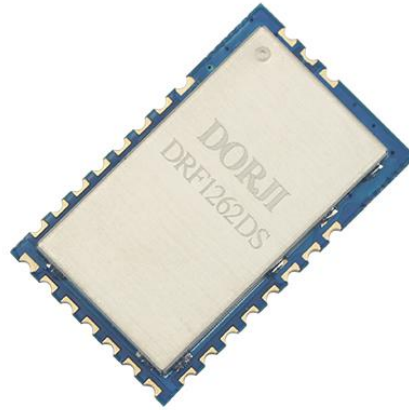## DRF1262DS
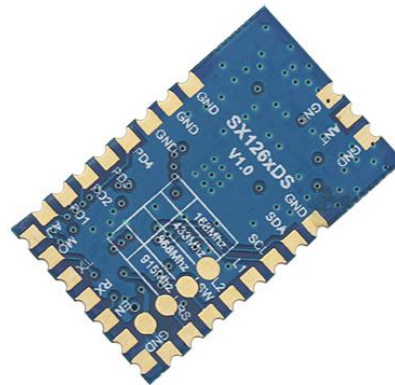## Low power long range data radio modem

Features:

- 868/915MHz ISM frequency band

- High sensitivity: -143dBm @ power mode 0/1
                    -132dBm @ power mode 2

- Max. Output power: 22dBm

- RF data rate: 0.073~62.5k bps

- UART data rate: 1.2~57.6k bps

- Standard /star network mode

- Multiple channel & air wake-up

- Receive current: 10mA

- Sleep current: 2uA

- Working voltage: 2.8~6V

- Working temperature: -40~+85℃

Applications:

- Home automation

- Wireless meter

- Industrial telemetry

- Robot & drone control

- Container information

- Supply & logistics

- Low power sensor network

INTRODUCTION:

DRF1262DS is a type of low cost and long range data radio modem based on the new generation of Lora chip sx126x from Semtech. It has the advantages of low receive current, long transmission range and strong anti-interference ability. It adopts high resolution TCXO which improves the reliability and robustness in the whole working temperature. DRF1262DS can work steadily even at extra low RF data rate. It has the standard UART interface so users can change the default parameters by using the configuration tool through computer or AT commands by MCU.

The module has two work modes: standard data transmission (or transparent data transmission) and star network. It also provides four types of power saving modes: short-preamble, long-preamble, CAD monitor and full sleep, which can be switched by the levels of I/O pins. The maximum data package size of the module is 200 bytes.
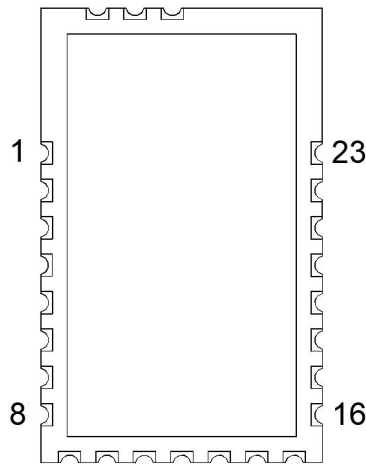
PIN DEFINITION：

Figure 1：Pin Sequence of DRF1262DS

Num	Name	I/O	Description
1	GND	---	Ground(0V)
2	SDA	I/O	I²C data pin, unused, unconnected
3	SCL	O	I²C clock pin, unused, unconnected
4	L1	O	LED indication pin for receive, which can be used to connect to external LED
5	L2	O	LED indication pin for transmit, which can be used to connect to external LED
6	SW	I	Update pin. Pleasekeep it unconnected in normal operation; the module will enter into bootloader when it is low for 3s at least.
7	RS	I	Reset pin
8	VCC	---	Normally 3.3V, it's the direct output of LDO on the module
9	GND	---	Ground(0V)
10	VDD		2.8~6V
11	EN	I	Enable pin
12	RX	I	UART RX pin
13	TX	O	UART TX pin
14	AU	O	Status indication pin
15	MO	I	Mode pin which is used together with EN pin
16	PD0	I/O	Unused, unconnected
17	PD1	I/O	Unused, unconnected
18	PD2	I/O	Unused, unconnected
19	PD3	I/O	Unused, unconnected
20	PD4	I/O	Unused, unconnected
21	GND	---	Ground(0V)
22	GND	---	Ground(0V)
23	GND	---	Ground(0V)
24	GND	---	Ground(0V)
25	ANT	---	ANT port (50 Ohm)
26	GND	---	Ground((0V)

Table 1：Pin Definition

MAIN PARAMETERS

Parameter	Value			Notes
	Min.	Typ.	Max.	
Working voltage (V)	2.8	5	6	VDD
I/O pin level (V)	0		3.3	3.3V TTL logic level
Operation temperature (℃)	-40	25	85	
Operation Frequency (MHz)	850		928	
TX current (mA)		156		@868MHz & VDD>3.5V
		122		@915MHz & VDD>3.5V
RX current (mA)		10		
Sleep current (uA)		2		Wireless & UART are closed
Output power (dBm)		21.2		@868MHz & VDD>3.5V
		20.6		@915MHz & VDD>3.5V
Sensitivity(-dBm)			-143	@ power mode 0
			-132	@ power mode 2
RF data rate (kbps)	0.08		62.5	@ power mode 0/1
	0.54		62.5	@ power mode 2
UART data rate (kbps)	1.2		57.6	

