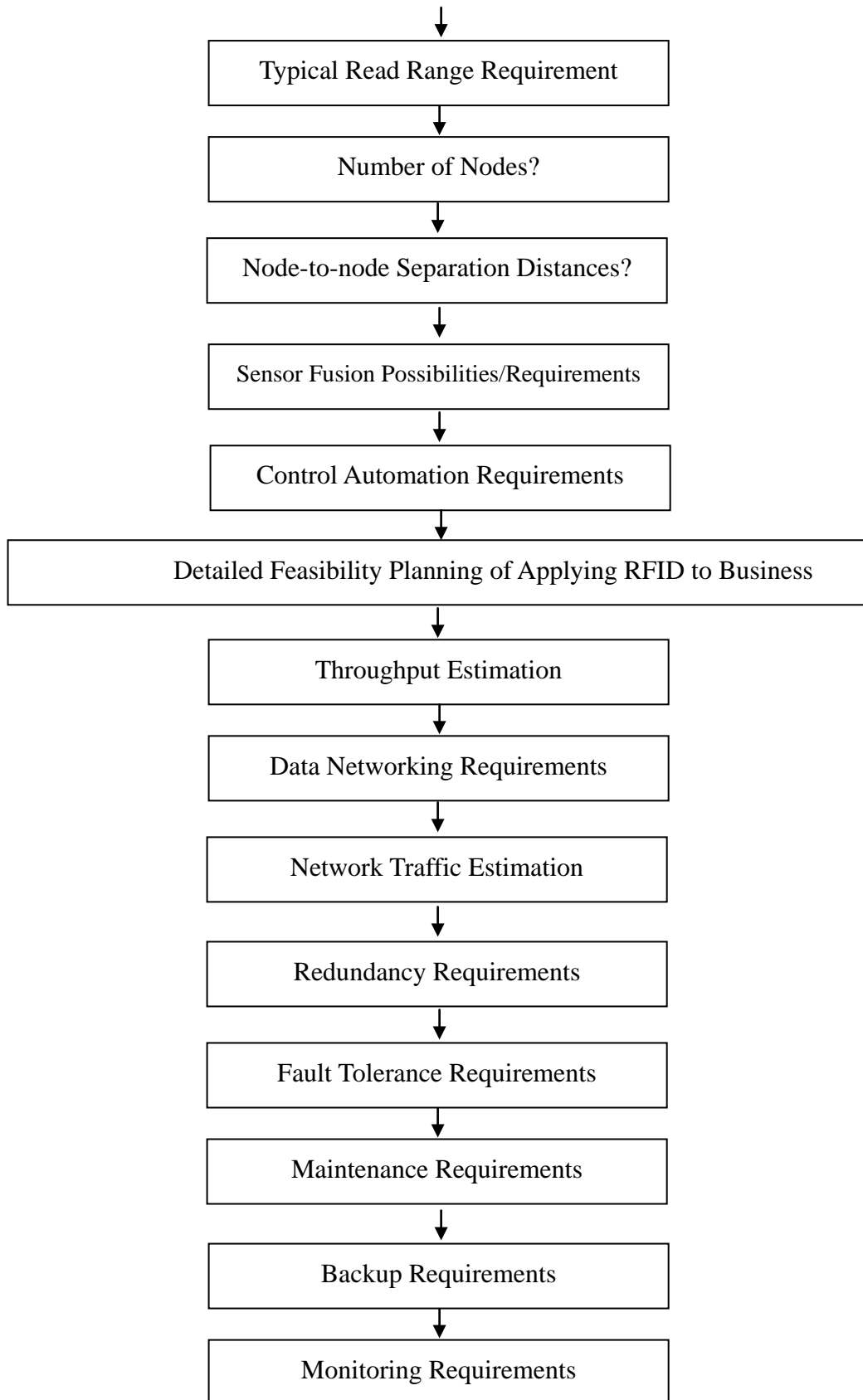
## 13.5 Application Details

### 13.5.1 Business Process Analysis

The business process of the customer must be analyzed carefully to find places where the RFID tagging and reading can occur. The system integrator may be applying RFID to the whole process or may only be able to apply RFID to part of the process. The most important principle is NOT to force change the business process to adapt for RFID implementation, but to have RFID implementation slip in as effortlessly and as un-noticeably as possible.







## Appendix A. RFID Basics

Passive tag RFID technology involves the reader, the antenna and the tag.

The reader sends out energy in the relevant frequency band to the antenna via RF cables, and the antenna radiates the energy out. This energy impinges on an RFID tag.

The RFID tag consists of an antenna coupled to an RFID IC. This IC converts the AC voltage it receives at the antenna port to DC voltage that in turn is used to empower the digital circuit inside.

