Advanced Card Systems Limited

Card and Reader Technologies

Design Specification

ACR122L-ACS

Revision History

Version	Date	Prepared By	Description
V0.01	16.Oct.2009	Macross Ng, Kit Au	Initial Release
V0.02	23.Nov.2009		Updated LCD command
V0.03	19.May.2010	Macross Ng	Update the product photo
V0.04	20.Sept.2010	Macross Ng	Add the Technical Specification

Table of Contents

1.0. Introduction

The ACR122L is a module for accessing both contact and contactless cards with LCD Display. It can support 3 SAMs access and ISO14443 Part 4 Type A & B, MIFARE, FeliCa and NFC tags.

2.0. Feature

- Serial Interface. Baud Rate = 9600 bps (default) or 115200 bps, 8-N-1. Initial Baud Rate is determined by the existence of R12. A command is also provided for changing the baud rate while the reader is running.
- CCID-liked Frame Format.
- Support ISO14443 Part 4 Type A & B, MIFARE, FeliCa and NFC tags.
- Built-in Antenna for contactless tags access.
- Support ISO7816 T=0 cards. (SAM Socket)
- 3 X SAM Interface
- 4 LEDs.
- Buzzer.

3.0. Hardware Interfaces

3.1. Serial Interface

The ACR122L is connected to a Host through the RS232C Serial Interface at 9600 bps and 115200 bps. 8-N-1

Pin	Signal	Function
1	VCC	+5V power supply for the reader (Max 200mA, Normal 100mA)
2	TXD	The signal from the reader to the host.
3	RXD	The signal from the host to the reader.
4	GND	Reference voltage level for power supply

3.2. LEDs

- 4 x User-controllable single color LEDs
- Can select control by firmware or by User
- From Left to right, the color of the LED is: Green, Blue, Yellow and Red

3.3. Buzzer

- User-controllable Mono-Tone buzzer.
- The default Buzzer State is OFF

3.4. SAM Interface

- 3 x SAMs socket is provided.
- Support ISO7816 Parts 1-3 T=0 cards

3.5. LCD

- User-controllable LCD
- User-controllable Yellow-Green Backlight
- 2 Line x 16 Character, 5 x 8 dot matrix, STN Yellow Green LCD Type
- 6 O'clock view angle

3.6. Built-in Antenna

- 3 turns symmetric loop antenna. Center tapped.
- The estimated size = 46mm x 64mm.
- The loop inductance should be around ~ 1.6uH to 2.5uH
- Operating Distance for different Tags ~ up to 50mm (depend on the Tag)
- Only one Tag can be accessed at any one time.

4.0. Implementation

4.1. The ACR122L is built based on the AC1038-2, AC1038s and PN5321 chips.

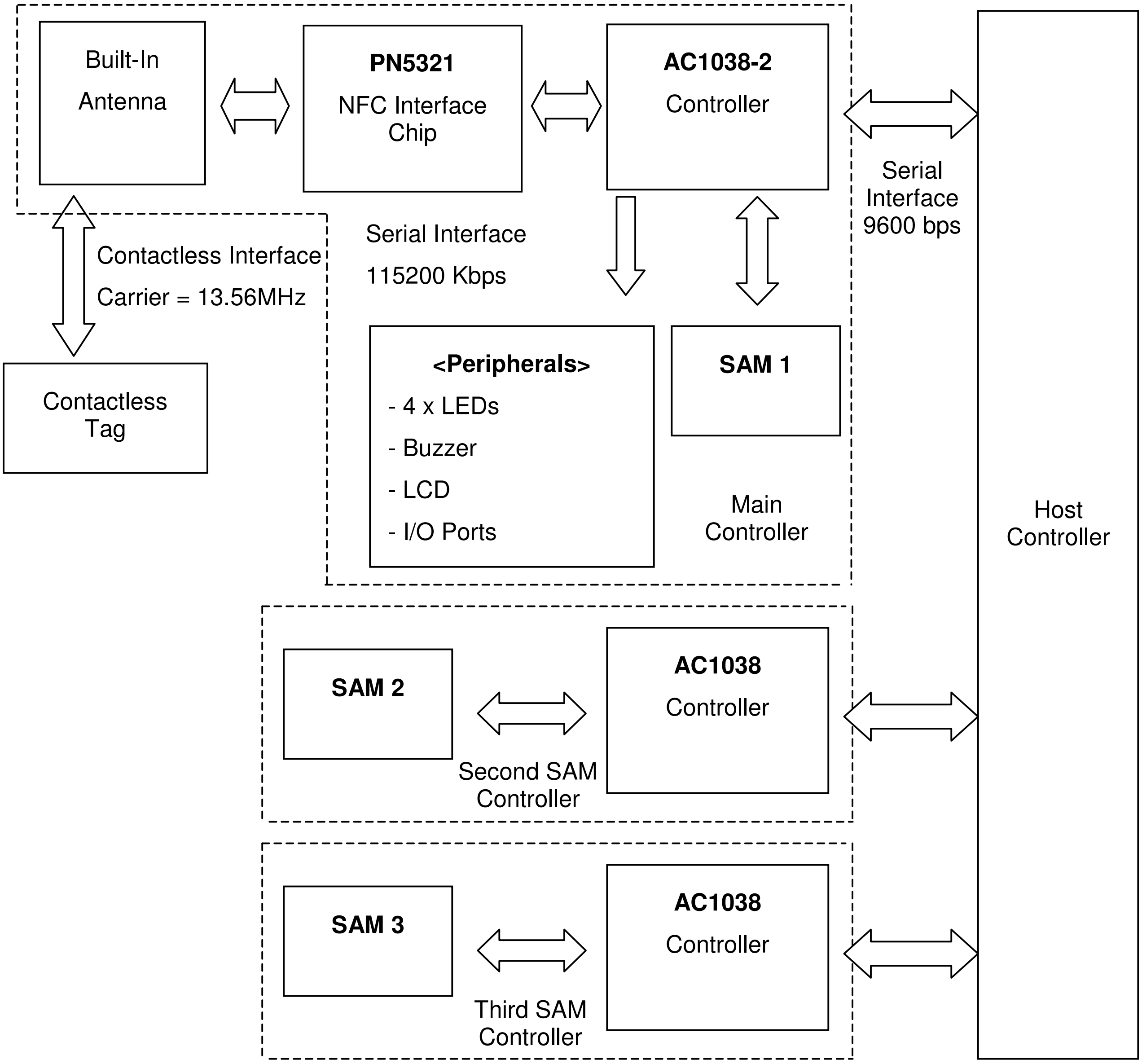
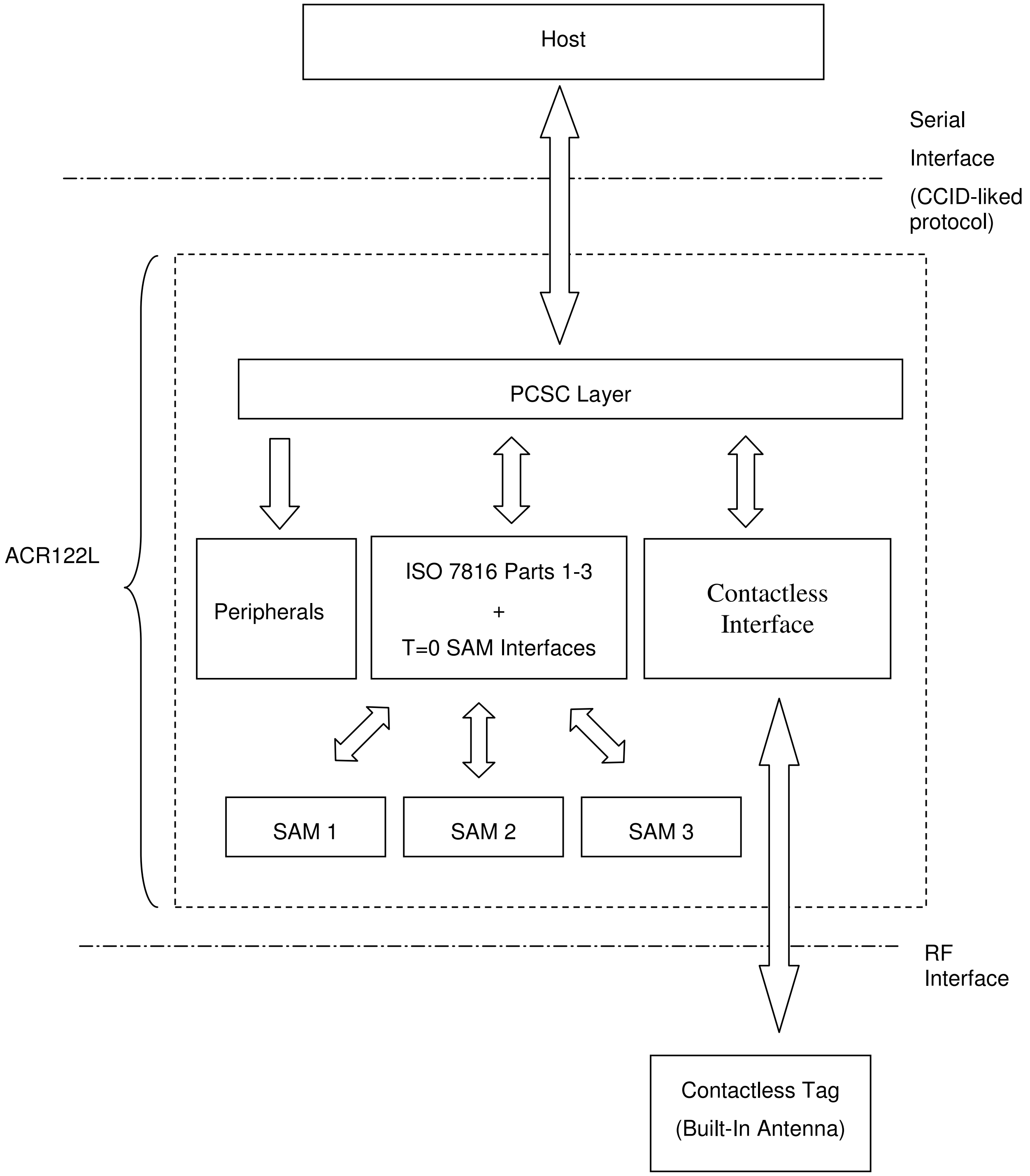


Figure 1.ACR122L System Block Diagram

4.2. Communication between the Host and the Contactless interface, SAM and Peripherals.

The Contactless interface & Peripherals are accessed through the use of Pseduo-APDUs.