Table 2：Main Parameters
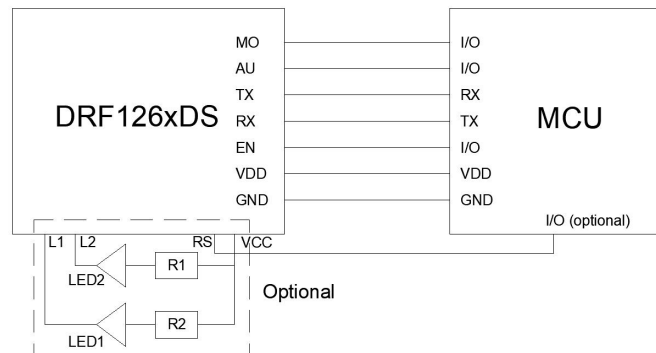
CONNECTION DIAGRAM
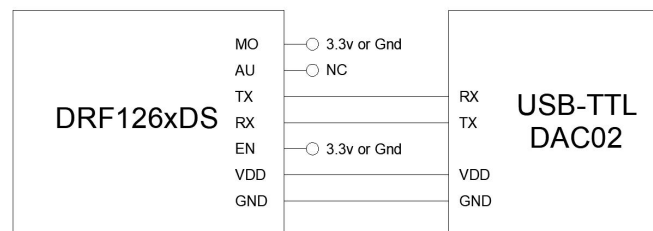

Figure 2: Connection between DRF1262DS and MCU

Figure 3: Connection between DRF1262DS and DAC02

Figure 2 shows the connection between DRF1262DS and the MCU. The level on MO and EN pins determines the power mode of DRF1262DS module. The AU pin is a status indication pin so it can be connected to a I/O pin or not. L1 and L2 are LED indication pins which can be connected to external LED or not according to the requirement of real applications. Keeping the L1/L2 pin unconnected can reduce the current. If the microcontroller has extra I/O pins, the RS (reset) pin of the module can be connected to the I/O pin of MCU to reset the module if necessary. Please keep the other unconnected pins floating.

If users want to connect the DRF1262DS to the computer through the USB-to-TTL converter board (such as DAC02), the MO or EN should be connected to the fixed high level (3.3V) or GND separately (if the VDD of the USB board is 5V) and the AU pin can be floating. It will be better to solder the DRF1262DS on the testing board DAD07 which offers jumpers for EN and MO pin to connect 3.3V or GND directly.

WORK MODE

1. STANDARD DATA TRANSMISSION

It is also called as transparent data transmission. When the module gets the data from the host through the RX pin of UART interface, it packs the data and sends it out by air. When another module receives the wireless data, it will transfer it to the host through the TX pin of the UART interface. The process in wireless transmission is fulfilled by the modules automatically so the users don't need to consider how the data is processed. In standard data transmission, there are four power modes which can be selected by changing the level of EN and MO pins.

Mode	EN	MO	Description	Notes
0	0	0	Wireless enabled, UART enabled	Short preamble communication
1	0	1	Wireless enabled, UART enabled	Long preamble communication
2	1	0	CAD monitor, UART disabled	Half sleep mode, only can communicate with mode 1
3	1	1	Wireless disable, UART disabled	Full sleep，can be evoked by EN/MO pin

Table 3：power Modes in Standard data transmission

Mode 0: Short preamble mode or normal working mode. In this mode, DRF1262DS works in full performance without power-saving. When the module is powered on, it will enter into receive mode automatically. When it detects effective wireless signal, it will receive the data package and set AU pin to low 2ms in advance before transferring the data to the host. Before the host sends data to DRF1262DS, it can check the level of AU pin first. If the AU pin is low, it means the module is receiving data so it can send data after AU pin is high. When the transmitting module is set to Mode 0, it sends short preamble so the receiving module must be in Mode 0 or Mode 1.

Mode 1.: Long preamble mode. The work mechanism of Mode 1 is nearly the same as Mode 0 except it sends long preamble (>sleep time) in transmitting, which can evoke the receiving mode in Mode 2 so transmitting module in Mode 1 can communicate with receiving module in Mode 0/1/2.

Mode 2.: Half sleep mode or CAD(channel activity detection) monitor mode. In this mode the UART port is closed and the module wakes up periodically to detect if there is any wireless signal. When DRF1262DS monitors the effective signal, it will receive the data, open the UART port and then transfer the data to the host. The transmitting module must send the preamble longer than the sleep time in order to evoke the receiving module in Mode 2 successfully. For this reason the transmitting module must be set to Mode 1 when the receiving module is in Mode 2. Since the UART port is closed, the host needs to switch the receiving module to mode 0 or mode 1 by changing the logic level of EN and MO pin if it wants to transfer the data to the module. Mode 2 is only suitable when the parameter bandwidth is $\geq$ 125kHz.

Mode 3.: Full sleep mode. The wireless function and UART interface are all closed. It means the module in this mode can not receive or transmit any data. Users can change the module to Mode 0/1/2 by changing the logic level of EN and MO pin. Please note that when the module is switched to other modes from Mode 3, the AUX pin will be in logic low in the process. When the mode switching is finished, the AUX pin will become logic high. Users can check this pin to judge if the mode switching is finished or not.

TX module	RX module	Description
Mode 0	Mode 0/ 1	Short preamble
Mode 1	Mode 0 /1 /2	Long preamble

Table 4：Compatible Communication in Standard Data Transmission

In standard data transmission or star network mode, switching power mode is realized by changing the logic level of EN and MO pins. If the two pins are floating, the external interference might make the module misjudge the level of the two pins. In real application, the two pins must to be connected to the logic high level or GND.

2. STAR NETWORK (NORMAL,PASSIVE)

Most of the point-to-point applications can be realized in standard data transmission. For multiple points applications, the star network mode will reduce or even avoid interference among points. The roles of central/node modules are introduced in star network to define the data flow control. According to the data transmission method of node modules, the star network can be divided into two modes: Normal mode and Passive mode. In order to activate the star network functions, users need to set one module as the central module and other modules as the node modules through AT commands or configuration tool by selecting the Work mode parameter and then set the modules in different Star modes.

Parameters	Value	Description
Work mode	NODE,CENTRAL	The roles of modules in star network
Star mode	NORMAL, PASSIVE	The data transmission method

Table 5：Roles and Modes in Star Network

2.1 NORMAL MODE in STAR NETWORK

In this mode the functions of central and mode modules are the nearly the same as the modules in standard data transmission except the verification function of Device ID is added. When the central module sends data to the node modules, the first two bytes (HEX format) of the data package sent by the central module should be the Device ID of the targeted node module. When the node module gets the data package, it will check if the content of the first two bytes is the same as its own Device ID. If they are the same, the node module will filter the two bytes and output the effective data to its host through UART interface. If they are not the same, the node will discard this data package so there will be no data output to the host. Please note that if the content of the first two types is 0(0x00 0x00) in the data package, the node module will receive the data and output it to the host no matter what its own Device ID is. Therefore users can use the ID(0x00 0x00) as broadcast command since all of the node modules will receive this data package successfully.

