CS203 Callback based API Demo Application Program
Quick Start Guide v0.6

8 October 2009

I. Introduction

This document will describe the details about the CS203 demo application program (CS203_Callback-API_DemoApp) that is based on the Callback-Based API set. Software developers can refer to this demo program for programming CS203 based on this new set of API.

The installer of the demo program can be found inside folder “Demo Applications Installer” of the document CD, while the source code is inside folder “Demo Applications Source Code”

II. Program Structure

The demo application program consists of several different folders:

Start Stop	Demonstrate start stop reader function
CS203 CALLBACK API CUST	Demo Application that demonstrate basic operation of the reader. E.g., inventory, read and write etc...
CSLibrary	All necessarily library files are put in this folder
DEMO	Installer files of Callback-based API Demo Application and GPIO demo program
Document	User manuals and guidelines
GPIO	Demonstrate the GPIO function of the reader

III. Build Project Requirement

To run the CS203 application programs, the PC must have the following software installed:

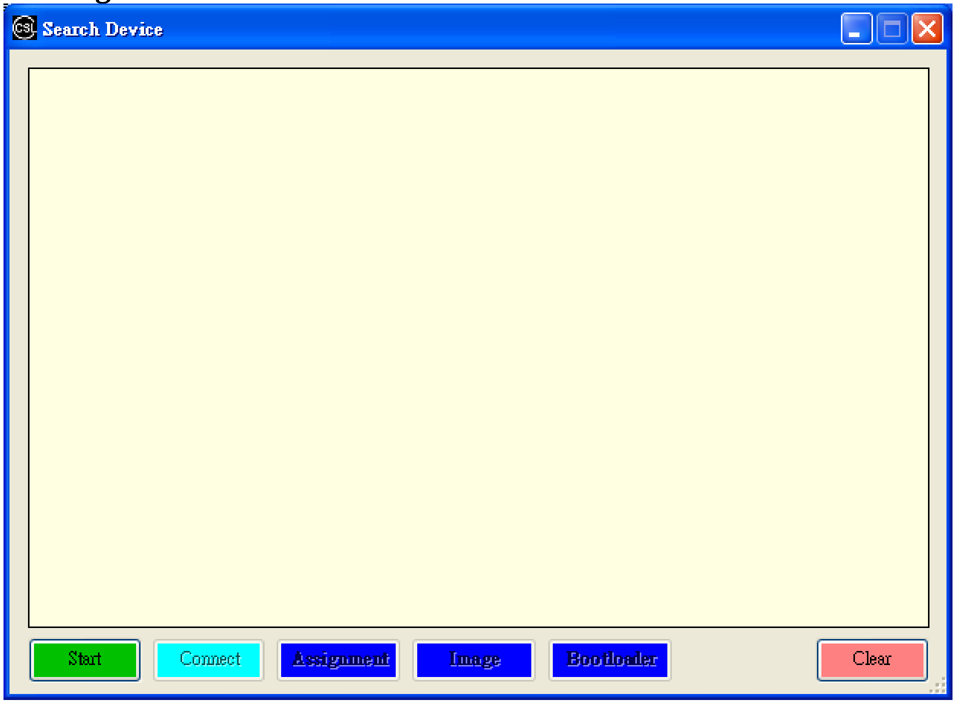
1) Dot Net Framework 3.5 or above
2) Visual C++ 2005 Redistributable package

The software can be downloaded from Microsoft website or found on the CS203 document CD inside folder “Software Development Environment on PC”.

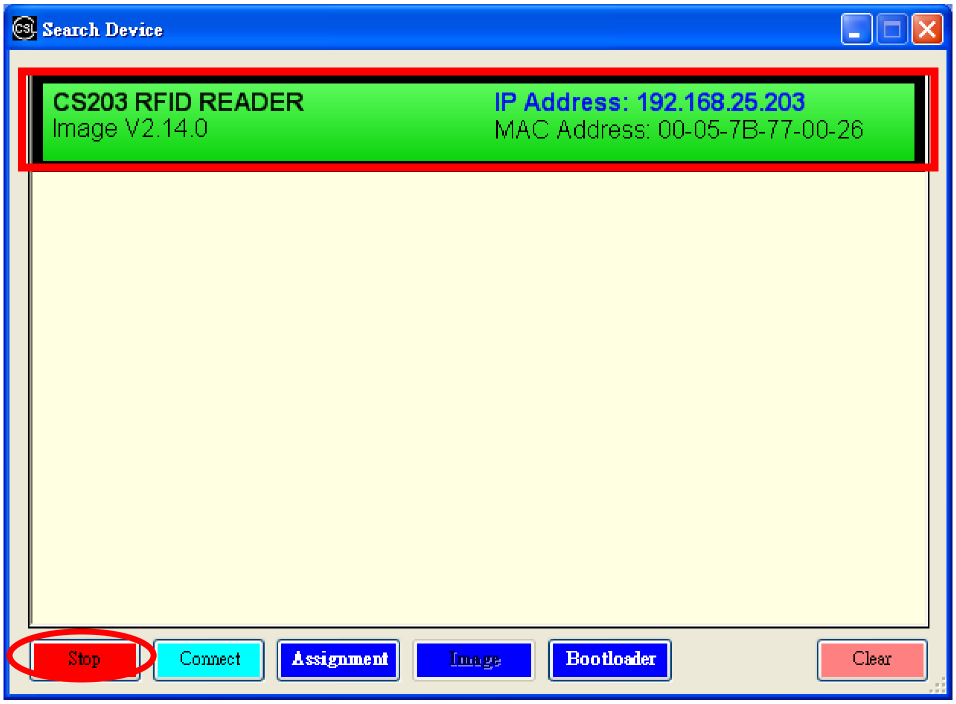
To build demo application successfully, you need to install Microsoft Visual Studio 2005 (with Visual C# component and SP1 patch) or above. For more detailed information, please go to Microsoft webpage (http://msdn.microsoft.com/en-us/vstudio/default.aspx).
Visual Studio 2005 SP1 -
http://www.microsoft.com/downloads/details.aspx?familyid=bb4a75ab-e2d4-4c96-b39d-37baf6b5b1dc&displaylang=en

IV. CS203 CALLBACK API DEMO Demo Program Operations

A. Searching for CS203 device



For the latest demo application, you can choose specific device to connect.



CS203 RFID READER
Image V2.14.0
IP Address: 192.168.25.203
MAC Address: 00-05-7B-77-00-26

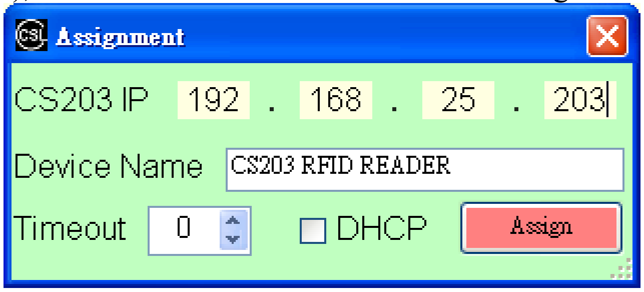
Click “Start” button to search device in the same network.

If you can't find any device, please check the following:

- make sure the Dot Net Framework 3.5 is installed
- make sure the Visual C++ 2005 Redistributable package is installed
- Disable the firewall setting on the PC or network (or open the port number 1515 and 1516)
- Reboot the CS203 device

B. Network Configuration of CS203

After you have found a CS203 device, you can configure the target device IP address (DHCP or static IP), Device Name and TCP timeout in "Assignment".



CS203 IP 192 . 168 . 25 . 203

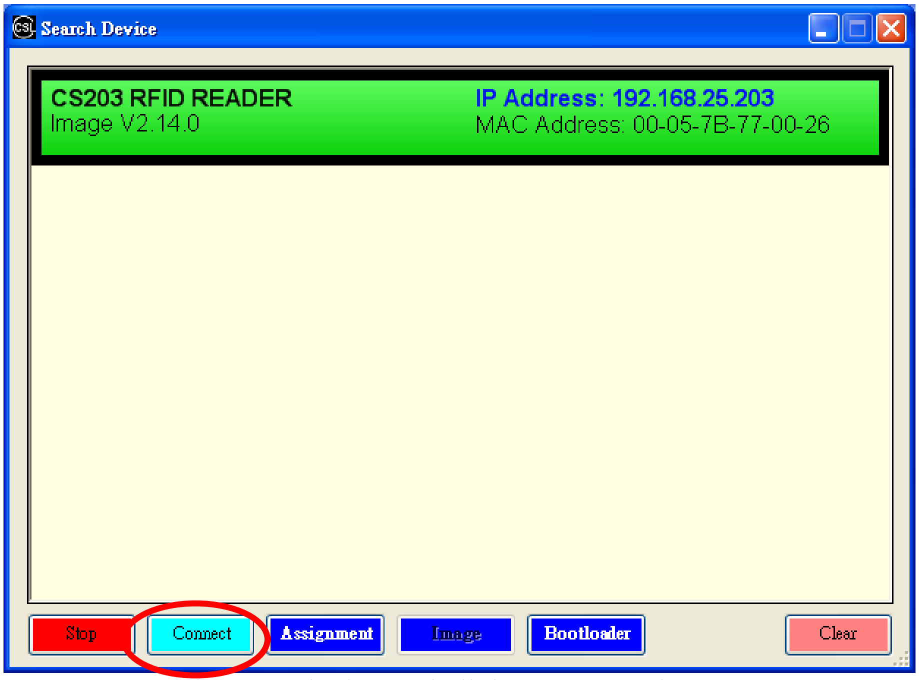
Device Name CS203 RFID READER

Timeout 0 □ DHCP

Note: Set TCP timeout to be zero at this moment.

C. Connecting to CS203

In order to connect to a CS203 device, select the device on the list and click the "Connect" button.



