FEITIAN
WE BUILD SECURITY

R502 CL
Smartcard Reader
USER MANUAL

Made by: Feitian Technologies

Dec, 2017

Revision Sheet

Date	Revision	Description
Feb, 2013	V1.0	Release the first version
May, 2013	V1.1	Add description when insert card, the USB port need provided at least 120mA current
October 17, 2016	V1.2	Publish new R502, update user manual
Dec, 2016	V1.3	Using new template
Dec, 2017	V1.4	Update contents and integrated all tools in one manual

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1.0 GENERAL INFORMATION

1.1 Product Introduction

R502 CL is a contactless smart card reader developed by Feitian Technologies. It is based on CCID driver. It supports contactless cards compliant with ISO 14443 and contactless cards following Mifare standard, suitable for many kinds of smart card applications.

R502 CL is a terminal interface device for smart card applications and system integration. R502 CL can be widely used in industries or applications requiring electronic payment and authentication, especially suitable for the high security fields. It is an optimal solution for authentication, e-commerce, financial organizations, access control etc.

1.2 Acronyms and Abbreviations

USB – Universal Serial Bus
CCID – (Chip Card Interface Device) Integrated Circuit(s) Card Interface Devices Specification
PCSC – (Short for "Personal Computer/Smart Card") is a specification for smart-card integration into computing environments.

1.3 Keywords and Features

Keywords: Smart Card Reader, CCID, USB, ISO 7816, ISO 14443, Type A, Type B, Felica(need OEM), Mifare, NFC, T0, T1, Full speed USB device, R502 CL

Features:

1. Support USB 2.0 interface
2. Power supply by USB, the USB interface must be provided 120mA current when insert card
3. The maximum current less than 100mA (no smartcard insert)
4. Accordance with CCID standard to do develop
5. Contactless card:
    a) Build-in antenna
    b) Accordance with ISO/IEC 14443 (A and B) standard
    c) Support Mifare S50/S70/Ultralight C cards
    d) Operating distance (0-30mm), Mifare card(0-45mm), it depends on cards
    e) Card clock Frequency: 13.56MHz
    f) Smart card communication speed: By default(106kbps,212kbps,424kbps) and 848kbps is optional, need OEM
6. Open UID(User ID) function

7. Support upgrade firmware (encrypted)
8. OS:
    a) Windows 2000/XP/2003/Vista/2008/7/8
    b) Linux Kernel 2.6+ (FC14 X64，ubuntu9.10，ubuntu10.04，ubuntu11.10，openSUSE11.3 X64)
    c) Mac OS X
    d) Android(OTG)

1.4 Applications

R502 CL is high speed smartcard reader product, it can using financial systems, e-commerce, e-government, e-banking, digital signatures, authentication, network access control, online games, recharge payment, ticketing system, parking and access control, public transportation system.

1.5 Security feature

1）Firmware cannot be read out. Anti-reverse analysis
2）Short circuit protection and overcurrent protection
3）Do not contain any users' sensitive data in product, such as password.
4）PCB board has a 5mm distance with reader shell.

1.6 Extension and maintenance

1）Product can be extended and disassembled.
2）Firmware can be extended, customized and updated.

1.7 Reliability

1）The period of hardware usable is at least 5 years.
2）Frequently read/write 200 times will not lead the system down or error.
3）Continuously using 48 hours will not lead error occurrence rate exceed 3‰

2.0 SPECIFICATION

General Parameters:

- Contactless card support:
  - ✓ Build-in antenna
  - ✓ Smart Card Clock Frequency: 13.56MHz
  - ✓ Smart Card Interface Speed : 106kbps,212kbps,424kbps, 848kbps(optional)
  - ✓ Support ISO 14443 Type A and Type B, Mifare© Protocol, Felica® protocol(Need do OEM)
- Communication interface:
  - ✓ Communication for PC: USB 1.1/2.0/3.0 full speed(12Mbps)
- Power supply mode:
  - ✓ USB DC 5V
- Physical Security
  - ✓ Short circuit and thermal protection/over-voltage protection
  - ✓ High security level chipset
  - ✓ Electrostatic prevention
- Firmware security
  - ✓ Firmware encryption mechanism
  - ✓ Firmware upgradability in encryption
  - ✓ Firmware cannot be read out. Anti-reverse analysis
- Open UID (User ID control) Function
- Support firmware upgrade in encryption
- The unique device ID
- Based on CCID standard, PC/SC compatible reader
- Driverless – Plug in and Play
- Support Android device, need OTG cable
- Warranty

- ✓ Meantime Between Failure(MTBF)：500,000 hours
- ✓ One year manufacturer's warranty

