

# RF12 programming guide

## 1. Brief description

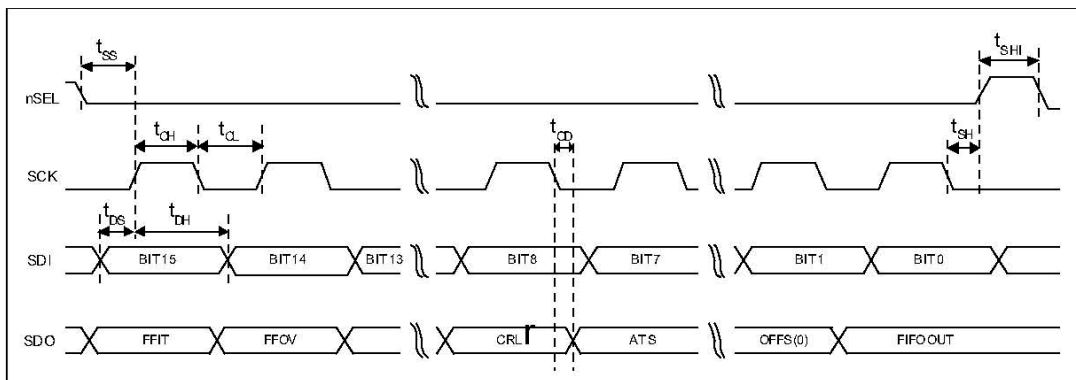
RF12 is a low cost FSK transceiver IC with integrated all RF functions in a single chip. It only need a MCU, a crystal, a decouple capacitor and antenna to build a hi reliable FSK transceiver system. The operation frequency can cover 300 to 1000MHz.

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:  $F_c = 310 + F * 0.0025$  MHz

433band:  $F_c = 430 + F * 0.0025$  MHz

868band:  $F_c = 860 + F * 0.0050$  MHz

915band:  $F_c = 900 + F * 0.0075$  MHz

$F_c$  is carrier frequency and  $F$  is the frequency parameter.  $36 \leq F \leq 3903$

### 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



This command is used to read FIFO data when FFIT interrupt generated. FIFO data output starts at 8<sup>th</sup> 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	r1	r0	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

r1..r0: 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 function

### 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	150
0	0	0	0	305
0	0	1	0	480
0	0	0	0	695
0	1	0	0	250
0	1	0	0	225
0	1	1	0	200
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:

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

### 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	C80Eh

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:

$$V_{lb}=2.2+V*0.1 [V]$$

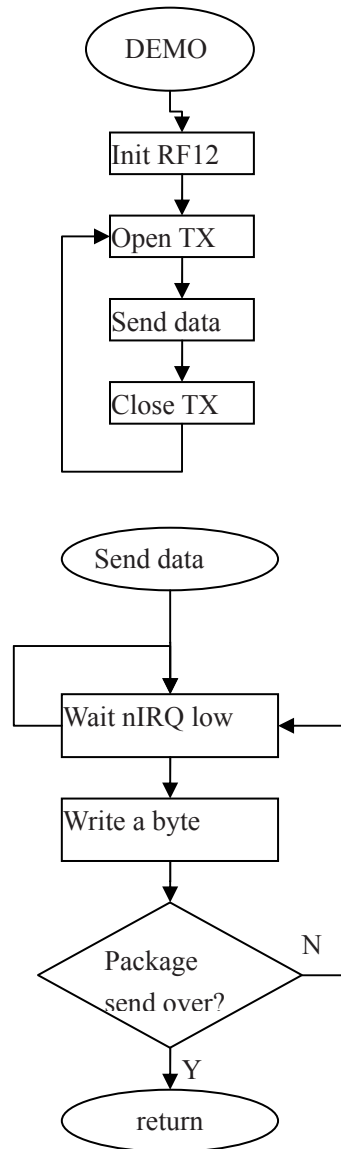
**16. Status Read Command**

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**

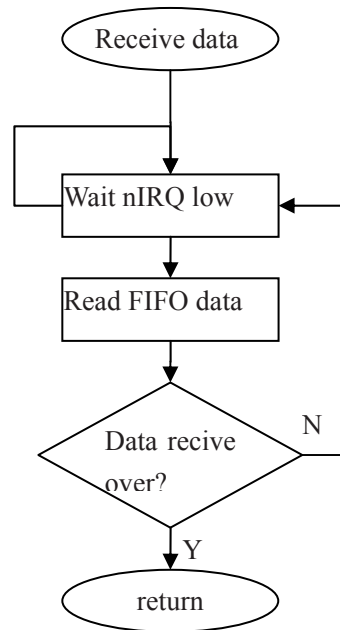
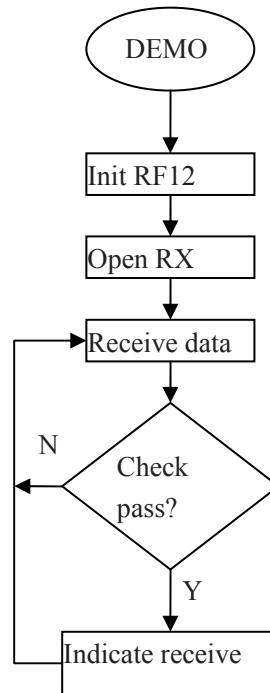
Transmitter:



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

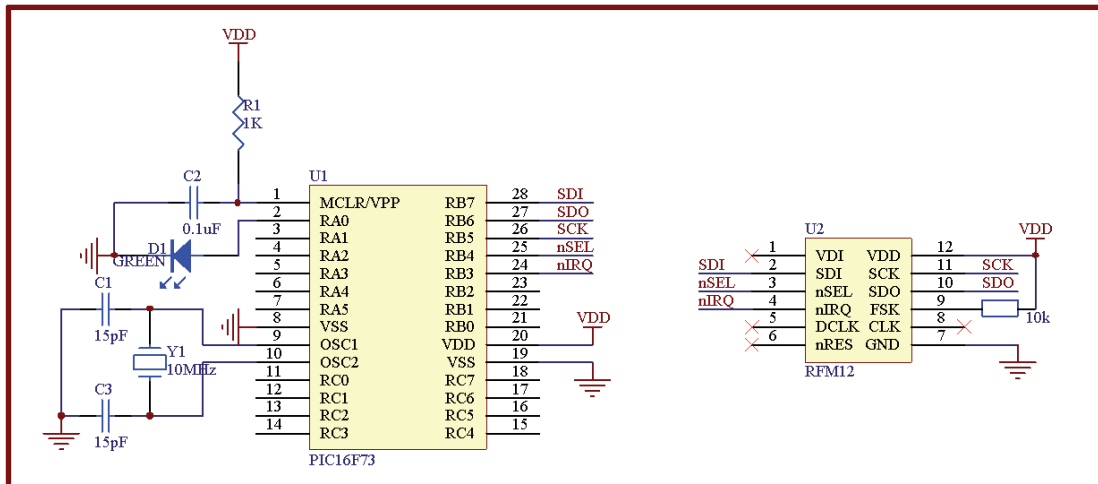
Receiver:





**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:

/\*\*\*\*\*\*

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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&=0xFF;
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();
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 ();  
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(SD0)                //Polling SD0
{
    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  
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 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();
```



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

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