Advanced Card Systems Ltd.
Card & Reader Technologies

ACR122S Serial NFC Reader

Communication Protocol V2.02

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1.0. Introduction

The ACR122S is a contactless smart card reader/writer used for accessing ISO 14443-4 Type A and B, MIFARE®, ISO 18092 or NFC, and FeliCa tags using the serial interface. This document will discuss the command set in implementing a smart card application using the ACR122S.

2.0. Features

- Serial RS-232 Interface: Baud Rate = 115200 bps, 8-N-1
- USB interface for power supply
- CCID-like frame format (Binary format)
- Smart Card Reader:
    - Read/Write speed of up to 424 Kbps
    - Built-in antenna for contactless tag access, with card reading distance of up to 50 mm (depending on tag type)
    - Support for ISO 14443 Part 4 Type A and B cards, MIFARE, FeliCa, and all four types of NFC (ISO/IEC 18092 tags)
    - Built-in anti-collision feature (only one tag is accessed at any time)
    - ISO 7816-compliant SAM slot
- Built-in Peripherals:
    - Two user-controllable LEDs
    - User-controllable buzzer
- Compliant with the following standards:
    - ISO18092
    - ISO 14443
    - CE
    - FCC
    - KC
    - VCCI
    - RoHS 2

2.1. Serial Interface

The ACR122S is connected to a Host through the RS-232C Serial Interface at 9600 bps, 8-N-1.

Pin	Signal	Function
1	V_{CC}	+5 V power supply for the reader (max. 200 mA; normal 100 mA)
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

Table 1: PIN Configuration

2.2. Bi-color LED

A user-controllable bi-color LED with red and green color is provided.

- The green LED will blink if the “Card Interface” is not connected.
- The green LED will turn on if the “Card Interface” is connected.
- The green LED will flash if the “Card Interface” is operating.
- The red LED is controlled by the application only.

2.3. Buzzer

A user-controllable buzzer with a default state of OFF is provided.

2.4. SAM Interface

One SAM socket is provided.

2.5. Built-in Antenna

A 3-turn symmetric loop antenna, center-tapped is provided.

- Estimated size is 60 mm x 48 mm
- Loop inductance is approximately 1.6 µH – 2.5 µH
- Operating distance for a different tag is approximately up to 50 mm (depends on the tag)
- Only one tag can be accessed at a time

3.0. Communication between contactless interface and peripherals

The contactless interface and peripherals are accessed through the use of pseudo-APDUs.

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

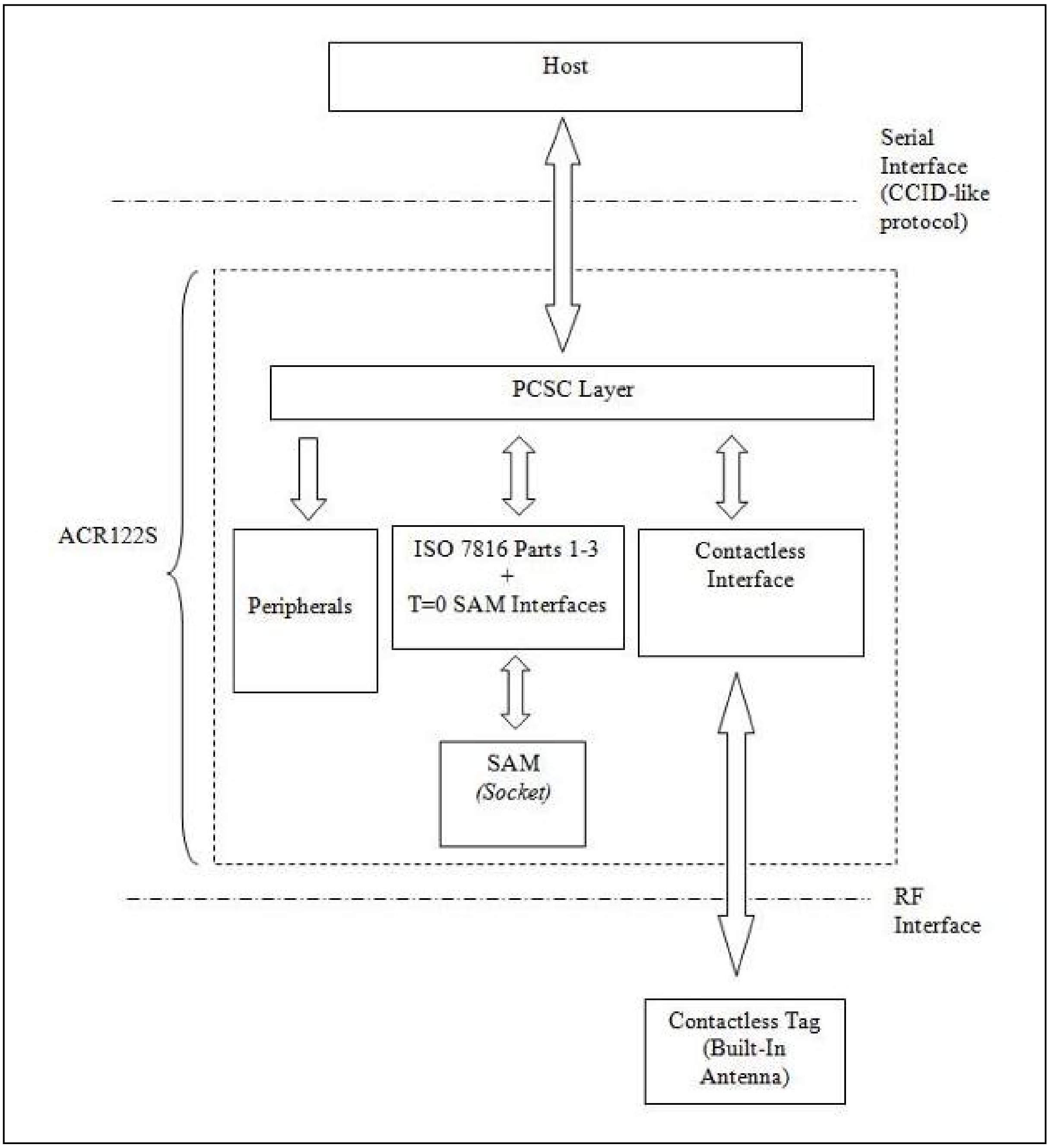

Figure 1: ACR122S Communication Flowchart

4.0. Serial Interface (CCID-like Frame Format)

***Note:** Communication setting: 9600 bps, 8-N-1.*

The communication protocol between the host and ACR122S is very similar to the CCID protocol.

Command Frame Format

STX (02h)	Bulk-OUT Header	APDU Command or Parameters	Checksum	ETX (03h)
1 Byte	10 Bytes	M Bytes (If applicable)	1 Byte	1 Byte

Status Frame Format

STX (02h)	Status	Checksum	ETX (03h)
1 Byte	1 Byte	1 Byte	1 Byte

Response Frame Format

STX (02h)	Bulk-IN Header	APDU Response or abData	Checksum	ETX (03h)
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}

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 ACR122S.

The SAM interface must be activated in order to use the contactless interface and peripherals. In short, all the APDUs are exchanged through the SAM 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 = ACR122S; HOST = Host Controller

HOST_to_RDR = Host Controller -> ACR122S

RDR_to_HOST = ACR122S -> Host Controller

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4.1. Protocol Flow Examples

A. 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	←

B. 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	←

C. 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)	←

HOST			RDR
		.. 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	←

Note: *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 incorrectly formatted.

CheckSum Error Frame = {02 FF FF 03}

Length Error Frame = {02 FE FE 03}. The length dDwLength is greater than 0105h bytes.

ETX Error Frame = {02 FD FD 03}. The last byte is not equal to ETX "03h".

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

5.0. SAM Interface

5.1. Activating the SAM interface

Command Frame Format

STX (02h)	Bulk-OUT Header (HOST_to_RDR_IccPowerOn)	Parameters	Checksum	ETX (03h)
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	*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 03h	Voltage that is applied to the ICC: 00h – Automatic Voltage Selection 01h – 5 V 02h – 3 V 03h – 1.8 V
8	*abRFU*	2		Reserved for Future Use.

Response Frame Format

STX (02h)	Bulk-IN Header (RDR_to_HOST_DataBlock)	abData	Checksum	ETX (03h)
1 Byte	10 Bytes	N Bytes (ATR)	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 ACR122S.
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		

Offset	Field	Size	Value	Description
9	*bChainParameter*	1		

Example: To activate the slot 0 (default), sequence number = 1, 5 V 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

5.2. Deactivating the SAM interface

Command Frame Format

STX (02h)	Bulk-OUT Header (HOST_to_RDR_IccPowerOff)	Parameters	Checksum	ETX (03h)
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	*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.

Response Frame Format

STX (02h)	Bulk-IN Header (RDR_to_HOST_SlotStatus)	abData	Checksum	ETX (03h)
1 Byte	10 Bytes	0 Byte	1 Byte	1 Byte

RDR_to_HOST_DataBlock Format

Offset	Field	Size	Value	Description
0	*bMessageType*	1	81h	Indicates that a data block is being sent from the ACR122S.
1	*dwLength* *<LSB .. MSB>*	4	0	Size of *abData* field (0 Byte).
5	*bSlot*	1	Same as Bulk-OUT	Identifies the slot number for this command.

