RC522 RFID module for arduino

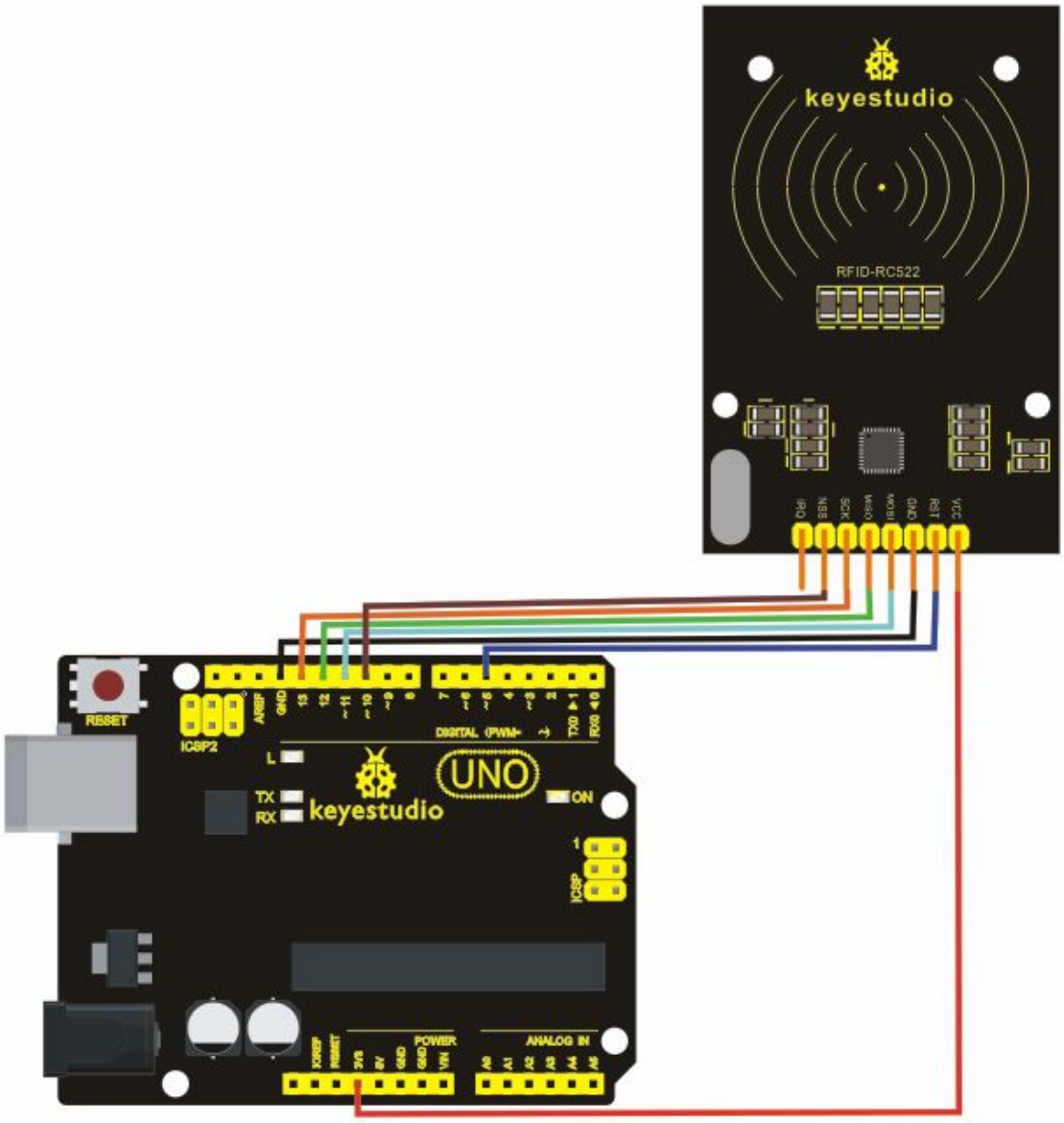
Introduction

MF522-AN module adopts Philips MFRC522 original reader circuit chip design, easy to use, low cost, suitable for equipment development, development of advanced applications such reader users, the need for RF card terminal design / production of the user. This module can be loaded directly into a variety of readers molds. Module uses voltage of 3.3V, through the SPI interface simple few lines can be directly connected to the user any CPU board communication module can guarantee stable and reliable work, reader distance;

Electrical parameters

Current :13-26mA / DC 3.3V
Idle Current :10-13mA / DC 3.3V
Sleep current: <80uA
Peak current: <30mA
Operating Frequency: 13.56MHz
Supported card types: mifare1 S50, mifare1 S70, mifare UltraLight, mifare Pro, mifare Desfire
×60mm mce_style="BACKGROUND-COLOR: #fff">Product Physical Characteristics:
Dimensions: 40mm × 60mm
Environmental Operating temperature: -20-80 degrees Celsius
Environment Storage temperature: -40-85 degrees Celsius
Relative Humidity: 5% -95%

Connection diagram



Sample Code

```
#include <SPI.h>
#define    uchar       unsigned char
#define    uint  unsigned int
#define MAX_LEN 16
const int chipSelectPin = 10;//if the controller is UNO,328,168
const int NRSTPD = 5;

//MF522command word
#define PCD_IDLE                0x00               //NO action; cancel current command
#define PCD_AUTHENT             0x0E               //verify key
#define PCD_RECEIVE             0x08               //receive data
```

```
#define PCD_TRANSMIT          0x04          //send data
#define PCD_TRANSCEIVE        0x0C          //receive and send data
#define PCD_RESETPHASE        0x0F          //reset
#define PCD_CALCCRC           0x03          //CRC calculation

//Mifare_One Card command word
#define PICC_REQIDL           0x26          // line-tracking area is dormant
#define PICC_REQALL           0x52          //line-tracking area is
interfered
#define PICC_ANTICOLL         0x93          //Anti collision
#define PICC_SElECTTAG        0x93          //choose cards
#define PICC_AUTHENT1A        0x60          //Verify A key
#define PICC_AUTHENT1B        0x61          //Verify B key
#define PICC_READ             0x30          // Reader Module
#define PICC_WRITE            0xA0          // letter block

#define PICC_DECREMENT        0xC0
#define PICC_INCREMENT        0xC1
#define PICC_RESTORE          0xC2          //Transfer data to buffer
#define PICC_TRANSFER         0xB0          //Save buffer data
#define PICC_HALT             0x50          //Dormancy


//MF522 Error code returned when communication
#define MI_OK                 0
#define MI_NOTAGERR           1
#define MI_ERR                2


//------------------MFRC522 Register---------------
//Page 0:Command and Status
#define     Reserved00            0x00
#define     CommandReg            0x01
#define     CommIEnReg            0x02
#define     DivlEnReg             0x03
#define     CommIrqReg            0x04
#define     DivIrqReg             0x05
#define     ErrorReg              0x06
#define     Status1Reg            0x07
#define     Status2Reg            0x08
#define     FIFODataReg           0x09
#define     FIFOLevelReg          0x0A
```

```
#define     WaterLevelReg          0x0B
#define     ControlReg             0x0C
