RF02 programming guide

1. Brief description

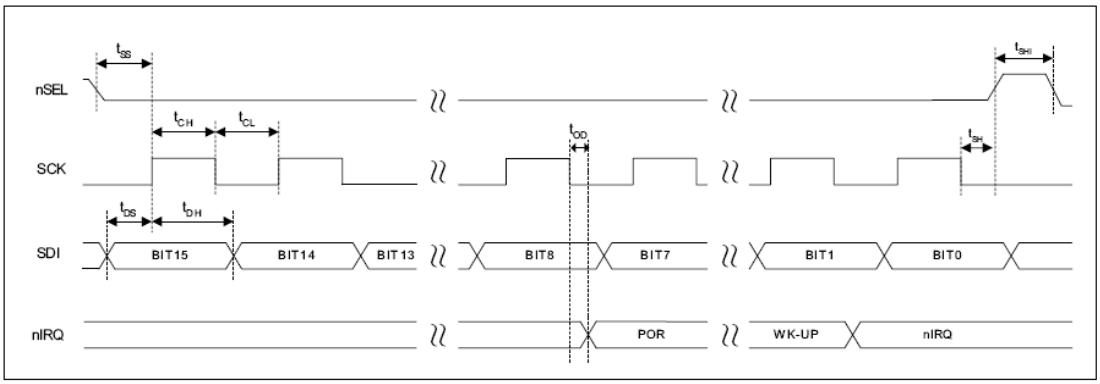
RF02 is a low cost FSK transmit IC witch integrated all RF functions in a single chip. It only need a MCU, a crystal, a decouple capacitor and antenna to build a hi reliable FSK transmitter. The operation frequency can cover 300 to 1000MHz.

RF02 supports a command interface to setup frequency, deviation, output power and also data rate. No need any hardware adjustment when using in frequency-hopping applications

RF02 can be used in applications such as remote control toys, wireless alarm, wireless sensor, wireless keyboard/mouse, home-automation and wireless data collection.

2. Commands

1. Timing diagram



2. Configuration Setting Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	0	0	b1	b0	d2	d1	d0	x3	x2	x1	x0	ms	m2	m1	m0	8080h

b1..b0: band select:

b1	b0	band[MHz]
0	1	433
1	0	868
1	1	915

d2..d0: select frequency of CLK pin

d2	d1	d0	CLK frequency[MHz]
0	0	0	1
0	0	1	1.25
0	1	0	1.66
0	1	1	2
1	0	0	2.5
1	0	1	3.33
1	1	0	5
1	1	1	10

CLK signal is derive form crystal oscillator and it can be applied to MCU clock in to save a second crystal.

If not used, please set bit “dc” to disable CLK output

x3..x0: select crystal load capacitor

x3	x2	x1	x0	Load capacitor [pF]
0	0	0	0	8.5
0	0	0	1	9.0
0	0	1	0	9.5
0	0	1	1	10.0
……		……		
1	1	1	0	15.5
1	1	1	1	16.0

To integrate the load capacitor internal can not only save cost, but also adjust reference frequency by software

ms: select modulation polarity

m2..m0: select frequency deviation

m2	m1	m0	frequency deviation[kHz]
0	0	0	30
0	0	1	60
0	1	0	90
0	1	1	120
1	0	0	150
1	0	1	180
1	1	0	210

3. Power Management Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	0	0	0	0	a1	a0	ex	es	ea	eb	et	dc	C000h

a1： Crystal oscillator and synthesizer are enabled by Data transmit Command and disable by Sleep command.

a0： Power amplifier is enabled by Data transmit Command and disable by Sleep Command.

ex：Enable crystal oscillator

es：Enable synthesizer

ea：Enable power amplifier

eb：Enable low battery detection funciton

et：Enable wake-up timer

dc：Disable output of CLK pin

4. Frequency Setting Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	0	1	0	f11	f10	f9	f8	f7	f6	f5	f4	f3	f2	f1	f0	A7D0h

f11..f0: set operation frequency:

