Wireless Sensor Transmitter RF5151

1. Features

♦ GFSK Transmitter Module
♦ ISM frequency bands
♦ 81K bps data rate
♦ 10dBm output power
♦ Baud rate configurable
♦ 256 bytes data buffer
♦ Standby current ≤2.5µA
♦ Supply voltage 2.1-3.6V

2. Application

♦ Temperature Measurement
♦ Humidity Measurement
♦ Wireless data logger
♦ Wireless sensor network

3. Description

RF5151 is a type of low-cost sub-1GHz transmitter module designed for operations in the licensed-free ISM (Industrial Scientific Medical) and LPRD bands. GFSK modulation/demodulation, multi-channel operation, high bandwidth efficiency and anti-blocking performance make RF5151 modules easy to realize the robust and reliable wireless link.

The module integrates 12bit high resolution ADC which can be used to connect different types of analog or digital sensor and RF5151 module and no external MCU or other components needed. For the simplest application users can solder sensor on the pins of RF5151 module to build a wireless sensor transmitting system easily. RF5151 module can collect data from sensors and send it to transmitting system easily. RF5151 can collect data from sensors and send it to transceiver module RF5151 at configurable intervals, which reduce the BOM cost and reduces development time for new projects.

The module can be configured to work in different channels with 200KHz channel spacing. Through APPCON Tool users also can change other parameters such as serial data rate, center frequency, output power, transmit interval, sensor types, etc. RF5151 integrates 256 bytes buffer. When the buffer is empty, users can transfer 256 bytes data per time and even limitless data transfer can be achieved as long as RF data rate (RF module to RF module) is configured to be faster than serial date rate (MCU to RF module). RF5151 operates at 2.1-3.6V with extra low standby current which makes it suitable for battery power-up applications.

4. PINOUT OF RF5151

PIN	Name	Function	Data Mode	Sensor Mode
1	GND	Ground	Ground(0V)	Ground(0V)
2	VCC	Power	Power supply	Power supply
3	VCC	Power	Connected to Pin2 internally	Connected to Pin2 internally
4	RXD/AD1	In/Output	UART input: Pull-up resistor 22K	1,GPIO;pull-up resistor 22K 2,AD1 input; no pull-up needed
5	TXD/AD2	In/Output	Enable pin;pull-up resistor 22K High→sleep;Low→work	1,GPIO;pull-up resistor 22K 2,AD2 input; no pull-up needed
6	AUX	Output	Data output indication	Sensor power supply control

Table1: RF5151 PIN Difinition

5. ELECTRICAL SPECIFICATIONS

Symbol	Parameter(condition)	Min.	Typ.	Max.	Units
VCC	Supply Voltage	2.1	3	3.6	V
Temp	Operating temperature range	-20	25	70	°C
RH	Operating relative humidity	10		90	%
Freq	Frequency range	425		450	MHz

Mod	Modulation type		GFSK		
I$_{DD\_T}$	Current in transmit mode @10dBm/3V		14		mA
I$_{DD\_S}$	Current in sleep mode @10dBm/3V		1.5	2.5	uA
Pout	Output power @3.0V			10	dBm
DR$_{GFSK}$	GFSK data rate	3.125		81.25	Kbps
DR$_{IN}$	UART data rate	1.2		115.2	Kbps
ZANT	Antenna Impedance		50		Ohm

Table 2: RF5151 Electrical Specifications

6. MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Units
VCC	Supply Voltage	-0.3	3.7	V
VI	Input Voltage	-0.3	VCC+0.3	V
Vo	Output Voltage	-0.3	VCC+0.3	V
TST	Storage Temperature	-55	125	°C

