# RF12 programming guide

## 1. Brief description

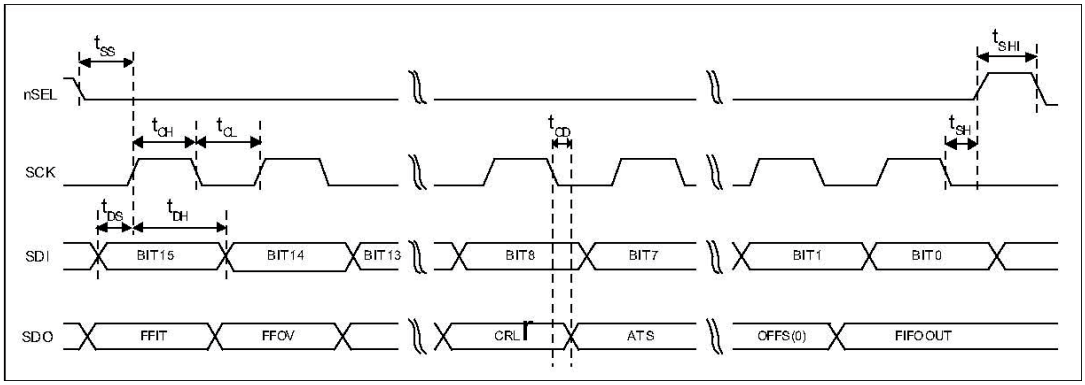
RF12 is a low cost FSK transceiver IC witch integrated all RF functions in a single chip. It only need a MCU, a crystal, a decouple capacitor and antenna to build a hi reliable FSK transceiver system. The operation frequency can cover 300 to 1000MHz.

RF12 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

RF12 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 | 0 | 0 | 0 | 0 | 0 | el | ef | b1 | b0 | x3 | x2 | x1 | x0 | 8008h |

e l: Enable TX register

e f: Enable RX FIFO buffer

b1..b0: select band

| b1 | b0 | band[MHz] |
|---|---|---|
| 0 | 0 | 315 |
| 0 | 1 | 433 |
| 1 | 0 | 868 |
| 1 | 1 | 915 |

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 |

### 3. Power Management Command

| bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | POR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | er | ebb | et | es | ex | eb | ew | dc | 8208h |

er： Enable receiver
ebb： Enable base band block
et： Enable transmitter
es： Enable synthesizer
ex： Enable crystal oscillator
eb： Enable low battery detector
ew： Enable wake-up timer
dc： Disable clock 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 | A680h |

f11..f0: Set operation frequency:
315band: Fc=310+F*0.0025 MHz
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 and F is the frequency parameter. 36≤F≤3903

### 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 | 0 | 1 | 1 | 0 | cs | r6 | r5 | r4 | r3 | r2 | r1 | r0 | C623h |

r6..r0: Set data rate:

BR=10000000/29/（R+1）/（1+cs*7）

### 6. Receiver Control Command

| bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | POR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0 | 0 | 1 | 0 | p20 | d1 | d0 | i2 | i1 | i0 | g1 | g0 | r2 | r1 | r0 | 9080h |

p20: select function of pin20

| p20 | |
|---|---|
| 0 | External interrupt in |
| 1 | VDI output |

i2..i0:select baseband bandwidth

| i2 | i1 | i0 | Baseband Bandwidth [kHz] |
|---|---|---|---|
| 0 | 0 | 0 | reserved |
| 0 | 0 | 1 | 400 |
| 0 | 1 | 0 | 340 |
| 0 | 1 | 1 | 270 |
| 1 | 0 | 0 | 200 |
| 1 | 0 | 1 | 134 |
| 1 | 1 | 0 | 67 |
| 1 | 1 | 1 | reserved |

d1..d0: select VDI response time

| d1 | d0 | Response |
|---|---|---|
| 0 | 0 | Fast |
| 0 | 1 | Medium |
| 1 | 0 | Slow |
| 1 | 1 | Always on |

g1..g0: select LNA gain

| g1 | g0 | LNA gain (dBm) |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | -6 |
| 1 | 0 | -14 |
| 1 | 1 | -20 |

r2..r0: select DRSSI threshold

| r2 | r1 | r0 | RSSIsetth [dBm] |
|---|---|---|---|
| 0 | 0 | 0 | -103 |
| 0 | 0 | 1 | -97 |
| 0 | 1 | 0 | -91 |
| 0 | 1 | 1 | -85 |
| 1 | 0 | 0 | -79 |
| 1 | 0 | 1 | -73 |
| 1 | 1 | 0 | -67 |
| 1 | 0 | 1 | -61 |