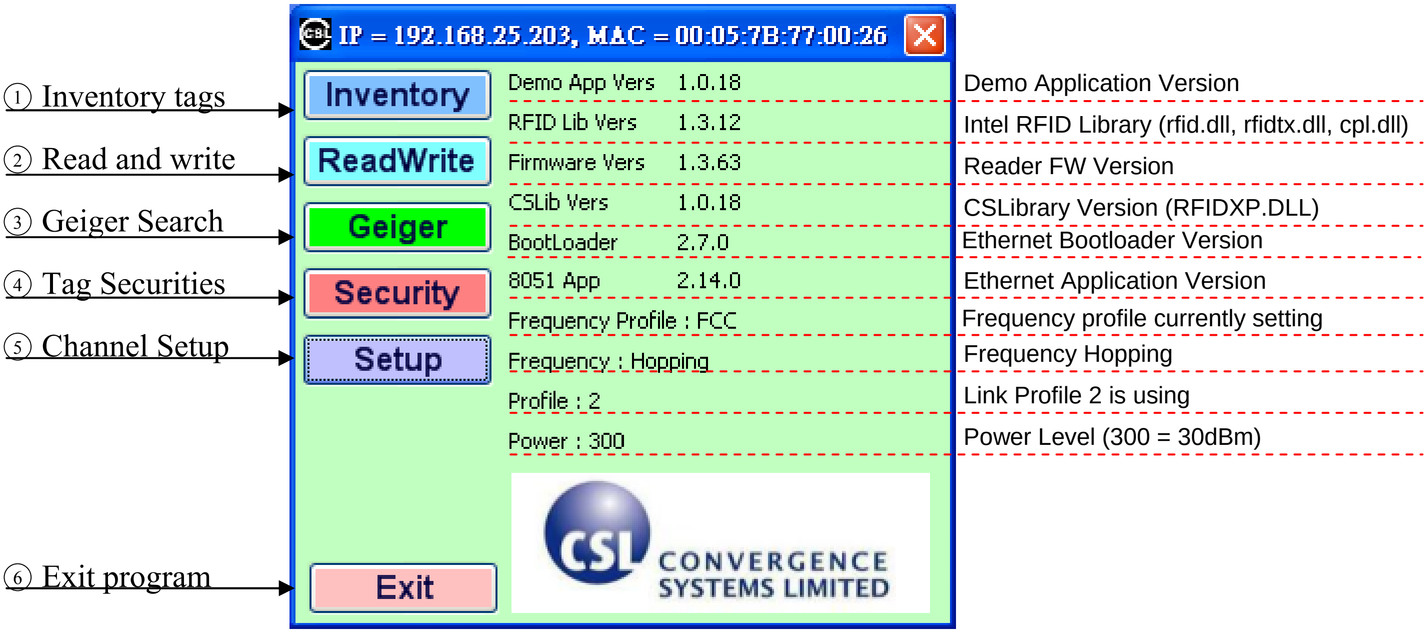
CS203 RFID READER
Image V2.14.0

IP Address: 192.168.25.203
MAC Address: 00-05-7B-77-00-26

Choose a device and click "Connect" button.

D. Main Menu

In the main menu of the CS203 CALLBACK API DEMO program, the configuration information of the reader is shown and you can select the various functions.



IP = 192.168.25.203, MAC = 00:05:7B:77:00:26

Demo App Vers	1.0.18	Demo Application Version
RFID Lib Vers	1.3.12	Intel RFID Library (rfid.dll, rfidtx.dll, cpl.dll)
Firmware Vers	1.3.63	Reader FW Version
CSLib Vers	1.0.18	CSLibrary Version (RFIDXP.DLL)
BootLoader	2.7.0	Ethernet Bootloader Version
8051 App	2.14.0	Ethernet Application Version
Frequency Profile : FCC		Frequency profile currently setting
Frequency : Hopping		Frequency Hopping
Profile : 2		Link Profile 2 is using
Power : 300		Power Level (300 = 30dBm)

① Inventory tags

② Read and write

③ Geiger Search

④ Tag Securities

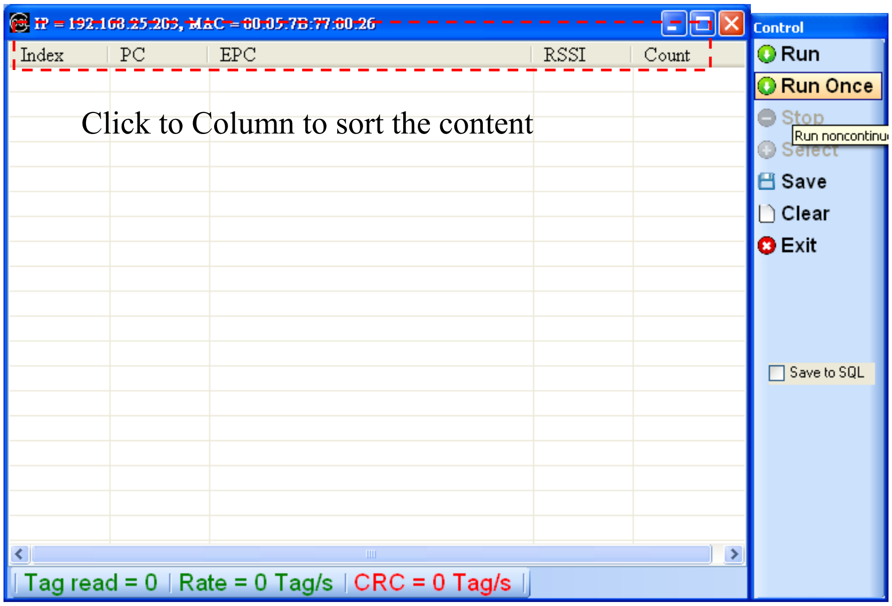
⑤ Channel Setup

⑥ Exit program

E. Inventory

This page demonstrates the tag inventory functions for reading tags continuously with the RSSI value and read count.

Click the “Run” button to start reading tags.

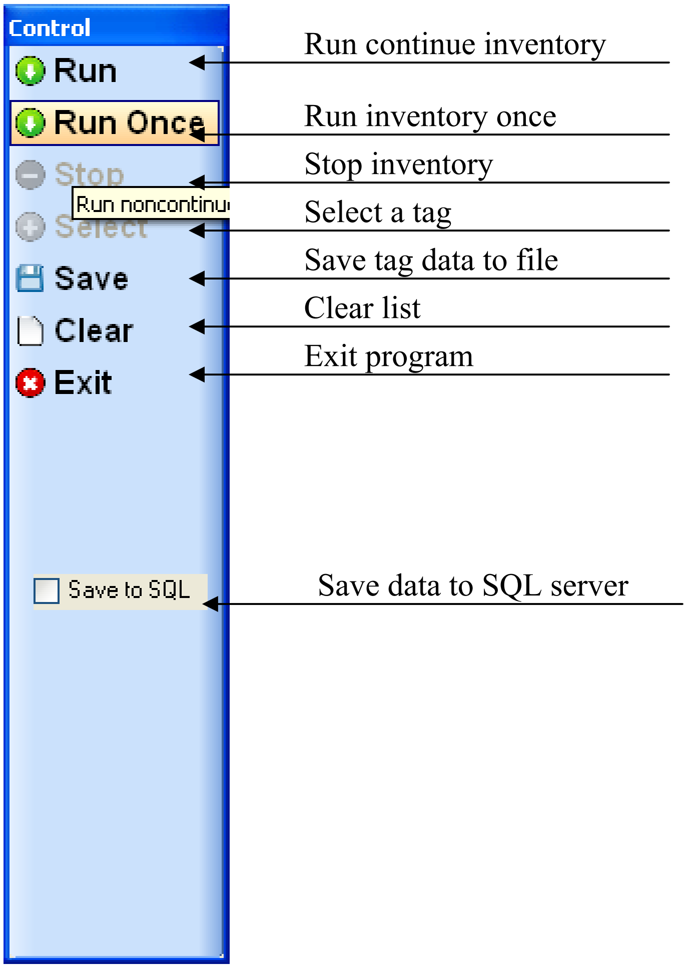


IP = 192.168.25.203, MAC = 00:05:7B:77:00:26

Index	PC	EPC	RSSI	Count

Click to Column to sort the content

Tag read = 0 | Rate = 0 Tag/s | CRC = 0 Tag/s



Run continue inventory

Run inventory once

Stop inventory

Select a tag

Save tag data to file

Clear list

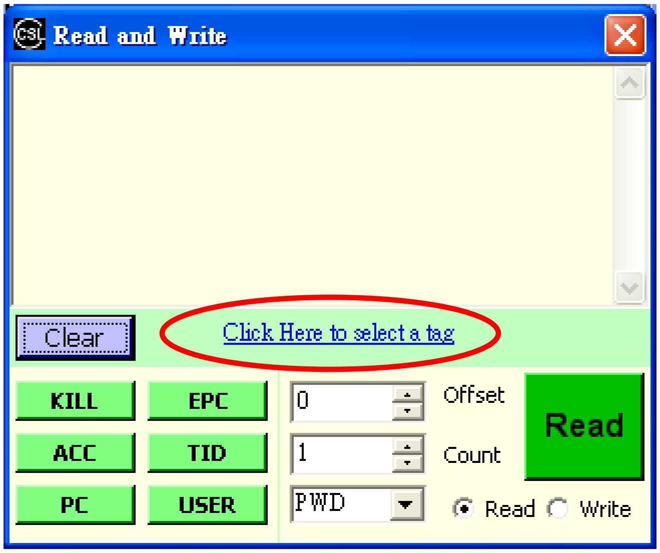
Exit program

Save data to SQL server

F. Read/Write

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

Click on the “Click Here to select a tag” to scan for and select the tag you want to access.

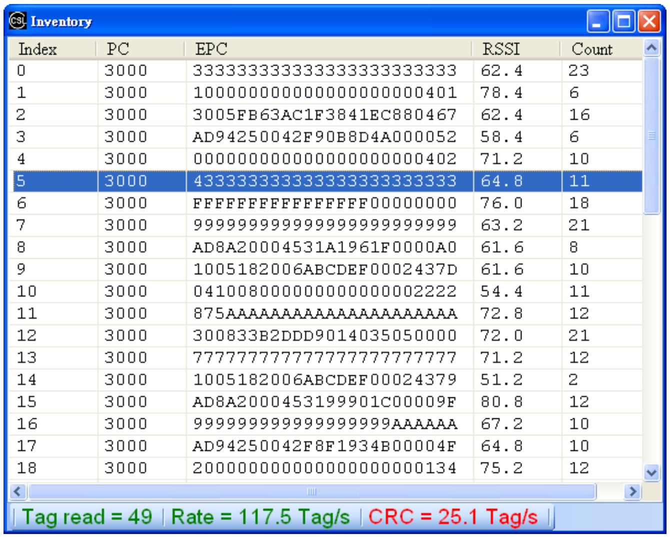


Offset: 0

Count: 1

PWD

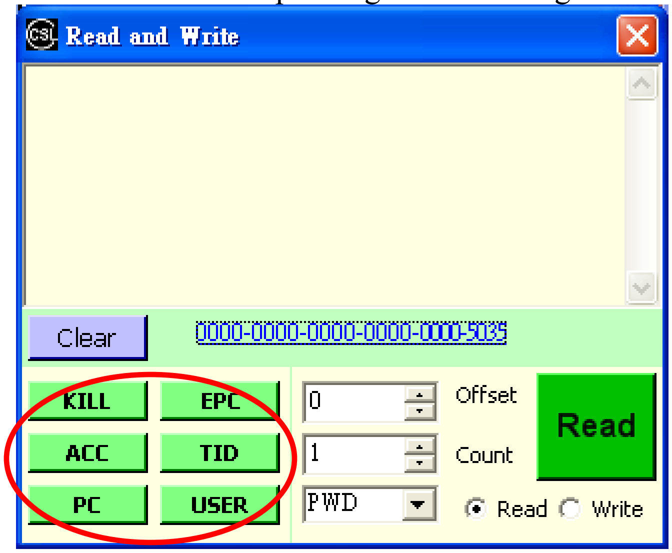
● Read ○ Write



Index	PC	EPC	RSSI	Count
0	3000	333333333333333333333333	62.4	23
1	3000	100000000000000000000401	78.4	6
2	3000	3005FB63AC1F3841EC880467	62.4	16
3	3000	AD94250042F90B8D4A000052	58.4	6
4	3000	000000000000000000000402	71.2	10
5	3000	433333333333333333333333	64.8	11
6	3000	FFFFFFFFFFFFFFFF00000000	76.0	18
7	3000	999999999999999999999999	63.2	21
8	3000	AD8A20004531A1961F0000A0	61.6	8
9	3000	1005182006ABCDEF0002437D	61.6	10
10	3000	041008000000000000002222	54.4	11
11	3000	875AAAAAAAAAAAAAAAAAAAAA	72.8	12
12	3000	300833B2DDD9014035050000	72.0	21
13	3000	777777777777777777777777	71.2	12
14	3000	1005182006ABCDEF00024379	51.2	2
15	3000	AD8A2000453199901C00009F	80.8	12
16	3000	999999999999999999AAAAAA	67.2	10
17	3000	AD94250042F8F1934B00004F	64.8	10
18	3000	200000000000000000000134	75.2	12

Tag read = 49 | Rate = 117.5 Tag/s | CRC = 25.1 Tag/s

After the tag is selected, you can click on the left hand side hotkey buttons or the "Read" button to read the corresponding data of the tag.



