ACR1281S
Specification

V1.01

Revision History

Rev Number	Date	Author	Notes
V1.00	2010-08-19	Nathan Li/ Kit Au	Preliminary specification for ACR1281S
V1.01	2010-12-15	Vincent Zhong/Jessy Wei	Modify Peripherals Control command

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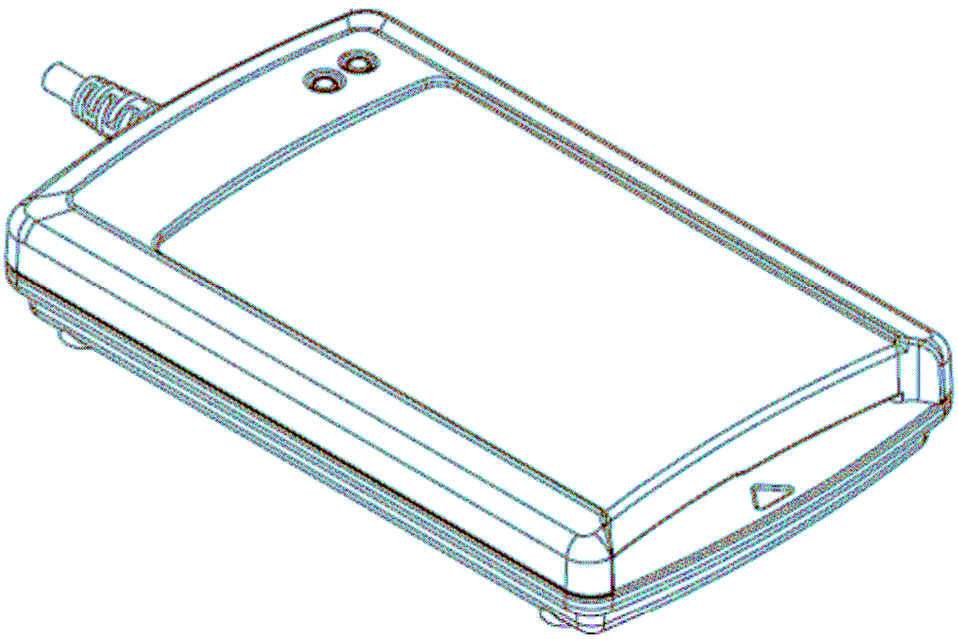
INTRODUCTION

The ACR1281S is a dual-interface reader(IFD and PCD) that supports both contact and contactless (PICC) smart cards.

FEATURES

- One standard ICC landing type card acceptor.
- ISO 7816 Parts 1-4 Compliant for Contact Smart Card Interface.
- Support contact memory cards.
- ISO 14443 Parts 1-4 Compliant for Contactless Smart Card Interface.
- A built-in antenna for PICC contactless access applications.
- The ACR1281 supports the following Tag Types:
    - MIFARE Classic. E.g. MIFARE 1K, 4K, MINI and Ultralight.
    - ISO14443-4 Type A and B.
- T=CL emulation for MIFare 1K/4K PICCs. Multi-Blocks Transfer Mode is provided for efficient PICC access.
- High Speed (424 kbps) Communication for PICCs. #Maximum 848 kbps.
- Intelligent Support for Hybrid Cards and Combi Cards.
- Energy saving modes for turning off the antenna field whenever the PICC is inactive, or no PICC is found. It prevents the PICC from exposing to the field all the time.
- User-Controllable Peripherals. E.g. LED, Buzzer.
- CCID-liked Frame Format.
- Serial Interface up to 500kbps.
- Device Firmware Upgradeable through the USB Interface.

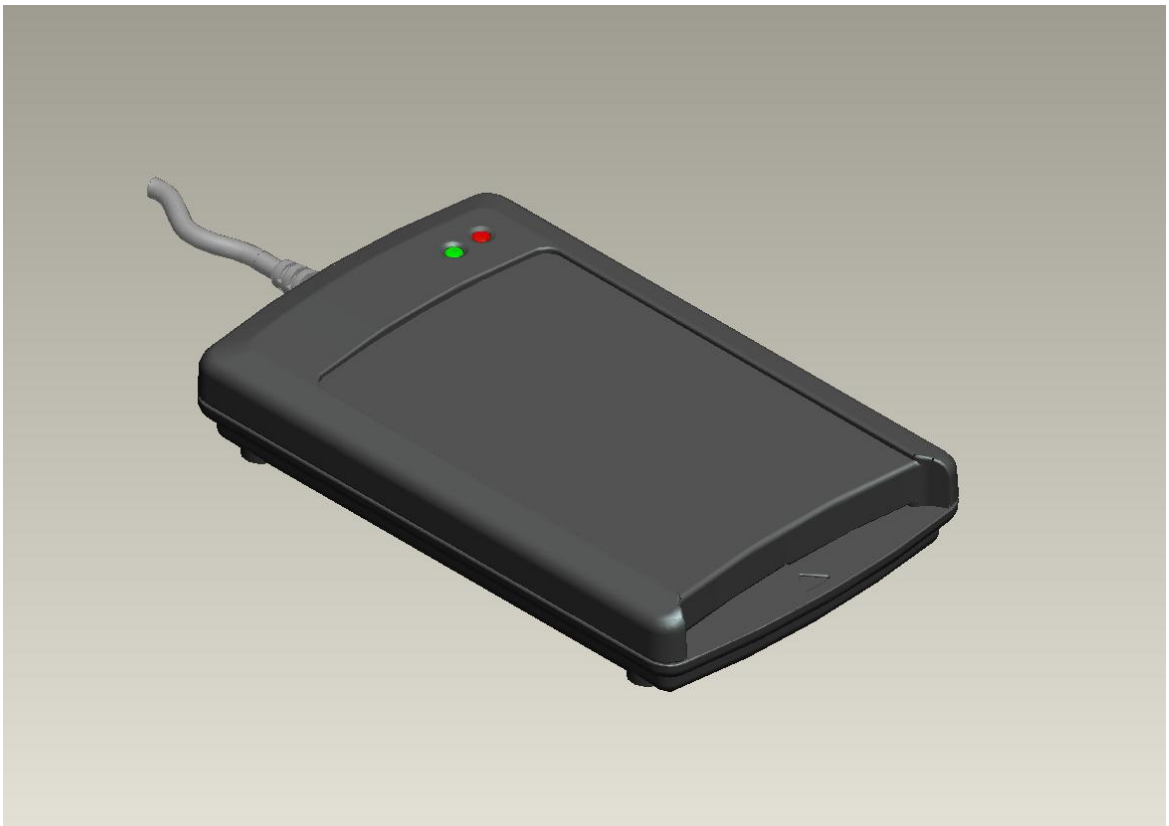


TERMS

- **IFD**: Interface Device. A terminal, communication device, or machine to which the integrated circuit(s) card is electrically connected during operation.
- **PCD**: Proximity Coupling Device. ISO 14443 Contactless Reader.
- **ICC**: Integrated Circuit(s) Card. Refer to a plastic card containing an integrated circuit, which is compatible with ISO 7816.
- **PICC**: Proximity Integrated Circuit(s) Card. Contactless Cards operating without mechanical contact to the IFD, using magnetic coupling.
- **Combi-Card**: A smart card that supports both ICC and PICC Interfaces. But only one interface can be operating at any one time.
- **Hybrid-Card**: A smart card that consists of both ICC and PICC cards. Both ICC and PICC cards can be operating at the same time.
- **USB**: Universal Serial Bus, a common device interface used in PC environment.
- **CCID**: The specifications for USB devices that interface with ICC or act as interfaces with ICC/PICC.
- **PCSC**: Personal Computer Smart Card, a specification that can facilitate the interoperability necessary to allow ICC/PICC technology to be effectively utilized in the PC environment.
- **ISO 7816**: A standard for contact smart cards (ICC).
- **T=0**: Character-oriented asynchronous half duplex transmission protocol for ICCs (ISO 7816).
- **T=1**: Block-oriented asynchronous half duplex transmission protocol for ICCs (ISO 7816).
- **ISO 14443**: A standard for contactless smart cards (PICC)
- **T=CL**: Block-oriented asynchronous half duplex transmission protocol for PICCs (ISO 14443).
- **APDU**: Application Protocol Data Unit.
- **ATR**: Answer-to-Reset. The transmission sent by an ICC to the reader (IFD) in response to a RESET condition.
- **ATS**: Answer-to-Select. The transmission sent by a PICC Type A to the reader (PCD) in response to a SELECT condition.
- **ATQB**: Answer-to-Request. The transmission sent by a PICC Type B to the reader (PCD) in response to a REQUEST condition.
- **Card Insertion Event**: Either an ICC or a PICC is just appeared to the reader.
- **Card Removal Event**: Either an ICC or a PICC is removed from the reader.
- **NAK**: Negative Acknowledge, only used to get the last response or slot change message report in ACR1281S.
- **XOR** : Exclusive OR
- **RDR**: ACR1281S.
- **HOST**: Host Controller.
- **HOST_to_RDR**: Host Controller -> ACR1281S
- **RDR_to_HOST**: ACR1281S -> Host Controlle

