TRW-400B

WENSHING®©

V1.07

Wireless Hi Power 0.5W RF Transceiver Module for Narrowband Systems

➢ 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	

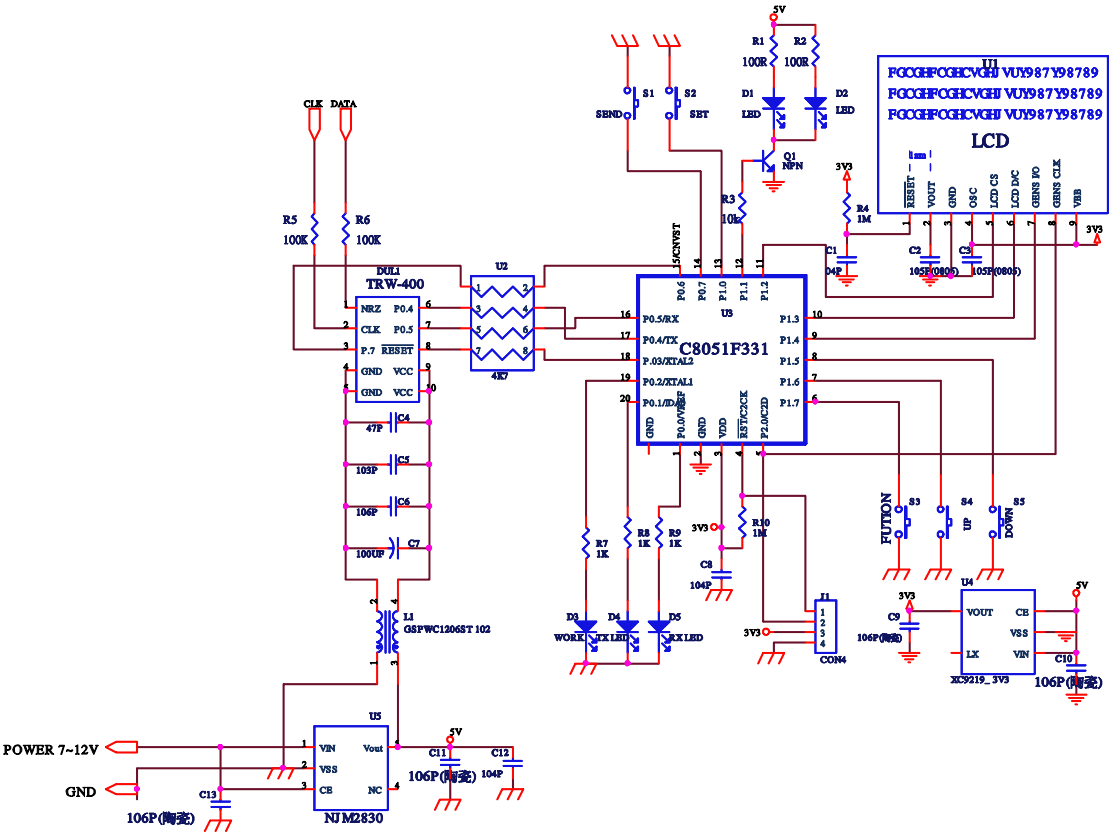
➢ RF Transmit Section:

Parameter	Specification			Units	Condition
	Min	Typ	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	