0000-0000-0000-0000-0000-5035

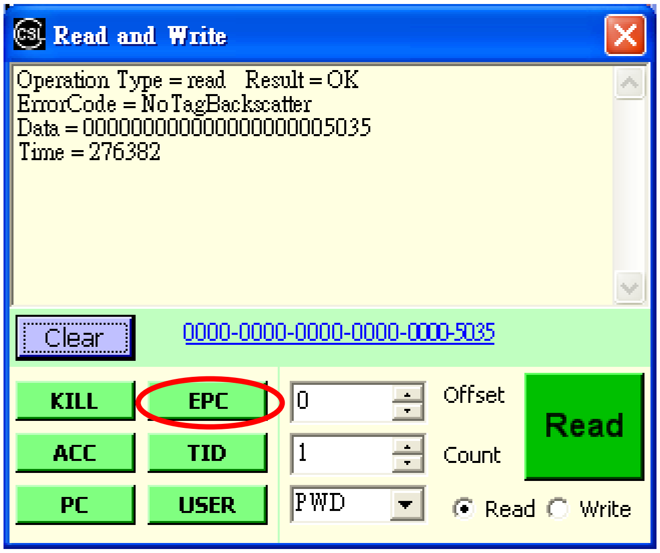
0 Offset

1 Count

PWD

● Read ○ Write

Read EPC: click on the "EPC" button to read the EPC ID



```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 000000000000000000005035
Time = 276382
```

0000-0000-0000-0000-0000-5035

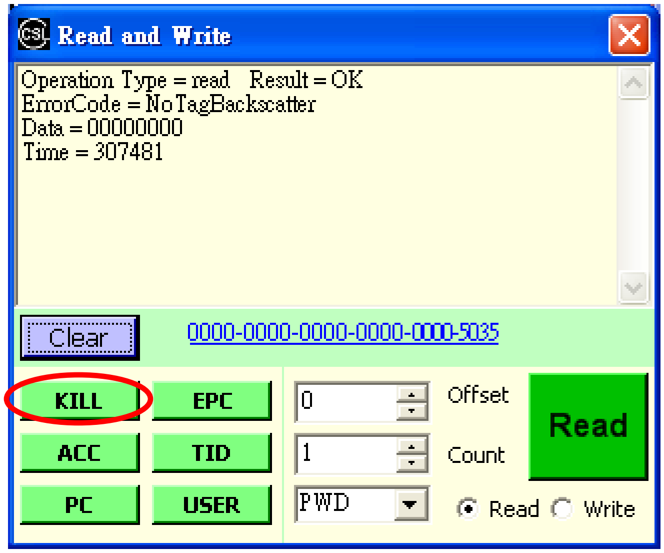
0 Offset

1 Count

PWD

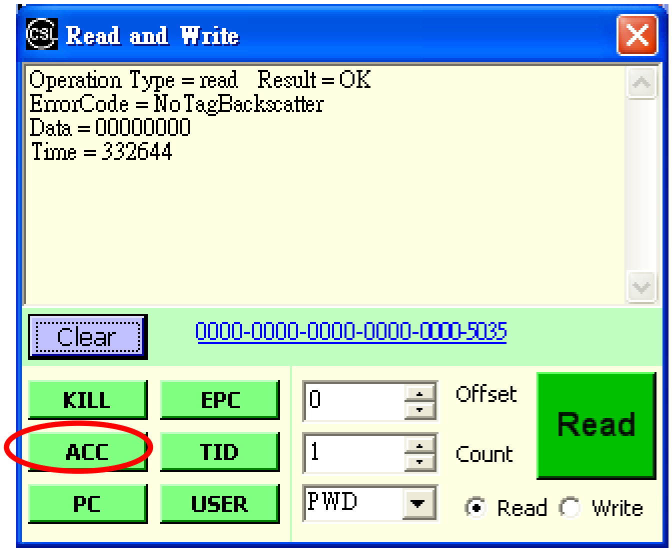
● Read ○ Write

Read Kill Password: click on the "Kill" button to read the kill password



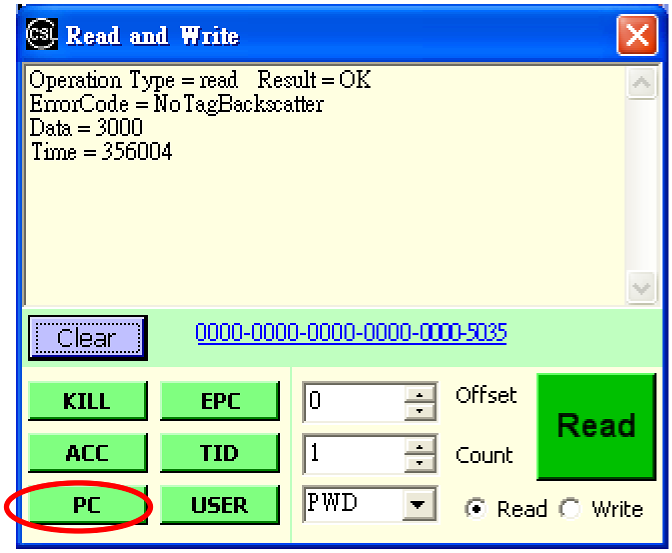
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 00000000
Time = 307481

Read Access Password: click on the "ACC" button to read the access password.



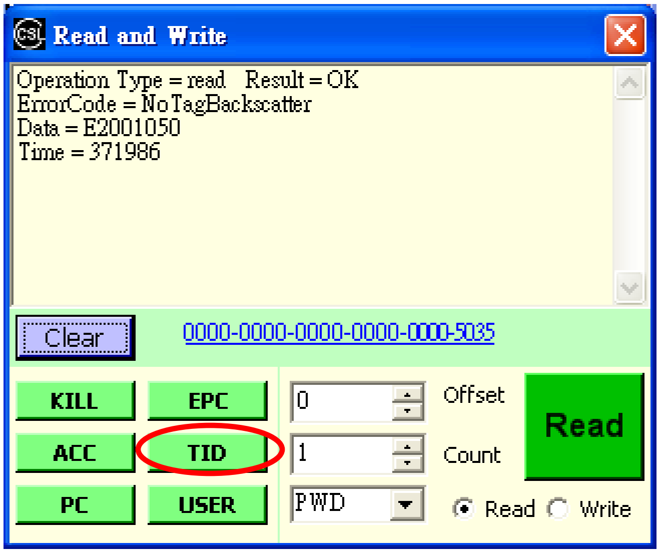
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 00000000
Time = 332644

Read Protocol Control (PC): click on the "PC" button to read the PC value.



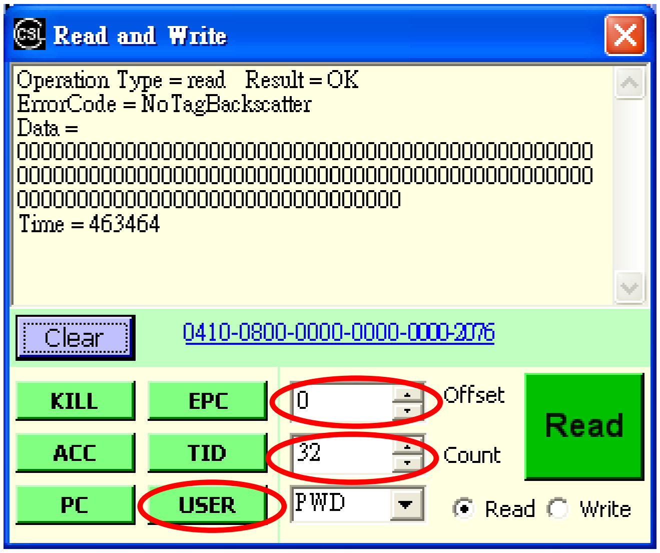
```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 3000
Time = 356004
```

Read TID Value: click on the "TID" button to read the TID value.



```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = E2001050
Time = 371986
```

Read User Memory: Set the offset word (starting word) and length of words (Count) you want to read for the user memory bank and click “USER” button to read it.



```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data =
000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000
00000000000000000000000000000000
Time = 463464
```

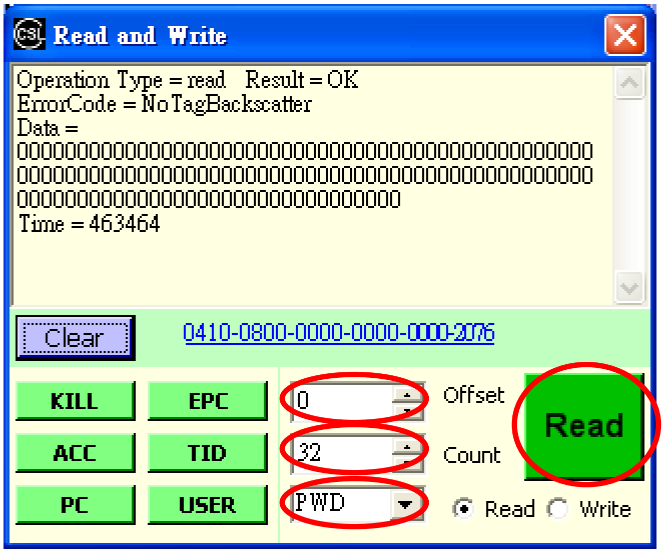
0410-0800-0000-0000-0000-2076

Offset: 0
Count: 32
PWD
● Read

For example, if you want to read from the 17th bit (after the first word) for a length of 32 bits (2 words), you should set Offset = 1 and Count = 2.

