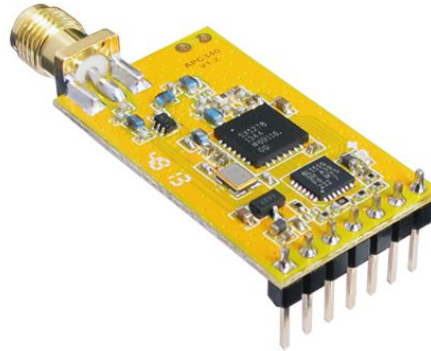


APC340

20dBm ISM RF Ultra Long Range Transceiver Module

V1.10



Features

- 3000m distance cover(0.81Kbps)
- LoRa spread spectrum modulation
- Frequency on 433MHz, 470MHz, 868MHz, 915MHz
- Multiple channels
- 20dBm Max.output power
- -132dBm sensitivity @0.81Kbps
- UART/TTL interface
- Supply voltage 5V , 3.3V optional

Application

- Wireless AMR Solution
- Battery powered equipment
- Ultra long range monitor and control
- Wireless remote telemetry
- Industrial data acquisition
- Wireless data communication
- Security and alarm system
- Wireless embedded system
- Home and building automation

DESCRIPTION

APC340 is a ultra long range transceiver module designed for operations in the unlicensed ISM (Industrial Scientific Medical) bands based on RFIC SX1276/8 from SEMTECH. It adopts LoRa spread spectrum modulation/demodulation to makes APC340 module easy to realize the robust and reliable ultra long range wireless link.

The module can be configured to work in different channels. With the high efficient looped interleaving EDAC (Error Detection and correction) coding, APC340 keeps in advance in error correction and coding efficiency over normal FEC (Forward Error Correction) coding. Because of its high reliability in correction, APC340 can filter error and fake information automatically and realize truly transparent wireless link, which makes it very suitable in the rigid communication environment.

APC340 integrates dual 256 bytes buffer. When the buffer is empty, users can transfer nearly 256

bytes data at a time and even limitless data transfer can be achieved as long as Air data rate is configured to be faster than UART data rate (MCU to RF module). APC340 provides standard UART/TTL interface. Users can choose six data rates and three parity checks which make APC340 possibly tailor-made for different applications. APC340 operates at 2.1~3.6V works in four different modes which are very suitable for battery powered-up applications.

PIN FUNCTIONS

PIN	Name	Function	Description
1	GND	Ground	Ground (0V)
2	VCC	Power	Power supply: 3.5~5.5V, 2.1~3.6V optional
3	SETA	Input	Parameter setting A; pull-up resistor: 47K Ohm
4	RXD	Input	UART input, TTL level; pull-up resistor:47K Ohm
5	TXD	Output	UART output, TTL level
6	AUX	Output	Data in/out indication
7	SETB	Input	Parameter setting B; pull-up resistor: 10M Ohm
8	NC	Ground	Ground or floating
9	NC	Ground	Ground or floating

Table 1: APC340 Pin functions

ELECTRICAL SPECIFICATIONS

Symbol	Parameter (condition)	Min.	Typ.	Max.	Units
VCC	Supply Voltage	3.5		5.5	V
Temp	Operating temperature range	-20	25	70	°C
RH	Operating relative humidity	10		90	%
Freq	Frequency range	433/470/868/915			MHz
Sf	Stepped-frequency		1		KHz
Mod	Modulation type	Lora spread spectrum			
Ir	Current in receive mode	13/(4.56Kbps) 15/(18.23Kbps)			mA
It	Current in transmit mode	100/(20dBm)			mA
Hs	Harmonic suppression	<-36/ (≤1GHz) <-30/ (>1GHz)			dBm
Is	Sleep mode at 3.3V		2.5	4.0	uA
Pout	Maximum output power			20	dBm
Sens	Receiving sensitivity at 0.81Kbps Receiving sensitivity at 18.23Kbps		-132 -118.5		dBm
DR _{LoRa}	Air data rate and Bandwidth occupation	0.81/(BW125K) 1.46/(BW125K) 2.6/(BW125K) 4.56/(BW125K)			Kbps