The SAM interface are accessed through the use of standard APDUs.



5.0. Serial Interface (CCID-liked FRAME Format)

Communication setting: 9600 bps, 8-N-1

The communication protocol between the Host and ACR122L is very similar to the CCID protocol.

ACR122L Command Frame Format

STX	Bulk-OUT Header	APDU Command Or Parameters	Checksum	ETX
1 Byte	10 Bytes	M Bytes (If applicable)	1 Byte	1 Byte

ACR122L Status Frame Format

STX	Status	Checksun	ETX
1 Byte	1 Byte	1 Byte	1 Byte

ACR122L Response Frame Format

STX	Bulk-IN Header	APDU Response Or abData	Checksun	ETX
1 Byte	10 Bytes	N Bytes (If applicable)	1 Byte	1 Byte

Checksum = XOR {Bulk-OUT Header, APDU Command or Parameters}

Checksum = XOR {Bulk-IN Header, APDU Response or abData}

For control SAM Socket 1, the STX must be equal to 0x02 and ETX must be equal to 0x03.

For control SAM Socket 2, the STX must be equal to 0x12 and ETX must be equal to 0x13.

For control SAM Socket 3, the STX must be equal to 0x22 and ETX must be equal to 0x23.

For control access contactless interface, peripherals (i.e. LEDs, LCD and Buzzer), the STX must be equal to 0x02 and ETX must be equal to 0x03, which is the same with control SAM Socket1.

In general, we would make use of three types of Bulk-OUT Header.

- HOST_to_RDR_IccPowerOn: To activate the SAM interface. The ATR of the SAM will be returned if available.
- HOST_to_RDR_IccPowerOff: To deactivate the SAM interface.
- HOST_to_RDR_XfrBlock: To exchange APDUs between the Host and ACR122L.

#The SAM1 interface must be activated in order to use the Contactless interface and Peripherals. In short, all the APDUs are exchanged through the SAM1 Interface.

Similarly, two types of Bulk-IN Header are used.

- RDR_to_HOST_DataBlock: In response to the “HOST_to_RDR_IccPowerOn” and “HOST_to_RDR_XfrBlock” Frames.
- RDR_to_HOST_SlotStatus: In response to the “HOST_to_RDR_IccPowerOff” Frame.

RDR = ACR122L; HOST = Host Controller.

HOST_to_RDR = Host Controller -> ACR122L

RDR_to_HOST = ACR122L -> Host Controller

Protocol Flow Examples(Use SAM Interface 1 as Example)

1) Activate a SAM

	HOST		**RDR**
1. HOST sends a frame	→	02 62 00 00 00 00 00 01 01 00 00 [Checksum] 03	
2. RDR sends back a positive status frame immediately		02 00 00 03 (positive status frame)	←
		.. After some processing delay...	
3. RDR sends back the response of the command		02 80 0D 00 00 00 00 01 00 00 00 3B 2A 00 80 65 24 B0 00 02 00 82 90 00 [Checksum] 03	←

2) Activate a SAM (Incorrect Checksum, HOST)

	HOST		**RDR**
1. HOST sends a corrupted frame	→	02 62 00 00 00 00 00 01 01 00 00 [Incorrect Checksum] 03	
2. RDR sends back a negative status frame immediately		02 FF FF 03 (negative status frame)	←
3. HOST sends the frame again.	→	02 62 00 00 00 00 00 01 01 00 00 [Checksum] 03	
4. RDR sends back a positive status frame immediately		02 00 00 03 (positive status frame)	←
		.. After some processing delay...	
5. RDR sends back the response of the command		02 80 0D 00 00 00 00 01 00 00 00 3B 2A 00 80 65 24 B0 00 02 00 82 90 00 [Checksum] 03	←

3) Activate a SAM (Incorrect Checksum, RDR)

	HOST		RDR
1. HOST sends a frame	→	02 62 00 00 00 00 00 01 01 00 00 [Checksum] 03	
2. RDR sends back a positive status frame immediately		02 00 00 03 (positive status frame)	←
		.. After some processing delay...	
3. RDR sends back the response (corrupted) of the command		02 80 0D 00 00 00 00 01 00 00 00 3B 2A 00 80 65 24 B0 00 02 00 82 90 00 [Incorrect Checksum] 03	←
4. HOST sends a NAK frame to get the response again.	→	02 00 00 00 00 00 00 00 00 00 00 00 03 (NAK)	
5. RDR sends back the response of the command		02 80 0D 00 00 00 00 01 00 00 00 3B 2A 00 80 65 24 B0 00 02 00 82 90 00 [Checksum] 03	←

Remarks:

If the frame sent by the HOST is correctly received by the RDR, a positive status frame = {02 00 00 03} will be sent to the HOST immediately to inform the HOST the frame is correctly received. The HOST has to wait for the response of the command. The RDR will not receive any more frames while the command is being processed.

In case of errors, a negative status frame will be sent to the HOST to indicate the frame is either corrupted or wrong formatted.

- CheckSum Error Frame = {02 FF FF 03}
- Length Error Frame = {02 FE FE 03}. The length "dDwLength" is greater than 0x0105 bytes.
- ETX Error Frame = {02 FD FD 03}. The last byte is not equal to ETX "0x03".
- TimeOut Error Frame = {02 FC FC 03}. Not Complete Package Received.

The NAK Frame is only used by the HOST to get the last response.

{02 00 00 00 00 00 00 00 00 00 00 00 03} // 11 zeros

To activate the SAM Interface

ACR122L Command Frame Format

STX	Bulk-OUT Header (HOST_to_RDR_IccPowerOn)	Parameters	Checksum	ETX
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

For SAM Interface 1, STX = 0x02 and ETX = 0x03

For SAM Interface 2, STX = 0x12 and ETX = 0x13

For SAM Interface 3, STX = 0x22 and ETX = 0x23

HOST_to_RDR_IccPowerOn Format

Offset	Field	Size	Value	Description
0	bMessageType	1	62h	
1	dDwLength <LSB .. MSB>	4	00000000h	Message-specific data length
5	bSlot	1	00-FFh	Identifies the slot number for this command. Default=00h
6	bSeq	1	00-FFh	Sequence number for command
7	bPowerSelect	1	00h, 01h, 02h, or 03h	Voltage that is applied to the ICC 00h – Automatic Voltage Selection 01h – 5.0 volts 02h – 3.0 volts 03h – 1.8 volts
8	abRFU	2		Reserved for Future Use

ACR122L Response Frame Format

STX	Bulk-IN Header (RDR_to_HOST_DataBlock)	abData	Checksum	ETX
1 Byte	10 Bytes	N Bytes (ATR)	1 Byte	1 Byte

For SAM Interface 1, STX = 0x02 and ETX = 0x03

For SAM Interface 2, STX = 0x12 and ETX = 0x13

For SAM Interface 3, STX = 0x22 and ETX = 0x23

RDR_to_HOST_DataBlock Format

Offset	Field	Size	Value	Description
0	bMessageType	1	80h	Indicates that a data block is being sent from the ACR122L
1	dwLength <LSB .. MSB>	4	N	Size of abData field. (N Bytes)
5	bSlot	1	Same as Bulk-OUT	Identifies the slot number for this command
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command
7	bStatus	1		
8	bError	1		
9	bChainParameter	1		

Example1. To activate the SAM Interface 1 slot 0 (default), sequence number = 1, 5V card.

```
HOST -> 02 62 00 00 00 00 00 01 01 00 00 [Checksum] 03
RDR -> 02 00 00 03
RDR -> 02 80 0D 00 00 00 00 01 00 00 00 3B 2A 00 80 65 24 B0 00 02 00 82 90
         00 [Checksum] 03
```

The ATR = 3B 2A 00 80 65 24 B0 00 02 00 82; SW1 SW2 = 90 00

Example2. To activate the SAM Interface 2 slot 0 (default), sequence number = 1, 5V card.

```
HOST -> 12 62 00 00 00 00 00 01 01 00 00 [Checksum] 13
RDR -> 12 00 00 13
RDR -> 12 80 0D 00 00 00 00 01 00 00 00 3B 2A 00 80 65 24 B0 00 02 00 82 90
         00 [Checksum] 13
```

The ATR = 3B 2A 00 80 65 24 B0 00 02 00 82; SW1 SW2 = 90 00

Example3. To activate the SAM Interface 3 slot 0 (default), sequence number = 1, 5V card.

```
HOST -> 22 62 00 00 00 00 00 01 01 00 00 [Checksum] 23
RDR -> 22 00 00 23
RDR -> 22 80 0D 00 00 00 00 01 00 00 00 3B 2A 00 80 65 24 B0 00 02 00 82 90
         00 [Checksum] 23
```

