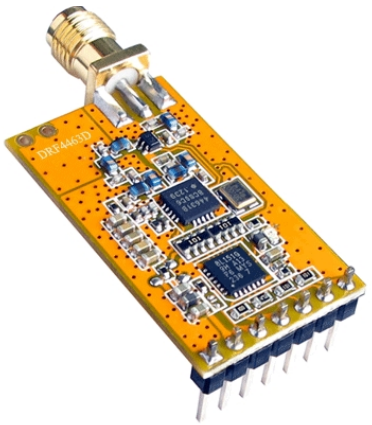
APC320

20dBm Medium Power ISM RF Transceiver Module V1.30



Features

- 2000m of communication distance (1000bps)
- GFSK Transceiver Module
- 410-440MHz or 470-510MHz or 868MHz, 915MHz ISM frequency band
- 40Kbps Air data rate
- Multiple channels
- 20dBm Max. output power
- -121dBm sensitivity @1k bps
- Supply voltage 2.1~3.6V

Application

- Home automation
- Security alarm
- Telemetry
- Automatic meter reading
- Contactless access
- Wireless data logger
- Remote motor control
- Wireless sensor network

DESCRIPTION

APC320 is a high efficient transceiver module designed for operations in the unlicensed ISM (Industrial Scientific Medical) and LPRD bands based on RFIC SI4463 from Silicon labs. GFSK modulation/demodulation, multi-channel operation, high bandwidth efficiency and anti-blocking performance make APC320 modules easy to realize the robust and reliable wireless link.

The module can be configured to work in different channels. It adopts the high efficient looped interleaving EDAC (Error Detection and correction) coding with coding gain up to 3dB which keeps in advance in error correction and coding efficiency over normal FEC (Forward Error Correction) coding. Because of its high reliability in correction, modules can filter error and fake information automatically and realize truly transparent wireless link, which makes APC320 very

suitable in the rigid communication environment.

APC320 integrates two 256 bytes buffer. When the buffer is empty, users can transfer nearly 256 bytes data per 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). APC320 provides standard UART/TTL interface. Users can choose seven data rates and three parity checks which make APC320 possibly tailor-made for different applications. APC320 operates at 2.1~3.6V with low power consumption. The module can work 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. 2.1~3.6V
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

Table 1: APC320 Pin functions

ELECTRICAL SPECIFICATIONS

Symbol	Parameter (condition)	Min.	Typ.	Max.	Units
VCC	Supply Voltage	2.1		3.6	V
Temp	Operating temperature range	-20	25	70	°C
RH	Operating relative humidity	10		90	%
Freq	Frequency range	410		440	MHz
Mod	Modulation type		GFSK		
Ir	Current in receive mode @10K bps @40K bps		15 16		mA
It	Current in transmit mode @ 20dBm		95		mA
Is	Sleep mode @3.3V		2.5	4.0	uA
Pout	Maximum output power			20	dBm
Sen	Receiving sensitivity @1K bps Receiving sensitivity @10K bps		-121 -111		dBm dBm
DR_{GFSK}	Air data rate	1		40	Kbps
DR_{IN}	UART data rate	1.2		115.2	Kbps

Tw	Wake-up period	50		5000	ms
Tr(1)	Wake-up & Search preamble time .@1K bps		20		ms
	@2K bps		13		ms
	@5K bps		6.1		ms
	@10K bps		3.9		ms
	@20K bps		2.8		ms
	@40K bps		1.8		ms
ZANT	Antenna Impedance		50		Ohm

Table 2: APC320 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	℃

Table 3: APC320 Maximum Ratings

WORK MECHANISM

1. CODING FORMAT FOR WIRELESS DATA PACKAGE

PREAMBLE	SYNC WORD	DATA+FEC+CRC

Table 4: APC320 Coding Format

The preamble is alternative “1010” codes which are used to make the clock of receiver synchronous with transmitter. In normal conditions, 40-bit preamble is enough for use. When APC320 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.

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 16-bit long time. In this case the transmitter must be configured to work in mode 2 so the longer preamble plus synchronous word 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 APC320 modules automatically so users only need to send data to modules at the predefined UART data format and don't need to consider these factors.

2. WORKING MODE

APC320 can work in 4 different modes which can be realized by configuring the levels of SETA and SETB pins. 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 APC320 and the tolerance between them can't exceed ±0.3V or else there will be large sink or source current. For example, if the working voltage of APC320 is 3.3V, the power supply for the host should be in the range of 3.0~3.6V.

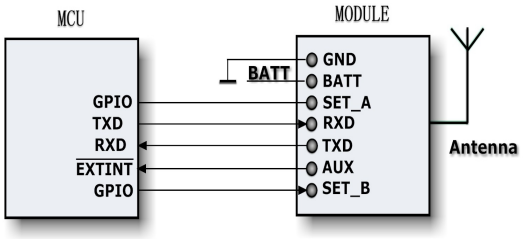


Figure 1: Connection Diagram

2.1 Normal mode: SETA=0 & SETB=0

The APC320 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 40-bit long 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 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.