When the node module sends data to the central module, users don't need to specify the Device ID of central module because the central module will receive the data from the node modules automatically as soon as they have the same Net ID. If the parameter(ID enable) is set to YES, the central module will output the Device ID of the node module and the data(from the node module) to its host. If it is set to No, the central module will only output the data to its host and the Device ID of the node module will be filtered automatically. For example, if there is one central module and three node modules:

The central module: Net ID=1,Device ID=1(or other values)
Node module a: Net ID=1,Device ID=1
Node module b: Net ID=1,Device ID=2
Node module c: Net ID=1,Device ID=3

The central module sends data： 0x00 0x00 0xaa 0xaa (0x00 0x00 is the Device ID information)
Node module a will receive data：0xaa 0xaa
Node module b will receive data：0xaa 0xaa
Node module c will receive data：0xaa 0xaa

The central module sends data：   0x00 0x02 0xaa 0xaa
Node module a will receive data：No data
Node module b will receive data：0xaa 0xaa
Node module c will receive data：No data

Node b(Device ID=2) sends data：   0x00 0x00 0xaa 0xaa
The central module(ID enable=NO) will output to its host with：   0x00 0x00 0xaa 0xaa
The central module(ID enable=YES) will output to its host with：   0x00 0x02 0x00 0x00 0xaa 0xaa

2.2 PASSIVE MODE in STAR NETWORK

In this mode, the node module doesn't send data to the central module unless it receives the data collection command from the central module. Users can set the node modules in power mode 0 (normal working mode) or power mode 2 (half sleep mode) for low power applications. If the node modules are set in power mode 0, the modules will be in receive status all the time so the power consumption of the node modules is high. If the node modules are set in power mode 2, these modules will wake up periodically from sleep status and monitor if there is any wake-up command from the central module. When it detects the effective command, it will check if its device ID is included in the wake-up command from the central module.

a-> If its ID is included in it, the node module will switch to power mode 0 forcibly no matter if the present power mode is 0 or 2 and keeps in the receive status to wait for the data collection command from the central module. Meanwhile it will set AU pin to low 2ms in advance and then sends Data Request Command (table 10) to its host. The host should respond with the data at the fixed data format (table 11). As soon as the node module receives the data collection command from the central module, it will send the data to the central module at once and then switch to previous mode (depending on the levels of EN and MO pin) from power mode 0 till the next wake-up command from the host.

b-> If its ID is not included in it, the node module will keep in present power mode (depending on the levels of EN and MO pin) and continue to monitor the wake-up command from the central module.

If the node modules work in power mode 2, the central module should work in power mode 1(long preamble mode) in order to wake up the node modules successfully. After the central module is powered on, it will be in the receive status and monitor the UART interface if there is any command from its host. When the host sends Setting Parameter Command (table 6) to it through UART interface, the central module will save the parameters and give the response (table 7) to the host. When the host receives the response, it can send Wake-up Command (table 8) again to the central module. The central module will also give response (table 9) to it and then broadcast wake-up command (including the parameters) automatically to the targeted node modules. After waiting for 1 Time Slot, the central module will start to collect the data from the targeted node modules by sending data collection command one by one (from the start ID to the end ID) at the interval of 1 time slot.

Header	Length	Command	Start ID	End ID	Time slot	CRC
FF FF	07	0D	xx xx	xx xx	xx	xx

Table 6：Network Parameter Setting Command(the host-->central module)

Header	Length	Command	CRC
FF FF	02	0E	10

Table 7：Response to Network Parameter Setting Command (central module-->its host)

Header	Length	Command	CRC
FF FF	02	21	23

Table 8：Wake-up Command (the host-->central module)

Header	Length	Command	CRC
FF FF	02	22	24

Table 9：Response to Wake-up Command (central module-->its host)

Header	Length	Command	CRC
FF FF	02	1F	21

Table 10：Data Request Command (the node module-->its host)

Header	Length	Command	Data	CRC
FF FF	xx	20	xxxxxx	xx

Table 11：Data Command Format (the host--> the node module)

For example, there are 1 central module and 10 node modules. The start ID=1, end ID=3 and the time slot=2S.

The host needs to send the Network Parameter Setting Command (FF FF 07 0D 00 01 00 03 02 1A) to the central module to set the network parameters. The central module receives it and will send response (FF FF 02 0E 10) to the host. When the host receives the response, it can send the Wake-up Command (FF FF 02 21 23) to the central module if it wants to start the data collection. As soon as the central gets this command, it will give response (FF FF 02 22 24) to the host and then automatically broadcast a wake-up command including parameters (start ID, end ID and time slot) to the node modules. The node modules with device ID in 1~3 find their IDs are included in this command. The three node modules will switch to power mode 0 forcibly and send Data Request Command to their hosts. After the node modules get the data from their hosts, they will store the data and wait for the data collection command from the central module. For other node modules with device ID in 4~10, they still stay in present power mode.

