



FM11RF08

8KBits Contactless Card IC

Functional Specification

May. 2008

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1. Features

● RF interface

- Compliant with ISO/IEC 14443-A
- Contactless transmission of data and supply (no battery needed)
- Operating frequency: 13.56MHz
- Fast communication baud rate: 106Kbit/s
- Contactless transmission of data and supply (no battery needed)
- Operating distance: up to 100mm (depending on antenna geometry)
- Half duplex communication protocol using handshake
- Encryption algorithm compatible with M1 standard
- Typical transaction time: <100ms

● EEPROM

- 1024x8bit EEPROM memory
- Organized in security separated 16 sectors supporting multi-application use.
- User flexible defines access conditions for each memory block.

● High security

- Mutual three pass authentication
- High security level data communication
- Each sector has its own two secret files for systems using key hierarchies.

● Arithmetic capability: increase and decrease.

● High Reliability

- Endurance: 100,000cycle
- Data Retention: 10 Years

2. Product Overview

2.1. Introduction

FM11RF08 is the contactless card IC according to ISO14443 Type A development by Shanghai FuDan Microelectronics Co., Ltd. This device has 1K x 8bits EEPROM organization. The maximum communication range between the reader antenna and contactless card is approximately 10 cm.

FM11RF08 also has a very high security performance with the encryption and communication circuit, and is a true multi-application smart card with the functionality of a processor card realized with hardware logic. So FM11RF08 can be especially tailored to meet the requirements of a payment card which can be used for ticketing systems in public transport and comparable applications.

The Contactless smart card contains three components: FM11RF08 chip、antenna and the card base with PVC (or PET) material. No battery is needed. When the chip is positioned in proximity of the coupling device antenna, the high speed RF communication interface allows transmitting data with 106-Kbit/s.

2.2. Block Diagram

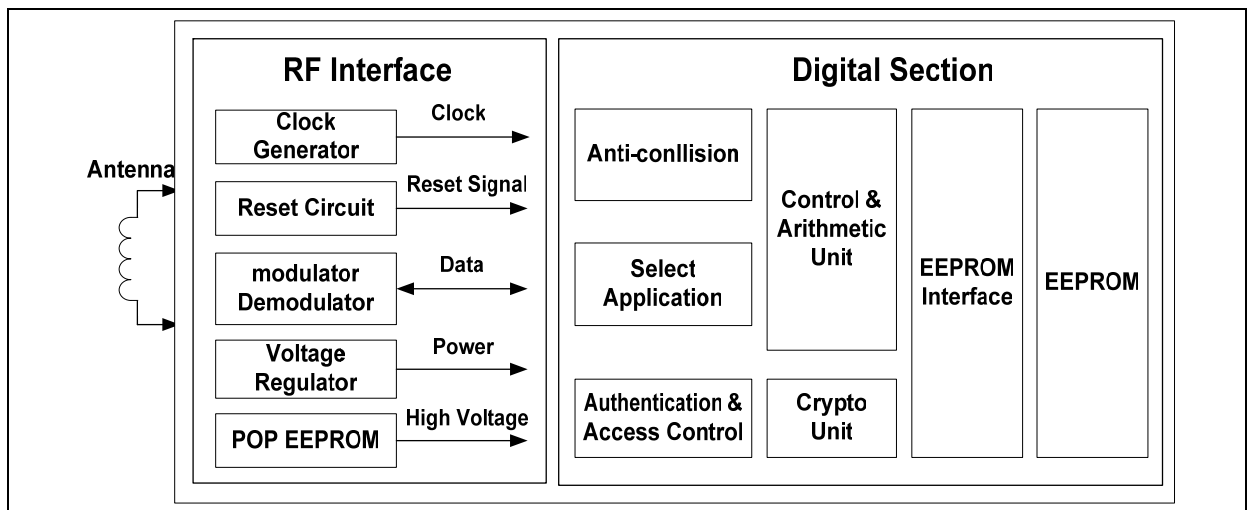


Figure 2-1 FM11RF08 Block Diagram

2.3. Pin Description

| PIN | SYMBOL | TYPE | DESCRIPTION |
|-----|--------|--------------|---------------------|
| 1 | IN1 | input/output | Antenna interface 1 |
| 2 | IN2 | input/output | Antenna interface 2 |