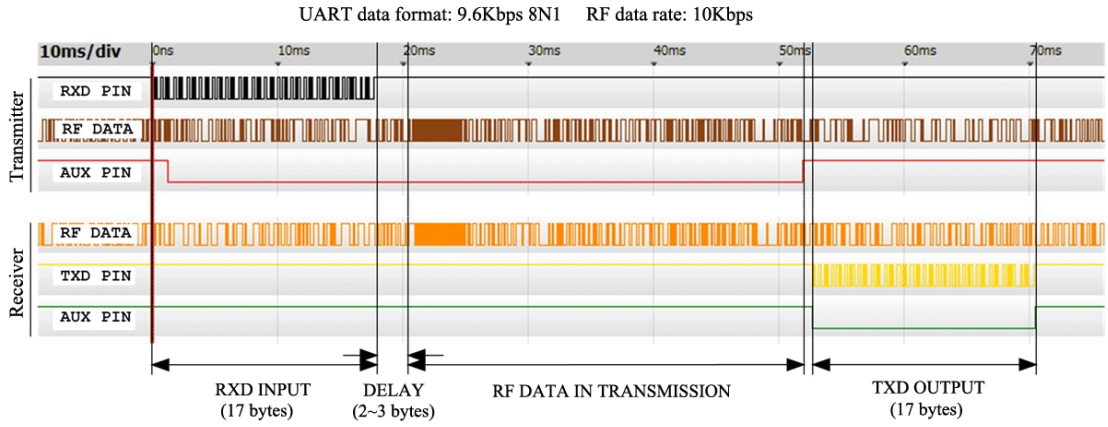


Figure 2: Timing Sequence in Data Transmission

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 APC320 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 APC320 so the module doesn't need to wait for 2~3 bytes time and transmits the data in the buffer out wirelessly at once.

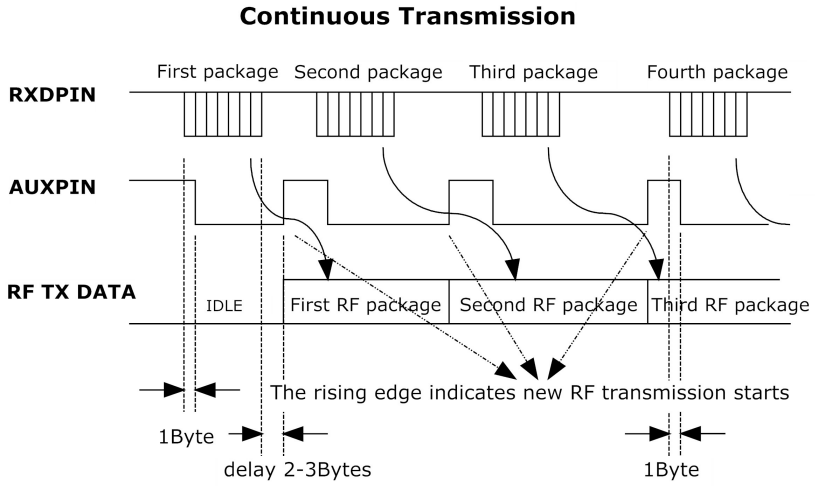


Figure 3: Continuous Transmission in Normal Mode

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

The APC320 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 (1 wake-up period plus extra 32 bits), 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.

RSSI (in dBm) = (RSSI_value /2) – 130

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.

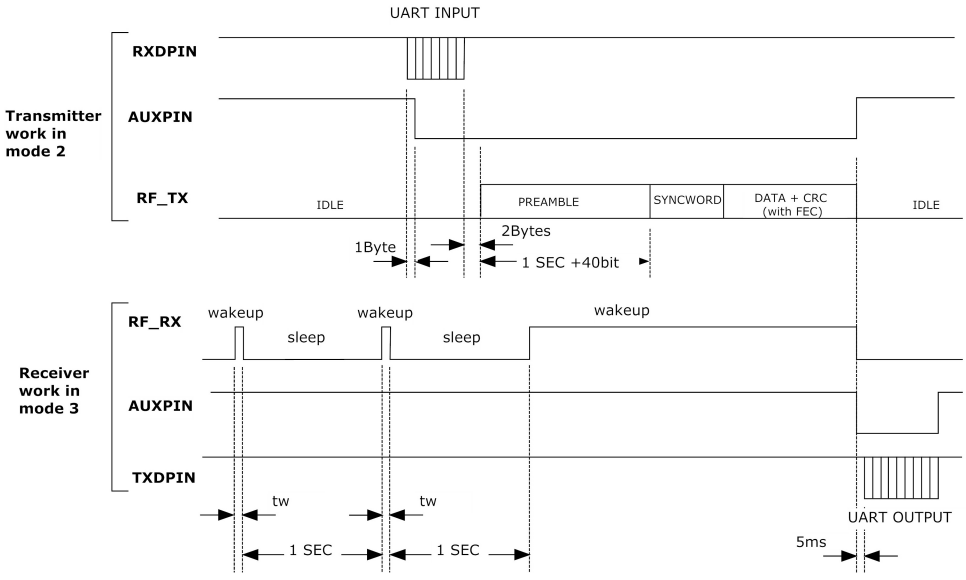


Figure 4: Transmit Module in Mode 2 and Receive Module in Mode 3

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 very short time and the

watchdog can be cleared. The current of module is about 2.5uA in this mode.