		9.11/(BW250K) 18.23/(BW500K)			
DR _{IN}	UART data rate	1.2		115.2	Kbps
Tw	Wake-up period	50		5000	ms
Tr ⁽¹⁾	Wake-up and Search preamble time	14.6/(0.81Kbps)			ms
		7.3/(1.46Kbps)			ms
		3.8/(2.6Kbps)			ms
		2.1/(4.56Kbps)			ms
		1.2/(9.11Kbps)			ms
		0.7/(18.23Kbps)			ms
Size		32.1 x 18.3 x 6.0			mm
Ai	Antenna Impedance		50		Ohm

Table 2: APC340 Electrical Specifications

ABSOLUTE 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: APC340 Maximum Ratings

WORK MECHANISM

1. CODING FORMAT FOR WIRELESS DATA PACKAGE

PREAMBLE	SYNC WORD	DATA+FEC+CRC
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Table 4: APC340 Coding Format

The preamble is used to make the clock of receiver synchronous with transmitter. In normal conditions, 8 symbols preamble is enough for use. When APC340 works in power-saving mode, the preamble also can be functioned to wake up the receiver so it must be long enough in order to obtain such a function. **Figure 4.**

E.g. if the receiver is configured to wake up at the interval of one second, it wakes up every second and searches the preamble for 2 symbols long time. In this case the transmitter must be configured to work in wake-up mode so the longer preamble plus synchronous words will be sent, which means the receiver can detect the preamble in wake-up period successfully.

This section shows the data frame structure in wireless transmission. The preamble, sync word, FEC/CRC are processed by APC340 modules automatically so users only need to send data to modules at the predefined UART data format and do not need to consider these factors.

2. WORKING MODE

APC340 can work in 4 different modes which can be realized by configuring the levels of SETA and SETB pins. **Figure 1.** The two pins have weak pull-up and can't be floated in normal operation in case the module will work unsteadily. Please note that the interface level of the host must be very close to the working voltage of APC340 and the tolerance between them can't exceed $\pm 0.3V$ or else there will be large sink or source current. For example, if the working voltage of APC340 is 3.3V, the power supply for the host should be in the range of 3.0~3.6V.

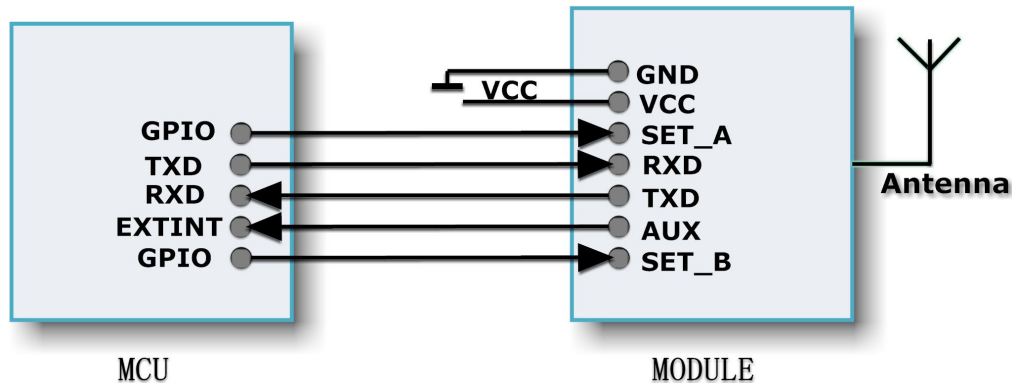


Figure 1: Connection Diagram

2.1 Normal mode: SETA=0 & SETB=0

The APC340 module sets AUX pin to low and monitor the level of SETB after the RXD pin of module receives the first byte from the host successfully. After the module receives the last byte of data package, it will wait for a short period (2~3 bytes). If there is no data coming in this period, the AUX pin will be set to high and the module will transmit the preamble, sync word and data after CRC and FEC. When all the data are sent out wirelessly, the module will enter corresponding mode according the levels of SETA and SETB. In this mode the preamble in transmitted data package is not long so the receiver module must work in Mode 1 or 2(continuous receive status).