Offset	Field	Size	Value	Description
6	*bSeq*	1	Same as Bulk-OUT	Sequence number for corresponding command.
7	*bStatus*	1		
8	*bError*	1		
9	*bClockStatus*	1		

Example: To deactivate the 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

5.3. Exchanging data through the SAM interface

Command Frame Format

STX (02h)	Bulk-OUT Header (HOST_to_RDR_XfrBlock)	Parameters	Checksum	ETX (03h)
1 Byte	10 Bytes	M Byte	1 Byte	1 Byte

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	

Response Frame Format

STX (02h)	Bulk-IN Header (RDR_to_HOST_DataBlock)	abData	Checksum	ETX (03h)
1 Byte	10 Bytes	N Bytes (ATR)	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 ACR122S.

Offset	Field	Size	Value	Description
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		

Example: To send an APDU "80 84 00 00 08" to the 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

6.0. Pseudo-APDUs for contactless interface and peripherals control

ACR122S comes with two primitive commands for this purpose. <Class FFh>

6.1. Direct Transmit

This command is used to send a pseudo-APDU (Tag Commands), and returns the length of the Response Data.

Direct Transmit Command Format (Length of the Tag Command + 5 Bytes)

Command	Class	INS	P1	P2	Lc	Data In	
Direct Transmit	FFh	00h	00h	00h	Number of bytes to send	Tag Command	Data

Where:

Lc Number of bytes to send (1 Byte)

Maximum 255 bytes

Data In Tag command.

The data to be sent to the tag.

Direct Transmit Response Format (Tag Response + Data + 2 Bytes)

Item	Command	Data			Meaning
1	D4 40	Tg		[DataOut[]]	Tag Exchange Data
2	D4 4A	MaxTg	BrTy	[InitiatorData[]]	Tag Polling

Where:

Tg A byte containing the logical number of the relevant target. This byte also contains the *More Information* (MI) bit (bit 6). When the MI bit is set to 1, this indicates that the host controller wants to send more data which is all the data contained in the DataOUT[] array. This bit is only valid for a TPE target.

DataOut An array of raw data (from 0 up to 262 bytes) to be sent to the target by the contactless chip.

MaxTg Maximum number of targets to be initialized by the contactless chip. The chip is capable of handling 2 targets maximum at once, so this field should not exceed 02h.

Brty Baud rate and the modulation type to be used during the initialization.

00h: 106 kbps type A (ISO/IEC14443 Type A),

01h: 212 kbps (FeliCa polling),

02h: 424 kbps (FeliCa polling),

03h: 106 kbps type B (ISO/IEC 14443-3B),

04h: 106 kbps Innovision Jewel tag.

InitiatorData[] An array of data to be used during the initialization of the target(s). Depending on the Baud Rate specified, the content of this field is different.

106 kbps type A

The field is optional and is present only when the host controller wants to initialize a target with a known UID.

In that case, InitiatorData[] contains the UID of the card (or part of it). The UID must include the cascade tag CT if it is cascaded level 2 or 3.

Cascade Level 1

UID1	UID2	UID3	UID4

Cascade Level 2

UID1	UID2	UID3	UID4	UID5	UID6	UID7

Cascade Level 3

UID1	UID2	UID3	UID4	UID5	UID6	UID7	UID8	UID9	UID10

106 kbps type B

In this case, InitiatorData[] is formatted as following:

AFI (1byte)	[Polling Method]

AFI The AFI (Application Family Identifier) parameter represents the type of application targeted by the device IC and is used to preselect the PICCs before the ATQB.

This field is mandatory.

Polling Method This field is optional. It indicates the approach to be used in the ISO/IEC 14443-3B initialization:

If bit 0 = 1: Probabilistic approach (option 1) in the ISO/IEC 14443-3B initialization,

If bit 0 = 0: Timeslot approach (option 2) in the ISO/IEC 14443-3B initialization,

If this field is absent, the timeslot approach will be used.

212/424 kbps In that case, this field is mandatory and contains the complete pay load information that should be used in the polling request command (5bypes, length bytes is excluded)

106 kbps InnoVision Jewel tag. This field is not used.

Data Out Tag Response returned by the reader.

Direct Transmit Response Format

<table>
<tr><th>Response</th><th colspan="5">Data Out</th></tr>
<tr><td rowspan="2">Result</td><td>D5 41</td><td>Status</td><td colspan="2">[DataIn[]]</td><td rowspan="2">SW1 SW2</td></tr>
<tr><td>D5 4B</td><td>NbTg</td><td>[TargetData1[]]</td><td>[TargetData2[]]</td></tr>
</table>

Where:

Status	A byte indicating if the process has been terminated successfully or not. When in either DEP or ISO/IEC 14443-4 PCD mode, this byte also indicates if *NAD (Node Address)* is used and if the transfer of data is not completed with bit *More Information*.
DataIn	An array of raw data (from 0 up to 262 bytes) received by the contactless chip.
NbTg	The number of initialized Targets (minimum 0, maximum 2 targets).
TargetDatai[]	The "i" in TargetDatai[] refers to "1" or "2". This contains the information about the detected targets and depends on the baud rate selected. The following information is given for one target, it is repeated for each target initialized (NbTg times).

106 kbps Type A

Tg	SENS_RES10 (2 bytes)	SEL_RES (1 byte)	NFCIDLength (1 byte)	NFCID1[] (NFCIDLength bytes)	[ATS[]] (ATSLength bytes11))

106 kbps Type B

Tg	ATQB Response (12 bytes)	ATTRIB_RES Length (1 byte)	ATTTRIB_RES[] (ATTRIB_RES Length)

212/424 kbps

Tg	POL_RES length	01h (response code)	NFCID2t	Pad	SYST_CODE (optional)
1 byte	1 byte	1 byte	8 bytes	8 bytes	2 bytes
	POL_RES (18 or 20 bytes)				

106 kbps Innovision Jewel tag

Tg	SENS_RES (2 bytes)	JEWELID[] (4 bytes)

Data Out SW1 SW2.

Status Code returned by the reader.

Results	SW1	SW2	Meaning
Success	90	00h	The operation is completed successfully.
Error	63	00h	The operation is failed.
Time Out Error	63	01h	The TAG does not response.

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Results	SW1	SW2	Meaning
Checksum Error	63	27h	The checksum of the Response is wrong.
Parameter Error	63	7Fh	The TAG Command is wrong.

6.2. Change Communication Speed

This command is used to change the baud rate.

Baud Rate Control Command Format (9 Bytes)

Command	Class	INS	P1	P2	Lc
Baud Rate Control	FFh	00h	44h	New Baud Rate	00h

Where:

P2 New Baud Rate

00h = Set the new baud rate to 9600 bps.

01h = Set the new baud rate to 115200 bps.

Data Out SW1 SW2.

Status Code

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

Where:

SW2 Current Baud Rate

00h = The current baud rate is 9600 bps.

01h = The current baud rate is 115200 bps.

***Note:** After the communication speed is changed successfully, the program has to adjust its communication speed 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 Tag Command = "09"

Tag 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 contactless chip = "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 Tag Command = "23"

Tag 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 26 00 00 00 00 02 00 00 00

FF 00 00 00 21 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 contactless chip = "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 Tag Command = "13"

Tag 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

[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 contactless chip = "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 Tag Command = "05"

Tag 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 contactless chip = "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 Tag Command = “08”

Tag 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 contactless chip = “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”

6.3. Get Firmware Version

This command is used to derive the firmware version of the reader.

Get Firmware Version Command Format (5 Bytes)

Command	Class	INS	P1	P2	Le
Get Response	FFh	00h	48h	00h	00h

Where:

Le Number of bytes to retrieve (1 Byte).

Maximum 255 bytes.

Get Firmware Version Response Format (10 Bytes)

Response	Data Out
Result	Firmware Version

Example:

Response = 41 43 52 31 32 32 53 31 30 30 (Hex) = ACR122S100 (ASCII)

6.4. Bi-color LED and Buzzer Control

This command is used to control the states of the bi-color LED and buzzer.

Bi-color LED and Buzzer Control Command Format (9 Bytes)

Command	Class	INS	P1	P2	Lc	Data In (4 Bytes)
Bi-color LED and Buzzer Control	FFh	00h	40h	LED State Control	04h	Blinking Duration Control

P2 LED State Control.

Bi-color LED and Buzzer Control Format (1 Byte)

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

Data In Blinking Duration Control.

Bi-Color LED Blinking Duration Control Format (4 Bytes)

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

Where:

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

00h = The buzzer will not turn on.

01h = The buzzer will turn on during the T1 Duration.

02h = The buzzer will turn on during the T2 Duration.

03h = The buzzer will turn on during the T1 and T2 Duration.

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

Status Code

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

Current LED State (1 Byte)

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

Notes:

1. *The LED State operation will be performed after the LED Blinking operation is completed.*
2. *The LED will not change if the corresponding LED Mask is not enabled.*
3. *The LED will not blink 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, set the P2 "LED State Control" to zero.*
6. *The make the buzzer operate, the "number of repetition" must be greater than zero.*
7. *To control the LED only, set the parameter "Link to Buzzer" to zero.*

Example 1: To read the existing LED State.

// Assume both Red and Green LEDs are OFF initially //

// Not linked to the buzzer //

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

Response = "90 00". RED and Green LEDs are OFF.

Example 2: To turn on RED and Green Color LEDs.

