Shanghai Fudan Microelectronics Group Company Limited

复旦微电子

FM11RF32N

32KBits Contactless IC Card Chip

Datasheet

Sep. 2013

Trademarks

Content

1. Features

- **Contactless communications RF interface**
  - Contactless transmission of data and supply (no battery needed)
  - Operating distance: up to 100mm (depending on antenna geometry)
  - Operating frequency: 13.56MHz
  - Fast communication baud rate: 106Kbit/s
  - Half duplex communication protocol using handshake
  - Compatible: with ISO/IEC 14443-A
  - Encryption algorithm compatible with M1 standard
  - Typical Ticking Transaction: ＜100ms
- **EEPROM**
  - 4096 x 8bit EEPROM
  - High security level data communication
  - Organized in 32 sectors of 4 blocks and 8 sectors of 16 blocks (one block consists of 16 byte).
- **High security**
  - Mutual three pass authentication
  - Each sector has its own two secret keys for systems using key hierarchies.
  - Assess conditions for each block defined by user
- **Arithmetic capability: increase and decrease.**
- **High reliability**
  - Endurance: 100,000 cycle
  - Data Retention: 10 Years

2. Product Overview

2.1. Introduction

FM11RF32N is the contactless IC card chip development by Shanghai FM Co., Ltd. The chip has 4K x 8bits EEPROM organization; the maximum communication range between the reader antenna and contactless card is approximately 10cm. Data is exchanged half duplex at a 106 Kbit/s rate.

The FM11RF32N is a true multi-application smart card with the functionality of a processor card realized with hardware logic, and also has a very high security performance with the encryption and communication circuit, so FM11RF32N 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: FM11RF32N 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