After the central module broadcasts the wake-up command, it will wait for 1 time slot and then start to send the first data collection command (containing device ID 1) to collect the data from node module 1. When the node module 1 receives this command, it will send data to the central module at once and then switch back to previous power mode. When the central module receives the data, it will transfer it to its host and start to send the second data collection command to collect data from node module 2. When the data from the three node modules are collected, the central module will enter into receive status and wait for the Data Collection Command or Parameter Setting Command (if needing to change the parameters) from the host to start the next round of data collection.
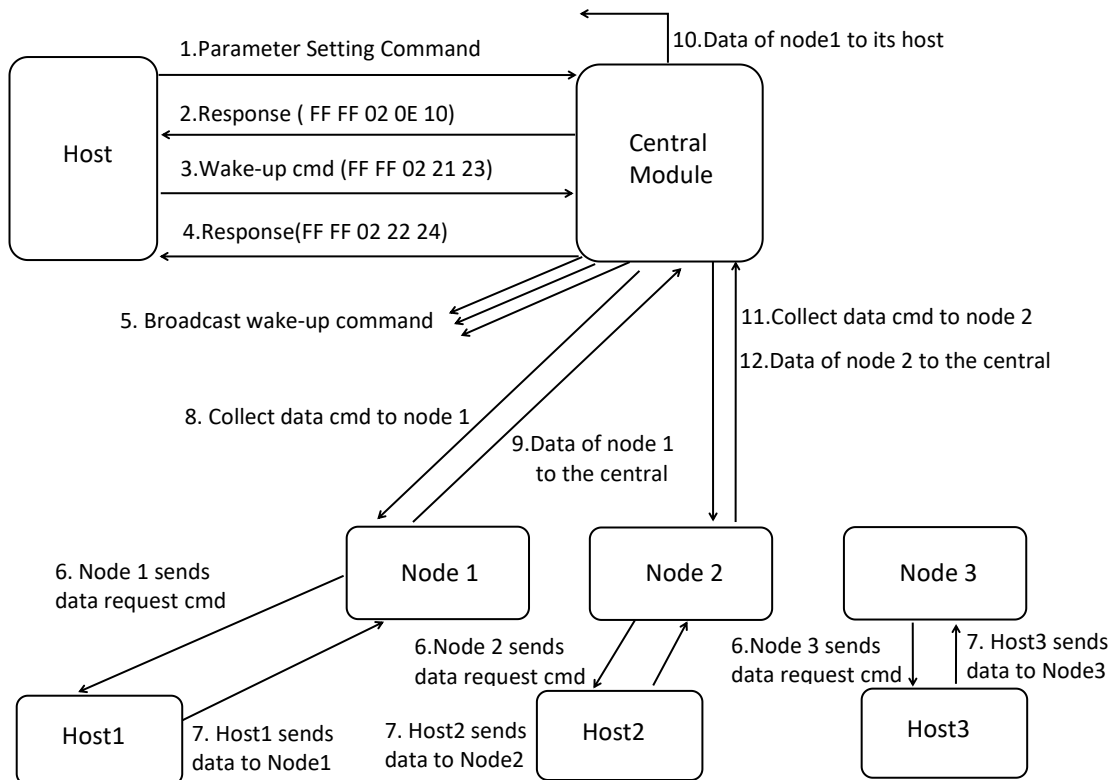

Figure 4：The Data Collection Procedure in Passive Mode

The parameter Time Slot refers to the maximum time between two successive data collection commands which are sent to node modules by the central module. It means if the central module doesn't receive the data from the node module in 1 time slot after sending data collection command, it will not wait for the data anymore and will start to send the another data collection command to the next node module. In other words, the central module is only assigned with 1 slot time to receive the data from one node module. Therefore the Time Slot is closely related to the RF data rate and data size from the node module. If this parameter is too small, it might result in the data collision of two neighbour node modules. There is a time calculator in the tool interface of configuration tool which can give the reference value for Time Slot when related parameters are selected. Please check the application document for more details.

In passive mode, the data exchange between the node module and its host is realized through the command. For example, if the host wants to send the character string(012) to the node module, it will need to check if the node module sends the Data Request Command (FF FF 02 1F 21) to it. As soon as the host receives it, it will send the data package (FF FF 05 20 30 31 32 B8) at fixed data format (table 11) to the node module. Among the data package: <FF FF> is the Header, <05> is the length of data package, <20> is the command word, <30 31 32> is the effective data 012 in HEX format and <B8> is the CRC byte. Below is the sample code for calculating the CRC.

```
unsigned char Protocol_Sum(unsigned char* buffer, unsigned char length)
{
    unsigned char sum = 0;
    unsigned char    i = 0;

    if(NULL == buffer|| length<= 0)
    {
        return 0;
    }
    for(i=0; i<length-1; i++)
    {
        sum += buffer[i];
    }
    return sum;
}


/*Pack the data*/
  void Packet_Protocol(unsigned char cmd,unsigned char *inbuf,unsigned char inlen,unsigned char
*outbuf,unsigned char *outlen)
  {
    unsigned char i = 0;
    outbuf[i++] = 0xff;
    outbuf[i++] = 0xff;
    outbuf[i++] = len+2;    //+cmd +sum
    outbuf[i++] = cmd;
    if( NULL != inbuf && 0 != inlen )    /*data package with payload */
    {
    memcpy(outbuf+i,inbuf,inlen);
    i = i+inlen;
    }
    outbuf[i++] = (unsigned char)Protocol_Sum(outbuf+2,inlen+3); //inlen+3 is the length of len->sum
    *outlen = i;
  }
```

CONFIGURATION

Usually the default parameters can not satisfy the requirements of all applications which might need different frequencies or different data rates. Users can change the values of the parameters through AT command or configuration tool provided by DORJI. The meaning of each parameter will be explained in details when introducing the function of configuration tool.

UART Parameters	Value Range
Baud rate	1.2,2.4,4.8,9.6,19.2,38.4,57.6k bps
Parity check	No parity, odd parity, even parity check
Stop bit	1, 1.5, 2 bits

Table 12：UART Parameters

If the host (MCU or PC) communicates with DRF1262DS module, the UART data format of it must be the same as DRF1262DS module's. The default UART data format of DRF1262DS is (9.6k bps baud rate, 1 stop bit, 8 data bit, No parity check).

COM COM18 ▼   Baud Rate 9600 ▼   Stop Bit 1 ▼   Data Bit 8 ▼   Parity Bit None ▼   Operate OPEN

Figure 5：Default Data Format of UART Interface

As showed in figure 6, the module contains two ID. One is net ID which means that all of the modules needing to communicate must have the same net ID so it also can be regarded as the group ID. Device ID is the unique ID of each module. In standard data transmission mode, the Device ID doesn't function so it is only meaningful in star network mode. When the wireless parameters, time parameters and net ID of modules are the same, they can communicate in standard data transmission mode.

