Wireless Hi Power 0.5W RF Transceiver Module for Narrowband System

Version History

Version	Date	Changes
V1.01	Jan.20,2010	1st. Edition
V1.02	Mar.3,2008	2nd. Edition

Specification

● UHF Wireless Data Transceiver	● 431MHz ~435MHz ISM
● 402 / 424 / 426 / 429 / 433 / 447 / 449 / 469 MHz Operation	
● Single 4V to 6V Supply	● Up to 0.5W Output Power
● Hi Sensitivity: -122dBm	● AFC Function
● Antenna On Board	● Digital RSSI and Carrier Sense Indicator
● Application Range : Remote Metering、Wireless Security Systems 、Automatic Meter 、Reading、Home Automation	

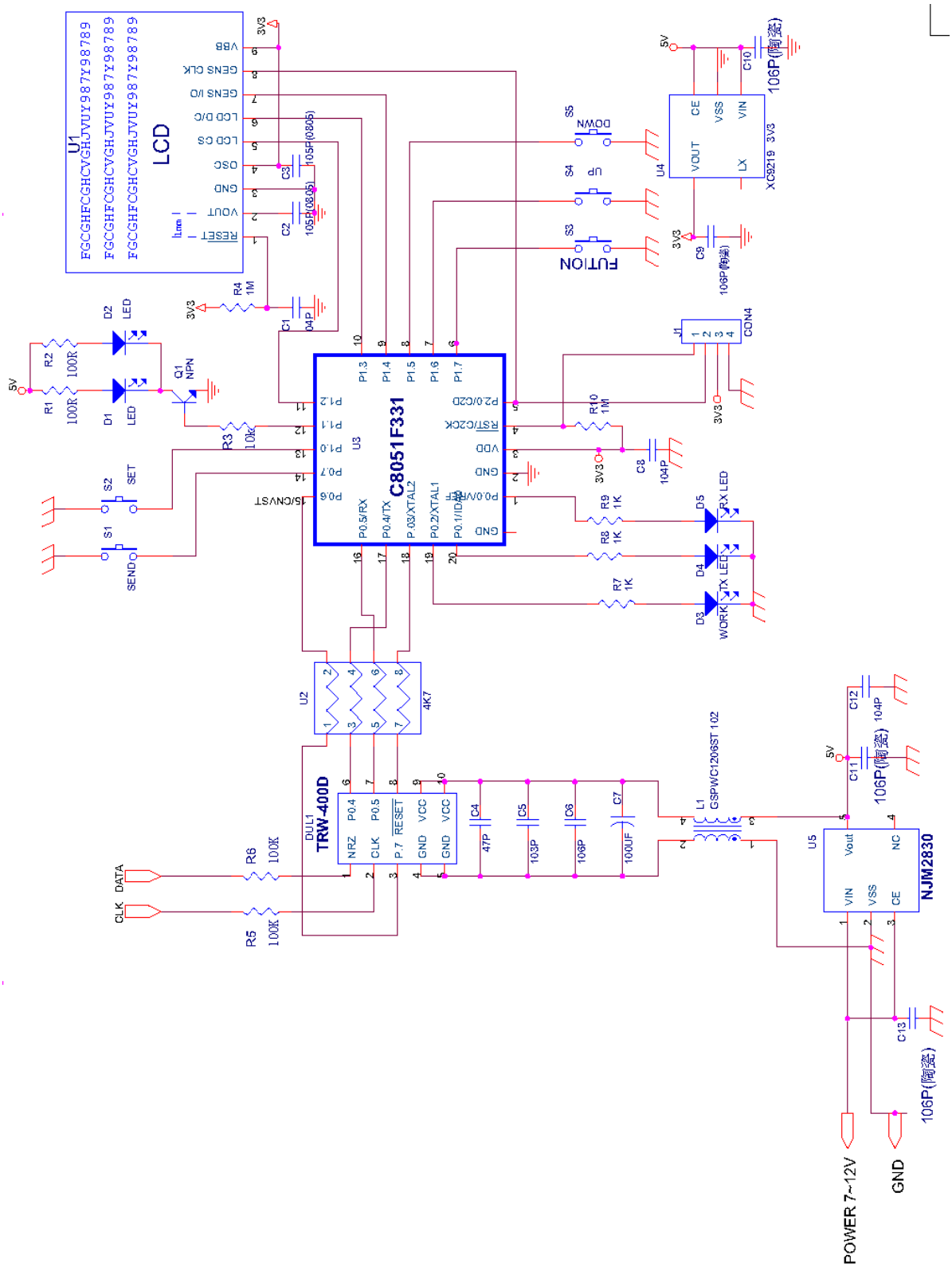
RF Transmit Section

Parameter	Specification			Unit	Condition
	Min	Type	Max		