#define     BitFramingReg          0x0D
#define     CollReg                0x0E
#define     Reserved01             0x0F
//Page 1:Command
#define     Reserved10             0x10
#define     ModeReg                0x11
#define     TxModeReg              0x12
#define     RxModeReg              0x13
#define     TxControlReg           0x14
#define     TxAutoReg              0x15
#define     TxSelReg               0x16
#define     RxSelReg               0x17
#define     RxThresholdReg         0x18
#define     DemodReg               0x19

#define     Reserved11             0x1A
#define     Reserved12             0x1B
#define     MifareReg              0x1C
#define     Reserved13             0x1D
#define     Reserved14             0x1E
#define     SerialSpeedReg         0x1F
//Page 2:CFG
#define     Reserved20             0x20
#define     CRCResultRegM          0x21
#define     CRCResultRegL          0x22
#define     Reserved21             0x23
#define     ModWidthReg            0x24
#define     Reserved22             0x25
#define     RFCfgReg               0x26
#define     GsNReg                 0x27
#define     CWGsPReg               0x28
#define     ModGsPReg              0x29
#define     TModeReg               0x2A
#define     TPrescalerReg          0x2B
#define     TReloadRegH            0x2C
#define     TReloadRegL            0x2D
#define     TCounterValueRegH      0x2E
#define     TCounterValueRegL      0x2F
//Page 3:TestRegister
#define     Reserved30             0x30
```

```
#define     TestSel1Reg             0x31
#define     TestSel2Reg             0x32
#define     TestPinEnReg            0x33
#define     TestPinValueReg         0x34
#define     TestBusReg              0x35
#define     AutoTestReg             0x36
#define     VersionReg              0x37
#define     AnalogTestReg           0x38
#define     TestDAC1Reg             0x39
#define     TestDAC2Reg             0x3A
#define     TestADCReg              0x3B
#define     Reserved31              0x3C
#define     Reserved32              0x3D
#define     Reserved33              0x3E
#define     Reserved34              0x3F
uchar serNum[5];
uchar    writeDate[16] ={'T', 'e', 'n', 'g', ' ', 'B', 'o', 0, 0, 0, 0, 0, 0, 0, 0,0};

uchar sectorKeyA[16][16] = {{0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF},
                            {0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF},
                            {0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF},
                           };
 uchar sectorNewKeyA[16][16] = {{0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF},
                                {0xFF,  0xFF,  0xFF,  0xFF,  0xFF,  0xFF,
0xff,0x07,0x80,0x69, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF},
                                {0xFF,  0xFF,  0xFF,  0xFF,  0xFF,  0xFF,
0xff,0x07,0x80,0x69, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF},
                               };

void setup() {
    Serial.begin(9600);                         // RFID reader SOUT pin connected to Serial
RX pin at 2400bps
 // start the SPI library:
  SPI.begin();

  pinMode(chipSelectPin,OUTPUT);                // Set digital pin 10 as OUTPUT to connect
it to the RFID /ENABLE pin
     digitalWrite(chipSelectPin, LOW);          // Activate the RFID reader