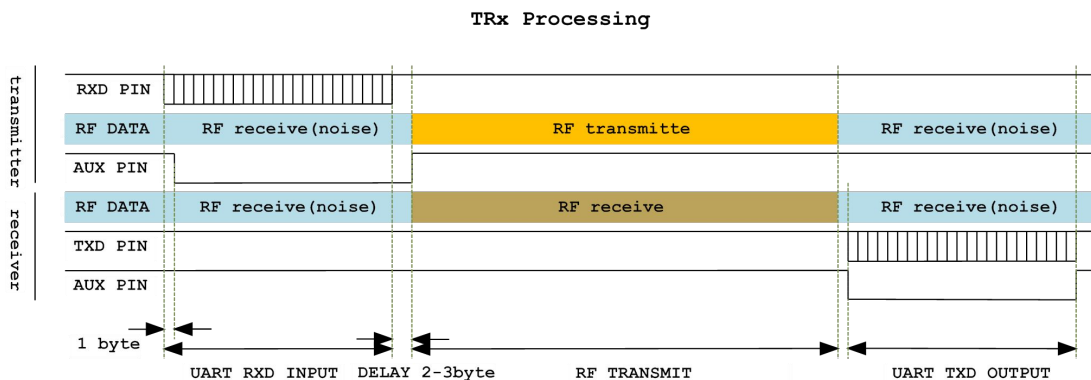


Figure 2: Timing Sequence in Normal mode

After transmit is finished, the module works in continuous receive status in this mode. When the module detects the data from present wireless channel and checks the data package is effective after decoding, it will set AUX pin to low and output data to UART interface. When data transfer

is finished, the AUX pin will be set to high again. **Figure 2.**

In the situation that needs the data packages to be sent continuously with delay as less as possible, users can take full use of AUX pin to reduce the waiting time of 2~3 bytes long. When APC340 detects the data from the host through RXD pin, it will set AUX pin to low. The module will set AUX pin to high again when it begins to transmit this package wirelessly. As soon as the host detects the AUX is high again, it can transfer the second package to the RXD pin of APC340 so the module doesn't need to wait for 2~3 bytes time and transmits the data in the buffer out wirelessly at once. **Figure 3.**

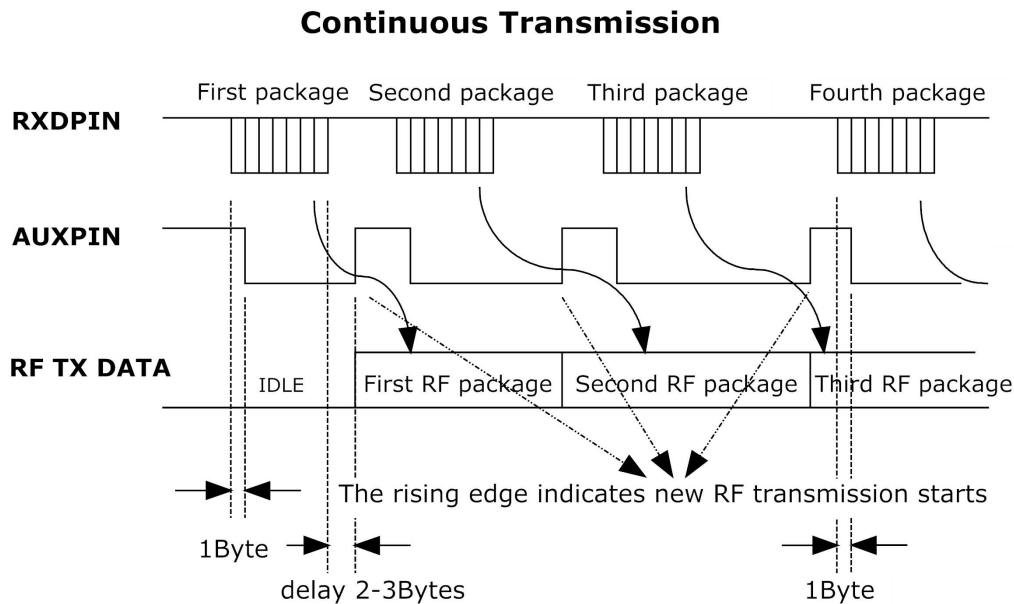


Figure 3: Continuous Transmission in Normal Mode

2.2 Wake-up mode: SETA=0 & SETB=1

The APC340 module sets AUX pin to low and monitor the level of SETB after the RXD pin of module receives the first byte from the host successfully. After the module receives the last byte of data package, it will wait for a short period (2~3 bytes). If there is no data coming in this period, the AUX pin will be set to high and transmit a long preamble time in 1 wake-up period plus sync word and data after CRC and FEC. When all the data are sent out wirelessly, the module will enter corresponding mode according the levels of SETA and SETB. In this mode the preamble in transmitted data package is long enough so the receiver module can work in Mode 1, 2 or 3.