// Assume both Red and Green LEDs are OFF initially //

// Not linked to the buzzer //

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

Response = "90 03". RED and Green LEDs are ON,

To turn off both RED and Green LEDs, APDU = "FF 00 40 0C 04 00 00 00 00"

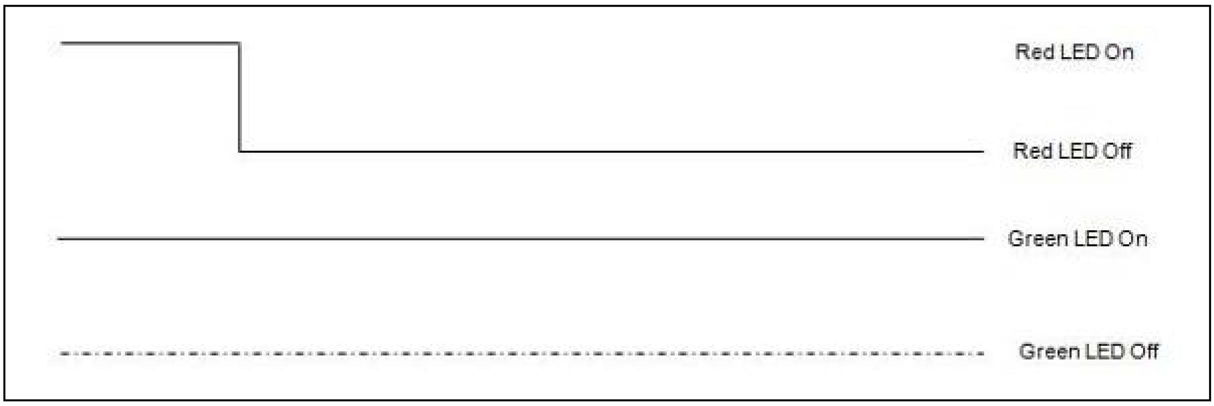
Example 3: To turn off the Red LED only, and leave the Green LED unchanged.

// Assume both Red and Green LEDs are ON initially //

// Not linked to the buzzer //

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

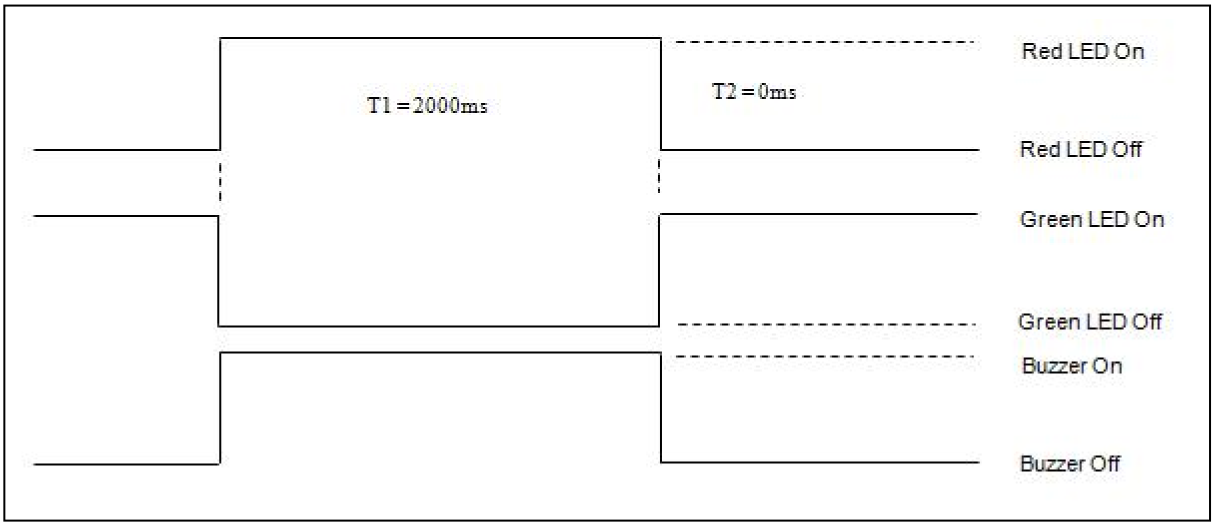
Response = "90 02". Green LED is not changed (ON); Red LED is OFF.



Example 4: To turn on the Red LED for 2 seconds. After that, resume to the initial state.

// Assume the Red LED is initially OFF, while the Green LED is initially ON. //

// The Red LED and buzzer will turn on during the T1 duration, while the Green LED will turn off during the T1 duration. //



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

T1 Duration = 2000 ms = 14h

T2 Duration = 0 ms = 00h

Number of repetition = 01h

Link to Buzzer = 01h

APDU = “FF 00 40 50 04 14 00 01 01”

Response = “90 02”

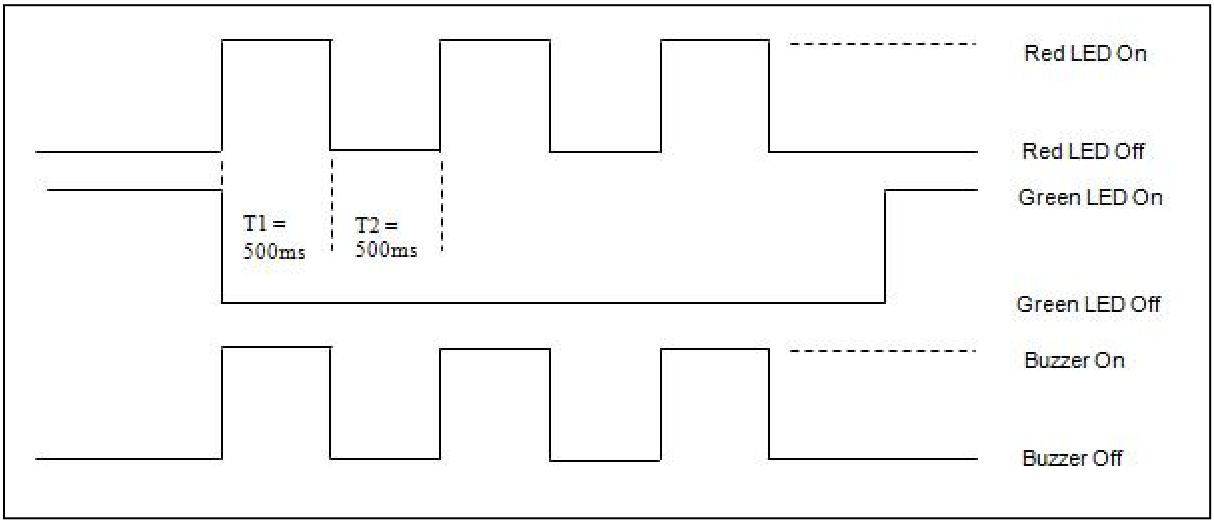
Example 5: To make the Red LED of 1 Hz blink for 3 times. After that, resume to initial state.

// Assume the Red LED is initially OFF, while the Green LED is initially ON. //

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

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

// After the blinking, the Green LED will turn ON. The Red LED will resume to the initial state after the blinking //



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

T1 Duration = 500 ms = 05h

T2 Duration = 500 ms = 05h

Number of repetition = 03h

Link to Buzzer = 01h

APDU = “FF 00 40 50 04 05 05 03 01”

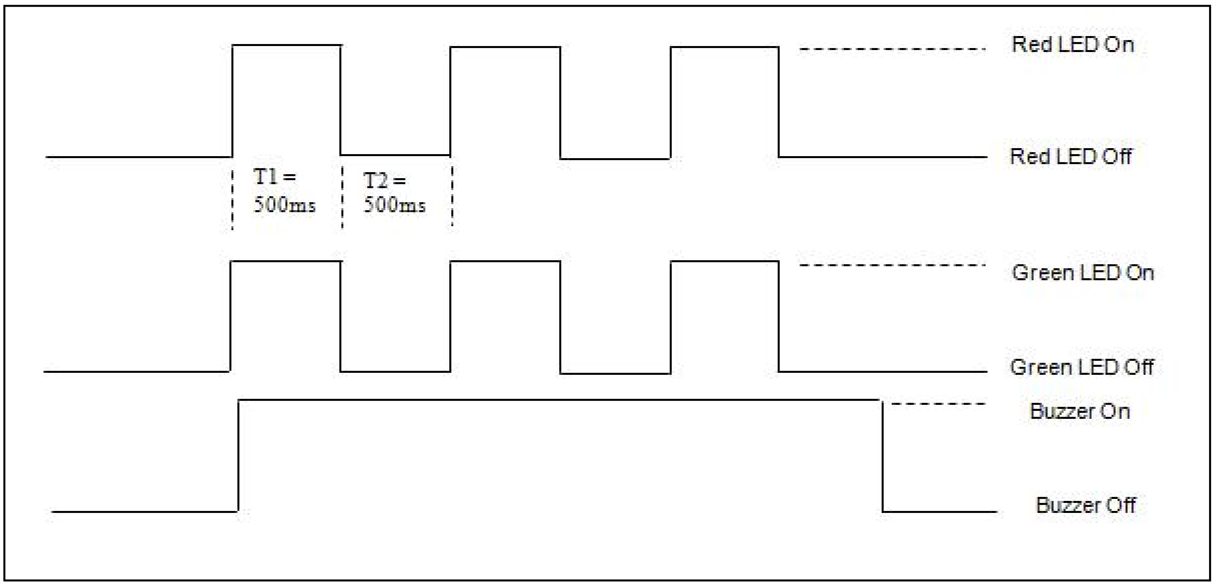
Response = “90 02”

Example 6: To make the Red and Green LEDs of 1 Hz blink for 3 times.