433band: Fc=430+F*0.0025 MHz

868band: Fc=860+F*0.0050 MHz

915band: Fc=900+F*0.0075 MHz

Fc is carrier frequency

5. Data Rate Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	1	0	0	0	r7	r6	r5	r4	r3	r2	r1	r0	C800h

r7..r0: set data rate

BR=10000000/29/（R+1）

BR is data rate

6. Power Setting Command

bit	7	6	5	4	3	2	1	0	POR
	1	0	1	1	0	p2	p1	p0	B0h

p2..p0: set relative output power:

Pout=Pmax-P*3 [dBm]

Pmax is the max output power; it is related to the antenna impedance.

7. Low Battery Detector and Tx bit Synchronization Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	0	0	1	0	dwc	0	ebs	t4	t3	t2	t1	t0	C200h

dwc：Disable wake-up timer periodical calibration

ebs：Enable TX bit synchronization function

t4..t0: Set threshold voltage of Low battery detector

Vlb=2.2+T*0.1 [V]

8. Sleep Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	0	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0	C400h

If crystal oscillator, synthesizer and power amplifier are auto-controlled, this command will close power amplifier and synthesizer immediately, then stop crystal oscillator after S periods of CLK signal

9. Wake-Up Timer Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	1	r4	r3	r2	r1	r0	m7	m6	m5	m4	m3	m2	m1	m0	E000h

The wake-up timer period is determined by:

$T_{wake-up} = M * 2^R$ [ms]

For continual operation, bit 'et' must be cleared and set

10. Data Transmit Command

bit	7	6	5	4	3	2	1	0
	1	1	0	0	0	1	1	0

This command indicate that the following data on SDI pin is to be transmitted, the transmission stops if nSel return to hi.

11. Status Register Read Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	--

This command is used to read internal status register content, output starts at 8_{th} clock of SCK.

12. PLL Setting and Reset Mode Command

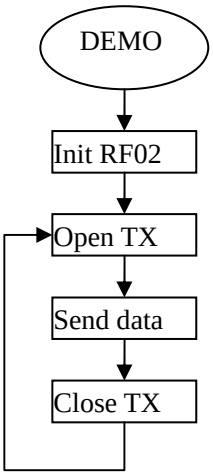
bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	1	0	0	1	0	bw1	bw0	0	0	0	0	dr	0	D200h

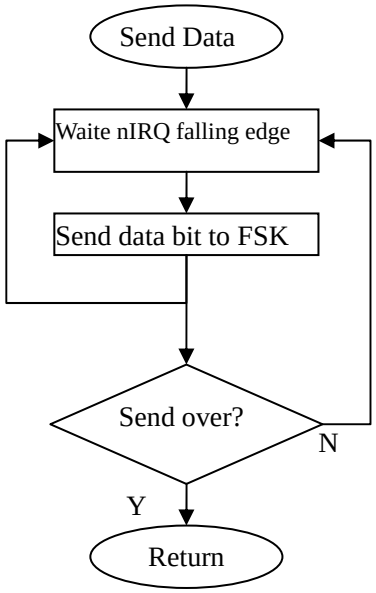
Bits 7-6 <bw1 : bw0> select the PLL bandwidth:

Bw1	Bw0	Max datarate [kbps]	Phase Noise at 1MHz offset [dBc/Hz](typical)	Charage pump current
0	1	19.2	-112	25%
1	1	38.4	-110	33%
0	0	68.9	-107	50%
1	0	115.2	-102	100%

Bit 1 (*dr*): Disables the highly sensitive RESET mode. If this bit is cleared, a 600 mV glitch in the power supply may cause a system reset. Formore detailed description see the *Reset modes* section