The actual DRSSI threshold is related to LNA setup:

$RSSI_{th} = RSSI_{setth} + G_{LNA.}$

### 7. Data Filter 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 | al | ml | 1 | s | 1 | f2 | f1 | f0 | C22Ch |

al: Enable clock recovery auto-lock

ml: Enable clock recovery fast mode

s: select data filter type

| s | Filter type |
|---|---|
| 0 | Digital filter |
| 1 | Analog RC filter |

f1..f0: Set DQD threshold

### 8. Output and FIFO mode 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 | 1 | 0 | f3 | f2 | f1 | f0 | 0 | al | ff | dr | CA80h |

f3..f0: Set FIFO interrupt level

al: select FIFO fill start condition

| al | |
|---|---|
| 0 | Sync-word |
| 1 | Always |

ff: Enable FIFO fill

dr: Disable hi sensitivity reset mode

### 9. Receiver FIFO Read Command

| bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | POR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | B000h |

This command is used to read FIFO data when FFIT interrupt generated. FIFO data output starts at 8th SCK period.

## 10. AFC 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 | a1 | a0 | rl1 | rl0 | st | fi | oe | en | C4F7h |

a1..a0: select AFC auto-mode：

| a1 | a0 | |
|---|---|---|
| 0 | 0 | Controlled by MCU |
| 0 | 1 | Run once at power on |
| 1 | 0 | Keep offset when VDI hi |
| 1 | 1 | Keeps independently from VDI |

rl1..rl0: select range limit

| r1 | r0 | range（fres） |
|---|---|---|
| 0 | 0 | No restriction |
| 0 | 1 | +15/-16 |
| 1 | 0 | +7/-8 |
| 1 | 1 | +3-4 |

fres

315，433band: 2.5kHz

868band: 5kHz

915band: 7.5kHz

st: st goes hi will store offset into output register

fi: Enable AFC hi accuracy mode

oe: Enable AFC output register

en: Enable AFC funcition

## 11. AFC Command

| bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | POR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0 | 0 | 1 | 1 | 0 | 0 | mp | m3 | m2 | m1 | m0 | 0 | p2 | p1 | p0 | 9800h |

m: select modulation polarity

m2..m0: select frequency deviation:

| m3 | m2 | m1 | m0 | frequency deviation [kHz] |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 15 |
| 0 | 0 | 0 | 1 | 30 |
| 0 | 0 | 1 | 0 | 45 |
| 0 | 0 | 0 | 1 | 60 |
| 0 | 1 | 0 | 0 | 75 |
| 0 | 1 | 0 | 1 | 90 |
| 0 | 1 | 1 | 0 | 105 |
| 0 | 1 | 1 | 1 | 120 |

p2..p0: select output power

| p2 | p1 | p0 | Output power[dBm] |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | -3 |
| 0 | 1 | 0 | -6 |
| 0 | 1 | 1 | -9 |
| 1 | 0 | 0 | -12 |
| 1 | 0 | 1 | -15 |
| 1 | 1 | 0 | -18 |
| 1 | 0 | 1 | -21 |

### 12. Transmitter Register Write Command

| bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | POR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | t7 | t6 | t5 | t4 | t3 | t2 | t1 | t0 | B8AAh |

This command is use to write a data byte to RF12 and then RF12 transmit it

### 13. 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 | E196h |

The wake-up period is determined by:

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

### 14. 低占空比命令（Low Duty-Cycle 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 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | en | C8OEh |

d6..d0: Set duty cycle

D.C.= (D * 2 +1) / M *100%

en：Enable low duty cycle mode

### 15. Low Battery Detector and Microcontroller Clock Divider 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 | d2 | d1 | d0 | v4 | v3 | v2 | v1 | v0 | C000h |

d2..d0: select frequency of CLK pin

| d2 | d1 | d0 | Clock 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

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

v4..v0: Set threshold voltage of Low battery detector：
Vlb=2.2+V*0.1 [V]