Frequency Range	431	433.92	435	MHz	
RF Channels		320			12.5KHz Channel
Transmit Data Rate	2.4		153.6	Kbps	2.4K/4.8K/9.6K/19.2K/ 38.4K/76.8K/153.6K
Output Power		+27		dBm	
Current Consumption		250		mA	

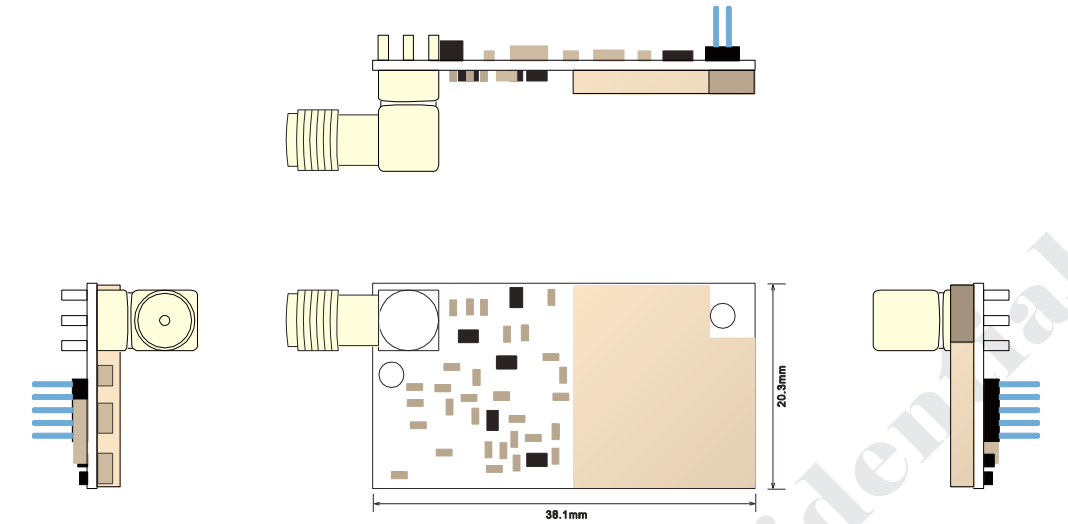
RF Receive Section

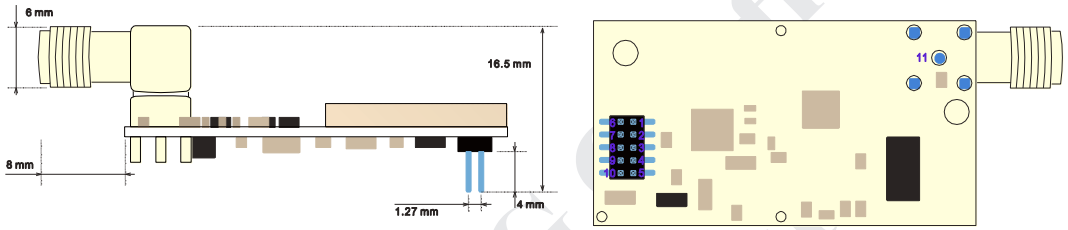
Parameter	Specification			Unit	Condition
	Min	Type	Max		
Frequency Range	431	433.92	435	MHz	
RF Channels		320			12.5KHz Channel
Transmit Data Rate	2.4		153.6	Kbps	2.4K/4.8K/9.6K/19.2K/ 38.4K/76.8K/153.6K
Sensitivity		-122		dBm	12.5KHz Channel
		-117		dBm	25KHz Channel
		-98		dBm	500KHz Channel Spacing: 153.6 K Band
Current Consumption		23		mA	
Operating Ambient Temperature Range	-10		+70	℃	