In addition to using the hotkeys on the left hand side, you could also use the “Read” button to read tags as follows:

1) Set the starting word you want to read at “Offset”
2) Set length of word you want to read at “Count”
3) Select the memory bank you want to read (PWD, PC-EPC, TID, USER)
4) Click “Read” button to read the data

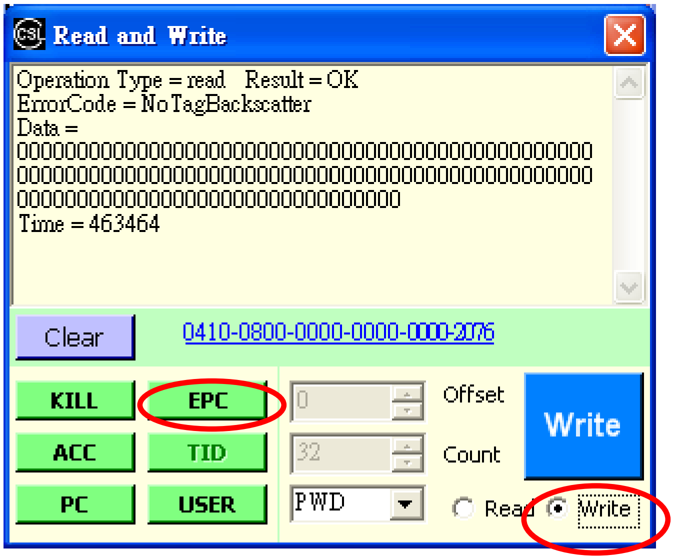


```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data =
000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000
00000000000000000000000000000000
Time = 463464
```

0410-0800-0000-0000-0000-2076

Offset: 0
Count: 32
PWD
● Read

Write EPC: select "Write" and click on "EPC" button to enter the write EPC page



Read and Write

```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data =
000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000
00000000000000000000000000000000
Time = 463464
```

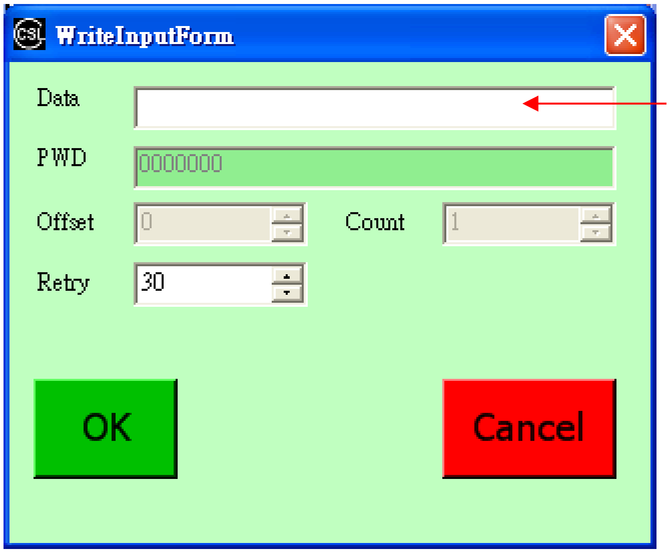
0410-0800-0000-0000-0000-2076

Offset: 0

Count: 32

PWD

○ Read ● Write



WriteInputForm

Data:

PWD: 0000000

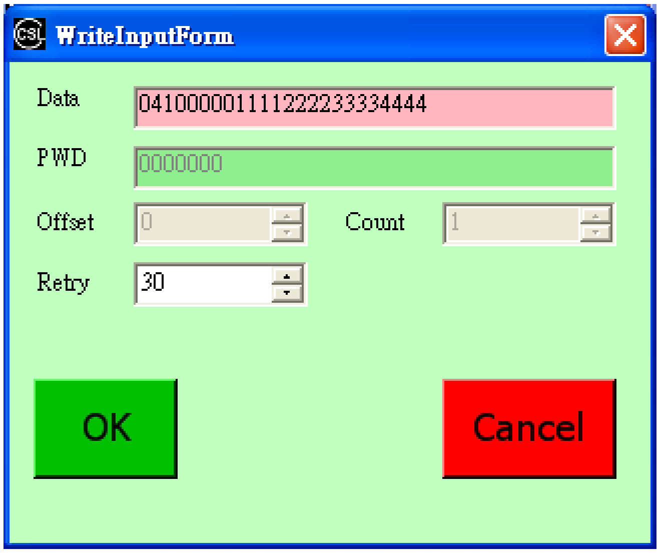
Offset: 0

Count: 1

Retry: 30

Input new EPC here

Input the new EPC ID in the "Data" field and then click "OK" button

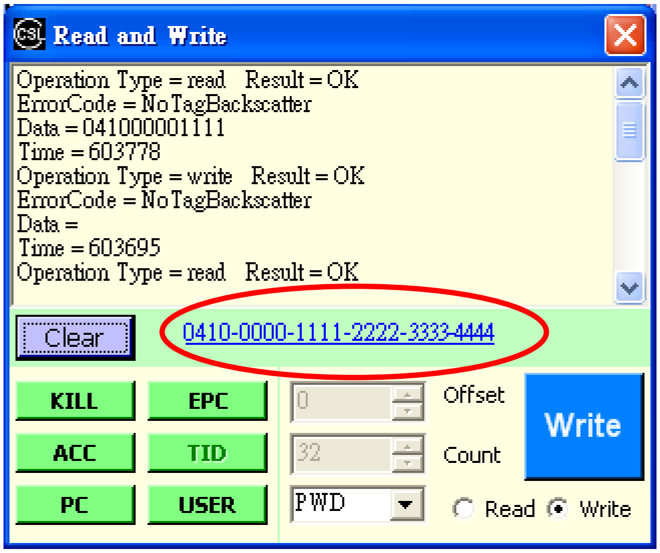


Data 041000001111222233334444

PWD 0000000

Offset 0 Count 1

Retry 30



```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 041000001111
Time = 603778
Operation Type = write   Result = OK
ErrorCode = NoTagBackscatter
Data =
Time = 603695
Operation Type = read   Result = OK
```

0410-0000-1111-2222-3333-4444

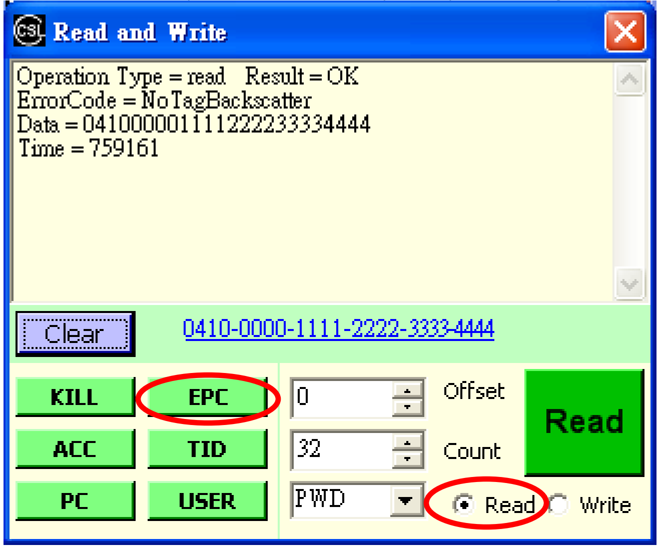
0 Offset

32 Count

PWD ○ Read ● Write

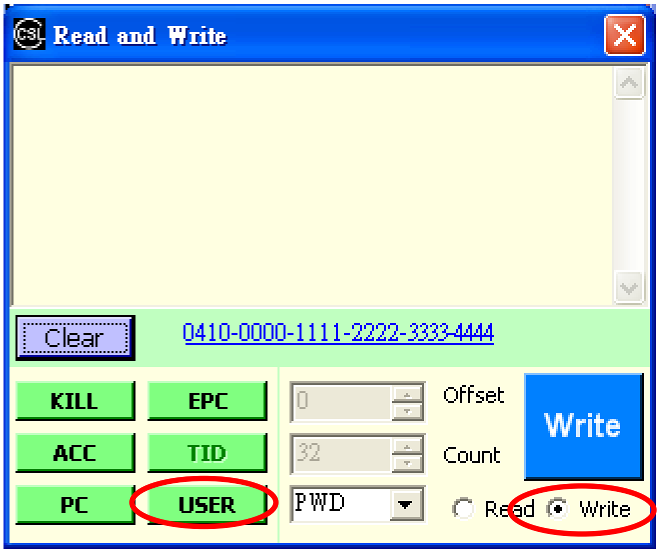
If write success, "Result = OK" will be shown on the screen.

After the EPC is written, you could verify it by reading the EPC ID again

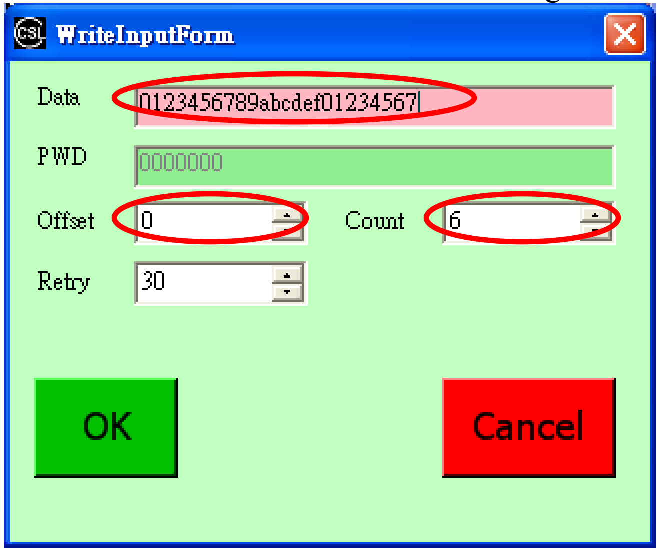


```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 041000001111222233334444
Time = 759161
```

Write User Memory: select “Write” and click on “USER” button to enter the write user memory page.



Select the offset word and length of words you want to write, then input the data into "Data" field and click "OK" button to write the tag.