// Assume both the Red and Green LEDs are initially OFF. //

// Both Initial Red and Green Blinking States are ON //

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



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

T1 Duration = 500 ms = 05h

T2 Duration = 500 ms = 05h

Number of repetition = 03h

Link to Buzzer = 03h

APDU = “FF 00 40 F0 04 05 05 03 03”

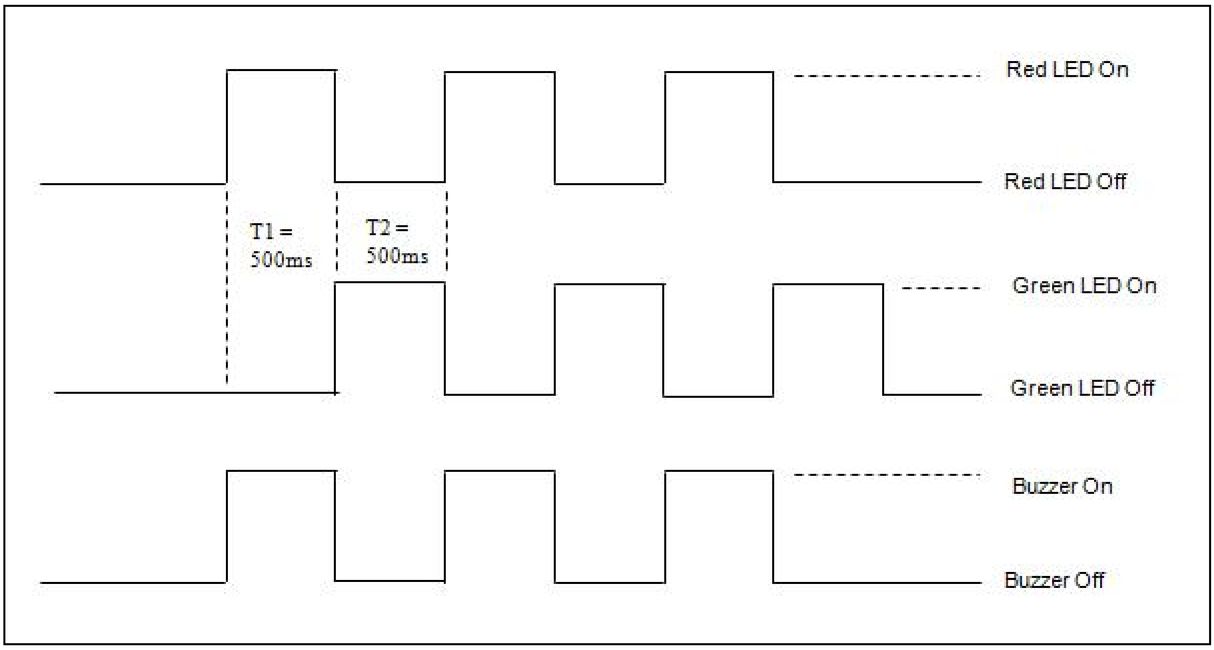
Response = “90 00”

Example 7: To make the Red and Green LEDs in turn of 1 Hz blink for 3 times.

// Assume both Red and Green LEDs are initially OFF. //

// The Initial Red Blinking State is ON; The Initial Green Blinking States is OFF //

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



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

T1 Duration = 500 ms = 05h

T2 Duration = 500 ms = 05h

Number of repetition = 03h

Link to Buzzer = 01h

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

Response = "90 00"

6.5. Topaz512 and Jewel96

Note: *This section only applies to ACR122S with firmware version 1.03.*

This command is used to Write-with-erase (8 Bytes), Write-no-erase (8 Bytes), Read (8 Bytes) and Read Segment.

Topaz 512 and Jewel 96 Command Format

Command	Class	INS	P1	P2	Lc	Data In
Direct Transmit	FFh	00h	00h	00h	Number of bytes to send	TAG Command

Where:

Lc Number of bytes to send (1 Byte).
Maximum 255 bytes.

Data In Tag Command.
The data to be sent to the tag.

Direct Transmit Response Format (Response Length + 2 Bytes)

Response	Data Out	
Result	Tag Response	SW1 SW2

Where:

Data Out Tag Response returned by the reader.

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

Status Code

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

Example 1: To Write-with-erase (8 Bytes) a Topaz512/Jewel96 tag.

Step 1. Issue a "Direct Transmit" APDU.

The APDU Command should be "FF 00 00 00 0D D4 40 01 54 05 01 23 45 67 89 AB CD EF"

In which,

Direct Transmit APDU = "FF 00 00 00"

Length of the Tag Command = "0D"

Tag Command (InDataExchange) = "D4 40 01"

Tag Command (Write-with-erase 8Bytes) = "54"

Tag Address (00~3F (hex)) = "05"

Tag Data = "01 23 45 67 89 AB CD EF"

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

HOST > 02 6F 12 00 00 00 00 01 00 00 00
FF 00 00 00 0D D4 40 01 54 05 01 23 45 67 89 AB CD EF
[Checksum] 03

RDR -> 02 00 00 03

RDR -> 02 80 0D 00 00 00 00 01 01 00 00
D5 09 05 01 23 45 67 89 AB CD EF 90 00
[Checksum] 03

The APDU Response is "D5 09 05 01 23 45 67 89 AB CD EF 90 00"

In which,

Response returned by the contactless chip = “D5 09 05 01 23 45 67 89 AB CD EF 90 00”

Write Tag Address = “05”

Write Tag 8 Bytes Data = “01 23 45 67 89 AB CD EF”

Status Code returned by the reader = “90 00”

Example 2: To Write-no-erase (8 Bytes) a Topaz512/Jewel96 tag.

Step 1. Issue a “Direct Transmit” APDU.

The APDU Command should be “FF 00 00 00 0D D4 40 01 1B 05 FF FF FF FF FF FF FF FF”

In which,

Direct Transmit APDU = “FF 00 00 00”

Length of the Tag Command = “0D”

Tag Command (InDataExchange) = “D4 40 01”

Tag Command (Write-no-erase 8Bytes) = “1B”

Tag Address (00~3F (hex)) = “05“

Tag Data = “FF FF FF FF FF FF FF FF”

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

HOST -> 02 6F 12 00 00 00 00 01 00 00 00
FF 00 00 00 0D D4 40 01 1B 05 FF FF FF FF FF FF FF FF
[Checksum] 03

RDR -> 02 00 00 03

RDR -> 02 80 0D 00 00 00 00 01 01 00 00
D5 09 05 FF FF FF FF FF FF FF FF 90 00
[Checksum] 03

The APDU Response is “D5 09 05 FF FF FF FF FF FF FF FF 90 00”

In which,

Response returned by the contactless chip = “D5 09 05 FF FF FF FF FF FF FF FF 90 00”

Write Tag Address = “05”

Write Tag 8Bytes Data = “FF FF FF FF FF FF FF FF”

Status Code returned by the reader = “90 00”

Example 3: To Read 8 Bytes a Topaz512/Jewel96 Tag.

Step 1. Issue a "Direct Transmit" APDU.

The APDU Command should be "FF 00 00 00 0D D4 40 01 02 05 00 00 00 00 00 00 00 00"

In which,

Direct Transmit APDU = "FF 00 00 00"

Length of the Tag Command = "0D"

Tag Command (InDataExchange) = "D4 40 01"

Tag Command (Read 8Bytes) = "02"

Tag Address (00~3F (hex)) = "05 "

Tag Data = "00 00 00 00 00 00 00 00"

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

HOST ->	02 6F 12 00 00 00 00 01 00 00 00 FF 00 00 00 0D D4 40 01 02 05 00 00 00 00 00 00 00 00 [Checksum] 03
RDR ->	02 00 00 03
RDR ->	02 80 0D 00 00 00 00 01 01 00 00 D5 09 05 01 23 45 67 89 AB CD EF 90 00 [Checksum] 03

The APDU Response is "D5 09 05 01 23 45 67 89 AB CD EF 90 00"

In which,

Response returned by the contactless chip = "D5 09 05 01 23 45 67 89 AB CD EF 90 00"

Read Tag Address = "05"

Read Tag 8Bytes Data = "01 23 45 67 89 AB CD EF"

Status Code returned by the reader = "90 00"

Example 4: To Read Segment a Topaz512/Jewel96 Tag.

Step 1. Issue a "Direct Transmit" APDU.

The APDU Command should be "FF 00 00 00 0D D4 40 01 10 00 00 00 00 00 00 00 00 00"

In which,

Direct Transmit APDU = "FF 00 00 00"

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Length of the Tag Command = “0D”

Tag Command (InDataExchange) = “D4 40 01”

Tag Command (Read Segment) = “10”

Tag Address (00/10/20/30) = “00 “(Block 0)

Tag Data = “00 00 00 00 00 00 00 00”

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

HOST -> 02 6F 12 00 00 00 00 01 00 00 00
FF 00 00 00 0D D4 40 01 10 00 00 00 00 00 00 00 00 00
[Checksum] 03
RDR -> 02 00 00 03
RDR -> 02 80 0D 00 00 00 00 01 01 00 00
D5 41 00 ... <128 bytes data> ... 90 00
[Checksum] 03

The APDU Response is “D5 41 00 … <128 bytes data> … 90 00”

In which,

Response returned by the contactless chip = “D5 41 00 … <128 bytes data> … 90 00”

Read Tag Segment Data = “<128 bytes data>”

Status Code returned by the reader = “90 00”

Example 5: To Write Multi-Data at Topaz/Jewel Tag.

***Note**: This function only can write at the segment 0.*

Step 1. Issue a “Direct Transmit” APDU.