The ATR = 3B 2A 00 80 65 24 B0 00 02 00 82; SW1 SW2 = 90 00

To deactivate the SAM Interface

ACR122L Command Frame Format

STX	Bulk-OUT Header (HOST_to_RDR_IccPowerOff)	Parameters	Checksum	ETX
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

For SAM Interface 1, STX = 0x02 and ETX = 0x03

For SAM Interface 2, STX = 0x12 and ETX = 0x13

For SAM Interface 3, STX = 0x22 and ETX = 0x23

HOST_to_RDR_IccPowerOff Format

Offset	Field	Size	Value	Description
0	bMessageType	1	63h	
1	dDwLength <LSB .. MSB>	4	00000000h	Message-specific data length
5	bSlot	1	00-FFh	Identifies the slot number for this command. Default=00h
6	bSeq	1	00-FFh	Sequence number for command
7	abRFU	3		Reserved for Future Use

ACR122L Response Frame Format

STX	Bulk-IN Header (RDR_to_HOST_SlotStatus)	abData	Checksum	ETX
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

For SAM Interface 1, STX = 0x02 and ETX = 0x03

For SAM Interface 2, STX = 0x12 and ETX = 0x13

For SAM Interface 3, STX = 0x22 and ETX = 0x23

RDR_to_HOST_DataBlock Format

Offset	Field	Size	Value	Description
0	bMessageType	1	81h	Indicates that a data block is being sent from the ACR122L
1	dwLength <LSB .. MSB>	4	0	Size of abData field. (0 Bytes)
5	bSlot	1	Same as Bulk-OUT	Identifies the slot number for this command
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command
7	bStatus	1		
8	bError	1		
9	bClockStatus	1		

Example1. To deactivate the SAM Interface 1 slot 0 (default), sequence number = 2.

```
HOST -> 02 63 00 00 00 00 00 02 00 00 00 [Checksum] 03
RDR -> 02 00 00 03
RDR -> 02 81 00 00 00 00 00 02 00 00 00 [Checksum] 03
```

Example2. To deactivate the SAM Interface 2 slot 0 (default), sequence number = 2.

```
HOST -> 12 63 00 00 00 00 00 02 00 00 00 [Checksum] 13
RDR -> 12 00 00 13
RDR -> 12 81 00 00 00 00 00 02 00 00 00 [Checksum] 13
```

Example3. To deactivate the SAM Interface 3 slot 0 (default), sequence number = 2.

```
HOST -> 22 63 00 00 00 00 00 02 00 00 00 [Checksum] 23
RDR -> 22 00 00 23
RDR -> 22 81 00 00 00 00 00 02 00 00 00 [Checksum] 23
```

To do data-exchange through the SAM Interface

ACR122L Command Frame Format

STX	Bulk-OUT Header (HOST_to_RDR_XfrBlock)	Parameters	Checksum	ETX
1 Byte	10 Bytes	M Byte	1 Byte	1 Byte

For SAM Interface 1, STX = 0x02 and ETX = 0x03

For SAM Interface 2, STX = 0x12 and ETX = 0x13

For SAM Interface 3, STX = 0x22 and ETX = 0x23

HOST_to_RDR_XfrBlock Format

Offset	Field	Size	Value	Description
0	bMessageType	1	6Fh	
1	dDwLength <LSB .. MSB>	4	M	Message-specific data length
5	bSlot	1	00-FFh	Identifies the slot number for this command. Default=00h
6	bSeq	1	00-FFh	Sequence number for command
7	bBWI	1	00-FFh	Used to extend the Block Waiting Timeout.
8	wLevelParameter	2	0000h	

ACR122L Response Frame Format

STX	Bulk-IN Header (RDR_to_HOST_DataBlock)	abData	Checksum	ETX
1 Byte	10 Bytes	N Bytes (ATR)	1 Byte	1 Byte

For SAM Interface 1, STX = 0x02 and ETX = 0x03

For SAM Interface 2, STX = 0x12 and ETX = 0x13

For SAM Interface 3, STX = 0x22 and ETX = 0x23

RDR_to_HOST_DataBlock Format

Offset	Field	Size	Value	Description
0	bMessageType	1	80h	Indicates that a data block is being sent from the ACR122L
1	dwLength <LSB .. MSB>	4	N	Size of abData field. (N Bytes)
5	bSlot	1	Same as Bulk-OUT	Identifies the slot number for this command
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command
7	bStatus	1		
8	bError	1		
9	bChainParameter	1		

Example1. To send an APDU “80 84 00 00 08” to the SAM Interface 1 slot 0 (default), sequence number = 3.

```
HOST -> 02 6F 05 00 00 00 00 03 00 00 00 80 84 00 00 08 [Checksum] 03

RDR -> 02 00 00 03

RDR -> 02 80 0A 00 00 00 00 03 00 00 00 E3 51 B0 FC 88 AA 2D 18 90 00
        [Checksum] 03
```

Response = E3 51 B0 FC 88 AA 2D 18; SW1 SW2 = 90 00

Example2. To send an APDU “80 84 00 00 08” to the SAM Interface 2 slot 0 (default), sequence number = 3.

```
HOST -> 12 6F 05 00 00 00 00 03 00 00 00 80 84 00 00 08 [Checksum] 13

RDR -> 12 00 00 13

RDR -> 12 80 0A 00 00 00 00 03 00 00 00 E3 51 B0 FC 88 AA 2D 18 90 00
        [Checksum] 13
```

Response = E3 51 B0 FC 88 AA 2D 18; SW1 SW2 = 90 00

Example3. To send an APDU “80 84 00 00 08” to the SAM Interface 3 slot 0 (default), sequence number = 3.

```
HOST -> 22 6F 05 00 00 00 00 03 00 00 00 80 84 00 00 08 [Checksum] 23

RDR -> 22 00 00 23

RDR -> 22 80 0A 00 00 00 00 03 00 00 00 E3 51 B0 FC 88 AA 2D 18 90 00
         [Checksum] 23
```

Response = `E3 51 B0 FC 88 AA 2D 18`; SW1 SW2 = `90 00`

Pseudo APDUs for Contactless Interface and Peripherals Control

ACR122L comes with two primitive commands for this purpose. <Class 0xFF>

****Remark: For all the Pseduo APDUs below (except Section 5.9 "GET the Firmware Version of the Reader" and "5.8 Pseduo APDU for changing the communication speed"), STX MUST EQUAL to 0x02 and ETX MUST EQUAL to 0x03**

5.1. Direct Transmit

To send a Pseudo APDU (PN532 and TAG Commands), and the Response Data will be returned.

Table 1.0A: Direct Transmit Command Format (Length of the PN532_TAG Command + 5 Bytes)

Command	Class	INS	P1	P2	Lc	Data In
Direct Transmit	0xFF	0x00	0x00	0x00	Number of Bytes to send	PN532_TAG Command

Lc: Number of Bytes to Send (1 Byte)

Maximum 255 bytes

Data In: PN532_TAG Command

The data to be sent to the PN532 and Tag.

Table 1.0B: Direct Transmit Response Format (Response Length + 2 Bytes)

Response	Data Out	
Result	PN532_TAG Response	SW1 SW2

Data Out: PN532_TAG Response

PN532_TAG Response returned by the reader.

Data Out: SW1 SW2

Status Code returned by the reader.

Table 1.0C: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.
Time Out Error	63	01	The PN532 does not response.
Checksum Error	63	27	The checksum of the Response is wrong.
Parameter Error	63	7F	The PN532_TAG Command is wrong.

Example 1. How to access MIFARE Classic Tags?

Typical sequence may be:

- Scanning the tags in the field (Polling)
- Authentication
- Read / Write the memory of the tag
- Halt the tag (optional)

```
Step 1) Polling for the MIFARE 1K/4K Tags, 106 kbps
<< 02 6F 09 00 00 00 00 01 00 00 00
      FF 00 00 00 04 D4 4A 01 00 [Checksum] 03
>> 02 00 00 03
>> 02 80 0E 00 00 00 00 01 01 00 00
      D5 4B 01 01 00 02 18 04 F6 8E 2A 99 90 00 [Checksum] 03
In which,   Number of Tag found = [01]; Target number = 01
            SENS_RES = 00 02; SEL_RES = 18,
            Length of the UID = 4; UID = F6 8E 2A 99
            Operation Finished = 90 00
```

Tip: The tag type can be determined by recognizing the SEL_RES.

SEL_RES of some common tag types.

```
      00 = MIFARE Ultralight
      08 = MIFARE 1K
      09 = MIFARE MINI
      18 = MIFARE 4K
      20 = MIFARE DESFIRE
      28 = JCOP30
      98 = Gemplus MPCOS
```

```
Step 2) KEY A Authentication, Block 04, KEY = FF FF FF FF FF FF, UID = F6
8E 2A 99
<< 02 6F 14 00 00 00 00 00 01 00 00 00
      FF 00 00 00 0F D4 40 01 60 04 FF FF FF FF FF FF F6 8E 2A 99 [Checksum]
      03
>> 02 00 00 03
>> 02 80 05 00 00 00 00 01 01 00 00
      D5 41 [00] 90 00 [Checksum] 03
```

Tip: If the authentication failed, the error code [XX] will be returned.

[00] = Valid, other = Error. Please refer to Error Codes Table for more details.