The digital circuit then turns on and off some components connected to the antenna port, thereby changing its scattering behavior, in a pre-designed clock rate.

This changing of antenna port parameters then causes a “modulation” of the back-scattered RF energy.

This modulated back-scattered energy is detected by the reader and the modulation is captured and analyzed.

## Appendix B. Glossary

### **Air interface**

The complete communication link between an Interrogator and a Tag including the physical layer, collision arbitration algorithm, command and response structure, and data-coding methodology.

### **Autonomous time trigger**

Each tag will only be reported once within a duplicate elimination time. See also duplicate elimination time.

### **Batch alert to server**

Collected tag information are sent to server at the end of each duplicate elimination cycle (Time Window)

### **Capture point**

Unique name corresponding to each of the four antennas

### **Command set**

The set of commands used to explore and modify a Tag population.

### **Continuous wave**

Typically a sinusoid at a given frequency, but more generally any Interrogator waveform suitable for powering a passive Tag without amplitude and/or phase modulation of sufficient magnitude to be interpreted by a Tag as transmitted data.

### **Cover-coding**

A method by which an Interrogator obscures information that it is transmitting to a Tag. To cover-code data or a password, an Interrogator first requests a random number from the Tag. The Interrogator then performs a bit-wise EXOR of the data or password with this random number, and transmits the cover-coded (also called ciphertext) string to the Tag. The Tag uncovers the data or password by performing a bit-wise EXOR of the received cover-coded string with the original random number.

### **Dense-Interrogator environment**

An operating environment (defined below) within which the number of simultaneously active

Interrogators is large relative to the number of available channels (for example, 50 active Interrogators operating in 50 available channels).

### **Duplicate elimination time**

Time span of a duplicate elimination cycle, within which duplicate tags will be removed.

### **Duplicate Elimination Triggering Method**

The method used to trigger inventory with duplicate elimination. See also autonomous time trigger and polling trigger by client.

### **Estimated tag time in field**

An estimation of how long a tag will remain within the read zone of antenna

### **Event**

An event defines action to be performed for a specific triggering logic. See also inventory enabling trigger, trigger, inventory disabling trigger, and resultant action.

### **Extended temperature range**

-40 °C to +65 °C (see nominal temperature range).

### **Full-duplex communications**

A communications channel that carries data in both directions at once. See also half-duplex communications.

### **Half-duplex communications**

A communications channel that carries data in one direction at a time rather than in both directions at once. See also full-duplex communications.

### **Instant alert to server**

Collected tag information are sent to server immediately as it is read

### **Inventoried flag**

A flag that indicates whether a Tag may respond to an Interrogator. Tags maintain a separate inventoried flag for each of four sessions; each flag has symmetric A and B values. Within any given session, Interrogators typically inventory Tags from A to B followed by a re-inventory of Tags from B back to A (or vice versa).

**Inventory enabling trigger**

The initial trigger that turns on the RF power of the reader to start doing inventory

**Inventory Enabling Cycle**

Time between an inventory enabling trigger and inventory disabling trigger.

**Inventory disabling trigger**

The trigger that turns off the RF power of the reader to stop doing inventory

**Inventory round**

The period between successive Query commands.

**Inventory Search Mode**

Method of reading tags by antenna. See also Single Target Large Population Inventory.

**Modulation Profile**

Way of transmitting information between tags and reader.

**Multiple-Interrogator environment**

An operating environment (defined below) within which the number of simultaneously active Interrogators is modest relative to the number of available channels (for example, 10 active Interrogators operating in 50 available channels).

**Network failure data backlog**

Tag data buffered in reader memory during network failure. Buffered tags are sent to trusted server when network is restored.

**Nominal temperature range**

-25 °C to +40 °C (see extended temperature range).

**Operating environment**

A region within which an Interrogator's RF transmissions are attenuated by less than 90dB. In free space, the operating environment is a sphere whose radius is approximately 1000m, with the Interrogator located at the center. © 2004, EPCglobal Inc. Page 13 of 94 31 January 2005. In a building or other enclosure, the size and shape of the operating environment depends on factors such as the material properties and shape of the building, and may be less than 1000m in certain directions and greater than 1000m in other directions.

## **Operating procedure**

Collectively, the set of functions and commands used by an Interrogator to identify and modify Tags. (Also known as the Tag-identification layer.)

## **Passive Tag (or passive Label)**

A Tag (or Label) whose transceiver is powered by the RF field.

## **Permalock or Permalocked**

A memory location whose lock status is unchangeable (i.e. the memory location is permanently locked or permanently unlocked) is said to be permalocked.

## **Persistent memory or persistent flag**

A memory or flag value whose state is maintained during a brief loss of Tag power.