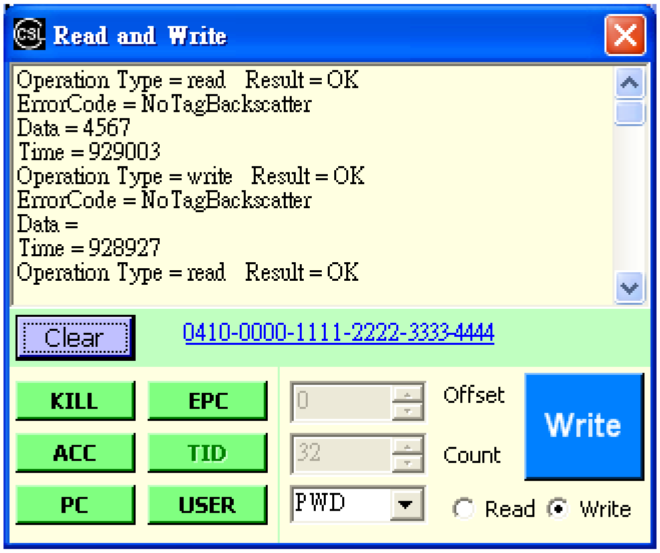


Data 0123456789abcdef01234567

PWD 0000000

Offset 0 Count 6

Retry 30



```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 4567
Time = 929003
Operation Type = write   Result = OK
ErrorCode = NoTagBackscatter
Data =
Time = 928927
Operation Type = read   Result = OK
```

0410-0000-1111-2222-3333-4444

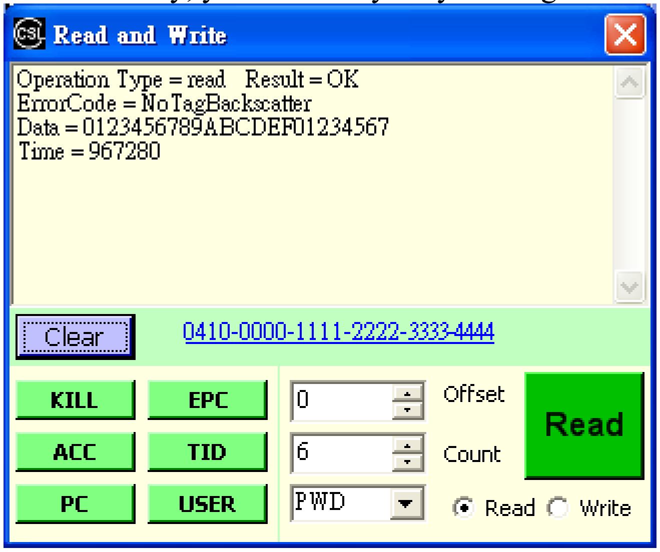
Offset 0

Count 32

PWD

○ Read ● Write

After writing the user memory, you can verify it by reading the user memory again.



```
Operation Type = read   Result = OK
ErrorCode = NoTagBackscatter
Data = 0123456789ABCDEF01234567
Time = 967280
```

Offset: 0

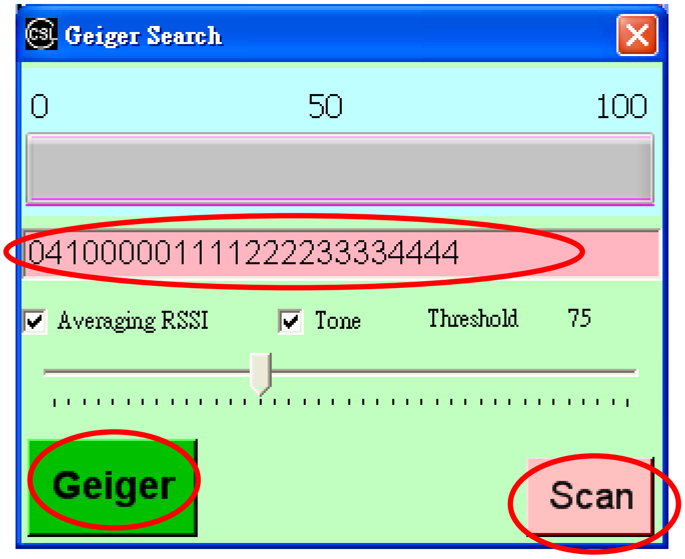
Count: 6

PWD

● Read ○ Write

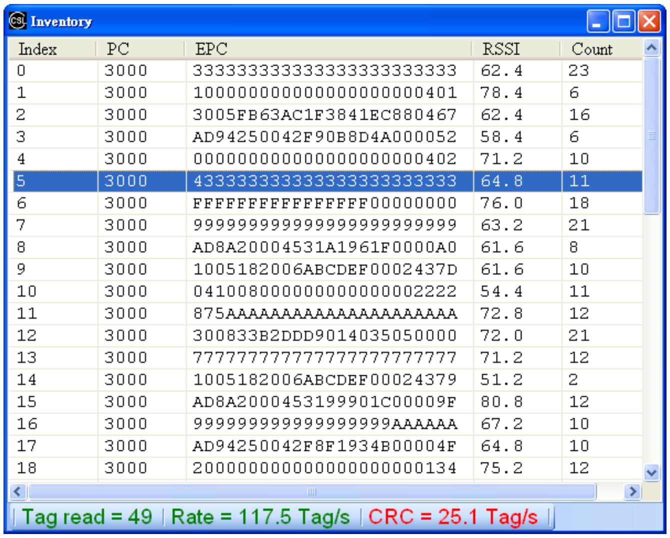
G. Geiger Counter Search

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



041000001111222233334444

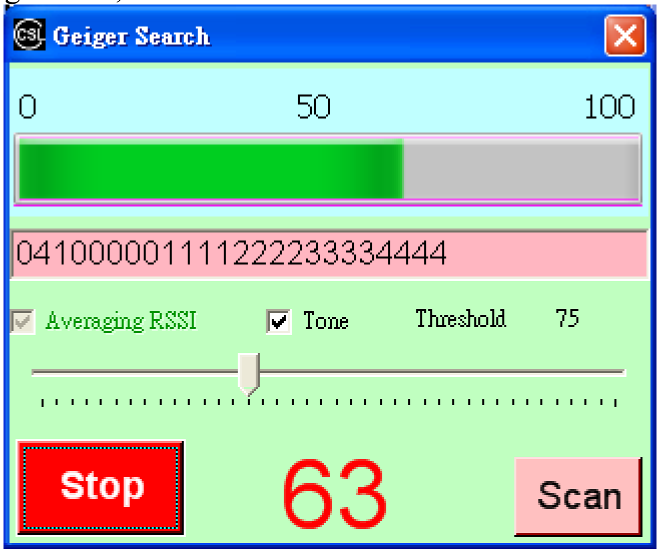
☑ Averaging RSSI ☑ Tone Threshold 75



Index	PC	EPC	RSSI	Count
0	3000	333333333333333333333333	62.4	23
1	3000	100000000000000000000401	78.4	6
2	3000	3005FB63AC1F3841EC880467	62.4	16
3	3000	AD94250042F90B8D4A000052	58.4	6
4	3000	000000000000000000000402	71.2	10
5	3000	433333333333333333333333	64.8	11
6	3000	FFFFFFFFFFFFFFFF00000000	76.0	18
7	3000	999999999999999999999999	63.2	21
8	3000	AD8A20004531A1961F0000A0	61.6	8
9	3000	1005182006ABCDEF0002437D	61.6	10
10	3000	041008000000000000002222	54.4	11
11	3000	875AAAAAAAAAAAAAAAAAAAAA	72.8	12
12	3000	300833B2DDD9014035050000	72.0	21
13	3000	777777777777777777777777	71.2	12
14	3000	1005182006ABCDEF00024379	51.2	2
15	3000	AD8A2000453199901C00009F	80.8	12
16	3000	999999999999999999AAAAAA	67.2	10
17	3000	AD94250042F8F1934B00004F	64.8	10
18	3000	200000000000000000000134	75.2	12

Tag read = 49 | Rate = 117.5 Tag/s | CRC = 25.1 Tag/s

When the tag is seen, it shows the RSSI value.



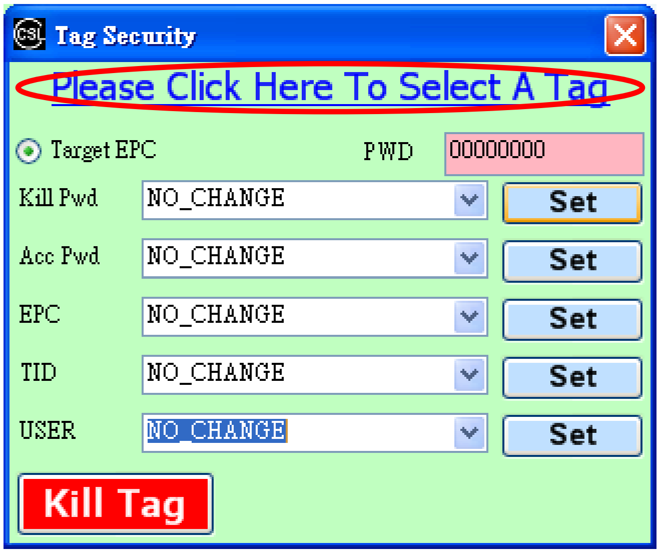
041000001111222233334444

☑ Averaging RSSI ☑ Tone Threshold 75

H. Tag Security

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

Click "*Please Click Here To Select A Tag*" to scan for and select the tag you want to access.



● Target EPC PWD 00000000

Kill Pwd NO_CHANGE

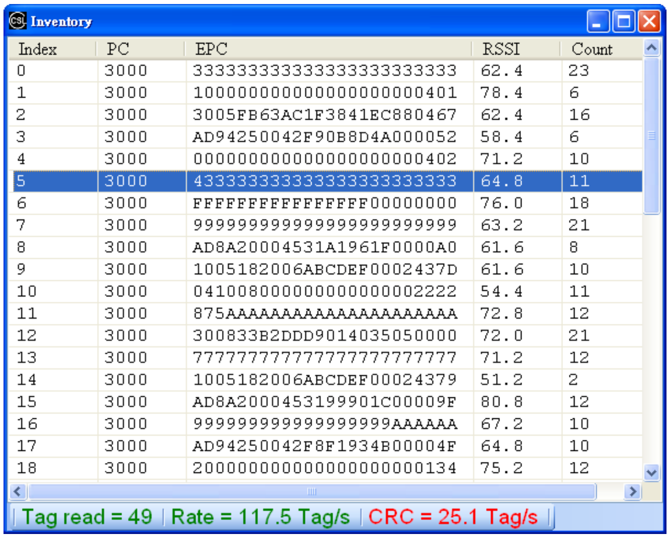
Acc Pwd NO_CHANGE

EPC NO_CHANGE

TID NO_CHANGE

USER NO_CHANGE

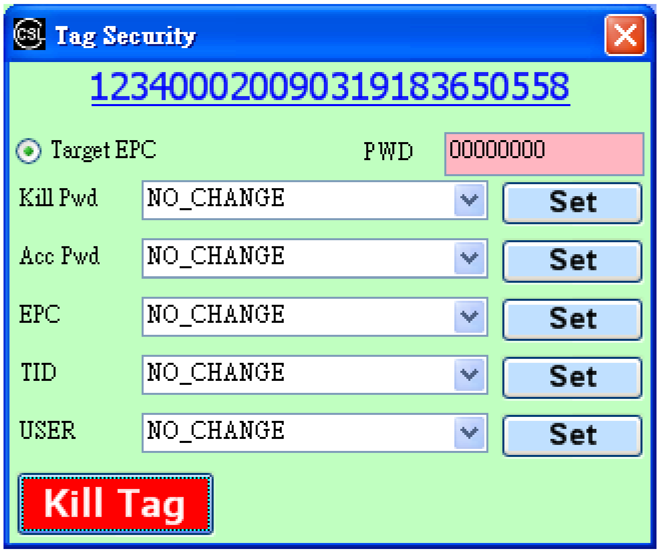
Highlight and select the tag you want to access in the list.