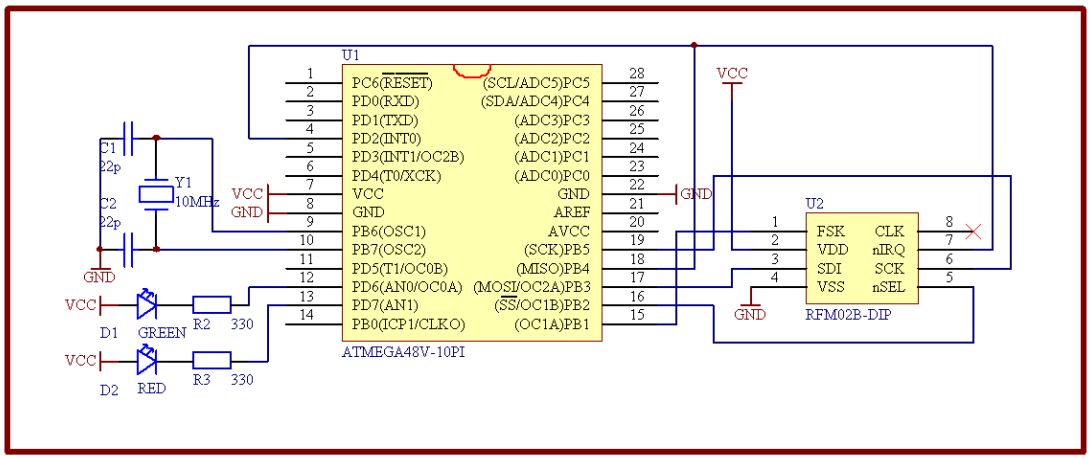
3. Transmission Demo flow diagram





Note: After RF02 initialization, Open transmitter and use nIRQ as data rate clock. MCU write data bit on FSK pin at nIRQ falling edge.