2.1 Technical Parameter Table

Technical Specification		
Basic Parameter	**Modal Name**	R502 CL
	Host Interface	USB 2.0 CCID
	Transmission Speed	12Mbps(USB 2.0 Full Speed)
	Power to Smart Card	60mA
	Reader Current	USB connection without any card: 170mA
		USB connection with contactless card: 200mA
	Contactless	Build-in antenna
		Smart Card Clock Frequency: 13.56MHz
		Smart Card Interface Speed : 106kbps,212kbps,424kbps, 848kbps(optional)
		Support ISO 14443 Type A and Type B, Mifare© Protocol, Felica® protocol(Need OEM)
	Custom Items	OEM logo, packaging, color and firmware
	Support OS	Win2000+/Linux/Mac OS X/UNIX/Android(OTG)
	Certificate	CE/FCC/RoHS/EMV Level 1/LTIC/BSMI/UL
Physical Parameter	**Material**	ABS+PC
	Weight	80g
	Status Indicator	Blue and Red
	Connector Cable	1.5m
	Color	Black
	Dimension	100*65*10.5(mm)
Work Environment	**Power supply**	USB 5V DC
	Working current	< 50mA without card
	Working Temperature	0°C ~ 60 °C
	Storage Temperature	~20°C ~ 85°C
	Humidity	≤90%(non-condensed)

Standard	**Card Reader Standard**	ISO 14443 Standard, Felica Standard, Mifare © Standard
		EMV Level 1 Standard
		PC/SC Standard
		USB 2.0 Standard
		CCID Standard
	API Standard	PC/SC Lite/WINSCARD API
Features	Plug and Play	
	Readily Compliant	
	Suits Any Application	
	Open UID(user ID) function	
	Meantime Between Failure (MTBF) - 500,000 hours	
Security	**Physical Security**	Short circuit and thermal protection/over-voltage protection
		High security level chipset
		electrostatic prevention
	Firmware Security	Firmware encryption mechanism
		Firmware upgradability in encryption
		Firmware cannot be read out. Anti-reverse analysis
Warranty	**Meantime Between Failure(MTBF)**	500,000 hours
	Warranty	One year manufacturer's warranty.

2.2 Key Application

2.2 Product photo

R502 CL reader is a kind of high-speed contractless smart card reader, which is used for PC environment or relevant smart card environment. Product shell is contactless only by default, if you have idea and want make your own casing, Feitian also provide mold service for customer. To suit some other requirements, like ATM machine or other industry which already had mold, we also offer hardware module for embedded.

Casing appearance:

3.0 HARDWARE CONFIGURATION

3.1 Operating Environment

R502 CL can be using in various operating environments, including hardware and software operating environments, thus expanding the scope of use of reader R502 CL Card Reader.

3.2 Hardware Operating Environment

R502 CL Card Reader providing user with USB, it helps to make connection between PC, Android device and other equipment more convenient. The card can be operate by local PC or Android device via R502 Card Reader.
To Use it for android, customer will need to buy OTG cable (USB Type A Female to MicroUSB (OTG))

3.3 Software Environment

R502 CL Card Reader has rich software environment. It supports Android (Has not be tasted on all Android versions or smartphones), Windows 2003Server, Windows XP (SP2, SP3), Windows 2008Server, Windows Vista, Windows 7, Windows CE, Linux, Mac OS X 10.6 (X64)/Mac OS X 10.6 (X32)/Mac OS X 10.5 (X32) (These systems need to install the driver first), etc.

If you are using Embedded Linux system, you will need cross-build CCID, libusb, pcsclite into your target platform. Go to SDK and check Cross_build_Driver_To_Embedded_Linux.txt, any questions, you can contact world.support@ftsafe.com to ask help.

$R502_SDK_Latest\Driver\Cross_build_Driver_To_Embedded_Linux.txt

3.4 Hardware Configuration

In order to help user to understand interaction between reader, device and card, the R502 CL Card Reader hardware has various status of prompt information. 2 LED indicator lights is provided for the user: red, blue, each of them representing power indicator light, card detection indicator light and data communication indicator. For details, please refer to the following table

We provided three indicators (Red/Blue) to inform the status of reader. It included below status of Reader (USB data transfer working status)

Contactless: Standard contactless antenna, support 13.56MHz contactless card

Name of indicator light	Color	Prompt state	
USB work indicator	Red	Flashing	USB Enumeration process
		Turn on	USB is established
		Irregular flashing	USB exchange data
Data communication indicator	Blue	Turn off	No card
		Turn on	Card insert
		Flashing	Exchange data between Card and reader

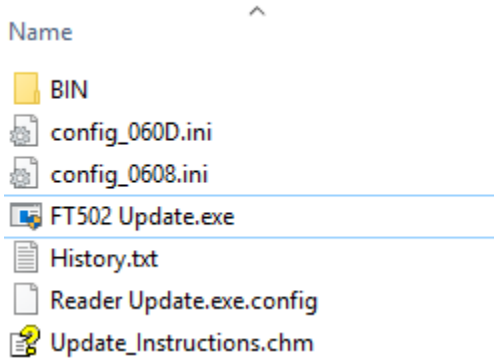
Note: When the program upgraded, the indicator light (except for the charge) is flashing.

