# Application Document for DRF1262DS/DRF1268DS

This document introduces the basic functions and configuration method of DRF1262DS/DRF1268DS modules. Both of the two modules are UART interface with the same function except they have different working frequencies. Users can use a USB-to-TTL converter board (DAC02) to connect the module to computer and run the configuration tool to change the default parameters in order to get the best performance for different applications.

| USB Board DAC02 | DRF126xDS | Pin Description |
|---|---|---|
| GND | GND | Ground |
| VDD | VDD | 2.8V~6V |
| --- | EN | Ground or 3.3V |
| TX | RX | 3.3V TTL |
| RX | TX | 3.3V TTL |
| --- | AU | Auxiliary pin, can be floating |
| --- | MO | Ground or 3.3V |

Table 1：Connection between DRF126xDS and USB Board

The EN pin and MO pin are used to choose the power mode of the modules but the parameters of the modules only can be changed in power mode 0 or mode 1. The two pins must be connected to a fixed level (0V or 3.3V) in case the external interference make the module misjudge the level on the two pins. If VDD>3.5V, the TTL logic high level can be 3.3V. If VDD<3.5V, the TTL logic high level can not exceed VDD.

| Mode | EN | MO | Description |
|---|---|---|---|
| 0 | 0 | 0 | Short preamble |
| 1 | 0 | 1 | Long preamble |
| 2 | 1 | 0 | Half sleep |
| 3 | 1 | 1 | Full sleep |

Table 2：EN/MO Pin Level vs Power Mode

Users can solder wires on the module to connect the USB converter board DAC02 or solder the module on the testing board **DAC07** directly and insert it into the USB board. When the module with USB board is connected to the computer, users can run the configuration tool, choose the right COM port and click the OPEN button on the right-top corner of the tool to activate the tool. The default UART data format is: 9600 bps, 1 stop bit, 8 data bits and no parity check.


Figure 1: Default UART Data Format

The configuration tool has four function block: Config, Update, Cmd and Tools. Users can click related button on the left side to activate corresponding interface.

## FUNCTION BLOCKS

### 1. Config

It's the main interface of the configuration tool, which can be used to read or change the parameters of the DRF1262DS/DRF1268DS modules.

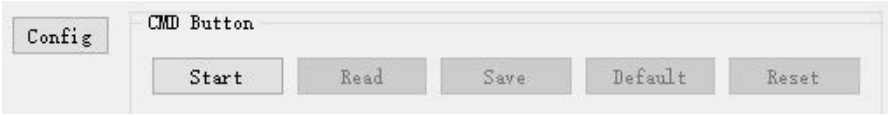


Figure 2：Configuration Button

After clicking Start button, the other four buttons will also be activated and the module will enter into configuration mode. The display area on the top-right side will give response (ff ff 02 1c 1e) for this operation.

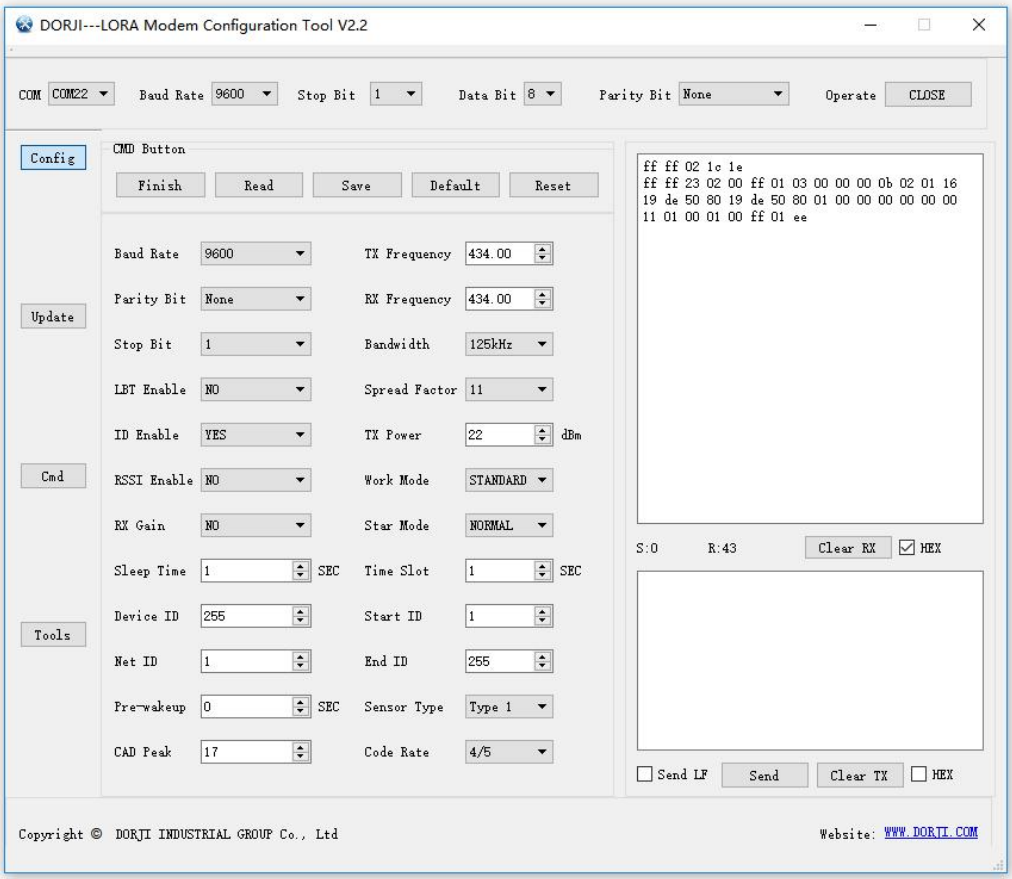


Figure 3：Configuration Mode

Pressing Read button, the tool will show the parameters in the module. Users can change the default parameters and click Save button to save the new parameters. A dialog box will pop up to show the successful saving operation.


Figure 4：Successful Saving Operation

Clicking the Default button will show the factory parameters inside the module and users need to click the Reset button to save the factory settings.

The meanings of the parameters in the interface of function block Config are explained in the datasheet of DRF1262DS/DRF1268DS module. In this document these parameters will be discussed in more details according to different applications.

1.1 Frequency: there are two frequencies: Transmit frequency and Receive frequency. The two parameters can be set to the same or not same. If they are different, the TX frequency of transmitting module must be the same as the RX frequency of receiving module or vice versa. This function is useful for the low power consumption applications.

For example, there are five modules among which one is used as the central module (C1) and the other four as node modules (N1, N2, N3, N4). In order to reduce power consumption, the node modules are set in mode 2 (half sleep mode) which means the node module will wake up periodically to check if there is any data from the C1 (central module).

Assuming C1 module.: TX frequency=434MHz RX frequency=435MHz
N1/N2/N3/N4 module: TX frequency=435MHz RX frequency=434MHz.