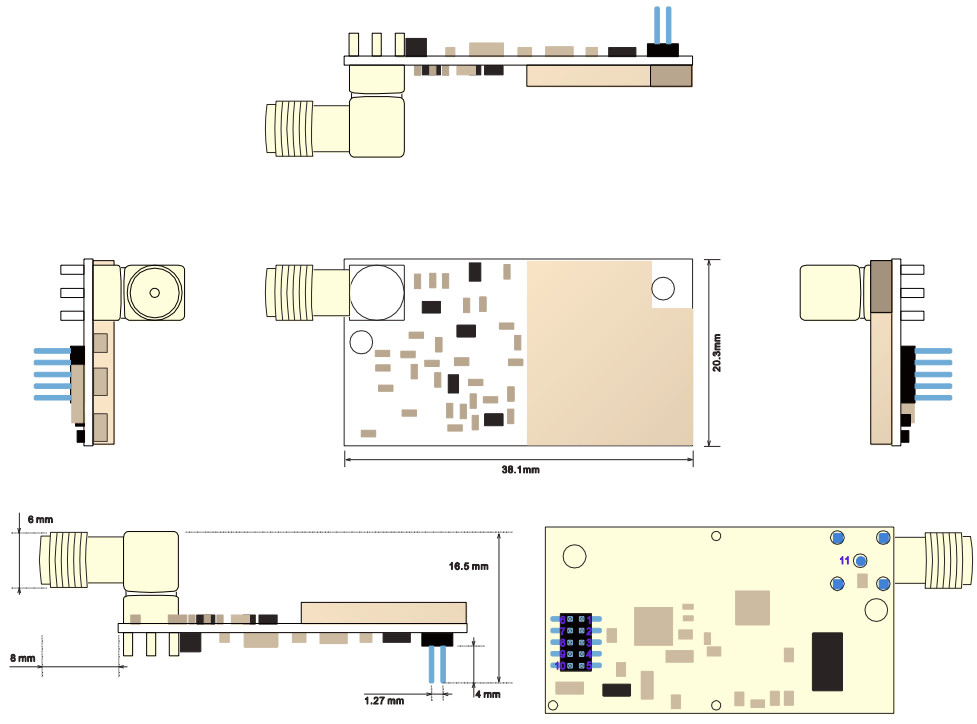
➢ RF Receive Section:

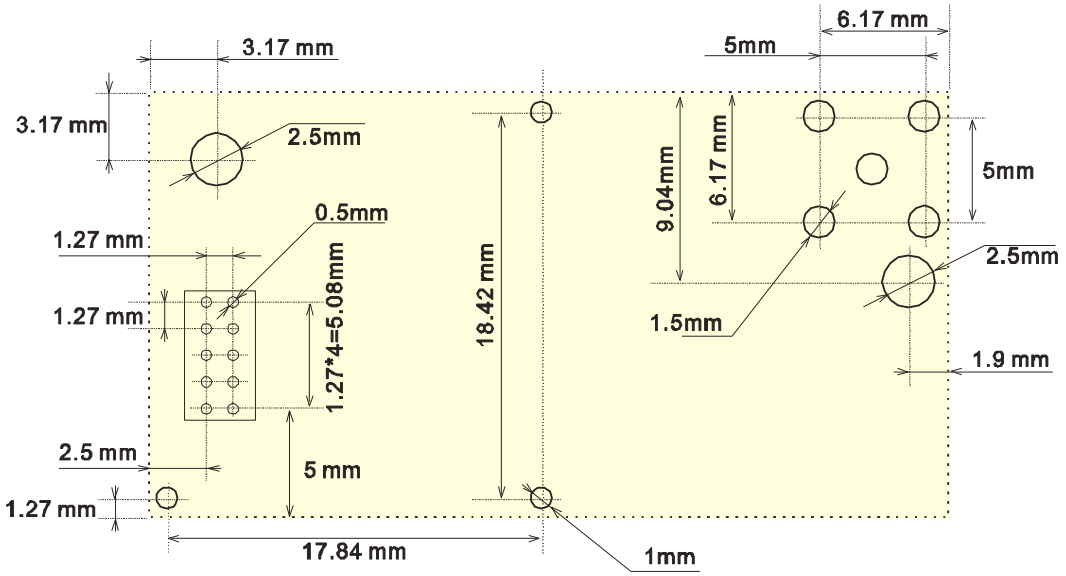
Parameter	Specification			Units	Condition
	Min	Typ	Max		
Frequency Range	431	433.92	435	MHz	
RF Channels		320			12.5KHz Channel
Transmit Data Rate	2.4		153.6	Kbps	2.4K/4.8K/9.6K/19.2K/ 38.4K/76.8K/153.6K
Sensitivity		-122		dBm	12.5KHz Channel
Sensitivity		-117		dBm	25KHz Channel
Sensitivity		-98		dBm	500KHz Channel Spacing: 153.6 KBand
Current Consumption		23		mA	
Operating Ambient Temperature Range	-40		+80	℃	
Dimenisions	38.1mm×20.3mm			mm	

➢ Demo Circuit：



➢ Pin & Size:



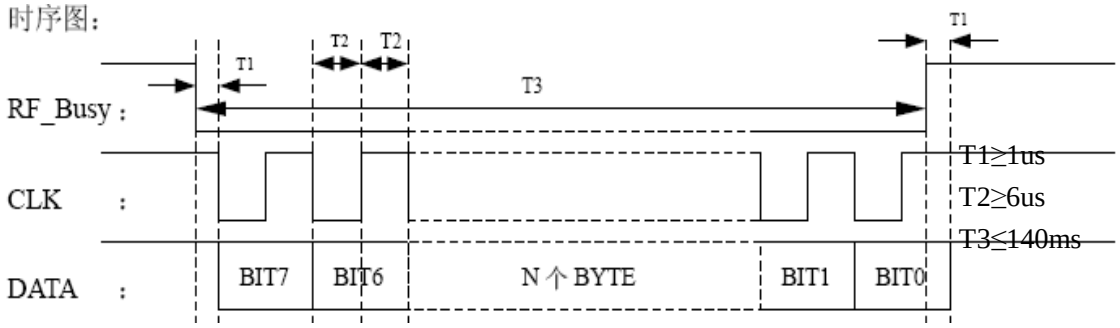


Reference hole position for PCB mounting(Bottom view)

➢ Pin Assignment:

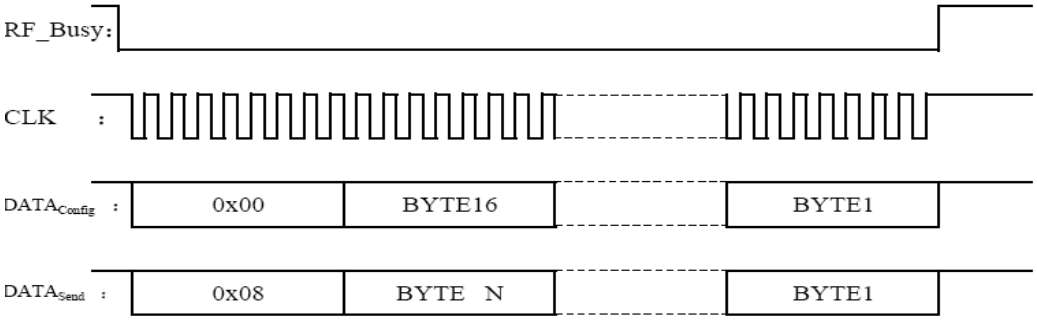
Pin	Function	Description
1	NRZ DATA	RF DATA
2	NRZ CLK	RF CLK（It's work data）
3	RF BUSY	INPUT/OUTPUT
4	GND	POWER GND
5	GND	POWER GND
6	DATA	INPUT/OUTPUT
7	CLK	INPUT
8	RESET	RF RESET (LO RESET)
9	VCC	POWER VDD
10	VCC	POWER VDD
11	SMA	RF ANTENNA

➢ Minimum Time Request：

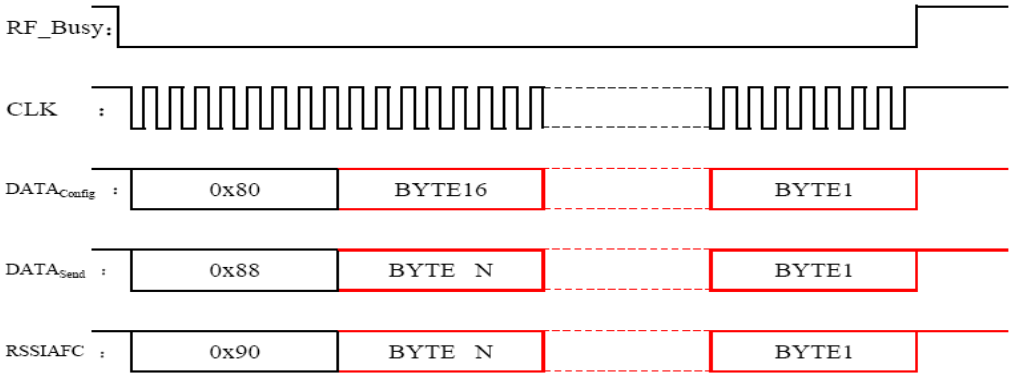


Write Configuration Register and transmit data:

NOTE：BLACK all come from user, RED all come from RF.