Tip: For ***KEY B Authentication***

```
<< 02 6F 14 00 00 00 00 00 01 00 00 00
      FF 00 00 00 0F D4 40 01 61 04 FF FF FF FF FF FF F6 8E 2A 99 [Checksum]
      03
```

Step 3) **Read** the content of Block **04**

```
<< 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D4 40 01 30 04 [Checksum] 03
>> 02 00 00 03
>> 02 80 05 00 00 00 00 01 01 00 00
      D5 41 [00] 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 90 00
      [Checksum] 03
```

In which, Block Data = 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16

Step 4) **Update** the content of Block **04**

```
<< 02 6F 1A 00 00 00 00 01 00 00 00
      FF 00 00 00 15 D4 40 01 A0 04 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D
      0E 0F 10 [Checksum] 03
>> 02 00 00 03
>> 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D5 41 [00] 90 00 [Checksum] 03
```

Step 5) **Halt the tag** (optional)

```
<< 02 6F 08 00 00 00 00 01 00 00 00
      FF 00 00 00 03 D4 44 01 [Checksum] 03
>> 02 00 00 03
>> 02 80 05 00 00 00 00 01 01 00 00
      D5 45 [00] 90 00 [Checksum] 03
```

MIFARE 1K Memory Map.

Sectors (Total 16 sectors. Each sector consists of 4 consecutive blocks)	**Data Blocks** (3 blocks, 16 bytes per block)	**Trailer Block** (1 block, 16 bytes)
Sector 0	0x00 ~ 0x02	0x03
Sector 1	0x04 ~ 0x06	0x07
..		
..		
Sector 14	0x38 ~ 0x0A	0x3B
Sector 15	0x3C ~ 0x3E	0x3F

1K Bytes

MIFARE 4K Memory Map.

Sectors (Total 32 sectors. Each sector consists of 4 consecutive blocks)	**Data Blocks** (3 blocks, 16 bytes per block)	**Trailer Block** (1 block, 16 bytes)
Sector 0	0x00 ~ 0x02	0x03
Sector 1	0x04 ~ 0x06	0x07
..		
..		
Sector 30	0x78 ~ 0x7A	0x7B
Sector 31	0x7C ~ 0x7E	0x7F

2K Bytes

Sectors (Total 8 sectors. Each sector consists of 16 consecutive blocks)	**Data Blocks** (15 blocks, 16 bytes per block)	**Trailer Block** (1 block, 16 bytes)
Sector 32	0x80 ~ 0x8E	0x8F
Sector 33	0x90 ~ 0x9E	0x9F
..		
..		
Sector 38	0xE0 ~ 0xEE	0xEF
Sector 39	0xF0 ~ 0xFE	0xFF

2K Bytes

Tip: Once the authentication is done, all the data blocks of the same sector are free to access. For example, once the data block 0x04 is successfully authenticated (Sector 1), the data blocks 0x04 ~ 0x07 are free to access.

Example 2. How to handle Value Blocks of MIFARE 1K/4K Tag?

The value blocks are used for performing electronic purse functions. E.g. Increment, Decrement, Restore and Transfer .. etc. The value blocks have a fixed data format which permits error detection and correction and a backup management.

Byte Number	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Value				$\overline{\text{Value}}$				Value				Adr	$\overline{\text{Adr}}$	Adr	$\overline{\text{Adr}}$

Value: A signed 4-Byte value. The lowest significant byte off a value is stored in the lowest address byte. Negative values are stored in standard 2's complement format.

Adr: 1-Byte address, which can be used to save the storage address of a block. (optional)

e.g. Value 100 (decimal) = 64 (Hex), assume Block = 0x05

The formatted value block = 64 00 00 00 9B FF FF FF 64 00 00 00 05 FA 05 FA

```
Step 1) Update the content of Block 05 with a value 100 (dec)
<< 02 6F 1A 00 00 00 00 01 00 00 00
      FF 00 00 00 15 D4 40 01 A0 05 64 00 00 00 9B FF FF FF 64 00 00 00 05
      FA 05 FA [Checksum] 03
>> 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D5 41 [00] 90 00 [Checksum] 03

Step 2) Increment the value of Block 05 by 1 (dec)
<< 02 6F 0E 00 00 00 00 01 00 00 00
      FF 00 00 00 09 D4 40 01 C1 05 01 00 00 00 [Checksum] 03
>> 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D5 41 [00] 90 00 [Checksum] 03

Tip: Decrement the value of Block 05 by 1 (dec)
<< 02 6F 0E 00 00 00 00 01 00 00 00
      FF 00 00 00 09 D4 40 01 C0 05 01 00 00 00 [Checksum] 03

Step 3) Transfer the prior calculated value of Block 05 (dec)
<< 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D4 40 01 B0 05 [Checksum] 03
```

```
>> 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D5 41 [00] 90 00 [Checksum] 03
```

*Tip: **Restore** the value of Block **05** (cancel the prior Increment or Decrement operation)*

```
<< 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D4 40 01 C2 05 [Checksum] 03
```

Step 4) **Read** the content of Block **05**

```
<< 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D4 40 01 30 05 [Checksum] 03
>> 02 6F 1A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D5 41 [00] 65 00 00 00 9A FF FF FF 65 00 00 00 05 FA
      05 FA 90 00 [Checksum] 03
```

In which, the value = 101 (dec)

Step 5) **Copy** the value of Block **05** to Block **06 (dec)**

```
<< 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D4 40 01 C2 05 [Checksum] 03
>> 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D5 41 [00] 90 00 [Checksum] 03
<< 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D4 40 01 B0 06 [Checksum] 03
>> 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D5 41 [00] 90 00 [Checksum] 03
```

Step 6) **Read** the content of Block **06**

```
<< 02 6F 0A 00 00 00 00 01 00 00 00
      FF 00 00 00 05 D4 40 01 30 06 [Checksum] 03
>> 02 6F 1A 00 00 00 00 01 00 00 00
      FF 00 00 00 15 D5 41 [00] 65 00 00 00 9A FF FF FF 65 00 00 00 05 FA
      05 FA 90 00 [Checksum] 03
```

In which, the value = 101 (dec). The Adr "05 FA 05 FA" tells us the value is copied from Block 05.

5.2. Pseudo APDU for LEDs and Buzzer Control

This APDU is used to control the states of the LED_0, LED_1 and Buzzer.

Table 2.0A: LED_0, LED_1 and Buzzer Control Command Format (9 Bytes)

Command	Class	INS	P1	P2	Lc	Data In (4 Bytes)
LEDs and Buzzer LED Control	0xFF	0x00	0x40	LED State Control	0x04	Blinking Duration Control

P2: LED State Control

Table 2.0B: LED_0, LED_1 and Buzzer Control Format (1 Byte)

CMD	Item	Description
Bit 0	Final LED_1 State	1 = On; 0 = Off
Bit 1	Final LED_0 State	1 = On; 0 = Off
Bit 2	LED_1 State Mask	1 = Update the State 0 = No change
Bit 3	LED_0 State Mask	1 = Update the State 0 = No change
Bit 4	Initial LED_1 Blinking State	1 = On; 0 = Off
Bit 5	Initial LED_0 Blinking State	1 = On; 0 = Off
Bit 6	LED_1 Blinking Mask	1 = Blink 0 = Not Blink
Bit 7	LED_0 Blinking Mask	1 = Blink 0 = Not Blink

Data In: Blinking Duration Control

Table 2.0C: LED_0, LED_1 Blinking Duration Control Format (4 Bytes)

Byte 0	**Byte 1**	**Byte 2**	**Byte 3**
T1 Duration Initial Blinking State (Unit = 100ms)	T2 Duration Toggle Blinking State (Unit = 100ms)	Number of repetition	Link to Buzzer

Byte 3: Link to Buzzer. Control the buzzer state during the LED Blinking.

0x00: The buzzer will not turn on

0x01: The buzzer will turn on during the T1 Duration

0x02: The buzzer will turn on during the T2 Duration

0x03: The buzzer will turn on during the T1 and T2 Duration.

Data Out: SW1 SW2. Status Code returned by the reader.

Table 2.0D: Status Code

Results	SW1	SW2	Meaning
Success	90	Current LED State	The operation is completed successfully.
Error	63	00	The operation is failed.

Table 3.0E: Current LED State (1 Byte)

Status	Item	Description
Bit 0	Current LED_1 LED	1 = On; 0 = Off
Bit 1	Current LED_0 LED	1 = On; 0 = Off
Bits 2 – 7	Reserved	

Remark:

1. The LED State operation will be performed after the LED Blinking operation is completed.
2. The LED will not be changed if the corresponding LED Mask is not enabled.
3. The LED will not be blinking if the corresponding LED Blinking Mask is not enabled. Also, the number of repetition must be greater than zero.
4. T1 and T2 duration parameters are used for controlling the duty cycle of LED blinking and Buzzer Turn-On duration.

   For example, if T1=1 and T2=1, the duty cycle = 50%. #Duty Cycle = T1 / (T1 + T2).
5. To control the buzzer only, just set the P2 "LED State Control" to zero.
6. The make the buzzer operating, the "number of repetition" must greater than zero.
7. To control the LED only, just set the parameter "Link to Buzzer" to zero.

Example 1: To read the existing LED State.

// Assume both LED_0 and LED_1 are OFF initially //

// Not link to the buzzer //

APDU = "FF 00 40 00 04 00 00 00 00"

Response = "90 00". LED_0 and LED_1 LEDs are OFF.