When C1 transmits data at 434MHz, the node modules will receive the data at 434MHz. If the N1 wants to send data to C1 at 435MHz (needing to switch it to mode 0 or 1), other node modules will not be woken up since the RX frequency of them is 434MHz. In short the node module in transmitting will not interfere other node modules in mode 2.

1.2 Communication: if two or more modules want to communicate, some of the parameters must be configured to the same. Different work modes have different requirements on the parameters (seeing table 3). For other parameters, they can be different or same except Device ID.

| Parameter | Standard data transmission | Normal mode in star | Passive mode in star |
|---|---|---|---|
| Bandwidth | same | same | same |
| Spread Factor | same | same | same |
| Code Rate | same | same | same |
| Work Mode | Standard | Node or Central | Node or Central |
| Sleep time | same | same | same |
| Net ID | same | same | same |
| Star Mode | | Normal | Passive |
| Start ID | | | same |
| End ID | | | same |
| Time slot | | | same |

Table 3：Parameters for the Same in different Work Mode

1.3 The Spread Factor and Bandwidth determines the RF data rate and sensitivity when the Code Rate is fixed. The table below gives the reference values in different combinations. Narrower bandwidth and larger Spread Factor means higher sensitivity and longer distance but longer air transmission time. Please note that the sensitivity in power mode 2 is lower than in power mode 0/1 so the values in blue color are not recommended for modules power mode 2.

| Bandwidth | Spread Factor | RF rate | Sens. | Bandwidth | Spread Factor | RF rate | Sens. |
|---|---|---|---|---|---|---|---|
| 500kHz | 12 | 1.172kbps | -131dBm | 250kHz | 12 | 0.586kbps | -134dBm |
| 500kHz | 11 | 2.148kbps | -128.5dBm | 250kHz | 11 | 1.074kbps | -131.5dBm |
| 500kHz | 10 | 3.906kbps | -126dBm | 250kHz | 10 | 1.953kbps | -129dBm |
| 500kHz | 9 | 7.031kbps | -123dBm | 250kHz | 9 | 3.516kbps | -126dBm |
| 500kHz | 8 | 12.5kbps | -120dBm | 250kHz | 8 | 6.25kbps | -123dBm |
| 500kHz | 7 | 21.875kbps | -117dBm | 250kHz | 7 | 10.938kbps | -120dBm |
| 500kHz | 6 | 37.5kbps | -112dBm | 250kHz | 6 | 18.75kbps | -115dBm |
| 500kHz | 5 | 62.5kbps | -111dBm | 250kHz | 5 | 31.25kbps | -114dBm |
| 125kHz | 12 | 0.293kbps | -137dBm | 62.5kHz | 12 | 0.146kbps | -140dBm |
| 125kHz | 11 | 0.537kbps | -134.5dBm | 62.5kHz | 11 | 0.269kbps | -137.5dBm |
| 125kHz | 10 | 0.977kbps | -132dBm | 62.5kHz | 10 | 0.488kbps | -135dBm |
| 125kHz | 9 | 1.758kbps | -129dBm | 62.5kHz | 9 | 0.879kbps | -133dBm |
| 125kHz | 8 | 3.125kbps | -126dBm | 62.5kHz | 8 | 1.563kpbs | -129dBm |
| 125kHz | 7 | 5.469kbps | -123dBm | 62.5kHz | 7 | 2.734kbps | -126dBm |
| 125kHz | 6 | 9.375kbps | -118dBm | 62.5kHz | 6 | 4.688kbps | -121dBm |
| 125kHz | 5 | 15.625kbps | -116dBm | 62.5kHz | 5 | 7.813kbps | -121dBm |
| 41.67kHz | 12 | 0.098kbps | -141.8dBm | 31.25kHz | 12 | 0.073kbps | -143.1dBm |
| 41.67kHz | 11 | 0.179kbps | -139.3dBm | 31.25kHz | 11 | 0.134kbps | -140.6dBm |
| 41.67kHz | 10 | 0.326kbps | -137dBm | 31.25kHz | 10 | 0.244kbps | -138.4dBm |
| 41.67kHz | 9 | 0.586kbps | -134.1dBm | 31.25kHz | 9 | 0.439kbps | -135.6dBm |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 41.67kHz | 8 | 1.042kbps | -131.2dBm | 31.25kHz | 8 | 0.781kbps | -132.8dBm |
| 41.67kHz | 7 | 1.823kbps | -127.8dBm | 31.25kHz | 7 | 1.367kbps | -129.2dBm |
| 41.67kHz | 6 | 3.125kbps | -123.6dBm | 31.25kHz | 6 | 2.344kbps | -125.4dBm |
| 41.67kHz | 5 | 5.209kbps | -122dBm | 31.25kHz | 5 | 3.906kbps | -123dBm |

Table 4：Bandwidth/Spread Factor vs Sensitivity/RF Data Rate

1.4 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. Therefore the default value 4/5 is enough for normal operations.

1.5 Time slot: It refers to the data collection time in the passive mode of star network. Usually it is closely related to the RF data rate, size of data package from node module and the UART data rate. The configuration tool provides a calculator which can be used to estimate the time slot. This function will be introduced in the function block Tools.

## 2. Update

This function is preserved in the preliminary version of the firmware so it might be canceled when the function of the firmware is fixed..

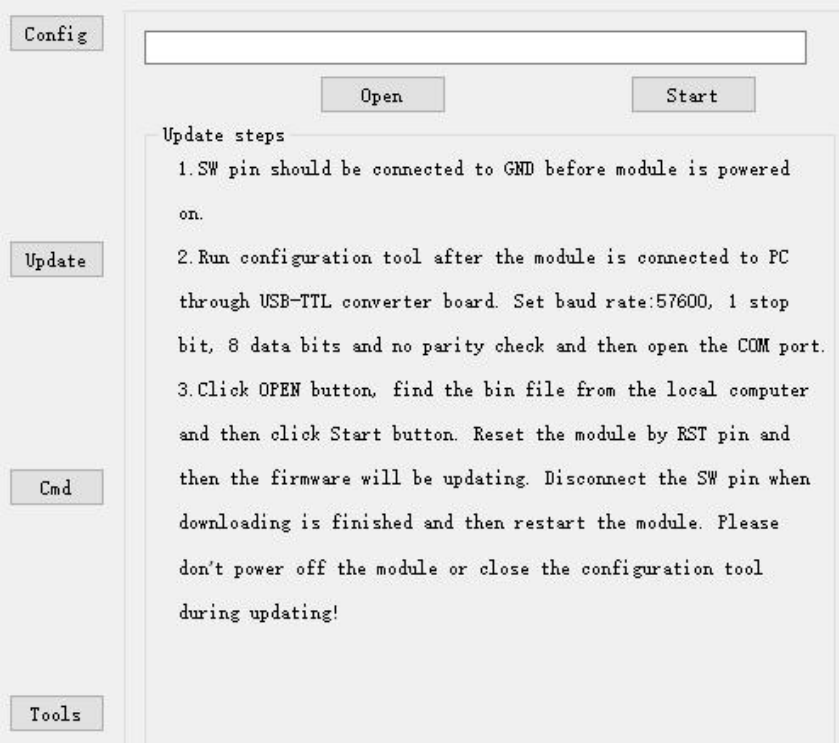


Figure 5：Function Block---Update

## 3. CMD

This function block shows the available command list. Each command can be selected through the drop-down menu and corresponding command format and response will be showed in the display area on the right. Some uncommon commands which are not listed in the datasheet also can be found in this block. For example, when users choose the command Get Version, the details of this command will be showed on the right side.

