DRF1278DM
LORA Long Range SX1278 Data Radio Modem   V2.73

Features

- LoRa^{TM} Frequency Spectrum
- 433Mhz ISM frequency band
- -138 dBm receive sensitivity
- 20dBm Max. output power
- Serial port wake-up
- Wireless wake-up
- Star networking ability
- Supply voltage 3.4~5.5V

Application

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

DESCRIPTION

DRF1278DM is a type of long range low data rate data radio modem based on SX1278 from Semtech. DRF1278DM is a low-cost sub-1 GHz transceiver module designed for operations in the unlicensed ISM (Industrial Scientific Medical) and LPRD bands. Frequency spectrum modulation/demodulation, multi-channel operation, high bandwidth efficiency and anti-blocking performance make DRF1278DM modules easy to realize the robust and reliable wireless link.

The module can work in two different modes: Standard mode and Star network mode. In the standard mode DRF1278DM acts as transparent data radio modem which it communicates with the host at the preset data format without encoding / decoding needed. In start network mode, one module will be the configured to the central module and other modules are set to node modules. The communication between the central module and node module are bidirectional but the node modules can not talk with each other.

PIN FUNCTIONS

PIN	DIP-A	Function	Description
1	GND	Ground	Ground (0V)
2	VCC	Power	Power supply
3	EN	Input	Enable pin, Low effective
4	RXD	Input	RXD: UART input, TTL level
5	TXD	Output	TXD: UART output, TTL level
6	AUX	Output	Data indication pin for waking up module
7	SET	Input	Control pin, effective in central/node mode

Table 1: DRF1278DM Pin functions

Note:

1. For firmware version < V2.0, SET pin is reserved without special function. For firmware version >= V2.0, the logic level of SET pin is used to switch between normal speed communication (or express communication) and breath period communication in central/node mode. In sleep status, the SET pin should be connected to logic high or floated. If users don't need normal speed communication, the SET pin also can be connected to logic high or floated to save power.

2. If the module is connected to the microcontroller, it will send a string to microcontroller when it is powered on

       9600 N 8 1 DRF1278X   V2.7

The last alphanumeric characters V2.7 indicate the firmware is 2.7. If users connect a USB adapter DAC02 to computer and run a serial tool such as Advanced Serial Port Monitor, the module also sends a string to the tool as soon as it is inserted into the USB adapter.

3. In order to configure the parameters, the EN pin should be connected to logic low in any mode. In standard mode, the EN pin also should be connected to logic low to let modules work normally. If the EN is connected to logic high in this mode, the RFIC and MCU of the modules will be in deep sleep and only can be waken up by setting this pin to logic low. In central mode, the EN pin also needs to be logic low just like in standard mode. In node mode, the module will monitor the wireless signal at the interval of breath period and close the UART interface to save power when EN pin is set to logic high. If the module in node mode needs to send data to central module, users can set the EN to logic low and the node module will enable UART interface to receive data from microcontroller.

ELECTRICAL SPECIFICATIONS

Symbol	Parameter (condition)	Min.	Typ.	Max.	Units
VCC	Supply Voltage	3.4		5.5	V
Temp	Operating temperature range	-40	25	80	°C
RH	Operating relative humidity	10		90	%
Freq	Frequency range	420		450	MHz
Mod	Modulation type		FS		
IR	Receive current in standard mode		15.2		mA
	Transmit mode @ 20dBm		75		mA
	Sleep mode		3.9		uA
Pout	Maximum output power			20	dBm
Sen	Receiving sensitivity			-138	dBm
DRIN	UART data rate	1.2	9.6	57.6	Kbps
TR	Wireless wake-up time	2		10	s
ZANT	Antenna Impedance		50		Ohm

Table 2: DRF1278DM Electrical Specifications

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min.	Max.	Units
VCC	Supply Voltage	-0.3	5.5	V
VI	Input voltage	-0.3	3.3	V
VO	Output voltage	-0.3	3.3	V
TST	Storage temperature	-55	125	°C

