Article ID: 1007-1202(2005)03-0550-05

Serial Peripheral Interface Communication Between MCU EM78P447A and RF Reader IC MF RC530

YOU Zhi, CHEN Shu-zhen, HUANG Ji-wu
School of Electronic Information, Wuhan University, Wuhan 430072, Hubei, China

Abstract: A significant method in the way the MCU EM78P447A manipulates the RF reader IC MF RC530's functions used in RF IC card application is presented. In this paper, RF reader IC MF RC530's SPI compatible interface is introduced. The kernel technologies including SPI connection, software design, register initiation, request-response between the reader IC and the MCU, authentication and the proper format of the key are explained. Adopting the serial peripheral interface is the innovation in the paper. The SPI communication mode proves feasible and precise. Furthermore, in the way we avoid the abuse of parallel interface.

Key words: RF card; RF reader IC MF RC530; security key; MCU EM78P447A; SPI communication

CLC number: TP 368.1; TP 273.5

Received date: 2004-07-06
Foundation item: Supported by the National Natural Science Foundation of China (50099620) and the National High Technology Development 863 Program of China (2001AA13050-02)
Biography: YOU Zhi (1977-), male, Master candidate, research direction: communication and information system. E-mail: mshanduo @163.com
† To whom correspondence should be addressed. E-mail: huangjwen @21en.com

Introduction

Radio frequency (RF) card is also named contactless integrated circuit (IC) card [1] (implemented microprogrammed control unit (MCU), application specific integrated circuit (ASIC) and so on), which has been greatly developed in recent years. The reader IC is the core of the whole system based on RF card. How to manipulate the reader IC correctly is the kernel technology in the application based on RF card.

The MF RC530 is a member of the reader ICs family of Philips semi-conductors. It supports all the layers of the ISO 14443A communication scheme and contactless communication using MIFARE higher baud rate. It also performs well for its power-saving working and serial peripheral interface (SPI).

In the most present smart systems based on IC card application, parallel interface is used in manipulating the reader IC. Contrastively, serial data communication [2] is rarely used. The paper introduces the technology of the serial data communication between processor EM78P447A [3] and RF reader IC MF RC530.

1 MF RC530 Internal Configuration

Two main blocks are implemented in the MF RC530, the digital circuitry block and the analog circuitry block [4]. Its configuration is shown in Fig. 1.

The digital circuitry block comprises state machine, reset control, 64 byte FIFO, 32 × 16 byte EEPROM, key buffer, 32-bit pseudo random generator, coder and decoder logic.
serial data switch and so on.

The state machine executes the command code in the command register filled by exterior \( \mu \) processor, and updates concerned register flags according to the result executed.

Internal registers are divided into 8 pages. Each page comprises 8 byte. Exterior \( \mu \) processor manipulates the MF RC530 by means of setting its registers. Moreover, key checking, data reading and writing between \( \mu \) processor and RF card all depend on the two steps: \( \mu \) processor’s manipulating MF RC530 and MF RC530’s handling RF card. In these processes, \( \mu \) processor acquires state information from MF RC530’s registers. Therefore, it is pivotal to set reader IC’s registers accurately. The hard-power reset to MF RC530 is operative during the following three cases: ① Power on reset caused by power-up at pin DVDD; ② Power on reset caused by power-up at pin AVDD; ③ A high level on pin RSTPD.

The EEPROM is divided into 32 blocks (address 0 to 31). Each block comprises 16 byte. The first block is read-only block in which product information is deposited including product type identification and product serial number. Register-initialization files are in the following two blocks. In the initialization course, registers addressing from 0x10 to 0x2F are initialized automatically consulting these register-initialization files. If different values of initialization are necessary, you can use the blocks addressing 3 to 7 in which you can fill any favorite values to accomplish the initialization or change them directly through register-writing. Lastly, the blocks addressing 8 to 31 are key fields (write-only). The key buffer comprises 12 byte where the key to be used during key-check is deposited. The 32-bit pseudo random generator generates random data for authentication.

The analog circuitry block comprises the modulator, the antenna driver, the receive and the amplification circuitry.

### 2 Connection for Serial Communication

The MF RC530 supports a serial peripheral interface (SPI) that makes it easy to communicate with the EM78P447A, which specializes in bit-data processing. Figure 2 shows the connection between the \( \mu \) processor and the MF RC530 using the SPI compatible interface.

![Connection to \( \mu \)-processor with SPI](image)

The reader IC MF RC530 is small outline packaged, which has 32 pins. Pin description is presented in Ref. [4]. I only introduce pins involved in the connection to the \( \mu \)-processor EM78P447A in SPI.

In the figure, the MF RC530 acts as a slave IC. Pin \( A_2 \) is defined as SCK-line connected with pin P73 of the master IC (EM78P447A). The SPI clock (SCK) has to be generated by the master. The MOSI-line (P74 to \( A_1 \)) is used to carry bit-stream from the master IC to the slave (MF RC530). The MISO-line (\( D_0 \) to P75) is used to transmit bit stream from MF RC530 to the master IC. Additionally, pin P77 of the master should be connected to pin ALE, which is defined as NSS.

### 3 Communication Programming

I would like to introduce the communication pro-