Command format: FF FF 02 29 2B
Description: Get the firmware version of the module, which which is a 4-byte string. The value in the response is 56 31 2e 31 as example.

Response: FF FF 06 2A 56 31 2e 31 16

The four bytes (56 31 2e 31) are ASCII in Hex format so the corresponding ASCII is V1.1 for firmware version.

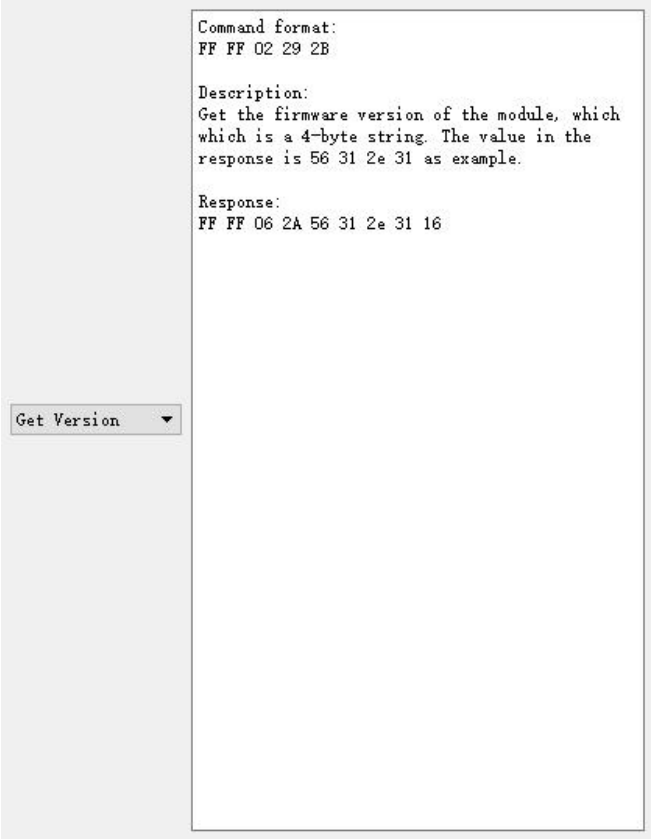


Figure 6：Function Block--- CMD

## 4. Tools

This function block provides some auxiliary tool which can be used to calculate the values of some parameters as reference. It includes three parts: Settings, Reference Values and Time Reference.

Settings area --- users need to make selection of the parameters in the area before the calculation starts. No matter what the present values of these parameters are showed, users need to **make selection for the Spread Factor** (no matter change it or not) to activate the tool. The Spread Factor and Bandwidth determines the air transmission rate (RF rate) and then the payload (effective data) will determine how much time will be used to transmit the data at this air transmission rate. Please note that the calculation is made when the code rate is set to 4/5. If the code rate is different, the air time will be longer than the calculated values.


Figure 7: Settings in Function Block---Tools

Reference Values --- this area shows the calculated results when the parameters in the Settings are selected. These values are only used for reference so users need to leave the margin when using the products in real-time applications.

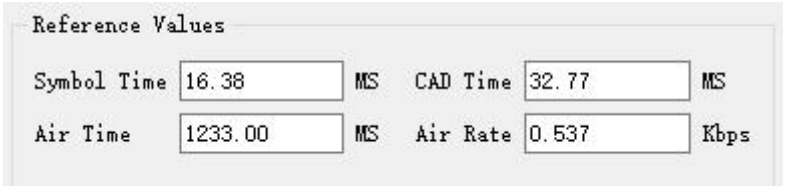


Figure 8: Reference Values in Function Block---Tools

Time Reference --- It gives the reference value for time slot when the parameters in the Settings are selected. When the Spread Factor, Bandwidth and Payload Size are selected, the air time will be calculated,which determines the time slot for node modules in passive mode of Star network. When users change any of the three parameters, the value of Time Slot will be updated and the max. number of nodes in this period will be showed.

For example: if Spread Factor=11 (this parameter must be selected in order to activate the calculator ) Bandwidth=125kHz and the payload=50 bytes. The estimated Air Time is about 1233ms and the recommended Time Slot=2 SEC. If the Sampling Period is set to 1 minute and the Star Mode is selected to Passive Mode (must be clicked in order to activate the calculation), the max. number of node is showed as 20.


Figure 9: Time Reference in Function Block---Tools

As discussed in the datasheet, one round collection of data in passive mode concerns the interactions between the central module and its host, between the central module and node module, and between the node module and its host. The time slot assigned to the node module is counted as soon as the central sends the data collection command to it. It means the node module should fulfill the data transmission in 1 time slot which can be sliced as below:

1. The central module sends the data collection command to the node module.
2. The node module receives the command and then send the data to the central module.
3. The central module receives the data.

If the central module receives the data in the time shorter than 1 time slot, it will finish the counting and start to send the data collection cmd to the next node and restart the counting for 1 time slot. If it doesn't receive the full data in 1 time slot, it will give up the data collection for present node and send the data collection cmd to the next node directly. The calculated Time Slot in the tool is a reference value. If users choose the extra low RF data rate or large payload, the value can be increased manually in order to avoid data loss or dumping.

## COMMUNICATIONS:

1. Standard Data Transmission:

If the parameters of the modules in table 3 are the same and the TX/RX frequencies are the same (or crossed), the modules can connect to any UART host with the same data format (Baud rate, parity check, data bit, stop bit, etc). In order to demonstrate the function of DRF126xDS easily, the modules are soldered on the testing kit DAC07 and are connected to the PC through USB-to-TTL converter board DAC02. Users can check the datasheet of DAC07 for more details about the power mode setting.

Figure 10: DRF126xDS module on DAC07 Board

In order to facilitate the testing, the module is set to power mode 0 (EN pin=0V, MO pin=0V) through the jumpers on the DAC07 board. After inserting the two kits into USB-to-TTL converter board DAC02 and connecting them to the computer, users can run the configuration tool by clicking the OPEN button to activate the tool, click Start to enter into the configuration mode and can click Read to read out the default parameters of the two modules. If the new values of the parameters are set, users need to click **Finish** to quit the configuration mode.

The tool can test the simple communication among modules. There are two areas on the right side of the tool. In configuration mode, the display area (called as RX area hereafter) at the top shows the response of the modules to the commands. In the normal communication mode, this area shows the data which the module receives. Users can send data or command in the textbox at the bottom area (called as TX area hereafter). The checkbox HEX can be used to receive or display the data in Hex format or not. For command input or communication in star network, the checkbox should be checked in order to interrupt the command or recognize the ID information correctly.