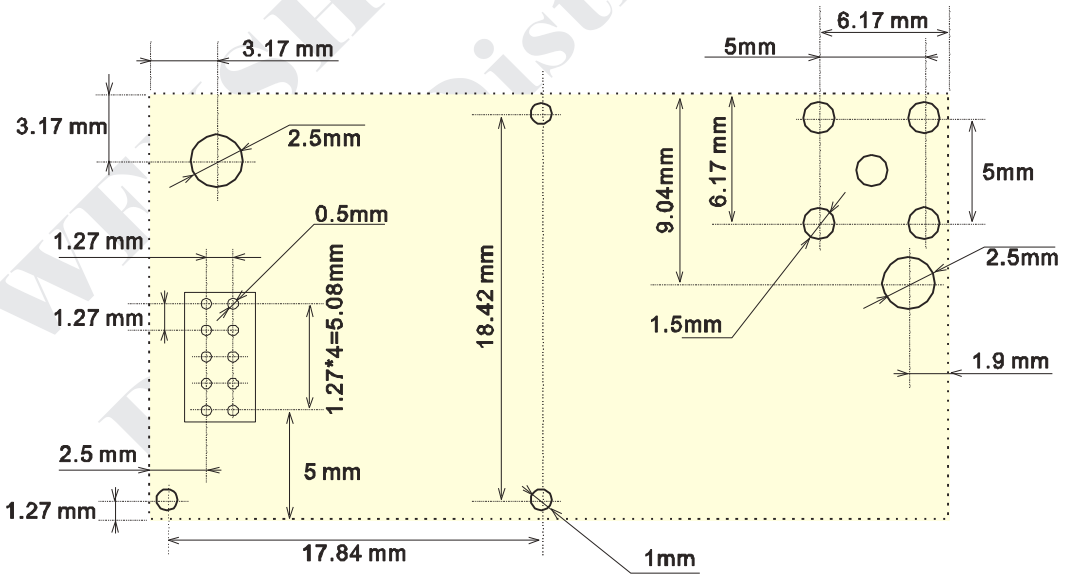
Demo Circuit



Size





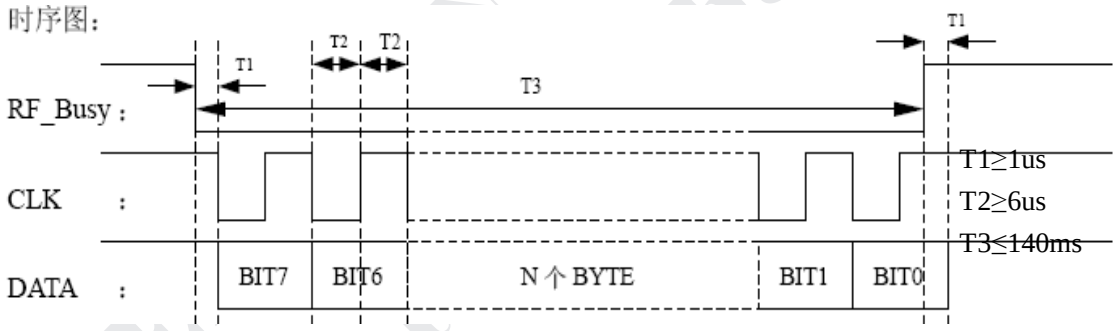


Reference hole position for PCB mounting(Bottom view)

Pin Assignment

Pin	Function	Description
1	NRZ DATA	RF DATA
2	NRZ CLK	RF CLK（work rate）
3	RF BUSY	INPUT/OUTPUT
4	GND	POWER GND
5	GND	POWER GND
6	DATA	INPUT/OUTPUT
7	CLK	INPUT
8	RESET	RF RESET (LO RESET)
9	VCC	POWER VDD
10	VCC	POWER VDD
11	SMA	RF ANTENNA