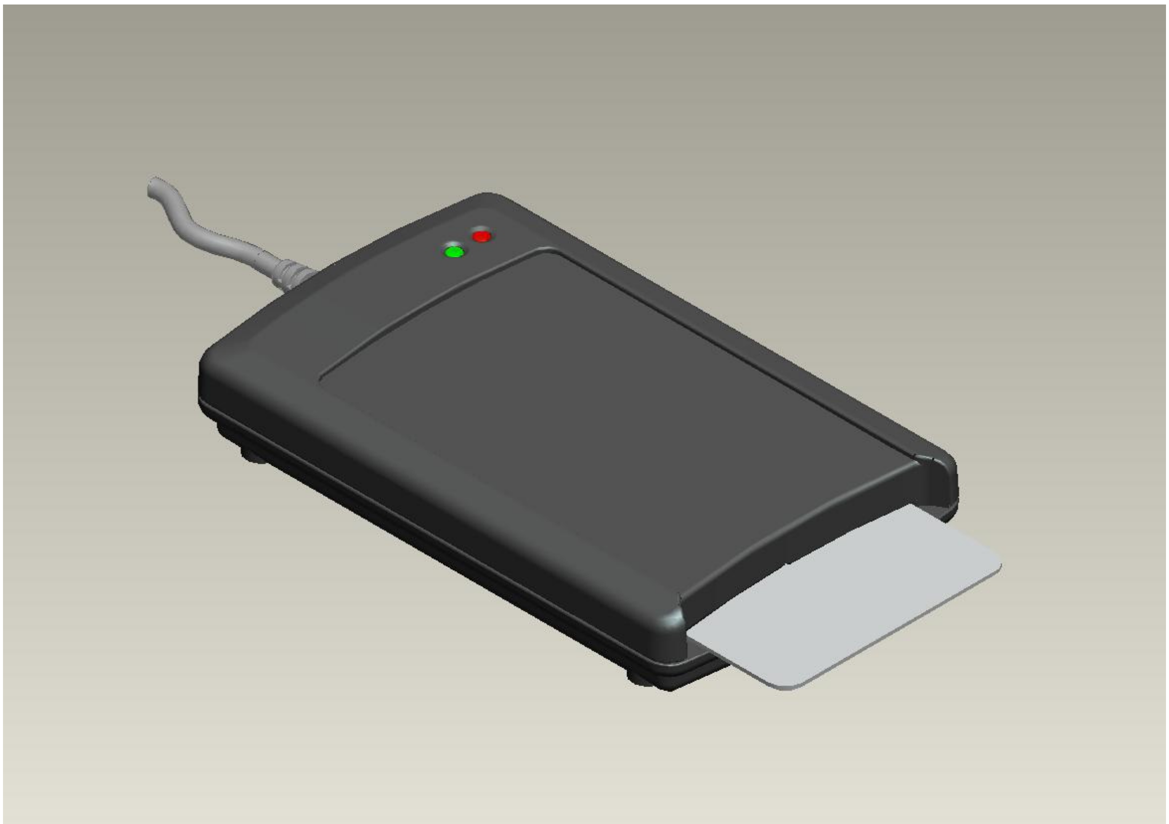
QUICK OVERVIEW OF THE ACR1281S READER

1. ACR1281S (with Contact Card Option)

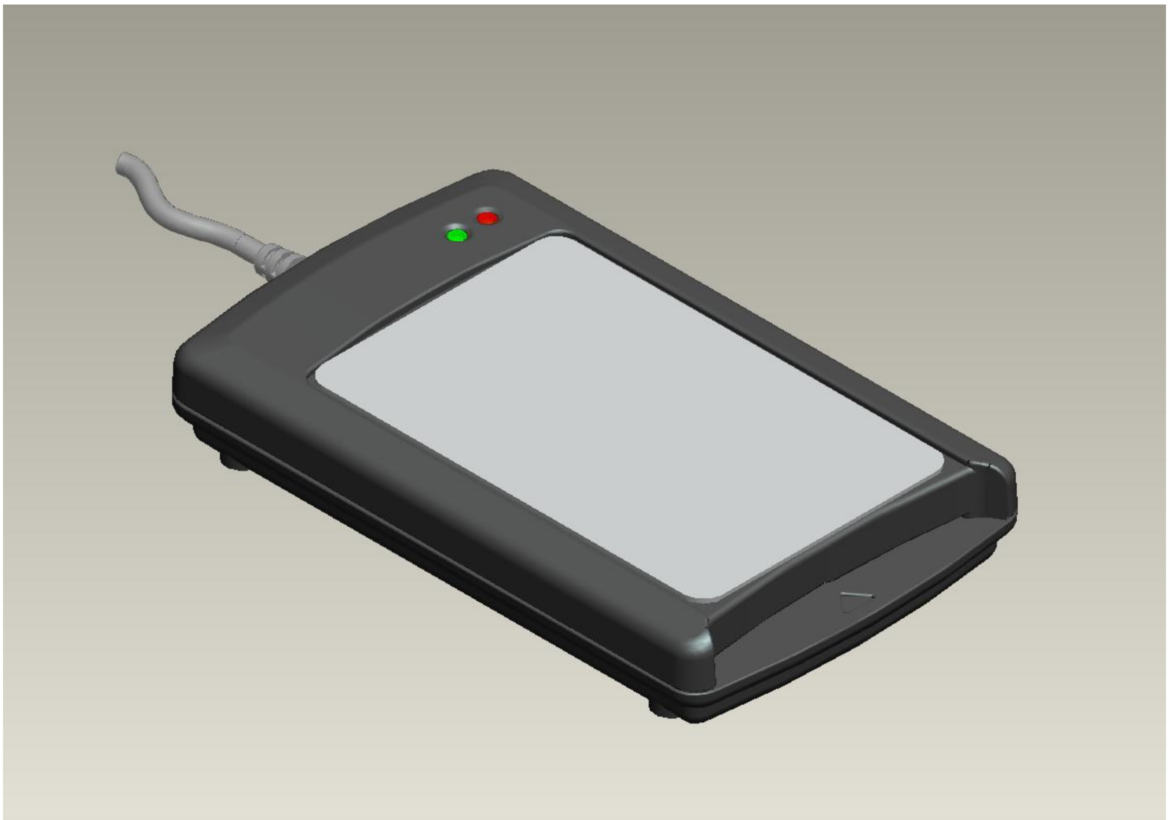


2. ACR1281S (without Contact Card Option)

3. ACR1281S ICC Interface

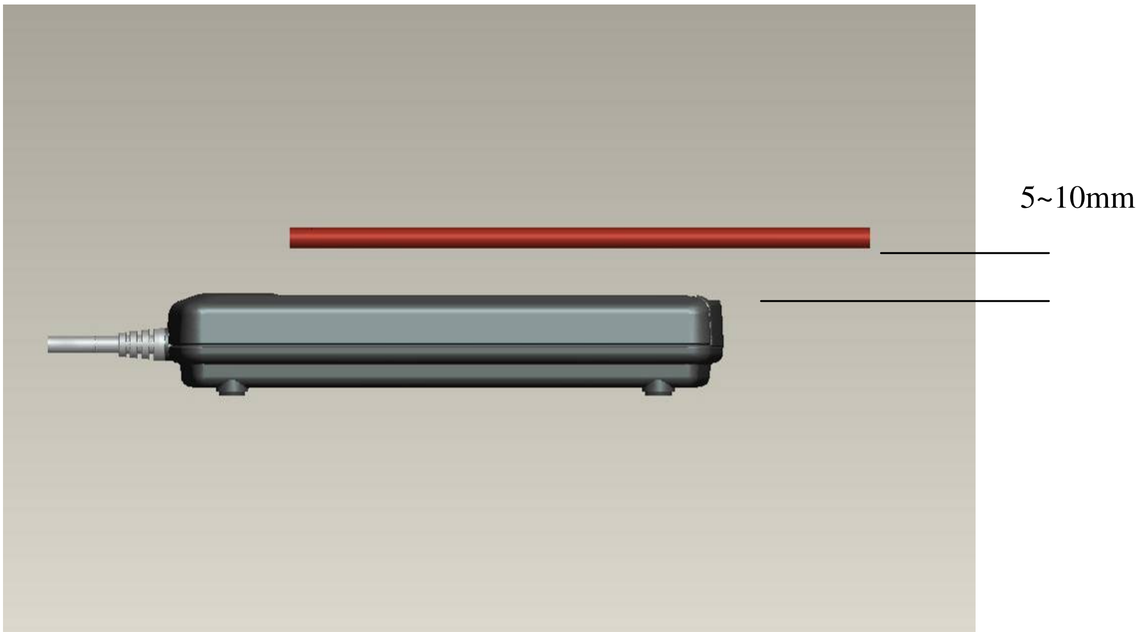


4. ACR1281S PICC Interface



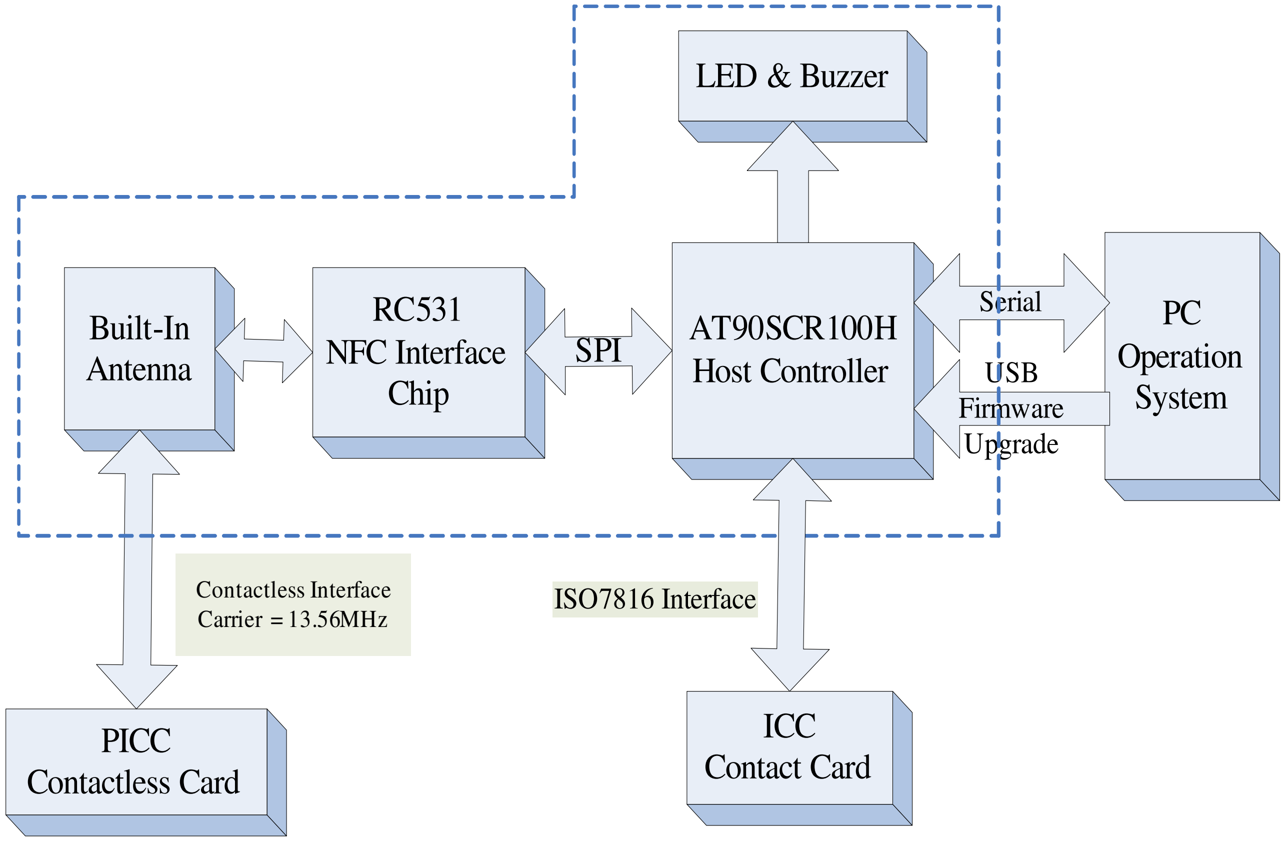
Recommended ICAO E-Passport Placement

- In case the E-Passport is not accessible, try to place the E-Passport above the reader by 5~10mm.