APC320 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 APC320 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.

PARAMETER SETTING

Users can configure the parameters (frequency, data rate, output power, etc.) of RF modules by MCU or PC through converter boards DAC01 or DAC02.

- **BY PC:** The interface of APC320 is UART/TTL. If connecting it to PC, users need to use a level converter board to transform the different levels. APPCONN Technologies provides converter boards DAC01 (TTL-to-RS232) and DAC02 (TTL-to-USB) for configuration.
  Firstly users need to insert module into converter board and connect converter board to PC by cable, then run APPCON tool(in Windows vista or above, the tool should be run as administrator). After that the status column of tool should display “Found Device”. Users then can read/write the module. At present the tool only recognizes the com port number below 10. For more details, please check the operation manuals.

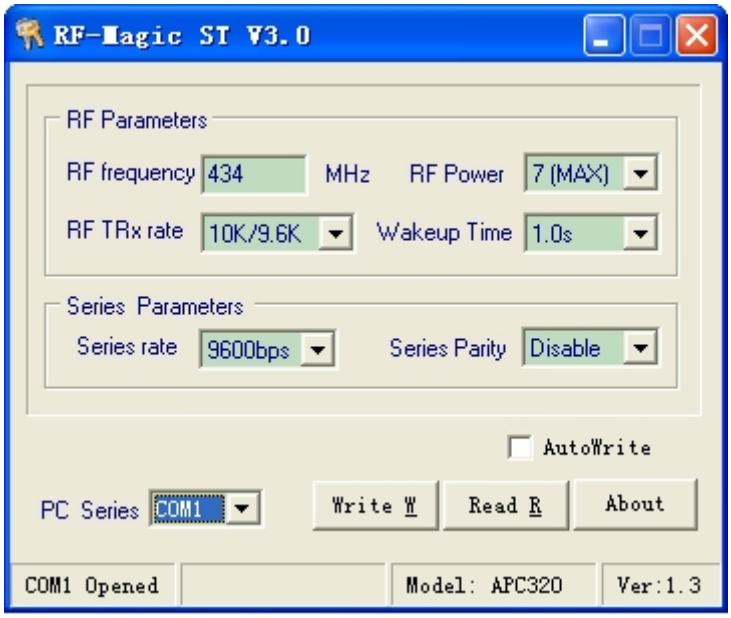


Figure 5: APPCON TOOL for APC320 Module

- **BY MCU**. The module can work normally after power-on for 500ms (T1). When configuring the APC320, 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 (series 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 APC320 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_{FSK},P_{OUT},DR_{IN},Parity,T_W

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

Para	Unit	Bytes	Explanation
Mt	---	1	module type: 0x0a
Mv	---	1	module version 0x00~0xff; unchangeable
Freq.	KHz	3	433920 KHz = 0x06, 0x9F, 0x00
DRFSK	K bps	1	1, 2, 5,10, 20, 40K bps equal to 0x00,0x01,0x02,0x03,0x04,0x05
POUT	dBm	1	0~7 = 0x00 to 0x07. One increment increases 3dBm. 0x07 refers to the max output power (20dBm).
DRIN	K bps	1	1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6, 115.2K bps refer 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 corresponding to 0x00~0x0b

Table 6: APC320 Parameter Coding

E.g. If the user wants to set the module work at Freq (433.92MHz), DRFSK (10K bps), POUT (20 dBm), DRIN (9.6k bps), 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 byte might be different when the software version of APC320 is updated.

MECHANICAL DATA

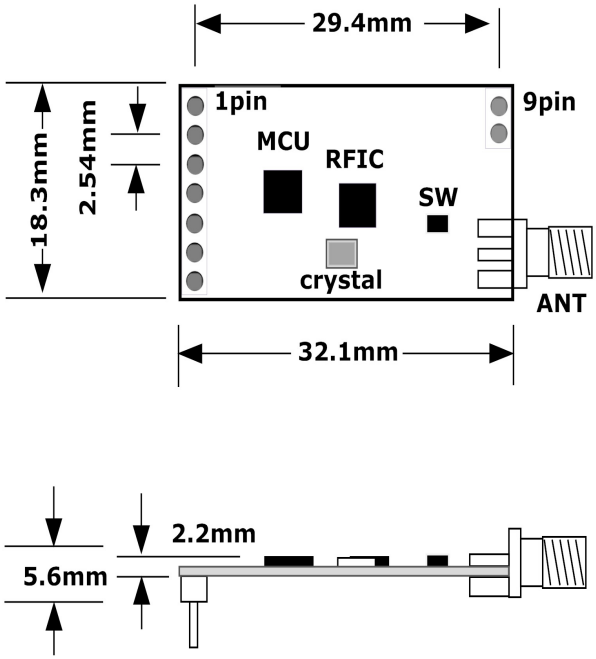


Figure 6: Mechanical Dimension

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