➢ Read Configuration Register and transmit data：



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

Address of writing Configuration Register is: 0x00H, and reading Configuration Register is: 0x80H.

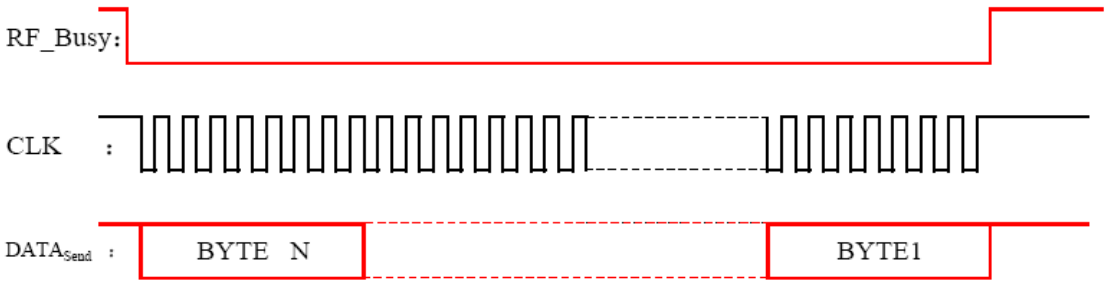
Address of writing transmit data is: 0x08H, and reading transmit data is: 0x88H.

Address of reading RSSI and AFC is: 0x90H.

REMARKS：

1. When Configuration Register, if the CLK number more than 136=（16+1）*8 of place CLK, it will only accept the CLK data for those before 136, after that will conceal automatically, waiting for RF_BUSY turns to high power. The situation is as the same as writing transmit data, except the number of CLK is decided by the first dispose Bit6~0 in BYTE16, its number =（Bit6~0+1）*8.
2. While RF under the state of transmitting, can not write or read the data if the DATA pin is low in RF, or else RF transmit data as error. Ascertain the state of DATA line 10us later after transmit data.
3. When module receives 0x90 this instruction, the user as long as to reads 2 BYTE data is enough; the first BYTE is the RSSI value, the second is the AFC value, both of two have the mark data. The value of RSSI exchanges to the dBm value unclear, only can say the value read bigger, the field intensity is stronger (has mark to differentiate), The value of AFC exchange to the frequency as follows: FAFC = AFC* working speed/16.

Reading Receive Data: CLK all come from user, RF-Busy/DATA come form RF automatically.



REMARKS：

1. The data of reading receive can output directly, do not need instruction, while input CLK number reach N*8, the RF_Busy will turn high automatically.
2. Can't writing configuration Register and user should input CLK to RF within the time of 1ms when RF_Busy is low at receive mode,
3. The value do not between 40H~77H or 80H~FFH in first BYTE address as BYTE 1

➢ **Using TRW-400B need the similar with SPI and with main transmit mode to transfer 16 BYTE to TRW-400B module for configuration register, it's configuration register address is 0x00, please see the following specification for the functions of 16 BYTE.**

BYTE16	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Mode select and Setting Package Length
	CM	Length of data							
BYTE15	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Setting Address Length , Work Rate and Tx/Rx Select
	RXEN	Adress Byte				Data Rate			

BYTE14	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Setting Receive Frequency reference to 1.3
	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	
	FREQ_2T								
BYTE10	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Setting transmit Frequency reference to 1.4
	FREQ_1T								
BYTE9	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	FREQ_0T								
BYTE8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Preamble as Fixed Length 4 Bytes in RF
	Preamble Byte								
BYTE7	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Setting Address code
	Adress Byte 6								
BYTE6	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Adress Byte 5								
BYTE5	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Adress Byte 4								
BYTE4	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Adress Byte 3								
BYTE3	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Adress Byte 2								
BYTE2	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Adress Byte 1								
BYTE1	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
	Adress Byte 0								

➢ BYTE Illustration :

1.1 BYTE16 :

Bit7(CM) mode selecting:

1------ for direct mode. Without MCU, through NRZ CLK and NRZ DATA line to RF. This mode can save the transmission time of SPI and improve the efficiency of transceiver.