## **Physical layer**

The data coding and modulation waveforms used in Interrogator-to-Tag and Tag-to-Interrogator signaling.

## **Polling Trigger by Client**

Tags read are buffered in reader until client application polls the read result. A tag will only be reported once in each polling trigger.

## **Protocol**

Collectively, a physical layer and a Tag-identification layer specification.

## **Q**

A parameter that an Interrogator uses to regulate the probability of Tag response. An Interrogator commands Tags in an inventory round to load a Q-bit random (or pseudo-random) number into their slot counter; the Interrogator may also command Tags to decrement their slot counter. Tags reply when the value in their slot counter (i.e. their slot – see below) is zero. Q is an integer in the range (0,15); the corresponding Tagresponse probabilities range from  $2^0 = 1$  to  $2^{-15} = 0.000031$ .

## **Resultant Action**

Resultant action that will be enforced when an event logic is established

## **Single Target Large Population Inventory**

A mode for reading a large number of tags at a time accurately. When this mode is used, tags

that are read already will not respond to the reader for a short period of time. This can avoid the strong tags from dominating the weak ones.

## **Session**

An inventory process comprising an Interrogator and an associated Tag population. An Interrogator chooses one of four sessions and inventories Tags within that session. The Interrogator and associated Tag population operate in one and only one session for the duration of an inventory round (defined above). For each session, Tags maintain a corresponding inventoried flag. Sessions allow Tags to keep track of their inventoried status separately for each of four possible time-interleaved inventory processes, using an independent inventoried flag for each process.

## **Single-Interrogator environment**

An operating environment (defined above) within which there is a single active Interrogator at any given time.

## **Singulation**

Identifying an individual Tag in a multiple-Tag environment.

## **Slot**

Slot corresponds to the point in an inventory round at which a Tag may respond. Slot is the value output by a Tag's slot counter; Tags reply when their slot (i.e. the value in their slot counter) is zero. See also Q (above).

## **Slotted random anticollision**

An anticollision algorithm where Tags load a random (or pseudo-random) number into a slot counter, decrement this slot counter based on Interrogator commands, and reply to the Interrogator when their slot counter reaches zero.

## **Tag-identification layer**

Collectively, the set of functions and commands used by an Interrogator to identify and modify Tags (also known as the operating procedure).

## **Tari**

Reference time interval for a data-0 in Interrogator-to-Tag signaling. The mnemonic "Tari" derives from the ISO/IEC 18000-6 (part A) specification, in which Tari is an abbreviation for Type A Reference Interval.

**Trigger**

A stimulus that causes the reader to recognize it and do something about it.

**Trusted Server**

Server for automatic data submission by the reader using the event engine.

## Appendix C. Federal Communication

### Commissions 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 D. Maximum Permissible Exposure

### Maximum Permissible Exposure Requirement: Section 47 CFR §1.1307

Three different categories of transmitters are defined by the FCC in OET Bulletin 65. These categories are fixed installation, mobile, and portable and are defined as follows:

- **Fixed Installations:** fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.
- **Mobile Devices:** a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.
- **Portable Devices:** a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