Table 2-1 FM11RF08 Pin Description

3. Commands

3.1. Command Code

| Commands | Code (HEX) |
|-------------------|------------|
| Request std | 26 |
| Request all | 52 |
| Anti-collision | 93 |
| Select Card | 93 |
| Authentication.la | 60 |
| Authentication.lb | 61 |
| Read | 30 |
| Write | A0 |
| Increment | C1 |
| Decrement | C0 |
| Restore | C2 |
| Transfer | B0 |
| Halt | 50 |

Table 3-1 FM11RF08 Command Code (HEX)

3.2. Commands Description

Answer to Request: Look for card in operating area. 'Request Std' means looking for card which is not set to halt, 'Request All' means looking for all cards which are in operating area.

Anti-collision: It means selecting only one card if there is one card or several cards in operating area.

Select Card: It means setting up the communication with the selected card after the anti-collision command.

Authentication: Before visiting memory, the user must verify if the operation is legal by coherence of cipher in RWD and cipher in card.

Read: Read 16 bytes of one block.

Write: Write data to one block.

Increment: Increment a certain value to numerical block, store the result in register.

Decrement: Decrement a certain value to numerical block, store the result in register.

Restore: Read contents of numerical block to register.

Transfer: Write contents of register to numerical block.

Halt: Card is set to halt.

