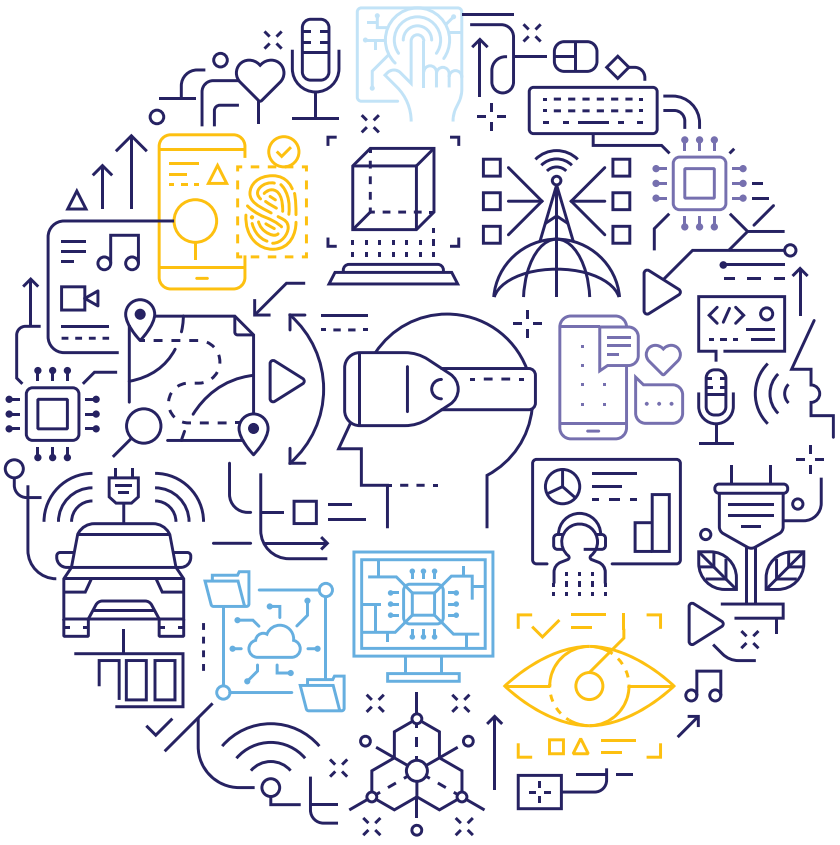
USER MANUAL

RA12 Mini Reader

Rev 3.0 (11, 2020)

This document descripts how to use RA12 Mini Reader with command line for exploring various features of RA12



Revision History

Revision	Date	Description
1.0	Nov 2018	1st Release
1.1	Dec 2018	Edit card detection mode
2.0	Feb 2019	Adding new revision RA12 demonstrate kit and description in part 1, 2.3 and 3.7 and rewriting part 5
2.1	Mar 2019	- Revise document content - Update connection diagram - Add information for important figure
2.2	Mar 2019	- Correct Footer version - Correct content in section **Error! Reference source not found.**
2.3	Oct 2019	- Revise read and write command - Add table of table
2.4	July 2020	- Add terminal software download and installation
3.0	Nov 2020	Revise document template

The information herein is for product information purposes. While the contents in this publication have been carefully checked; no responsibility, however, is assumed for inaccuracies. Silicon Craft Technology PLC. reserves the right to make changes to the products contained in this publication to improve design, performance, or reliability.

Contents

List of Figures

List of Tables

1. Introduction

RA12 is a single chip reader IC for 13.56MHz RFID/contactless standard protocols including ISO14443A/B, ISO15693. The RA12 contains efficient power saving modes: hard power down, soft power down, standby and low-power card detection. The low-power card detection mode allows the chip to not operate at full power continuously. The chip periodically senses the external card and send interrupt signal MCU when external card is sensed.

Silicon Craft Technology PLC. (SIC) creates this document to describe how to use RA12 Mini Reader for trial and evaluation. RA12 Mini Reader consists of RA12 module with antenna 30x30 mm and STM8L MCU Module with UART connection.

Figure 1-1 RA12 Mini Reader

2. Getting Start

Before user can operate RA12 Mini Reader, proper operational environment and the following requirements must be prepared.

2.1. System and Hardware requirements

- Computer : PC with USB Port
- Operating System : Window XP, Window 7, 8, 10
- Software Requirement : Hyper Terminal, Tera Term, Putty, MobaXterm, etc.
- Others : ISO14443A/B or ISO15693 Card or Tag.

2.2. Software Setup

2.2.1. Serial Communication Configuration

To communicate with the reader, user must establish a serial connection. The setting below is to config the serial session to match the reader communication configuration.

- Serial Port : Select COM Port which match to USB to UART converter
- Baud Rate : 115200 bps
- Data : 8 bits
- Parity bit : None
- Stop bit : 1 bit

2.2.2. Terminal Software (MobaXterm)

To interact with the reader, a terminal software is needed. Generally, any terminal software is compatible. However, we will use MobaXterm as an example terminal software to communicate with the reader in this case.

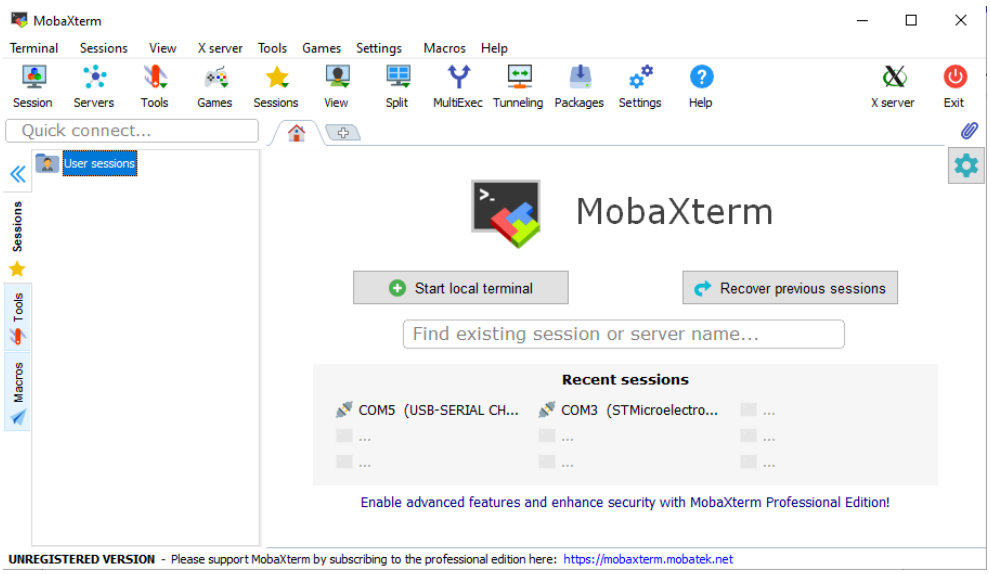


Figure 2-1 MobaXterm

2.2.3. Downloading and Installing MobaXterm

1. To download MobaXterm, please go to this url: https://mobaxterm.mobatek.net/ then, click the tab "Download" as shown in **Figure 2-2.**