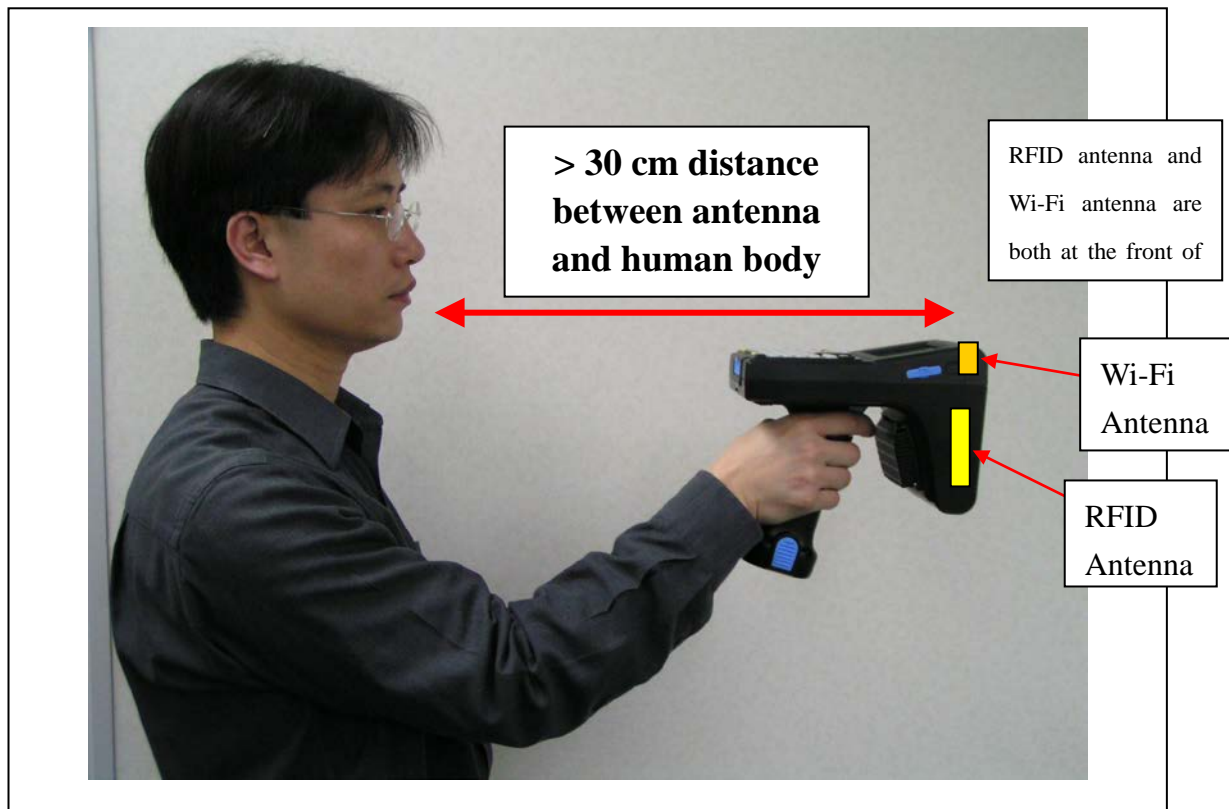
The FCC also categorizes the use of the device as based upon the user's awareness and ability to exercise control over his or her exposure. The two categories defined are Occupational/Controlled Exposure and General Population/Uncontrolled Exposure. These two categories are defined as follows:

- **Occupational/Controlled Exposure:** In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled

limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.

- **General Population/Uncontrolled Exposure:** The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

The CS101 RFID reader is a handheld reader that is used in a handheld operation manner:



The user takes the handheld reader and moves around the work space and read tags. Since it is not used in a fixed place, it falls into the category of mobile or portable devices. Since the antenna is actually > 30 cm away from the user body torso, it can be categorized as mobile devices. Since the distance between antenna and body is generally > 30 cm, the **simplified method of power density compliance is used in this report to show CS101-2 complies with FCC MPE limit of General Population / Uncontrolled Exposure.**

### Radio Frequency Radiation Exposure Evaluation – RFID Mode:

The measured highest RF output power of the EUT feeding to the embedded antenna was 28.6dBm at 927.25MHz. According to §1.1310 of the FCC rules, the power density limit for **General Population/Uncontrolled Exposure** at 927.25 MHz is  $f_{(\text{MHz})}/1500 = 0.6182\text{mW}/\text{cm}^2$ . The maximum permissible exposure (MPE) is calculated to show the required separation distance that must be maintained during installation to maintain compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

where:

S = Power density

P = Power feeding to the embedded patch antenna

G = Tx gain of the antenna (linear gain)

R = Distance from the antenna

For the EUT, the calculation is as follows:

$$P = 28.6\text{dBm} = 724.4\text{mW}$$

$$G = \text{Maximum Antenna Gain} = 5.5\text{dBi} = \text{anti-log}(5.5/10) = 3.55$$

At 20cm separation,

$$S = \frac{724.4 \times 3.55}{4\pi(20)^2} = 0.5116\text{mW}/\text{cm}^2$$

Based on the above calculation for 20cm separation, the power density does not exceed FCC limit of  $0.6182\text{mW}/\text{cm}^2$ .

**Radio Frequency Radiation Exposure Evaluation – WiFi Mode:**

The measured highest RF output power of the EUT feeding to the embedded antenna was 11.5dBm at 2412MHz. According to §1.1310 of the FCC rules, the power density limit for **General Population/Uncontrolled Exposure** at 2412MHz is = 1.0 mW/cm<sup>2</sup>. The maximum permissible exposure (MPE) is calculated to show the required separation distance that must be maintained during installation to maintain compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

where:

S = Power density

P = Power feeding to the embedded patch antenna

G = Tx gain of antenna (linear gain)

R = Distance from the antenna

For the EUT, the calculation is as follows:

$$P = 11.5\text{dBm} = 14.13\text{mW}$$

$$G = \text{Maximum Antenna Gain} = 2.0\text{dBi} = \text{anti-log}(2.0/10) = 1.585$$

At 20cm separation,

$$S = \frac{14.13 \times 1.585}{4\pi(20)^2} = 0.004456\text{mW/cm}^2$$

Based on the above calculation for 20cm separation, the power density does not exceed FCC limit of 1.0mW/cm<sup>2</sup>.