The APDU Command should be “FF 00 00 00 36 D4 40 01 58 20 30 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47”

In which,

Direct Transmit APDU = “FF 00 00 00”

Length of the Tag Command = “36”

Tag Command (InDataExchange) = “D4 40 01”

Tag Command (Write Multi-Data) = “58”

Tag Address = “20 (0 0100 000) “(Block 4, Byte-0) (refer to **Figure 2**)

Tag Data = “00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47"

Address operand 'ADD'							
Block = select one of blocks $0_h - F_h$ Byte = select one of Bytes 0 – 7							
msb							lsb
b8	b7	b6	b5	b4	b3	b2	b1
0_b	Block				Byte		

Figure 2: Tag Address "ADD"

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

HOST -> 02 6F 3B 00 00 00 00 01 00 00 00

FF 00 00 00 36 D4 40 01 58 20 30 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47

[Checksum] 03

RDR -> 02 00 00 03

RDR -> 02 80 05 00 00 00 00 01 01 00 00

D5 41 00 90 00

[Checksum] 03

The APDU Response is "D5 41 00 90 00"

In which,

Response returned by the contactless chip = "D5 41 00 90 00"

Write Tag Data = "00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47"

Status Code returned by the reader = "90 00"

If Status Code returned by the reader = "63 00" that means this operation is not complete.

Example 6: To Write Multi-8 bytes Data at Topaz512/Jewel96 tag.

Step 1. Issue a "Direct Transmit" APDU.

The APDU Command should be "FF 00 00 00 36 D4 40 01 5A 04 30 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47"

In which,

Direct Transmit APDU = "FF 00 00 00"

Length of the Tag Command = "36"

Tag Command (InDataExchange) = “D4 40 01”

Tag Command (Write Multi-Data) = “5A”

Tag Address (Block No.00-3F) = “04 “(Block No. 4) (refer to below Fig. 3)

Tag Data = “00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47”

Address operand ‘ADD8’ Block = select one of the 8-Byte blocks 00_h – $3F_h$							
msb							lsb
b8	b7	b6	b5	b4	b3	b2	b1
0_b	0_b	Global Block					

Figure 3: Tag Address “ADD8”

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

HOST -> 02 6F 3B 00 00 00 00 01 00 00 00

FF 00 00 00 36 D4 40 01 5A 04 30 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47

[Checksum] 03

RDR -> 02 00 00 03

RDR -> 02 80 04 00 00 00 00 01 01 00 00

D5 09 90 00

[Checksum] 03

The APDU Response is “D5 09 90 00”

In which,

Response returned by the contactless chip = “D5 09 90 00”

Write Tag Data = “00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47”

Status Code returned by the reader = “90 00”

If Status Code returned by the reader = “63 00” that mean this operation is not complete.

6.6. Basic program flow for ISO 14443-4 Type A and B tags

Typical sequence may be:

1. Scanning the tags in the field (Polling) with the correct parameter (Type A or B).
2. Change the Baud Rate (optional for Type A tags only).
3. Perform any T=CL command.
4. Deselect the tag.

Step 1. Set the retry time.

HOST -> 02 6F 0B 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 06 D4 32 05 00 00 01 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 04 00 00 00 00 01 01 00 00

RDR -> D5 33 90 00 [Checksum] 03

Step 2. Polling for the ISO 14443-4 Type A Tag, 106 kbps.

HOST -> 02 6F 09 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 04 D4 4A 01 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> D5 4B 01 01 00 08 28 04 85 82 2F A0 07 77 F7 80 02 47 65 90 00 [Checksum] 03

In which, Number of Tag found = [01];

Target number = 01

SENS_RES = 00 08; SEL_RES = 28,

Length of the UID = 4;

UID = 85 82 2F A0

ATS = 07 77 F7 80 02 47 65

Operation Finished = 90 00

OR

Step 2. Polling for the ISO14443-4 Type B Tag, 106 kbps.

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 05 D4 4A 01 03 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 14 00 00 00 00 01 01 00 00

RDR -> D5 4B 01 01 50 00 01 32 F4 00 00 00 00 33 81 81 01 21 90 00 [Checksum] 03

In which, Number of Tag found = [01];
Target number = 01
ATQB = 50 00 01 32 F4 00 00 00 00 33 81 81
ATTRIB_RES Length = 01; ATTRIB_RES = 21
Operation Finished = 90 00

Step 3. Change the default Baud Rate to other Baud Rate (optional).
HOST -> 02 6F 0A 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)
HOST -> FF 00 00 00 05 D4 4E 01 02 02 [Checksum] 03 // Change to Baud Rate 424 kbps
Or
HOST -> FF 00 00 00 05 D4 4E 01 01 01 [Checksum] 03 // Change to Baud Rate 212 kbps
RDR -> 02 00 00 03 (Waiting the Tag)
RDR -> 02 80 05 00 00 00 00 01 01 00 00
RDR -> D5 4F [00] 90 00 [Checksum] 03
Note: *Please check the maximum baud rate supported by the tags. Only Type A tags are supported.*

Step 4. Perform T=CL command, Get Challenge APDU = 00 84 00 00 08.
HOST -> 02 6F 0D 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)
HOST -> FF 00 00 00 08 D4 40 01 00 84 00 00 08 [Checksum] 03
RDR -> 02 00 00 03 (Waiting the Tag)
RDR -> 02 80 0F 00 00 00 00 01 01 00 00
RDR -> D5 41 [00] 62 89 99 ED C0 57 69 2B 90 00 90 00 [Checksum] 03
In which, Response Data = 62 89 99 ED C0 57 69 2B 90 00

Step 5. Deselect the tag.
HOST -> 02 6F 08 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)
HOST -> FF 00 00 00 03 D4 44 01 [Checksum] 03
RDR -> 02 00 00 03 (Waiting the Tag)
RDR -> 02 80 05 00 00 00 00 01 01 00 00
RDR -> D5 41 [00] 90 00 [Checksum] 03

Step 6. Turn off the Antenna Power (optional).
HOST -> 02 6F 09 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)
HOST -> FF 00 00 00 04 D4 32 01 00
RDR -> 02 00 00 03 (Waiting the Tag)
RDR -> 02 80 04 00 00 00 00 01 01 00 00
RDR -> D5 33 90 00 [Checksum] 03

Note: *Please refer to the Tag specification for more detailed information.*

6.7. Basic program flow for MIFARE applications

Typical sequence may be:

1. Scanning the tags in the field (Polling).
2. Authentication.
3. Read/Write the memory of the tag.
4. Halt the tag (optional).

Step 1. Set the retry time.

HOST -> 02 6F 0B 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 06 D4 32 05 00 00 01 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 04 00 00 00 00 01 01 00 00

RDR -> D5 33 90 00 [Checksum] 03

Step 2. Polling for the MIFARE 1K/4K tags, 106 kbps.

HOST -> 02 6F 09 00 00 00 00 01 00 00 00 FF 00 00 00 04 D4 4A 01 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 0E 00 00 00 00 01 01 00 00

RDR -> 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

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

SEL_RES of some common tag types.

00 = MIFARE® Ultralight®

08 = MIFARE® Classic 1K

09 = MIFARE® Mini

18 = MIFARE® Classic 4K

20 = MIFARE® DESFire®

28 = JCOP30

98 = Gemplus MPCOS

Step 3. KEY A Authentication, Block **04**, KEY = FF FF FF FF FF FF, UID = F6 8E 2A 99

HOST -> 02 6F 14 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 0F D4 40 01 **60** **04** FF FF FF FF FF FF F6 8E 2A 99 [Checksum] 03

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RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

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

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

For KEY B Authentication

HOST -> 02 6F 14 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 0F D4 40 01 **61** **04** FF FF FF FF FF FF F6 8E 2A 99

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

Step 4. Read the content of Block **04**.

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00 FF 00 00 00 05 D4 40 01 **30** **04** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> 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 5. Update the content of Block **04**.

HOST -> 02 6F 1A 00 00 00 00 01 00 00 00

HOST -> 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

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

Step 6. Halt the tag (optional).

HOST -> 02 6F 08 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 03 D4 44 01 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 45 [00] 90 00 [Checksum] 03

6.7.1. Handling the value blocks of MIFARE 1K/4K tag?

The value blocks are used for performing electronic purse functions (Increment, Decrement, Restore, Transfer, etc). These 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	$\overline{\text{Adr}}$

Where:

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).

Example:

Value 100 (decimal) = 64 (Hex), assume Block = 05h

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)**.

HOST -> 02 6F 1A 00 00 00 00 01 00 00 00

HOST -> 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

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

Step 2. Increment the value of Block **05 by 1 (dec)**.

HOST -> 02 6F 0E 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 09 D4 40 01 **C1** **05** 01 00 00 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

Note: *Decrement the value of Block **05 by 1 (dec)**.*

HOST -> FF 00 00 00 09 D4 40 01 **C0** **05** 01 00 00 00

Step 3. Transfer the prior calculated value of Block **05 (dec)**.

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **B0** **05** [Checksum] 03

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RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

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

HOST -> FF 00 00 00 05 D4 40 01 **C2** **05**

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

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **30** **05** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> 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)**.

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **C2** **05** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **B0** **06** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

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

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **30** **06** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> 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.

Note: *Please refer to the MIFARE specification for more detailed information.*

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	00h ~ 02h	03h
Sector 1	04h ~ 06h	07h
..		
..		
Sector 14	38h ~ 0Ah	3Bh
Sector 15	3Ch ~ 3Eh	3Fh

1 KB

Table 2: MIFARE 1K 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	00h ~ 02h	03h
Sector 1	04h ~ 06h	07h
..		
..		
Sector 30	78h ~ 7Ah	7Bh
Sector 31	7Ch ~ 7Eh	7Fh

2 KB

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	80h ~ 8Eh	8Fh
Sector 33	90h ~ 9Eh	9Fh
..		
..		
Sector 38	E0h ~ EEh	EFh
Sector 39	F0h ~ FEh	FFh

2 K

Table 3: MIFARE 4K Memory Map

Note: *Once the authentication is done, all the data blocks of the same sector are free to access. For example, once the data block 04h is successfully authenticated (Sector 1), the data blocks 04h ~ 07h are free to access.*

6.7.2. Accessing MIFARE Ultralight tags

Typical sequence may be:

1. Scanning the tags in the field (Polling).
2. Read/Write the memory of the tag.
3. Halt the tag (optional).

Step 1. Set the retry time.