4.0 R502 CL CARD READER FIRMWARE UPDATE TOOL

4.1 Introduction of Update tool

Firmware update tool using to upgrade R502 CL Card Reader firmware, it is for maintain in future. R502 CL Card Reader apply dual encrypted mechanism. The firmware will have encrypted by UID (User ID), only the right UID firmware can be update by right reader. We will explain UID function later. To using update tool, please check R502 CL Card Reader SDK.

*The related files of update application



- ➔ BIN include update firmware BIN file
- ➔ config_060D.ini and config_0608.ini is dependence file by “FT502 Update.exe”
- ➔ FT502 Update.exe is executable file for update, need using administrator to run, the file will need modify your register to open escape command which has mentioned in CCID standard
- ➔ README explain history of the tool
- ➔ Update_Instructions.chm is manual for update tool

4.2 The operation of Update tool

The update tool is easy, convenient and safe too. We will introduce how to using this tool to update your reader.

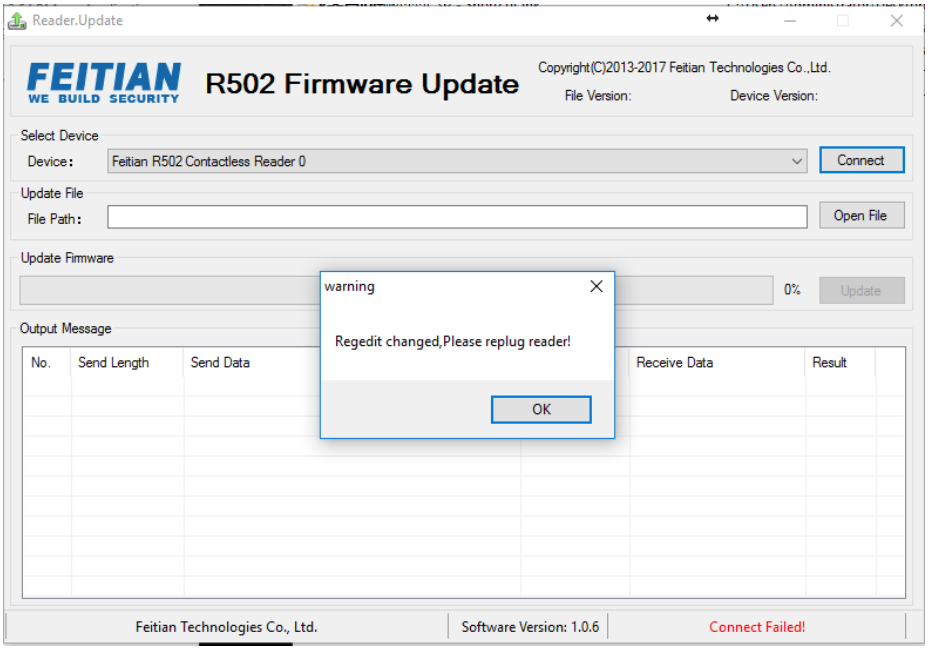
Update application software used to update old program through a new edition of program. The software includes the following items: Select Device, Update File, Update Firmware, and Output Message.

Note:

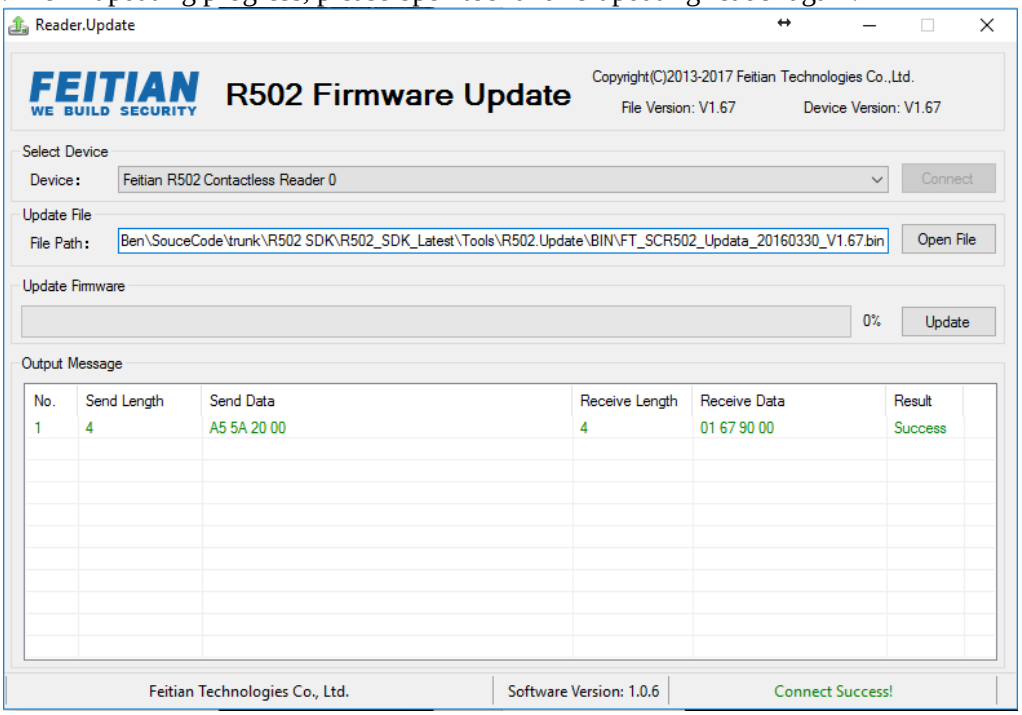
R502 CL latest firmware version is 7.02

Step #1: Insert reader to PC and double click “FT502 Update.exe” by **administrator**. If you are first running this tool, the tool will inform to re-plug reader.

Select the name of the smart card reader, and then connect the reader. Before Update the reader, you must connect the smart card reader.



Step #2: After re-plug reader, open update tool application again, choose your firmware file and then starts updating.
The whole progress will cost around 30s. **Please not remove reader while in updating.** If something happens while in updating progress, please open tool and re-updating reader again.

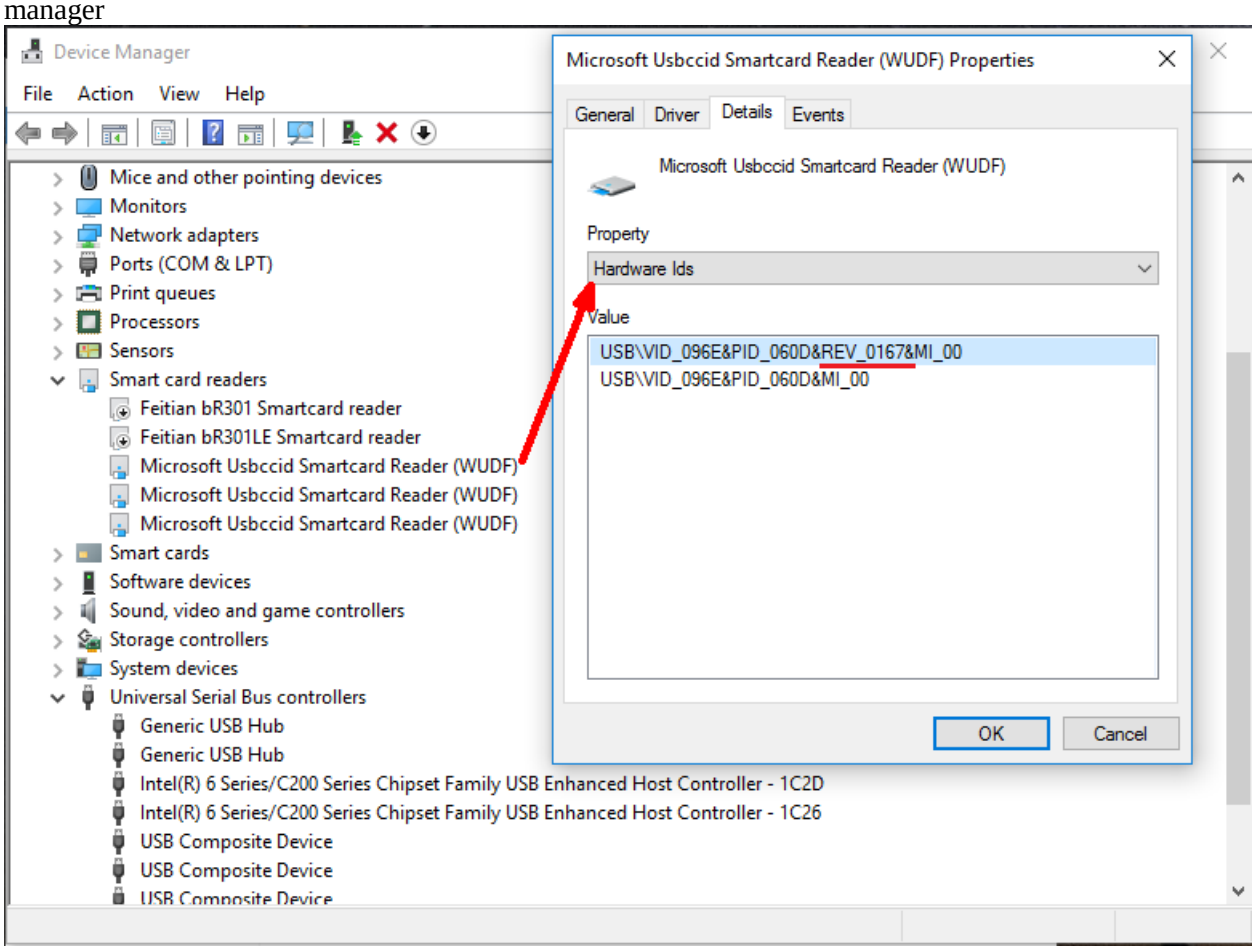


4.3 Errors and solutions

1. If the update tool happens “open register” error, please do re-plug reader and using your administrator to run again, if it still happen, you can try using pstool.exe https://docs.microsoft.com/en-

us/sysinternals/downloads/psexec Using administrator to open CMD.exe, switch to psexec directory, run below command to open registry, like below:
$psexec.exe -i -d -s regedit.exe
Follow below path and delete below keys, then re-plug your reader and try again.
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Enum\USB\VID_096E&PID_0608
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Enum\USB\VID_096E&PID_060D