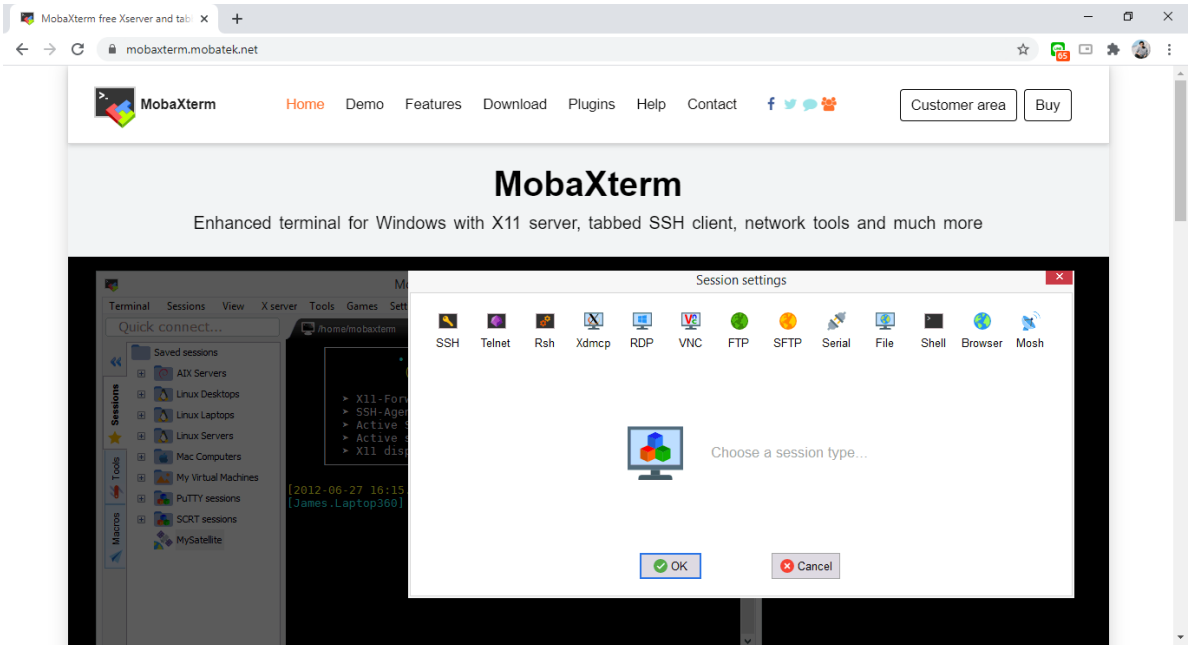


Figure 2-2 MobaXterm Website

2. At download page, click at "Download now" to go to home edition download page as shown in **Figure 2-3**.

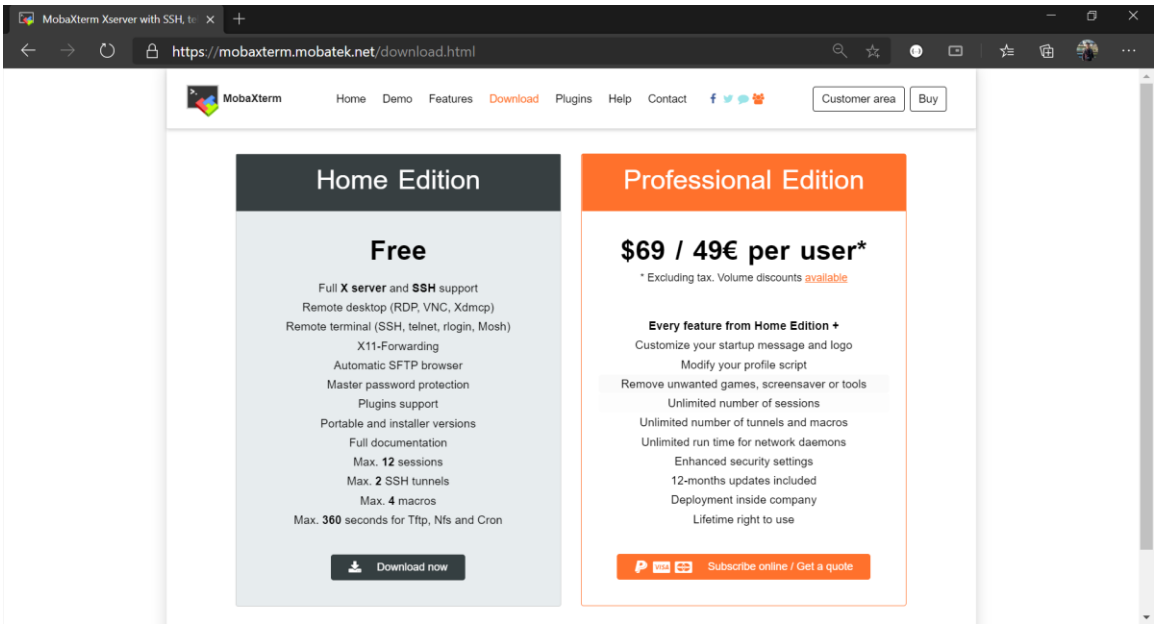


Figure 2-3 MobaXterm Download Page

3. At Home Edition download page, click at "MobaXterm Home Edition v20.2 (Installer Edition)" to download the installer as shown in **Figure 2-4**.

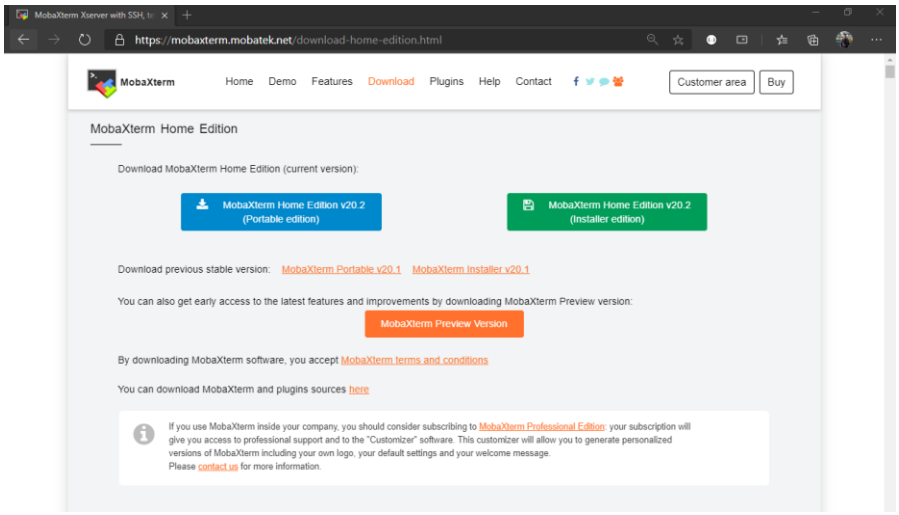


Figure 2-4 MobaXterm Home Edition Download Page

4. When the download is completed, extract the installer.
5. Inside the extracted folder, double click at "MobaXterm_installer_20.2.msi" to begin installation.
6. The installation window will pop up, click "Next" as shown in **Figure 2-5**.

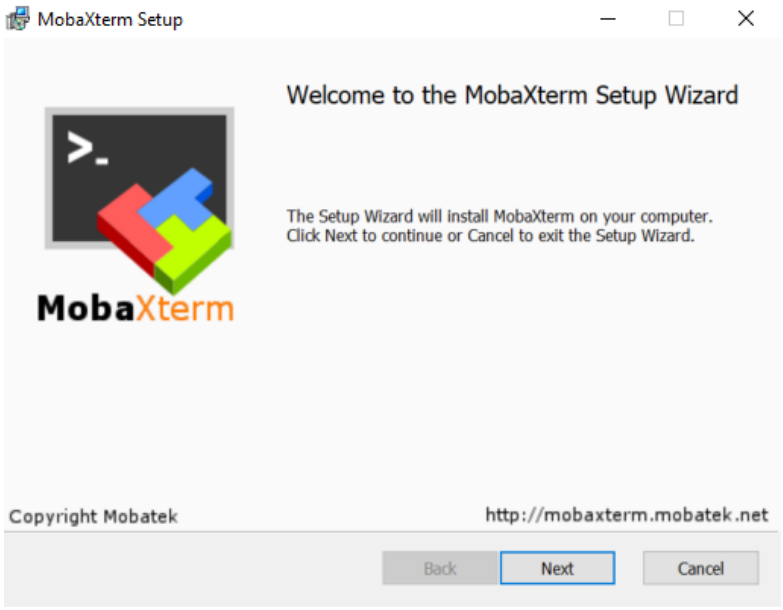


Figure 2-5 MobaXterm Installation Window

7. At End-User License Agreement page, "**check**" the accept box and then click "**Next**".
8. The window will prompt the user to choose the installation folder. Choose your path where you want to install the program then click "**Next**".
9. Click "**Install**" to begin installation.
10. Click "**Finish**" when the installation is completed.

2.2.4. Connecting with PC

In order to communicate with the reader, a serial connection must be initialized. The steps below describe how to properly connect the reader with a PC.

1. Connect the reader to PC using a micro USB cable.
2. Open MobaXterm.
3. On the menu bar at the top left of the program, click at "Session" to create a new session.

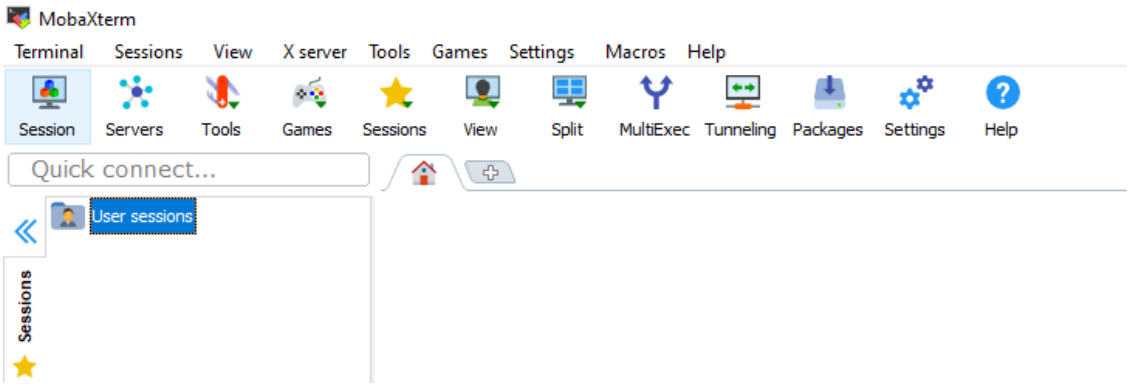


Figure 2-6 MobaXterm Create new session

4. The program will pop up a new window called "**Session settings**", click on "**Serial**" to set up a new serial monitor.