  pinMode(NRSTPD,OUTPUT);                       // Set digital pin 10 , Not Reset and
Power-down
     digitalWrite(NRSTPD, HIGH);
```

```
   MFRC522_Init();
}

void loop()
{
      uchar i,tmp;
      uchar status;
            uchar str[MAX_LEN];
            uchar RC_size;
            uchar blockAddr;    //Select the address of the operation 0～63


            // searching card, return card type
            status = MFRC522_Request(PICC_REQIDL, str);
            if (status == MI_OK)
            {
            }


            status = MFRC522_Anticoll(str);
            memcpy(serNum, str, 5);
            if (status == MI_OK)
            {
                              Serial.println("The card's number is    : ");
                  Serial.print(serNum[0],BIN);
                  Serial.print(serNum[1],BIN);
                  Serial.print(serNum[2],BIN);
                  Serial.print(serNum[3],BIN);
                  Serial.print(serNum[4],BIN);
                              Serial.println(" ");
            }

            // select card, return card capacity
            RC_size = MFRC522_SelectTag(serNum);
            if (RC_size != 0)
            {}

            // write data card
            blockAddr = 7;              // data block 7
            status = MFRC522_Auth(PICC_AUTHENT1A, blockAddr, sectorKeyA[blockAddr/4],
serNum); // authentication
            if (status == MI_OK)
```

```
        {
            // write data
            status = MFRC522_Write(blockAddr, sectorNewKeyA[blockAddr/4]);
                        Serial.print("set the new card password, and can modify the data of
the Sector: ");
                        Serial.print(blockAddr/4,DEC);

                        // write data
                        blockAddr = blockAddr - 3 ;
                        status = MFRC522_Write(blockAddr, writeDate);
                        if(status == MI_OK)
                        {
                            Serial.println("OK!");
                        }
        }

        // read card
        blockAddr = 7;              // data block 7
        status = MFRC522_Auth(PICC_AUTHENT1A, blockAddr,

sectorNewKeyA[blockAddr/4], serNum);     // authentication
        if (status == MI_OK)
        {
            // read data
                        blockAddr = blockAddr - 3 ;
                        status = MFRC522_Read(blockAddr, str);
            if (status == MI_OK)
            {
                                    Serial.println("Read from the card ,the data is : ");
                for (i=0; i<16; i++)
                {
                                Serial.print(str[i]);
                }
                                    Serial.println(" ");
            }
        }
                Serial.println(" ");
        MFRC522_Halt();             // command card into sleeping mode

}

void Write_MFRC522(uchar addr, uchar val)
```

```
{
    digitalWrite(chipSelectPin, LOW);

    SPI.transfer((addr<<1)&0x7E);
    SPI.transfer(val);

    digitalWrite(chipSelectPin, HIGH);
}


uchar Read_MFRC522(uchar addr)
{
    uchar val;

    digitalWrite(chipSelectPin, LOW);

    //address format: 1XXXXXX0
    SPI.transfer(((addr<<1)&0x7E) | 0x80);
    val =SPI.transfer(0x00);


    digitalWrite(chipSelectPin, HIGH);

    return val;
}


void SetBitMask(uchar reg, uchar mask)
{
    uchar tmp;
    tmp = Read_MFRC522(reg);