According to the function of parameters, they can be divided into four parts: wireless parameters, UART port parameters, work mode parameters and auxiliary parameters.

Baud Rate	9600	TX Frequency	868.00
Parity Bit	None	RX Frequency	868.00
Stop Bit	1	Bandwidth	125kHz
LBT Enable	NO	Spread Factor	11
ID Enable	YES	TX Power	22 dBm
RSSI Enable	NO	Work Mode	STANDARD
RX Gain	NO	Star Mode	NORMAL
Sleep Time	1 SEC	Time Slot	1 SEC
Device ID	255	Start ID	1
Net ID	1	End ID	255
Pre-wakeup	0 SEC	Sensor Type	Type 1
CAD Peak	17	Code Rate	4/5
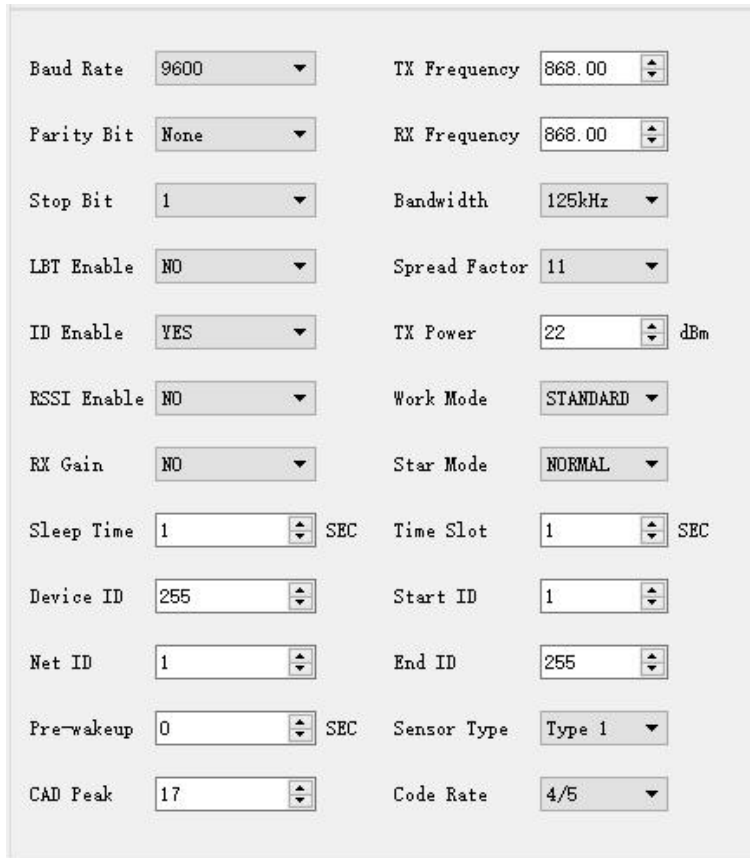
Figure 6：Parameters in Standard Data Transmission Mode

Wireless Parameters	Value Range	Default Value
TX Freq[①]	850~928MHz	868MHz or 915MHz
RX Freq	850~928MHz	868MHz or 915MHz
Bandwidth[②]	31.25,41.67,62.5,125,250,500kHz	125kHz
Spreading Factor[③]	5,6,7,8,9,10,11,12	11
Output power[④]	0~22dBm	22dBm
Code rate	4/5,4/6,4/7,4/8	4/5

Table 13：Wireless Parameters

① The transmit frequency and receive frequency are usually set to the same. If users want to set different frequencies, the transmit frequency of transmitter must be the same as the receive frequency of receiver and vice versa. Users can check the application document of DRF1262DS module to get more details.

② Bandwidth refers the frequency bandwidth which the Lora modulation signal occupies. For example, if the transmitting frequency of module is set to 420MHz and the bandwidth is 250kHz, the frequency range (419.875~420.125MHz) is used by the module to carry data. Wider bandwidth means higher data transmission efficiency but the sensitivity will be degraded. Please note the bandwidth is not the same concept as channel space. Channel space is usually 2 times or more of bandwidth in order to reduce the interference from neighbour channels.

③ For Lora Modulation, each effective data bit is represented by multiple symbol bits. The number of symbol bits is Spreading Factor. For example, if there is data bit "1" and the spreading factor is 8, the module will transmit "11111111"(8*1bit) to represent this bit. It can reduce the bit error rate but also lowers down the effective data transmission rate. In short narrower Bandwidth and larger Spreading Factor mean lower RF data rate but higher sensitivity. The table below shows the relationships between Bandwidth/Spreading factor and RF data rate/sensitivity. The configuration tool provides the calculator which the corresponding RF data rate can be obtained when the Bandwidth and Spread Factor are changed by users.

Bandwidth	Spreading Factor	RF data rate	Sensitivity
31.25kHz	12	0.073kbps	-143.1dBm
31.25kHz	11	0.134kbps	-140.6 dBm
62.5kHz	12	0.146kbps	-140dBm
62.5kHz	11	0.269kbps	-137.5dBm
125kHz	11	0.537kbps	-134.5dBm
125kHz	10	0.977kbps	-132dBm
125kHz	8	3.125kbps	-126dBm
125kHz	6	9.375kbps	-118dBm
250kHz	6	18.75kbps	-115dBm
250kHz	5	31.25kbps	-114dBm
500kHz	5	62.5kbps	-111dBm

Table 14：Bandwidth/Spreading factor and RF data rate/sensitivity

④ The max. output power of RFIC sx126x on module is 22dBm and its adjustable range is 0~22dBm. Since the matching and filtering circuits between the output pin of sx126x and the ANT pin of module will introduce about 0.5~2dBm(varying from different frequencies) insertion loss, the actual output power of module is about 20~21.5dBm when this parameter is is set to 22dBm.

Mode parameters	Value range	Description
Work mode[①]	STANDARD,NODE,CENTRAL	Standard data transmission or Star network
Star network mode[②]	NORMAL,PASSIVE	Data collecting method in star network

Table 15：Working Mechanism Parameters

① If the modules work in the standard data transmission mode，the option STANDARD must be selected for all of the modules. NODE and CENTRAL refer to the roles of modules in star network mode.