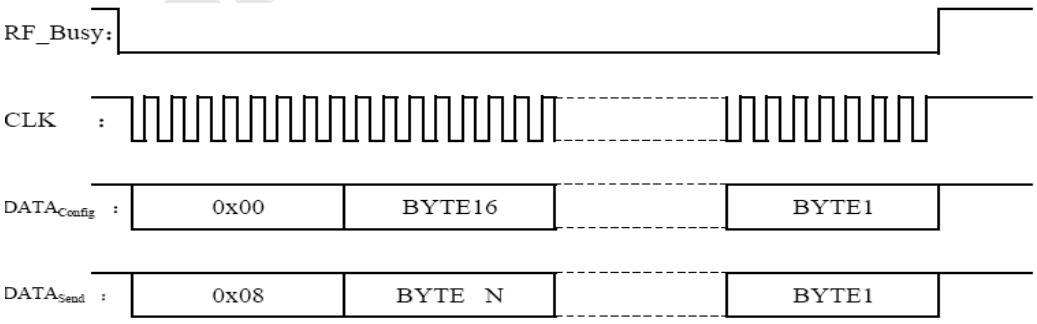
Minimum Time Request



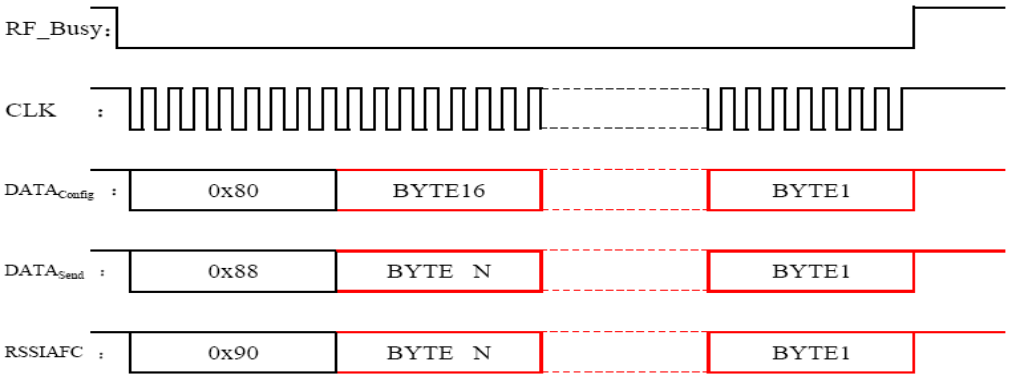
Note:

Sequence Diagram(writing) for configuration and data send:

All black come from user, all RED come from RF.



Sequence Diagram (reading) for configuration and data send



Note:"N" is decided by Configuration Bit6~0 in BYTE16.

Command for write configuration data: 0x00H, command for read configuration data : 0x80H.
Command for data send: 0x08H, command for read data set: 0x88H
Command for red RSSI and AFC:0x90H.

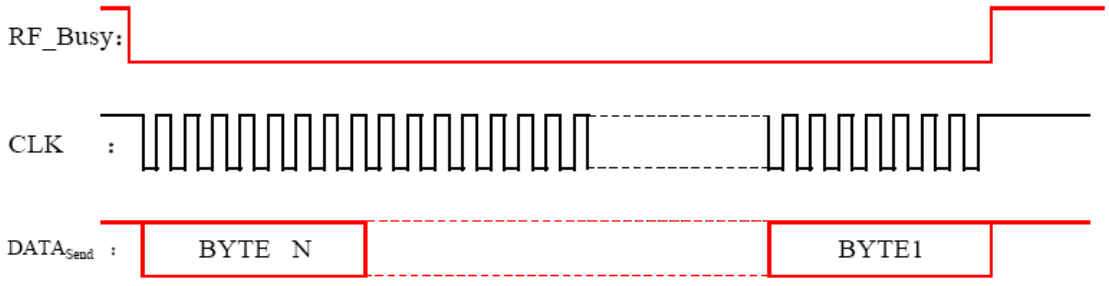
Remark:

1. When it configure, if below CLK number are over 136=(16+1)*8, only need to accept data before 136 CLK and others will automatically mask and wait RF_BUSY become high level.
   Send data which wrote are also the same, but LCK number is decided by BIT6~0 of first BYTE of configuration, it's number = （Bit6~0+1）*8.
2. When RF working under transmission, it will detect DATA PIN is in low.
   You can write and read data in RF at this time, otherwise, RF will be wrong.
   After send data for one time, it will determine DATA line status every 10us.
3. When module received 0x90 command, please read 2 bytes.
   First BYTE is RSSI value, second BYTE is AFC value, and those two are with sign.
   If RSSI value transfer to dBm is not sure, we only can say if read value is larger, sense indicator (it has sign differentiate) is stronger.
   AFC value transfer to frequency is as below:
   F_{AFC} = AFC* Work rate/16。

Remark:

Receiving Data Sequence Diagram :

CLK are all from user, RF_Busy/DATA come from RF automatically.



Remark:

1. Read receiving data is not input from command directly. When CLK which input reach N*8, RF_ Busy will automatically become high.
2. When RF_Busy is low, you can give configuration data to RF. User also need to input LCK to RF in 1ms, otherwise, this data will be loss.
3. First BYTE address(first BYTE) value doesn't during 40H~77H or 80H~FFH.

When using TRW-400D Transceiver Module, please use main transmit mode which is similar to SPI protocol to send 16 bytes to TRW-400D for configuration.
Configuration address is 0x00, please check more details of 16 bytes as below:

BYTE16	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Select mode and package length.
	CM	Length of data							
BYTE15	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	ID setting ,work Rate and Tx/Rx Select
	RXEN	Address BYTE				Data Rate			
BYTE14	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Receive Frequency setting.
	FREQ_2R								
BYTE13	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	FREQ_1R								
BYTE12	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	FREQ_0R								
BYTE11	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Transmit Frequency setting.
	FREQ_2T								
BYTE10	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	FREQ_1T								
BYTE9	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	FREQ_0T								
BYTE8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Preamble setting, fixed length on 4 bytes .
	Preamble BYTE								
BYTE7	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Setting ID code.
	Address BYTE 6								
BYTE6	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Address BYTE 5								
BYTE5	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Address BYTE 4								
BYTE4	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Address BYTE 3								
BYTE3	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Address BYTE 2								
BYTE2	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Address BYTE 1								
BYTE1	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Address BYTE 0								

BYTE Description

1.1 BYTE16 :

Bit7(CM) mode selection:

1------ Direct mode. Send and receive data from RF CLK and RF DATA line, not through MCU. This mode can save SPI sending time and increase sending rate.

0------ Indirect mode. Send data and receive data through MCU.

Bit6~0 package length should be between 1~100 bytes.

1.2 BYTE15：

Bit7(RXEN) receive and transmit selection position:

1------ RF Working is on receiving mode.

0------ RF Working is on transmitting mode.

Bit6~4(Adress_Byte) ID code setting:

At most is 7 bytes; if it is less than 7 bytes, please select low.

If ID number set on 4, ID code save on: BYTE4，BYTE1, high is in front.

Attention:

ID data and ID code of paring receiver and transmitter module must be the same.

Bit3 RF module low power consumption:

0------ RF chip woks on low power consumption.

1------ RF chip works on normal.

For Bit2~0 RF working rate, there are several for your selection as below:

2.4K/4.8K/9.6K/19.2K/38.4K/76.8K/153.6Kbps, 6 types for your selection.

Ex: [Bit2~0]=4 when choose 38.4Kbps.

1.3 BYTE14~12 is the value of receiving frequency:

BYTE14 is the highest byte of receiving frequency, BYTE12 is the lowest byte. Its formula is as below:

FREQ = {[(f_{SF}-307.2K) - (3/4)*7372800]*32768 – 3686400}/ 3686400

f_{SF} is the actual working frequency. FREQ is the value of write in BYTE14~12（have to use hexadecimal method）, whatever the lowest is 0 or 1, all replace by 1.