Table 3: DRF1278DM Maximum Ratings

WORKING MODE

1. STANDARD MODE

Standard mode is also called transparent mode in which the module receives from or sends data to the host through serial port (UART) at preset data format and users don't need to care about the process of data inside the module. The AUX pin of DRF1278DM will give indication about the data IN/OUT of serial port 2ms in advance, which can be used to wake up the host. In this mode the EN pin should be set to logic low in case the module will enter into deep sleep.
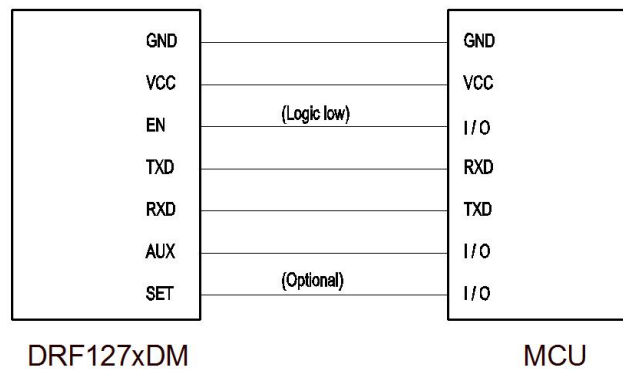
Figure 1: Pin Connections in Standard Mode

The AUX pin of DRF1276DM will give indication about the data IN/OUT at UART interface 2ms in advance so users can use this feature to inform the host about the data. It's optional in application.
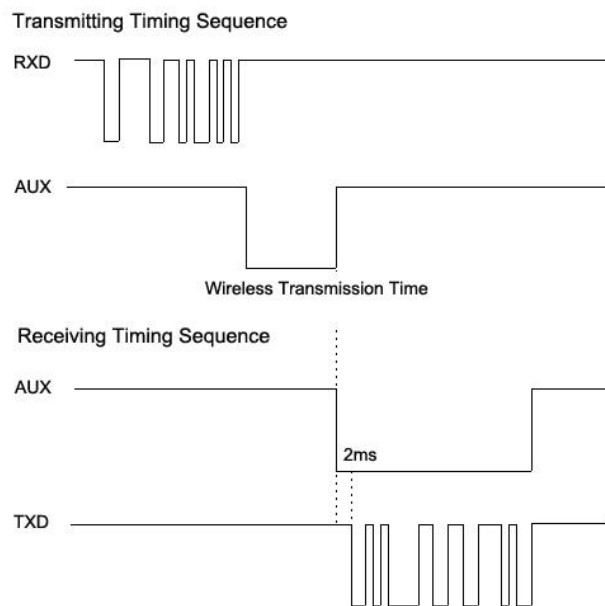

Figure 2: DRF1278DM Timing Sequence

2. STAR NETWORK MODE

In this mode one DRF1278DM module needs to set one module as the central module and other modules should be node modules for star networking. For central module, it works in the full performance so its power consumption is the same as in the standard mode and the EN pin of it should be connected to logic low. The logic level of SET pin for central module should be the same as the node module.

The SET pin is used in central/node mode to switch the communication ways (**express communication** and **breath period communication**) of node module. When the EN pin and the SET pin of the node module are set to logic high or floated, the node module will work in breath period communication way. It wakes up at the interval of breath period and spend the short time (wake timer parameter) to monitor the wireless signal so the central module will need to send a long preamble (>breath period) in order to assure the node module to receive the data successfully.
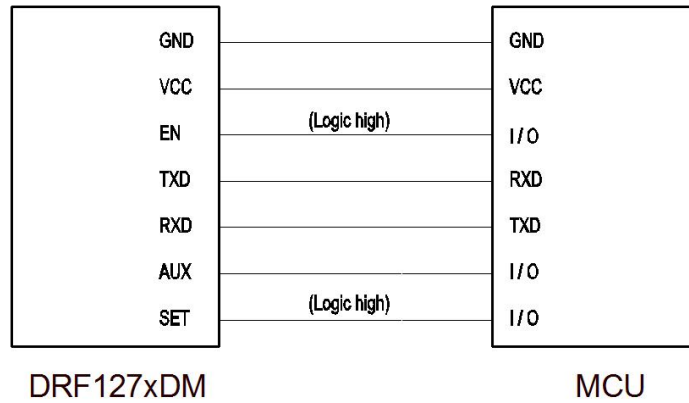