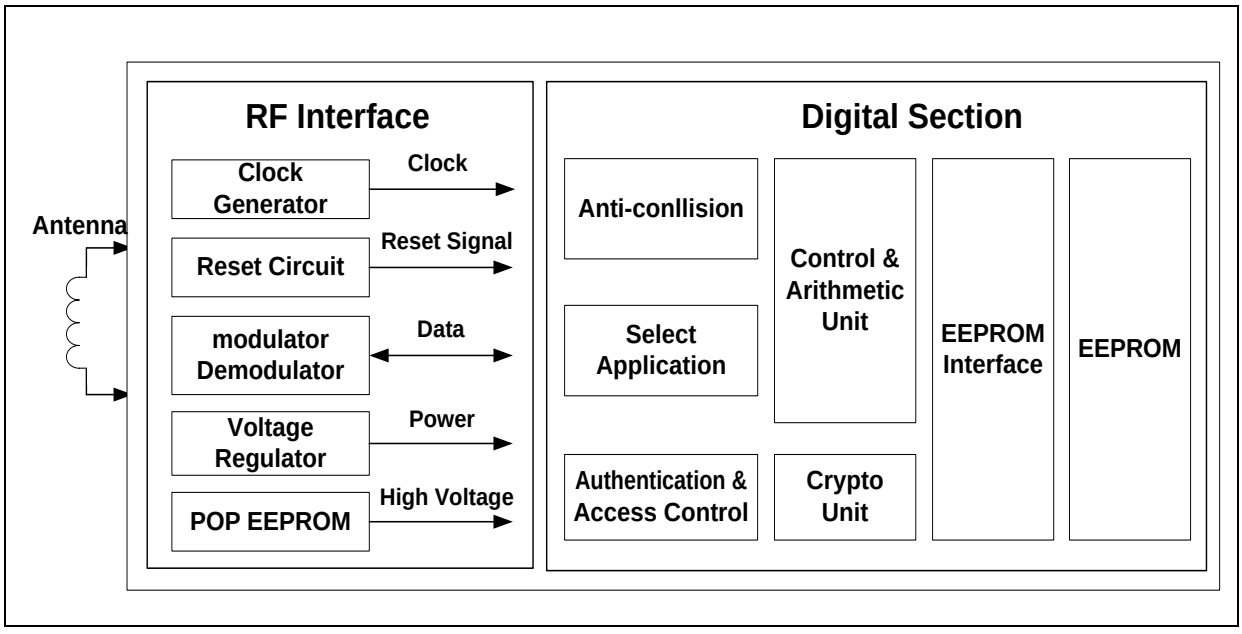

Figure 2-1 FM11RF32N Block Diagram

2.3. Function Description

2.3.1. Transaction sequence

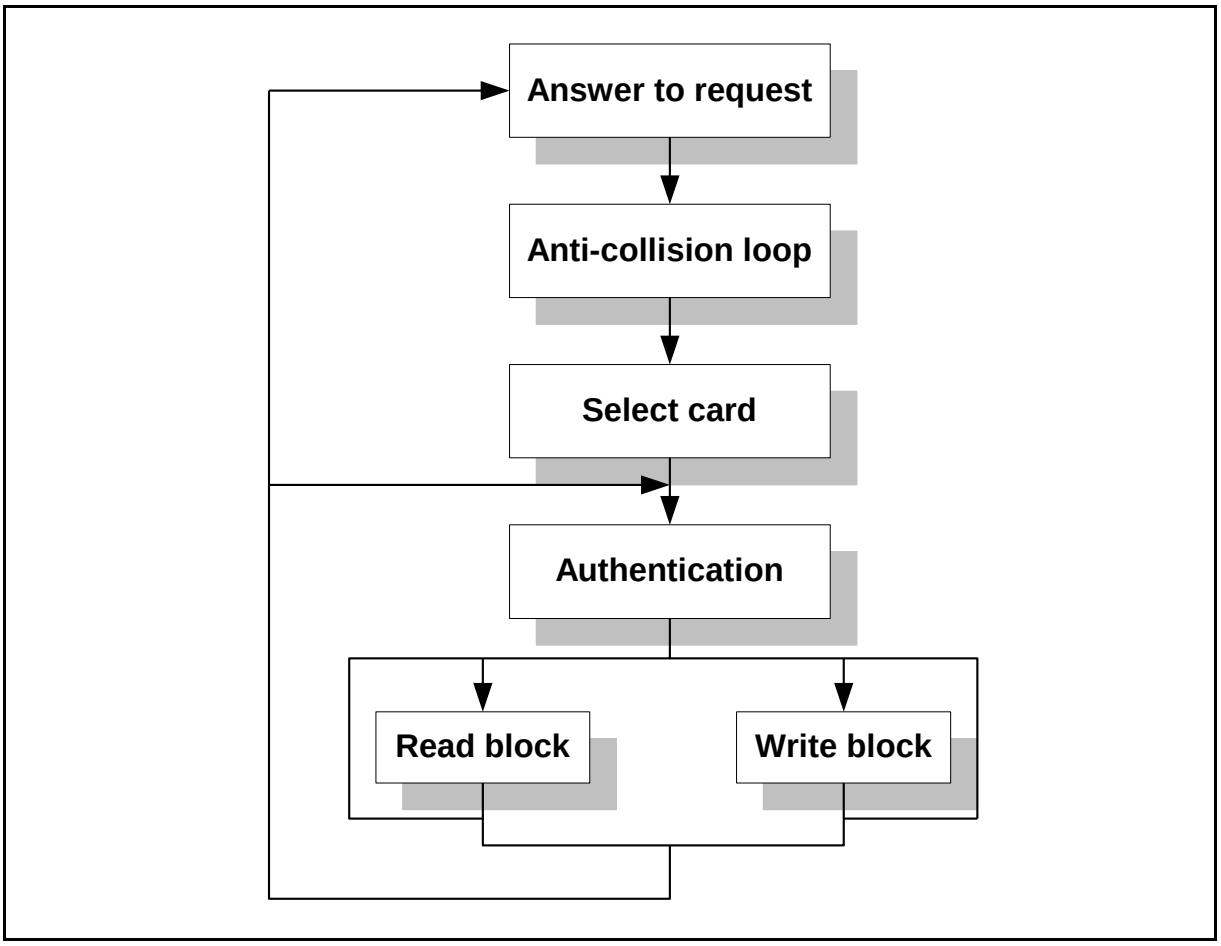

Figure 2-2 FM11RF32N Transaction sequence diagram

2.3.2. Transaction sequence description

Answer to Request: The communication protocol and the communication baud rate between RWD and card are defined in advance. When a card is in the operating range of a RWD, the RWD will communication with the appropriate protocol, to validate 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 unique serial numbers and one can be 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 a card selection, the card returns the Answer to Select code (SAK).

3 Pass Authentication: After selection of a card, RWD specifies the sector number and use the corresponding key for the 3 Pass Authentication procedures. Any communication after authentication is performed via stream cipher encryption. (If the next sector is selected, cipher verifying is necessary to the new sector.).