2. If occurs error while in updating, and stop at 30%, then please wait, because at this stage, the tool will hot-plug reader in application, may take 10-15 seconds. If it give error, then please re-plug reader and running application do updating again
3. If the tool has not list any reader name, then please check your USB connection is correctly. (Or check your reader hasn't connect to VMware). The error means have not found your reader. If still empty and confirm the reader connect to PC correctly, please send mail to world.support@ftsafe.com, some OEM reader cannot detect by standard tool, and we will need check your information before provide resource to you.
4. Check reader firmware version, you can follow below step to check firmware version in device manager



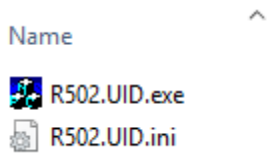
5.0 R502 CL CARD READER UID TOOL

5.1 Introduction of UID Tool

UID(User) Tool is security mechanism for distributor or people who want the reader only can be distinguish by their application, The UID is generate by seed code, user can input their privacy seed code, using UID Tool write code into reader, reader generate 8bytes ID, called user ID. And FEITIAN provide API to read this UID from different platform. Then user only need keep their seed won't be stolen, and do bind their application with this UID, to keep their customer only can be using specified reader.

UID application software used to generate the ID of User (UID). Only the User holding the legal UID can update the smart card reader. The software includes the following items: Seed File, Generate UID, Read UID, and Erase UID.

The operation API include in R502 CL Smart Card Reader SDK, also we provide windows tool for customer do operation on Windows. For mobile platform, also have such API for call (check developer guide).



➔ R502.UID.exe is execute file
➔ R502.UID.ini is config file

Note: before using the tool, please make sure your reader model, if your reader is contactless interface reader only, you will need modify the reader name to "Feitian R502 0"

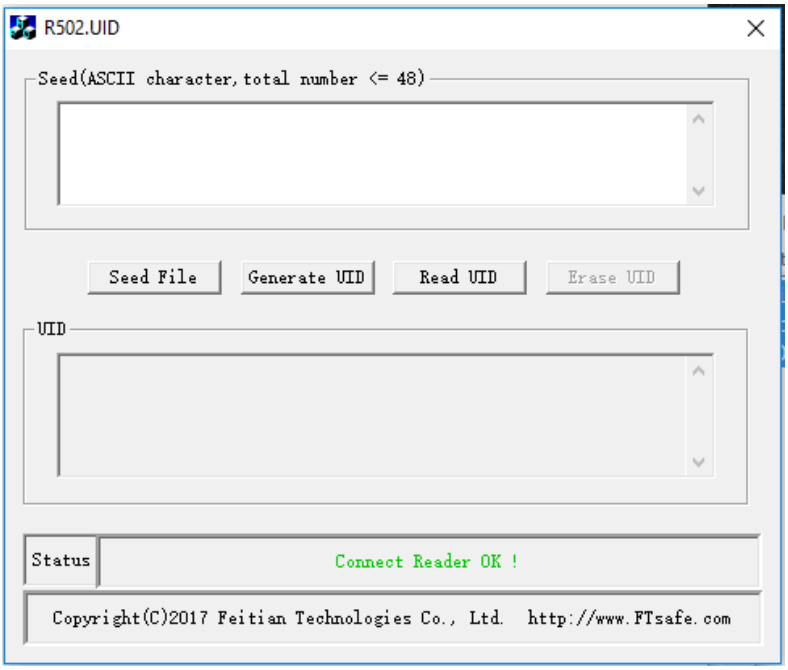
As we motioned before, the UID function using to manager customer brand and encrypted firmware. If you don't want your reader using by others, you can write your private seed and get UID, bind your UID with your application to make the application only detect this UID after then can using reader, if the UID is not your specific UID, then refuse it.

This tool show user read/write/erase UID, the UID generated by private algorithm through the seed. the default UID is 16xFF, before input your seed, please don't forget it. If you forgot the seed or lost the seed, without exist seed, you cannot change others and erase it.

On other hand, we provide read/write/erase APDU and sample code allow using to do bind in mobile and PC platform. For such document, please contact Feitian and sign NDA to get it.