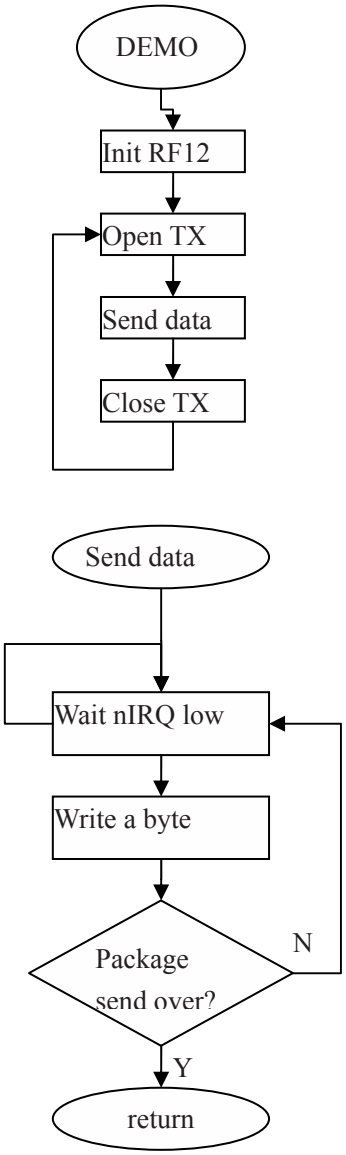
**16. Status Read Command**

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

This command starts with a 0 and be used to read internal status register

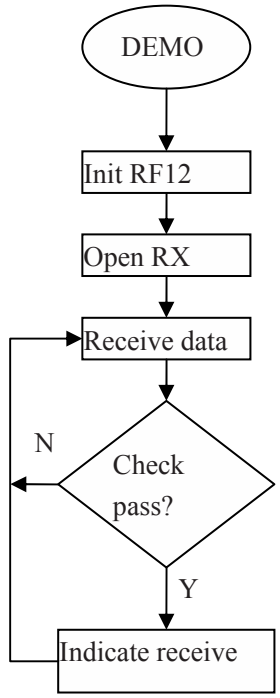
## 3. Demo flow diagram

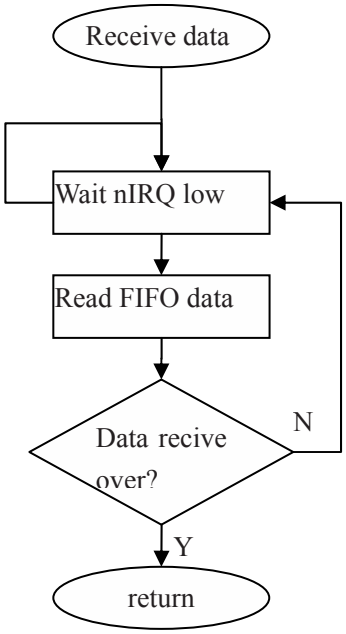
Transmitter:




Note: Initialize RF12 and open transmitter, RF12 will transmit a byte and pull nIRQ low when transmit over, then MCU can write next byte to transmit

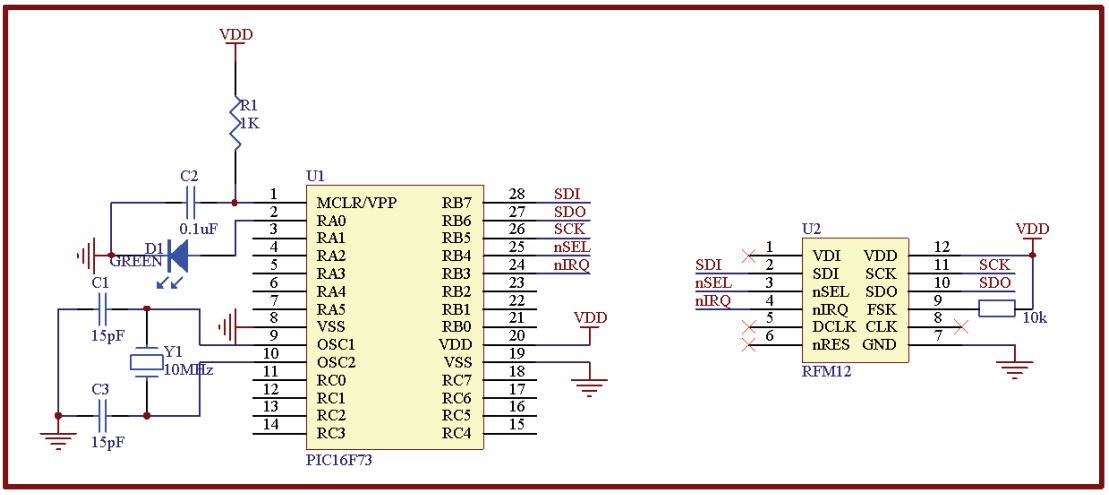
Receiver:




**Note:** After RF12 initialization, Open FIFO receive mode and wait nIRQ low, only then MCU can read received and stored in FIFO data. For next package receive, please reset FIFO.