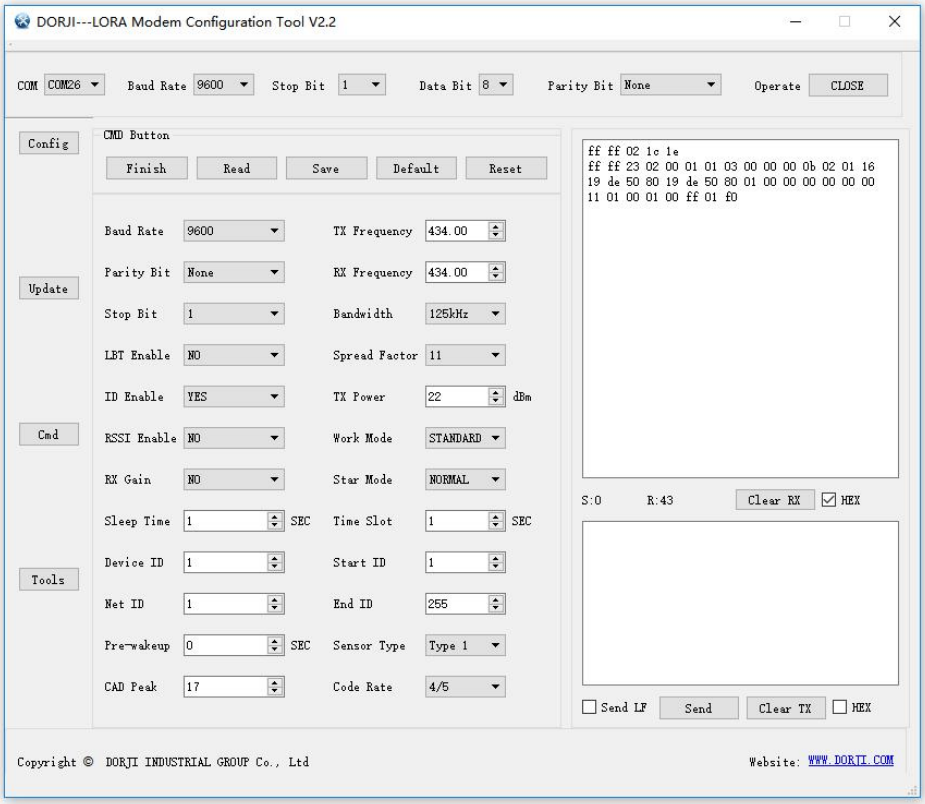


Figure 11: Module 1 Occupying COM 26 in Configuration Mode

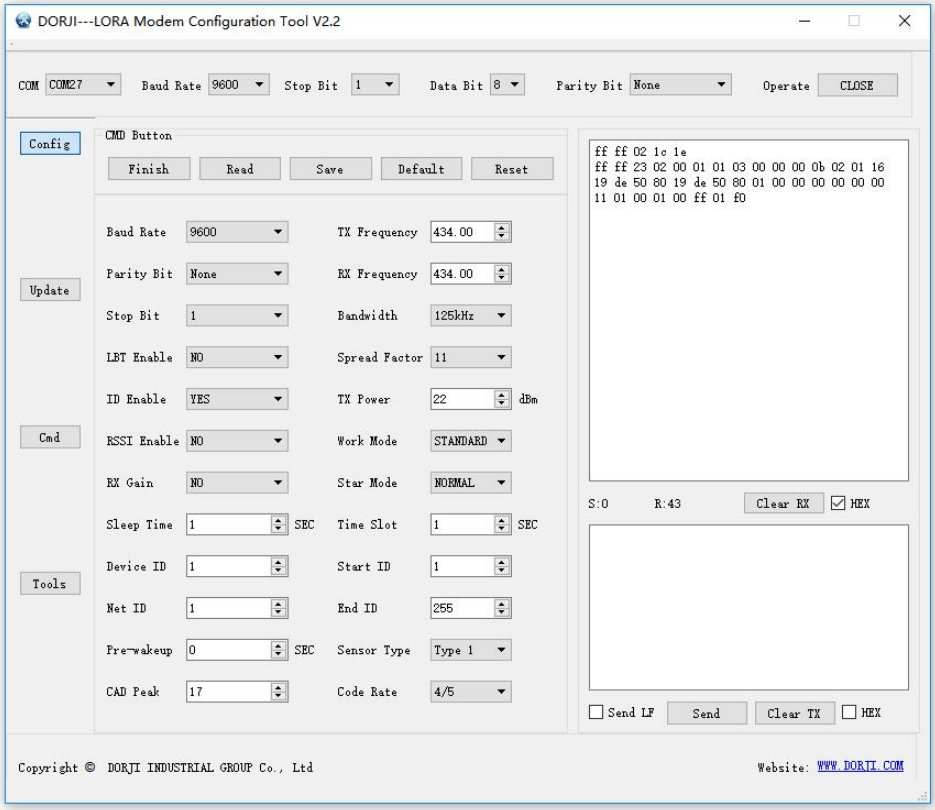


Figure 12: Module 2 Occupying COM 27 in Configuration Mode

If the default parameters don't need to be changed, users need to click the Finish button to quit the configuration mode. The response information in RX area can be cleared by clicking the Clear RX button before testing communication. Input data (Test the communication between module 1 and module 2 ) in the TX area in the module 1 and click Send, the module 2 will show this message in the RX area.