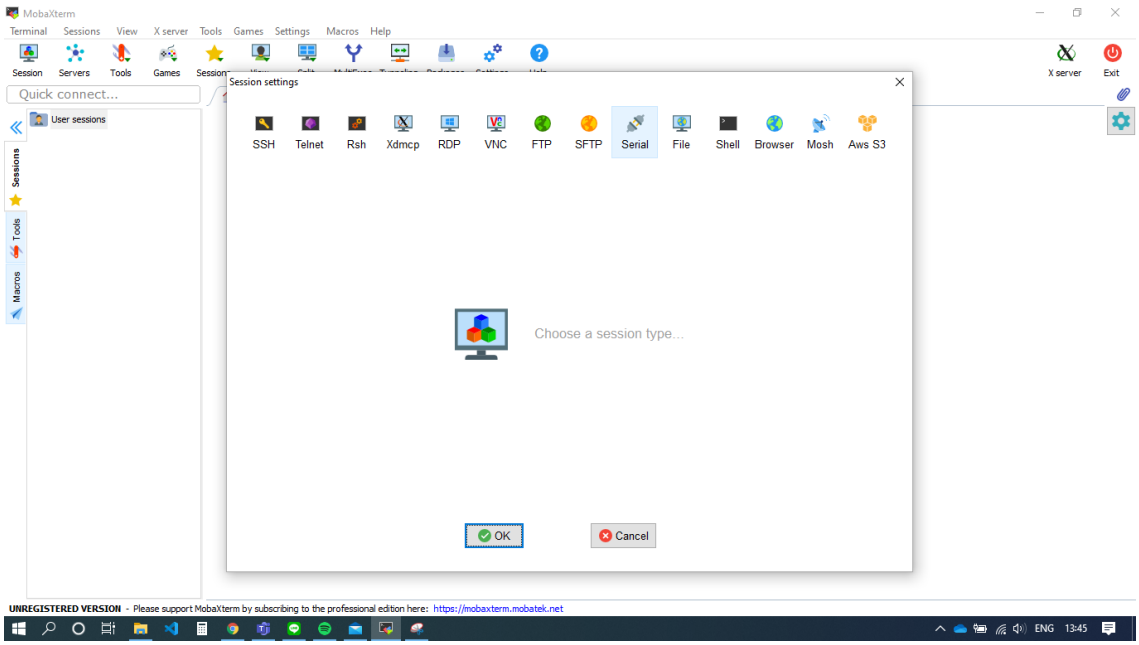


Figure 2-7 Sesstion setting

5. Under the tab "**Basic Serial settings**", click at the drop-down menu "**Serial port**" to select a port to connect. If the reader is already connected with the PC then the correspondent port number should be automatically shown up here. Otherwise, try restarting MobaXterm.