## 4. （for PIC microcontroller）




RF12 transmitter demo:

```
/*********************************************************
    copyright (c) 2010
Title:              RFM12A transmitter simple example based on PIC C
Current version:    v1.1
Function:           Package send Demo
Processor           PIC16F73 DIP-28
Clock:              10MHz Crystal
Operate frequency:  434MHz
Data rate:          4.8kbps
Package size:       23byte
Author:             Simon.Yang
Company:            Hope microelectronic Co.,Ltd.
Contact:            +86-0755-82973805
E-MAIL:             faerf@hoperf.com
Date:               2010-06-28
*********************************************************/
#include "pic.h"

typedef unsigned char uchar;
typedef unsigned int  uint;

#define  SDI            RB7
#define  SDO            RB6
#define  SCK            RB5
#define  nSEL           RB4
#define  LED            RA0

#define  SDI_OUT()      TRISB7=0
#define  SDO_IN()       TRISB6=1
```

```
#define  SCK_OUT()      TRISB5=0
#define  nSEL_OUT()     TRISB4=0
#define  LED_OUT()      TRISA0=0

void Init_RF12(void);
void Write0( void );
void Write1( void );
void WriteCMD( uint CMD );
void DelayUs( uint us );
void DelayMs(uint ms);
void WriteFSKbyte( uchar DATA );

__CONFIG(0x3FF2);

void Init_RF12(void)
{
  nSEL_OUT();
  SDI_OUT();
  SDO_IN();
  SCK_OUT();
  LED_OUT();
  LED=0;
  nSEL=1;
  SDI=1;
  SCK=0;
  WriteCMD(0x80D8);//enable register,433MHz,12.5pF
  WriteCMD(0x8208);//Turn on crystal,!PA
  WriteCMD(0xA640);// 434MHz
  WriteCMD(0xC647);// 4.8kbps
  WriteCMD(0x94A0);//VDI,FAST,134kHz,0dBm,-103dBm
  WriteCMD(0xC2AC);
  WriteCMD(0xCA80);
  WriteCMD(0xCA83);//FIFO8,SYNC,
  WriteCMD(0xC49B);
  WriteCMD(0x9850);//!mp,9810=30kHz,MAX OUT
  WriteCMD(0xE000);//NOT USE
  WriteCMD(0xC80E);//NOT USE
  WriteCMD(0xC000);//1.0MHz,2.2V
}

void main()
{
  uint ChkSum;
  Init_RF12();
```

```
while(1)
 {
   ChkSum=0;
   WriteCMD(0x8228);      //OPEN PA
   DelayUs( 4 );
   WriteCMD(0x8238);
   NOP();
   NOP();
   WriteFSKbyte( 0xAA );
   WriteFSKbyte( 0xAA );
   WriteFSKbyte( 0xAA );
   WriteFSKbyte( 0x2D );
   WriteFSKbyte( 0xD4 );

   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 );
      WriteFSKbyte( 0xAA );
      WriteCMD( 0x8208 );       //CLOSE PA
      WriteCMD(0x8200);     //Receive end, enter sleep
      LED=1;
      DelayMs(100);
      LED=0;
      DelayMs(1000);
    }
}

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();
  NOP();
  NOP();
  NOP();
  SCK=1;
  NOP();
}

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();
}

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;
}

void WriteFSKbyte( uchar DATA )
{

  uchar RGIT=0;
  uint temp=0xB800;
  temp|=DATA;
Loop: SCK=0;
  nSEL=0;
```

```
  SDI=0;
  SCK=1;
  if(SDO)                 //Polling SDO
   {
    RGIT=1;
   }
  else
   {
    RGIT=0;
   }
  SCK=0;
  SDI=1;
  nSEL=1;
  if(RGIT==0)
   {
    goto Loop;
   }
  else
  {
   RGIT=0;
   WriteCMD(temp);
  }
}


void DelayUs( uint us )
{
  uint i;
  while( us-- )
    {
       i=2;
       while( i-- )
         {
           NOP();
         }
    }
}

void DelayMs(uint ms)
{
  uchar i;
  while(ms--)
  {
   i=35;
```

```
   while(i--)
   {
     DelayUs(1);
   }
  }
}
```