Index	PC	EPC	RSSI	Count
0	3000	333333333333333333333333	62.4	23
1	3000	100000000000000000000401	78.4	6
2	3000	3005FB63AC1F3841EC880467	62.4	16
3	3000	AD94250042F90B8D4A000052	58.4	6
4	3000	000000000000000000000402	71.2	10
5	3000	433333333333333333333333	64.8	11
6	3000	FFFFFFFFFFFFFFFF00000000	76.0	18
7	3000	999999999999999999999999	63.2	21
8	3000	AD8A20004531A1961F0000A0	61.6	8
9	3000	1005182006ABCDEF0002437D	61.6	10
10	3000	041008000000000000002222	54.4	11
11	3000	875AAAAAAAAAAAAAAAAAAAAA	72.8	12
12	3000	300833B2DDD9014035050000	72.0	21
13	3000	777777777777777777777777	71.2	12
14	3000	1005182006ABCDEF00024379	51.2	2
15	3000	AD8A2000453199901C00009F	80.8	12
16	3000	999999999999999999AAAAAA	67.2	10
17	3000	AD94250042F8F1934B00004F	64.8	10
18	3000	200000000000000000000134	75.2	12

Tag read = 49 | Rate = 117.5 Tag/s | CRC = 25.1 Tag/s

The EPC ID of the selected tag is shown.



123400020090319183650558

● Target EPC PWD 00000000

Kill Pwd NO_CHANGE

Acc Pwd NO_CHANGE

EPC NO_CHANGE

TID NO_CHANGE

USER NO_CHANGE

After the tag is selected, select the security you want to apply on each memory bank.

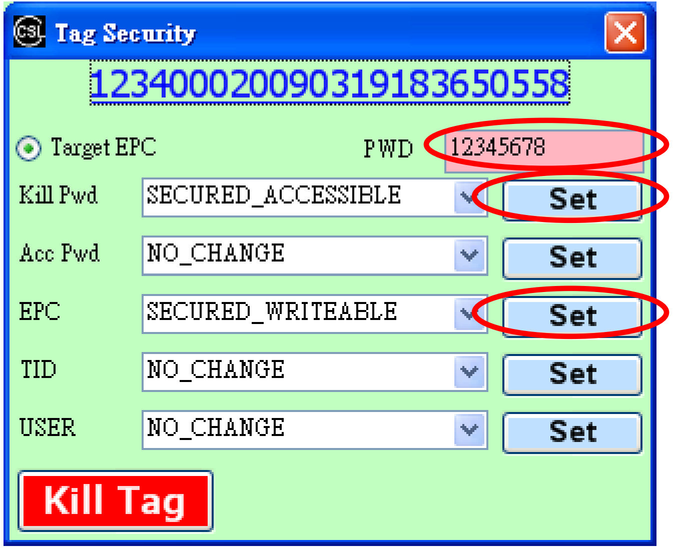
For Kill Password (Kill Pwd) and Access Password (Acc Pwd) banks:

- ACCESSIBLE: Unlock the bank – allow user to read and write it without access password
- ALWAYS_ACCESSIBLE: Permanently unlock the bank – allow user to read and write it forever without access password (cannot lock it again)
- SECURED_ACCESSIBLE: Lock the bank – cannot read and write the tag, need access password to unlock it
- ALWAYS_NOT_ACCESSIBLE: Permanently lock the bank – cannot read and write the tag forever (cannot unlock it again)
- NO_CHANGE: Keep the existing security state

For EPC and User Memory (USER) banks:

- WRITEABLE: Unlock the bank – allow user to write it without access password
- ALWAYS_WRITEABLE: Permanently unlock the bank – allow user to write it forever without access password (cannot lock it again)
- SECURED_WRITEABLE: Lock the bank – cannot write the tag, need access password to unlock it
- ALWAYS_NOT_WRITEABLE: Permanently lock the bank – cannot write the tag forever (cannot unlock it again)
- NO_CHANGE: Keep the existing security state

Enter the access password in "PWD", and click "Set" button to set the security setting.



123400020090319183650558

● Target EPC PWD 12345678

Kill Pwd SECURED_ACCESSIBLE Set

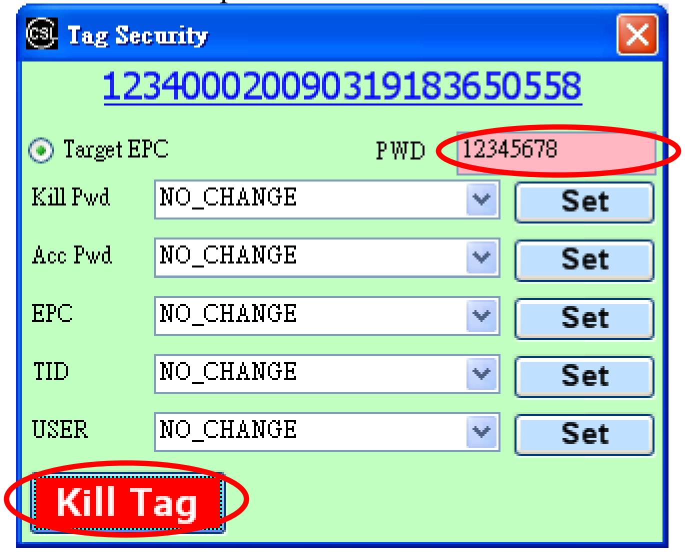
Acc Pwd NO_CHANGE Set

EPC SECURED_WRITEABLE Set

TID NO_CHANGE Set

USER NO_CHANGE Set

To kill the tag, enter the access password in “PWD” and click “Kill Tag button.



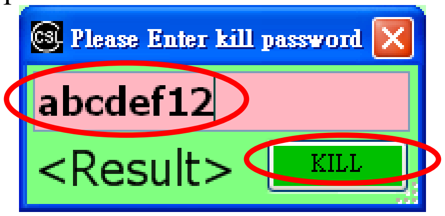
Tag Security

123400020090319183650558

○ Target EPC PWD 12345678

Kill Pwd	NO_CHANGE	Set
Acc Pwd	NO_CHANGE	Set
EPC	NO_CHANGE	Set
TID	NO_CHANGE	Set
USER	NO_CHANGE	Set

After that, enter the kill password and click the “KILL” button to kill the tag



Please Enter kill password

abcdef12

<Result>

I. Setup

The "Setup" page allows the user to configure the country setting, link profile and Gen2 parameter settings.

General Options

In "General Options", you could configure the reader's link profile, power and frequency settings.

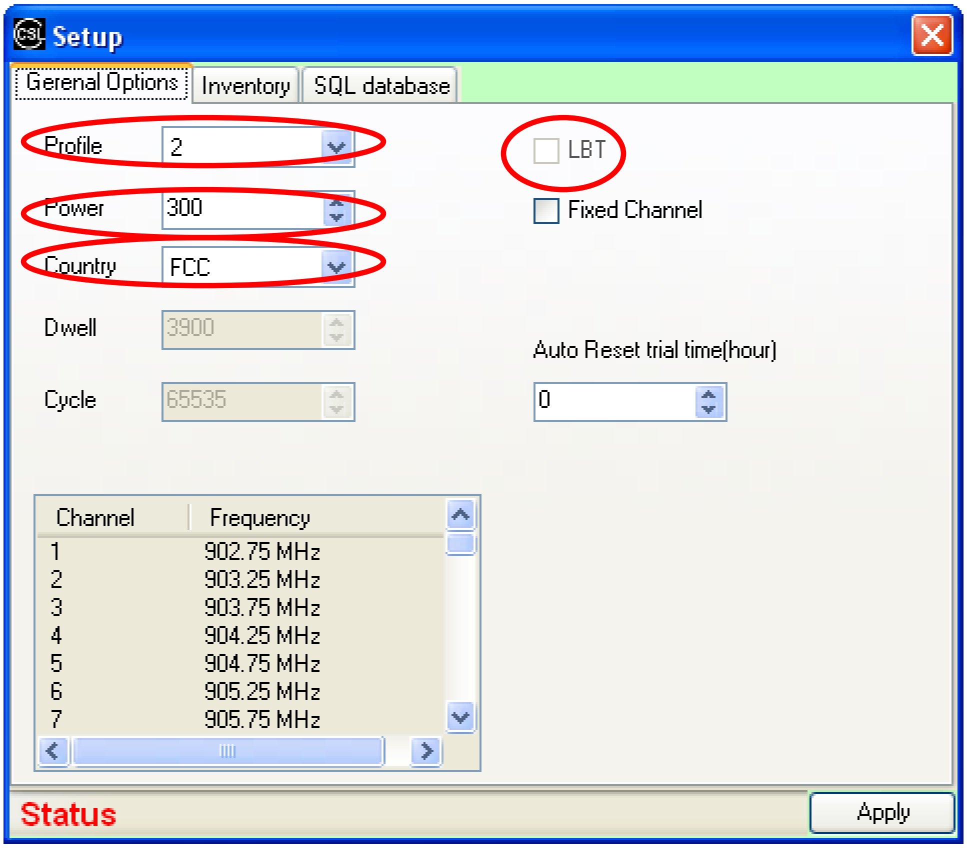
Profile – default setting is profile 2

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

Country – Select the corresponding country the reader operates in

LBT – Listen-before-talk option, available for CS203-3 (TELEC) readers only

Fixed Channel – Option for selecting fixed frequency channel



Profile 2

Power 300

Country FCC

Dwell 3900

Cycle 65535

□ LBT

□ Fixed Channel

Auto Reset trial time(hour)

0

Channel	Frequency
1	902.75 MHz
2	903.25 MHz
3	903.75 MHz
4	904.25 MHz
5	904.75 MHz
6	905.25 MHz
7	905.75 MHz

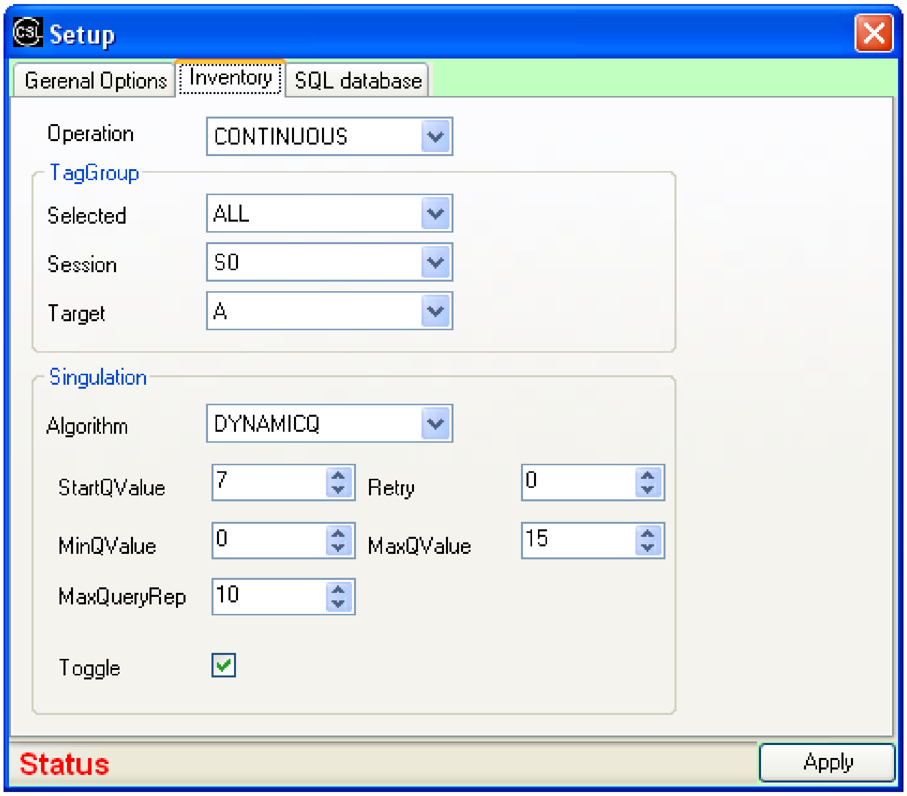
Status

Inventory

In “*Inventory*”, you could configure the reader’s Gen2 parameter settings for custom inventory operation.