Read/Write: After authentication, 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: Writes the contents of the data-register to one block

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

Halt: Pause operation

3. Commands

3.1. Command code (HEX)

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

Table 3-1 FM11RF32N Command Code (HEX)

3.2. Commands demonstration

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. Memory Organization and Access Conditions

The FM11RF32N has integrated a 32Kbits EEPROM which is organized in 32 sectors of 4 blocks and 8 sectors of 16 blocks. One block contains 16 bytes. The structure of memory is shown below:

Sector	Block	Byte Number within a Block																Description
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
39	15	Key A						Access bits				Key B						Control Block
	14				Data													Data
	13				Data													Data
	…																	…
	2																	Data
	1																	Data
	0																	Data
…																		…
…																		…
32	15	Key A						Access bits				Key B						Control Block
	14				Data													Data
	13				Data													Data
	…				…													…
	2				Data													Data
	1				Data													Data
	0				Data													Data
31	3	Key A						Access bits				Key B						Control Block
	2																	Data
	1																	Data
	0																	Data
…																		…
…																		…
0	3	Key A						Access bits				Key B						Control Block
	2																	Data
	1																	Data
	0																	Manufacturer Block

Figure 4-1 FM11RF32N Memory Organization

The last block of any sector which named the control block contains access KEYA (6 bytes), KEYB (6 bytes) and the access conditions (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 and is also solidified. In many documents it is named “block0”. There are two kinds of data block application, one is data reserved and direct read/write, the other is denoted special data format, it can be initialization evaluation, increment, decrement and read. The structure of the control block is shown below.

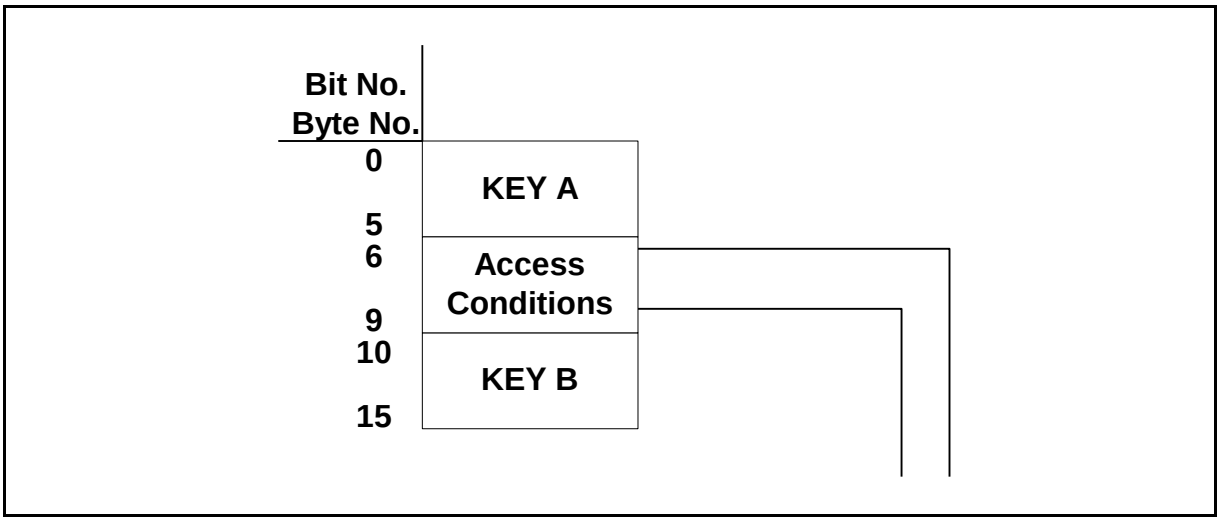

Figure 4-2 FM11RF32N Structure of the Control Block

bit 7	bit 6	bit 5	bit4	bit3	bit 2	bit 1	bit 0
$C2_3$_b	$C2_2$_b	$C2_1$_b	$C2_0$_b	$C1_3$_b	$C1_2$_b	$C1_1$_b	$C1_0$_b
$C1_3$	$C1_2$	$C1_1$	$C1_0$	$C3_3$_b	$C3_2$_b	$C3_1$_b	$C3_0$_b
$C3_3$	$C3_2$	$C3_1$	$C3_0$	$C2_3$	$C2_2$	$C2_1$	$C2_0$
B7	B6	B5	B4	B3	B2	B1	B0

Note: _b stands for inversion e.g.:C2X3_b=INV(C2X3)

C stands for control bit

B stands for reserve bit

Access condition for the control Block

			KEYA	KEYA	Access Con	Access Con	KEYB	KEYB
C1	C2	C3	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 the Data Blocks

C1	C2	C3	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

Table 4-1 FM11RF32N Access condition for the Data Blocks

5. Data Integrity

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

- Anti-collision
- 16 bit 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)

6. Security

The FM11RF32N Card has high security: 3 Pass Authentication must be through before read/write operation. Each card has different Serial Numbers, Crypto-Data transfer, Key Transfer and Access Key Protection which guarantee the uniqueness of each card.

Keys in the cards are read protected but can be altered by who knows the actual key. There are 48 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 FM11RF32N offers real multi-application functionality.

Revision History

Version	Publication date	Pages	Paragraph or Illustration	Revise Description
1.0	Apr.2012	15		Initial Release.
1.1	Sep.2013	15	Sales and service	1. Updated the legal disclaimer 2. Updated the address of sales and service

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