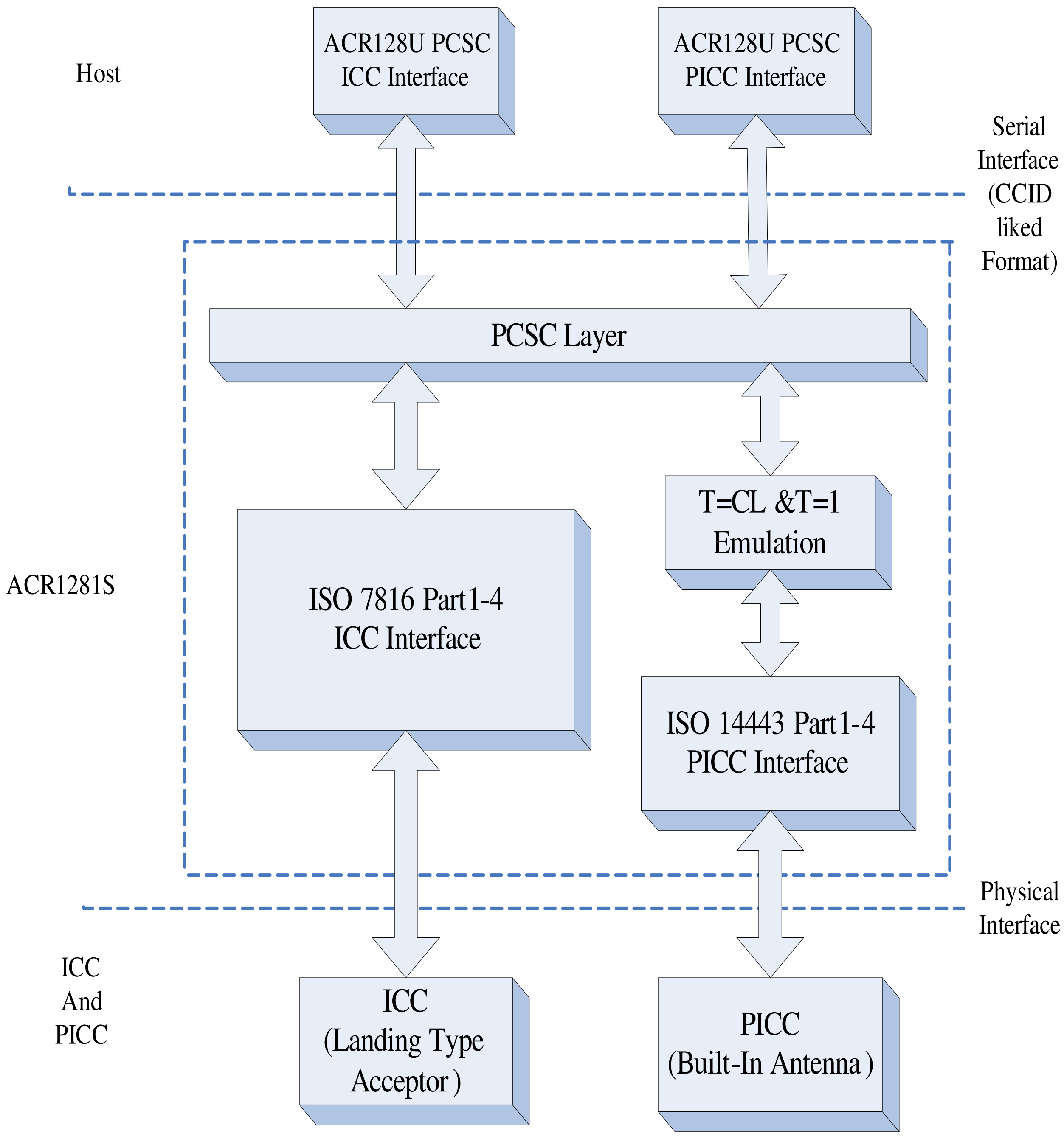


SYSTEM DESCRIPTION

1. The Reader Block Diagram



2. Communication Flow Chart of ACR1281S



HARDWARE DESCRIPTION

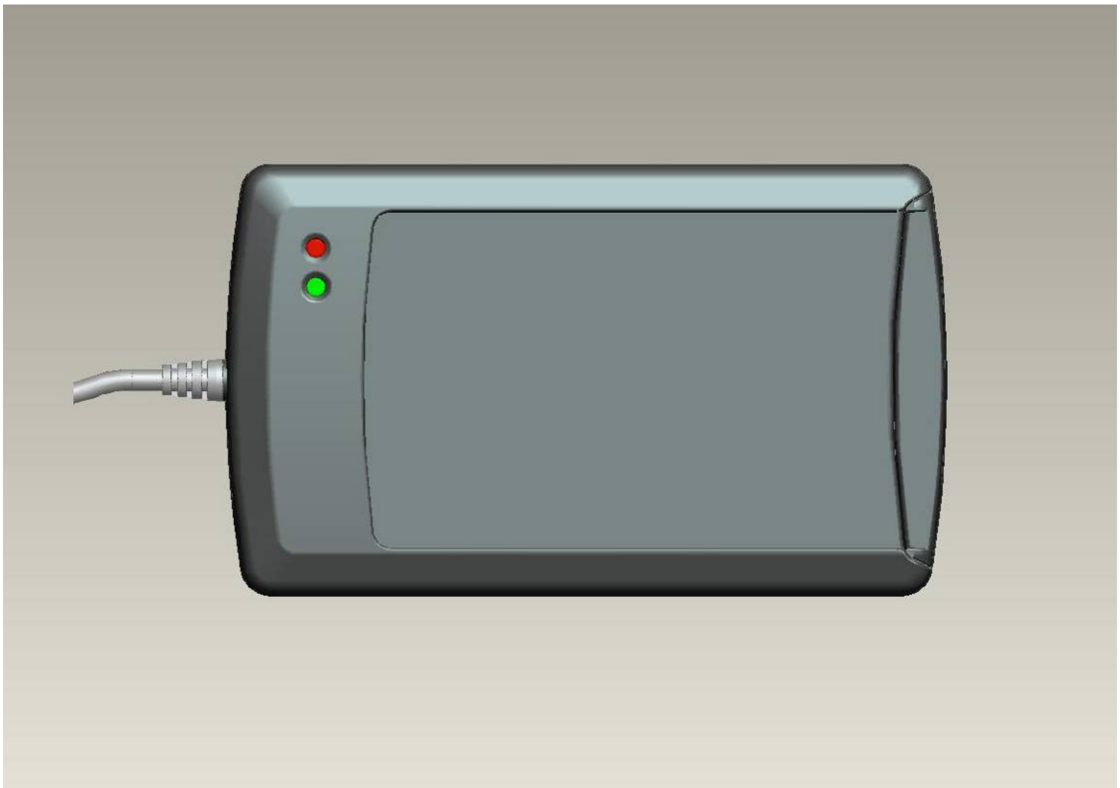
3. USB Interface

The ACR1281S is connected to a Host through the RS232 Serial Interface; the max speed is up to 500kbps.

Pin	Signal	Function
1	VCC	+5V power supply for the reader.
2	RXD	The signal from the reader to the host.
3	TXD	The signal from the host to the reader.
4	GND	Reference voltage level for power supply

4. LED Indicator

The LEDs are used for showing the state of the contact and contactless interfaces.The Red LED is used for showing PICC status and Green LED for ICC.



Reader States	Red LED PICC Indicator	Green LED ICC Indicator
1. No PICC Found or PICC present but not activated.	A single pulse per ~ 5 seconds	
2. PICC is present and activated	ON	
3. PICC is operating	Blinking	
4. ICC is present and activated		ON
5. ICC is absent or not activated		OFF
6. ICC is operating		Blinking

5. Buzzer

A monotone buzzer is used to show the “Card Insertion” and “Card Removal” events.

Events	Buzzer
1. The reader powered up and initialization success.	Beep
2. Card Insertion Event (ICC or PICC)	Beep
3. Card Removal Event (ICC or PICC)	Beep

6. ICC Interface (Contact Smart Card)

A landing type Smart Card Acceptor is used for providing reliable operations. The minimum life cycle of the acceptor is about 300K times of card insertion and removal.

7. PICC Interface (Contactless Smart Card)

A built-in antenna is used for communication between the PCD and PICC.

SERIAL COMMUNICATION PROTOCOL (CCID-LIKED FRAME FORMAT)

Communication setting: 9600 bps(Default), 19200 bps, 38400 bps, 57600 bps and 115200 bps,128000bps, 250000bps, 500000bps.
Byte format: 8-N-1.

The communication protocol between the Host and ACR1281S is very similar to the CCID protocol.

Command Frame Format

STX (0x02)	Bulk-OUT Header	APDU Command Or Parameters	Checksum	ETX (0x03)
1 Byte	10 Bytes	M Bytes (If applicable)	1 Byte	1 Byte

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

Status Frame Format

STX (0x02)	Status	Checksun	ETX (0x03)
1 Byte	1 Byte	1 Byte	1 Byte

NOTE: Checksum = Status

Response Frame Format

STX (0x02)	Bulk-IN Header	APDU Response Or abData	Checksum	ETX (0x03)
1 Byte	10 Bytes	N Bytes (If applicable)	1 Byte	1 Byte

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

8. Bulk-OUT Command

8.1 HOST_to_RDR_IccPowerOn

This command is used to activate the ICC and PICC . The ATR will be returned if available in response "RDR_to_HOST_DataBlock" Format (See 2.1).

Command Frame Format

STX (0x02)	Bulk-OUT Header (HOST_to_RDR_IccPowerOn)	Parameters	Checksum	ETX (0x03)
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

HOST_to_RDR_IccPowerOn Format

Offset	Field	Size	Value	Description
0	bMessageType	1	62h	
1	dwLength <LSB .. MSB>	4	00000000h	Message-specific data length
5	bSlot	1	00h,01h	00h forPICC interface, 01h for ICC
6	bSeq	1	00h-FFh	Sequence number for command
7	bPowerSelect	1	00h, 01h, 02h, 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

Note: The ICC interface must be activated before access contact cards while PICC interface is optional.

Example: Power on PICC slot

Command: 02 62 00 00 00 00 00 00 00 00 00 62 03

ACK: 02 00 00 03

Response: 02 80 10 00 00 00 00 00 00 81 00 3B 8B 80 01 4A 43 4F 50 33 31 33 36 47 44 54 4C 2A 03

8.2 HOST_to_RDR_IccPowerOff

This command is used to deactivate the ICC. For PICC, it does nothing.

Command Frame Format

STX (0x02)	Bulk-OUT Header (HOST_to_RDR_IccPowerOff)	Parameters	Checksum	ETX (0x03)
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

HOST_to_RDR_IccPowerOff Format

Offset	Field	Size	Value	Description
0	bMessageType	1	63h	
1	dwLength <LSB .. MSB>	4	00000000h	Message-specific data length
5	bSlot	1	00h,01h	00h forPICC interface, 01h for ICC
6	bSeq	1	00-FFh	Sequence number for command
7	abRFU	3		Reserved for Future Use

Example: Power off PICC slot
Command: 02 63 00 00 00 00 00 00 00 00 00 63 03
ACK: 02 00 00 03
Response: 02 81 00 00 00 00 00 00 00 81 00 00 03

8.3 HOST_to_RDR_XfrBlock

This command is used to exchange APDUs between the Host and ACR1281S.

Command Frame Format

STX (0x02)	Bulk-OUT Header (HOST_to_RDR_XfrBlock)	APDU Commands	Checksum	ETX (0x03)
1 Byte	10 Bytes	M Bytes	1 Byte	1 Byte

HOST_to_RDR_XfrBlock Format

Offset	Field	Size	Value	Description
0	bMessageType	1	6Fh	
1	dwLength <LSB .. MSB>	4	M	Message-specific data length
5	bSlot	1	00h,01h	00h forPICC interface, 01h for ICC
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	
10	abData	Byte array		Data sent to the reader.

Example: Read 256 bytes from PICC slot
Command: 02 6F 05 00 00 00 00 00 00 00 00 80 B2 00 00 00 58 03
ACK: 02 00 00 03
Response: 02 80 02 01 00 00 00 00 00 81 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11 12 13 14 15 16 17 18 19 1A 1B 1C 1D 1E 1F 20 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F 30 31 32 33 34 35 36 37 38 39 3A 3B 3C 3D 3E 3F 40 41 42 43 44 45 46 47 48 49 4A 4B 4C 4D 4E 4F 50 51 52 53 54 55 56 57 58 59 5A 5B 5C 5D 5E 5F 60 61 62 63 64 65 66 67 68 69 6A 6B 6C 6D 6E 6F 70 71 72 73 74 75 76 77 78 79 7A 7B 7C 7D 7E 7F 80 81 82 83 84 85 86 87 88 89 8A 8B 8C 8D 8E 8F 90 91 92 93 94 95 96 97 98 99 9A 9B 9C 9D 9E 9F A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 AA AB AC AD AE AF B0 B1 B2 B3 B4 B5 B6 B7 B8 B9 BA BB BC BD BE BF C0 C1 C2 C3 C4 C5 C6 C7 C8 C9 CA CB CC CD CE CF D0 D1 D2 D3 D4 D5 D6 D7 D8 D9 DA DB DC DD DE DF E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 EA EB EC ED EE EF F0 F1 F2 F3 F4 F5 F6 F7 F8 F9 FA FB FC FD FE FF 00 90 00 92 03

8.4 HOST_to_RDR_GetSlotStatus

This command is used to get the status of ICC, PICC slots.
Command Frame Format

STX (0x02)	Bulk-OUT Header (HOST_to_RDR_XfrBlock)	Parameters	Checksum	ETX (0x03)
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

HOST_to_RDR_GetSlotStatus Format

Offset	Field	Size	Value	Description
0	bMessageType	1	65h	
1	dwLength <LSB .. MSB>	4	00000000h	Message-specific data length
5	bSlot	1	00h,01h	00h forPICC interface, 01h for ICC
6	bSeq	1	00-FFh	Sequence number for command
7	abRFU	3		Reserved for Future Use

8.5 HOST_to_RDR_SetParameters

This command is used to change the parameters for contact interface to implement PPS.