Table 3: RF5151 Maximum Ratings

7. Working Modes

RF5151 modules can work in two modes: Data transmission mode and Sensor data mode. In data transmission mode RF5151 module acts as transparent data transmitter and it receives data from MCU or other hosts and then sends them to other modules. Under sensor data mode, RF5151 can sample signal from two input pins, process and then send to other modules.
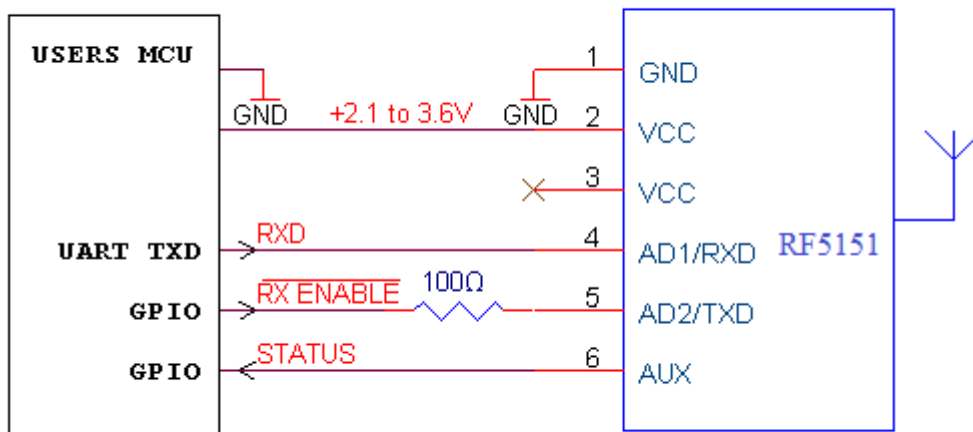
a. Data Transmission Mode

In this mode RF5151 is common data transmitter module. It doesn't contain ID will not transmit data automatically at the preset interval. The 5th pin is used as Enable Pin. When it is in high level, the module will enter into sleep mode and the current is about 1.5μA. When the 5th PIN is connected to low the module will work in receiving mode. The 6th pin will be set to low when RF5151 receives the first byte of data and it will be set to high after transmission is finished so it can be used to monitor transmit status. The module will detect the status of the 5th PIN after transmission is finished so users can set the 5th pin to high after MCU sends out all the data.

If the data package is less than 60 bytes RF5151 module will begin to transmit after the whole package is

received. If the data package size is larger than 60 bytes it will split the package into smaller package size (60 bytes) and send them out serially. RF5151 integrates 256 bytes buffer. If the buffer is empty users can send 256 bytes of data one time. When the RF GFSK data rate is faster than serial data rate the size of data package can be limitless.

Figure 1: RF5151 in Data Transmission Mode

b.   SENSOR DATA MODE

In this mode RF5151 module contains ID and it will transmit at the preset interval. The ID includes two parts: Group ID and Slave ID. The transceiver RF4432S will be used as receiver. When the group ID of RF4432S is the same as RF5151 or its ID is 0x00, it can receive the data sent from RF5151 and will append RSSI information to the data package and then transfer the processed data to MCU. In order to avoid data bump, RF5151 transmits periodically in the cycle of ±10% interval.

For example: If the Tx interval is set to 1s, the RF5151 will transmit between 0.9S and 1.1S.

Because of short data package, the feature can let many RF5151 work with the same settings with little interference and RF4432S module can read the data correctly.

The transmitted data format of RF5151: ID (Group ID+ Slave ID) + Data + Bat
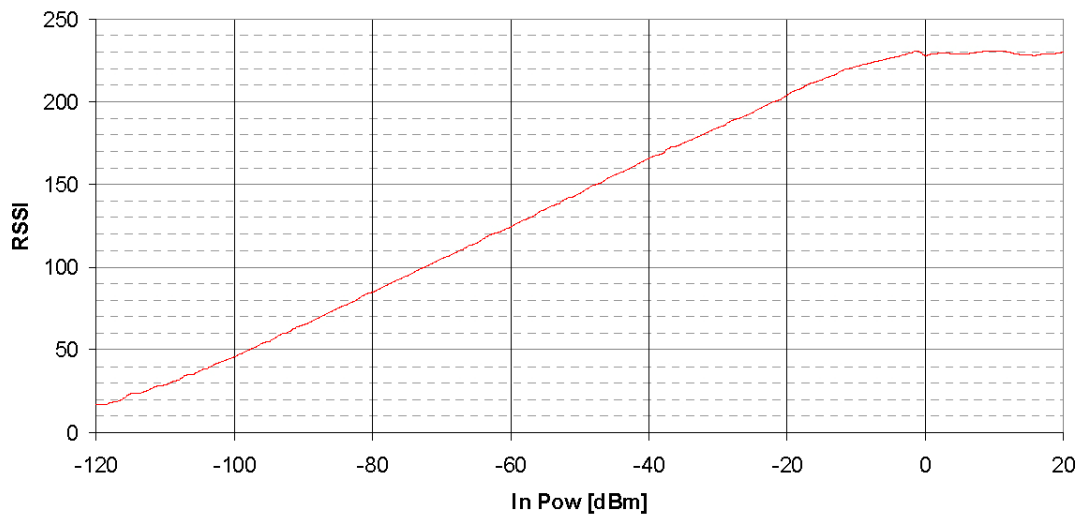The output data format of RF4432S: ID (Group ID+ Slave ID) + Data + Bat + RSSI

