RC522 RFID Module for Arduino

Introduction

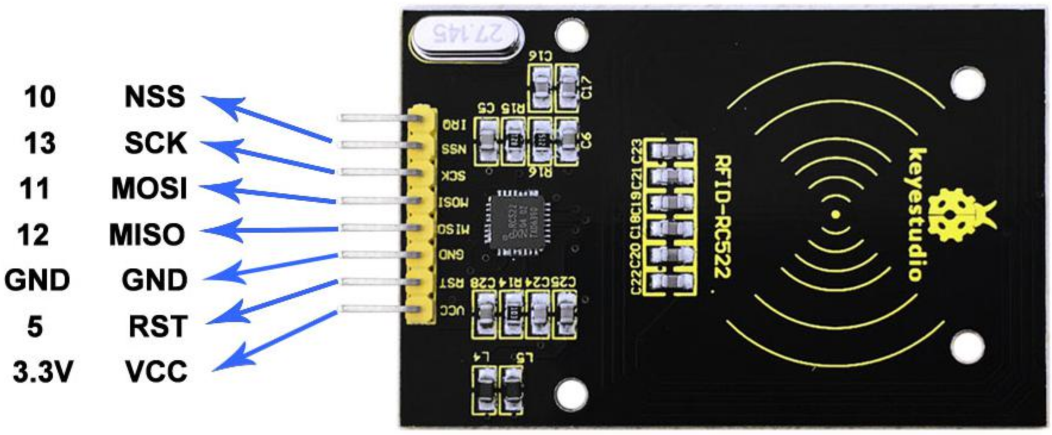
MRC522 RFID module adopts Philips MFRC522 original reader circuit chip design, easy to use, low cost, suitable for equipment development, development of advanced applications, the need for RF card terminal design / production.

This module can be loaded directly into a variety of readers molds. Module uses voltage of 3.3V, and can be directly connected to any CPU boards for communication through the SPI interface using simple few lines, which can guarantee stable and reliable reader distance.

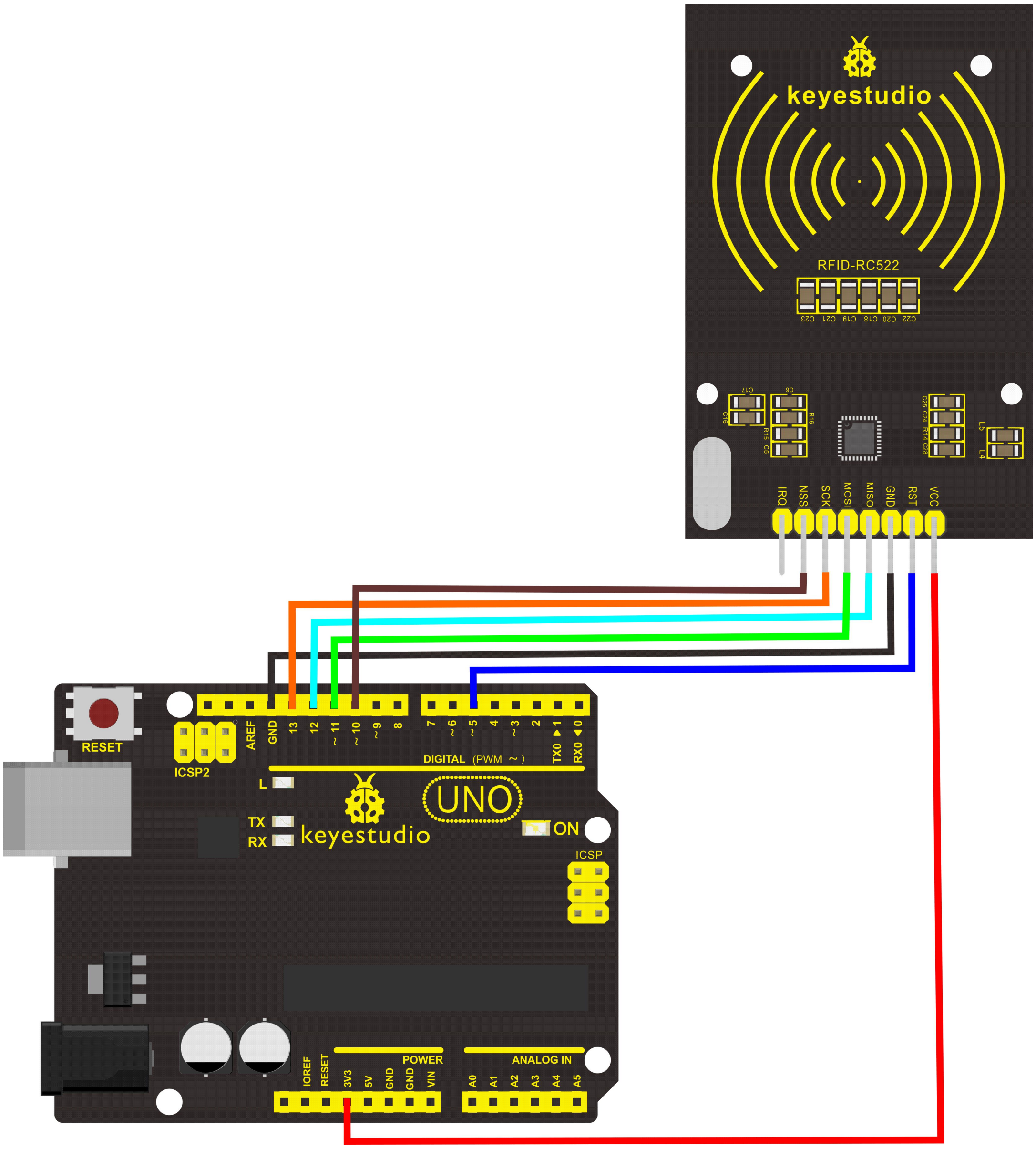
Parameters

- 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, and more
- Environmental Operating temperature: -20 to 80 degrees Celsius
- Environment Storage temperature: -40 to 85 degrees Celsius
- Relative Humidity: 5% to 95%