6. Click at the drop-down menu "**Speed (bps)**", select "**115200**" and then click OK to start session.

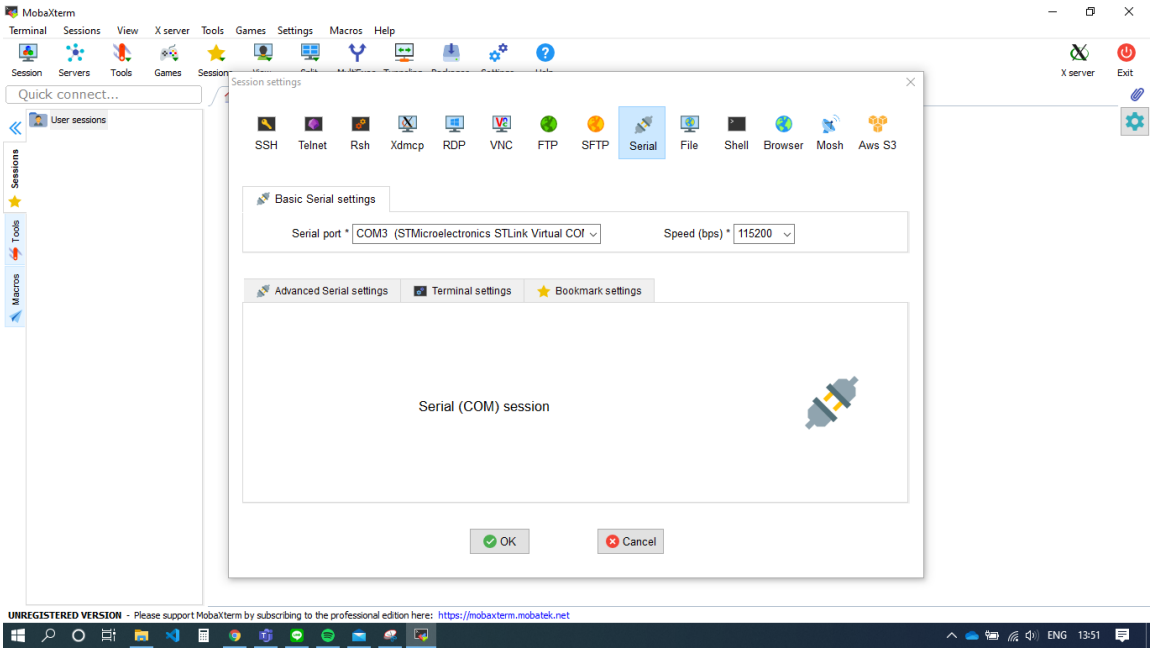


Figure 2-8 Basic Serial Setting

7. Consequently, a new session is shown. Press enter to trigger SIC Command Line interface.

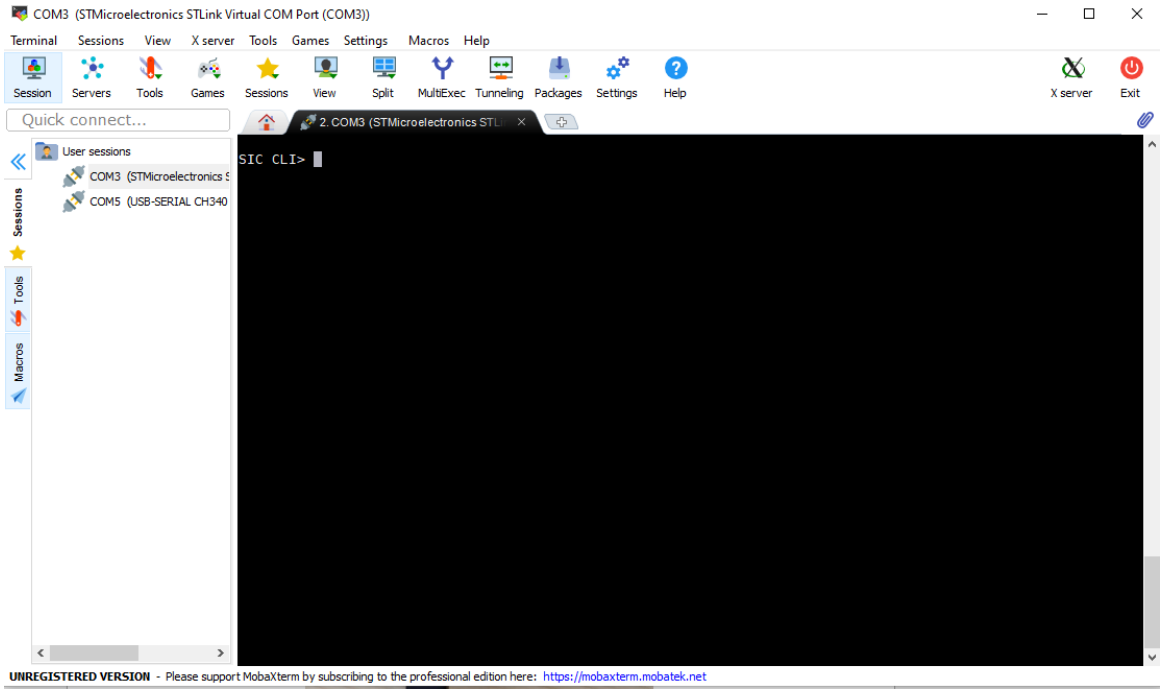


Figure 2-9 Successfully Created Serial Session

2.3. Hardware Setup

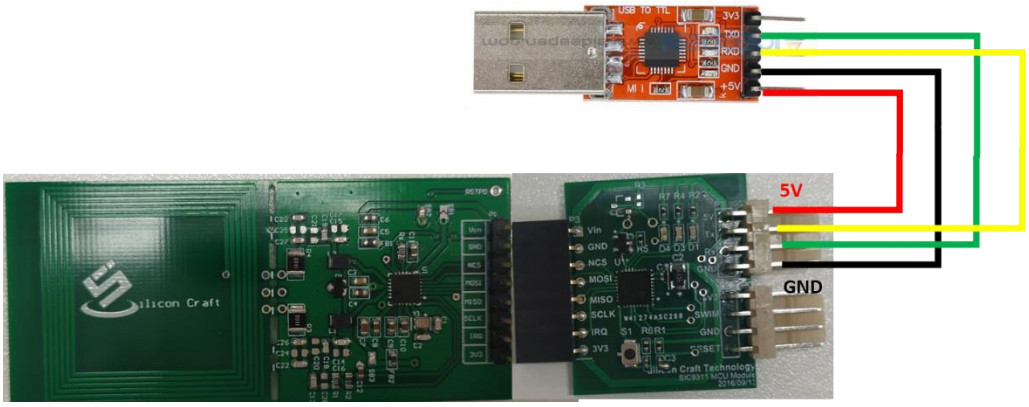


Figure 2-10 RA12 Mini Reader Connection

Refer to **Figure 2-10**, please follow setting below steps:

1. Connects RA12 Mini Reader via UART pin by using USB to UART module and then connect USB to PC.
2. Open software and set up according to section 2.2.4

3. Command Line

RA12 Mini Reader communicates with user through command line via serial communication. There are 2 groups of command line including as explain below.

3.1. Basic Command

Basic commands are the command operating specific purpose. There are 4 commands including.

3.1.1. Help

This command is used for showing all available commands.

```
SIC CLI> help
CMD: help,   DESC: List available commands
CMD: info,   DESC: Print out device informations
CMD: read,   DESC: Read data at a given address
CMD: write,  DESC: Write data at a given address
CMD: config,DESC: Configure reader for a tag type communication
CMD: scan,   DESC: Read Tag's UID (ISO1443A, ISO14443B, ISO15693)
CMD: lowpwr,DESC: Set MCU to low power mode
CMD: cd,     DESC: Set RA12 to cd mode
CMD: wkup,   DESC: Set wake up timer for using with cd mode
OK
```

Figure 3-1 Help Command

3.1.2. Board Information

This command is used for showing the information of the firmware.

```
SIC CLI> info
MCU: STM32F103T8
RA12 revision: 10 (RA12A)
Firmware : version 2.0.1
OK
```

Figure 3-2 Board Information Example

3.1.3. Read Register

This command is used for reading register from RA12. The option of read command is shown below. All inputs and display values are in Hexadecimal.

Table 3-1 Read Register Command

Command	Input Data	Description
read -h	-	Display all options of "read" command.
read -all	-	Read value from all registers in RA12
read	<address (HEX)>	Read a value from a specified register address. Default register address bases on Section 0.
read	-<section no.> <address (HEX)>	Read a value from a specified register address on a specified section address. The section address can be Section 0 (-s0) or Section 1 (-s1).

```
SIC CLI> read 1A
SEC[HEX]: 00
ADDR[HEX]: 1A, VAL[HEX]:28
OK

SIC CLI> read -s1 01
SEC[HEX]: 01
ADDR[HEX]: 01, VAL[HEX]:76
OK

SIC CLI> read -all
SEC[HEX]: 00
ADDR[HEX]: 00, VAL[HEX]:00
ADDR[HEX]: 01, VAL[HEX]:00
ADDR[HEX]: 02, VAL[HEX]:00
ADDR[HEX]: 03, VAL[HEX]:05
ADDR[HEX]: 04, VAL[HEX]:00
ADDR[HEX]: 05, VAL[HEX]:20
ADDR[HEX]: 06, VAL[HEX]:00
ADDR[HEX]: 07, VAL[HEX]:01
ADDR[HEX]: 09, VAL[HEX]:00
ADDR[HEX]: 0A, VAL[HEX]:40
ADDR[HEX]: 0B, VAL[HEX]:00
ADDR[HEX]: 0C, VAL[HEX]:FF
```

Figure 3-3 Read register command

3.1.4. Write Register

This command is used for writing register to RA12 reader. The option of write command is shown below. All inputs and display values are in Hexadecimal.

Table 3-2 Write Register Command

Command	Input Data	Description
write -h	-	Display all options of "write" command.
write	<address (HEX)> <value (HEX)>	Use this command to write a value to a specified register address. Default register address bases on Section 0.
write	-<section no.> <address (HEX)> <value (HEX)>	Use this command to write a value to a specified register on a specified section. The section address can be Section 0 (-s0) or Section 1 (-s1).

```
SIC CLI> write 1A 10
SEC[HEX]: 00
ADDR[HEX]: 1A, WR[HEX]:10
OK

SIC CLI> write -p1 05 00
SEC[HEX]: 01
ADDR[HEX]: 05, WR[HEX]:00
OK

SIC CLI>
```

Figure 3-4 Write register command

3.2. Complex Command

3.2.1. Card Type Configuration

This command initials multiple RA12 registers with pre-configuration value in order to setup RA12 in common use-cases i.e. ISO14443, ISO15693. The option of config command is shown as below.

Table 3-3 Config Command

Command	Input Data	Description
config -h	-	Display all options of "config" command.
config -43a	-	Configure tag type communication on RA12 reader to be ISO14443A.
config -43b	-	Configure tag type communication on RA12 reader to be ISO14443B.
config -15693	-	Configure tag type communication on RA12 reader to be ISO15693.

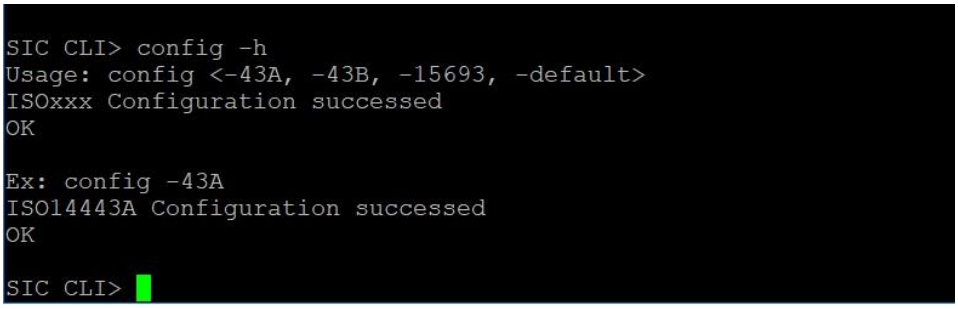


Figure 3-5 Config command example

3.2.2. Get tag UID

This command is used for scanning tag and getting tag UID which depends on card type configuration setting (setting by command 3.2.1 Card Type Configuration). The option of scan command is shown as below.

Table 3-4 Scan Command

Command	Input Data	Description
scan -h	-	Display all options of "scan" command.
scan	-	Use for scanning tag once time. The scanning mode (ISO1443A/B or ISO15693) depends on recent card type configuration of command. The default mode is ISO14443A.
scan -l	-	Use for scanning tag by using loop scanning. User can exit scanning loop by press any key on the keyboard. The scanning mode (ISO1443A/B or ISO15693) depends on recent card type configuration of command. The default mode is ISO14443A similar to **scan** command.

```
SIC CLI> scan -h
Usage: -scan
       -scan -l : Scan Tag's UID by looping
NOTE: Press any key for breaking loop.

Ex: scan
UID> 39020000xxxx
OK

SIC CLI>
```

Figure 3-6 Scan command example

3.2.3. Card Detection mode

RA12 includes card detection feature which periodically transmits short RF pulse to check the existing tag near antenna. In case the card has been detected by RA12, it will send interrupt signal to the MCU to proceed the following action. This operation scheme significantly reduces power consumption of the overall system.

RA12 supports two wake-up behaviors during low power card detection mode as shown in **Figure 3-7** including

- RA12 remains in sleeping after IRQ of card detection is set to high.
- RA12 wake up after IRQ of card detection is set to high.