② This parameter is only applicable in star network mode, which will be introduced in details in related sections.

Aux. parameter	Value range	Description
Net ID	1 - 255	Or group ID, modules in communication must have the same Net ID
Device ID	1 - 65534	The unique ID of each module. It doesn't function in standard data transmission mode
Sleep time	1 -10s	Sleep time in mode 2. Longer sleep time means lower average power consumption but it also means the transmitter needs to send longer preamble, which lowers down the data transmission efficiency.
RSSI Enable	YES, NO	Enable RSSI function,the last byte of the data package is the RSSI value
ID Enable	YES, NO	Only effective in star network mode. When it is enabled, the central module will show the Device ID information in the received data package.
LBT Enable[①]	YES, NO	Listen before talk(LBT). Only available in standard data transmission and the normal mode of star network.
Code Rate[②]	4/5 - 4/8	Forward error detection and correction efficiency
CAD Peak[③]	17~22	Threshold for CAD (channel activity detection)
Pre-wakeup	0	This parameter is reserved
Sensor Type	---	This parameter is reserved

Table 16：Auxiliary Parameters

① The module support channel RSSI output which can be used to evaluate the signal quality and monitor environment noise.When it is enabled,the module will monitor the present channel if there is any other device which is using the same frequency before it transmit wireless data. If the interference at present frequency exceeds a threshold (fixed in the firmware), the module will stop transmission and send string "busy" to the host through UART interface. If there is no interference, the module will return "ok" to the host and then send the data out. This function is available in standard transmission mode and the normal mode of start network.

② To further improve the robustness of the link, the module employs cyclic error coding to perform forward error detection and correction. A higher coding rate provides better noise immunity at the expense of longer transmission time. In normal conditions a factor of 4/5 provides the best trade-off; in the presence of strong interferers a higher coding rate may be used.

This parameter is only used in power mode 2. In power mode 2, the module wakes up periodically to monitor if there is any wireless signal by checking the channel RSSI value. The CAD peak defines the threshold for judging effective wireless signal. When the module detects the RSSI value lower than this parameter, it will regard it as noise or other interference and filter these interferers. If this parameters is set to a high value, the weak wireless data might also be filtered. If it is set to a very low value, the module in power mode 2 will be waken up frequently by the interferers, which makes the power-saving meaningless. Therefore a relative high value is used in order to reduce or avoid the interference by sacrificing the sensitivity. That's why the sensitivity of DRF1262DS in power mode 2 is much lower than in power mode 0/1 and the value of this parameter is closely related to the sensitivity of the module. The value of this parameter is calculated automatically according to Spread Factor in firmware if the Bandwidth is fixed. If users changes the Bandwidth, users only need to set the minimum value for different Bandwidths,

Bandwidth	125kHz	250kHz	500kHz
CAD Peak	17	18	19

Table 17：Bandwidth vs CAD Peak

If users find that the modules with the recommended CAD Peak value are still waken up easily by the interference in power mode 2, users can try increase the CAD Peak by 1 or 2 to filter the weak signal.

If the DRF1262DS connects to the MCU, it will be more convenient to change the parameters through AT commands. There are three types of AT commands: command with parameters, command without parameter and command with data. The length of AT command is calculated from the command byte to CRC byte. The CRC value is the sum calculated from the length byte to the parameters or data before CRC byte. Users need to send the Enter AT Mode before changing parameters and send the Quit Command to finish the configuration. The Cmd block of the configuration tool provides the example of each command so users can check the tool for how to use the commands.

Header	Length	Command	CRC
2 bytes	1 byte	1 byte	1 byte

Table 18：Command without Parameter

Header	Length	Command	Parameter list	CRC
2 bytes	1 byte	1 byte	N bytes	1 byte

Table 19：Command with Parameter

Header	Length	Command	Data	CRC
2 bytes	1 byte	1 byte	N bytes	1 byte

Table 20：Command with Data

1) Enter AT Mode

Header	Length	Command	CRC
0xFFFF	0x02	0x1B	0x1D

Table 21：Enter AT Mode Command (Host-->Module)

Header	Length	Command	CRC
0xFFFF	0x02	0x1C	0x1E

Table 22：Response (Module-->Host)

2) Quit Command

Header	Length	Command	CRC
0xFFFF	0x02	0x1D	0x1F

Table 23：Quit Configuration Command (Host-->Module)

Header	Length	Command	CRC
0xFFFF	0x02	0x1E	0x20

Table 24：Response (Module-->Host)

3) Read Parameter Command

Header	Length	Command	CRC
0xFFFF	0x02	0x01	0x03

Table 25：Read Parameter Command (Host-->Module)

Header	Length	Command	Parameter List	CRC
0xFFFF	0x23	0x02	xx...xx	xx

Table 26：Response (Module-->Host)

Num	Parameter	Length	Range
1	Device ID	2	0x0001-0xFFFE
2	Net ID	1	0x01~0xFF
3	Baud Rate	1	0x00->1.2kbps, 0x01->2.4kbps, 0x02->4.8kbps, 0x03->9.6kbps, 0x04->19.2kbps, 0x05->38.4kbps, 0x06->57.6kpbs
4	Data Bit	1	0x00->8 bit
5	Parity Check	1	0x00->no parity check, 0x04->even check, 0x06->odd check
6	Stop Bit	1	0x00->1 bit, 0x30->1.5 bit, 0x20->2 bits
7	Spread Factor	1	0x05~0x0C->5~12