HOST -> 02 6F 0B 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 06 D4 32 05 00 00 01 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 04 00 00 00 00 01 01 00 00

RDR -> D5 33 90 00 [Checksum] 03

Step 2. Polling for the MIFARE Ultralight tags, 106 kbp.

HOST -> 02 6F 09 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 04 D4 4A 01 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 11 00 00 00 00 01 01 00 00

RDR -> D5 4B 01 01 00 44 00 07 04 6E 0C A1 BF 02 84 90 00 [Checksum] 03

In which, Number of Tag found = [01];

Target number = 01

SENS_RES = 00 44; SEL_RES = 00,

Length of the UID = 7;

UID = 04 6E 0C A1 BF 02 84

Operation Finished = 90 00

Step 3. Read the content of Page **04**.

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **30** **04** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> 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

Note: *4 consecutive Pages will be retrieved. Pages 4, 5, 6 and 7 will be retrieved. Each data page consists of 4 bytes.*

Step 4. Update the content of Page **04 with** the data “AA BB CC DD”.

HOST -> 02 6F 0E 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 09 D4 40 01 **A2** **04** AA BB CC DD [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

OR

Step 4. Write (MIFARE compatible Write) the content of Page **04 with** the data “AA BB CC DD”.

HOST -> 02 6F 1A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 15 D4 40 01 **A0** **04** AA BB CC DD 00 00 00 00 00 00 00 00 00 00 00 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

Note: *This command is implemented to accommodate the established MIFARE 1K/4K infrastructure. We have to assemble the data into a 16 bytes frame. The first 4 bytes are for data, the rest of the bytes (12 ZEROS) are for padding. Only the page 4 (4 bytes) is updated even though the whole 16 bytes frame is sent to the reader.*

Step 5. Read the content of Page **04** again.

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **30** **04** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] AA BB CC DD 05 06 07 08 09 10 11 12 13 14 15 16 90 00 [Checksum] 03

In which, Block Data = AA BB CC DD 05 06 07 08 09 10 11 12 13 14 15 16

Note: *Only the page 4 is updated. Pages 5, 6 and 7 remain the same.*

Step 6. Halt the tag (optional).

HOST -> 02 6F 08 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 03 D4 44 01 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 45 [00] 90 00 [Checksum] 03

Note: *Please refer to the MIFARE Ultralight specification for more detailed information.*

Byte Number	0	1	2	3	Page
Serial Number	SN0	SN1	SN2	BCC0	0
Serial Number	SN3	SN4	SN5	SN6	1
Internal/Lock	BCC1	Internal	Lock0	Lock1	2
OTP	OPT0	OPT1	OTP2	OTP3	3
Data read/write	Data0	Data1	Data2	Data3	4
Data read/write	Data4	Data5	Data6	Data7	5
Data read/write	Data8	Data9	Data10	Data11	6
Data read/write	Data12	Data13	Data14	Data15	7
Data read/write	Data16	Data17	Data18	Data19	8
Data read/write	Data20	Data21	Data22	Data23	9
Data read/write	Data24	Data25	Data26	Data27	10
Data read/write	Data28	Data29	Data30	Data31	11
Data read/write	Data32	Data33	Data34	Data35	12
Data read/write	Data36	Data37	Data38	Data39	13
Data read/write	Data40	Data41	Data42	Data43	14
Data read/write	Data44	Data45	Data46	Data47	15

512 bits
Or
64 bytes

Table 4: MIFARE Ultralight Memory Map

6.7.3. Accessing MIFARE Ultralight C tag

Typical sequence may be:

1. Scanning the tags in the field (Polling).
2. Authentication.
3. Read/Write the memory of the tag.
4. Halt the tag (optional).

Step 1. Set the retry time.

HOST -> 02 6F 0B 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 06 D4 32 05 00 00 01 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 04 00 00 00 00 01 01 00 00

RDR -> D5 33 90 00 [Checksum] 03

Step 2. Polling for the MIFARE Ultralight C tags, 106 kbps.

HOST -> 02 6F 09 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 04 D4 4A 01 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

info@acs.com.hk
www.acs.com.hk

RDR -> 02 80 11 00 00 00 00 01 01 00 00

RDR -> D5 4B 01 01 00 44 00 07 04 6E 0C A1 BF 02 84 90 00 [Checksum] 03

In which, Number of Tag found = [01]; Target number = 01

SENS_RES = 00 44; SEL_RES = 00,

Length of the UID = 7;

UID = 04 6E 0C A1 BF 02 84

Operation Finished = 90 00

Step 3. 3DES Authentication.

HOST -> 02 6F 09 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 04 D4 42 1A 00 10 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 0E 00 00 00 00 01 01 00 00

RDR -> D5 43 [00] 04 77 64 89 99 74 24 67 90 00 [Checksum] 03

In which, 3DES challenge from the card = [04 77 64 89 99 74 24 67];

h = 90 00

HOST -> 02 6F 18 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 13 D4 42 AF 88 68 45 07 65 86 99 67 00 53 77 56 98 65 49 67 [Checksum] 03

In which, 3DES reply to the card = [88 68 45 07 65 86 99 67 00 53 77 56 98 65 49 67];

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 0E 00 00 00 00 01 01 00 00

RDR -> D5 43 [00] 00 06 78 53 80 68 89 61 24 90 00 [Checksum] 03

In which, 3DES reply from the card = [06 78 53 80 68 89 61 24];

Operation Finished = 90 00

Note: *The 3DES reply from the card should be checked to make sure the card is legitimate.*

Step 4. Read the content of Page **04**.

HOST -> 02 6F 09 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **30** **04** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> 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

Note: *4 consecutive Pages will be retrieved. Pages 4, 5, 6 and 7 will be retrieved. Each data page consists of 4 bytes.*

Step 5. Update the content of Page **04 with** the data "AA BB CC DD".

HOST -> 02 6F 0E 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 09 D4 40 01 **A2** **04** AA BB CC DD [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

OR

Step 5. Write (MIFARE compatible Write) the content of Page **04 with** the data "AA BB CC DD".

HOST -> 02 6F 1A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 15 D4 40 01 **A0** **04** AA BB CC DD 00 00 00 00 00 00 00 00 00 00 00 00 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] 90 00 [Checksum] 03

Note: *This command is implemented to accommodate the established MIFARE 1K/4K infrastructure. We have to assemble the data into a 16 bytes frame. The first 4 bytes are for data, the rest of the bytes (12 ZEROS) are for padding. Only the page 4 (4 bytes) is updated even though the whole 16 bytes frame is sent to the reader.*

Step 6. Read the content of Page **04** again.

HOST -> 02 6F 0A 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 05 D4 40 01 **30** **04** [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 15 00 00 00 00 01 01 00 00

RDR -> D5 41 [00] AA BB CC DD 05 06 07 08 09 10 11 12 13 14 15 16 90 00 [Checksum] 03

In which, Block Data = AA BB CC DD 05 06 07 08 09 10 11 12 13 14 15 16

Note: *Only the page 4 is updated. Pages 5, 6 and 7 remain the same.*

Step 7. Halt the tag (optional).

HOST -> 02 6F 08 00 00 00 00 01 00 00 00

HOST -> FF 00 00 00 03 D4 44 01 [Checksum] 03

info@acs.com.hk
www.acs.com.hk

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 05 00 00 00 00 01 01 00 00

RDR -> D5 45 [00] 90 00 [Checksum] 03

Note: *Please refer to the MIFARE Ultralight C specification for more detailed information.*

Byte Number	0	1	2	3	Page
Serial Number	SN0	SN1	SN2	BCC0	0
Serial Number	SN3	SN4	SN5	SN6	1
Internal/Lock	BCC1	Internal	Lock	Lock	2
OTP	OTP0	OTP1	OTP2	OTP3	3
Data read/write	Data0	Data1	Data2	Data3	4
Data read/write	Data4	Data5	Data6	Data7	5
Data read/write	Data8	Data9	Data10	Data11	6
Data read/write	Data12	Data13	Data14	Data15	7
Data read/write	Data16	Data17	Data18	Data19	8
Data read/write	Data20	Data21	Data22	Data23	9
Data read/write	Data24	Data25	Data26	Data27	10
Data read/write	Data28	Data29	Data30	Data31	11
Data read/write	Data32	Data33	Data34	Data35	12
Data read/write	Data36	Data37	Data38	Data39	13
Data read/write	Data40	Data41	Data42	Data43	14
Data read/write	Data44	Data45	Data46	Data47	15
Data read/write	Data48	Data49	Data50	Data51	16
Data read/write	Data52	Data53	Data54	Data55	17
Data read/write	Data56	Data57	Data58	Data59	18
Data read/write	Data60	Data61	Data62	Data63	19
Data read/write	Data64	Data65	Data66	Data67	20
Data read/write	Data68	Data69	Data70	Data71	21
Data read/write	Data72	Data73	Data74	Data75	22
Data read/write	Data76	Data77	Data78	Data79	23
Data read/write	Data80	Data81	Data82	Data83	24
Data read/write	Data84	Data85	Data86	Data87	25
Data read/write	Data88	Data89	Data90	Data91	26
Data read/write	Data92	Data93	Data94	Data95	27
Data read/write	Data96	Data97	Data98	Data99	28
Data read/write	Data100	Data101	Data102	Data103	29
Data read/write	Data104	Data105	Data106	Data107	30