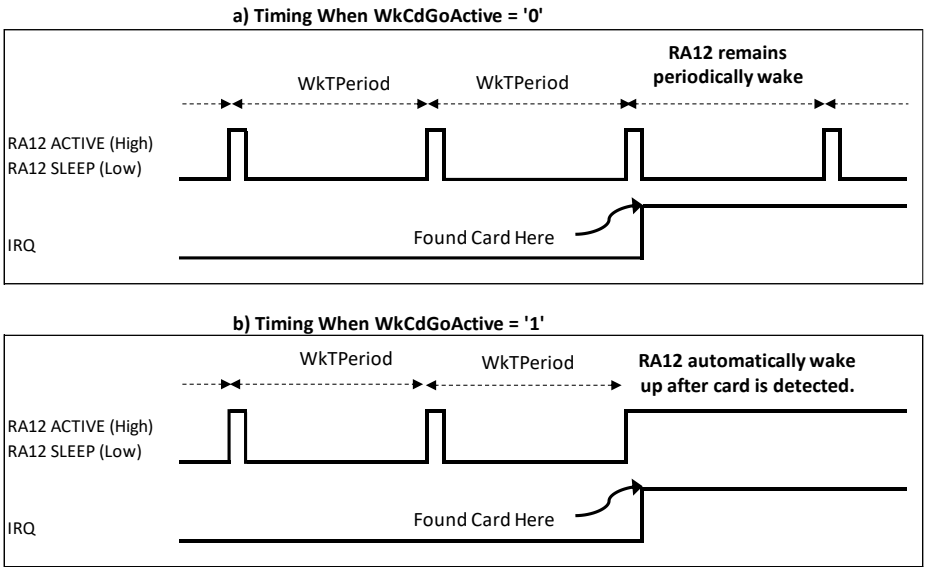


Figure 3-7 RA12 Wake-up Behavior

To demonstrate both behaviors of RA12 card detection, the available options related card detection mode are listed below. The example how to execute card detection command is shown in **Figure 3-8**.

Table 3-5 Card Detection Command

Command	Input Data	Description
cd -h	-	Display all options of "cd (card detection)" command.
cd -cal	-	Use for scanning tag once time. The scanning mode (ISO1443A/B or ISO15693) depends on recent card type configuration of command. The default mode is ISO14443A. Calibrate threshold of card detection.
cd -c	-	Use for scanning tag by using loop scanning. User can exit scanning loop by press any key on the keyboard. The scanning mode (ISO1443A/B or ISO15693) depends on recent card type configuration of command. The default mode is ISO14443A similar to **scan** command. Enter RA12 Mini Reader to cd mode with "WkCdGoActive = 1". RA12 wake up after the detection of RF field changes and MCU will try to get tag UID automatically after receive interrupt signal from RA12.
cd -w	-	Enter RA12 Mini Reader to cd mode with "WkCdGoActive = 0". RA12 only send interrupt signal to MCU after found RF field change. MCU will wait for user key input to continue.

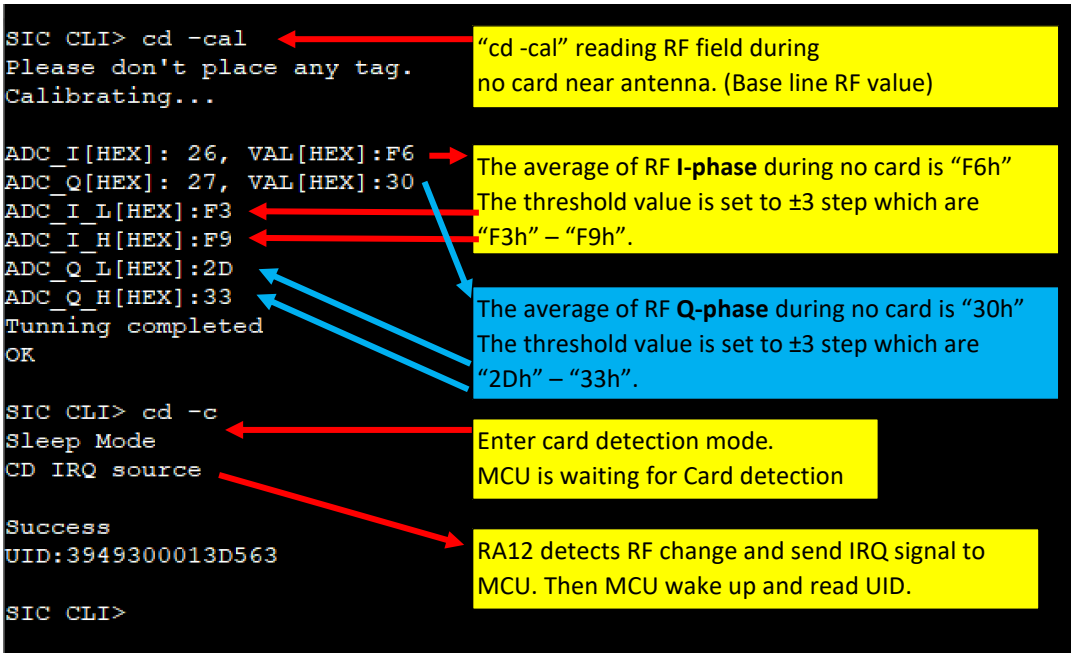


Figure 3-8 Example of execute card detection mode

3.2.4. Wake up Timer Setting

This command defines RA12 card detection frequency by define RA12 internal timer period. There are two register values to set including 1) Prescaler register (WkTPrescaler) and 2) Reload register (WkTReloadValue) as explain in equation (1).

$$WKUP\ Period = \frac{(m \times 2^n)}{16.38\ kHz} \quad (1)$$

n : Wake up timer prescaler (WkTPrescaler)
m : Wake up timer reload. (WkTReloadValue)

The commands to control the operation of wake up timer are shown in the following and the example of these commands are shown in **Figure 3-9**.

Table 3-6 Wake up timer setup command

Command	Input Data	Description
wkup -h	-	Display all options of "wkup" command.
wkup -prescaler	-	Write Prescaler register (WkTPrescaler)
wkup -reload	-	Write Reload register (*WkTReloadValue*) .
wkup -default	-	Configure wake up timer to default value (500ms)

```
SIC CLI> wkup -h
Usage: -wkup -prescaler <00 - 0F>
       -wkup -reload <01 - FF>
       -wkup -default
NOTE: Default of WKUP timer period
      is 500 ms.
Eq: TWkUp_Period = ((2^n) x m)/16.38kHz
    n : Prescaler
    m : Reload

Ex: wkup -prescaler 0A
    Prescaler is 0A (HEX)
    OK

SIC CLI> wkup -reload 0B
Reload is 0B (HEX)
OK
SIC CLI> wkup -prescaler 08
Prescaler is 08 (HEX)
OK
SIC CLI>
```

Figure 3-9 Using "wkup" command to set register in RA12 card detection period

3.2.5. Set up low power mode

This command defines MCU operation during card detection mode. User can select from Sleep mode (4 mA – 7 mA), Stop mode (11.7 µA) and Normal/Run mode (normal operating current).

The command to specify these power modes to MCU are shown in the following and the example of this command is shown in **Figure 3-10**.

Table 3-7 Setup low power command

Command	Input Data	Description
lowpwr -h	-	Display all options of "lowpwr" command.
lowpwr -sleep	-	Define MCU to enter Sleep mode during card detection command
lowpwr -stop	-	Define MCU to enter Stop mode during card detection command
lowpwr -none	-	Define MCU to Run normally during card detection command

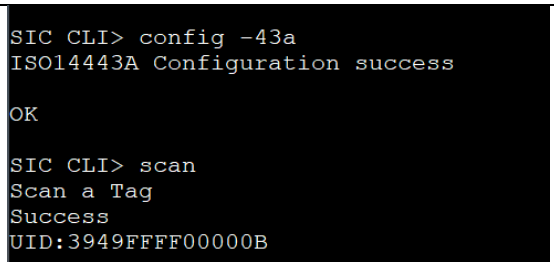
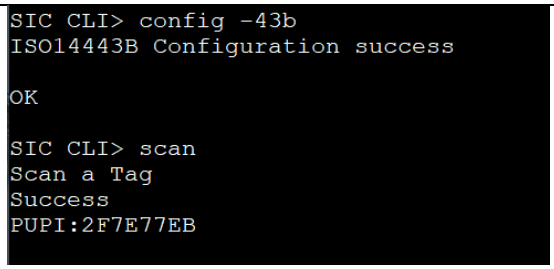
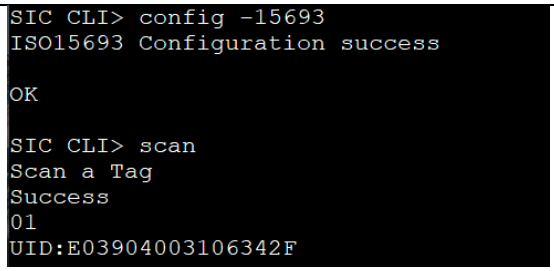
```
SIC CLI> lowpwr -h
Usage: -lowpwr -sleep : MCU will go to sleep mode
                        after execute RA12 to CD mode.
       -lowpwr -stop  : MCU will go to stop mode
                        after execute RA12 to CD mode.
       -lowpwr -none  : MCU won't go to low power mode

Ex: lowpwr -sleep
    MCU sleep mode
    OK

SIC CLI> lowpwr -stop
MCU Low power mode : stop mode
OK

SIC CLI>
```

Figure 3-10 Using "lowpwr" command to define MCU operation during card detection mode

4. Example Use Case

4.1. Scan Tag UID

The following section shown how to enter scan tag UID in various card type.