8	Bandwidth	1	0x00->500kHz, 0x01->250kHz, 0x02->125kHz, 0x03->62.5kHz, 0x04->41.67kHz 0x05->31.25kHz
9	Code Rate	1	0x00->4/5, 0x01->4/6, 0x02->4/7, 0x03->4/8
10	TX Power	1	0x00~0x16->0~22dBm
11	TX Frequency	4	850000000~928000000Hz
12	RX Frequency	4	850000000~928000000Hz
13	ID/ Rx Gain Enable	1	0x00->ID Enable=NO, RX Gain=NO 0x01->ID Enable=YES, RX Gain=NO 0x80->ID Enable=NO, RX Gain=YES 0x81->ID Enable=YES, RX Gain=YES
14	LBT Enable	1	0x00->NO, 0x01->YES
15	RSSI Enable	1	0x00-> NO, 0x01->YES
16	Sensor Type	1	0x00->Type 1, 0x01->Type 2, 0x02->Type 3 0x03->Type 4
17	Pre-wakeup	1	0x00~0x05
18	Work Mode	1	0x00->STANDARD, 0x01->NODE, 0x02->CENTRAL
19	Star Mode	1	0x00->NORMAL, 0x01->PASSIVE
20	CAD Peak	1	0x11~0xFF->17-255
21	Sleep Time	1	0x01~0x0A->1~10s
22	Start ID	2	0x0001~0xFFFE
23	End ID	2	0x0001~0xFFFE
24	Time Slot	1	0x01~0x0A->1~10s

Table 27：Parameter List in Read/Write Command

4) Write Command

Header	Length	Command	Parameter List	CRC
0xFFFF	22	0x03	xx...xx	xx

Table 28：Write Command (Host-->Module)

Header	Length	Command	CRC
0xFFFF	0x02	0x04	0x06

Table 29：Response (Module-->Host)

5) Read Data RSSI Command

Header	Length	Command	CRC
0xFFFF	0x02	0x0F	0x11

Table 30：Read Channel RSSI Command (Host-->Module)

Header	Length	Command	RSSI Value	CRC
0xFFFF	0x04	0x10	xx xx	xx

Table 31：Response (Module-->Host)

6) Read Channel RSSI Command

Header	Length	Command	CRC
0xFFFF	0x02	0x11	0x13

Table 32：Read Data RSSI Command   (Host-->Module)

Header	Length	Command	RSSI Value	CRC
0xFFFF	0x04	0x12	xx xx	xx

Table 33：Response (Module-->Host)

7)　　Set ID Command (Device ID+Net ID)

Header	Length	Command	Device +Net ID	CRC
0xFFFF	0x05	0x09	xx xx xx	xx

Table 34：Set ID Command (Host-->Module)

Header	Length	Command	CRC
0xFFFF	0x02	0x0A	0x0C

Table 35：Response (Module-->Host)

8)　　Set UART Parameter Command

Header	Length	Command	Parameter List	CRC
0xFFFF	06	0x05	xx xx xx xx	xx

Table 36：Set UART Parameter Command (Host-->Module)

xx	xx	xx	xx
Baud rate	Data bit	Parity check	Stop bit

Table 37：Parameter List of Set UART Parameter Command

Header	Length	Command	CRC
0xFFFF	0x02	0x06	0x08

Table 38：Response (Module-->Host)

9)　　Set RF Parameter Command

Header	Length	Command	Parameter List	CRC
0xFFFF	0E	0x07	xx... ... xx	xx

Table 39：Set RF Parameter Command (Host-->Module)

xx	xx	xx	xx	xx xx xx xx	xx xx xx xx
Spread factor	Bandwidth	Tx power	Code rate	TX frequency	RX frequency

Table 40：Parameter List of Set UART Parameter Command

Header	Length	Command	CRC
0xFFFF	0x02	0x08	0x0A

Table 41：Response (Module-->Host)

10)　Set Mode Command

Header	Length	Command	Parameter List	CRC
0xFFFF	06	0x0B	xx... ... xx	xx

Table 42：Set Mode Command (Host-->Module)

xx	xx	xx	xx
Work mode	Star mode	Wake-up time	Sleep time

Table 43：Parameter List of Set Mode Parameter Command

Header	Length	Command	CRC
0xFFFF	0x02	0x0C	0x0E

Table 44：Response (Module-->Host)

11) Reset Command

Header	Length	Command	CRC
0xFFFF	0x02	0x15	0x17

Table 45：Reset Command (Host-->Module)

Header	Length	Command	CRC
0xFFFF	0x02	0x16	0x18

Table 46：Response (Module-->Host)

12) Stop Data Collection Command

Header	Length	Command	CRC
0xFFFF	0x02	0x23	25

Table 47：Stop Data Collection Command (Host-->Module)

Header	Length	Command	CRC
0xFFFF	0x02	0x24	0x26

Table 48：Response (Module-->Host)

Notes:

1. All of the AT commands can be verified through configuration tool. If users are not sure about the correctness of CRC value, the command can be input into the tool to verify if the response to it can be showed in the tool.

2. The value range of the parameter list in the command can be found in the table 26. If users don't want to write all of the parameters into the module by Write Command, the shorter parameter setting commands (like Set Mode, Set ID, etc.) can be used to change specific parameters.

3. Usage of AT commands:
   3.1. When the DRF126xDS receives the Write Command, it will be reset automatically after giving the response to the host.
   3.2. For Set UART Parameter Command, it only comes to effect after the module is reset manually.
   3.3. When the module receives reset command, it will give the response to the host and then restart after 0.5 second.
   3.4. Wake-up command is only available for the central module in the passive mode of star network.
   3.5. Data Request Command is sent to the host by node module in the passive mode of start network so it can not be sent by the host.
   3.6. Stop Data Collection Command is only available for the central module in the passive mode of star network. When the central module receives this command, it will stop sending data collection command to the node modules and will broadcast a stop command to the node modules, which will let the node modules quit from power mode 0 and be back to previous power mode (according to the level of EN and MO pins).
   3.7. For the other short setting parameter commands, they will come into effect as soon as the module receive them and give the response to the host.

4. Code Rate: To further improve the robustness of the link the LoRa® modem employs cyclic error coding to perform forward error detection and correction. A higher coding rate provides better noise immunity at the expense of longer transmission time. In normal conditions a factor of 4/5 provides the best trade-off; in the presence of strong interferers a higher coding rate may be used. If the applications don't care about the transmission time, smaller value can improve the reliability of communication and distance to some extent.