Example 2: To turn on LED_0 and LED_1

// Assume both LED_0 and LED_1 are OFF initially //

// Not link to the buzzer //

APDU = "FF 00 40 0F 04 00 00 00 00"

Response = "90 03". LED_0 and LED_1 are ON,

#To turn off both LED_0 and LED_1, APDU = "FF 00 40 0C 04 00 00 00 00"

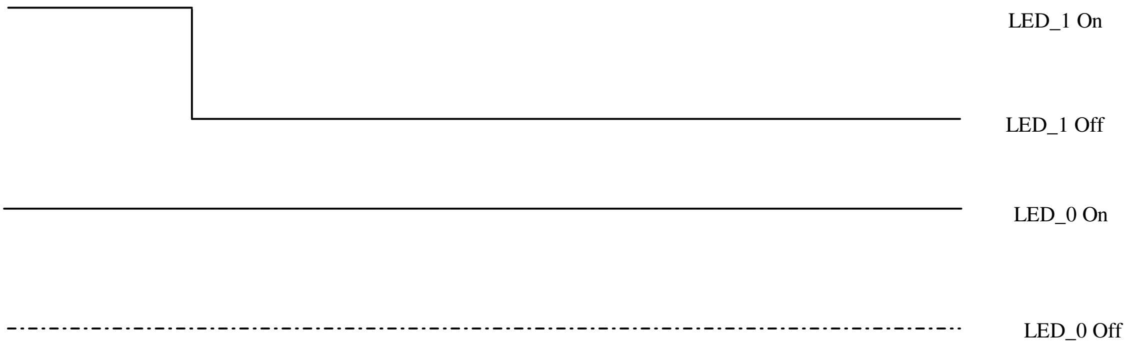
Example 3: To turn off the LED_1 only, and left the LED_0 unchanged.

// Assume both LED_0 and LED_1 are ON initially //

// Not link to the buzzer //

APDU = "FF 00 40 04 04 00 00 00 00"

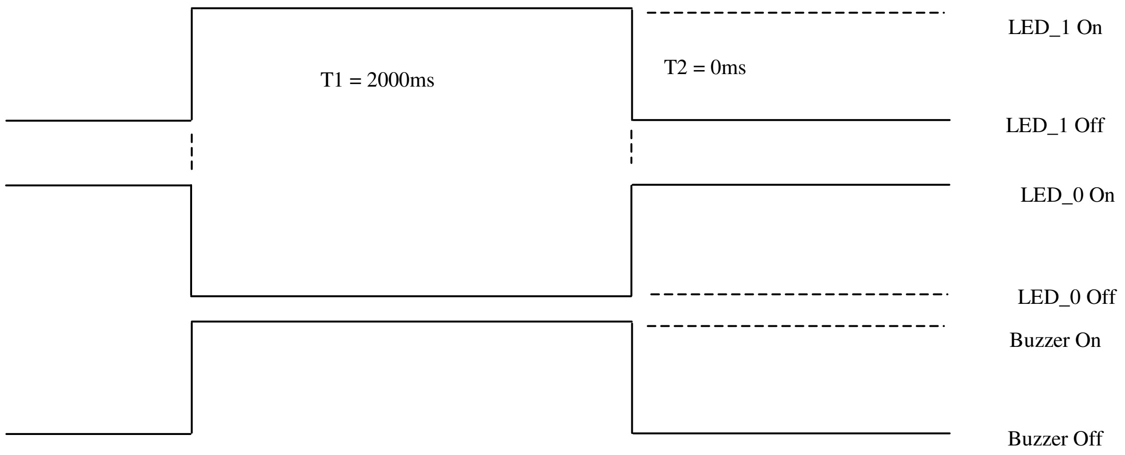
Response = "90 02". LED_0 is not changed (ON); LED_1 is OFF,



Example 4: To turn on the LED_1 for 2 sec. After that, resume to the initial state

// Assume the LED_1 is initially OFF, while the LED_0 is initially ON. //

// The LED_1 and buzzer will turn on during the T1 duration, while the LED_0 will turn off during the T1 duration. //



1Hz = 1000ms Time Interval = 500ms ON + 500 ms OFF
T1 Duration = 2000ms = 0x14

T2 Duration = 0ms = 0x00

Number of repetition = 0x01

Link to Buzzer = 0x01

APDU = “FF 00 40 50 04 14 00 01 01”

Response = “90 02”

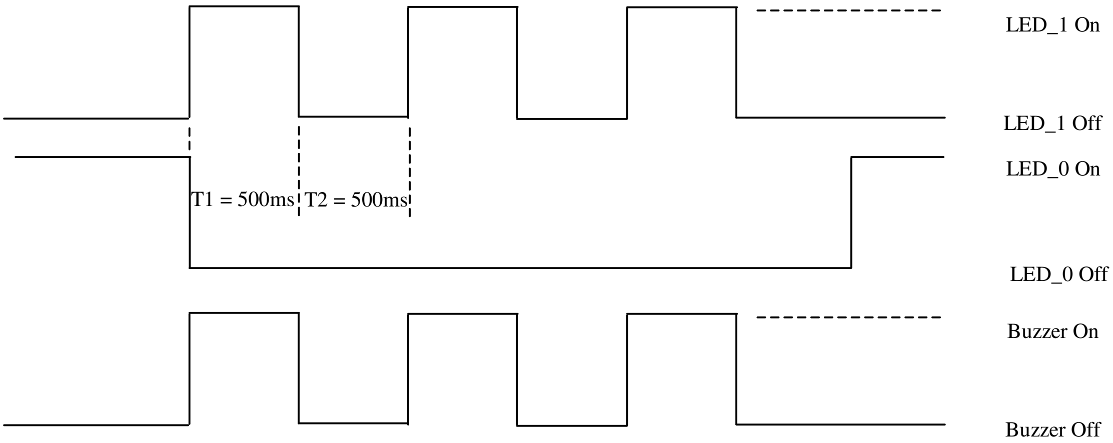
Example 5: To blink the LED_1 of 1Hz for 3 times. After that, resume to initial state

// Assume the LED_1 is initially OFF, while the LED_0 is initially ON. //

// The Initial LED_1 Blinking State is ON. Only the LED_1 will be blinking.

// The buzzer will turn on during the T1 duration, while the LED_0 will turn off during both the T1 and T2 duration.

// After the blinking, the LED_0 will turn ON. The LED_1 will resume to the initial state after the blinking //



1Hz = 1000ms Time Interval = 500ms ON + 500 ms OFF

T1 Duration = 500ms = 0x05

T2 Duration = 500ms = 0x05

Number of repetition = 0x03

Link to Buzzer = 0x01

APDU = "FF 00 40 50 04 05 05 03 01"

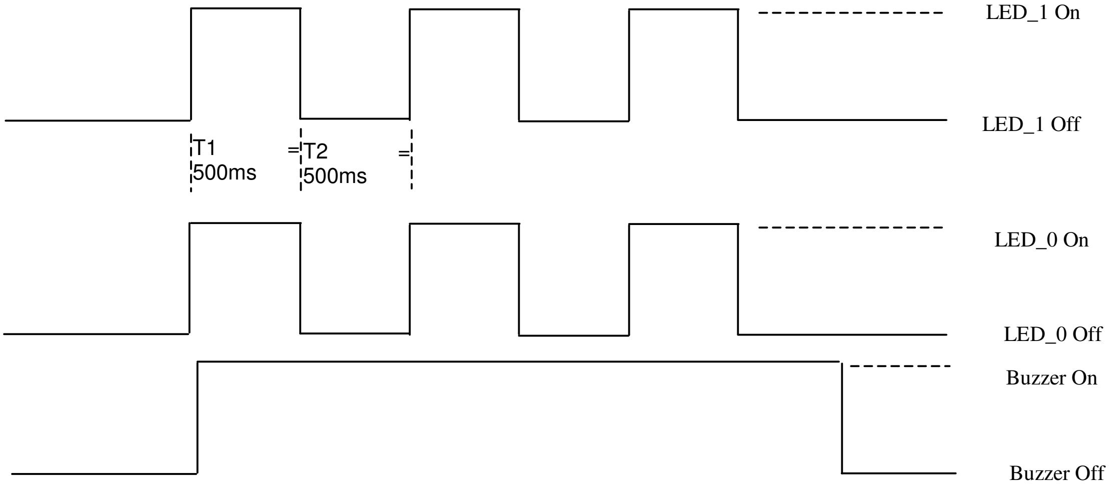
Response = "90 02"

Example 6: To blink the LED_1 and LED_0 of 1Hz for 3 times

// Assume both the LED_0 and LED_1 are initially OFF. //

// Both Initial LED_0 and LED_1 Blinking States are ON //

// The buzzer will turn on during both the T1 and T2 duration//



1Hz = 1000ms Time Interval = 500ms ON + 500 ms OFF

T1 Duration = 500ms = 0x05

T2 Duration = 500ms = 0x05

Number of repetition = 0x03

Link to Buzzer = 0x03

APDU = "FF 00 40 F0 04 05 05 03 03"

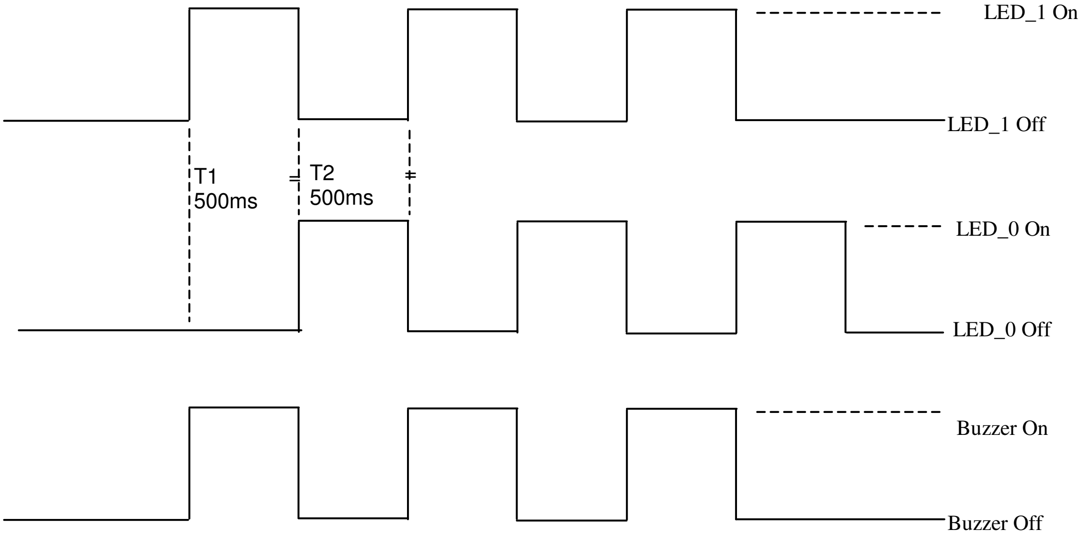
Response = "90 00"

Example 7: To blink the LED_1 and LED_0 in turn of 1Hz for 3 times

// Assume both LED_0 and LED_1 LEDs are initially OFF. //

// The Initial LED_1 Blinking State is ON; The Initial LED_0 Blinking States is OFF //

// The buzzer will turn on during the T1 duration//



1Hz = 1000ms Time Interval = 500ms ON + 500 ms OFF
T1 Duration = 500ms = 0x05

T2 Duration = 500ms = 0x05

Number of repetition = 0x03

Link to Buzzer = 0x01

APDU = "FF 00 40 D0 04 05 05 03 01"

Response = "90 00"

5.3. Pseudo APDU for LEDs Control Enable

This APDU is used to set the LEDs Control Enable/ Disable by user.