Scan ISO 14443A Tag UID	 Figure 4-1 Scan ISO14443A Tag
Scan ISO 14443B Tag PUPI	 Figure 4-2 Scan ISO 14443B Tag
Scan ISO 15693 Tag UID	 Figure 4-3 Scan ISO 15693 Tag

4.2. Use Card Detection

The following section shown the step to enter card detection mode according to tag type.

1. Configure tag type:
   a. Using command "config -43a"

```
SIC CLI> config -43a
ISO14443A Configuration successed

OK

SIC CLI> scan
Scan a Tag
Success
UID:39020000007A9A
```

Figure 4-4 Configure Tag Type A

2. Calibrate threshold:
   a. Keep NFC tag/card or metal away from antenna area.
   b. Using command "cd –cal" to measure baseline value.

```
SIC CLI> cd -cal
Please don't place any tag.
Calibrating...

ADC_I[HEX]: 26, VAL[HEX]:B5
ADC_Q[HEX]: 27, VAL[HEX]:8A
ADC_I_L[HEX]:B2
ADC_I_H[HEX]:B8
ADC_Q_L[HEX]:87
ADC_Q_H[HEX]:8D
Tunning completed
OK
```

Figure 4-5 Calibrate card detection threshold

3. Enter to card detection mode:
   a. Using command "cd –c" to enter card detection mode. MCU will enter lower mode as well.
   b. Tap a card to antenna area. As show in Figure 4-5, the IRQ will occur which makes MCU wakes up to reads tag UID.

```
SIC CLI> cd -c
Sleep Mode
CD IRQ source

Success
UID:39020000007A9A
```

Figure 4-6 Enter card detection mode

5. Card Detection Manually

Instead of entering RA12 card detection mode using Card detection Mode command explained in section 3.2.3, manual step to enter card detection mode is also available. The following section explain how to enter card detection mode manually which will lead to more understanding in RA12 card detection operation.

1. **Calibrate threshold of card detection mode**: There are 2 options to set up RF detection threshold. First, user can use "cd -cal" command to reading RF field during no card near antenna as explain in section 3.2.3. In the other way, user can manually set threshold value to registers in the following table.

Table 5-1 The RF threshold register

Register Name	Section	Address	Length	Definitions
CDThreshold_I_L	0	0x34	8 bits	Low side threshold for I phase
CDThreshold_I_H	0	0x35	8 bits	High side threshold for I phase
CDThreshold_Q_L	0	0x36	8 bits	Low side threshold for Q phase
CDThreshold_Q_H	0	0x37	8 bits	High side threshold for Q phase

2. Setup interrupt event when card is detected at register **Interrupt Enable** by set bit SetIEN and CDIEN to 1b.

Table 5-2 Interrupt Enable register

Register Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Interrupt Enable (0x06)	SetIEN	CDIEN						

3. **Setup wake up period**: In card detection mode, RA12 wakes up periodically base on 2 registers, **WkTPrescaler** and **WkTReloadValue**. The period is defined by equation 1 (in section 3.2.4).

Table 5-3 The Wake up time register

Register Name	Section	Address	Length	Definitions
WkTPrescaler	0	0x2D	4 bits (3:0)	Wake up prescaler register
WkTReloadValue	0	0x2E	8 bits	Wake up reload register

4. Set RA12 to wake up even during Field Detection (i.e. other mobile phone or HF reader come close to antenna) by set **WkIgnoreFD** to 1b.

Table 5-4 CDControl register

Register Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CDControl (0x31)		WkIgnoreFD						

5. Prepare RA12 Wake Up timer counting operation at **WkTimerControl**
   a. Start timer by set **WkTStartNow** to 1b.
   b. Set wake up auto restart by set **WkAutoRestart** to 1b.

Table 5-5 WkTimerControl register

Register Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
WkTimerControl (0x2D)	WkTStartNow			WkAutoRestart				

6. Set RA12 to enter wake up card detection mode by set **WkUpCD** to 1b.

Table 5-6 Control register

Register Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Control (0x09)		WkUpCD						

For more information please refer to: PD-FM-51-PDTS-RA12-R0.1-20181128.pdf

Error! Reference source not found. and Error! Reference source not found. are shown step of input to enter card detection mode.

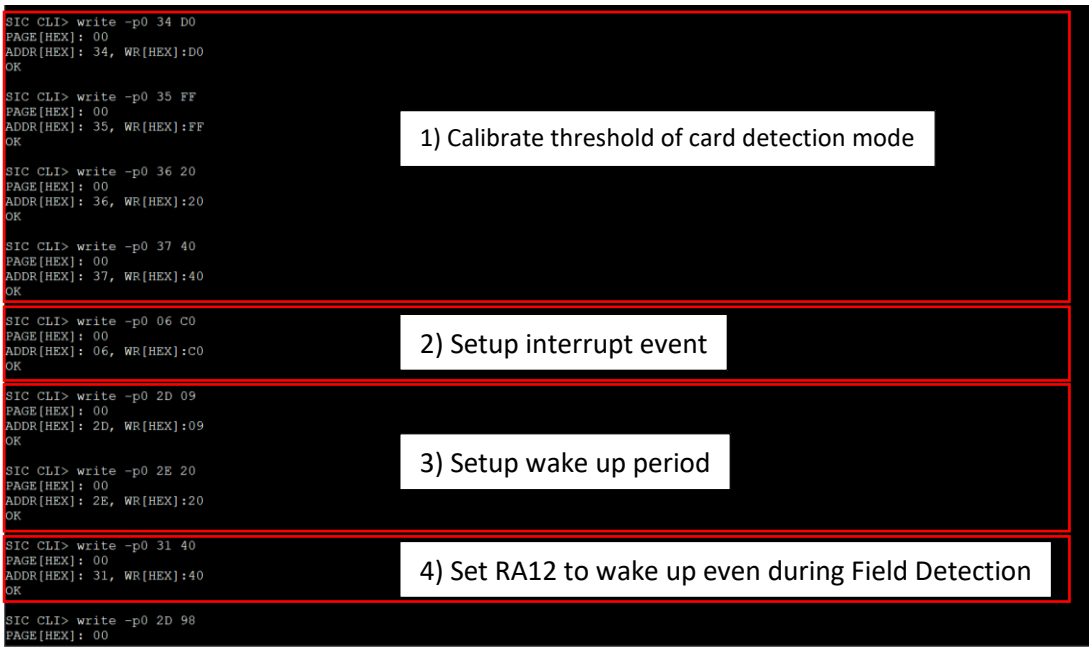
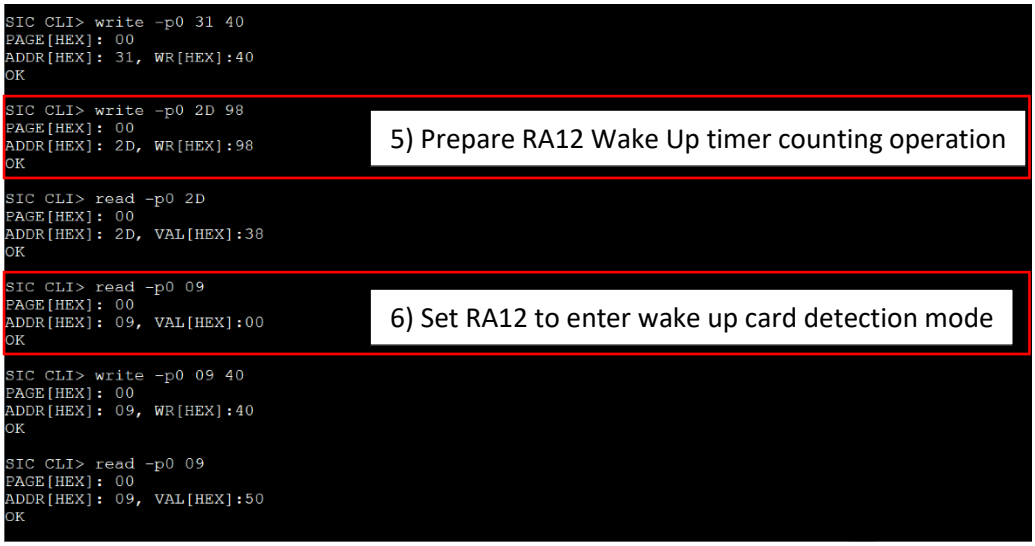