Figure 3: Node Module in Breath Period Communication

Wake timer parameter is introduced in version 2.7 in order to provide more flexibility in power consumption in breath period communication. The wake timer refers to the time length for the node module to detect the wireless signal when the node module wakes up in the breath period. The shorter time means less power consumption but it needs the central module to send data at higher RF data rate. In other words shorter wake timer means less power consumption but shorter distance because of higher RF data rate.
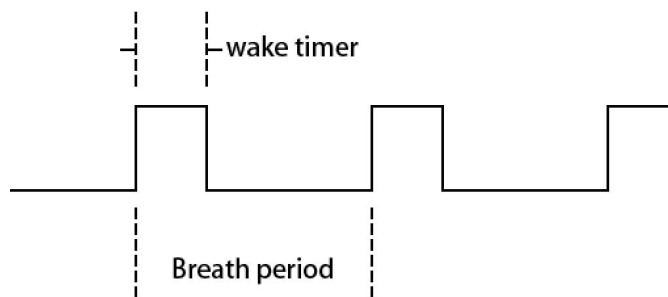

Figure 4: Wake Timer & Breath Period

In order to reduce the complexity of calculating the wake timer with RF data rate, the node module will choose the suitable RF_BW and RF_factor parameters automatically according to the wake timer parameter. Therefore the two parameters RF_BW and RF_factor don't function in this mode and users only need to set the wake timer parameter according to the actual applications.

Wake timer	RF data rate	Sensitivity
2ms	5.47Kbs	-123Dbm
4ms	3.125Kbs	-136Dbm
8ms	1.758Kbs	-129Dbm
16ms	0.977Kbs	-132Dbm
32ms	0.537Kbs	-135Dbm
64ms	0.293Kbs	-138Dbm

Table 4: Wake timer & RF data rate & Sensitivity

For node module, if the EN pin and the SET pin of it are set to logic low, it will work in full performance so the central module doesn't need to send long preamble. That's why it is called express communication. The disadvantage of this way is that the node module will consume much higher current. Not matter in which way, the logic level of the SET pins of central module and node module should be configured to the same in case the central module sends the wrong length of preamble, which results in the loss of data. Please note that changing the logic level of SET pin should be done after the EN pin is set to logic low.
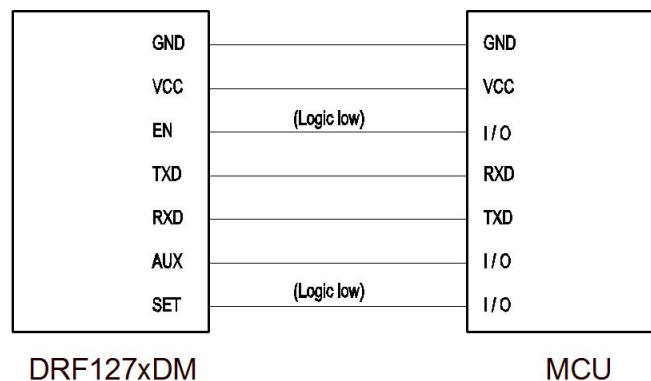

Figure 5: Node Module in Express Communication

In star network mode the first two bytes of data package which central module sends to node module should be the node ID of the targeted node module. When the node module detects the effective wireless signal from central module, it will check the first two bytes of the data package and compare it with its own. According to the value of node ID information in the data package, the node module will have different process ways. Assuming central module sends the data string: 0x00 0x01 0x02 0x03 0x04 0x05 (**the first two bytes must be the node ID** of the targeted module).

- If the node ID of the node module is 0x00 0x00, when it receives the data package, it will transfer the whole string [0x00 0x01 0x02 0x03 0x04 0x05] to the host (microcontroller or PC) and doesn't filter the ID information of the data package.

- If the node ID of the node module is 0x00 0x01, when it receives the data package, it compares the first two bytes of the data package and will know the data is for it. The module will filter the first two types of ID information and transfer the real data string [0x02 0x03 0x04 0x05] to the host.

● If the node ID of the node module is between 0x00 0x02 and 0xFF 0xFF, when it receives the data package, it will find the ID is different from its own and will filter the whole data package so the host will not get any data.

The ID value in the data package sent by the central module can be 0x00 0x00 ~ 0xFF 0xFF in which 0xFF 0xFF is a special ID value which can be functioned as broadcasting command. When all of the node modules detect the ID information in the data package as 0xFF 0xFF, the nodes will not make any comparison with its own ID and pick out the real data automatically. It is very useful in meter data collecting application.