    Write_MFRC522(reg, tmp | mask);    // set bit mask
}



void ClearBitMask(uchar reg, uchar mask)
{
    uchar tmp;
    tmp = Read_MFRC522(reg);
    Write_MFRC522(reg, tmp & (~mask));    // clear bit mask
}
```

```
void AntennaOn(void)
{
    uchar temp;

    temp = Read_MFRC522(TxControlReg);
    if (!(temp & 0x03))
    {
        SetBitMask(TxControlReg, 0x03);
    }
}

void AntennaOff(void)
{
    ClearBitMask(TxControlReg, 0x03);
}

void MFRC522_Reset(void)
{

    Write_MFRC522(CommandReg, PCD_RESETPHASE);
}

void MFRC522_Init(void)
{
    digitalWrite(NRSTPD,HIGH);

    MFRC522_Reset();

    //Timer: TPrescaler*TreloadVal/6.78MHz = 24ms
    Write_MFRC522(TModeReg, 0x8D);          //Tauto=1; f(Timer) = 6.78MHz/TPreScaler
    Write_MFRC522(TPrescalerReg, 0x3E);     //TModeReg[3..0] + TPrescalerReg
    Write_MFRC522(TReloadRegL, 30);
    Write_MFRC522(TReloadRegH, 0);

    Write_MFRC522(TxAutoReg, 0x40);         //100%ASK
    Write_MFRC522(ModeReg, 0x3D);           //CRC original value 0x6363  ???

    AntennaOn();        // open antenna
}
uchar MFRC522_Request(uchar reqMode, uchar *TagType)
{
    uchar status;
```

```
    uint backBits;              // bits of data received
    Write_MFRC522(BitFramingReg, 0x07);          //TxLastBists = BitFramingReg[2..0]    ???

    TagType[0] = reqMode;
    status = MFRC522_ToCard(PCD_TRANSCEIVE, TagType, 1, TagType, &backBits);

    if ((status != MI_OK) || (backBits != 0x10))
    {
        status = MI_ERR;
    }

    return status;
}

uchar MFRC522_ToCard(uchar command, uchar *sendData, uchar sendLen, uchar *backData, uint *backLen)
{
    uchar status = MI_ERR;
    uchar irqEn = 0x00;

    uchar waitIRq = 0x00;
    uchar lastBits;
    uchar n;
    uint i;

    switch (command)
    {
        case PCD_AUTHENT:          // card key authentication
        {
            irqEn = 0x12;
            waitIRq = 0x10;
            break;
        }
        case PCD_TRANSCEIVE:    // send data in FIFO
        {
            irqEn = 0x77;
            waitIRq = 0x30;
            break;
        }
        default:
            break;
    }
```

```
Write_MFRC522(CommIEnReg, irqEn|0x80);     // permission for interrupt request
ClearBitMask(CommIrqReg, 0x80);            // clear all bits of the interrupt request
SetBitMask(FIFOLevelReg, 0x80);            //FlushBuffer=1, FIFO initialize

Write_MFRC522(CommandReg, PCD_IDLE);    //NO action; clear current command      ???

// write data into FIFO
for (i=0; i<sendLen; i++)
{
      Write_MFRC522(FIFODataReg, sendData[i]);
}

// execute command
Write_MFRC522(CommandReg, command);
if (command == PCD_TRANSCEIVE)
{
      SetBitMask(BitFramingReg, 0x80);          //StartSend=1,transmission of data starts
}


// wait for the completion of data transmission
i = 2000; // adjust i according to clock frequency, max wait time for M1 card operation 25ms
???
do
{
      //CommIrqReg[7..0]
      //Set1 TxIRq RxIRq IdleIRq HiAlerIRq LoAlertIRq ErrIRq TimerIRq
      n = Read_MFRC522(CommIrqReg);
      i--;
}
while ((i!=0) && !(n&0x01) && !(n&waitIRq));

ClearBitMask(BitFramingReg, 0x80);              //StartSend=0

if (i != 0)
{
      if(!(Read_MFRC522(ErrorReg) & 0x1B))    //BufferOvfl Collerr CRCErr ProtecolErr
      {
            status = MI_OK;
            if (n & irqEn & 0x01)
            {
                  status = MI_NOTAGERR;                 //??