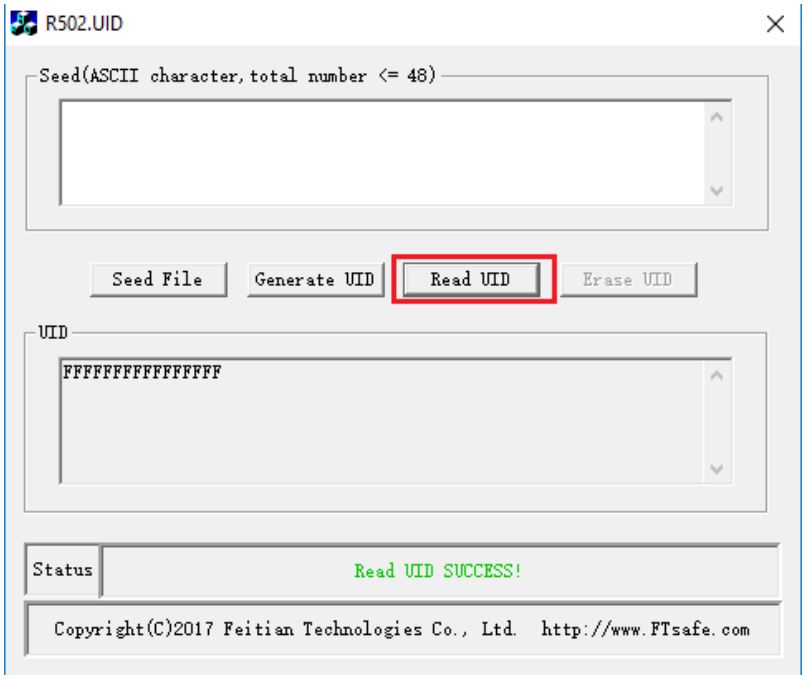
5.2 The operation of UID tool

Step #1: Please keep the related file in same directory, and using administrator to running R502.UID.exe, if you are first using this tool, you will need re-plug reader. See below:



Step #2: re-plug reader and using administrator to run the tool again. And start to do operation. The tool provide three function, we will do introduction later.

- ➔ Seed File (can choose your seed code from a file)
- ➔ Generate UID
- ➔ Read UID