Figure 5-1 Setup to enter card detection mode (1/2)



Error! Reference source not found. Step to enter card detection mode (2/2)

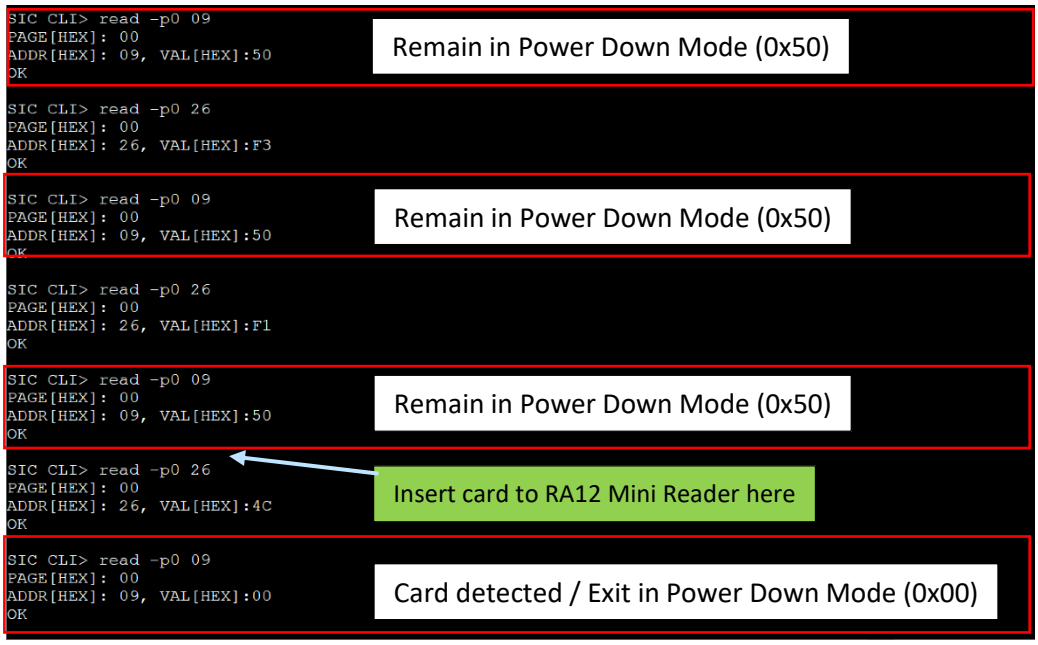


Figure 5-2 Step to confirm card detection mode entering and exit

6. Schematic

6.1. RA12 Module

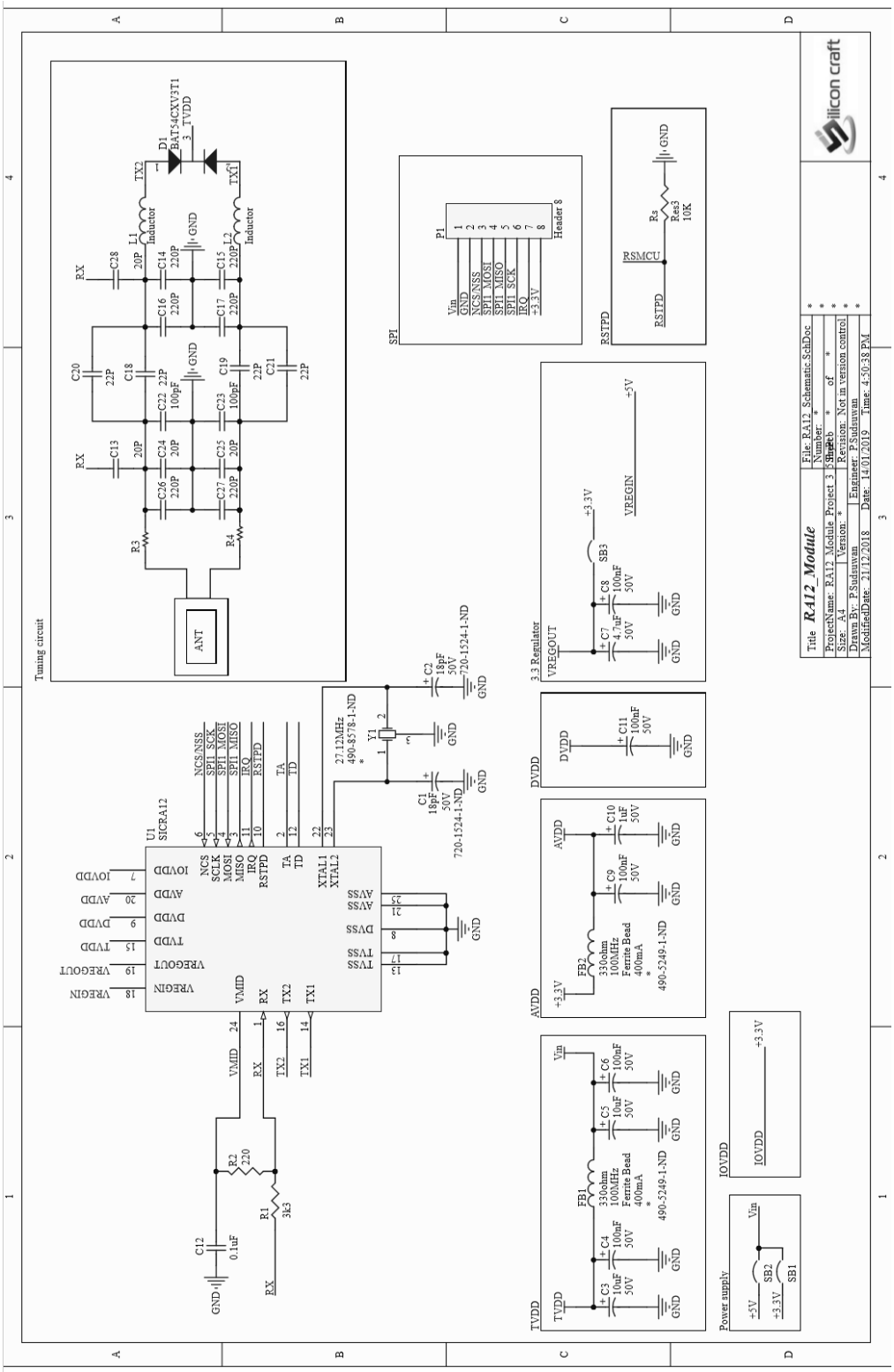


Figure 6-1 RA12 Module Schematic

6.2. MCU Module

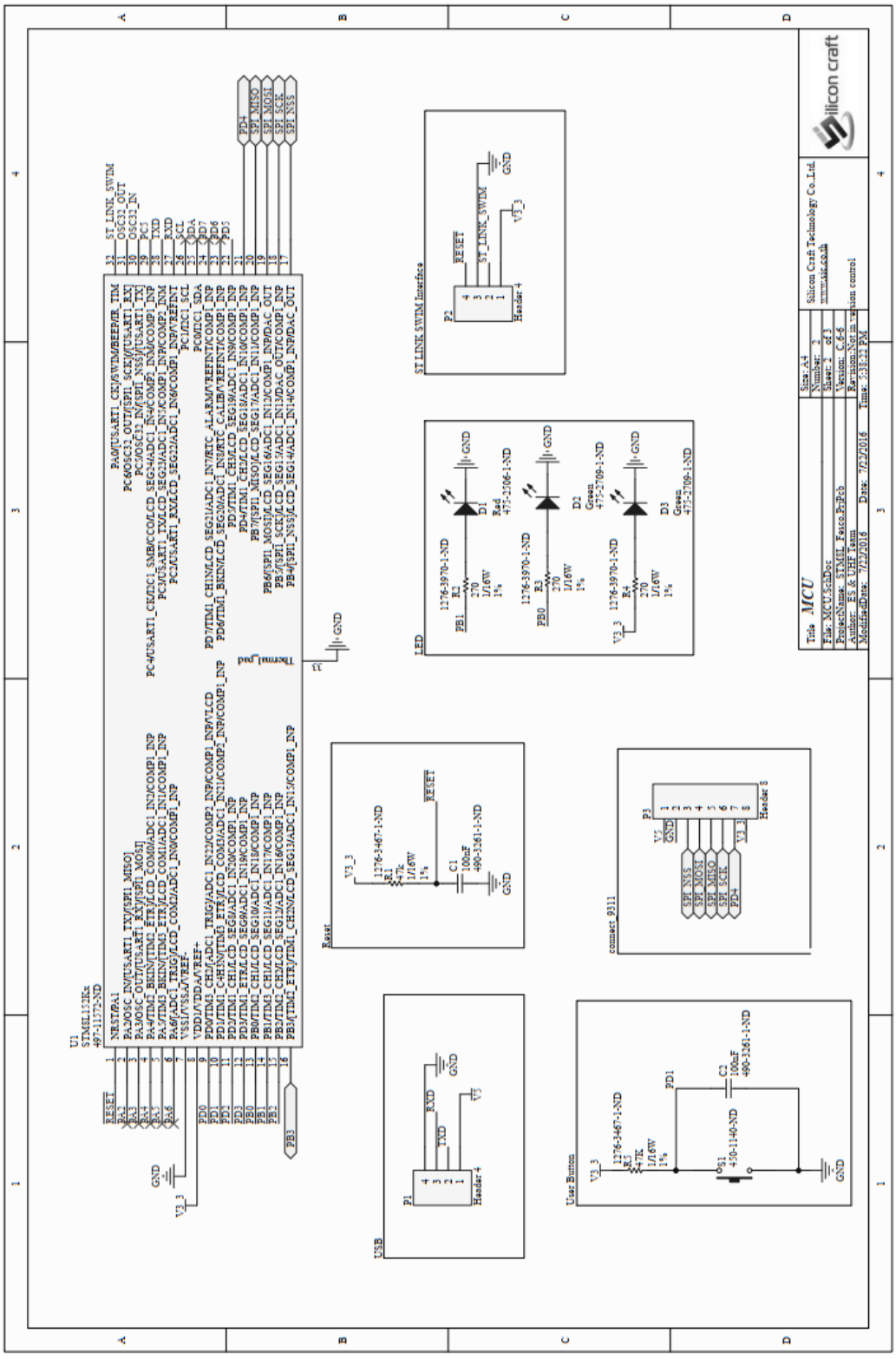


Figure 6-2 STM8L MCU Module Schematic

7. Upgrade Firmware

The operation of RA12 Mini Reader is controlled by STM8L MCU. The kit can be programmed or perform firmware update using wire debugging (SWIM). User can use ST-LINK/V2 module with ST Visual Programmer to upgrade firmware.

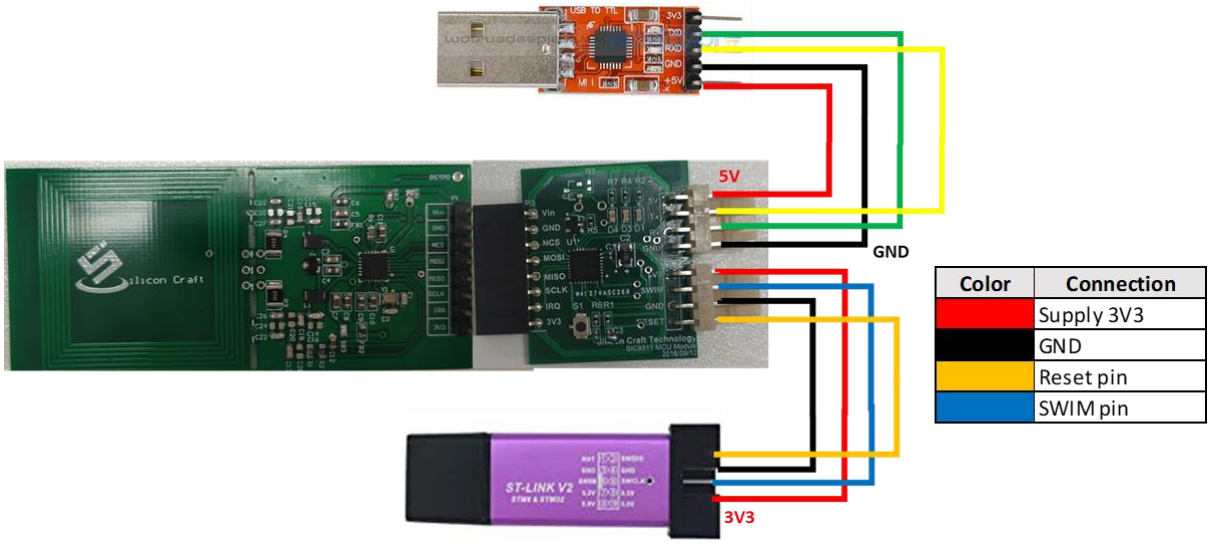


Figure 7-1 STM8L MCU Connection via SWIM

8. Product and Documentation Support

For more information of the SIC products, tools, and support that are available to help your development, please visit www.sic.co.th

8.1. Notation

The register definition is shown in the Figure 15.

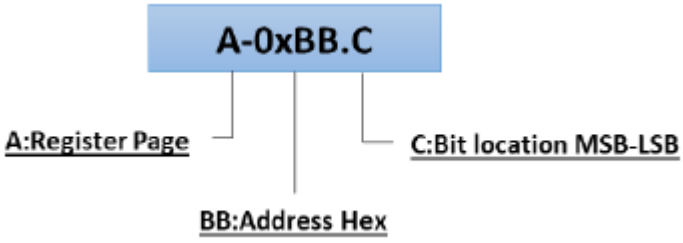


Figure 8-1 Register Definition

Styles and Fonts for key words

This part defines styles and fonts used for the key words throughout this document. The key words are names of signal, register and pin. The styles, fonts and their indications are shown in **Table 8-1**.

Table 8-1 Styles and Fonts for keywords

Symbol	Indication
Signal	Signal name
Register	Register name or Bit name
pin **RX**	Pin name
"State of Operation"	State of operation
Command	Command name in register 0x01 sector 0

To refer to a register address, a hexadecimal number proceeding with "0x" is used, for example 0x05 refer to a register address 0x05.

To refer to a bit located in a register address, a symbol "." following by a number reflecting the bit location starting from 0 to 7 is used. For example, 0x05.2 refers to bit 7, MSB, in the register address 0x05.

To refer to a set of consecutive bits located in a register address, a format ".[MSB:LSB]" is used after a register address . For example, a value of 0x05.[3:0] refers to bit 3, 2, 1 and 0 in the register 0x05.

To refer to a binary value in some registers, the letter "b" is placed at the end of binary number. For an example "0101b".