After transmit is finished, the module works in continuous receive status in this mode. When the module detects the data from present wireless channel and checks the data package is effective after decoding, it will set AUX pin to low and output data to the host through UART interface. When data transfer is finished, the AUX pin will be set to high again. Different from Mode 1, the RSSI value is attached at the end of received data package automatically so the last byte of each data package is the RSSI value in this mode.

2.3 Power saving mode: SETA=1 & SETB=0

The serial port of module is disabled. The receiver will wake up at predefined interval and monitor if there is any preamble coming in present wireless channel. If the preamble is detected, the module will be in receive mode continuously and wait for the whole preamble and sync word. After receiving the data package and verifying it successfully, the module will set AUX pin to low in order to wake up the host (MCU or other external device). After 5 ms delay, the module will enable UART interface and output data to the host. When data transfer is finished, the UART interface will be disabled again and AUX will be set to high. If the levels of SETA and SETB are not changed, the module will enter into sleep mode again and wake up at the next wake-up period.

Figure 4.

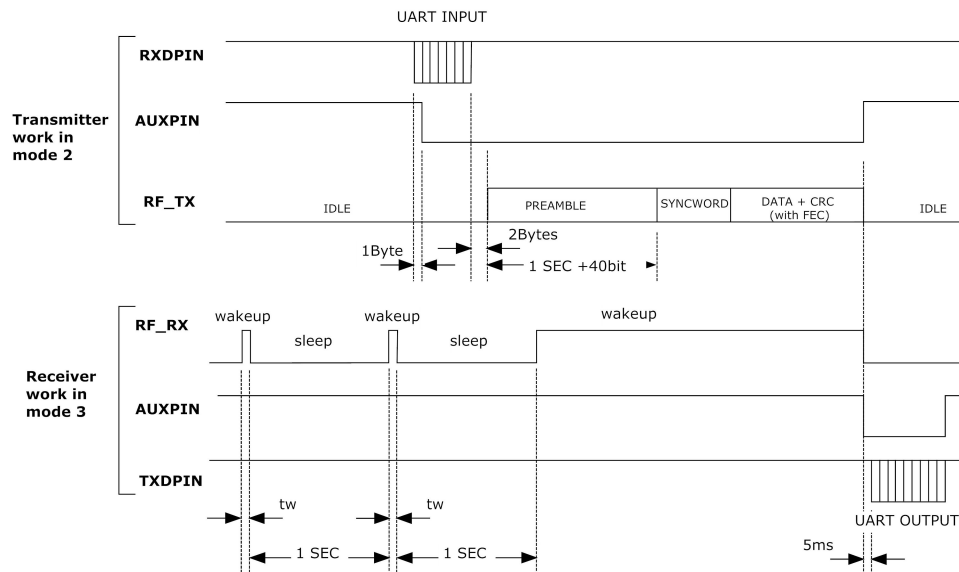


Figure 4: Transmit Module in Mode 2 and Receive Module in Mode 3

2.4 Sleep mode: SETA=1 & SETB=1

In this mode, the UART port is disabled and levels of port are kept in previous status. The RF circuit, MCU clock and related peripheral circuits are all shut down but the watchdog and low frequency clock still work so that the MCU can be waken up quickly in a very short time and the watchdog can be cleared. The current of module is about 2.5uA in this mode.

APPLICATION METHOD

APC340 module enters into sleep status by software control. In sleep status the levels of serial port are kept in the same status just before entering sleep mode. It only needs 20us to wake up the module from sleep status, which means data can be output to serial port after SETA pin is set to low for more than 20us. When the module is in transmit/receive process, it only can enter power saving or sleep mode after the transmitting or receiving process is finished.

When APC340 works in power saving or sleep mode, users can set pin SETA to low to wake up the module and output data to its RXD pin. If the module receives the first byte of data package, it will set AUX pin to low and check the level of pin SETB. If SETB is high, longer preamble is

transmitted; otherwise the normal preamble is transmitted. If users want to let the module enter into sleep mode after transmission is finished, users can set SETA to high after AUX pin is low because the module will check the level of SETA automatically when data is transmitted out successfully. If the SETA pin is high, the module then enters into sleep mode. Users can judge if the wireless data transmission is finished by checking the level of AUX.