Operation: operate in continuous or non-continuous reading (CONTINUOUS or NONCONTINUOUS)
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)
StartQValue: the starting Q-value for Dynamic Q algorithms
Retry: the number of retry for each Q-value inventory
MinQValue: the minimum Q-value allowed for Dynamic Q algorithms
MaxQValue: the maximum Q-value allowed for Dynamic Q algorithms
MaxQueryRep: the maximum number of QueryRep in inventory
Toggle: tick this box for allow toggle of flag during inventory

For detail explanation of these Gen2 parameters, please refer to *Appendix Operation Profile and Gen2 Parameters* or the specification of EPC Class 1 Gen 2 Protocol.



Operation: CONTINUOUS

TagGroup

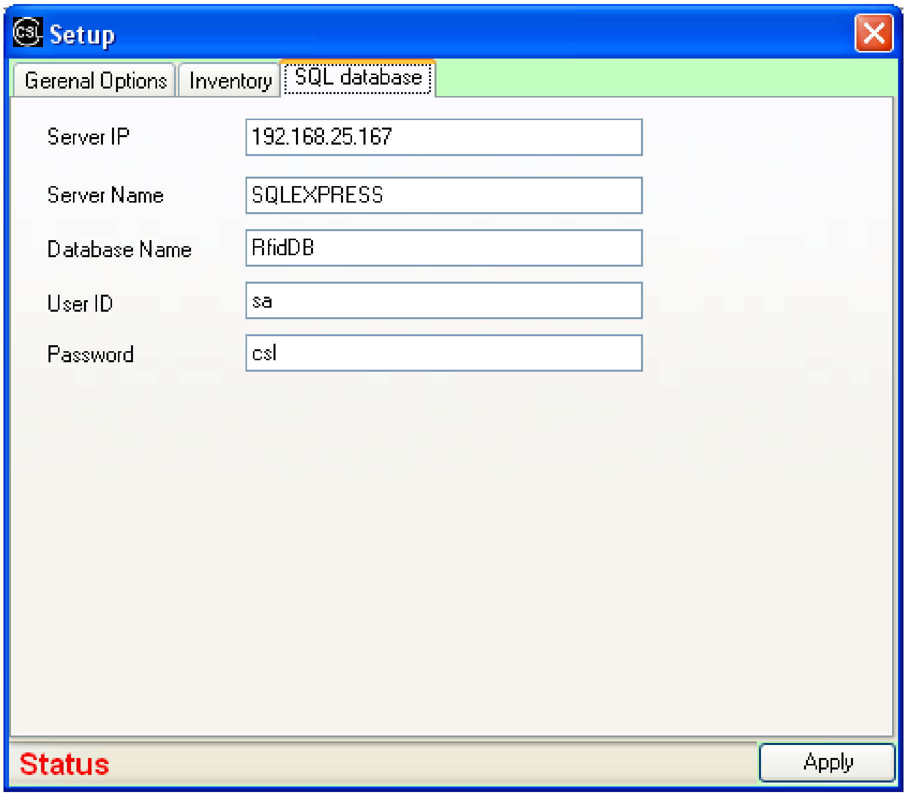
Selected: ALL
Session: S0
Target: A

Singulation

Algorithm: DYNAMICQ
StartQValue: 7
Retry: 0
MinQValue: 0
MaxQValue: 15
MaxQueryRep: 10
Toggle: ☑

SQL database

In “SQL database”, you could configure the SQL server information for saving the tag data.



Server IP 192.168.25.167

Server Name SQLEXPRESS

Database Name RfidDB

User ID sa

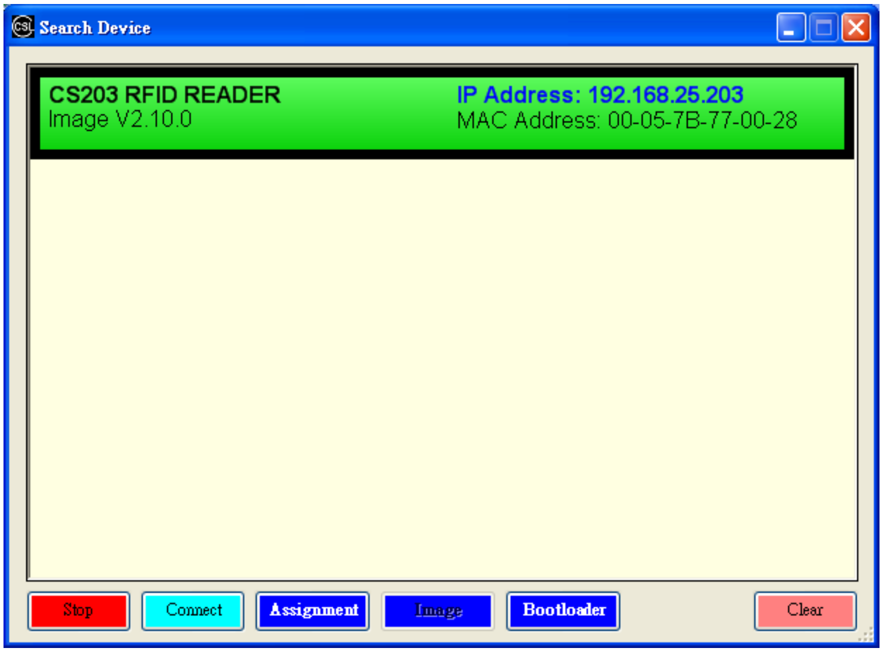
Password csl

J. Firmware Upgrade

The Callback-based API DEMO program could also be used to perform firmware upgrade on CS203 readers. There are 2 types of firmware: bootloader and application image.

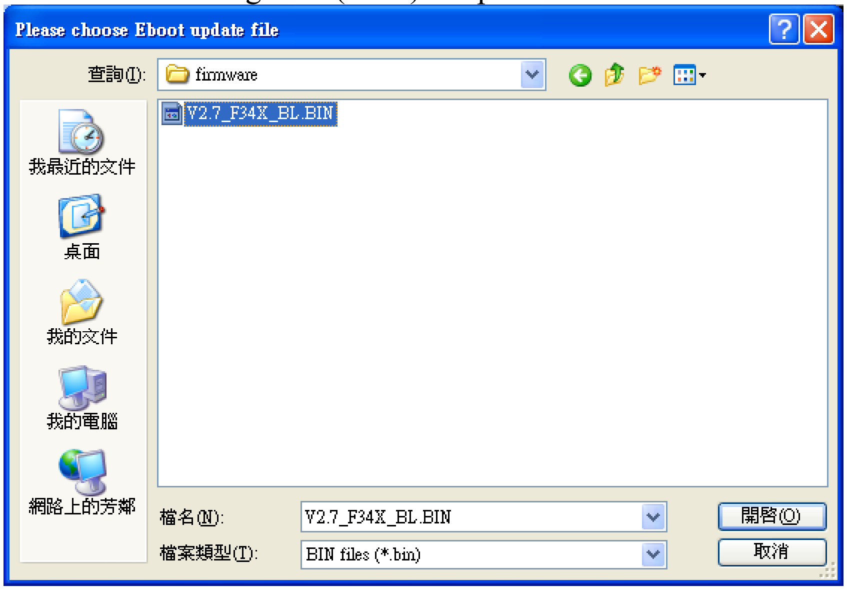
i) Bootloader Upgrade

1. Boot up CS203 reader
2. Run Callback-based API DEMO program and click “Start” to search the reader
3. Select the reader on the list and click “Bootloader” button



CS203 RFID READER
Image V2.10.0
IP Address: 192.168.25.203
MAC Address: 00-05-7B-77-00-28

4. Select the bootloader image file (*.bin) to update



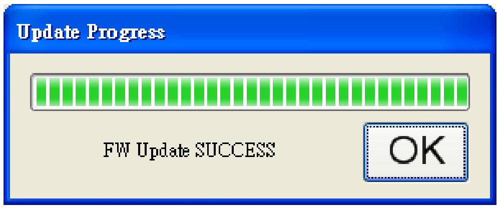
查詢(I): firmware

V2.7_F34X_BL.BIN

檔名(N): V2.7_F34X_BL.BIN

檔案類型(T): BIN files (*.bin)

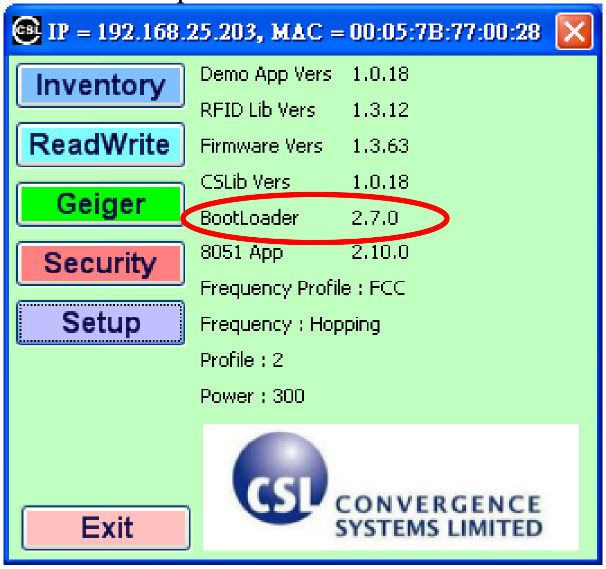
5. Wait until the update finish and then click "OK" button to continue


Update Progress

FW Update SUCCESS

Remark: If "Update successful" doesn't appear after 10 seconds, please restart CS203 and the DemoApp program and repeat the bootloader update process.