Data Format	Group ID	Slave ID	Data	Bat	RSSI
Length(byte)	1	1	2~4	1	1

Table 4: RF5151 Data Format

The data package varies between 2 and 4 bytes and its length will depend on the selection of sensor type from the configuration tool. Bat is one byte of battery information. The calculation function is: Battery voltage= (Bat + 200)/100.

**Figure 2: RSSI vs Input Power**

The relationship of the field strength of received signal (RSSI) and input power is showed as the picture above. The higher value of RSSI means more reliable wireless link. If the RSSI 〈0x40 at 50Kbps RF data rate or RSSI 〈0x30 at 6.25Kbps RF data rate, it means the field strength is too weak and the probability of package loss will increase.

RF5151 integrates a 12bit ADC. When connecting to analog sensor, the output data is 2 bytes with ranges from 0x0000~0xFFFF. For digital sensors, RF5151 will read out data without processing, so users can refer to the datasheets of corresponding sensors and make calculation.

1) Analog Sensor Mode

In this mode, RF5151 module will use integrated 12bit ADC. The 5th PIN will be used as analog input and Vref will be connected to VCC PIN. The module will sample the analog signal at intervals

When one Tx interval finishes, the module firstly set the 6th AUX from High to Low. After 1ms the internal ADC will sample 6 times and then set AUX to High. After removing the highest and lowest values, the module will output the average of 4 sampling values. User can connect an analog sensor such as PT1000 and connect a high resolution resistor between the 5th PIN and 6th PIN. The value of resistor is usually equal to the resistance of analog sensor. The Max. drive-in of the 6th PIN AUX is 20mA. Being connecting different resistors the voltage drop on AUX has slight difference so users can make compensation in calculating to get a higher resolution. The reference connection diagram in analog sensor mode is showed as below.
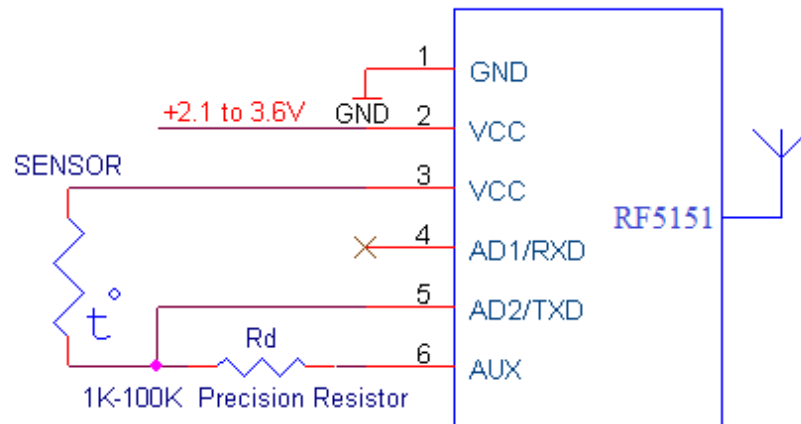
Figure 3: RF5151 in Analogue Sensor Mode