Command Frame Format

STX (0x02)	Bulk-OUT Header (HOST_to_RDR_XfrBlock)	Parameters	Checksum	ETX (0x03)
1 Byte	10 Bytes	5 or 7 bytes	1 Byte	1 Byte

HOST_to_RDR_SetParameters Format

Offset	Field	Size	Value	Description
0	bMessageType	1	61h	
1	dwLength <LSB .. MSB>	4	00000005h, 00000007h	Message-specific data length
5	bSlot	1	00h,01h	00h forPICC interface, 01h for ICC
6	bSeq	1	00-FFh	00h for protocol T=0, 01h for T=1.
7	bProtocolNum	1	00h,01h	Used to extend the Block Waiting Timeout.
8	abRFU	2		Reserved for Future Use
10	abProtocolDataStructure	Byte array		Protocol Data Structure

Remarks:

For protocol T = 0, dwLength = 00000005h; for protocol T = 1, dwLength = 00000007h. More detail about the abProtocolDataStructure field, please refer to CCID specification.

8.6 HOST_to_RDR_Escape

This command is used to peripherals control such as LED & Buzzer control, Get firmware Version, set the serial communication mode and so on.

Command Frame Format

STX (0x02)	Bulk-OUT Header (HOST_to_RDR_XfrBlock)	Commands	Checksum	ETX (0x03)
1 Byte	10 Bytes	M bytes	1 Byte	1 Byte

HOST_to_RDR_Escape Format

Offset	Field	Size	Value	Description
0	bMessageType	1	6Bh	
1	dwLength <LSB .. MSB>	4	M	Message-specific data length

5	bSlot	1	00h,01h	00h for PICC interface, 01h for ICC
6	bSeq	1	00-FFh	00h for protocol T=0, 01h for T=1.
7	abRFU	3		Reserved for Future Use
10	abData	Byte array		Data block sent to the reader.

Example for buzzer on 50ms :
Command: 02 6B 06 00 00 00 01 00 00 00 00 E0 00 00 28 01 05 A0 03

ACK: 02 00 00 03

Response: 02 83 06 00 00 00 01 00 02 00 00 E1 00 00 00 01 05 63 03

9. Bulk-IN Response

9.1 RDR_to_HOST_DataBlock

The reader in response to the "HOST_to_RDR_IccPowerOn" and "HOST_to_RDR_XfrBlock" command messages.

Response to the "HOST_to_RDR_IccPowerOn":
Response Frame Format

STX (0x02)	Bulk-IN Header (RDR_to_HOST_DataBlock)	abData	Checksum	ETX (0x03)
1 Byte	10 Bytes	N Bytes of ATR (If card is available)	1 Byte	1 Byte

RDR_to_HOST_DataBlock Format

Offset	Field	Size	Value	Description
0	bMessageType	1	80h	Indicates that a data block is being sent from the ACR1281S
1	dwLength <LSB .. MSB>	4	N	Size of abData field. (N Bytes)
5	bSlot	1	Same as Bulk-OUT	00h for PICC interface, 01h for ICC
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command.
7	bStatus	1		
8	bError	1		
9	bChainParameter	1		

Response to "HOST_to_RDR_XfrBlock"
Response Frame Format

STX (0x02)	Bulk-IN Header (RDR_to_HOST_DataBlock)	abData	Checksum	ETX (0x03)
1 Byte	10 Bytes	N Bytes	1 Byte	1 Byte

RDR_to_HOST_DataBlock Format

Offset	Field	Size	Value	Description
0	bMessageType	1	80h	Indicates that a data block is being sent from the ACR1281S
1	dwLength <LSB .. MSB>	4	N	Size of abData field. (N Bytes)
5	bSlot	1	Same as Bulk-OUT	00h for PICC interface, 01h for ICC
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command.
7	bStatus	1		
8	bError	1		
9	bChainParameter	1		

9.2 RDR_to_HOST_SlotStatus

The reader in response to the "HOST_to_RDR_IccPowerOff" and "HOST_to_RDR_GetSlotStatus" command messages.

Response Frame Format

STX (0x02)	Bulk-IN Header (RDR_to_HOST_SlotStatus)	abData	Checksum	ETX (0x00)
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

RDR_to_HOST_SlotStatus Format

Offset	Field	Size	Value	Description
0	bMessageType	1	81h	Indicates that a data block is being sent from the ACR1281S
1	dwLength <LSB .. MSB>	4	00000000h	Size of abData field. (0 Bytes)
5	bSlot	1	Same as Bulk-OUT	00h for PICC, 01h for ICC
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command
7	bStatus	1		
8	bError	1		
9	bClockStatus	1		

9.3 RDR_to_HOST_Parameters

The reader in response to the "HOST_to_RDR_SetParameters" command messages.

Response Frame Format

STX (0x02)	Bulk-IN Header (RDR_to_HOST_SlotStatus)	abData	Checksum	ETX (0x00)
1 Byte	10 Bytes	5 or 7 Bytes	1 Byte	1 Byte

RDR_to_HOST_SlotStatus Format

Offset	Field	Size	Value	Description
0	bMessageType	1	82h	Indicates that a data block is being sent from the ACR1281S
1	dwLength <LSB .. MSB>	4	00000005h, 00000007h	Size of abData field.
5	bSlot	1	Same as Bulk-OUT	00h for PICC, 01h for ICC
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command
7	bStatus	1		
8	bError	1		
9	bProtocolNum	1		
10	abProtocolDataStructure	Byte array		Protocol Data Structure

Remarks:

For protocol T = 0, dwLength = 00000005h; for protocol T = 1, dwLength = 00000007h. More detail about the abProtocolDataStructure field, please refer to CCID specification.

9.4 RDR_to_HOST_Escape

The reader in response to “HOST_to_RDR_Escape” command messages.

Response Frame Format

STX (0x02)	Bulk-IN Header (RDR_to_HOST_DataBlock)	abData	Checksum	ETX (0x03)
1 Byte	10 Bytes	N Bytes	1 Byte	1 Byte

RDR_to_HOST_Escape Format

Offset	Field	Size	Value	Description
0	bMessageType	1	83h	Indicates that a data block is being sent from the ACR1281S
1	dwLength <LSB .. MSB>	4	N	Size of abData field. (N Bytes)
5	bSlot	1	Same as Bulk-OUT	00h for PICC, 01h for ICC
6	bSeq	1	Same as Bulk-OUT	Sequence number for corresponding command
7	bStatus	1		
8	bError	1		
9	bRFU	1	00h	Reserved for Future Use
10	abData	Byte array		Data sent from reader.

10. RDR_to_PC_NotifySlotChange Messages

This message is used to report the Card Insertion/Removal Event to the HOST.

Frame Format

STX (0x02)	Interrupt-In Messages	Checksum	ETX (0x03)
1 Byte	2 Bytes	1 Byte	1 Byte

RDR_to_PC_NotifySlotChange Format

Offset	Field	Size	Value	Description
0	bMessageType	1	50h	
1	bmSlotCardState	1		Each slot has 2 bits. The least significant bit reports the current state of the slot (0b = no card present, 1b = card present). The most significant bit reports whether the slot has changed state since the last RDR_to_PC_NotifySlotChange message was sent (0b = no change, 1b = change).

bmSlotCardState Bit Map

Offset	Field	Description
Bit0	Slot 0 current state	PICC slot state
Bit1	Slot 0 changed status	PICC slot changed status
Bit2	Slot 1 current state	ICC slot state
Bit3	Slot 1 changed status	ICC slot changed status
Bit4	Slot 2 current state	RFU
Bit5	Slot 2 changed status	RFU
Bit6	RFU	RFU
Bit7	RFU	RFU

11. Error Handling

- ACK Frame: {02 00 00 03}.
  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.

- NAK Frame = {02 00 00 00 00 00 00 00 00 00 00 00 03} // 11 zeros
  The NAK Frame is only used by the HOST to get the last response or card insertion/ removal event messages.

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}.
  The received data checksum is not correct.

- Length Error Frame = {02 FE FE 03}.
  The length “dwLength” is greater than 0x0105 bytes.

- ETX Error Frame = {02 FD FD 03}.
  The last byte is not equal to ETX “0x03”.

- Slot error Frame = {02 FB FB 03}.
  The Slot number is not 00 or 01 .

- Time out Error Frame : {02 99 99 03}.
  The time of data transmit is over.

12. Protocol Flow Examples

1) Activate a ICC

	HOST		RDR
1. HOST sends a frame	→	02 62 00 00 00 00 01 00 00 00 00 63 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 13 00 00 00 01 00 00 81 00 3B BE 11 00 00 41 01 38 00 00 01 00 00 00 00 00 01 90 00 6F 03	←

2) Activate a ICC (Incorrect Checksum, HOST)

	HOST		RDR
1. HOST sends a corrupted frame	→	02 62 00 00 00 00 01 00 00 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 01 00 00 00 00 63 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 13 00 00 00 01 00 00 81 00 3B BE 11 00 00 41 01 38 00 00 01 00 00 00 00 00 01 90 00 6F 03	←

3) Activate a ICC (Incorrect Checksum, RDR)

	HOST		RDR
1. HOST sends a frame	→	02 62 00 00 00 00 01 00 00 00 00 63 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 13 00 00 00 01 00 00 81 00 3B BE 11 00 00 41 01 38 00 00 01 00 00 00 00 00 01 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	
5. RDR sends back the response of the command		02 80 13 00 00 00 01 00 00 81 00 3B BE 11 00 00 41 01 38 00 00 01 00 00 00 00 00 01 90 00 6F 03	←

4) Exchange APDU with ICC

	HOST		RDR
1. HOST sends a frame	→	02 6F 05 00 00 00 01 00 00 00 00 80 84 00 00 08 67 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 0A 00 00 00 01 00 00 81 00 C2 FF 2D 23 C5 F6 5C F2 90 00 34 03	←

APDU Command: 80 84 00 00 08

APDU Response: 22 5C E9 1C A4 5A A4 D6 90 00

5) Insert contact card into the ICC slot

	HOST		RDR
1. Insert contact card into the ICC slot			
2. RDR sends a Interrupt-In Message frame to HOST		02 50 0C [Checksum] 03	←
3. Present contactless card to the Antenna field			
4. RDR sends a Interrupt-In Message frame to HOST		02 50 07 [Checksum] 03	←
5. HOST sends a NAK frame to get the Message again.	->		
6. RDR sends back the last messages.		02 50 07 [Checksum] 03	←

PERIPHERALS CONTROL

The reader's peripherals control is implemented by Escape Command.

1. Set Serial Communication Mode

APDU Command = {44 "CMD"}
APDU Response = {90 "Status"}

CMD Bit Map

Offset	Description	Description
Bit 0-3	Indicate Serial Communication Speed	0 = 9600bps(Default) 1= 19200bps 2 = 38400bps 3 = 57600bps 4 = 115200bps 5 = 128000bps 6 = 230400bps 7 = 250000bps 8 = 256000bps 9 = 500000bps Other value reserve for future use.
Bit 4	RFU	RFU
Bit 5	RFU	RFU
Bit 6	RFU	RFU
Bit 7	Interrupt-In Message(CCID-liked Format)	1 = Report Interrupt-In Message. 0 = Not report(Default).

The "Status" bit map is the same as "CMD".
Example: change the communication speed to 115200bps
Command: 02 6B 02 00 00 00 01 00 00 00 00 44 04 28 03
ACK : 02 00 00 03
Response: 02 83 02 00 00 00 01 00 00 81 00 90 04 95 03

Remarks:

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 9600 bps (Default) and not report Interrupt-In Message.