Byte Number	0	1	2	3	Page
Data read/write	Data108	Data109	Data110	Data111	31
Data read/write	Data112	Data113	Data114	Data115	32
Data read/write	Data116	Data117	Data118	Data119	33
Data read/write	Data120	Data121	Data122	Data123	34
Data read/write	Data124	Data125	Data126	Data127	35
Data read/write	Data128	Data129	Data130	Data131	36
Data read/write	Data132	Data133	Data134	Data135	37
Data read/write	Data136	Data137	Data138	Data139	38
Data read/write	Data140	Data141	Data142	Data143	39
Lock	Lock	Lock	-	-	40
16 bit counter	16 bit counter	16 bit counter	-	-	41
Authentication configuration	Authentication configuration	Authentication configuration	Authentication configuration	Authentication configuration	42
Authentication configuration	Authentication configuration	Authentication configuration	Authentication configuration	Authentication configuration	43
Authentication key	Authentication key	Authentication key	Authentication key	Authentication key	44
Authentication key	Authentication key	Authentication key	Authentication key	Authentication key	45
Authentication key	Authentication key	Authentication key	Authentication key	Authentication key	46
Authentication key	Authentication key	Authentication key	Authentication key	Authentication key	47

Table 5: MIFARE Ultralight C Memory Map

Total Page Size: 792 bits of 198 Bytes.

6.8. Basic program flow for FeliCa applications

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

Step 1. The second thing to do is to change the operating parameters of the contactless chip. Set the Retry Time to two.

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.

Notes:

1. *The default Retry Time of the Tag command "InListPassiveTarget" is infinity. Send the APDU "FF 00 00 00 06 D4 32 05 00 00 01" to change the Retry Time to two.*
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"

6.9. Basic program flow for NFC Forum Type 1 tag applications

Example: Jewel and Topaz tags.

Typical sequence may be:

1. Scanning the tags in the field (Polling).
2. Read/Update the memory of the tag.
3. Deselect the tag.

Step 1. Set the retry time.

HOST -> 02 6F 0B 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 06 D4 32 05 00 00 01 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 04 00 00 00 00 01 01 00 00

RDR -> D5 33 90 00 [Checksum] 03

Step 2. Polling for the Jewel or Topaz Tag, 106 kbps.

HOST -> 02 6F 09 00 00 00 00 01 00 00 00 (HOST_to_RDR_XfrBlock Format)

HOST -> FF 00 00 00 04 D4 4A 01 04 [Checksum] 03

RDR -> 02 00 00 03 (Waiting the Tag)

RDR -> 02 80 0C 00 00 00 00 01 01 00 00

RDR -> D5 4B 01 01 0C 00 B5 3E 21 00 90 00 [Checksum] 03

In which, Number of Tag found = [01];
Target number = 01
ATQA_RES = 0C 00; UID = B5 3E 21 00
Operation Finished = 90 00

Step 3. Read the memory address 08 (Block 1: Byte-0)

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

RDR -> 02 00 00 03 02 80 06 00 00 00 00 01 01 00 00 D5 41 [00] 18 90 00 [Checksum] 03

In which, Response Data = 18

***Note:** To read all the memory content of the tag starting from the memory address 00:*

HOST -> 02 6F 09 00 00 00 00 01 00 00 00 FF 00 00 00 04 D4 40 01 00 [Checksum] 03

RDR -> 02 00 00 03 02 80 7F 00 00 00 00 01 01 00 00 D5 41 00 11 48

RDR -> show all data … 90 00 [Checksum] 03

Step 4. Update the memory address 08 (Block 1: Byte-0) with the data FF

HOST -> 2 6F 0B 00 00 00 00 01 00 00 00 FF 00 00 00 06 D4 40 01 53 08 FF [Checksum] 03

RDR -> 02 00 00 03 02 80 05 00 00 00 00 01 01 00 00 D5 41 [00] FF 90 00 [Checksum] 03

In which, Response Data = FF

***Note:** To update more than one memory content of the tag starting form the memory address 08 (Block 1: Byte-0)*

HOST -> 02 6F 0D 00 00 00 00 01 00 00 00 FF 00 00 00 08 D4 40 01 58 08 02 AA BB [Checksum] 03

RDR -> 02 00 00 03 02 80 06 00 00 00 00 01 01 00 00 D5 41 [00] 90 00 [Checksum] 03

In which, Command = 58; Starting memory address = 08;
Number of write content = 02;
Memory content = AA, BB;

Step 5. Deselect the tag.

HOST -> 02 6F 08 00 00 00 00 01 00 00 00 FF 00 00 00 03 D4 44 01 [Checksum] 03

RDR -> 02 00 00 03 02 80 05 00 00 00 00 01 01 00 00 D5 45 [00] 90 00 [Checksum] 03

Appendix A. Topaz

EEPROM Memory Map										
Type	Block No.	Byte-0 (LSB)	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5	Byte-6	Byte-7 (MSB)	Lockable
UID	0	UID-0	UID-1	UID-2	UID-3	UID-4	UID-5	UID-6		Locked
Data	1	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7	Yes
Data	2	Data8	Data9	Data10	Data11	Data12	Data13	Data14	Data15	Yes
Data	3	Data16	Data17	Data18	Data19	Data20	Data21	Data22	Data23	Yes
Data	4	Data24	Data25	Data26	Data27	Data28	Data29	Data30	Data31	Yes
Data	5	Data32	Data33	Data34	Data35	Data36	Data37	Data38	Data39	Yes
Data	6	Data40	Data41	Data42	Data43	Data44	Data45	Data46	Data47	Yes
Data	7	Data48	Data49	Data50	Data51	Data52	Data53	Data54	Data55	Yes
Data	8	Data56	Data57	Data58	Data59	Data60	Data61	Data62	Data63	Yes
Data	9	Data64	Data65	Data66	Data67	Data68	Data69	Data70	Data71	Yes
Data	A	Data72	Data73	Data74	Data75	Data76	Data77	Data78	Data79	Yes
Data	B	Data80	Data81	Data82	Data83	Data84	Data85	Data86	Data87	Yes
Data	C	Data88	Data89	Data90	Data91	Data92	Data93	Data94	Data95	Yes
Reserved	D									
Lock/Reserved	E	LOCK-0	LOCK-1	OTP-0	OTP-1	OTP-2	OTP-3	OTP-4	OTP-5	

	Reserved for internal use
	User Block Lock & Status
	OTP bits

Appendix B. Topaz512

EEPROM Memory Map (Segment0)

Type	Block No.	Byte-0 (LSB)	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5	Byte-6	Byte-7 (MSB)	Lockable
UID	00	UID-0	UID-1	UID-2	UID-3	UID-4	UID-5	25h		Locked
Data	01	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7	Yes
Data	02	Data8	Data9	Data10	Data11	Data12	Data13	Data14	Data15	Yes
Data	03	Data16	Data17	Data18	Data19	Data20	Data21	Data22	Data23	Yes
Data	04	Data24	Data25	Data26	Data27	Data28	Data29	Data30	Data31	Yes
Data	05	Data32	Data33	Data34	Data35	Data36	Data37	Data38	Data39	Yes
Data	06	Data40	Data41	Data42	Data43	Data44	Data45	Data46	Data47	Yes
Data	07	Data48	Data49	Data50	Data51	Data52	Data53	Data54	Data55	Yes
Data	08	Data56	Data57	Data58	Data59	Data60	Data61	Data62	Data63	Yes
Data	09	Data64	Data65	Data66	Data67	Data68	Data69	Data70	Data71	Yes
Data	0A	Data72	Data73	Data74	Data75	Data76	Data77	Data78	Data79	Yes
Data	0B	Data80	Data81	Data82	Data83	Data84	Data85	Data86	Data87	Yes
Data	0C	Data88	Data89	Data90	Data91	Data92	Data93	Data94	Data95	Yes
Reserved	0D									N/A
Lock/OTP	0E	LOCK-0	LOCK-1	OTP-0	OTP-1	OTP-2	OTP-3	OTP-4	OTP-5	N/A
Lock/OTP	0F	OTP-6	OTP-7	LOCK-2	LOCK-3	LOCK-4	LOCK-5	LOCK-6	LOCK-7	N/A

EEPROM Memory Map (Segment1)

Type	Block No.	Byte-0 (LSB)	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5	Byte-6	Byte-7 (MSB)	Lockable
Data	10	Data96	Data97	Data98	Data99	Data100	Data101	Data102	Data103	Yes
Data	11	Data104	Data105	Data106	Data107	Data108	Data109	Data110	Data111	Yes
Data	12	Data112	Data113	Data114	Data115	Data116	Data117	Data118	Data119	Yes
Data	13	Data120	Data121	Data122	Data123	Data124	Data125	Data126	Data127	Yes
Data	14	Data128	Data129	Data130	Data131	Data132	Data133	Data134	Data135	Yes
Data	15	Data136	Data137	Data138	Data139	Data140	Data141	Data142	Data143	Yes
Data	16	Data144	Data145	Data146	Data147	Data148	Data149	Data150	Data151	Yes
Data	17	Data152	Data153	Data154	Data155	Data156	Data157	Data158	Data159	Yes
Data	18	Data160	Data161	Data162	Data163	Data164	Data165	Data166	Data167	Yes
Data	19	Data168	Data169	Data170	Data171	Data172	Data173	Data174	Data175	Yes
Data	1A	Data176	Data177	Data178	Data179	Data180	Data181	Data182	Data183	Yes
Data	1B	Data184	Data185	Data186	Data187	Data188	Data189	Data190	Data191	Yes
Data	1C	Data192	Data193	Data194	Data195	Data196	Data197	Data198	Data199	Yes
Data	1D	Data200	Data201	Data202	Data203	Data204	Data205	Data206	Data207	Yes
Data	1E	Data208	Data209	Data210	Data211	Data212	Data213	Data214	Data215	Yes
Data	1F	Data216	Data217	Data218	Data219	Data220	Data221	Data222	Data223	Yes