APC340 has dual 256Bytes data buffer and 2 methods to transmit after UART receive data:

- 1) After RXD received data, wait for 2-3Bytes long time, if no data received then start to transmit data.(e.g. Serial data rate at 9600bps, 2-3Bytes will take 2-3ms)
- 2) After RXD received data length greater or equal to 99Bytes(Customized), APC340 can transmit data which in receive data buffer immediately, meanwhile, RXD can receive data from serial at the same time, if data buffer has data left, then APC340 will transmit them all.

As APC340 on transmit status, SETA level is low, SETB level will define the status to transmit longer preamble or not to wake up receiver.

RSSI [dBm] = -137 + RSSI_value

In receive status, SETA level is low, SETB level will define to output RSSI or not, SETB level is low, APC340 on normal receive status, SETB level is high then output data with 1Byte RSSI at the end of every packed data. The large data are divided into data packet to transmit, the receiver will be output every data packet with RSSI at end.

In battery powered system, slave APC340 (Installed in slave machine: water meter, gas meter) can be configured at Mode 3, master APC340(Installed in collector or Hand Held Unit) to transmit data at Mode 2, after finished data receive, slave APC340 wake-up MCU of slave machine by AUX and output data to it, when MCU finished data input then transfer slave APC340 to Mode 1 to answer master APC340, Master APC340 has optional transfer to Mode 1 or Mode 3 after received the answer, Master APC340 can achieve high speed data transmission with slave APC340 by transfer to Mode 1; if no data interact then transfer Slave APC340 to Mode 3 for next wake up, Finally, transfer Master APC340 to Mode 4 .

The APC340 periodically wake up to receive data for power saving. The power saving is determined by wake-up period, searching preamble time(t_w) and static power consumption at sleep mode. Wake-up period range from 50ms to 5s. Searching preamble time(t_w) depends on Air data rate, it is 2.1ms at 4.56Kbps.

Working life

$$= \frac{\text{Battery Capacity}}{(t_w/(\text{wake-up period}+t_w))*\text{Receiving current}+\text{Sleep current}}$$

E.g. If one APC240 equipped with one 3.6V/3.6A ER18505, the Receiving current is 13mA, Sleep current is 2.5uA, Air data rate at 4.56Kbps, wake-up period is 1s, then the battery can be

defined by the equation:

Battery life

$$= \frac{3600\text{mAH}}{(2.3\text{ms}/(1000\text{ms}+2.3\text{ms}))*13\text{mA}+0.0025\text{mA}} \approx 111346\text{Hours} \approx (12.71\text{years})$$

In Consideration of the factors to battery life, e.g. Battery discharge, Battery capacity difference under different current and temperature, MCU consumption and meter reading works every month, the battery and module can works for several years by only 1pc LI/SOCL₂ 3.6V/3.6A ER18505.

The LI/SOCL₂ has passivation character, The internal resistance will be gradually increasing under small current discharge status, so one low leakage current super capacitor(0.47F/5V) connected in parallel is recommended to obtain better instant power supply.

Power saving Mode is best for battery powered system, for instance: Wireless AMR on Water meter or Gas meter, Data acquisition system.

PARAMETER SETTING

Users can configure the parameters (frequency, data rate, output power, etc.) of RF modules by MCU or PC through converter boards.