2) DS18B20 Sensor

DS18B20 is a type of high resolution digital temperature sensor from Maxim. It works at 3.0~5.0V and the measurement range is -55~125℃ with ±0.5℃ accuracy. It can be connected to RF5151 module without extra components. RF5151 supports 9 bit low resolution and 12 bit high resolution measurement. DS18B20 consumes about 1mA current in working mode. The measurement time for low resolution mode is 93.75ms and 750ms for high resolution mode. Application which is sensitive to power consumption might choose low resolution mode to have a better battery life. RF5151 will send temperature data: Byte0 (LSB) and Byte1 (MSB) at intervals.
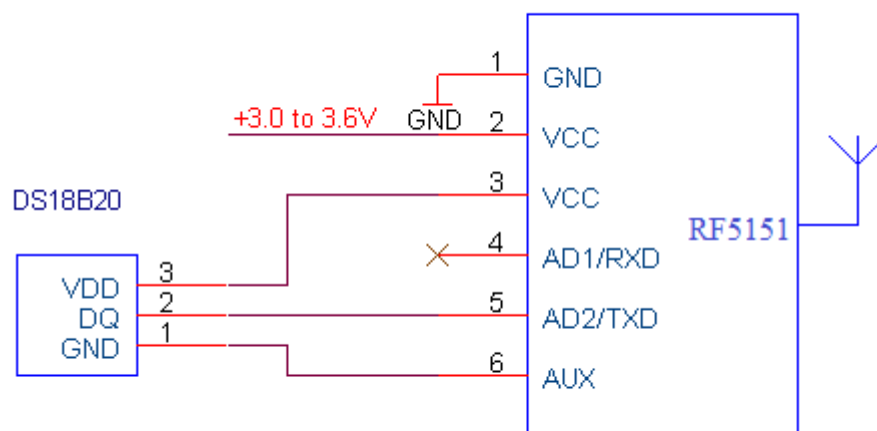

Figure 4: RF5151 in DS18B20 Sensor Mode

3) SHT2x & SHT1x Mode

SHT1x and SHT2x sensor from SENSIRION integrate temperature and humidity function. They can be connected to RF5151 directly. According to the specification of sensors a filter capacitor is needed to be connected between VCC and GND. For SHT1x serials of sensors, it also supports two measurement modes: low resolution and high resolution.

When the distance between digital sensor and RF5151 is less than 30cm, no pull-up resistor is needed. However **when the distance exceeds 30cm, the distributed capacitance must be taken into consideration. The pull-up resistors (Usually 4.7KΩ) are needed to add the actual values of resistors will be selected according to the specifications of sensor products. But the Max distance should not exceed 2 meters.** The 6th pin AUX is connected to the GND of digital sensor so it will be kept in low in use. Users also can choose connect the GND of digital sensors to the GND of RF5151 module and keep AUX suspended.
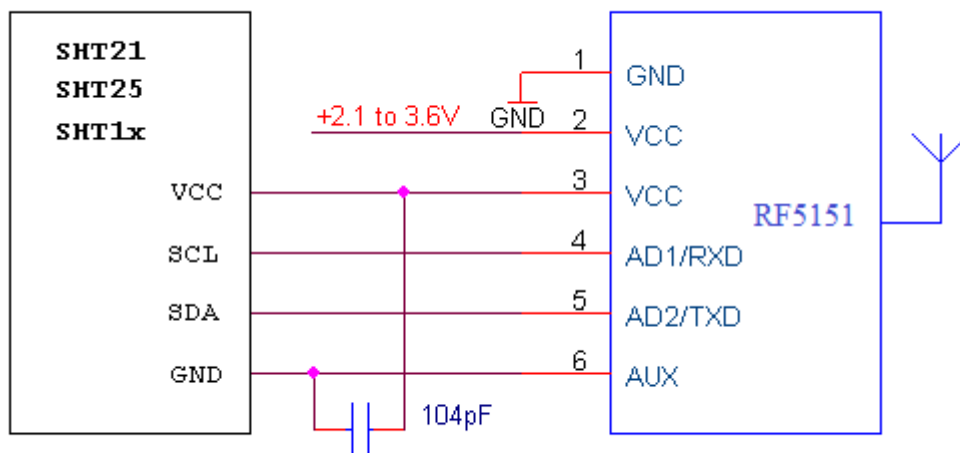
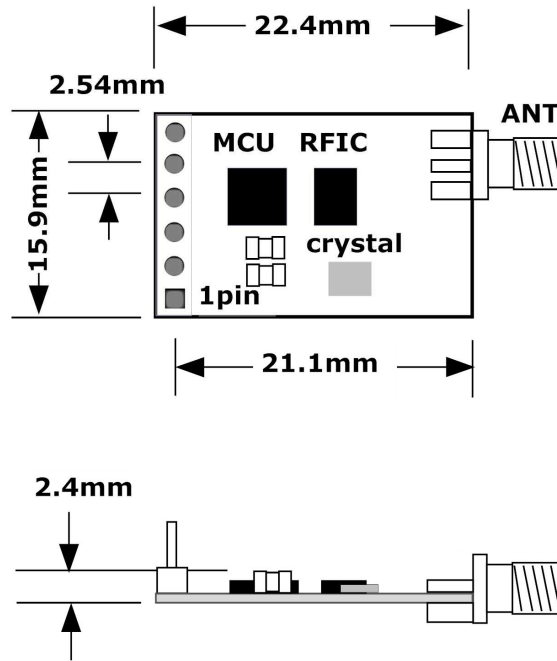**Figure 5: RF5151 in SHTxx Sensor Mode**