For example, the node modules in meters work in breath period communication way in most time in order to reduce power consumption. When the central module in the data logger wants to collect meter data, it can sends a special data string with node ID information 0xFF 0xFF, the node modules in the meters can be wake up in breath period communication way. When the host in the node modules detects the special string, it will know that the data logger will collect the meter data and can switch from breath period communication to express communication by controlling the EN and SET pin and will let the node module work in full performance. Therefore the data logger can collect the data quickly and don't need to wait for a breath period for each module to wake up.

3. CONFIGURATION

For some applications the default parameters might not be the best choice so users might need to change the parameters. There are two ways to adjust them: by MCU or by PC. In configuration mode, the EN pin must be connected to GND and then the configuration tool or commands can work effectively.
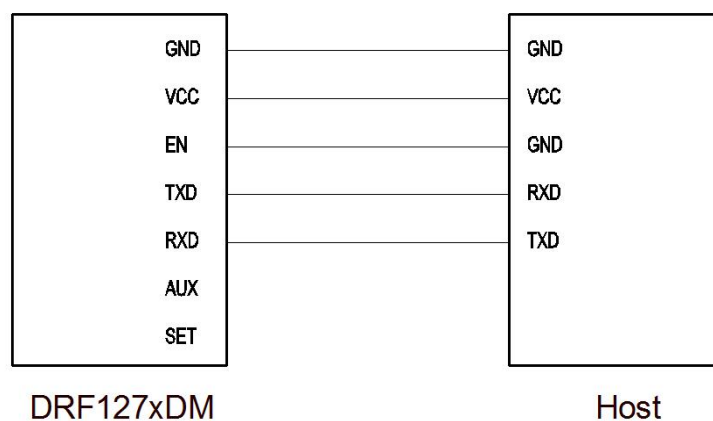

Figure 6: Pin Connection in Configuring the Module

By PC: DORJI offers PC based configuration tool which can be used to change the parameters through graphic interface. Users can insert DRF1278DM module into UART-to-USB converter board DAC02 and connect them to computer and run the
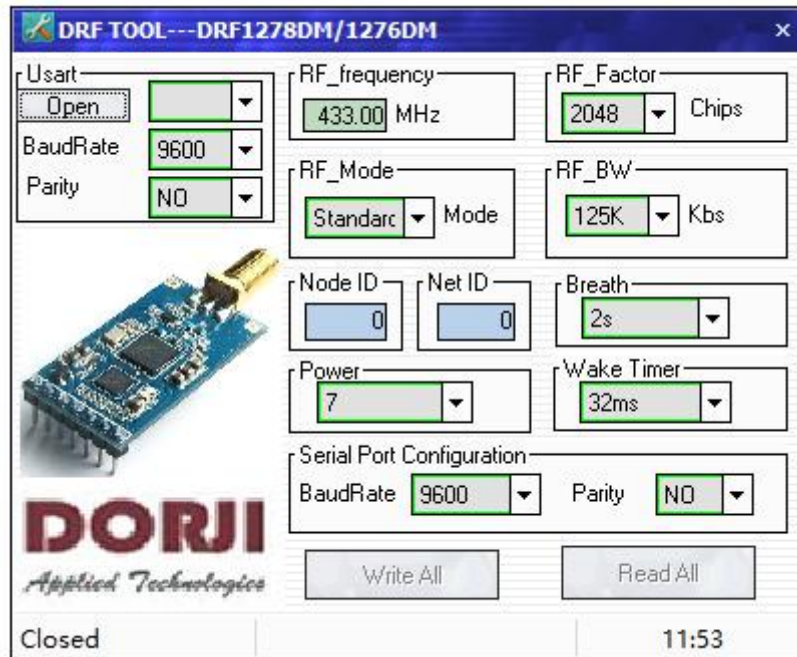
configuration tool.

Figure 7: Configuration Tool Interface

Parameter	Description
UART area	The values are fixed at 9.6k bps & no parity check.
RF frequency	It indicates the center frequency of RF carrier
RF mode	Standard mode, central mode and node mode
RF_Factor	Lora spreading factor. Larger value means higher sensitivity but longer air transmission time. It only can be changed by users in standard mode
RF_BW	Lora bandwidth. Larger value means lower sensitivity. Recommended value: 125K. It only can be changed by users in standard mode.
Node ID	It is only used for node modules: 0~65535
Net ID	Only the modules with the same network ID (0~255) can communicate with each other. It can avoid interferences from irrelative modules
Power	It is used to set the output power of DRF1278D. There are 7 power levels. The 7 means the max. output power---20dBm and 0 means the lowest output power.
Breath	The wake-up period for node module. Only available for firmware 2.0 or above
Wake timer	The time for detecting wireless signal during breath period, only available for firmware 2.7 or above
Serial baudrate	It defines the data rate between DRF1278DM and the host
Serial parity	It defines the parity check between DRF1278DM and the host

Table 5: DRF1278DM Parameter Table

Please note that the preconditions for two or more modules to communicate are that the frequency, RF factor, RF_BW and Net ID must be the same.