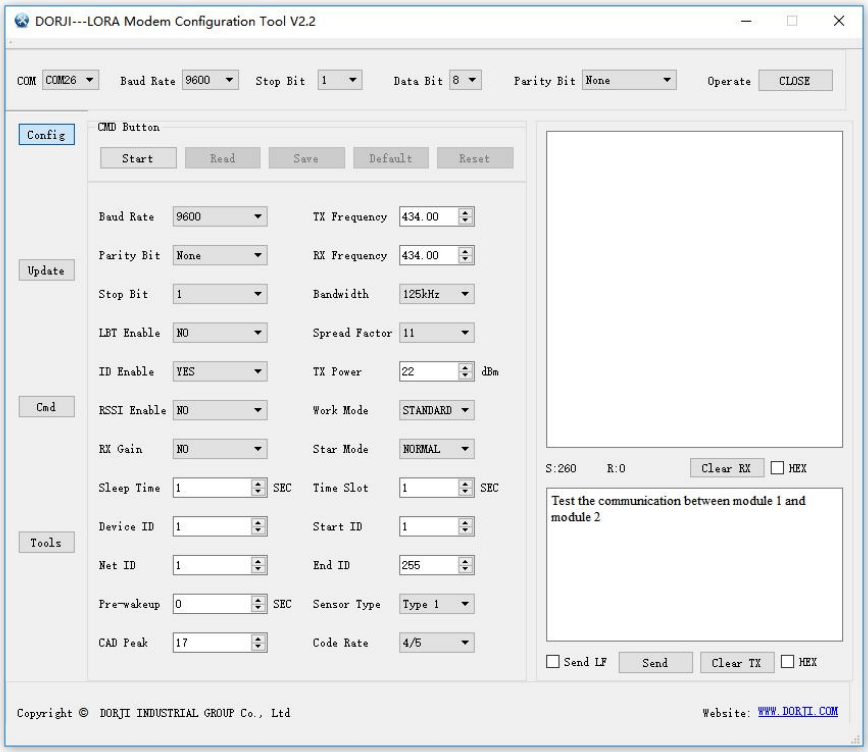


Figure 13: Module 1 Sending Data to Module 2

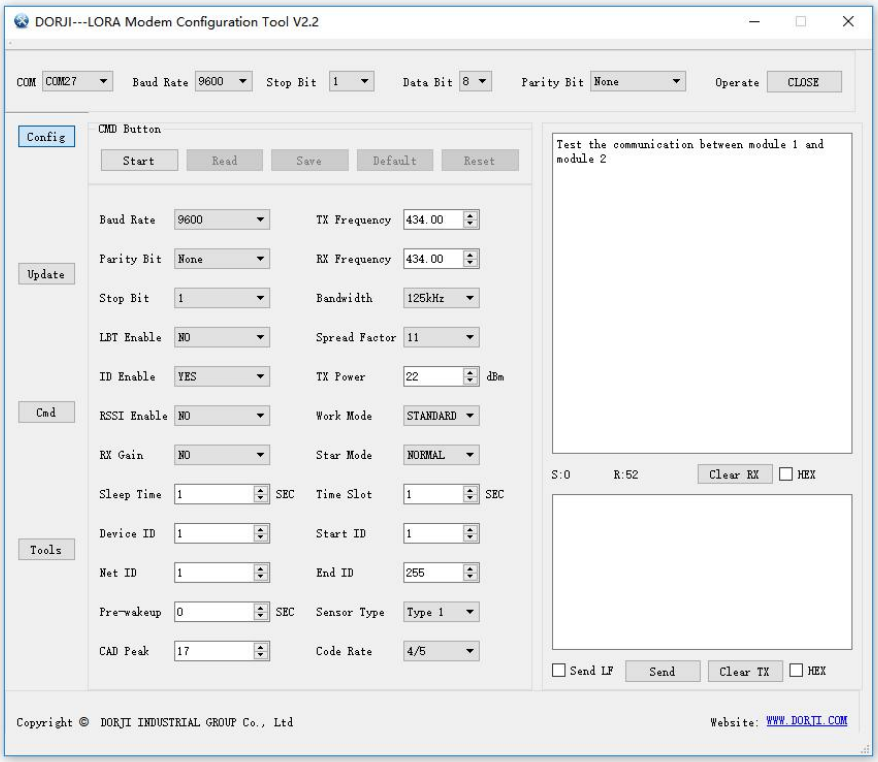


Figure 14: Module 2 Receiving Data from Module 1

Except configuration tool, users also can choose other serial port tool to test the communication as long as the UART data format are set to the same. Below is the testing with Advanced Serial Port Monitor.

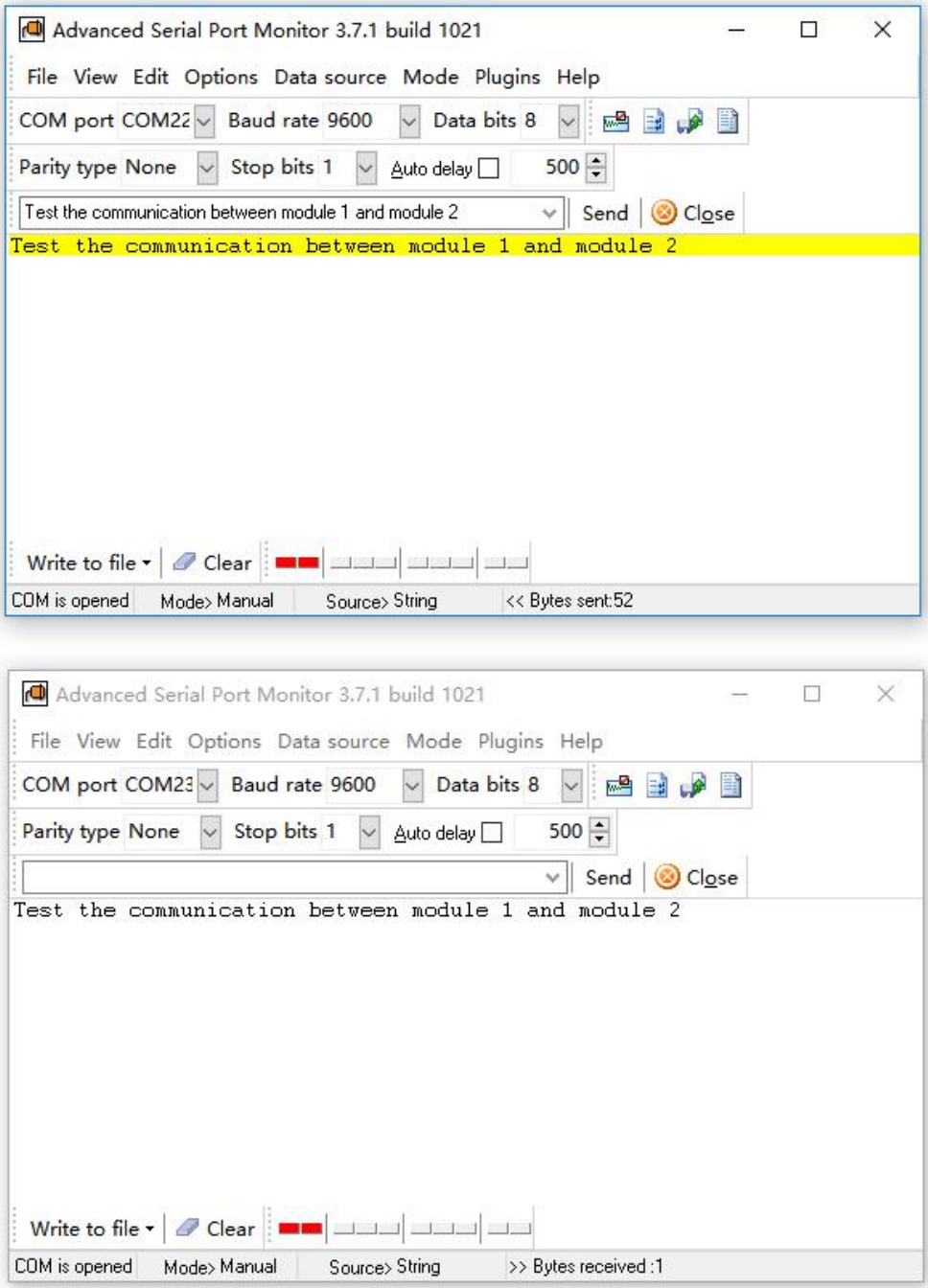


Figure 15: Testing with Advanced Serial Port Monitor

In summary if users don't need to change the default parameters, users only need to make the UART data format (serial port parameters) of the host the same as the data format of the modules. When the module receives the data from its host, it will transmit it automatically. If the module receives the wireless data from another module, it will transfer it to its host directly. If users want to use a different RF data rate (air transmission rate), the Spread Factor and Bandwidth can be changed.