Ex: while configuration is in 433.92MHz

FREQ =（433920000-307200-0.75*7372800*32768-3686400）/3686400

= 3805183 =0x3A0FFF

1.4 BYTE11~9 is the value of transmitting frequency:

BYTE11 is the highest byte of transmitting frequency, the lowest byte is BYTE9. Its formula is as below:

FREQ =[（433920000-0.75*7372800）*32768-3686400]/3686400

= 3807913 =0x3A1AA9

f_{SF} is the actual working frequency. FREQ is the value write in BYTE11~9（have to use hexadecimal method）, whatever lowest is 0 or 1, all replace by 1.

Ex: while configuration is 433.92MHz

FREQ =[（433920000-0.75*7372800）*32768-3686400]/3686400

= 3807913 =0x3A1AA9

1.5 BYTE8 is for the number of preamble code, the value is between 4~255.

1.6 BYTE7~1 are the ID numbers for distinguish from transmitter and receiver. The value has to be the same for a relative pair of transmitter and receiver.

When configuration RF, data writing to RF are as follows:

C0+BYTE16+BYTE15+…+BYTE2+BYTE1

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NRZ DATA :

When CM=1, it is the data line of RF.

When CM=0, do not need this line.

NRZ CLK :

The data rate of RF: 2.4, 4.8, 9.6, 19.2, 38.4, 76.8, 153.6Kbps.

RF_Busy :

Transmitting status:

= 0, modules is under busy status, control chip can't read and write module, otherwise, it will has error.

= 1, it can read/write data and configuration data.

Receiving mode:

= 0, indicate module already received data and wait for MCU read data.

When this line keeps 1ms and MCU doesn't read number, this data will get lost.

= 1 indicate RF module waiting for data receiving and can write configuration data into module.

RESET: Module reset pin, low level reset.

Data: RF module control signal and signal line.

CLK: RF control signal and signal line. When it is free, this line is high level.

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Remark:

The time for T1 is over 1us, time for T2 is over 6us , time for T3 can't over 140ms(data will not deal if connection is over time).

CLK is low, it write into data, CLK is high, it read data.

1. Under (read/write) transmitting data and (read/write) configuration status:
   Clock of RF_BUSY, CLK and DATA will produce from user.

a) Write configuration command: 0xxx0xxxB
   Format: 00H+16 bytes configuration information.

b) Write transmitting data command: 0xxx1xxxB
   Format: 08H+N bytes of data.

c) Read configuration command: 1xx00xxxB
Format: 80H+16 bytes configuration data.

d) Read transmitted data command: 1xx01xxxB
Format: 88H+N bytes data.
Remark:
When it is on configuration, below CLK number should be over 136 CLK data, behind data will be mask automatically and wait RF_BUSY become high level.
When it write into transmitted data, it is also the same, but CLK numbers will decided by BIT6~0 of first byte of configuration, number=（Bit6~0+1）*8。

e) When MCU detect DATA line is low, it can give configuration and send data to RF.

2. Under receive status:

RF_BUSY, data produce from RF , CLK produce from user.

a) Read configuration command: 1xx00xxxB
Format: 80H+16 bytes configuration information.

b) Write configuration command: 0xxx0xxxB
Format: 00H+16 bytes configuration information.

c) Read RSSI & AFC command: 1xx1xxxxB
Format: 90H+AFC+RSSI
Before received data, value of read RSSI & AFC are 0.
In direct mode, it can read AFC & RSSI value.

d) Read received data is not through command input. When you input CLK into internal to identify data, RF_BUSY will automatically become high.

e) When RF_BUSY is low, you can give configuration data to RF.

3. The functions are all the same as below, only add save electricity function:

a) When BIT3~BIT0 of BYTE2 is equal to 0111b, meanwhile, RF entry into stop status.
Current is less than 1mA.
Wake up method:
Give RESET line of RF a low pulse for 20ms. After it normal working, it will automatically working and under the status of writing Bit7 of BYTE2, but rate will become 4.8K.
Note:
When BIT2~0 is 111, there is no any relative rate to select.
When it is other value, relative rate is as below: 4K/4.8K/9.6K/19.2K/38.4K/76.8K/153.6K

b) When BIT3 of BYTE2 is 0, Bit2~0 is not 111 and RF WILL entry into standby status.
Give configuration data, it can work on transmitted status or received status.
Address of first BYTE should be not between 40H~77H or 80H~EFH.