4. Example 1(for AVR microcontroller)




```
/*****************************************************************************
copyright (c) 2006
Title:              RF02B simple example based on AVR C
Current version:    v1.0
Function:           Package send Demo
Processor           ATMEGA48
Clock:              10MHz Crystal
Operate frequency:  434MHz
Data rate:          4.8kbps
Package size:       23byte
Author:             Tank
Company:            Hope microelectronic Co.,Ltd.
Contact:            +86-0755-86106557
E-MAIL:             hopefsk@hoperf.com
Date:               2006-10-24

                Connections

        ATMEGA48 SIDE       RF02B SIDE
          SCK---------------->SCK
         MISO:NC
         MOSI---------------->SDI
           SS---------------->nSEL
          PB1---------------->FSK
         INT0<----------------nIRQ

         PC0~PC3: LED0~LED3

*****************************************************************************/
```

```
#include <mega48.h>

#define DDR_IN          0
#define DDR_OUT         1

#define PORT_SEL        PORTB
#define PIN_SEL         PINB
#define DDR_SEL         DDRB

#define PORT_SDI        PORTB
#define PIN_SDI         PINB
#define DDR_SDI         DDRB

#define PORT_SCK        PORTB
#define PIN_SCK         PINB
#define DDR_SCK         DDRB

#define PORT_SDO        PORTB
#define PIN_SDO         PINB
#define DDR_SDO         DDRB

#define PB7             7//--\
#define PB6             6//  |
#define RFXX_SCK        5//  |
#define RFXX_SDO        4//  |RF_PORT
#define RFXX_SDI        3//  |
#define RFXX_SEL        2//  |
#define RFXX_DATA       1//  |
#define PB0             0//--/

#define SEL_OUTPUT()    DDR_SEL |= (1<<RFXX_SEL)
#define HI_SEL()        PORT_SEL|= (1<<RFXX_SEL)
#define LOW_SEL()       PORT_SEL&=~(1<<RFXX_SEL)

#define SDI_OUTPUT()    DDR_SDI |= (1<<RFXX_SDI)
#define HI_SDI()        PORT_SDI|= (1<<RFXX_SDI)
#define LOW_SDI()       PORT_SDI&=~(1<<RFXX_SDI)

#define SDO_INPUT()     DDR_SDO&= ~(1<<RFXX_SDO)
#define SDO_HI()        PIN_SDO&(1<<RFXX_SDO)

#define SCK_OUTPUT()    DDR_SCK |= (1<<RFXX_SCK)
#define HI_SCK()        PORT_SCK|= (1<<RFXX_SCK)
#define LOW_SCK()       PORT_SCK&=~(1<<RFXX_SCK)
```

```
void RFXX_PORT_INIT(void){
  HI_SEL();
  HI_SDI();
  LOW_SCK();
  SEL_OUTPUT();
  SDI_OUTPUT();
  SDO_INPUT();
  SCK_OUTPUT();
}
unsigned int RFXX_WRT_CMD(unsigned int aCmd){
  unsigned char i;
  unsigned int temp;
  LOW_SCK();
  LOW_SEL();
  for(i=0;i<16;i++){
    temp<<=1;
    if(SDO_HI()){
      temp|=0x0001;
    }
    LOW_SCK();
    if(aCmd&0x8000){
      HI_SDI();
    }else{
      LOW_SDI();
    }
    HI_SCK();
    aCmd<<=1;
  };
  LOW_SCK();
  HI_SEL();
  return(temp);
}

void RF02B_SEND(unsigned char aByte){
  unsigned char i;

  for(i=0;i<8;i++){
    while(PINB&(1<<RFXX_SDO));//Polling nIRQ
    while(!(PINB&(1<<RFXX_SDO)));
    if(aByte&0x80){
      PORTB|=(1<<RFXX_DATA);
    }else{
      PORTB&=~(1<<RFXX_DATA);
```

```
    }
    aByte<<=1;
  }

}

void main(void)
{
  unsigned int i,j,ChkSum;

  RFXX_PORT_INIT();

  RFXX_WRT_CMD(0xCC00);
  RFXX_WRT_CMD(0x8B81);//433BAND,+/-60kHz
  RFXX_WRT_CMD(0xA640);//434MHz
  RFXX_WRT_CMD(0xC847);//4.8kbps
  RFXX_WRT_CMD(0xC220);//ENABLE BIT SYNC
  RFXX_WRT_CMD(0xC001);//CLOSE ALL

  PORTB|=(1<<RFXX_DATA);
  DDRB|=(1<<RFXX_DATA);//SET DATA OUTPUT

  while(1){
    RFXX_WRT_CMD(0xC039);//START TX
    ChkSum=0;
    RF02B_SEND(0xAA);//PREAMBLE
    RF02B_SEND(0xAA);//PREAMBLE
    RF02B_SEND(0xAA);//PREAMBLE
    RF02B_SEND(0x2D);//HEAD HI BYTE
    RF02B_SEND(0xD4);//HEAD LOW BYTE
    RF02B_SEND(0x30);//DATA0
    ChkSum+=0x30;
    RF02B_SEND(0x31);//DATA1
    ChkSum+=0x31;
    RF02B_SEND(0x32);
    ChkSum+=0x32;
    RF02B_SEND(0x33);
    ChkSum+=0x33;
    RF02B_SEND(0x34);
    ChkSum+=0x34;
    RF02B_SEND(0x35);
    ChkSum+=0x35;
    RF02B_SEND(0x36);
    ChkSum+=0x36;
```