RF12 receiver demo:

```
/*************************************************************
    copyright (c) 2010
Title:              RFM12A recieve simple example based on PIC C
Current version:    v1.1
Function:           Package send Demo
Processor           PIC16F73 DIP-28
Clock:              10MHz Crystal
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E-MAIL:             faerf@hoperf.com
Date:               2010-06-28
*************************************************************/
#include "pic.h"

typedef unsigned char uchar;
typedef unsigned int  uint;

#define  SDI            RB7
#define  SDO            RB6
#define  SCK            RB5
#define  nSEL           RB4
#define  nIRQ           RB3
#define  LED            RA0
#define  LED_OUT()      TRISA0=0
#define  nIRQ_IN()      TRISB3=1
#define  SDI_OUT()      TRISB7=0
#define  SDO_IN()       TRISB6=1
#define  SCK_OUT()      TRISB5=0
#define  nSEL_OUT()     TRISB4=0
```

```
void Init_RF12(void);
void Write0( void );
void Write1( void );
void WriteCMD( uint CMD );
uchar RF12_RDFIFO(void);
void Delayus( uint us );

__CONFIG(0x3FF2);
bank1 uchar RF_RXBUF[19];
void Init_RF12(void)
{

  LED_OUT();
  nSEL_OUT();
  SDI_OUT();
  SDO_IN();
  SCK_OUT();
  nIRQ_IN();
  nSEL=1;
  SDI=1;
  SCK=0;
  SDO=0;
  LED=0;
  WriteCMD(0x80D8);//enable register,433MHz,12.5pF
  WriteCMD(0x82D8);//enable receive,!PA
  WriteCMD(0xA640);// 434MHz
  WriteCMD(0xC647);// 4.8kbps
  WriteCMD(0x94A0);//VDI,FAST,134kHz,0dBm,-103dBm
  WriteCMD(0xC2AC);
  WriteCMD(0xCA80);
  WriteCMD(0xCA83);//FIFO8,SYNC,
  WriteCMD(0xC49B);
  WriteCMD(0x9850);//!mp,90kHz deviation,MAX OUT
  WriteCMD(0xE000);//NOT USE
  WriteCMD(0xC800);//NOT USE
  WriteCMD(0xC000);//1.0MHz,2.2V
}

void main()
{
  uchar i=0,j=0;
  uint  CheckSum;

  Init_RF12();
```

```
  while(1)
   {
     while(!nIRQ)
     {
      RF_RXBUF[i++]=RF12_RDFIFO();
      if(i==17)
       {
        i=0;
        WriteCMD(0xCA80);
        WriteCMD(0xCA83);        //reset FIFO and read to receive next Byte
        CheckSum=0;
        for(j=0;j<16;j++)
         CheckSum+=RF_RXBUF[j];  //add 0x30-----0x3F
        CheckSum&=0x0FF;
        if(CheckSum==RF_RXBUF[16])
         {
           LED=1;
         }
        Delayus(1);
        LED=0;
        }
       }
   }
}

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();
  NOP();
  SCK=1;
  NOP();
}

void Write1( void )
{
  SCK=0;
  NOP();
  SDI=1;
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  NOP();
  SCK=1;
  NOP();
}

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;
}



uchar RF12_RDFIFO(void)
{
  uchar i,Result;
  SCK=0;
  SDI=0;
  nSEL=0;
  for(i=0;i<16;i++)
  {                     //skip status bits
    SCK=1;
    NOP();
    NOP();
    SCK=0;
    NOP();
    NOP();
  }
  Result=0;
  for(i=0;i<8;i++)
   {                    //read fifo data byte
    Result=Result<<1;
    if(SDO)
    {
      Result|=1;
    }
    SCK=1;
    NOP();
    NOP();
    SCK=0;
    NOP();
    NOP();
   }
  nSEL=1;
  return(Result);
}
void Delayus( uint us )
{
  uint i;
  while( us-- )
    {
       i=1000;
```

```
        while( i-- )
          {
            NOP();
          }
    }
}
```