RF_factor	RF_BW	RF data rate	Sensitivity
4096	125	293 bps	-138 dBm
2048	125	537 bps	-135 dBm
4096	250	586 bps	-135 dBm
1024	125	977 bps	-132 dBm
2048	250	1074 bps	-132 dBm
4096	500	1172 bps	-132 dBm
512	125	1758 bps	-129 dBm
1024	250	1954 bps	-129 dBm
2048	500	2148 bps	-129 dBm
256	125	3125 bps	-126 dBm
512	250	3516 bps	-126 dBm
1024	500	3908 bps	-126 dBm
128	125	5470 bps	-123 dBm
256	250	6250 bps	-123 dBm
512	500	7032 bps	-123 dBm
128	250	10940 bps	-120 dBm
256	500	12500 bps	-120 dBm
128	500	21880 bps	-117 dBm

Table 6: Sensitivity: RF_Factor & BW

By MCU: Users also can use microcontroller to change the default parameters. The work mechanism is the same as in PC.

Sync word		ID code		Header	Command		Length	Data	CRC	End code	
0xAF	0xAF	0x00	0x00	0XAF	XX	YY	LEN	XXXX	CS	0X0D	0X0A

Table 7: DRF1278DM Command Structure

Notes: 1. The ID code is 0x00 0x00 in command.

2. In command column, XX in sending command is 0x80 and in response command is 0x00. YY is the command type.

Y	TYPE	YY	TYPE	YY	TYPE	YY	TYPE	YY	TYPE
0x01	write	0x02	read	0x03	standard	0x04	Central	0x05	Node

Table 8: Command Type and Value

3. Length refers to the data bytes between Length byte and CRC byte which the two bytes are not calculated in the length.

4. Data refers to the detailed parameters which need to be changed.

Baudrate	Parity	Frequency	RF_Factor	Mode	RF_BW	ID	NetID	Power	Breath	Wake timer

Table 9: Parameter Sequence in Data Section

Parameters	Length	Values
Baudrate	1 byte	1=1200, 2=2400, 3=4800, 4=9600, 5=19200,6=38400, 7=57600
Parity	1 byte	0=no parity check, 1=odd parity, 2=even parity
Frequency	3 bytes	The value=Frequency/61.035. E.g. For 433MHz, the value= 433000000/61.035
RF_Factor	1 byte	7=128, 8=256, 9=512, 10=1024, 11=2048, 12=4096
Mode	1 byte	0=standard, 1=central, 2=node
RF_BW	1 byte	6=62.5k, 7=125k, 8=256k, 9=500k
ID	2 bytes	0x0000 ~ 0xFFFF, high byte first
NetID	1 byte	0x00~0xFF
RF_Power	1 byte	1=4dBm, 2=7dBm, 3=10dBm, 4=13dBm, 5=14dBm, 6=17dBm, 7=20dBm
Breath	1 byte	0=2s, 1=4s, 2=6s, 3=8s, 4=10s
Wake timer	1 byte	0=2ms, 1=4ms, 2=8ms, 3=16ms, 4=32ms, 5=64ms

Table 10: Parameter Length & Value Range

5. CS refers to CRC value which is the remainder of the sum (of the bytes before CS) divided by 256.

6. If the carrier frequency of module is the times of 32MHz, the sensitivity will go down sharply so it will be better to avoid using the times of 32MHz as the carrier frequency.

7. The breath parameter is introduced in the firmware 2.0 or later. In earlier firmware version the breath parameter is fixed at 2s and can not be changed so the data length for old firmware is 12 bytes. For firmware 2.0 or above, the data length is 13 bytes.

In order to understand the commands, the section will demonstrate the use of commands by some examples.