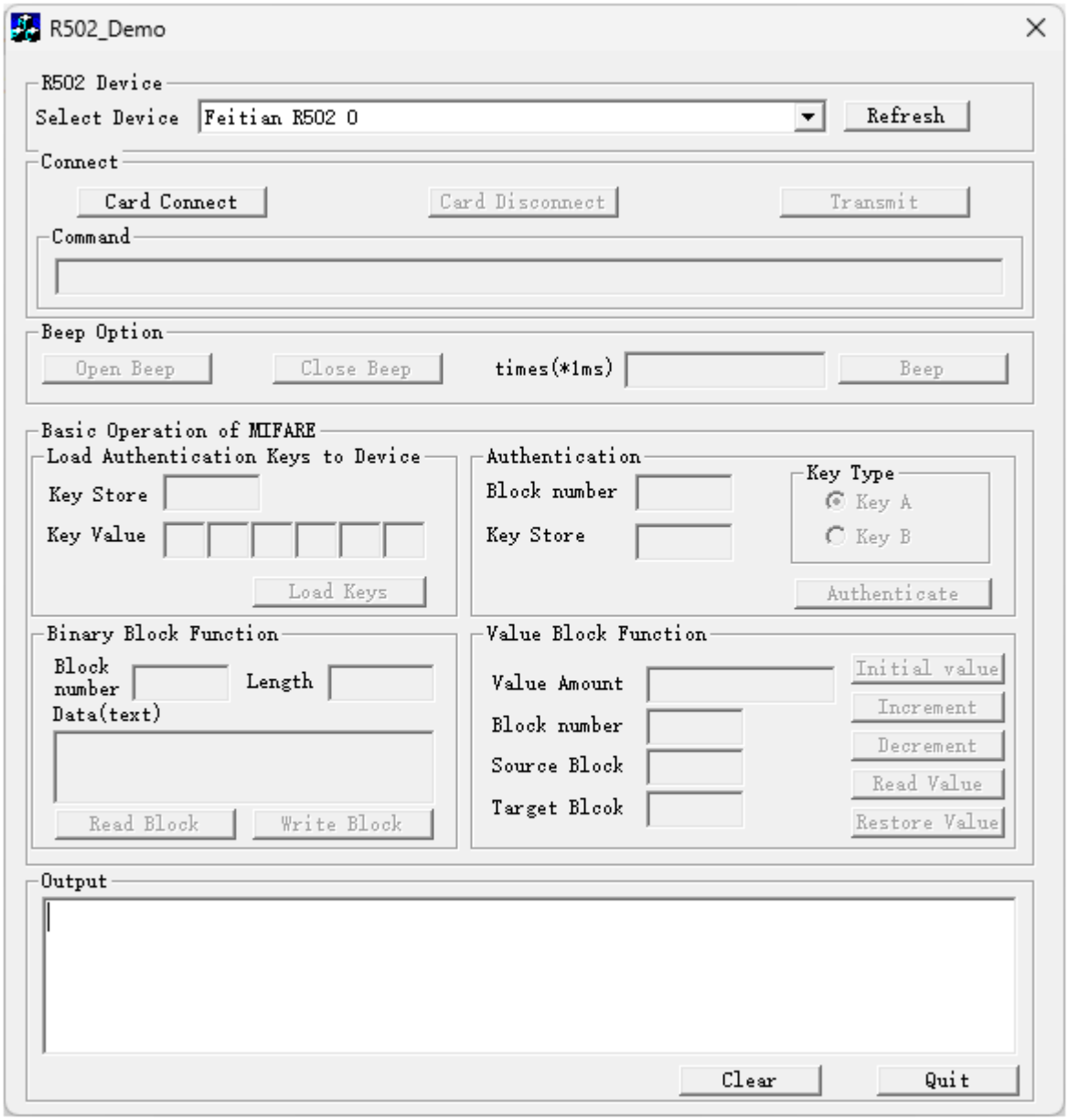


6.0 R502 CARD READER DEMO TOOL

6.1 Introduction of Demo Tool

The Demo Application provides users a graphic interface to manipulate smart cards and readers. User can send APDU to specific smart card and reader and then observe the output information from smart card or smart card reader. It is easy to operate the smart card or smart card reader, which is extremely useful in practice. Before applying this demo to the smart card reader, please make sure the smart card reader is properly installed at first or the application will not work well.

The Demo dialogue mainly includes the following controls: Select Device, Connect, Beep Option, Basic Operation of Mifare one and Output (as shown in the following picture).



6.2 Select Device

In order to meet the different requirements of users and markets, this demo software will provide three options for users: Feitian R502 Reader 0. Before selecting this option, please make certain that the smart card reader and PC are under the status of connection. Then please open the demo application software, click “refresh” button and select the reader’s name in the drop-down menu.

6.3 Connect

a) Card Connect
You need to select the reader’s name and specific card before connecting the smart card reader. If there is no smart card in the reader, the reader will fail to connect the smart card. When a smart card is connected successfully, the “ATR” of the smart card will be displayed in the output field.

b) Card Disconnect
This command will terminate an open connection by sending the SCardDisconnect.

c) Command
This field can be used to specify application commands, which will be sent to a connected smart card. It will be executed by clicking the transmission button, once the command has been specified.

d) Transmit
This command uses the service SCardTransmit to send a command to the smart card, which has been specified, in the command field. Please input the APDU in the command field and click on the button of Transmit. As a result, the APDU of the response will be displayed in the Output field.

6.4 Beep Option

3. Beep Option
This software, which can provide users with secondary development, does not support this function at present. You can achieve the following operations if this option is developed.
a) Open Beep
When clicking the button, the reader’s buzzer does not stop sounding until you click “Close Beep”.

b) Close Beep
This command terminates an open buzzer service. If you do not want the reader buzzer sound frequently, please click this button.

c) Beep
This command can set the buzzer according to the custom time of its user. Please input the time in the textbox. If the time textbox is empty, the output dialog will appear “Please input Beep time!”

Note: The R502 disable Beep feature by default, if you need, please contact world.support@ftsafe.com to have support.

6.5 Basic Operation of MIFARE

a) Load Keys
Load keys command loads a Mifare one card key and stores it in the reader's memory, thus preparing the reader for subsequent card authentication. Mifare one smart card reader can only store one key at a time.

b) Authentication
The Authenticate command authenticates the card of the selected page by the reader system. For the authentication of Mifare one, this command requires previous Load Keys.

c) Read Block
The Read command can read a specific block. For the Mifare one card, only sixteen bytes can read at a time.

d) Write Block
Input the block number and the specific data you want and then click the button. For the Mifare one card, only sixteen bytes can be write at a time.

e) Initial value
If you want some data to be increase or decrease or restored, you have to initialize the data block.

f) Increment
This command can add a data value to a block. User should input the block number and data value in the textbox or output dialog will appear "Input Block number, Please!" or "Input data Value, Please!".

g) Decrement
This command can decrease the data value of a block. Users should input block number and data value in the textbox or output dialog will appear "Input Block number, Please!" or "Input data Value, Please!".

h) Read Value
The read value command reads one memory value. Please input the block number or output dialog will appear "Input Block number, Please!"

i) Restore value
The restore value command can transfer the contents of a data block into the data register.

6.6 Output Field

As the various responses to the different commands, the response messages brought by the reader and the smart card will be show here.

a) Output Field-Clearing: This command clear out the whole information appeared in the output field.

b) Quit: This command ends the demo application program.