```

```
        }

        if (command == PCD_TRANSCEIVE)
        {
            n = Read_MFRC522(FIFOLevelReg);
            lastBits = Read_MFRC522(ControlReg) & 0x07;
            if (lastBits)
            {
                *backLen = (n-1)*8 + lastBits;
            }
            else
            {
                *backLen = n*8;
            }

            if (n == 0)
            {
                n = 1;
            }
            if (n > MAX_LEN)

            {
                n = MAX_LEN;
            }

            // read the data received in FIFO
            for (i=0; i<n; i++)
            {
                backData[i] = Read_MFRC522(FIFODataReg);
            }
        }
    }
    else
    {
        status = MI_ERR;
    }

}

//SetBitMask(ControlReg,0x80);                  //timer stops
//Write_MFRC522(CommandReg, PCD_IDLE);
```

```
    return status;
}

uchar MFRC522_Anticoll(uchar *serNum)
{
    uchar status;
    uchar i;
    uchar serNumCheck=0;
    uint unLen;

    Write_MFRC522(BitFramingReg, 0x00);          //TxLastBists = BitFramingReg[2..0]

    serNum[0] = PICC_ANTICOLL;
    serNum[1] = 0x20;
    status = MFRC522_ToCard(PCD_TRANSCEIVE, serNum, 2, serNum, &unLen);

    if (status == MI_OK)
    {
        // verify card sequence number
        for (i=0; i<4; i++)
        {

            serNumCheck ^= serNum[i];
        }
        if (serNumCheck != serNum[i])
        {
            status = MI_ERR;
        }
    }

    //SetBitMask(CollReg, 0x80);            //ValuesAfterColl=1

    return status;
}

void CalulateCRC(uchar *pIndata, uchar len, uchar *pOutData)
{
    uchar i, n;

    ClearBitMask(DivIrqReg, 0x04);              //CRCIrq = 0
    SetBitMask(FIFOLevelReg, 0x80);             // clear FIFO pointer
    //Write_MFRC522(CommandReg, PCD_IDLE);
```

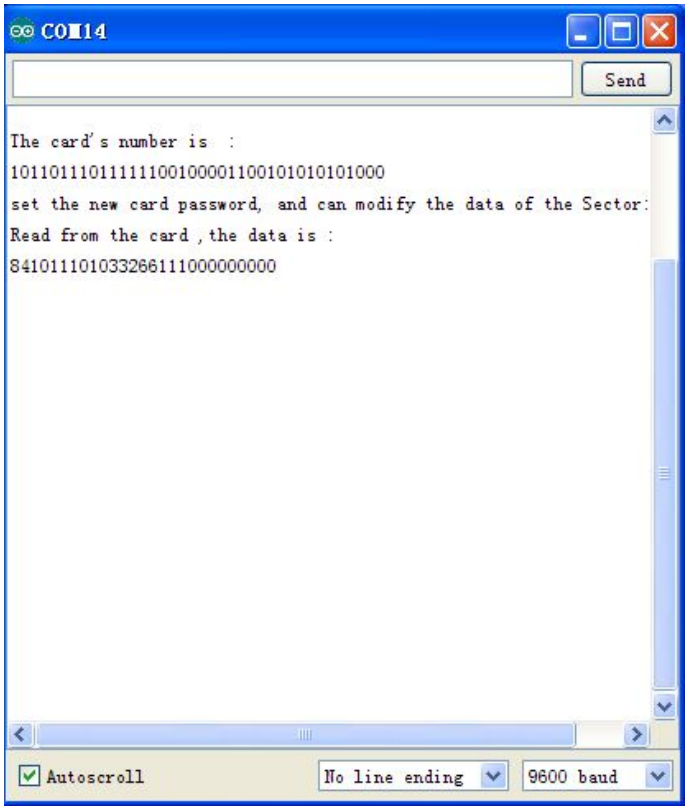
```
    // write data into FIFO
    for (i=0; i<len; i++)
    {
        Write_MFRC522(FIFODataReg, *(pIndata+i));
    }
    Write_MFRC522(CommandReg, PCD_CALCCRC);

    // wait for completion of CRC calculation
    i = 0xFF;
    do
    {
        n = Read_MFRC522(DivIrqReg);
        i--;
    }
    while ((i!=0) && !(n&0x04));                    //CRCIrq = 1

    // read result from CRC calculation
    pOutData[0] = Read_MFRC522(CRCResultRegL);
    pOutData[1] = Read_MFRC522(CRCResultRegM);
}


uchar MFRC522_SelectTag(uchar *serNum)
{
    uchar i;
    uchar status;
    uchar size;
    uint recvBits;
    uchar buffer[9];

    //ClearBitMask(Status2Reg, 0x08);                    //MFCrypto1On=0

    buffer[0] = PICC_SElECTTAG;
    buffer[1] = 0x70;
    for (i=0; i<5; i++)
    {
        buffer[i+2] = *(serNum+i);
    }
    CalulateCRC(buffer, 7, &buffer[7]);            //??