2. Normal Mode in Star Network

The work mechanism in this mode is nearly the same as in standard data transmission except that the ID verification function is added. The parameter ID Enable determines if the central module filters the first two bytes (Device ID of the node module) of the data package which it receives from the node modules or not. Therefore this parameter only affects the central module in star network mode. ID Enable is set to YES by default.

Users can let the modules enter into the configuration mode and change the work mode of module 1 (in COM26) to CENTRAL and module 2 (in COM27) to NODE. The Star Modes of the two modules are set to NORMAL. For central module, it needs to specify the device ID of the node module in the data package and the ID must be shown in HEX format in case the node module can not recognize it. When the node module sends data to the central module, it doesn't need to specify the device ID of the central module which will receive the data from the node modules with the same net ID automatically. Assuming the net ID of module 1 and module 2 are set to 1, the device ID of module 1(the central module)=1 and the device ID of module 2 (the node module)=2. The checkbox HEX must be selected.

The central module sends out three data packages(00 00 01 02 03 04 05), (00 01 02 03 04 05 06) and (00 02 03 04 05 06 07) one by one (totally 21 bytes). The ID=00 00 in the first data package means it's a broadcasting data so any node module can receive the data (01 02 03 04 05). The ID=00 01 in the second data means the data is for the node module with device ID=1 so it can not be received by the node module. The ID=00 02 in the last data package is for the node module with device ID=2 so it is well received. Therefore the node module receives the first one and the last one (totally 10 bytes).