Default “Disable”, the LED perform by the firmware

Table 3.0A: Clear LCD Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc
LED Control	0xFF	0x00	0x43	bLEDCtrl	0x00

P2: bLEDCtrl (1 Byte)

CMD	Description
0x00	Disable LEDs Control by user
0xFF	Enable LEDs Control by user

Data Out: SW1 SW2.

Table 3.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.4. Pseudo APDU for LEDs Control

This APDU is used to control 4 LEDs

Table 4.0A: Clear LCD Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc
LED Control	0xFF	0x00	0x41	bLEDsState	0x00

P2: bLEDsState

LED_0, LED_1, LED_2 and LED_3 Control Format (1 Byte)

CMD	Item	Description
Bit 0	LED_0 State	1 = On; 0 = Off
Bit 1	LED_1 State	1 = On; 0 = Off
Bit 2	LED_2 State	1 = On; 0 = Off

Bit 3	LED_3 State	1 = On; 0 = Off
Bits 4 – 7	Reserved	

Data Out: SW1 SW2.

Table 4.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.5. Pseduo APDU for Buzzer Control

This APDU is used to control Buzzer

Table 5.0A: Buzzer Control Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc	Data In (3 Bytes)
Buzzzer Control	0xFF	0x00	0x42	0x00	0x03	Buzzer Control

Data In: Buzzer Control

Table 5.0B: Buzzer On/Off Duration Control Format (4 Bytes)

Byte 0	**Byte 1**	**Byte 2**
T1 Duration On State (Unit = 100ms)	T2 Duration Off State (Unit = 100ms)	Number of repetition

Data Out: SW1 SW2.

Table 5.0C: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.6. Pseudo APDU for Clear LCD

This APDU is used to clear all content show on the LCD

Table 6.0A: Clear LCD Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc
Clear LCD	0xFF	0x00	0x60	0x00	0x00

Data Out: SW1 SW2.

Table 6.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.7. Pseudo APDU for LCD Display (ASCII Mode)

This APDU is used to Display LCD Message in ASCII Mode

Table 7.0A: LCD Display Command Format (5 Bytes + LCD Message Length)

Command	Class	INS	P1	P2	Lc	Data In (Max. 16Bytes)
LCD Display	0xFF	Option Byte	0x68	LCD XY Position	LCD Message Length	LCD Message

INS: Option Byte (1 Byte)

CMD	Item	Description
Bit 0	Character Bold Font	1 = Bold; 0 = Normal
Bit 1 - 3	Reserved	
Bit 4 - 5	Table Index	00 = Fonts Set A 01 = Fonts Set B 10 = Fonts Set C
Bits 6 – 7	Reserved	

P2: LCD XY Position

The Character to be displayed on the LCD position specified by DDRAM Address

Please follow the DDRAM table below for the LCD character position's representation

For Fonts Set 1 and 2,

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	DISPLAY POSITION
1st LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	LCD XY POSITION
2nd LINE	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	

For Fonts Set 3,

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	DISPLAY POSITION
1st LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	LCD XY POSITION
2nd LINE	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	
3rd LINE	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	
4th LINE	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F	

Lc: LCD Message Length

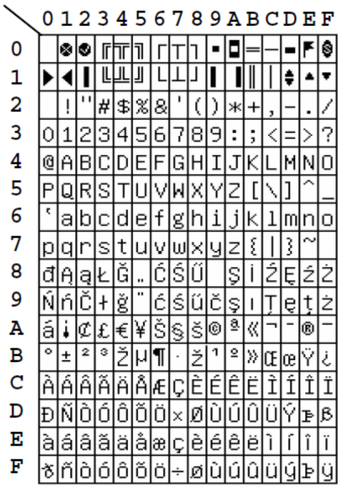
The length of the LCD message (max. 0x10); If the message length is longer than the number of character that the LCD screen's can be shown, then the redundant character will not be shown on the LCD

Data In: LCD Message

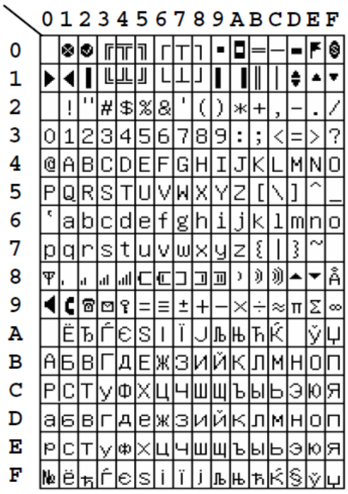
The data to be sent to LCD, maximum 16 Character for each line

Please follow the Fonts tables (selected by INS Bit 4 - 5) below for the LCD Character Index

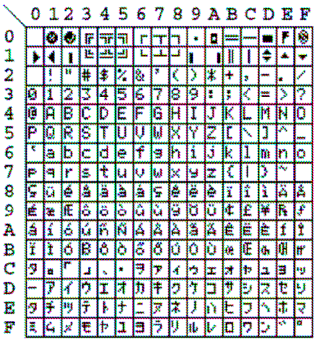
Remarks: Size of the Characters in Fonts Set A and Fonts Set B is 8x16, but size of the Characters in Fonts Set C is 8x8



Character Set A



Character Set B



Character Set C

Data Out: SW1 SW2.

Table 7.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.8. Pseudo APDU for LCD Display (GB Mode)

This APDU is used to Display LCD Message in GB Mode

Table 8.0A: LCD Display Command Format (5 Bytes + LCD Message Length)

Command	Class	INS	P1	P2	Lc	Data In (Max. 16 Bytes)
LCD Display	0xFF	Option Byte	0x69	LCD XY Position	LCD Message Length	LCD Message

INS: Option Byte (1 Byte)

CMD	Item	Description
Bit 0	Character Bold Font	1 = Bold; 0 = Normal
Bit 1 - 7	Reserved	

P2: LCD XY Position

The Character to be displayed on the LCD position specified by DDRAM Address

Please follow the DDRAM table below for the LCD character position's representation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	DISPLAY POSITION
FIRST LINE	00		01		02		03		04		05		06		07		LCD XY POSITION
SECOND LINE	40		41		42		43		44		45		46		47		

Lc: LCD Message Length

The length of the LCD message (max. 0x10); If the message length is longer than the number of character that the LCD screen's can be shown, then the redundant character will not be shown on the LCD

The length of the LCD message should multiple of 2 because each Chinese Character (GB code) should be contain two bytes

Data In: LCD Message

The data to be sent to LCD, maximum 8(2 x 8bit each character) Character for each line

Please follow the Fonts table of GB Coding

Data Out: SW1 SW2.

Table 8.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.9. Pseudo APDU for LCD Display (Graphic Mode)

This APDU is used to Display LCD Message in Graphic Mode

Table 9.0A: LCD Display Command Format (5 Bytes + LCD Message Length)

Command	Class	INS	P1	P2	Lc	Data In (max. 128 Bytes)
LCD Display	0xFF	0x00	0x6A	Line Index	Pixel Data Length	Pixel Data

P2: Line Index

To set which line to start to update the LCD Display

Refer to Below LCD Display Position

Lc: Pixel Data Length

The length of the pixel data (max. 0x80)

Data In: Pixel Data

The pixel data to be sent to LCD for display

LCD Display Position (Total LCD Size: 128x32):

X-axis Line Index	Byte 0x00 (X = 0x00)								Byte 0x01 (X = 0x01)								…	Byte 0x0F (X = 0x0F)							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	…	7	6	5	4	3	2	1	0
0x00																									
0x01																									
0x02																									
0x03																									
0x04																									
0x05																									
0x06																									
0x07																									
0x08																									
0x09																									
…	…																								
0x1F																									

Data Out: SW1 SW2.