4. Address of first BYTE should be now between 40H~77H or 80H~EFH.

```
; ----------------------------------------------------
; ----------------------------------------------------
Read_Config     EQU 80H ;
Read_Send       EQU 88H ;
```

```
; ------------------------------------------------
; ------------------------------------------------
      ORG         0000H                          ;
      NOP                                        ;
      NOP                                        ;
      SJMP    RESET                              ;
; ------------------------------------------------
RESET:
      LCALL   Delay200ms                 ;
; ------------------------------------------------
      SETB    RF_Busy                            ;
      SETB    CLK                                ;
      SETB    DATA                               ;
; ------------------------------------------------
; Transmitted status
; ------------------------------------------------
Config_TX_State:
      MOV         DPTR    ,#Config_Tx_Table      ;
      MOV         R2      ,#17                   ;
      LCALL   Config_Send_Data                   MOV         A       ,#Read_Config
      MOV         R2      ,#16                   :This is not necessary, just in order
to verify wrote data is correct or not.
      LCALL   Read_Config_Send                   ;
; ------------------------------------------------
Send_DATA_Loop:
      LCALL   Delay20us                          : Only need to extend 20us.
      JB          DATA    ,$                     ;
      MOV         DPTR    ,#Send_Data            ;
      MOV         R2      ,#5                    ;
      LCALL   Config_Send_Data                   ;
      LCALL   Delay20us                          :This is not necessary
      MOV         A       ,#Read_Send            ;
      MOV         R2      ,#4                    ;
      LCALL   Read_Config_Send                   ;
      AJMP    Send_DATA_Loop                     ;
; ************************************************************
; ************************************************************
; Received status
; ------------------------------------------------
      MOV         DPTR    ,#Config_Rx_Table      ;
      MOV         R2      ,#17                   ;
      LCALL   Config_Send_Data                   ;
; ------------------------------------------------
Receive_Data_Loop:
```

```
        JB      RF_BUSY,$                       ;
        MOV     R2      ,#4                     ;
        LCALL   Read_DATA                       ;
        AJMP    Receive_Data_Loop               ;
; ---------------------------------------------
; Standby status
; ---------------------------------------------
        MOV     DPTR    ,#Config_Idle_Table     ;
        MOV     R2      ,#17                        ;
        LCALL   Config_Send_Data                ;
        AJMP    Config_TX_State                 ;
        AJMP    Config_RX_State                 ; OR
; ---------------------------------------------
; Stop status
; ---------------------------------------------
        MOV     DPTR    ,#Config_Stop_Table     ;
        MOV     R2      ,#17                        ;
        LCALL   Config_Send_Data                ;
        CLR     RESET                           ;
        LCALL   Delay20ms                       ;
        SETB    RESET                           ;
        AJMP    $                               ;
; ---------------------------------------------------
; ---------------------------------------------------
; ---------------------------------------------------
Read_Config_Send:
        JNB     DATA    ,$                      ;
        CLR     RF_Busy                         : Transfer  to output status.
Read_Config_Send_000:
        MOV     R3      ,#8                     ;
Read_Config_Send_001:
        CLR     CLK                             ;
        CLR     DATA                            ;
        JNB     ACC.7 ,Read_Config_Send_002     ;
        SETB    DATA                            ;
Read_Config_Send_002:
        CLR     CLK                             ;
        LCALL   Delay10Cycle                    ;
        LCALL   Delay10Cycle                    ;
        LCALL   Delay10Cycle                    ;
        SETB    CLK                             ;
        RL      A                               ;
        LCALL   Delay10Cycle                    ;
        LCALL   Delay10Cycle                    ;
```

```
    LCALL   Delay10Cycle                    ;