7.0 DRIVER

The R502 is CCID standard reader, after windows XP, Microsoft has integrated CCID driver in system by default, if your system is Windows 2000 or Windows XP, please download driver from:
http://download.ftsafe.com/files/reader/CCID_driver_on_Windows2000+.zip

For Linux:
* Please refer to http://pcsclite.alioth.debian.org/ccid/shouldwork.html
Install CCID driver on your Linux, follow http://pcsclite.alioth.debian.org/ccid.html#download

For Mac OS X 10.5 - 10.10:
* The Mac OS X already integrated FEITIAN R502 support, you just plug-in and using. Also you can build CCID driver by yourself on MAC OS X, check:
https://pcsclite.apdu.fr/ and https://blog.apdu.fr/posts/2014/03/level-1-smart-card-support-on-mac-os-x/

Buy samples, please access https://www.ftsafe.com/store/

8.0 OEM ITEMS

1. **Case Customization**
   Feitian can provide AI file of the casing, and customer can based on our AI put their logo on casing or provide logo with AI file, Feitian help do it.

   Customization options: Silk-Printing

2. **Packaging Customization**
   A: using Feitian packaging directly
   B: Customer give idea, Feitian charging OEM fee to do OEM packaging for customer

3. **Firmware Customization Information**
   PC/Android smart card reader:
   Manufacturer name: XXXX
   Reader name: XXXX
   Firmware version: XXXX
   UID (User ID): FFFFFFFFFFFFFFFF (The default UID is all FF, user can do OEM, the UID function introduction: http://javacardos.com/javacardforum/viewtopic.php?f=19&t=811)

9.0 FAQ

Q：How to develop application based on Feitian R301/R502/IR301/BR301 reader on PC?
A: The SDK based on PCSC API implement, we provide demo source code to reference and guidance customer how to call our APIs.
Also possible check: https://ludovicrousseau.blogspot.jp/2010/04/pcsc-sample-in-different-languages.html

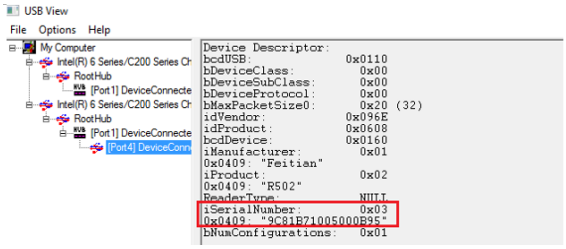
Q: Why there is no "found new hardware" popup window when I attach a R502 reader?
Symptom: After attached R502 reader, there is no "found new hardware" popup window.
A: Right click "My Computer" -> "Device Manager" -> "Smart card readers", right click "update driver", need open your system update.

Q: Red light is off
Symptom: The device light is off. The device may not be correctly connected.
A: Re-attach the device, check the USB connection or using bus hound to capture data for us to do check.
http://perisoft.net/bushound/

Q: Red light is flashing when no card is in card reader
Symptom: The device is broken.
A: Return this device to manufacturer for repairing.

Q: Blue light is flashing when a card is inserted in the card reader
Symptom: Blue light is flashing when a card is inserted in the card reader. The card is unusable.
A: Insert the card again with another side;
The card is not compatible with the ISO-7816 (e.g., timeout, byte intervals);
The card is not compatible with the power supply.
The output current of the card is too weak to be recognized by the card reader.
The card is damaged.
The device is damaged and need to be return to manufacturer.

Q: How to check SN from usb description?
A: You can using USBViewer to do check, the code also opened by Microsoft, check from below:
When you run USBViewer, the tool will need authorize to change register in register.
So when you run USBViewer at first time, you need plug-in two times.
The tool can run on Windows system, the source code can found from
https://github.com/Microsoft/Windows-driver-samples/tree/master/usb/usbview
Below just show you the SN from USB card reader:



We also have a demo app for read SN, check
https://github.com/FeitianSmartcardReader/R301/tree/master/Sample%20Code/GetR301E2SN

10.0 APPENDIX ABBREVIATION

CE Attestation of Conformity

The equipment complies with the principal protection requirement of the EMC Directive (Directive 89/336/EEC relating to electromagnetic compatibility) based on a voluntary test.

This attestation applies only to the particular sample of the product and its technical documentation provided for testing and certification.

After preparation of the necessary technical documentation as well as the conformity declaration the CE marking as shown below can be affixed on the equipment as stipulated in Article 10.1 of the Directive. Other relevant Directives have to be observed.

FCC certificate of approval

This Device is conformance with Part 15 of the FCC Rules and Regulations for Information Technology Equipment.

WEEE

Dispose in separate collection.

RoHS

FCC Statement

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

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

(1) This device may not cause harmful interference, and

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

Note : This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates,uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
—Reorient or relocate the receiving antenna
—Increase the separation between the equipment and receiver.
—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
—Consult the dealer or an experienced radio/TV technician for help

RF Exposure Statement：
The device has been evaluated to meet general RF exposure requirment. The device can be used in portable exposure condition without restriction.