5. Longer air transmission time means the wireless data might be interrupted by the interferer more easily. Therefore the extra low RF data rates are only suitable for short data transmission. Theoretically higher sensitivity means longer distance. In the field testing, the improvement for communication distance is not so distinctive when the sensitivity is higher than -137dBm since the environment noises have great impact on the weak signal.

6. Power modes of DRF1262DS reflect the power consumption of the module and are determined by the levels on EN and MO pins so power modes can be applied to any work mode.

ADDITIONAL INFORMATION

1. Function of AU Pin

1.1. When DRF1262DS is powered on, the AU pin will be in logic low during the initialization of the module. As soon as the initialization is finished, the AU will be in logic high.

1.2. When DRF1262DS is in power mode 3 (full sleep mode), the AUX is in logic low all the time. The AU pin will become logic high when the switching from power mode 3 to other modes is finished.

1.3. When DRF1262DS in standard mode or normal mode of star network receives the wireless data, the AU pin will be set to logic low 2ms in advance before it transfer the data to the host through UART interface. When the data transfer to the host is finished, the AU pin will become logic high again.

1.4. In the passive mode of star network, the AU pin of the node modules will be in logic low at once as soon as the node modules wake-up command from the central. The node module will send the Data Request Command to the host 2ms later. The host should transfer the data to the node module after it receives this command. In the low power applications, the falling edge of the AU pin can be used to wake up the host in sleep mode. When the node module receives Data collection Command, the AU pin will become logic high after the node module sends data to the central module. In short the AU pin will be in logic low when the node module receives the Wake-up command from the central module and it will become logic high till the node module sends data to the central module.

2. Power Consumption

In power mode 0 and power mode 1, DRF1262DS module will be in the receive status all the time if it doesn't need to transmit data so the module has the highest power consumption comparing to power mode 2/3. Since the RFIC on the module works in the full performance, it will receive any effective signal from the transmitter quickly and has more robust communication for the same reason.

In power mode 2, the DRF1262DS module wakes up periodically to monitor if there is any effective wireless signal from the transmitter module. Longer sleep time means less average power consumption. However longer sleep time needs the transmitter to send longer preamble in order to wake up the receiver module in power mode 2, which might affect the usage of other products in the same frequency band. Except sleep time, the wake-up time also affects the average power consumption. This parameter is closely related to the RF data rate. Users can find the reference value for wake-up time (CAD time) in the Tools block of configuration tool. Higher RF data rate means shorter wake-up time and less average power consumption but shorter communication distance. Users need to make a trade-off between distance and power consumption in this mode.

There is a register value (CAD Peak) in the RFIC which determines the threshold for judging the effective signal. Smaller value makes the module detect weaker wireless signal effectively in power mode 2 but it also makes the module more easily be waken up by the interferers, which increases the average power consumption. Larger value will make the module filter the weak signal which degrades the module's sensitivity. If DRF1262DS works in a severe environment, which the noise and other interference are too strong to wake up the module frequently, users can try to increase the CAD peak value one by one to find a suitable value in order to reduce the unnecessary power consumption.
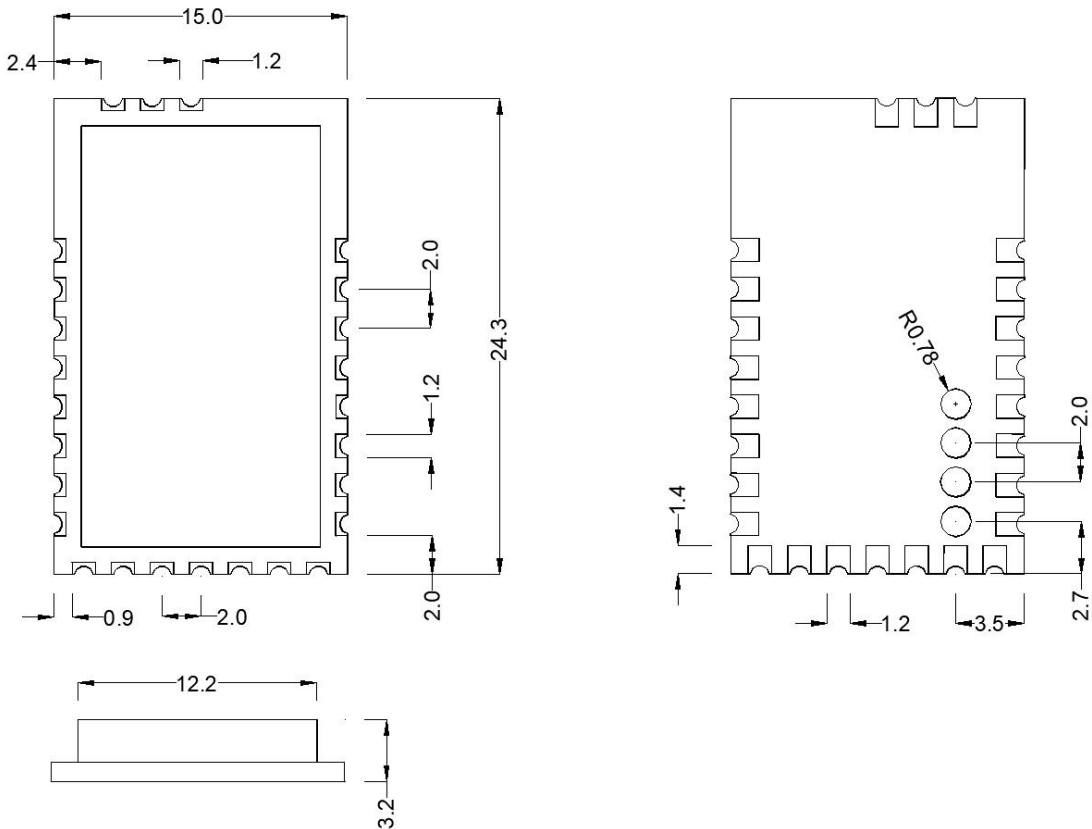
DIMENSIONS (unit:mm)：

Figure 7：Dimensions of DRF1262DS Module