8. MECHANICAL DATA

Figure 6: Mechanical Dimension

Wireless Sensor receiver RF4432S

1. Features

♦ GFSK receiver module
♦ ISM frequency band
♦ 81K bps data rate
♦ Multiple channels
♦ -120dBm sensitivity
♦ Baud rate configurable
♦ 256 bytes data buffer
♦ Standby current < 3uA
♦ Supply voltage 3.4~5.5V

2. Application

♦ Humidity Measurement
♦ Wireless data logger
♦ Wireless sensor network
♦ Home automation
♦ Temperature Measurement
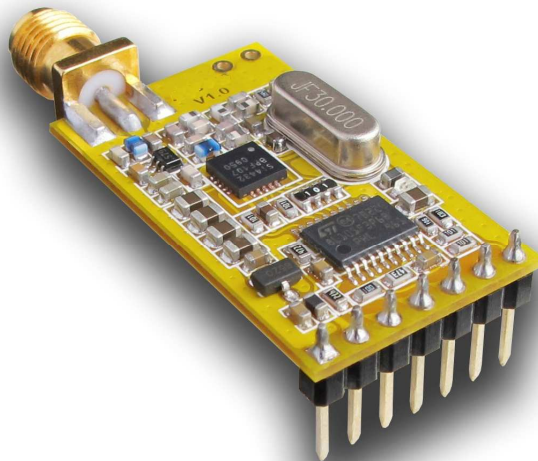
3. Description

RF4432S is a low-cost sub-1 GHz transceiver module designed for operations in the unlicensed ISM (Industrial Scientific Medical) and LPRD bands. GFSK (Frequency Shift Keying) modulation /demodulation, multi-channel operation, high bandwidth efficiency and anti-jamming performance make RF4432S modules easy to realize the robust and reliable wireless link.

The receiver module RF4432S is based on si4432 RFIC from Silicon labs and uses the same hardware platform as data transmission module RF4432. It can only be used as receiver in wireless sensor application so it is incompatible with RF4432. RF4432S is used together with RF5151 to build wireless sensor applications. It collects sensor data from sensor transmitter modules RF5151 and transfers data at fixed format which is determined by the sensor working mode configured through 'Wireless sensor module setting software'.