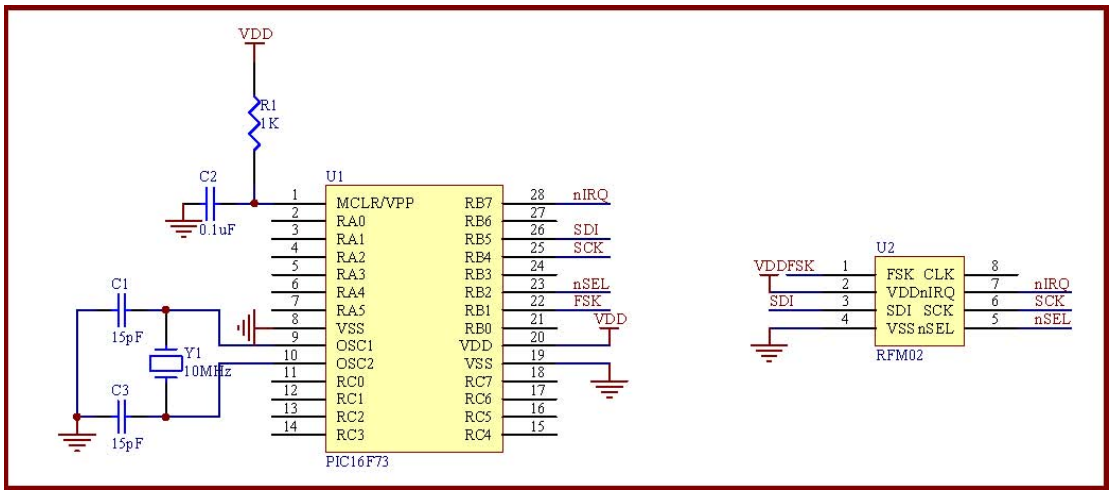
```
    RF02B_SEND(0x37);
    ChkSum+=0x37;
    RF02B_SEND(0x38);
    ChkSum+=0x38;
    RF02B_SEND(0x39);
    ChkSum+=0x39;
    RF02B_SEND(0x3A);
    ChkSum+=0x3A;
    RF02B_SEND(0x3B);
    ChkSum+=0x3B;
    RF02B_SEND(0x3C);
    ChkSum+=0x3C;
    RF02B_SEND(0x3D);
    ChkSum+=0x3D;
    RF02B_SEND(0x3E);
    ChkSum+=0x3E;
    RF02B_SEND(0x3F);//DATA15
    ChkSum+=0x3F;
    RF02B_SEND(ChkSum);//DATA16
    RF02B_SEND(0xAA);//DUMMY BYTE

    RFXX_WRT_CMD(0xC001);//CLOSE TX

    for(i=0;i<5000;i++)for(j=0;j<123;j++);

  };
}
```