2. Get Firmware Version

APDU Command = {E0 00 00 18 00}
APDU Response = {E1 00 00 00 "Frame Length" {Firmware Version}}
Example:
Command: 02 6B 05 00 00 00 01 00 00 00 00 E0 00 00 18 00 97 03
ACK: 02 00 00 03
Response: 02 83 12 00 00 00 01 00 00 81 00 E0 00 00 00 00 41 43 52 31 32 38 31 53 20 56 31 30 33 BC 03
In which, Firmware Version = 11 bytes;
e.g. Response = E1 00 00 00 0F 41 43 52 31 32 38 31 53 20 56 31 30 33

Firmware Version (HEX) = 41 43 52 31 32 38 31 53 20 56 31 30 33
Firmware Version (ASCII) = "ACR1281S V103"

3. Enter Firmware Upgrade Mode

Command = {FF 00 00 E0 00}
Response = {FF 00 00 E1 02 90 00}
Example:
Command: 02 6B 05 00 00 00 01 00 00 00 00 FF 00 00 E0 00 70 03
ACK: 02 00 00 03
Response: 02 83 07 00 00 00 01 00 00 00 00 FF 00 00 E1 02 90 00 09 03

Hints:
After the response display, the reader will enter the firmware upgrade mode that the reader can be upgraded firmware.

4. LED Control

- **Setting the LED State:**

APDU Command = {E0 00 00 29 01 "CMD"}.
APDU Response = {E1 00 00 00 01 "Status"}

- **Reading the existing LED State:**

APDU Command = {E0 00 00 29 00}.
APDU Response = {E1 00 00 00 01 "Status"}

CMD Bit Map

CMD	Description	Description
Bit 0	RED LED	1 = ON; 0 = OFF
Bit 1	GREEN LED	1 = ON; 0 = OFF
Bit 2	RFU	RFU
Bit 3	RFU	RFU
Bit 4	RFU	RFU
Bit 5	RFU	RFU
Bit 6	RFU	RFU
Bit 7	RFU	RFU

The "Status" bit map is the same as "CMD".
Example: Red LED ON
Command: 02 6B 06 00 00 00 01 00 00 00 00 E0 00 00 29 01 01 A5 03
ACK: 02 00 00 03
Response: 02 83 06 00 00 00 01 00 00 81 00 E0 00 00 00 01 01 E5 03

5. Buzzer Control

- **Setting the Buzzer State:**

APDU Command = {E0 00 00 28 01 "Duration"} Unit = 10mS

00 = Turn off
01 ~ FE = Duration
FF = Turn o
APDU Response = {E1 00 00 00 01 "Status"}

- **Reading the existing Buzzer State:**

APDU Command = {E0 00 00 28 00}
APDU Response = {E1 00 00 00 01 "Status"}

Example for buzzer on 50ms :
Command: 02 6B 06 00 00 00 01 00 00 00 00 E0 00 00 28 01 05 A0 03
ACK: 02 00 00 03
Response: 02 83 06 00 00 00 01 00 00 81 00 E0 00 00 00 01 05 E1 03

6. Default LED and Buzzer State

CMD	MODE	Description
Bit 0	ICC Activation Status LED	To show the activation status of the ICC interface. 1 = Enable; 0 =Disable
Bit 1	PICC Polling Status LED	To show the PICC Polling Status. 1 = Enable; 0 =Disable
Bit 2	PICC Activation Status LED	To show the activation status of the PICC interface 1 = Enable; 0 =Disable
Bit 3	Card Insertion and Removal Events Buzzer	To make a beep whenever a card insertion or removal event is detected. (For both ICC and PICC) 1 = Enable; 0 =Disabled
Bit 4	RFU	RFU
Bit 5	RFU	RFU
Bit 6	RFU	RFU
Bit 7	Card Operation Blinking LED	To blink the LED whenever the card (PICC or ICC) is being accessed.

- **Setting the LED and Buzzer behaviors:**

Command = { E0 00 00 21 01 "CMD"}. Default value of CMD = 8F;
Response = {E1 00 00 00 01 "Status"}

- **Reading the existing behaviors of the LED and Buzzer:**

Command = { E0 00 00 21 00}
Response = {E1 00 00 00 01 "Status"}

Hints:
If you want to enjoy the silent environment, just set the CMD value to "87".

7. Automatic PICC Polling

Whenever the reader is connected to the PC, the PICC polling function will start the PICC scanning to determine if a PICC is placed on / removed from the built-antenna.

We can send a command to disable the PICC polling function. The command is sent through the PCSC Escape command interface. To meet the energy saving requirement, special modes are provided for turning off the antenna field whenever the PICC is inactive, or no PICC is found. The reader will consume less current in power saving mode.

Register 0x23: Automatic PICC Polling (Default value = 0x8F)

CMD	Description	Description
Bit 0	Auto PICC Polling	1 = Enable; 0 =Disable
Bit 1	Turn off Antenna Field if no PICC found	1 = Enable; 0 =Disable
Bit 2	Turn off Antenna Field if the PICC is inactive.	1 = Enable; 0 =Disable
Bit 3	Activate the PICC when detected.	1 = Enable; 0 =Disable
Bit 5 .. 4	PICC Poll Interval for PICC	<Bit 5 – Bit 4> <0 – 0> = 250 msec <0 – 1> = 500 msec <1 – 0> = 1000 msec <1 – 1> = 2500 msec
Bit 6	RFU	-
Bit 7	Enforce ISO14443A Part 4	1= Enable; 0= Disable.

- Enable Auto PICC Polling Function = { E0 00 00 23 01 8F}
- Disable Auto PICC Polling Function = { E0 00 00 23 01 8E}
- Read the existing status = { E0 00 00 23 00}; Response = {E1 00 00 00 01 “Status”}

Hints:
1. It is recommended to enable the option “Turn Off Antenna Field if the PICC is inactive”, so that the “Inactive PICC” will not be exposed to the field all the time so as to prevent the PICC from “warming up”.

2. The longer the PICC Poll Interval, the more efficient of energy saving. However, the response time of PICC Polling will become longer. The Idle Current Consumption in Power Saving Mode is about 60mA, while the Idle Current Consumption in Non-Power Saving mode is about 130mA. #Idle Current Consumption = PICC is not activated.

3. The reader will activate the ISO14443A-4 mode of the “ISO14443A-4 compliant PICC” automatically. Type B PICC will not be affected by this option.

4. The JCOP30 card comes with two modes: ISO14443A-3 (MIFARE 1K) and ISO14443A-4 modes. The application has to decide which mode should be selected once the PICC is activated.

8. PICC Polling for specific PICC Types

The PICC polling function can be configured to detect “ISO14443 Type A PICCs” or “ISO14443 Type B PICCs” or both.

- ISO 14443 Type A PICCs Only = { E0 00 00 20 01 01}
- ISO 14443 Type B PICCs Only = { E0 00 00 20 01 02 }
- ISO 14443 Type A and B PICCs = { E0 00 00 20 01 03} #default setting
- Read the existing status = { E0 00 00 20 00}; Response = {E1 00 00 00 01 "Status"}

Hints:
1. It is recommended to specific the PICC types in the application so as to speed up the card detection process.

9. Auto PPS for the PICC Interface (Communication Speed Change)

Whenever a PICC is recognized, the reader will try to change the communication speed between the PCD and PICC defined by the Maximum Connection Speed. If the card does not support the proposed connection speed, the reader will try to connect the card with a slower speed setting.

- Set Connection Speed = {E0 00 00 24 02 "Max Tx Speed" "Max Rx Speed"}
  <Max Tx Speed> & <Current Tx Speed> or <Max Rx Speed> & <Current Rx Speed>

  106k bps = 00
  212k bps = 01
  424k bps = 02 #default setting
  848k bps = 03

- Read the existing status = {E0 00 00 24 00};
  Response = {E1 00 00 00 04 "Max Tx Speed" "Current Tx Speed" "Max Rx Speed" "Current Rx Speed"}

Hints:
1. Normally, the application should know the maximum connection speed of the PICCs being used.
#The environment also affects the maximum achievable speed. The reader just uses the proposed communication speed to talk with the PICC. The PICC will become inaccessible if the PICC or environment does not meet the requirement of the proposed communication speed.
2. The reader supports different speed between sending and receiving.

10. Antenna Field ON/OFF for the PICC Interface

This command is used for turning on/off the antenna field.

- Antenna Field ON APDU Command = {E0 00 00 25 01 01}
- Antenna Field OFF APDU Command = {E0 00 00 25 01 00}
- Read the existing status APDU Command = {E0 00 00 25 00};
- APDU Response = {E1 00 00 00 01 "Status"}

Hints:
1. Make sure the Auto PICC Polling is disabled first before turning off the antenna field.

11. Exclusive Mode Configure

To speed up the card detection time, we can enable the "Enforce ICC & PICC Exclusive Mode"

- Enforce ICC & PICC Exclusive Mode = {E0 00 00 2B 01 "New Mode Configuration"}.
  <New Mode Configuration> #default value 01
  00 = Both ICC & PICC interfaces can be activated at the same time.
  01 = Either ICC or PICC interface can be activated at any one time. But not both!

- Read the existing status = {E0 00 00 2B 00}
  Response {E1 00 00 00 01 "Current Mode"}
  <Current Mode >
  00 = Exclusive Mode is not activated. PICC Interface is available.

01 = Exclusive Mode is activated now. PICC Interface is not available until the ICC interface is deactivated.

Hints:

1. Don't insert any card into the contact card acceptor while the PICC is activate,or the PICC may be deselected.

12. Request Command Test

This command is used for sending REQA/REQB by the reader to test antenna field and the response.

- Command = {E0 00 00 26 02 "Command" "Speed"}
- Response = {E1 00 00 00 "Length" "Data"}

Command coding:
REQA = 01
REQB = 02
WUPA = 03
WUPB = 04

Speed coding:
106k bps = 00
212k bps = 01
424k bps = 02

Length:
No response: 00
ATQA: 02
ATQB: 0C
Others: RFU

Data:
Response Data (ATQA/ATQB/Others)

Hints:
1. Make sure the Auto PICC Polling is disabled first before sending this command.

13. Continuous Wake Up Command Sending Test for the PICC Interface

This command is used for sending WUPA/WUPB by the reader continuously to test antenna field.

- Command = {E0 00 00 27 02 “Command” “Speed”}
- Disable Command Sending = { E0 00 00 27 02 00 00}
- Response = {E1 00 00 00 01 “Status”}

Command coding:
WUPA = 01
WUPB = 02
Speed coding:
106k bps = 00
212k bps = 01
424k bps = 02
Status:
WUPA Sending = 01
WUPB Sending = 02

Hints:
1. Make sure the Auto PICC Polling is disabled first before sending this command.
2. The reader will send the command continuously as long as the command starts. It can be stopped by “E0 00 00 27 02 00 00”.