    status = MFRC522_ToCard(PCD_TRANSCEIVE, buffer, 9, buffer, &recvBits);

    if ((status == MI_OK) && (recvBits == 0x18))
```

```
    {
        size = buffer[0];
    }
    else
    {
        size = 0;
    }

    return size;
}

uchar MFRC522_Auth(uchar authMode, uchar BlockAddr, uchar *Sectorkey, uchar *serNum)
{
    uchar status;
    uint recvBits;
    uchar i;
    uchar buff[12];

    // Verification instructions + block address + sector password + card sequence number
    buff[0] = authMode;
    buff[1] = BlockAddr;
    for (i=0; i<6; i++)

    {
        buff[i+2] = *(Sectorkey+i);
    }
    for (i=0; i<4; i++)
    {
        buff[i+8] = *(serNum+i);
    }
    status = MFRC522_ToCard(PCD_AUTHENT, buff, 12, buff, &recvBits);

    if ((status != MI_OK) || (!(Read_MFRC522(Status2Reg) & 0x08)))
    {
        status = MI_ERR;
    }

    return status;
}

uchar MFRC522_Read(uchar blockAddr, uchar *recvData)
{
```

```
    uchar status;
    uint unLen;

    recvData[0] = PICC_READ;
    recvData[1] = blockAddr;
    CalulateCRC(recvData,2, &recvData[2]);
    status = MFRC522_ToCard(PCD_TRANSCEIVE, recvData, 4, recvData, &unLen);

    if ((status != MI_OK) || (unLen != 0x90))
    {
        status = MI_ERR;
    }

    return status;
}

uchar MFRC522_Write(uchar blockAddr, uchar *writeData)
{
    uchar status;
    uint recvBits;
    uchar i;
    uchar buff[18];


    buff[0] = PICC_WRITE;
    buff[1] = blockAddr;
    CalulateCRC(buff, 2, &buff[2]);
    status = MFRC522_ToCard(PCD_TRANSCEIVE, buff, 4, buff, &recvBits);

    if ((status != MI_OK) || (recvBits != 4) || ((buff[0] & 0x0F) != 0x0A))
    {
        status = MI_ERR;
    }

    if (status == MI_OK)
    {
        for (i=0; i<16; i++)        // write 16Byte data into FIFO
        {
            buff[i] = *(writeData+i);
        }
        CalulateCRC(buff, 16, &buff[16]);
        status = MFRC522_ToCard(PCD_TRANSCEIVE, buff, 18, buff, &recvBits);
```

```
            if ((status != MI_OK) || (recvBits != 4) || ((buff[0] & 0x0F) != 0x0A))
            {
                status = MI_ERR;
            }
        }

        return status;
}

void MFRC522_Halt(void)
{
        uchar status;
        uint unLen;
        uchar buff[4];

        buff[0] = PICC_HALT;
        buff[1] = 0;
        CalulateCRC(buff, 2, &buff[2]);

        status = MFRC522_ToCard(PCD_TRANSCEIVE, buff, 4, buff,&unLen);
}
```

In this experiment, when the IC card gets close, RFID module writes data into the IC card, then reads out the data and display it in the monitor window. As below picture shows:


COM14
Send
The card's number is :
1011011101111110010000110010101010101000
set the new card password, and can modify the data of the Sector:
Read from the card , the data is :
84101110103326611100000000
Autoscroll
No line ending
9600 baud