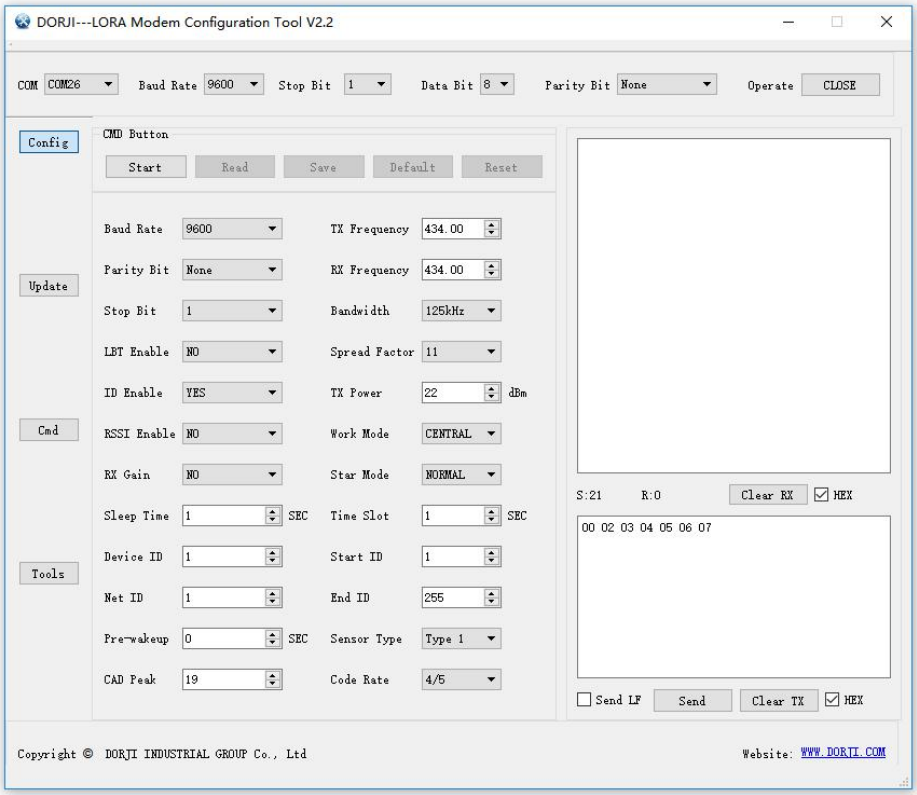


Figure 16: Module 1(Central Module in COM26) Sends Data to Module 2

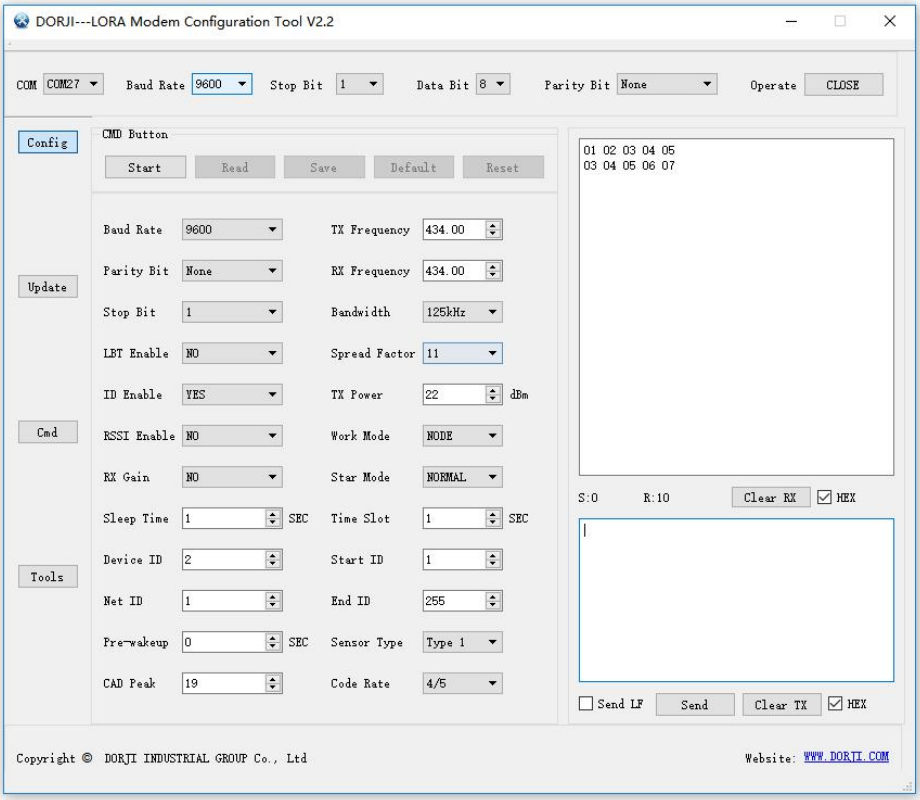


Figure 17: Module 2(Node Module in COM27) Receives Data from Module 1

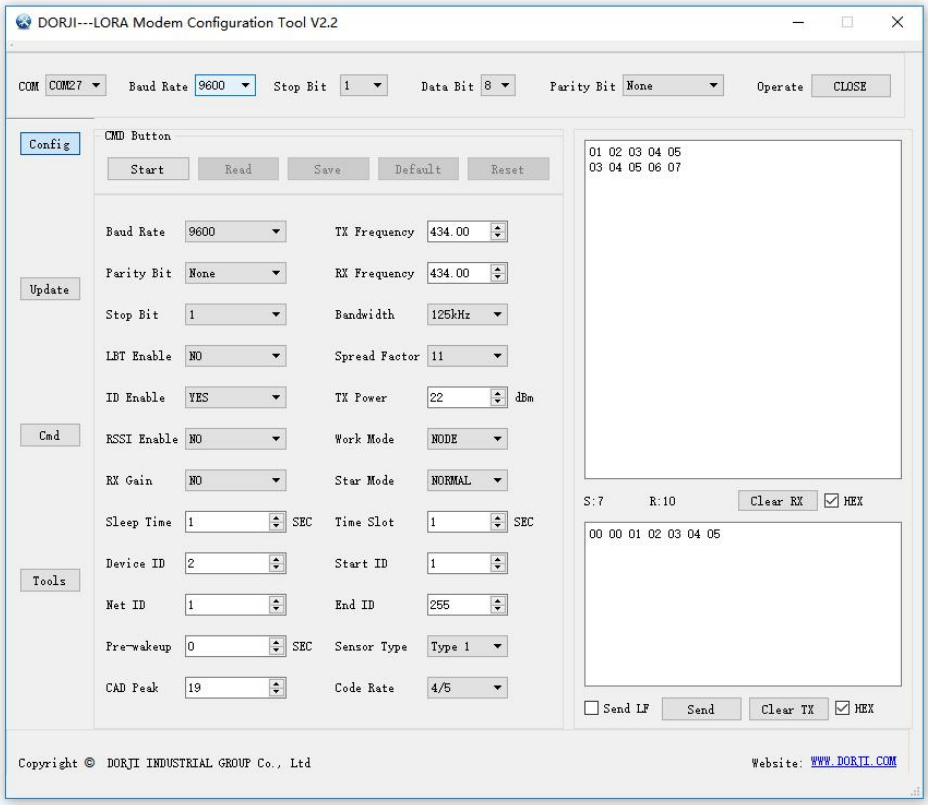


Figure 18: Module 2(Node Module) Sends Data to Module 1

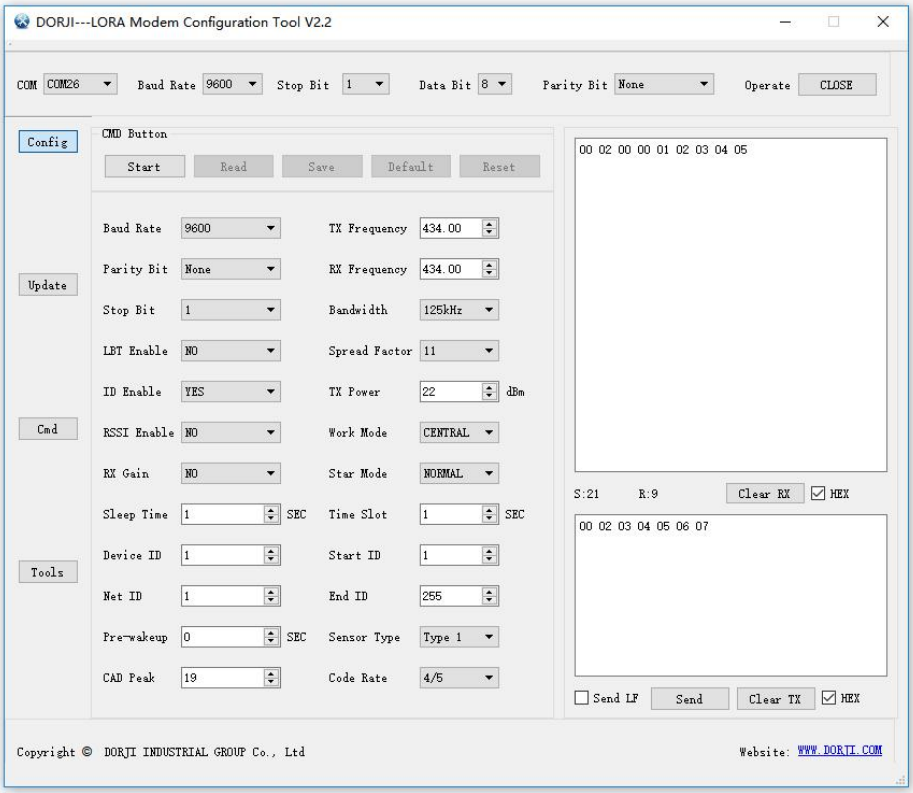


Figure 19: Module 1(Central Module) Receives Data from Module 2

The node module sends data (00 00 01 02 03 04 05) and the central module receives the data (00 02 00 00 01 02 03 04 05). Since the ID Enable is YES, the device ID (00 02) of the node module is shown in the data package. If ID Enable is NO, the central module will receive the data (00 00 01 02 03 04 05).

3. Passive Mode in Star Network

Users need to change the star mode of the two modules to PASSIVE through configuration tool and keep other parameters unchanged. In low power applications, the node module usually works in power mode 2 (EN=1, MO=0). It means the central module needs to send longer preamble in order to wake up the node module effectively. Therefore the power mode of the central module should be set to mode 1 (EN=0, MO=1).

| Parameter | Module 1 | Module 2 |
|---|---|---|
| Net ID | 1 | 1 |
| Device ID | 1 | 2 |
| Work mode | Central | Node |
| Star mode | Passive | Passive |
| Sleep time | 1s | 1s |
| Time Slot | 2s | 2s |

Table 5: Parameters in Passive Mode

If the data which will be sent by node is 0123456789 (totally 10 bytes), the time slot can be calculated in the Tool block of the configuration tool.