14. Read and Update the RC531 Register for the PICC Interface

- Read the Register APDU Command = {E0 00 00 19 01 “Register No”}
- APDU Response = {E1 00 00 00 01 “Current Value”}
- Update the Register APDU Command = {E0 00 00 1A 02 “Register No” “New Value”}
- APDU Response = {E1 00 00 00 00}

15. Go into Contactless EMV Terminal Loop

- Command = {0E 00 01 00 00}
- Response = {90“Current Value”}

16. Go into Contact EMV Terminal Loop

- Command = {0E 01 01 00 00}
- Response = {E1 00 00 00 01 “Current Value”}

17. Read and Initial Card Insert Counter

- Read the Register = {E0 00 00 09 00}
- Initialize the counter = {E0 00 00 09 04 “ICC Counter (LSB)” “ICC Counter (MSB)” “PICC Counter (LSB)” “PICC Counter (MSB)”}
  Response = {E1 00 00 00 04 “ICC Counter (LSB)” “ICC Counter (MSB)” “PICC Counter (LSB)” “PICC Counter (MSB)”}
- Update the counter data to static storage unit = {E0 00 00 0A 00}

18. Initial RC531 Setting For PICC

- Read the Register = {E0 00 00 2F 00}
-
- Update the Registers:
  E0 00 00 2F 13 BModeIndex RxAThres106 RxAThres212 RxAThres424 RxAThres848 RxBThres106 RxBThres212 RxBThres424 RxBThres848 RxACtl106 RxACtl212 RxACtl424 RxACtl848 RxBCtl106 RxBCtl212 RxBCtl424 RxBCtl848 CWAConductonce CWBConductonce

- Response:

  E1 00 00 00 13 BModeIndex RxAThres106 RxAThres212 RxAThres424 RxAThres848 RxBThres106 RxBThres212 RxBThres424 RxBThres848 RxACtl106 RxACtl212 RxACtl424 RxACtl848 RxBCtl106 RxBCtl212 RxBCtl424 RxBCtl848 CWAConductonce CWBConductonce

PICC INTERFACE DESCRIPTION

1. ATR Generation

If the reader detects a PICC, an ATR will be sent to the PCSC driver for identifying the PICC.

1.1 ATR format for ISO 14443 Part 3 PICCs.

Byte	Value (Hex)	Designation	Description
0	3B	Initial Header	
1	8N	T0	Higher nibble 8 means: no TA1, TB1, TC1 only TD1 is following. Lower nibble N is the number of historical bytes (HistByte 0 to HistByte N-1)
2	80	TD1	Higher nibble 8 means: no TA2, TB2, TC2 only TD2 is following. Lower nibble 0 means T = 0
3	01	TD2	Higher nibble 0 means no TA3, TB3, TC3, TD3 following. Lower nibble 1 means T = 1
4 To 3+N	80	T1	Category indicator byte, 80 means A status indicator may be present in an optional COMPACT-TLV data object
	4F	Tk	Application identifier Presence Indicator
	0C		Length
	RID		Registered Application Provider Identifier (RID) # A0 00 00 03 06
	SS		Byte for standard
	C0 .. C1		Bytes for card name
	00 00 00 00	RFU	RFU # 00 00 00 00
4+N	UU	TCK	Exclusive-oring of all the bytes T0 to Tk

e.g. ATR for MIFare 1K = {3B 8F 80 01 80 4F 0C A0 00 00 03 06 03 00 01 00 00 00 00 6A}

Length (YY) = 0x0C
RID = {A0 00 00 03 06} (PC/SC Workgroup)
Standard (SS) = 03 (ISO14443A, Part 3)
Card Name (C0 .. C1) = {00 01} (MIFare 1K)

Card Name (C0 .. C1)
00 01: Mifare 1K
00 02: Mifare 4K
00 03: Mifare Ultralight
00 26: Mifare Mini
FF [SAK]: undefined tags

1.2 ATR format for ISO 14443 Part 4 PICCs.

Byte	Value (Hex)	Designation	Description
0	3B	Initial Header	
1	8N	T0	Higher nibble 8 means: no TA1, TB1, TC1 only TD1 is following. Lower nibble N is the number of historical bytes (HistByte 0 to HistByte N-1)
2	80	TD1	Higher nibble 8 means: no TA2, TB2, TC2 only TD2 is following. Lower nibble 0 means T = 0
3	01	TD2	Higher nibble 0 means no TA3, TB3, TC3, TD3 following. Lower nibble 1 means T = 1
4 to 3 + N	XX	T1	Historical Bytes: ISO14443A: The historical bytes from ATS response. Refer to the ISO14443-4 specification. ISO14443B: The higher layer response from the ATTRIB response (ATQB). Refer to the ISO14443-3 specification.
	XX XX XX	Tk	
4+N	UU	TCK	Exclusive-oring of all the bytes T0 to Tk

E.g 1. ATR for DESFire = { 3B 81 80 01 80 80 } // 6 bytes of ATR

Hint: Use the APDU "FF CA 01 00 00" to distinguish the ISO14443A-4 and ISO14443B-4 PICCs, and retrieve the full ATS if available. ISO14443A-3 or ISO14443B-3/4 PICCs do have ATS returned.

APDU Command = FF CA 01 00 00
APDU Response = 04 2C 46 71 E6 23 80 90 00
ATS = {04 2C 46 71 E6 23 80}

Command: 02 6F 05 00 00 00 00 00 00 00 00 FF CA 00 00 00 5F 03
ACK: 02 00 00 03
Response: 02 80 09 00 00 00 00 00 00 81 00 04 2C 46 71 E6 23 80 90 00 C2 03

PICC APDU COMMANDS FOR GENERAL PURPOSES

1. Get Data

The “Get Data command” will return the serial number or ATS of the “connected PICC”.

Table 1.1-1a: Get UID APDU Format (5 Bytes)

Command	Class	INS	P1	P2	Le
Get Data	FF	CA	00 01	00	00 (Max Length)

Table 2.1-1b: Get UID Response Format (UID + 2 Bytes) if P1 = 0x00

Response	Data Out					
Result	UID (LSB)			UID (MSB)	SW1	SW2

Table 2.1-1c: Get ATS of a ISO 14443 A card (ATS + 2 Bytes) if P1 = 0x01

Response	Data Out		
Result	ATS	SW1	SW2

Table 2.1-1d: Response Codes

Results	SW1	SW2	Meaning
Success	90	00	The operation is completed successfully.
Warning	62	82	End of UID/ATS reached before Le bytes (Le is greater than UID Length).
Error	6C	XX	Wrong length (wrong number Le: ‘XX’ encodes the exact number) if Le is less than the available UID length.
Error	63	00	The operation is failed.
Error	6A	81	Function not supported

Examples:

```
// To get the serial number of the “connected PICC”
UINT8 GET_UID[5]={0xFF, 0xCA, 0x00, 0x00, 0x00};

// To get the ATS of the “connected ISO 14443-4 A PICC”
UINT8 GET_ATS[5]={0xFF, 0xCA, 0x01, 0x00, 0x00};
```

PICC APDU COMMANDS (T=CL EMULATION) FOR MIFARE 1K/4K MEMORY CARDS

2.1 Load Authentication Keys

The "Load Authentication Keys command" will load the authentication keys into the reader. The authentication keys are used to authenticate the particular sector of the Mifare 1K/4K Memory Card. Two kinds of authentication key locations are provided, volatile and non-volatile key locations respectively.

Table 2.1-1a: Load Authentication Keys APDU Format (11 Bytes)

Command	Class	INS	P1	P2	Lc	Data In
Load Authentication Keys	FF	82	Key Structure	Key Number	06	Key (6 bytes)

Key Structure (1 Byte):
0x00 = Key is loaded into the reader volatile memory.
0x20 = Key is loaded into the reader non-volatile memory.
Other = Reserved.

Key Number (1 Byte):
0x00 ~ 0x1F = Non-volatile memory for storing keys. The keys are permanently stored in the reader and will not be disappeared even the reader is disconnected from the PC. It can store up to 32 keys inside the reader non-volatile memory.
0x20 (Session Key) = Volatile memory for storing a temporally key. The key will be disappeared once the reader is disconnected from the PC. Only 1 volatile key is provided. The volatile key can be used as a session key for different sessions. Default Value = {FF FF FF FF FF FF}

Key (6 Bytes):
The key value loaded into the reader. E.g. {FF FF FF FF FF FF}

Table 2.1-1b: Load Authentication Keys Response Format (2 Bytes)

Response	Data Out	
Result	SW1	SW2

Table 2.1-1c: Load Authentication Keys Response Codes

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

Examples:

// Load a key {FF FF FF FF FF FF} into the non-volatile memory location 0x05.
APDU = {FF 82 20 05 06 FF FF FF FF FF FF}

<Similarly>
// Load a key {FF FF FF FF FF FF} into the volatile memory location 0x20.
APDU = {FF 82 00 20 06 FF FF FF FF FF FF}

Hints:
1. Basically, the application should know all the keys being used. It is recommended to store all the required keys to the non-volatile memory for security reasons. The contents of both volatile and non-volatile memories are not readable by the outside world.

2. The content of the volatile memory "Session Key 0x20" will remain valid until the reader is reset or power-off. The session key is useful for storing any key value that is changing from time to time. The session key is stored in the "Internal RAM", while the non-volatile keys are stored in "EEPROM" that is relatively slower than "Internal RAM".

3. It is not recommended to use the "non-volatile key locations 0x00 ~ 0x1F" to store any "temporally key value" that will be changed so often. The "non-volatile keys" are supposed to be used for storing any "key value" that will not change frequently. If the "key value" is supposed to be changed from time to time, please store the "key value" to the "volatile key location 0x020".

2.2.1 Authentication for MIFARE 1K/4K

The "Authentication command" uses the keys stored in the reader to do authentication with the MIFARE 1K/4K card (PICC). Two types of the keys are used for authentication, TYPE_A and TYPE_B respectively.

Table 2.2-1a: Load Authentication Keys APDU Format (6 Bytes) #Obsolete

Command	Class	INS	P1	P2	P3	Data In
Authentication	FF	88	00	Block Number	Key Type	Key Number

Table 2.2-1b: Load Authentication Keys APDU Format (10 Bytes)

Command	Class	INS	P1	P2	Lc	Data In
Authentication	FF	86	00	00	05	Authenticate Data Bytes

Authenticate Data Bytes (5 Byte):

Byte1	Byte 2	Byte 3	Byte 4	Byte 5
Version 0x01	0x00	Block Number	Key Type	Key Number

Block Number (1 Byte):
The memory block is authenticated.

For MIFARE 1K Card, it has totally 16 sectors and each sector consists of 4 consecutive blocks. E.g. Sector 0x00 consists of Blocks {0x00, 0x01, 0x02 and 0x03}; Sector 0x01 consists of Blocks {0x04, 0x05, 0x06 and 0x07}; the last sector 0x0F consists of Blocks {0x3C, 0x3D, 0x3E and 0x3F}. Once the authentication is done successfully, there is no need to do the authentication again provided that the blocks to be accessed are belonging to the same sector. Please refer to the MIFARE 1K/4K specification for more details.

#Once the block is authenticated successfully, all the blocks belonging to the same sector are accessible.

Key Type (1 Byte):
0x60 = Key is used as a TYPE A key for authentication.
0x61 = Key is used as a TYPE B key for authentication.

Key Number (1 Byte):
0x00 ~ 0x1F = Non-volatile memory for storing keys. The keys are permanently stored in the reader and will not be disappeared even the reader is disconnected from the PC. It can store 32 keys into the reader non-volatile memory.
0x20 = Volatile memory for storing keys. The keys will be disappeared when the reader is disconnected from the PC. Only 1 volatile key is provided. The volatile key can be used as a session key for different sessions.

Table 2.2-1b: Load Authentication Keys Response Format (2 Bytes)

Response	Data Out	
Result	SW1	SW2

Table 2.2-1c: Load Authentication Keys Response Codes

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

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

Examples:

// To authenticate the Block 0x04 with a {TYPE A, non-volatile, key number 0x05}.
// PC/SC V2.01, Obsolete
APDU = {FF 88 00 04 60 05};

<Similarly>
// To authenticate the Block 0x04 with a {TYPE A, non-volatile, key number 0x05}.
// PC/SC V2.07
APDU = {FF 86 00 00 05 01 00 04 60 05}

Hints:

MIFARE Ultralight does not need to do any authentication. The memory is free to access.

2.3 Read Binary Blocks

The "Read Binary Blocks command" is used for retrieving a multiple of "data blocks" from the PICC. The data block/trailer block must be authenticated first before executing the "Read Binary Blocks command".