4. Transaction Sequence Description

4.1. Transaction sequence Diagram

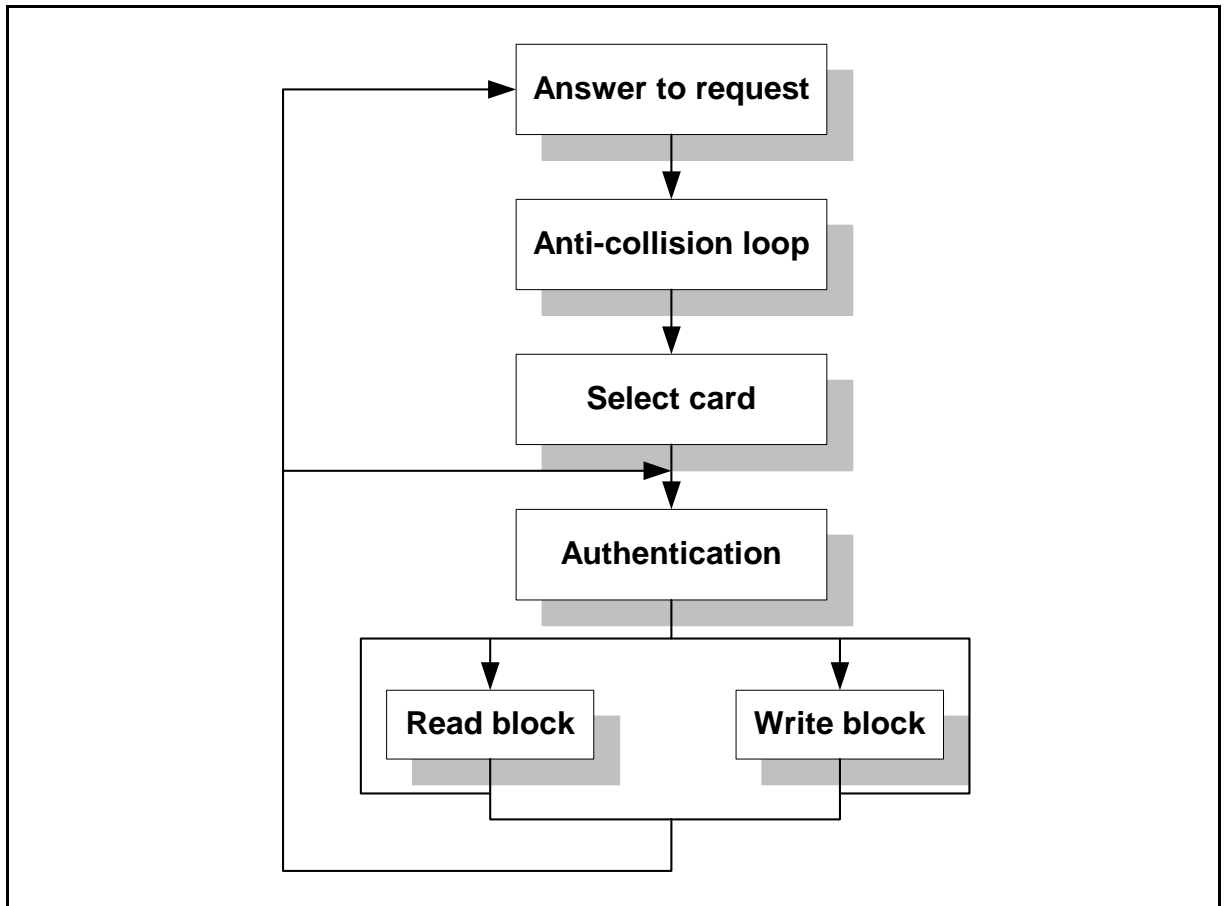


Figure 4-1 FM11RF08 Transaction Sequence Diagram

4.2. Transaction Sequence Description

Answer to Request: The type of a card defines the communication protocol and the communication baud rate between RWD and card. When a card is in the operating range of a RWD, the RWD continues communication with the appropriate protocol, specified by the type of a card.

Anti-collision Loop: If there are several cards in the operating range of RWD they can be distinguished by their different serial numbers and one selected for further transactions. The unselected cards return to the standby mode and wait for a new Answer to Request and Anti-collision loop.

Select Card: After selection of a card, the card returns the Answer to Select code (SAK).

3 Pass Authentication: After Selection of a card, RWD specifies the memory location of the following memory access and use the corresponding key for the 3 Pass Authentication procedures. Any communication after authentication is performed via stream cipher encryption.

Read/Write:

After authentication of the following operations may be performed:

READ: Read one block

WRITE: Write one block

DECREMENT: Decrements the contents of one block and stores the result in the data-register.

INCREMENT: Increments the contents of one block and stores the result in the data-register.

TRANSFER: Write the contents of the data-register to one block

RESTORE: Stores the contents of one block in the data-register

Halt: Pause operation

5. Memory Organization and Access Right

The FM11RF08 has integrated an 8K bits EEPROM which is split into 16 sectors with 4 blocks. One block consists of 16 bytes each.

The structure of memory is shown below:

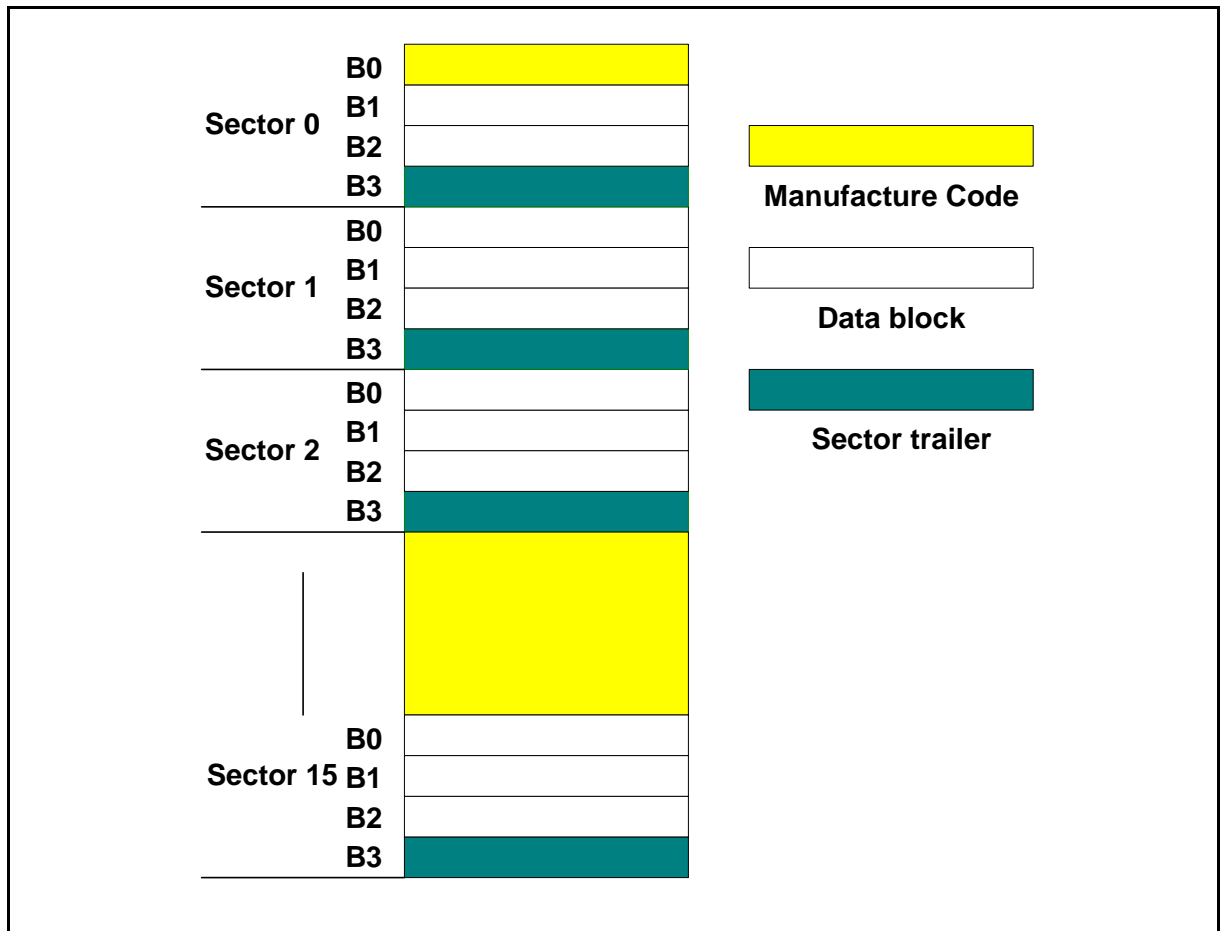


Figure 5-1 FM11RF08 Memory Organization

The fourth block of any sector contains access KEYA (6 bytes), an optional KEYB (6 bytes) and the access conditions for the four blocks of that sector (4 bytes). The other blocks of the sector serve as common data blocks. The first block of the memory is reserved for manufacturer data like 32 bit serial number. This is a read only block. In many documents it is named "block0".

The structure of block3 is shown below:

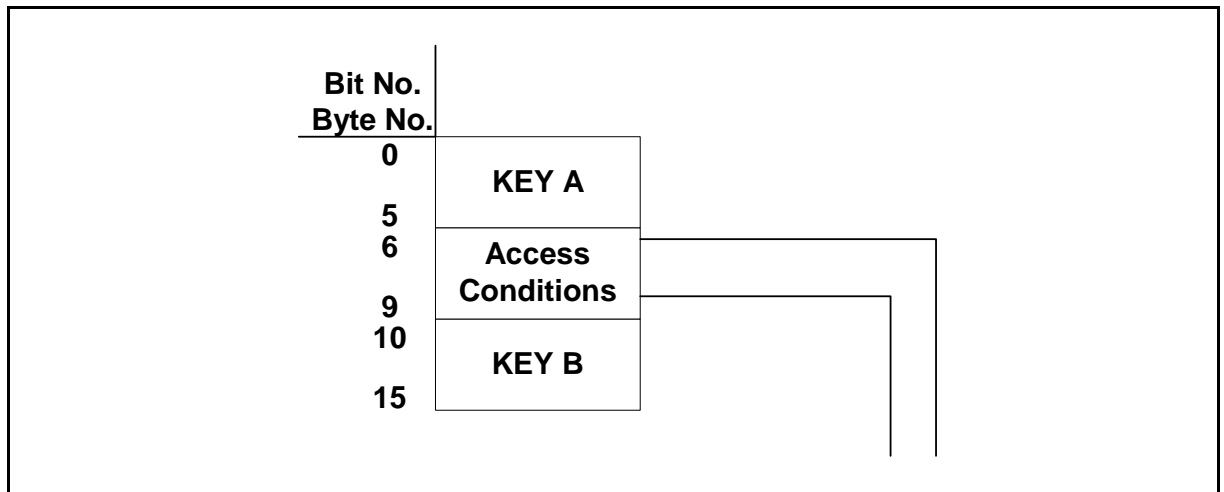


Figure 5-2 FM11RF08 Structure of Block 3

Memory organization:

| Bit7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|--------|--------|--------|--------|--------|--------|--------|--------|
| C2X3_b | C2X2_b | C2X1_b | C2X0_b | C1X3_b | C1X2_b | C1X1_b | C1X0_b |
| C1X3 | C1X2 | C1X1 | C1X0 | C3X3_b | C3X2_b | C3X1_b | C3X0_b |
| C3X3 | C3X2 | C3X1 | C3X0 | C2X3 | C2X2 | C2X1 | C2X0 |
| BX7 | BX6 | BX5 | BX4 | BX3 | BX2 | BX1 | BX0 |

Note:

- b stands for inversion e.g.:C2X3_b=INV(C2X3)
- X stands for sector No.(0~15)
- Y stands for block No.(0~3)
- C stands for control bit
- B stands for reserve bit

Access condition for the Block 3 (X=0-15)

| | | | KEYA | KEYA | Access Con | Access Con | KEYB | KEYB |
|------|------|------|-------|--------|------------|------------|--------|--------|
| C1X3 | C2X3 | C3X3 | read | Write | Read | Write | read | Write |
| 0 | 0 | 0 | never | KEYA B | KEYA B | Never | KEYA B | KEYA B |
| 0 | 1 | 0 | never | Never | KEYA B | Never | KEYA B | Never |
| 1 | 0 | 0 | never | KEYB | KEYA B | Never | never | KEYB |
| 1 | 1 | 0 | never | Never | KEYA B | Never | never | Never |
| 0 | 0 | 1 | Never | KEYA B | KEYA B | KEYA B | KEYA B | KEYA B |
| 0 | 1 | 1 | Never | KEYB | KEYA B | KEYB | never | KEYB |
| 1 | 0 | 1 | Never | Never | KEYA B | KEYB | never | Never |
| 1 | 1 | 1 | Never | Never | KEYA B | Never | never | Never |

Note: KEY A|B means KEY A or KEY B;

Never means can't perform the function.

Access condition for Data Blocks (X=0-15 sectors, y=0-2 block of each sector)

| C1XY | C2XY | C3XY | Read | Write | Increment | decr, transfer, restore |
|------|------|------|--------|--------|-----------|-------------------------|
| 0 | 0 | 0 | KEYA B | KEYA B | KEYA B | KEYA B |
| 0 | 1 | 0 | KEYA B | Never | Never | Never |
| 1 | 0 | 0 | KEYA B | KEYB | Never | Never |
| 1 | 1 | 0 | KEYA B | KEYB | KEYB | KEYA B |
| 0 | 0 | 1 | KEYA B | Never | Never | KEYA B |
| 0 | 1 | 1 | KEYB | KEYB | Never | Never |
| 1 | 0 | 1 | KEYB | Never | Never | Never |
| 1 | 1 | 1 | Never | Never | Never | Never |

6. Data Integrity

Following mechanisms are implemented in the contactless communication link between RWD and card to ensure very reliable data transmission.

- Anti-collision
- 16bit CRC per block
- Parity bits for each byte
- Bit count checking
- Bit coding to distinguish between “1”, “0”, and no information
- Channel monitoring (Protocol sequence and bit stream analysis)

7. Security

The FM11RF08 Card has high security: 3PASS Authentication must be through before read/write operation. Serial Numbers, which can not be altered, guarantee the uniqueness of each card. Crypto-Data transfer, Key Transfer and Access Key Protection.

Keys in the cards are read protected but can be altered by who knows the actual key. There are 16 sectors in the card, each sector has own keys (Key A, Key B). Two different keys for each sector support systems using key hierarchies, so FM11RF08 offers real multi-application functionality.

Revision History

| Version | Publication date | Pages | Paragraph or Illustration | Revise Description |
|---------|------------------|-------|---------------------------|-----------------------------------|
| 1.0 | Oct. 2004 | 4 | | Initial Release. |
| 2.0 | Oct. 2007 | 15 | | Updated Format. |
| 2.1 | May. 2008 | 15 | Sales and service | Updated the address of HK office. |

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