Write Command Code: 0x01

For firmware <2.0

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x01, 0x0C, ... CS, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x01, 0x0C, ... CS, 0x0D, 0x0A

For firmware 2.0

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x01, 0x0D, ... CS, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x01, 0x0D, ... CS, 0x0D, 0x0A

For firmware 2.7

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x01, 0x0E, ... CS, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x01, 0x0E, ... CS, 0x0D, 0x0A

Read Command Code: 0x02

For firmware <2.0

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x02, 0x0C,0x00,0x00, 0x00, 0x00, 0x00,
            0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,0x9B, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x02, 0x0C ......, 0x0D, 0x0A

For firmware =2.0, the data length is 13 bytes

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x02, 0x0D,0x00,0x00, 0x00, 0x00, 0x00,
            0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x9C, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x02, 0x0D ......, 0x0D, 0x0A

For firmware =2.7, the data length is 14 bytes

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x02, 0x0E,0x00,0x00, 0x00, 0x00, 0x00,
            0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x9D, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x02, 0x0E ......, 0x0D, 0x0A

Standard Mode Command Code: 0x03

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x03, 0x02, 0x00, 0x00, 0x92, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x03, 0x02, 0x00, 0x00, 0x12, 0x0D, 0x0A

Central Mode Command Code: 0x04

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x04, 0x02, 0x00, 0x00, 0x93, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x04, 0x02, 0x00, 0x00, 0x13, 0x0D, 0x0A

Node Mode Command Code: 0x05

Command: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x80, 0x05, 0x02, 0x00, 0x00, 0x94, 0x0D, 0x0A

Response.: 0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x05, 0x02, 0x00, 0x00, 0x14, 0x0D, 0x0A

Please note that the working modes changed by the 0x03, 0x04 and 0x05 commands will not be written into nonvolatile memory so the working mode will be restored to the former mode before change after power-off. If needing to keep the changed mode after next power-on, users should use the write command instead to change the parameters.

The data below is the response of Read command from the module with firmware < 2.0 so the length byte is 0x0C---12bytes without breath period parameter.

0xAF, 0xAF, 0x00, 0x00, 0xAF, 0x00, 0x02, 0x0C, 0x04, 0x00, 0x6C, 0x80, 0x12, 0x0B, 0x00, 0x07, 0x00, 0x00, 0x00, 0x07, 0x36, 0x0D, 0x0A

Sync word		ID code		Header	Command		Length	Data	CRC	End code	
0xAF	0xAF	0x00	0x00	0XAF	0x00	0x02	0x0c	XXXX	0x36	0X0D	0X0A

Table 11: Response of Read Command

Baudrate	Parity	Frequency	RF_Factor	Mode	RF_BW	ID	NetID	Power
0x04	0x00	0x6c,0x80,0x12	0x0B	0x00	0x07	0x00,0x00	0x00	0x07
9.6k bps	No	434MHz	2048	Standard	125k	0	0	20dBm

Table 12: The Data Section in Response of Read Command
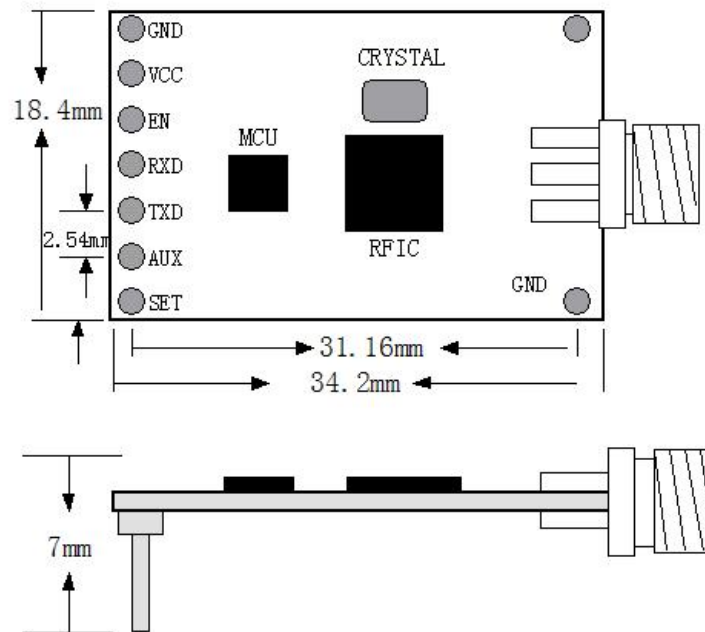
MECHANICAL DATA

Figure 8: DIP Package Dimension

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