5. Example 2(for PIC microcontroller)




```
/*****************************************************************
    copyright (c) 2006
Title:              RF02B simple example based on PIC C
Current version:    v1.0
Function:           Package send Demo
Processor           PIC16F73
Clock:              10MHz Crystal
Operate frequency:  434MHz
Data rate:          4.8kbps
Package size:       23byte
Author:             Robben
Company:            Hope microelectronic Co.,Ltd.
Contact:            +86-0755-86106557
E-MAIL:             hopefsk@hoperf.com
Date:               2006-11-10
*****************************************************************/
#include "pic.h"

typedef unsigned char uchar;
typedef unsigned int  uint;

#define SDI             RB5
#define SCK             RB4
#define nSEL            RB2
#define FSK             RB1
#define nIRQ            RB7
#define SDO             RB6
#define SDI_OUT()       TRISB5=0
#define SCK_OUT()       TRISB4=0
#define nSEL_OUT()      TRISB2=0
```

```
#define FSK_OUT()       TRISB1=0
#define nIRQ_IN()       TRISB7=1
#define SDO_IN()        TRISB6=1

void Write0( void );
void Write1( void );
void WriteCMD( uint CMD );
void RF2_Init( void );
void DelayUs( uint us );
void WriteFSKbyte( uchar DATA );
void DelayMs(uint ms);

__CONFIG(0x3FF2);
/*****************************************
初始化端口
*****************************************/
void RF2_Init( void )
{
  nSEL=1;
  SDI=1;
  SCK=0;
  FSK=0;
  nSEL_OUT();
  SDI_OUT();
  SDO_IN();
  SCK_OUT();
  FSK_OUT();
  nIRQ_IN()
}
void main()
{
  uint ChkSum=0;

  RF2_Init( );

  WriteCMD( 0xCC00 );   // read status
  WriteCMD( 0x8B81 );  //433BAND,+/-60kHz
  WriteCMD( 0xA640 );  // freq = 434MHz
  WriteCMD( 0xC847 ); // 4.8k bps
  WriteCMD( 0xC220 ); // ENABLE BIT SYNC
  WriteCMD( 0xC001 );  // close all

  while(1)
   {
```

```
WriteCMD( 0xC039 ); // stat Tx

WriteFSKbyte( 0xAA ); // send  Preamble
WriteFSKbyte( 0xAA ); // send preamble
WriteFSKbyte( 0xAA ); // send preamble
WriteFSKbyte( 0x2D );  // send sync word
WriteFSKbyte( 0xD4 );  // send sync word

WriteFSKbyte( 0x30 );//DATA0
ChkSum+=0x30;
WriteFSKbyte( 0x31 );//DATA1
ChkSum+=0x31;
WriteFSKbyte( 0x32 );
ChkSum+=0x32;
WriteFSKbyte( 0x33 );
ChkSum+=0x33;
WriteFSKbyte( 0x34 );
ChkSum+=0x34;
WriteFSKbyte( 0x35 );
ChkSum+=0x35;
WriteFSKbyte( 0x36 );
ChkSum+=0x36;
WriteFSKbyte( 0x37 );
ChkSum+=0x37;
WriteFSKbyte( 0x38 );
ChkSum+=0x38;
WriteFSKbyte( 0x39 );
ChkSum+=0x39;
WriteFSKbyte( 0x3A );
ChkSum+=0x3A;
WriteFSKbyte( 0x3B );
ChkSum+=0x3B;
WriteFSKbyte( 0x3C );
ChkSum+=0x3C;
WriteFSKbyte(0x3D);
ChkSum+=0x3D;
WriteFSKbyte( 0x3E );
ChkSum+=0x3E;
WriteFSKbyte( 0x3F );//DATA15
ChkSum+=0x3F;
ChkSum&=0x0FF;
WriteFSKbyte( ChkSum );  // send checksum
WriteFSKbyte( 0xAA );
WriteCMD( 0xC001 );
```

```
    DelayMs( 1000 );
   }
}
/*************************************
命令字写 0，提供时序
*************************************/
void Write0( void )
{
  SCK=0;
  NOP();
  SDI=0;
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  SCK=1;
  NOP();
}
/*************************************
命令字写 1，提供时序
*************************************/
void Write1( void )
{
  SCK=0;
  NOP();
  SDI=1;
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
```

```
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  SCK=1;
  NOP();
}
/**************************************
写一个字节发送数据
**************************************/
void WriteFSKbyte( uchar DATA )
{
  uchar n=8;
  while(n--)
   {
     while(!nIRQ);
     while(nIRQ);
     if(DATA&0x80)
       FSK=1;
     else
       FSK=0;
     DATA=DATA<<1;
   }
}
/**************************************
写一条命令字
**************************************/
void WriteCMD( uint CMD )
{
  uchar n=16;
  SCK=0;
  nSEL=0;
  while(n--)
   {
     if(CMD&0x8000)
      Write1();
     else
      Write0();
     CMD=CMD<<1;
   }
```

```
  SCK=0;
  nSEL=1;
}
/*****************************************
延时
*****************************************/
void DelayUs( uint us )
{
  uint i;
  while( us-- )
    {
       i=2;
       while( i-- )
         {
           NOP();
         }
    }
}
/*************************************
延时
*************************************/
void DelayMs(uint ms)
{
  uchar i;
  while(ms--)
  {
   i=35;
   while(i--)
   {
     DelayUs(1);
   }
  }
}
```

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