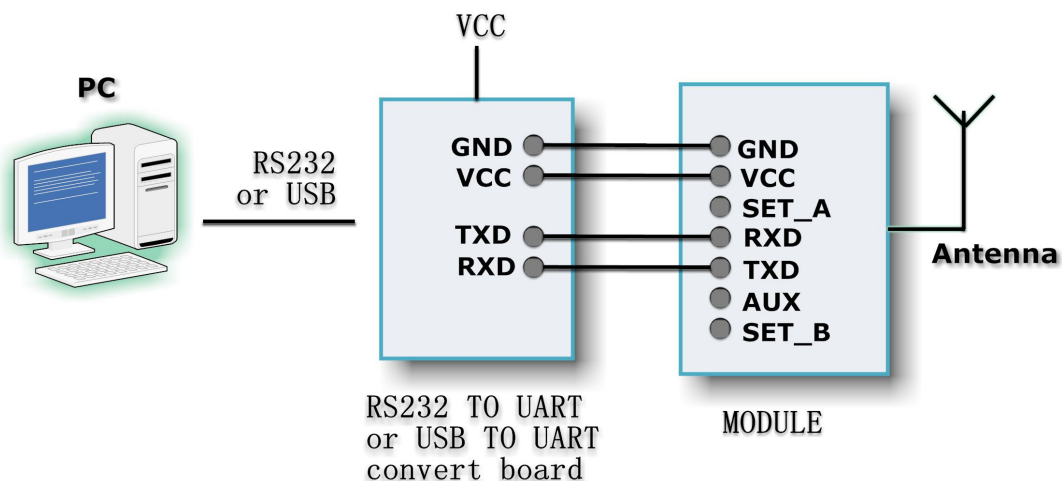


Figure 5: Setting Connection Diagram

BY PC: The interface of APC340 is UART/TTL. Users have to use an level converter board to connect the PC, **Figure 5**. APPCON provides two types converter boards (TTL-to-RS232 and TTL-to-USB) to do it. Then run the RF-Magic software(The software should be run as administrator). **Figure 6**. when the status bar of software shows “Found Device”. Users could read/write the parameters for module configuration.

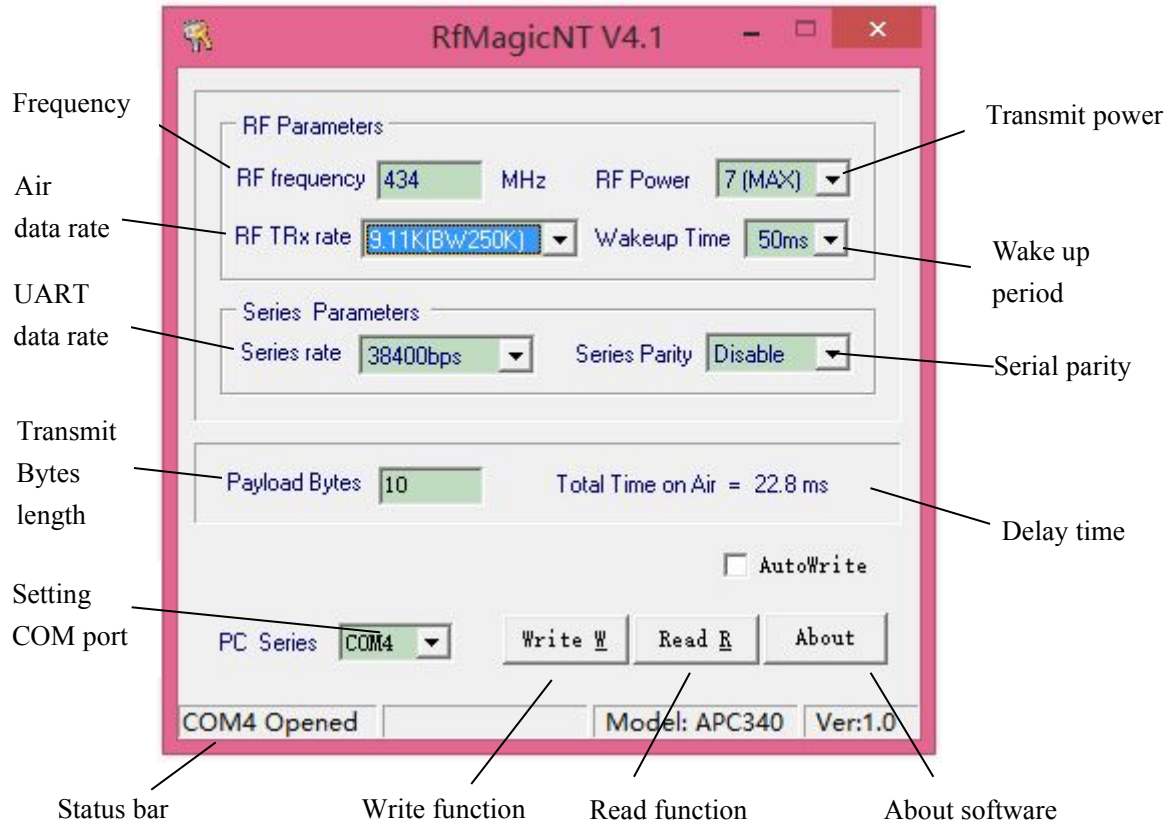


Figure 6: RF-Magic for APC340

BY MCU: The module can work normally after power-on for 500ms (T1). When configuring the APC340, users need to switch it to Mode 4 from other modes. After the module enters into sleep mode for 10ms or more (T2), it can be configured through MCU. When commands are output to RXD pin, the module will be waken up no matter what status of UART interface is and it will use 9600 bps (UART data rate) and no parity check as default data format to configure parameters. If the commands are set correctly, the module will give response and then it will be reset and initialized. After 500ms (T4), the module will work with the new parameters. Please note that if the commands are set incorrectly, the module will give no feedback but it will still be reset and initialized. Users can take this advantage to wake up modules in long-term sleep or in the cases which need to reset the modules.