Table 2.3-1a: Read Binary APDU Format (5 Bytes)

Command	Class	INS	P1	P2	Le
Read Binary Blocks	FF	B0	00	Block Number	Number of Bytes to Read

Block Number (1 Byte):
The starting block.

Number of Bytes to Read (1 Byte):
Multiply of 16 bytes for MIFARE 1K/4K or Multiply of 4 bytes for MIFARE Ultralight

- Maximum 16 bytes for MIFARE Ultralight.
- Maximum 48 bytes for MIFARE 1K. (Multiple Blocks Mode; 3 consecutive blocks)
- Maximum 240 bytes for MIFARE 4K. (Multiple Blocks Mode; 15 consecutive blocks)

Example 1: 0x10 (16 bytes). The starting block only. (Single Block Mode)
Example 2: 0x40 (64 bytes). From the starting block to starting block+3. (Multiple Blocks Mode)

#For safety reason, the Multiple Block Mode is used for accessing Data Blocks only. The Trailer Block is not supposed to be accessed in Multiple Blocks Mode. Please use Single Block Mode to access the Trailer Block.

Table 2.3-1b: Read Binary Block Response Format (Multiply of 4/16 + 2 Bytes)

Response	Data Out		
Result	Data (Multiply of 4/16 Bytes)	SW1	SW2

Table 2.3-1c: Read Binary Block Response Codes

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

Examples:
// Read 16 bytes from the binary block 0x04 (MIFARE 1K or 4K)
APDU = {FF B0 00 04 10}

// Read 240 bytes starting from the binary block 0x80 (MIFARE 4K)
// Block 0x80 to Block 0x8E (15 blocks)
APDU = {FF B0 00 80 F0}

2.4 Update Binary Blocks

The "Update Binary Blocks command" is used for writing a multiple of "data blocks" into the PICC. The data block/trailer block must be authenticated first before executing the "Update Binary Blocks command".

Table 2.3-1a: Update Binary APDU Format (Multiple of 16 + 5 Bytes)

Command	Class	INS	P1	P2	Lc	Data In
Update Binary Blocks	FF	D6	00	Block Number	Number of Bytes to Update	Block Data (Multiple of 16 Bytes)

Block Number (1 Byte):
The starting block to be updated.

Number of Bytes to Update (1 Byte):

- Multiply of 16 bytes for MIFARE 1K/4K or 4 bytes for MIFARE Ultralight.
- Maximum 48 bytes for MIFARE 1K. (Multiple Blocks Mode; 3 consecutive blocks)
- Maximum 240 bytes for MIFARE 4K. (Multiple Blocks Mode; 15 consecutive blocks)

Example 1: 0x10 (16 bytes). The starting block only. (Single Block Mode)
Example 2: 0x30 (48 bytes). From the starting block to starting block+2. (Multiple Blocks Mode)

#For safety reason, the Multiple Block Mode is used for accessing Data Blocks only. The Trailer Block is not supposed to be accessed in Multiple Blocks Mode. Please use Single Block Mode to access the Trailer Block.

Block Data (Multiply of 16 + 2 Bytes, or 6 bytes):
The data to be written into the binary block/blocks.

Table 2.3-1b: Update Binary Block Response Codes (2 Bytes)

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

Examples:

// Update the binary block 0x04 of MIFARE 1K/4K with Data {00 01 .. 0F}
APDU = {FF D6 00 04 10 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F}

// Update the binary block 0x04 of MIFARE Ultralight with Data {00 01 02 03}
APDU = {FF D6 00 04 04 00 01 02 03}

2.5 Value Block Related Commands

The data block can be used as value block for implementing value-based applications.

2.5.1 Value Block Operation

The "Value Block Operation command" is used for manipulating value-based transactions. E.g. Increment a value of the value block etc.

Table 2.5.1-1a: Value Block Operation APDU Format (10 Bytes)

Command	Class	INS	P1	P2	Lc	Data In	
Value Block Operation	FF	D7	00	Block Number	05	VB_OP	VB_Value (4 Bytes) {MSB .. LSB}

Block Number (1 Byte):
The value block to be manipulated.

VB_OP (1 Byte):
0x00 = Store the VB_Value into the block. The block will then be converted to a value block.
0x01 = Increment the value of the value block by the VB_Value. This command is only valid for value block.
0x02 = Decrement the value of the value block by the VB_Value. This command is only valid for value block.

VB_Value (4 Bytes):
The value used for value manipulation. The value is a signed long integer (4 bytes).

E.g. 1: Decimal –4 = {0xFF, 0xFF, 0xFF, 0xFC}

VB_Value			
MSB			LSB
FF	FF	FF	FC

E.g. 2: Decimal 1 = {0x00, 0x00, 0x00, 0x01}

VB_Value			
MSB			LSB
00	00	00	01

Table 2.5.1-1b: Value Block Operation Response Format (2 Bytes)

Response	Data Out	
Result	SW1	SW2

Table 2.5.1-1c: Value Block Operation Response Codes

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

2.5.2 Read Value Block

The "Read Value Block command" is used for retrieving the value from the value block. This command is only valid for value block.

Table 2.5.2-1a: Read Value Block APDU Format (5 Bytes)

Command	Class	INS	P1	P2	Le
Read Value Block	FF	B1	00	Block Number	00

Block Number (1 Byte):
The value block to be accessed.

Table 2.5.2-1b: Read Value Block Response Format (4 + 2 Bytes)

Response	Data Out		
Result	Value {MSB .. LSB}	SW1	SW2

Value (4 Bytes):
The value returned from the card. The value is a signed long integer (4 bytes).

E.g. 1: Decimal –4 = {0xFF, 0xFF, 0xFF, 0xFC}

Value			
MSB			LSB
FF	FF	FF	FC

E.g. 2: Decimal 1 = {0x00, 0x00, 0x00, 0x01}

Value			
MSB			LSB
00	00	00	01

Table 2.5.3-1c: Read Value Block Response Codes

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

2.5.3 Restore Value Block

The "Restore Value Block command" is used to copy a value from a value block to another value block.

Table 2.5.3-1a: Restore Value Block APDU Format (7 Bytes)

Command	Class	INS	P1	P2	Lc	Data In	
Value Block Operation	FF	D7	00	Source Block Number	02	03	Target Block Number

Source Block Number (1 Byte): The value of the source value block will be copied to the target value block.

Target Block Number (1 Byte): The value block to be restored. The source and target value blocks must be in the same sector.

Table 2.5.3-1b: Restore Value Block Response Format (2 Bytes)

Response	Data Out	
Result	SW1	SW2

Table 2.5.3-1c: Restore Value Block Response Codes

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

Examples:

// Store a value "1" into block 0x05
APDU = {FF D7 00 05 05 00 00 00 00 01}

// Read the value block 0x05
APDU = {FF B1 00 05 00}

// Copy the value from value block 0x05 to value block 0x06
APDU = {FF D7 00 05 02 03 06}

// Increment the value block 0x05 by "5"
APDU = {FF D7 00 05 05 01 00 00 00 05}

BASIC PROGRAM FLOW FOR CONTACTLESS APPLICATIONS

Step 0. Start the application. The reader will do the PICC Polling and scan for tags continuously. Present a PICC tag at the field of the reader.
Step 1. Power on the PICC Interface
Step 2. Access the PICC by exchanging APDUs.

Step 2. Access the PICC by exchanging APDUs.

..

Step N. Power off the PICC Interface. Shut down the application.

1. How to access PCSC Compliant Tags (ISO14443-4)?

Basically, all ISO 14443-4 complaint cards (PICCs) would understand the ISO 7816-4 APDUs. The ACR1281S Reader just has to communicate with the ISO 14443-4 complaint cards through exchanging ISO 7816-4 APDUs and Responses. ACR1281S will handle the ISO 14443 Parts 1-4 Protocols internally.

MIFARE 1K, 4K, MINI and Ultralight tags are supported through the T=CL emulation. Just simply treat the MIFARE tags as standard ISO14443-4 tags. For more information, please refer to topic "PICC Commands for MIFARE Classic Memory Tags"

Table 3.1-1a: ISO 7816-4 APDU Format

Command	Class	INS	P1	P2	Lc	Data In	Le
ISO 7816 Part 4 Command					Length of the Data In		Expected length of the Response Data

Table 3.1-1b: ISO 7816-4 Response Format (Data + 2 Bytes)

Response	Data Out		
Result	Response Data	SW1	SW2

Table 3.1-1c: Common ISO 7816-4 Response Codes

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

Typical sequence may be:

- Present the Tag and Connect the PICC Interface
- Read / Update the memory of the tag

Step 1) **Connect the Tag**

The ATR of the tag is 3B 8C 80 01 50 00 05 70 3B 00 00 00 00 33 81 81 20

In which,

The ATQB = 50 00 05 70 3B 00 00 00 00 33 81 81. It is an ISO14443-4 Type B tag.

Step 2) **Send an APDU, Get Challenge.**
APDU Command: 00 84 00 00 08
APDU Response: 1A F7 F3 1B CD 2B A9 58 90 00

Hint:
For ISO14443-4 Type A tags, the ATS can be obtained by using the APDU “FF CA 01 00 00

For Example: ISO7816-4 APDU
// To read 8 bytes from an ISO 14443-4 Type B PICC (ST19XR08E)
APDU Command ={80 B2 80 00 08}

Class = 0x80
INS = 0xB2
P1 = 0x80
P2 = 0x00
Lc = None
Data In = None
Le = 0x08

APDU Response: 00 01 02 03 04 05 06 07 90 00

2. How to access DESFIRE Tags (ISO14443-4)?

The DESFIRE supports ISO7816-4 APDU Wrapping and Native modes. Once the DESFire Tag is activated, the first APDU sent to the DESFire Tag will determine the "Command Mode". If the first APDU is "Native Mode", the rest of the APDUs must be in "Native Mode" format. Similarly, If the first APDU is "ISO7816-4 APDU Wrapping Mode", the rest of the APDUs must be in "ISO7816-4 APDU Wrapping Mode" format.

Example 1: DESFIRE ISO7816-4 APDU Wrapping.
// To read 8 bytes random number from an ISO 14443-4 Type A PICC (DESFIRE)
APDU = {90 0A 00 00 01 00 00}

Class = 0x90; INS = 0x0A (DESFire Instruction); P1 = 0x00; P2 = 0x00
Lc = 0x01; Data In = 0x00; Le = 0x00 (Le = 0x00 for maximum length)

Answer: 7B 18 92 9D 9A 25 05 21 91AF

Status Code{91 AF} is defined in DESFIRE specification. Please refer to the DESFIRE specification for more details.

Example 2: DESFIRE Frame Level Chaining (ISO 7816 wrapping mode)
// In this example, the application has to do the "Frame Level Chaining".
// To get the version of the DESFIRE card.

Step 1: Send an APDU {90 60 00 00 00} to get the first frame. INS=0x60
Answer: 04 01 01 00 02 18 05 91 AF

Step 2: Send an APDU {90 AF 00 00 00} to get the second frame. INS=0xAF
Answer: 04 01 01 00 06 18 05 91 AF

Step 3: Send an APDU {90 AF 00 00 00} to get the last frame. INS=0xAF
Answer: 04 52 5A 19 B2 1B 80 8E 36 54 4D 40 26 04 91 00

Example 3: DESFIRE Native Command.
// We can send Native DESFire Commands to the reader without ISO7816 wrapping if we find that the Native DESFire Commands are more easier to handle.

// To read 8 bytes random number from an ISO 14443-4 Type A PICC (DESFIRE)
APDU = {0A 00}
Answer: AF 25 9C 65 0C 87 65 1D D7

In which, the first byte "AF" is the status code returned by the DESFire Card.
The Data inside the blanket [1DD7] can simply be ignored by the application.

Example 4: DESFIRE Frame Level Chaining (Native Mode)
// In this example, the application has to do the "Frame Level Chaining".
// To get the version of the DESFIRE card.