4. PINOUT OF RF4432S

PIN	Name	Function	Description
1	GND	Ground	Ground(0V)
2	VCC	Power	Power supply
3	EN	Chip Enable	Enable Pin($\leqq$0.5): work mode; Enable Pin($\geqq$2.0V): sleep mode
4	RXD	Input	UART input. TTL level
5	TXD	Output	UART output. TTL level
6	AUX	Output	Data In/Out Indication
7	SET	--	Testing pin, must be suspended
8	NC	--	No Connection
9	NC	--	No Connection

Table 5: RF4432S Pin Functions

5. ELECTRICAL SPECIFICATIONS

Symbol	Parameter(condition)	Min.	Typ.	Max.	Units
VCC	Supply Voltage	3.4		5.5	V
Temp	Operating temperature range	-20	25	70	°C
RH	Operating relative humidity	10		90	%
Freq	Frequency range	425		450	MHz
Mod	Modulation type		GFSK		
I_{DD_T}	Current in receive mode @433MHz		20		mA
I_{DD_S}	Current in sleep mode @433MHz		3		uA
Sen.	Receive sensitivity　@433MHz, 3.125Kbps		-120		dBm
DR_{GFSK}	GFSK data rate	3.125		81.25	Kbps
DR_{IN}	UART data rate	1.2		115.2	Kbps
T_E	Evoking time from Sleep to Normal			20	uS
ZANT	Antenna Impedance		50		Ohm

Table 6: RF4432S Electrical Specifications

6. MAXIMUM RATING

Symbol	Parameter	Min	Max	Units
VCC	Supply Voltage	-0.3	5.5	V
VI	Input Voltage	-0.3	VCC+0.3	V
VO	Output Voltage	-0.3	VCC+0.3	V
TST	Storage temperature	-55	125	℃

Table 7: RF4432S Maximum Ratings

7. MECHANICAL DATA
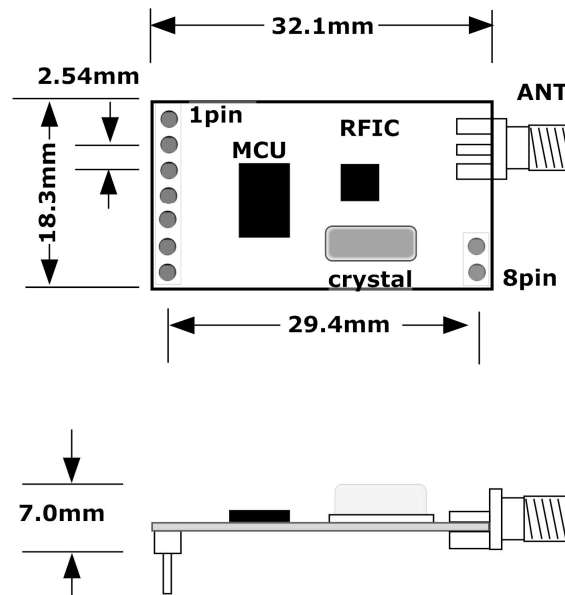
Figure 7: Mechanical Dimension

8. Default Setting

Parameter	Option	Default	Unit
Serial data rate	1.2~115.2	9.6	Kbps
Parity|Check	No check, Even parity, Odd parity	No check	
Frequency	425~450MHz	433.92	MHz
GFSK data rate	3.125~81.25	9.6	Kbps
Group ID	0~255	123	

Table 8: RF4432S Default Settings

9. Parameter Configuration

Users can configure the parameters (frequency, data rate, group ID, etc.) of DRF modules with RS232 converter board or USB converter board configuration tool 'Wireless sensor module setting software'. Because RF4432S shares the same configuration tool with RF5151, some parameters such as slave ID, Tx interval, etc are not applicable for receiver module RF5151.