The commands of APC340 are in HEX format. The configuring data rate is 9600 bps and no parity check. The command set includes two commands: Read command and Write command.

Read command: 0xFF,0x56,0xAE,0x35,0xA9,0x55,0xF0
Response: 0x24,Mt,Mv,Freq,DR_{LoRa},P_{OUT},DR_{IN},Parity,T_W

Write command: 0xFF,0x56,0xAE,0x35,0xA9,0x55,0x90,Freq,DR_{LoRa},P_{OUT},DR_{IN},Parity,T_W
Response: 0x24,Mt,Mv,Freq,DR_{FSK},P_{OUT},DR_{IN},Parity,T_W

Symbol	Unit	Bytes	Explanation
Mt	---	1	Module model: 14 in decimal code
Mv	---	1	Module version: 0x00~0xff
Freq	KHz	3	433920 KHz = 0x06, 0x9F, 0x00
DR _{LoRa}	Kbps	1	0.81, 1.46, 2.6, 4.56, 9.11, 18.23 equal to 0x00, 0x01, 0x02, 0x03, 0x04, 0x05
P _{OUT}	dBm	1	0~7 = 0x00 to 0x07. One increment to increases 3dBm. 0x07 refers to the max output power (20dBm)
DR _{IN}	Kbps	1	1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6, 115.2 equal to 0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07
Parity	---	1	0x00: no parity; 0x01: even parity; 0x02: odd parity
Tw	s	1	0.05, 0.1, 0.2, 0.4, 0.6, 1, 1.5, 2, 2.5, 3, 4, 5 equal to 0x00~0x0b

Table 6: APC340 Parameter Coding

E.g. If the user wants to set the module work at Freq (433.920MHz), DR_{LoRa} (4.56Kbps), P_{OUT} (20dBm), DR_{IN} (9.6kbps), Parity (no parity), Tw (1s wake-up period), the command can be written as below:

Write Command: 0xFF,0x56,0xAE,0x35,0xA9,0x55,0x90,0x06,0x9F,0x00,0x03,0x07,0x03,
0x00,0x05

Response: 0x24,0x0a,0x01,0x06,0x9F,0x00,0x03,0x07,0x03,0x00,0x05

Please note that the value of module version might be different when the software version of APC340 is updated.

MECHANICAL DATA

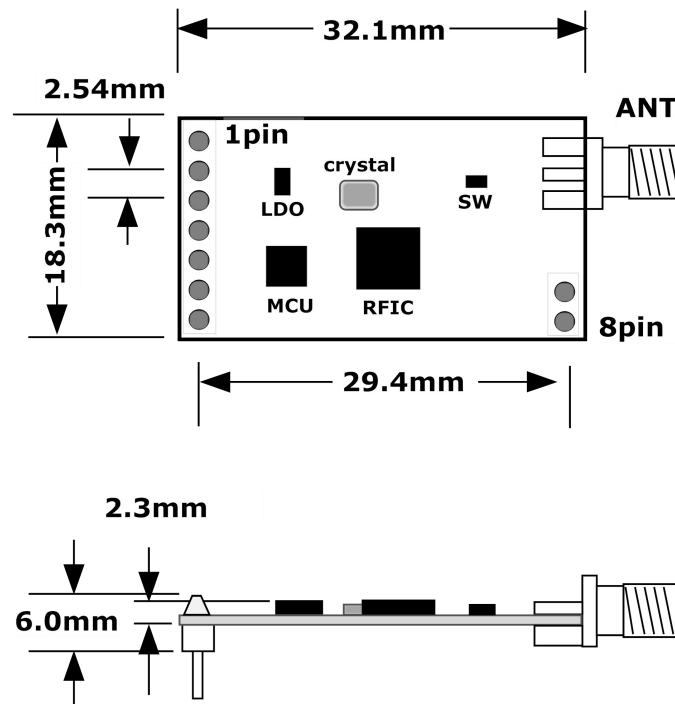


Figure 7: Mechanical Dimension

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