Step 1: Send an APDU {60} to get the first frame. INS=0x60
Answer: AF 04 01 01 00 02 18 05

Step 2: Send an APDU {AF} to get the second frame. INS=0xAF
Answer: AF 04 01 01 00 06 18 05

Step 3: Send an APDU {AF} to get the last frame. INS=0xAF
Answer: 00 04 52 5A 19 B2 1B 80 8E 36 54 4D 40 26 04

Hints:
In DESFIRE Native Mode, the status code [90 00] will not be added to the response if the response length is greater than 1. If the response length is less than 2, the status code [90 00] will be added in order to meet the requirement of PCSC. The minimum response length is 2.

BASIC PROGRAM FLOW FOR CONTACT APPLICATIONS

Step 0. Start the application and insert a ICC Card into the ICC Interface.
Step 1. Power on the ICC Interface
Step 2. Access the ICC by exchanging APDUs.

..

Step N. Power off the ICC Interface. Shut down the application.

1. How to access ACOS3 ICC Cards (ISO7816)?

Typical sequence may be:

- Insert the Card and Power On the ICC Interface
- Read / Update the date of the Card

Step 1) **Power on the Tag**

Command: 02 62 00 00 00 00 01 00 00 00 00 63 03
ACK:02 00 00 03
Response: 02 80 13 00 00 00 01 00 00 81 00 3B BE 11 00 00 41 01 38 00 00 01 00 00 00 00 00 01 90 00 6F 03

The ATR of the Card is 3B BE 11 00 00 41 01 38 00 00 01 00 00 00 00 00 01 90 00
In which,
TD1 = 00 and TD2 is absent ,So the Card is a T=0 ICC Card

2) Get a random for the ACOS3

Command:02 6F 05 00 00 00 01 00 00 00 00 80 84 00 00 08 67 03
ACK:02 00 00 03
Response:02 80 0A 00 00 00 01 00 00 81 00 C2 FF 2D 23 C5 F6 5C F2 90 00 34 03
3) Create a file at the Card and Open it

Command: 02 6F 0D 00 00 00 01 00 00 00 00 80 20 07 00 08 41 43 4F 53 54 45 53 54 C4 03
ACK:02 00 00 03
Response:02 80 02 00 00 00 01 00 00 81 00 90 00 92 03

Command:02 6F 07 00 00 00 01 00 00 00 00 80 A4 00 00 02 FF 02 B2 03
ACK:02 00 00 03
Response: 02 80 02 00 00 00 01 00 00 81 00 90 00 92 03

Command: 02 6F 09 00 00 00 01 00 00 00 00 80 D2 00 00 04 00 00 01 00 30 03
ACK:02 00 00 03
Response: 02 80 02 00 00 00 01 00 00 81 00 90 00 92 03

Command: 02 6F 07 00 00 00 01 00 00 00 00 80 A4 00 00 02 FF 04 B4 03
ACK:02 00 00 03
Response: 02 80 02 00 00 00 01 00 00 81 00 90 00 92 03

Command: 02 6F 0B 00 00 00 01 00 00 00 00 80 D2 00 00 06 FF 01 00 00 55 55 CF 03
ACK:02 00 00 03
Response: 02 80 02 00 00 00 01 00 00 81 00 90 00 92 03

Command: 02 6F 07 00 00 00 01 00 00 00 00 80 A4 00 00 02 55 55 4F 03
ACK:02 00 00 03
Response: 02 80 02 00 00 00 01 00 00 81 00 91 00 93 03

```
File name is 55 55
```

```
4)Write a date to the file in 3)step
```

Command: 02 6F 0d 00 00 00 01 00 00 00 00 80 d2 00 00 08 01 02 03 04 05 06 07 08 31 03
ACK:02 00 00 03
Response: 02 80 02 00 00 00 01 00 00 81 00 90 00 92 03

```
5) Read a date from a file
```

Command: 02 6F 05 00 00 00 01 00 00 00 00 80 B2 00 00 08 51 03
ACK:02 00 00 03
Response: 02 80 0A 00 00 00 01 00 00 81 00 01 02 03 04 05 06 07 08 90 00 92 03

ANNEX A

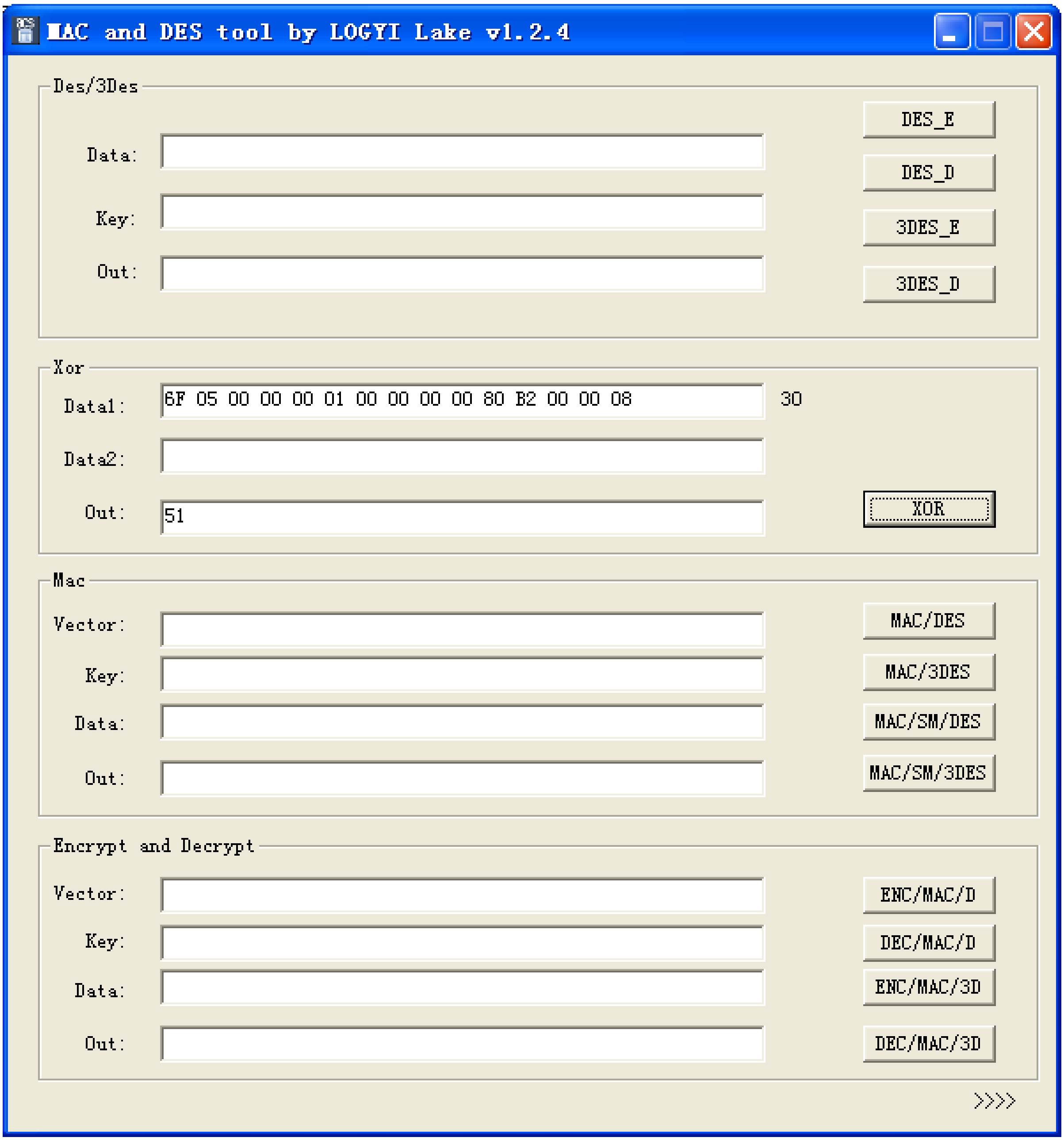
Example of XOR:

The Checksum byte is one byte in length and is calculated as the exclusive-OR of all the bytes with the Bulk-Header field and information field.

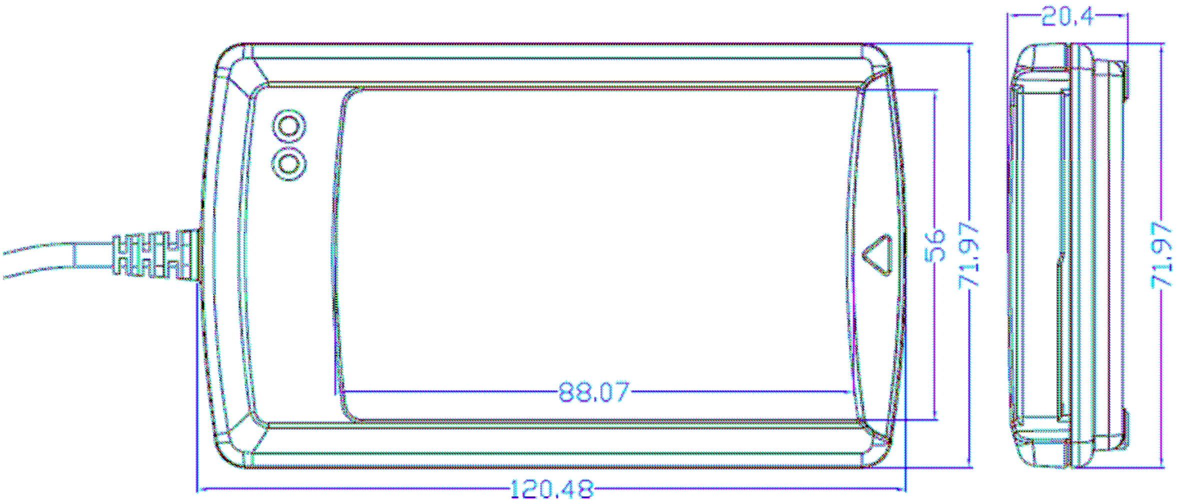
E.g.:

Command: 02 6F 05 00 00 00 01 00 00 00 00 80 B2 00 00 08 51 03

The Bulk-Header field is 6F 05 00 00 00 01 00 00 00 00, and the information field is 80 B2 00 00 08 and the checksum is 0x51



TECHNICAL SPECIFICATION



Universal Serial Bus Interface

Power source....................................... From +5V power or USB
Speed.. up to 500Kbps
Supply Voltage..................................... Regulated 5V DC
Supply Current .... 200mA (max); 100mA (normal)

Contactless Smart Card Interface

Standard.. ISO 14443 A & B Parts 1-4
Protocol .... ISO14443 T=CL for ISO14443-4 compliant cards and T=CL Emulation for MIFARE 1K/4K.
Smart card read / write speed .... 106 kbps, 212 kbps, 424 kbps and 848 kbps

Contact Smart Card Interface

Standard.. ISO 7816 1/2/3, Class A, B (5V, 3V), T=0 and T=1
Supply current...................................... max. 60mA
Smart card read / write speed max412kbps
Short circuit protection .... +5V / GND on all pins
CLK frequency..................................... 4.8 MHz
Card connector .... Landing
Card insertion cycles............................ min. 300,000

Case

Dimensions.. 120.48 mm (L) x 71.97 mm (W) x 20.4 mm (H)
Material.. ABS
Color.. Metallic Silver Grey

Antenna

Antenna Size .... 65mm x 60mm
Operating distance............................... up to 50 mm

Operating Frequency for Contactless Cards Access

Operating Frequency .... 13.56 MHz

Built-in peripherals

Monotone buzzer
Dual-Color LED

Operating Conditions

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

Cable Connector

Length.. 10m (RS232）

Standard/Certifications

CE, FCC

OS

Windows 98, ME, 2K, XP

OEM

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

FCC Caution:

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.