Firstly users need to insert module into converter board, connect converter board to PC and then open 'Wireless sensor module setting software'. In Windows XP system, the software can be run directly but in Windows Vista/7 system users should run it as administrator. After that the status column of tool should display "Found Device". Users then can read/write the module. For more details, please check the operation

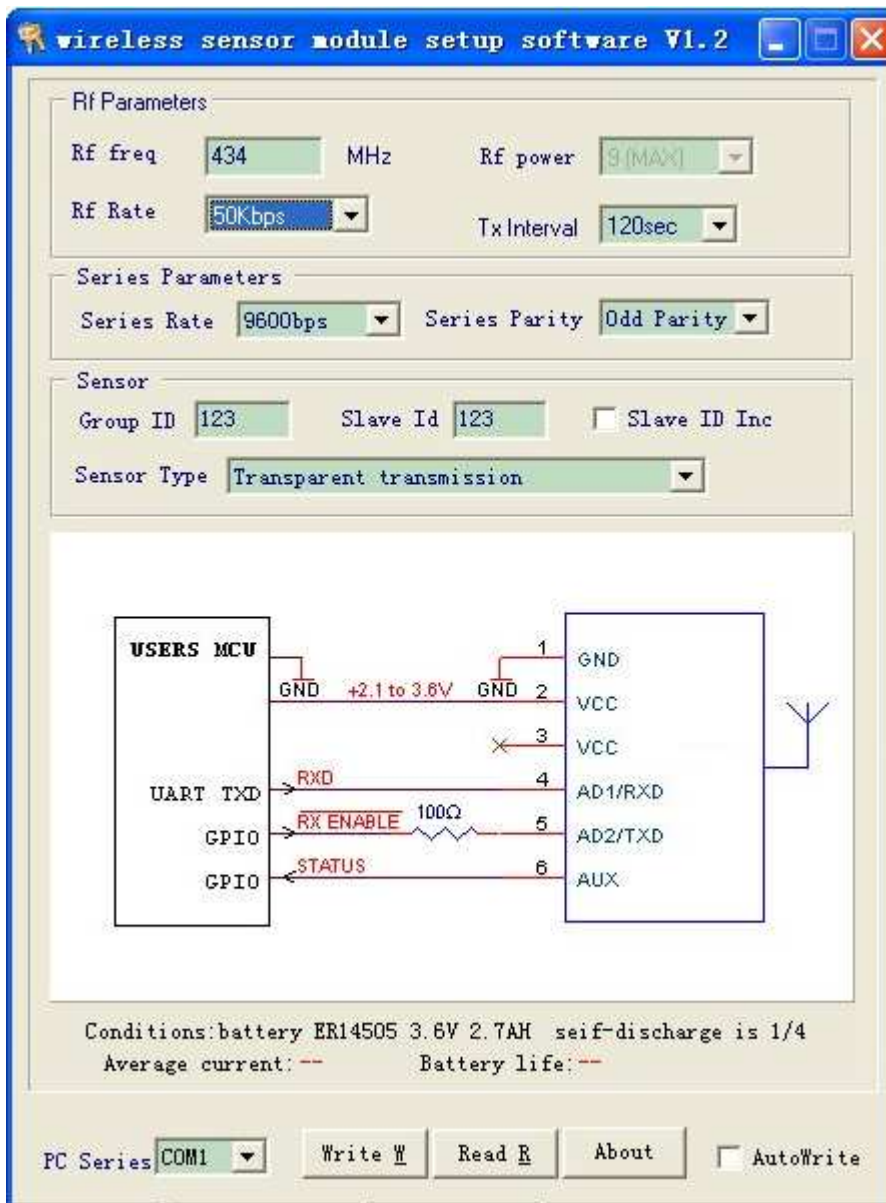manuals of converter boards on accessory page.