Table 9.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.10. Pseudo APDU for Scrolling LCD Current Display

This APDU is used to set scrolling feature of the Current LCD Display

Table 10.0A: Scrolling LCD Command Format (5 Bytes + LCD Message Length)

Command	Class	INS	P1	P2	Lc	Data In (6 Bytes)
LCD Display	0xFF	0x00	0x6D	0x00	0x06	Scroll Ctrl

Data In: Scroll Ctrl

Table 10.0B: Scrolling Control Format (6 Bytes)

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
X Position	Y Position	Scrolling Range (Horizontal)	Scrolling Range (Vertical)	Refresh Speed Ctrl	Scrolling Direction

X Position: Horizontal Start Up Position, Ref to LCD Display Position Below

Y Position: Vertical Start Up Position, Ref to LCD Display Position Below

LCD Display Position (Total LCD Size: 128x32):

	Byte 0x00 (X = 0x00)								Byte 0x01 (X = 0x01)								…	Byte 0x0F (X = 0x0F)							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	…	7	6	5	4	3	2	1	0
0x00																									
0x01																									
0x02																									
0x03																									
0x04																									
0x05																									
0x06																									
0x07																									
0x08																									
0x09																									
…	…																								
0x1F																									

Scrolling Range (Horizontal): How many 8 pixels in Horizontal after X position will be scrolled

Scrolling Range (vertical): How many pixels in Vertical after Y position will be scrolled

Refresh Speed Ctrl:

Bit0~Bit3 – how many pixel move pre scrolling

Bit4~Bit7 – Scrolling period

Bit7	Bit6	Bit5	Bit4	Scrolling period
0	0	0	0	1 Unit
0	0	0	1	3 Units
0	0	1	0	5 Units
0	0	1	1	7 Units
0	1	0	0	17 Units

0	1	0	1	19 Units
0	1	1	0	21 Units
0	1	1	1	23 Units
1	0	0	0	129 Units
1	0	0	1	131 Units
1	0	1	0	133 Units
1	0	1	1	135 Units
1	1	0	0	145 Units
1	1	0	1	147 Units
1	1	1	0	149 Units
1	1	1	1	151 Units

Scrolling Direction: the Scrolling Direction

Bit1	Bit0	Scrolling Direction
0	0	From Left to Right
0	1	From Right to Left
1	0	From Top to Bottom
1	1	From Bottom to Top

Data Out: SW1 SW2.

Table 10.0C: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.11. Pseudo APDU for Pause LCD Scrolling

This APDU is used to Pause the LCD Scrolling set before

To resume the scrolling, send again the scrolling LCD command (5.10) to perform

Table 11.0A: Pause Scrolling Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc
Clear LCD	0xFF	0x00	0x6E	0x00	0x00

Data Out: SW1 SW2.

Table 11.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.12. Pseudo APDU for Stop LCD Scrolling

This APDU is used to stop the LCD Scrolling set before, the LCD display will back to normal display position

Table 12.0A: Stop Scrolling LCD Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc
Clear LCD	0xFF	0x00	0x6F	0x00	0x00

Data Out: SW1 SW2.

Table 12.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.13. Pseudo APDU for LCD Contrast Control

This APDU is used to Control the LCD Contrast

Table 13.0A: LCD Contrast Control Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc
LCD Contrast Control	0xFF	0x00	0x6C	Contrast Control	0x00

P2: Contrast Control

The value range is between 0x00 to 0x0F. It is as large as brighten on contrast. Otherwise the contrast will been darken.

Data Out: SW1 SW2.

Table 13.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.14. Pseudo APDU for LCD Backlight Control

This APDU is used to Control the LCD Backlight

Table 14.0A: LCD Backlight Control Command Format (5 Bytes)

Command	Class	INS	P1	P2	Lc
LCD Backlight Control	0xFF	0x00	0x64	Backlight Control	0x00

P2: Backlight Control

Table 14.0B: Backlight Control Format (1 Byte)

CMD	Description
0x00	LCD Backlight Off
0xFF	LCD Backlight On

Data Out: SW1 SW2.

Table 14.0C: Status Code

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Error	63	00	The operation is failed.

5.15. Pseudo APDU for changing the communication speed

This APDU is used to change the baud rate.

****Remark: STX = 0x32 and ETX = 0x33**

Table 15.0A: Baud Rate Control Command Format (9 Bytes)

Command	Class	INS	P1	P2	Lc
Baud Rate Control	0xFF	0x00	0x44	New Baud Rate	0x00

P2: New Baud Rate

0x00: Set the new baud rate to 9600 bps.

0x01: Set the new baud rate to 115200 bps.

****Remark: The feedback's STX = 0x02 and ETX = 0x03**

Data Out: SW1 SW2.

Table 15.0B: Status Code

Results	SW1	SW2	Meaning
Success	90	Current Baud Rate	The operation is completed successfully.
Error	63	00	The operation is failed.

SW2: Current Baud Rate

0x00: The current baud rate is 9600 bps.

0x01: The current baud rate is 115200 bps.

Remark:

After the communication speed is changed successfully, the program has to adjust its communication speed so as to continue the rest of the data exchanges.

The initial communication speed is determined by the existence of R12 (0 ohm).

- With R12 = 115200 bps
- Without R12 = 9600 bps (default)

Example 1: To initialize a FeliCa Tag (Tag Polling)

Step 1: Issue a “Direct Transmit” APDU.

The APDU Command should be “FF 00 00 00 09 D4 4A 01 01 00 FF FF 01 00”

#In which,
Direct Transmit APDU = “FF 00 00 00”
Length of the PN532_Tag Command = “09”
PN532 Command (InListPassiveTarget 212Kbps) = “D4 4A 01 01”
Tag Command (System Code Request) = “00 FF FF 01 00”

To send an APDU to the slot 0 (default), sequence number = 1.

```
HOST -> 02 6F 0E 00 00 00 00 01 00 00 00
          FF 00 00 00 09 D4 4A 01 01 00 FF FF 01 00
          [Checksum] 03

RDR -> 02 00 00 03

RDR  -> 02 81 1A 00 00 00 00 01 00 00 00
          D5 4B 01 01 14 01 01 01 05 01 86 04 02 02 03 00
          4B 02 4F 49 8A 8A 80 08 90 00
          [Checksum] 03
```

The APDU Response is
“D5 4B 01 01 14 01 01 01 05 01 86 04 02 02 03 00 4B 02 4F 49 8A 8A 80 08 90 00”

#In which,
Response returned by the PN532 =
“D5 4B 01 01 14 01 01 01 05 01 86 04 02 02 03 00 4B 02 4F 49 8A 8A 80 08”
NFCID2t of the FeliCa Tag = “01 01 05 01 86 04 02 02”
Status Code returned by the reader = “90 00”

Example 2: To write 16 bytes data to the FeliCa Tag (Tag Write)

Step 1: Issue a "Direct Transmit" APDU.

The APDU Command should be "FF 00 00 00 23 D4 40 01 20 08 01 01 05 01 86 04 02 02 01 09 01 01 80 00 00 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA"

#In which,

Direct Transmit APDU = "FF 00 00 00"

Length of the PN532_Tag Command = "23"

PN532 Command (InDataExchange) = "D4 40 01"

Tag Command (Write Data) = "20 08 01 01 05 01 86 04 02 02 01 09 01 01 80 00 00 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA".

To send an APDU to the slot 0 (default), sequence number = 2.

```
HOST -> 02 6F 28 00 00 00 00 02 00 00 00
         FF 00 00 00 00 23 D4 40 01 20 08 01 01 05 01 86
         04 02 02 01 09 01 01 80 00 00 AA 55 AA 55 AA 55
         AA 55 AA 55 AA 55 AA
         [Checksum] 03

RDR -> 02 00 00 03

RDR  -> 02 81 11 00 00 00 00 02 00 00 00
         D5 41 00 0C 09 01 01 05 01 86 04 02 02 00 00 90 00
         [Checksum] 03
```

The APDU Response would be
"D5 41 00 0C 09 01 01 05 01 86 04 02 02 00 00 90 00"

#In which,

Response returned by the PN532 = "D5 41"

Response returned by the FeliCa Tag = "00 0C 09 01 01 05 01 86 04 02 02 00 00"

Status Code returned by the reader = "90 00"

Example 3: To read 16 bytes data from the FeliCa Tag (Tag Write)

Step 1: Issue a "Direct Transmit" APDU.

The APDU Command should be "FF 00 00 00 13 D4 40 01 10 06 01 01 05 01 86 04 02 02 01 09 01 01 80 00"

#In which,

Direct Transmit APDU = "FF 00 00 00"

Length of the PN532_Tag Command = "13"

PN532 Command (InDataExchange) = "D4 40 01"

Tag Command (Read Data) = "10 06 01 01 05 01 86 04 02 02 01 09 01 01 80 00"

To send an APDU to the slot 0 (default), sequence number = 3.

```
HOST -> 02 6F 18 00 00 00 00 03 00 00 00
          FF 00 00 00 13 D4 40 01 10 06 01 01 05 01 86 04
          02 02 01 09 01 01 80 00 FF
          [Checksum] 03

RDR -> 02 00 00 03

RDR  -> 02 81 22 00 00 00 00 03 00 00 00
          D5 41 00 1D 07 01 01 05 01 86 04 02 02 00 00 01 00
          AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA 90 00
          [Checksum] 03
```

The APDU Response would be

"D5 41 00 1D 07 01 01 05 01 86 04 02 02 00 00 01 00 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA 90 00"

#In which,

Response returned by the PN532 = "D5 41"

Response returned by the FeliCa Tag =

"00 1D 07 01 01 05 01 86 04 02 02 00 00 01 00 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA 55 AA"

Status Code returned by the reader = "90 00"

Example 4: To initialize an ISO 14443-4 Type B Tag (Tag Polling)

Step 1: Issue a "Direct Transmit" APDU.