    DJNZ    R3      ,Read_Config_Send_001;
    SETB    DATA                            : Transfer  to input status.
    MOV     R3      ,#8                     ;
Read_Config_Send_100:
    CLR     CLK                             ;
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    SETB    CLK                             ;
    CLR     ACC.7                           ;
    JNB     DATA    ,Read_Config_Send_101;
    SETB    ACC.7                           ;
Read_Config_Send_101:
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    RL      A                               ;
    DJNZ    R3      ,Read_Config_Send_100;
    MOV     R3      ,#8                     ;
    MOV     @R0     ,A                          ;
    INC     R0                              ;
    DJNZ    R2      ,Read_Config_Send_100;
    SETB    DATA                            ; Transfer  to input status.
    SETB    RF_BUSY                         ; Transfer  to input status.
    RET                                     ;
; ------------------------------------------------------
; ------------------------------------------------------
Read_DATA:
    MOV     R3      ,#8                     ;
Read_DATA_Loop:
    CLR     CLK                             ;
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    SETB    CLK                             ;
    CLR     ACC.7                           ;
    JNB     DATA    ,Read_DATA_Loop_000     ;
    SETB    ACC.7                           ;
Read_DATA_Loop_000:
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    LCALL   Delay10Cycle                    ;
    RL      A                               ;
```

```
        DJNZ    R3      ,Read_DATA_Loop         ;
        MOV         @R0     ,A                      ;
        INC     R0                              ;
        DJNZ    R2      ,Read_DATA              ;
        RET                                     ;
; ---------------------------------------------------
; This sub-program  can use on configuration  TX/RX  and send data.
; ---------------------------------------------------
Config_Send_Data:
        JNB     DATA    ,$                      ;
        CLR     RF_Busy                         ; Transfer  to output status.
Config_Send_Data_000:
        CLR     A                               ;
        MOVC    A       ,@A+DPTR                ;
        INC     DPTR                            ;
        MOV         R3      ,#8                 ;
Config_Send_Data_001:
        CLR     CLK                             ;
        CLR     DATA                            ;
        JNB     ACC.7   ,Config_Send_Data_002;
        SETB    DATA                            ;
Config_Send_Data_002:
        CLR     CLK                             ;
        LCALL   Delay10Cycle                    ;
        LCALL   Delay10Cycle                    ;
        LCALL   Delay10Cycle                ;
        SETB    CLK                             ;
        RL      A                               ;
        LCALL   Delay10Cycle                    ;
        LCALL   Delay10Cycle                    ;
        LCALL   Delay10Cycle                    ;
        DJNZ    R3      ,Config_Send_Data_001;
        DJNZ    R2      ,Config_Send_Data_000;
        SETB    RF_BUSY                         ; Transfer  to input status
        SETB    DATA                            ; Transfer  to input status
        RET                                     ;
; ---------------------------------------------------
; Configuration  result:
; Rate: 4.8K
; Frequency:  433.9
; Send BYTE number: 4
; Received  BYTE number:  4
; Preamble  code: fixed on 4.
; Address code: 4
```

```
; ----------------------------------------------------
Config_Tx_Table:
    DB 000H,004H,039H,03AH,00FH,04FH,03AH,019H,0F9H  ;
    DB      004H,034H,056H,078H,090H,012H,034H,03FH  ;
; ----------------------------------------------------
Config_Rx_Table:
    DB 000H,004H,0B9H,03AH,00FH,04FH,03AH,019H,0F9H  ;
    DB      004H,034H,056H,078H,090H,012H,034H,03FH  ;
; ----------------------------------------------------
Config_Idle_Table:
    DB 000H,004H,031H,03AH,00FH,04FH,03AH,019H,0F9H  ;
    DB      004H,034H,056H,078H,090H,012H,034H,03FH  ;
; ----------------------------------------------------
Config_Stop_Table:
    DB 000H,004H,037H,03AH,00FH,04FH,03AH,019H,0F9H  ;
    DB      004H,034H,056H,078H,090H,012H,034H,03FH  ;
; ----------------------------------------------------
Send_Data:
    DB 008H,012H,034H,056H,067H
; ----------------------------------------------------
; end
```