0------ for indirect mode.

Bit6~0 Transmit of bytes per package, the number should between 1 to 100 Bytes.

1.2 BYTE15：

Bit7(RXEN) receive and transmit selecting position: 1------ for working RF receiving mode.

0------ for working RF transmitting mode

Bit6~4(Adress_Byte): At most 7 BYTE of the address for RF, The address data is in BYTE6~1.

ATTENTION: The address data and number at transmitter and receiver mode have to be the same.

Bit3 The low power consumption of RF modules:

0------ indicate the RF module working under low power consumption state.

1------ indicate the RF module working under normal working state.

Bit2~0 Several selections are providing as follows.

2.4K/4.8K/9.6K/19.2K/38.4K/76.8K/153.6Kbps 6 kinds for selection.

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

NOTE : **if bit3~0 equal to 0111,indicate the RF module woking under stop mode.**

: if bit3~0 unequal to 0111, but Bit3 equal to 0, indicate the RF module woking under idle mode.

1.3 BYTE14~12 for the value of receiving frequency:

BYTE14 is the highest of receiving frequency, the lowest is BYTE12. Its formula of calculation 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）, no matter the lowest is 0 or 1, all replace by 1.

ex: while dispose in 433.92MHz

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

= 3805183 =0x3A0FFF

1.4 BYTE11~9 for the value of transmitting frequency:

BYTE11 is the highest of receiving frequency, the lowest is BYTE9. Its formula of calculation as below:

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

f_{SF} is the actual working frequency. FREQ is the value write in BYTE11~9（have to use hexadecimal method）, no matter the lowest is 0 or 1, all replace by 1.

ex: while dispose 433.92MHz

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

= 3807913 =0x3A1AA9

1.5 BYTE8 is for the number of previous call in transmitting, the value Fixed Length 4 Bytes in RF.

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 register RF module, data writing to RF are as follows:

C0+BYTE16+BYTE15+…+BYTE2+BYTE1

NRZ DATA : When CM=1, it is the data line of RF. When CM=0, do not need the line.

NRZ CLK : The data speed of RF: 2.4, 4.8, 9.6, 19.2, 38.4, 76.8, 153.6Kbps

RF_Busy :

Transmit mode:

= 0 RF module in busy mode, user's not reading from and writine to RF

module, or else transmit data as error.

= 1 Allow user reading from and writing to data RF module

Receive mode:

= 0 indicate RF module as received package, user should input CLK to RF within the time of 1ms when RFBusy is low

= 1 indicate RF module waiting data

RESET : RF module RESET. An external source can initiate a system reset by driving this pin low for at lease 10us.

DATA : The signal line of control and data of RF module.

CLK : The signal line of control and data of RF module.

REMARKS: The time for T1 is above 1us, T2 above 6us, T3 can not over 140ms (Otherwise, if connection over the time, the data will not be deal with）. Write data while CLK is low; read data while it is high.

1. While (read/write) the data of transmitting and (read/write) the state of configuration register: The clock of RF_BUSY, CLK, and DATA are all produce from user.
   a) Instruction for writing dispose is 0xxx0xxxB, the format is: 00H+16 BYTE dispose information.
   b) Instruction for writing transmit data is 0xxx1xxxB, the format is: 08H+N BYTE data.
   c) Instruction for reading dispose is 1xx00xxxB, the format is: 80H+16 BYTE dispose information.
   d) Instruction for reading transmit data is 1xx01xxxB, the format is: 88H+N BYTE data.
   e) REMARKS: Under dispose, if the CLK number more than 136=（16+1）*8, will only accept 136 CLK data, the number after 136 will miss automatically, wait for RF_BUSY turns to high power. The situation is as the same in writing transmit data, except the number of CLK is decided by the first dispose BIT6~0 in BYTE, NUMBER=（Bit6~0+1）*8.
   f) While MCU test the DATA line is low, can not dispose and transmit data to RF.
2. Under receiving sate: RF_BUSY, DATA produce form RF, CLK produce from user.
   a) Instruction for reading dispose is 1xx00xxxB, the format is: 80H+16 BYTE dispose information.
   b) Instruction for writing dispose is 0xxx0xxxB, the format is: 00H+16 BYTE dispose information.
   c) Instruction for reading RSSI&AFC is: 1xx1xxxxB, the format is : 90H+AFC+RSSI. Before receive data, the data of reading RSSI&AFC data are all 0. Can also read the AFC&RSI under direct mode.
   d) Reading receive data can output directly, do not have instruction. When output CLK reach the data of inner definition, RF_Busy will become higher automatically.
   e) When RF_Busy is low, can not put dispose data to RF.
3. Basically as pervious functions, just increase one more function for power saving:

a) When BIT3~BIT0 in BYTE2 are 1, RF is in the sate of stop working，and electric current is under 1mA. For awake method: place 20ms low impulse to the RESET line of RF, after normal function, will working automatically and write the sate of Bit7 in BYTE2 in the last time, but speed will become 4.8K.

ILLUSTRATION: Due to there's no corresponding speed can be choose while BIT2~0 is 111.When under others data, the correspondence speed is the speed that provide previously: 2.4K/4.8K/9.6K/19.2K/38.4K/76.8K/153.6K.

b) When BIT3 in BYTE2 is 1 and Bit2~0 are not 111, RF is under state of waiting. Can work by place dispose information under state of transmit or receive.

4． Above-mentioned CLK is for IIC CLK line, DATA is for IIC DATA line.

5. The first BYTE address have better do not between 40H~77H or 80H~EFH.

➢ Demo Program :

```
; ---------------------------------------------------
; ---------------------------------------------------
Read_Config     EQU 80H ;
Read_Send       EQU 88H ;
; ---------------------------------------------------
; ---------------------------------------------------
    ORG         0000H                       ;
    NOP                                     ;
    NOP                                     ;
    SJMP    RESET                           ;
; ---------------------------------------------------
RESET:
    LCALL   Delay200ms                  ;
; ---------------------------------------------
    SETB    RF_Busy                     ;
    SETB    CLK                         ;
    SETB    DATA                        ;
; ---------------------------------------------
; Transmitting Condition:
; ---------------------------------------------
Config_TX_State:
    MOV         DPTR    ,#Config_Tx_Table       ;
    MOV         R2      ,#17                    ;
    LCALL   Config_Send_Data                ;
    MOV   A   ,#Read_Config             * In order to test if the read in data is correct,
                                          therefore it could be abbreviated.
    MOV         R2      ,#16                    ;
    LCALL   Read_Config_Send                ;
; ---------------------------------------------
```

```
Send_DATA_Loop:
      LCALL    Delay20us                          ; Add delay 20us is enough.
      JB       DATA    ,$                         ;
      MOV           DPTR    ,#Send_Data                ;
      MOV           R2      ,#5                        ;
      LCALL    Config_Send_Data                   ;
      LCALL    Delay20us                          ; abbreviated
      MOV           A       ,#Read_Send                ;
      MOV           R2      ,#4                        ;
      LCALL    Read_Config_Send                   ;
      AJMP     Send_DATA_Loop                     ;
; ************************************************************
; ************************************************************
; Receiving Condition
; ------------------------------------------------
      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 Condition
; ------------------------------------------------
      MOV           DPTR    ,#Config_Idle_Table        ;
      MOV           R2      ,#17                       ;
      LCALL    Config_Send_Data                   ;
      AJMP     Config_TX_State               ;
      AJMP     Config_RX_State               ; OR
; ------------------------------------------------
; Off Condition
; ------------------------------------------------
      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                         ; Turn in and Output Condition
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                            ; Turn in and Input Condition.
    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                            ; Turn in and Input Condition.
```

```
    SETB    RF_BUSY                     ; Turn in and Input Condition
    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 may be used in disposes TX/RX on transmitting data.
; ------------------------------------------------------
Config_Send_Data:
    JNB     DATA    ,$                  ;
    CLR     RF_Busy                     ; Turn in and output Condition
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                         ; Turn in and Input Condition
        SETB    DATA                            ; Turn in and Input Condition
        RET                                     ;
; ---------------------------------------------------
; The Result of Disposition：
; Speed   ：4.8K
; freq.   ：433.9
; Transmit BYTE No.：4
; Receive BYTE No.：4
; Lead code   ：4 (fixed)
; 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
```