EEPROM Memory Map (Segment2)										
Type	Block No.	Byte-0 (LSB)	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5	Byte-6	Byte-7 (MSB)	Lockable
Data	20	Data224	Data225	Data226	Data227	Data228	Data229	Data230	Data231	Yes
Data	21	Data232	Data233	Data234	Data235	Data236	Data237	Data238	Data239	Yes
Data	22	Data240	Data241	Data242	Data243	Data244	Data245	Data246	Data247	Yes
Data	23	Data248	Data249	Data250	Data251	Data252	Data253	Data254	Data255	Yes
Data	24	Data256	Data257	Data258	Data259	Data260	Data261	Data262	Data263	Yes
Data	25	Data264	Data265	Data266	Data267	Data268	Data269	Data270	Data271	Yes
Data	26	Data272	Data273	Data274	Data275	Data276	Data277	Data278	Data279	Yes
Data	27	Data280	Data281	Data282	Data283	Data284	Data285	Data286	Data287	Yes
Data	28	Data288	Data289	Data290	Data291	Data292	Data293	Data294	Data295	Yes
Data	29	Data296	Data297	Data298	Data299	Data300	Data301	Data302	Data303	Yes
Data	2A	Data304	Data305	Data306	Data307	Data308	Data309	Data310	Data311	Yes
Data	2B	Data312	Data313	Data314	Data315	Data316	Data317	Data318	Data319	Yes
Data	2C	Data320	Data321	Data322	Data323	Data324	Data325	Data326	Data327	Yes
Data	2D	Data328	Data329	Data330	Data331	Data332	Data333	Data334	Data335	Yes
Data	2E	Data336	Data337	Data338	Data339	Data340	Data341	Data342	Data343	Yes
Data	2F	Data344	Data345	Data346	Data347	Data348	Data349	Data350	Data351	Yes

EEPROM Memory Map (Segment3)										
Type	Block No.	Byte-0 (LSB)	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5	Byte-6	Byte-7 (MSB)	Lockable
Data	30	Data352	Data353	Data354	Data355	Data356	Data357	Data358	Data359	Yes
Data	31	Data360	Data361	Data362	Data363	Data364	Data365	Data366	Data367	Yes
Data	32	Data368	Data369	Data370	Data371	Data372	Data373	Data374	Data375	Yes
Data	33	Data376	Data377	Data378	Data379	Data380	Data381	Data382	Data383	Yes
Data	34	Data384	Data385	Data386	Data387	Data388	Data389	Data390	Data391	Yes
Data	35	Data392	Data393	Data394	Data395	Data396	Data397	Data398	Data399	Yes
Data	36	Data400	Data401	Data402	Data403	Data404	Data405	Data406	Data407	Yes
Data	37	Data408	Data409	Data410	Data411	Data412	Data413	Data414	Data415	Yes
Data	38	Data416	Data417	Data418	Data419	Data420	Data421	Data422	Data423	Yes
Data	39	Data424	Data425	Data426	Data427	Data428	Data429	Data430	Data431	Yes
Data	3A	Data432	Data433	Data434	Data435	Data436	Data437	Data438	Data439	Yes
Data	3B	Data440	Data441	Data442	Data443	Data444	Data445	Data446	Data447	Yes
Data	3C	Data448	Data449	Data450	Data451	Data452	Data453	Data454	Data455	Yes
Data	3D	Data456	Data457	Data458	Data459	Data460	Data461	Data462	Data463	Yes
Data	3E	Data464	Data465	Data466	Data467	Data468	Data469	Data470	Data471	Yes
Data	3F	Data472	Data473	Data474	Data475	Data476	Data477	Data478	Data479	Yes

	Reserved for internal use
	User Block Lock & Status
	OTP bits

Appendix C. Jewel64

EEPROM Memory Map (Segment0)										
Type	Block No.	Byte-0 (LSB)	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5	Byte-6	Byte-7 (MSB)	Lockable
UID	0	UID-0	UID-1	UID-2	UID-3	UID-4	UID-5	25_h		Locked
Data	1	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7	Yes
Data	2	Data8	Data9	Data10	Data11	Data12	Data13	Data14	Data15	Yes
Data	3	Data16	Data17	Data18	Data19	Data20	Data21	Data22	Data23	Yes
Data	4	Data24	Data25	Data26	Data27	Data28	Data29	Data30	Data31	Yes
Data	5	Data32	Data33	Data34	Data35	Data36	Data37	Data38	Data39	Yes
Data	6	Data40	Data41	Data42	Data43	Data44	Data45	Data46	Data47	Yes
Data	7	Data48	Data49	Data50	Data51	Data52	Data53	Data54	Data55	Yes
Reserved	8	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	N/A
Reserved	9	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	N/A
Reserved	A	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	N/A
Reserved	B	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	N/A
Data	C	Data56	Data57	Data58	Data59	Data60	Data61	Data62	Data63	Yes
Reserved	D	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	N/A
Lock/OTP	E	LOCK-0	LOCK-1	OTP-0	OTP-1	OTP-2	OTP-3	OTP-4	OTP-5	N/A

	Reserved for internal use
	User Block Lock & Status
	OTP bits

Appendix D. Jewel96

EEPROM Memory Map										
Type	Block No.	Byte-0 (LSB)	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5	Byte-6	Byte-7 (MSB)	Lockable
UID	0	UID-0	UID-1	UID-2	UID-3	UID-4	UID-5	UID-6		Locked
Data	1	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7	Yes
Data	2	Data8	Data9	Data10	Data11	Data12	Data13	Data14	Data15	Yes
Data	3	Data16	Data17	Data18	Data19	Data20	Data21	Data22	Data23	Yes
Data	4	Data24	Data25	Data26	Data27	Data28	Data29	Data30	Data31	Yes
Data	5	Data32	Data33	Data34	Data35	Data36	Data37	Data38	Data39	Yes
Data	6	Data40	Data41	Data42	Data43	Data44	Data45	Data46	Data47	Yes
Data	7	Data48	Data49	Data50	Data51	Data52	Data53	Data54	Data55	Yes
Data	8	Data56	Data57	Data58	Data59	Data60	Data61	Data62	Data63	Yes
Data	9	Data64	Data65	Data66	Data67	Data68	Data69	Data70	Data71	Yes
Data	A	Data72	Data73	Data74	Data75	Data76	Data77	Data78	Data79	Yes
Data	B	Data80	Data81	Data82	Data83	Data84	Data85	Data86	Data87	Yes
Data	C	Data88	Data89	Data90	Data91	Data92	Data93	Data94	Data95	Yes
Reserved	D									
Lock/Reserved	E	LOCK-0	LOCK-1	OTP-0	OTP-1	OTP-2	OTP-3	OTP-4	OTP-5	

Reserved for internal use
User Block Lock & Status
OTP bits

Appendix E. ACR122 Error Codes

Error Code	Error
00h	No error.
01h	Time Out, the target has not answered.
02h	A CRC error has been detected by the contactless UART.
03h	A Parity error has been detected by the contactless UART.
04h	During a MIFARE anti-collision/select operation, an erroneous Bit Count has been detected.
05h	Framing error during MIFARE operation.
06h	An abnormal bit-collision has been detected during bit wise anti-collision at 106 kbps.
07h	Communication buffer size insufficient.
08h	RF Buffer overflow has been detected by the contactless UART (bit BufferOvfl of the register CL_ERROR).
0Ah	In active communication mode, the RF field has not been switched on in time by the counterpart (as defined in NFCIP-1 standard).
0Bh	RF Protocol error (cf. reference [4], description of the CL_ERROR register).
0Dh	Temperature error: the internal temperature sensor has detected overheating, and therefore has automatically switched off the antenna drivers.
0Eh	Internal buffer overflow
10h	Invalid parameter (range, format, etc.)
12h	DEP Protocol: The chip configured in target mode does not support the command received from the initiator (the command received is not one of the following: ATR_REQ, WUP_REQ, PSL_REQ, DEP_REQ, DSL_REQ, RLS_REQ, ref. [1]).
13h	DEP Protocol/MIFARE/ISO/IEC 14443-4: The data format does not match to the specification. Depending on the RF protocol used, it can be: • Bad length of RF received frame, • Incorrect value of PCB or PFB, • Invalid or unexpected RF received frame, • NAD or DID incoherence.
14h	MIFARE: Authentication error.
23h	ISO/IEC 14443-3: UID Check byte is wrong.
25h	DEP Protocol: Invalid device state, the system is in a state which does not allow the operation.
26h	Operation not allowed in this configuration (host controller interface).
27h	This command is not acceptable due to the current context of the chip (Initiator vs. Target, unknown target number, Target not in the good state, etc.).
29h	The chip configured as target has been released by its initiator.
2Ah	ISO/IEC 14443-3B only: the ID of the card does not match, meaning that the expected card has been exchanged with another one.
2Bh	ISO/IEC 14443-3B only: the card previously activated has disappeared.

Error Code	Error
2Ch	Mismatch between the NFCID3 initiator and the NFCID3 target in DEP 212/424 kbps passive.
2Dh	An over-current event has been detected.
2Eh	NAD missing in DEP frame.