To refer to logic level, the number in single quote '1' and '0' are used to refer to binary logic level.

8.2. Tools and Software

- Development Kit and Reference Design

8.3. Documentation Support

Datasheet and Factsheet

- RA12 Data Sheet

- RA12 Fact Sheet

Application Note

- RA12 Mini Reader User Manual

- RA12 and RE31 Differences and Migration

8.4. Contact Information

Tel: +66 2 589 9991

Fax: +66 2 589 8881

Email: info@sic.co.th

9. Legal Information

9.1. Disclaimer

- The information described herein is subject to change without notice.

- Although the IC contains a static electricity protection circuit, static electricity or voltage that exceeds the limit of the protection circuit should not be applied.

- SIC assumes no responsibility for how this IC is used in products created using this IC or for the specifications of that product, nor does SIC. Assume any responsibility for any infringement of patents or copyrights by-products that include this IC either in Thailand or in other countries.

- SIC is not responsible for any problems caused by circuits or diagrams described herein whose related industrial properties, patents, or other rights belong to third parties. The application circuit examples explain typical applications of the products and do not guarantee the success of any specific mass-production design.

- The use of the information described herein for other purposes and/or reproduction or copying without the express permission of SIC is strictly prohibited.

- The products described herein cannot be used as part of any device or equipment affecting the human body, such as exercise equipment, medical equipment, security systems, gas equipment, or any apparatus installed in airplanes and other vehicles, without prior written permission of SIC.

- Although SIC exerts the greatest possible effort to ensure high quality and reliability, the failure or malfunction of semiconductor products may occur. The user of these products should, therefore, give thorough consideration to safety design, including redundancy, fire-prevention measures, and malfunction prevention, to prevent any accidents, fires, or community damage that may ensue.