PINOUT Diagram



Connection Diagram



Sample Code

****

```
#include <SPI.h>

#defineuchar   unsigned char

#defineuint    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;
}
```

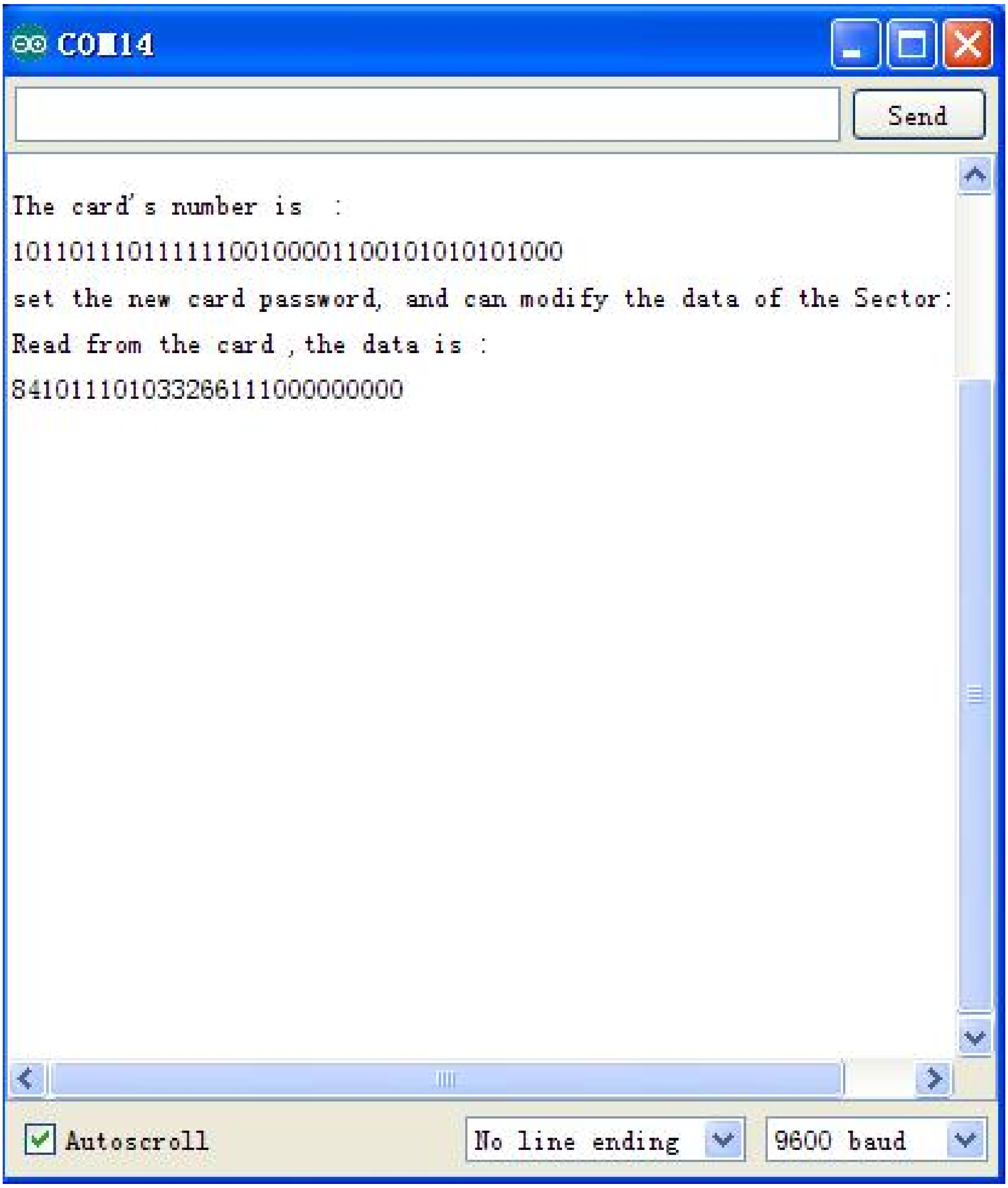
```
void CalulateCRC(uchar *pIndata, uchar len, uchar *pOutData)
{
    uchar i, n;

    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);
}
*****************************************************
```

Test Phenomenon

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



```
The card's number is  :
10110111011111100100001100101010101000
set the new card password, and can modify the data of the Sector:
Read from the card ,the data is :
841011101033266111000000000
```

Shipping List:

- RC522 RFID Module for Arduino x 1
- White access card x 1
- Blue key chain x 1