6. After bootloader upgrade process completed, connect to the reader to check if the new bootloader version is updated.


IP = 192.168.25.203, MAC = 00:05:7B:77:00:28

Demo App Vers	1.0.18
RFID Lib Vers	1.3.12
Firmware Vers	1.3.63
CSLib Vers	1.0.18
BootLoader	2.7.0
8051 App	2.10.0

Frequency Profile : FCC

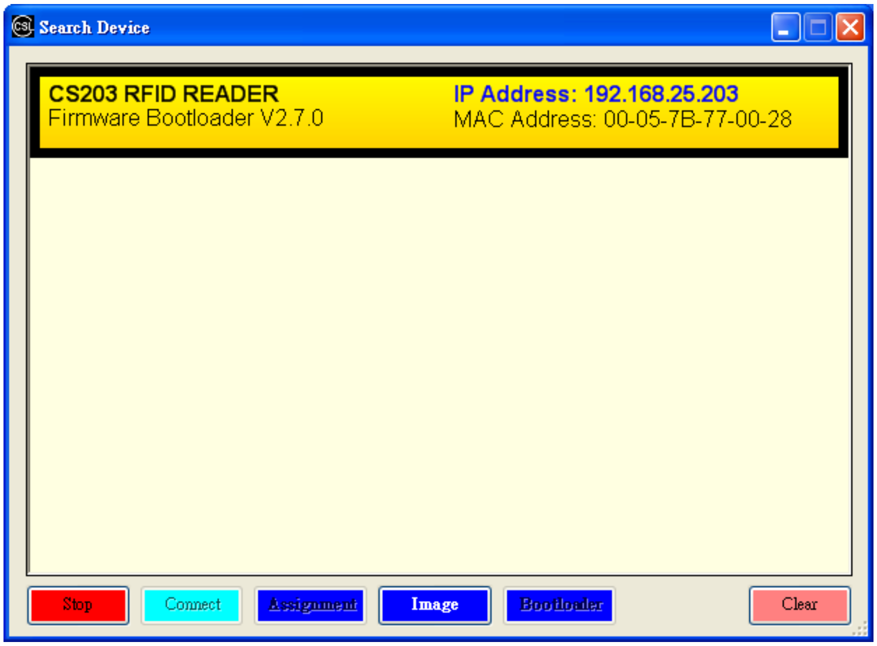
Frequency : Hopping

Profile : 2

Power : 300

ii) Application Image Upgrade

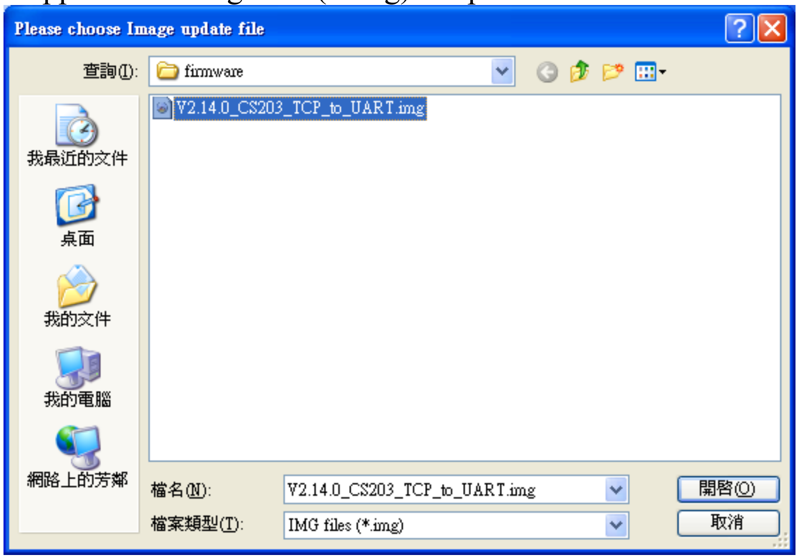
1. Boot up the reader to "Bootloader Mode" by:
   - Push the reset button and hold it
   - Power up the CS203
   - Wait for 5 seconds and then release the reset button
   - The "RFID" LED on the back of CS203 should be flashing every second
2. Run the Callback-based API Demo program and click the "Start" button to search the reader. If the reader is successfully boot in Bootloader mode, it will be displayed in the list with yellow background color.



CS203 RFID READER
Firmware Bootloader V2.7.0

IP Address: 192.168.25.203
MAC Address: 00-05-7B-77-00-28

3. Select the reader in the list and click “Image” button.
4. Select the application image file (*.img) to update



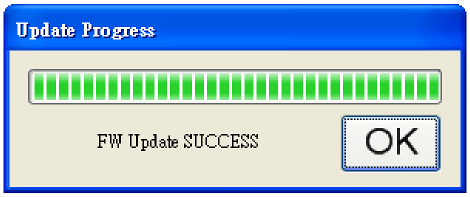
查詢(I): firmware

V2.14.0_CS203_TCP_to_UART.img

檔名(N): V2.14.0_CS203_TCP_to_UART.img

檔案類型(T): IMG files (*.img)

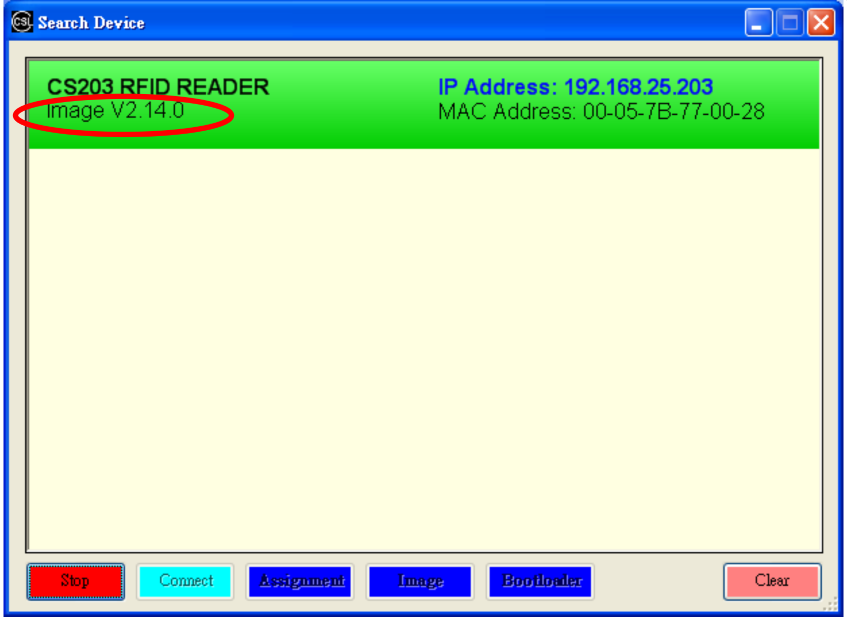
5. Wait until the update finish and then click “OK” button to continue.



FW Update SUCCESS

Remark: If “FW Update SUCCESS:” doesn’t appear after 20 seconds, please restart CS203 in Bootloader mode and the DemoApp program and repeat the image update process.

6. After the image upgrade process completed, search for the reader on the Callback-based API Demo program again and check if the new image version is updated.



CS203 RFID READER
Image V2.14.0

IP Address: 192.168.25.203
MAC Address: 00-05-7B-77-00-28

Appendix: Operation Profiles and Gen2 Parameters

Link Profile

Different modulation profile can be selected by the user for different situation.
In CS203-3 (Japan) and CS203-1 (ETSI) readers, only profiles 0, 2, 3 and 5 are selectable. The default setting is profile 2. It is also the recommended setting for most of the common applications.

Profile	0	1	2	3	4	5
R-T Modulation	DSB-ASK	DSB-ASK	PR-ASK	PR-ASK	DSB-ASK	PR-ASK
Tari (µs)	25.00	12.50	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 (uS)	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

Q-Value

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

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 $2^Q = 2^6 = 64 > 40$.

In CS203, it consists of four main inventory algorithm (one fixed Q and three variable Q). 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).

1) Fixed Q (Generic) Algorithm

- Fixed Q value
- Basis for all inventory algorithms.
- Optionally executes rounds until no tags are read.
- Optionally retries a rounds “n” times.
- Optionally flips A/B flag at end of round

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 2Q. 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 that the frequency hop time (and the session is 0) or antenna dwell time, the round will never complete.

2) Dynamic Q Algorithm (1)

- Q adjusts up or down at the end of each round.
- Executes repeated rounds until no tags are read when Q = Q minimum.
- Uses Qstart,Qmax and Qmin parameters to control the range of Q.
- MaxReps to limit time spent at each Q value.
- HighThres and LowThres to control how Q will adjust.

In algorithm 1, the value of Q is dynamically adjusted based on the periodic evaluation of the relative frequency of RN16 timeouts vs 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.

3) Dynamic Q Algorithm (2) – Dynamic Q Adjust

- Almost identical to algorithm 1.
- Same control interface as algorithm 1.
- Uses QueryAdjust command to modify Q value

Algorithm 2 is identical to algorithm 1 with the sole exception that a queryAdjust command is used to adjust the value of Q rather than a query command.

Read rate performance is increased relative to algorithm 1 because a) the query Adjust command is shorter, and b) new rounds are not initiated each time the value of Q changes, reducing the frequency of duplicate tag reads in the course of an inventory cycle.

Note though that algorithm 1 may deliver superior performance when reading small fast moving (or changing) tag populations due to the increased frequency with which query Commands are issued.

4) Dynamic Q Algorithm (3) – Dynamic Q Thresh

- New Q adjustment algorithm.
- Uses Qstart,Qmax and Qmin parameters to control the range of Q.
- QueryReps are not limited to a maximum number on a round.

- Single threshold multiplier used to control Q adjustment.
- QueryAdjust command used to modify Q value as in Algorithm 2.

In algorithm 3, the value of Q is adjusted based on the continuous evaluation of the relative frequency of RN16 timeouts vs EPC timeouts.
An inventory cycle consists of a single round initiated by a Query command.
Following the query command, up to ((2^^Q)-1) queryRep commands are issued.
If in the course of operation the number RN16 timeouts exceeds the adjusted number of EPC timeouts by a calculated threshold, the value of Q is decremented (presumed empty slots outnumber presumed collisions). If the adjusted number of EPC timeouts exceeds the number of RN16 timeouts by a calculated threshold, the value of Q is incremented (presumed collisions outnumber presumed empty slots). While the relative number of RN16 time outs vs the adjusted number of EPC time outs falls within the threshold, Q is unchanged.
When the value of Q changes, or if all slots under the current Q value have been inventoried, the slot counters of the participating tag population is refreshed using a queryAdjust command.
The calculated threshold equals the current value of Q times a multiplier (set by default to 1).
The EPC timeout count is adjusted by Rtot, the ratio of (EPC timeout / RN16 timeout).
An inventory cycle is terminated when all slots have been checked with Q = Qmin and no tags have been read.
Read rate performance is increased relative to algorithm 2 because a) Q remains unchanged while well matched to the population, b) Q value is changed more quickly when it is not well matched, and c) on the average, fewer queryAdjust commands are issued.

Session
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.

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