Figure 8 Wireless sensor module setting tool

The sleep mode of RF4432S is realized through software. In sleep mode, the levels of RF4432S module remain the same status before entering sleep mode so the module can quickly enter receive mode. The switching time from sleep mode to receive is about 20us. Please note that the RF4432S module only can enter into sleep mode after receive process is finished and the AUX pin is kept in low.
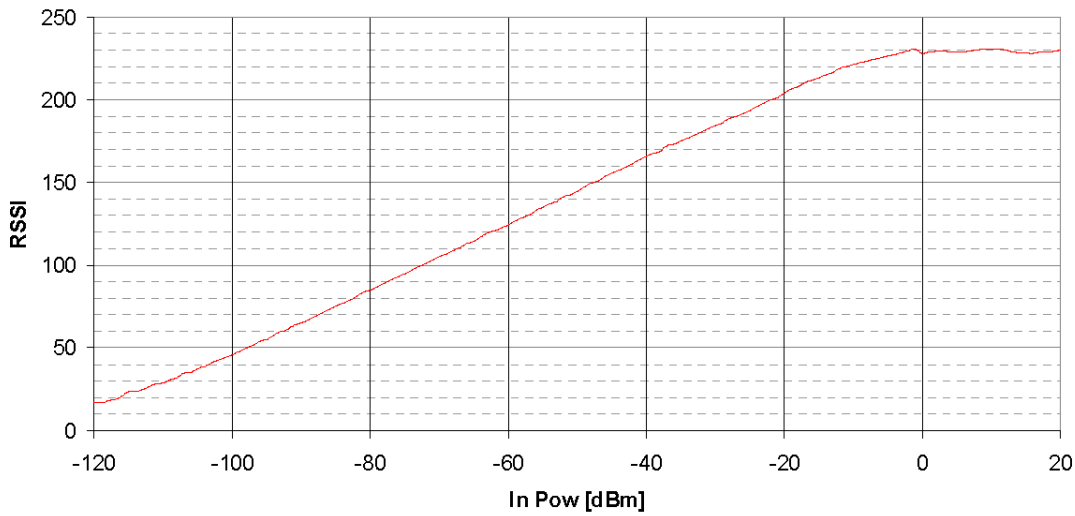
Figure 9: RSSI Value vs Input Power

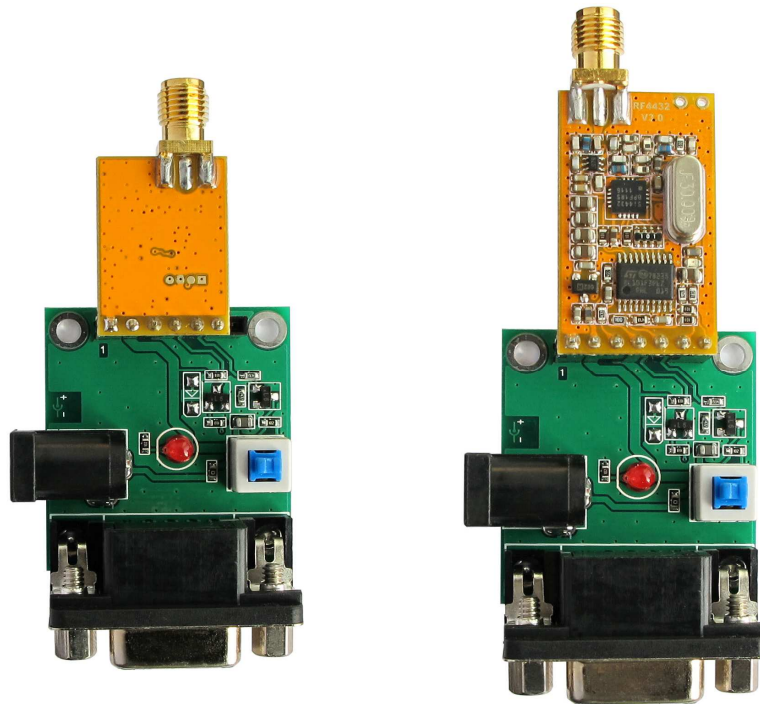When modules connect with RS232 board, please follow this as Figure 10 shown.

Figure 10: Connection with RS232 board

a. RF5151 is placed opposite side, while RF4432S is frontage. Shown in the pic.
b. RF5151 has 6 pins and RF4432S has 7 pins. The first pin "GND" should match the first pin of RS232 board, where has a silk print '1'.
c. The supply voltage range of RF5151 is 2.1V-3.6V and RF4432S's is 2.5V-5.5V when configuration. DO NOT over voltage the module, especially RF5151.

d. Some parameters is especially designed for RF5151, like 'SlaveID', 'Tx Interval'. The user could overlook these when setting RF4432S. On the contrary, the parameters of 'Series Rate', 'Series Parity' are designed for RF4432S. They are unavailable for RF5151.

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