The APDU Command should be "FF 00 00 00 05 D4 4A 01 03 00"

#In which,

Direct Transmit APDU = "FF 00 00 00"

Length of the PN532_Tag Command = "05"

PN532 Command (InListPassiveTarget Type B 106Kbps) = "D4 4A 01 03 00"

To send an APDU to the slot 0 (default), sequence number = 4.

```
HOST -> 02 6F 0A 00 00 00 00 04 00 00 00
          FF 00 00 00 05 D4 4A 01 03 00
          [Checksum] 03

RDR -> 02 00 00 03

RDR  -> 02 81 14 00 00 00 00 04 00 00 00
          D5 41 01 01 50 00 01 32 F4 00 00 00 00 33 81 81 01 21
          90 00 [Checksum] 03
```

The APDU Response is
"D5 4B 01 01 50 00 01 32 F4 00 00 00 00 33 81 81 01 21 90 00"

#In which,

Response returned by the PN532 =

"D5 4B 01 01"

ATQB of the Type B Tag = "50 00 01 32 F4 00 00 00 00 33 81 81"

CRC-B = "01 21"

Status Code returned by the reader = "90 00"

Example 5: To send an APDU to an ISO 14443-4 Type B Tag (Data Exchange)

Step 1: Issue a "Direct Transmit" APDU.

The USER APDU Command should be "00 84 00 00 08"

The Composed APDU Command should be "FF 00 00 00 08 D4 40 01 00 84 00 00 08"

#In which,

Direct Transmit APDU = "FF 00 00 00"

Length of the PN532_Tag Command = "08"

PN532 Command (InDataExchange) = "D4 40 01"

Tag Command (Get Challenge) = "00 84 00 00 08"

To send an APDU to the slot 0 (default), sequence number = 5.

```
HOST -> 02 6F 0D 00 00 00 00 05 00 00 00
          FF 00 00 00 08 D4 40 01 00 84 00 00 08
          [Checksum] 03

RDR -> 02 00 00 03

RDR  -> 02 81 0F 00 00 00 00 05 00 00 00
          D5 41 00 01 02 03 04 05 06 07 08 90 00 90 00
          [Checksum] 03
```

The APDU Response is

"D5 41 00 0B 01 02 03 04 05 06 07 08 90 00"

#In which,

Response returned by the PN532 =

"D5 41 00"

Response from the Type B Tag = "01 02 03 04 05 06 07 08 90 00"

Status Code returned by the reader = "90 00"

5.16. Get the Firmware Version of the reader

To retrieve the firmware versions of the reader.

For SAM Interface 1 controller, STX = 0x02 and ETX = 0x03

For SAM Interface 2 controller, STX = 0x12 and ETX = 0x13

For SAM Interface 3 controller, STX = 0x22 and ETX = 0x23

Table 16.0A: Get Firmware Version Command Format (5 Bytes)

Command	Class	INS	P1	P2	Le
Get Response	0xFF	0x00	0x48	0x00	0x00

Le: Number of Bytes to Retrieve (1 Byte)

Maximum 255 bytes

For SAM Interface 1 controller, the feedback's STX = 0x02 and ETX = 0x03

For SAM Interface 2 controller, the feedback's STX = 0x12 and ETX = 0x13

For SAM Interface 3 controller, the feedback's STX = 0x22 and ETX = 0x23

Table 16.0B: Get Firmware Version Response Format (14 bytes)

Response	Data Out
Result	Firmware Version

E.g. 1 Response for SAM Interface 1 controller

= 41 43 52 31 32 32 4C 31 30 31 53 41 4D 31(Hex) = ACR122L101SAM1 (ASCII)

E.g. 2 Response for SAM Interface 2 controller

= 41 43 52 31 32 32 4C 31 30 31 53 41 4D 32(Hex) = ACR122L101SAM2 (ASCII)

E.g. 3 Response for SAM Interface 3 controller

= 41 43 52 31 32 32 4C 31 30 31 53 41 4D 33(Hex) = ACR122L101SAM3 (ASCII)

5.17. Basic Program Flow for FeliCa Applications

Step 0. Start the application. The first thing is to activate the "SAM Interface". The ATR of the SAM (if a SAM is inserted) or a Pseduo-ATR "3B 00" (if no SAM is inserted) will be returned. In other word, the SAM is always existed from the view of the application.

Step 1. The second thing to do is to change the operating parameters of the PN531. Set the Retry Time to one.

Step 2. Poll a FeliCa Tag by sending "Direct Transmit" and "Get Response" APDUs (Tag Polling).

Step 3. If no tag is found, go back to Step 2 until a FeliCa Tag is found.

Step 4. Access the FeliCa Tag by sending APDUs (Tag Read or Write)

Step 5. If there is no any operation with the FeliCa Tag, then go back to Step 2 to poll the other FeliCa Tag.

..

Step N. Deactivate the "SAM Interface". Shut down the application.

Remark:

1. The default Retry Time of the PN532 command "InListPassiveTarget" is infinity. Send the APDU "FF 00 00 00 06 D4 32 05 00 00 00" to change the Retry Time to one.

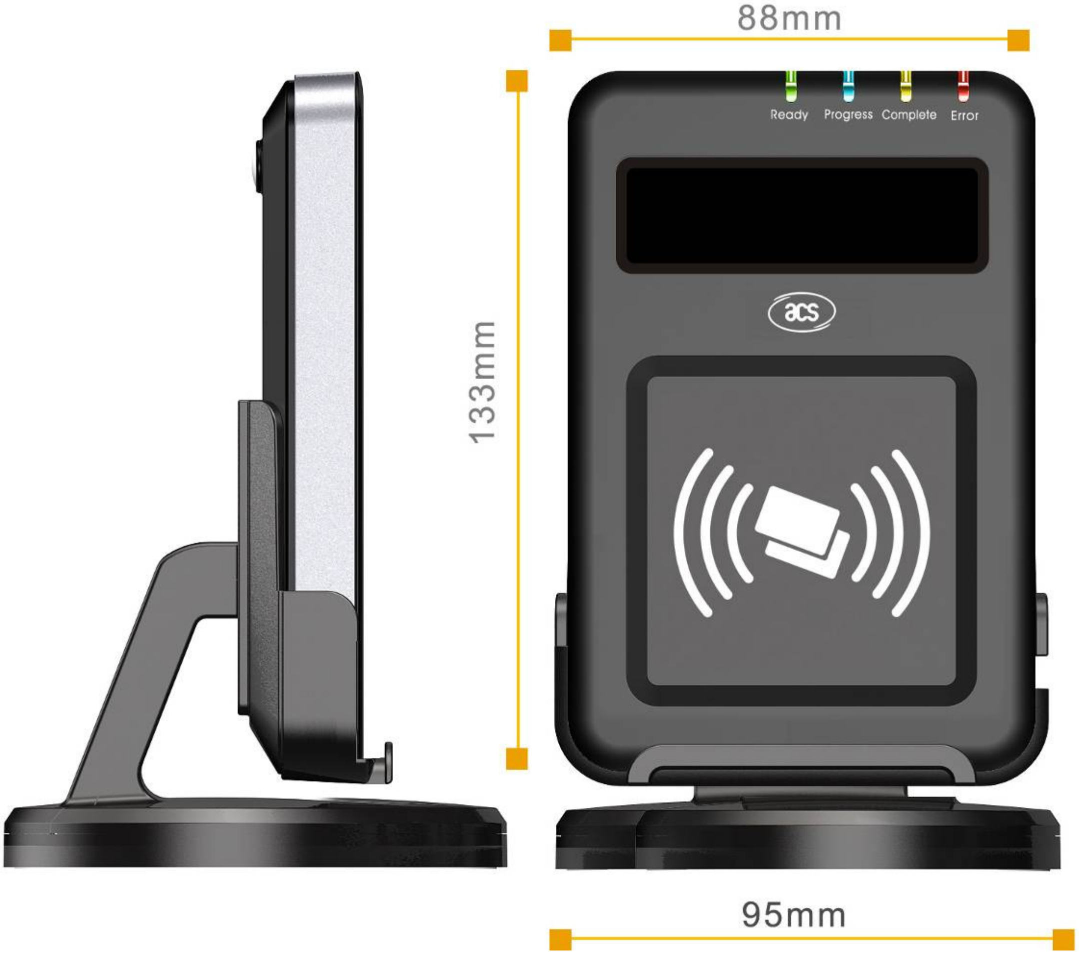
2. It is recommended to turn off the Antenna if there is no contactless access.
   APDU for turning on the Antenna Power = APDU "FF 00 00 00 04 D4 32 01 03"
   APDU for turning off the Antenna Power = APDU "FF 00 00 00 04 D4 32 01 02"

FCC Warning:

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.

6.0. Mechanical Design



7.0. Technical Specification

Serial Interface

Power source	7V AC/DC Switching Power Supply
Speed	9.6Kbps, 115.2Kbps (default)
Supply Voltage	Regulated 5V DC
Supply Current	350mA (maximum); 200mA (normal)

Contactless Smart Card Interface

Standard	MIFARE Classic, ISO14443-4 Type A & B, FeliCa, ISO/IEC 18092 NFC
Operating Frequency	13.56 MHz
Smart card read / write speed	106, 212, 424 kbps

SAM Interface

Standard	ISO 7816
Protocol	T=0 protocol
Operating Frequency	4 MHz
Smart card read / write speed	9600 - 115200 bps

Case

Dimensions	133 mm (L) x 88.66 mm (W) x 19 mm (H)
Material	ABS
Color	Black
Antenna Size	64mm x 46mm
Operating distance	up to 50 mm (depended on tag type)
Modulation	ASK and BPSK

Built-in peripherals

LED	Green, Blue Orange and Red
Buzzer	Monotone

Operating Conditions

Temperature	0 - 50° C
Humidity	10% - 80%

Cable Connector

Length	1.5 M (DB9 + DC Plug)

Standard/Certifications

CE, FCC, VCCI

OS

Windows 98, ME, 2K, XP, Vista, 7

OEM

OEM-Logo possible, customer-specific colors, casing, and card connector