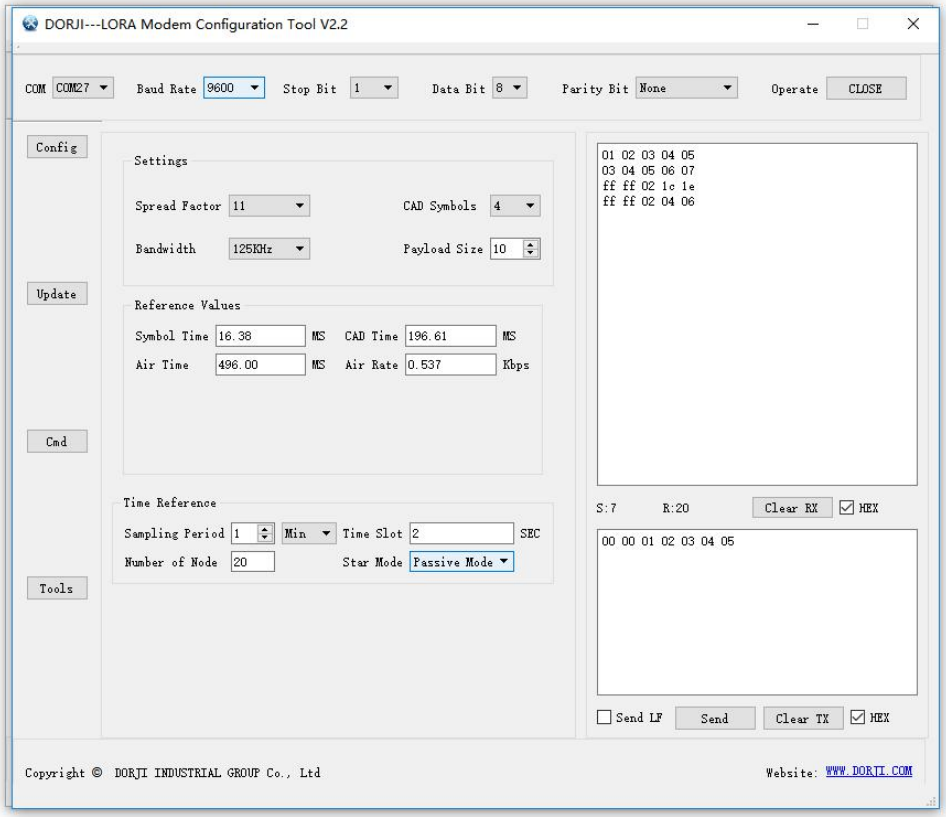


Figure 20: Calculating the Time Slot

One successful data collection in passive mode concerns the commands and responses between the central module and its host, broadcasting command from the central module to the node modules and the data / command exchange between the node module and its host. Therefore the configuration tool can not satisfy the testing for the modules in the passive mode of star network. DORJI provides another simple testing tool which can be used to demonstrate the whole process for one round of data collection. The tool also shows the basic use of commands concerning the passive mode of star network. Making sure the two modules are configured with the correct parameters and the corresponding COM ports occupying by the configuration tools are closed before running the testing tool.

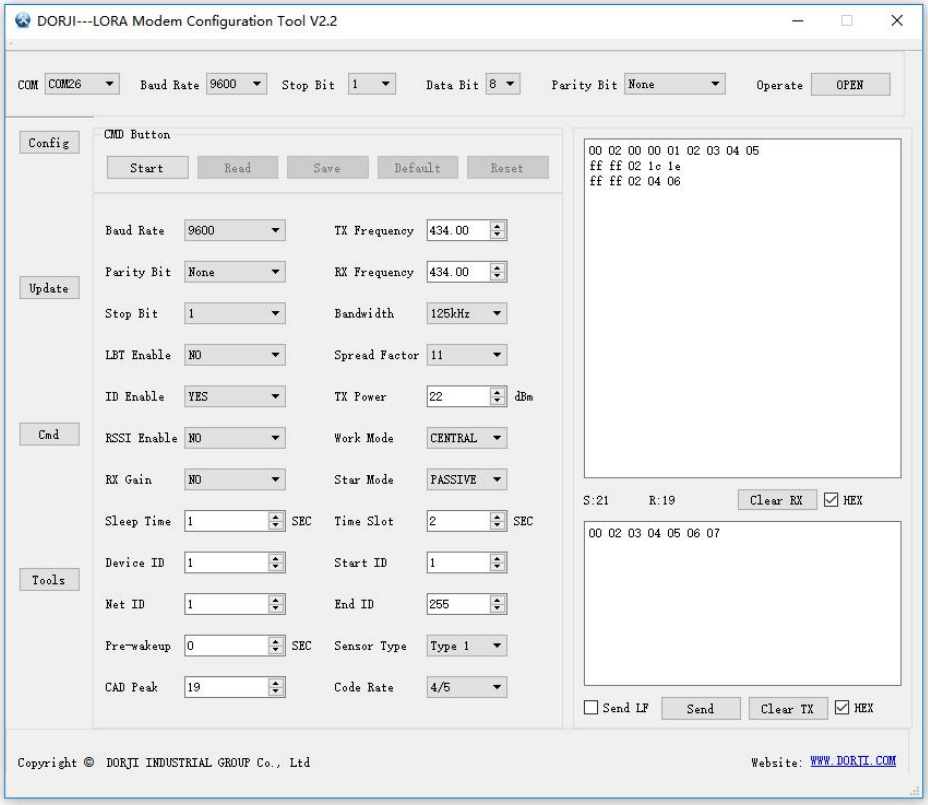


Figure 21: Module 1 in COM26 is Set to Central Module in Passive Mode

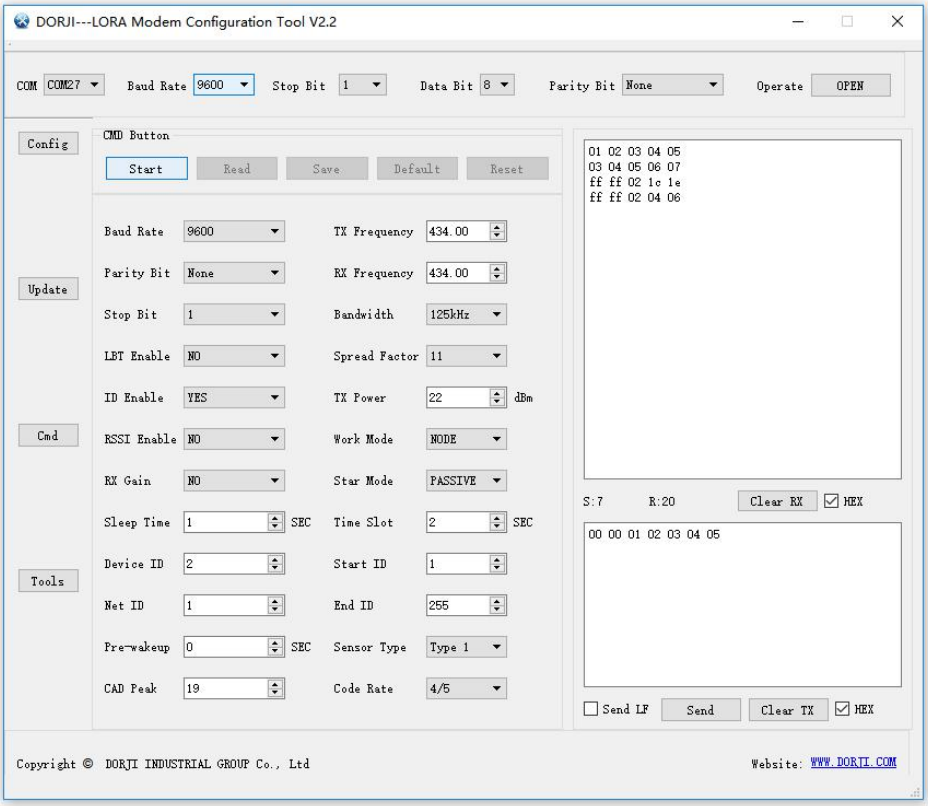


Figure 22: Module 2 in COM27 is Set to Node Module in Passive Mode

The testing tool for passive mode of star network contains three parts. The first part refers to the parameters concerning UART data format which has the same meaning in the configuration tool. Users need to set the same parameters as what the DRF126xDS modules have.

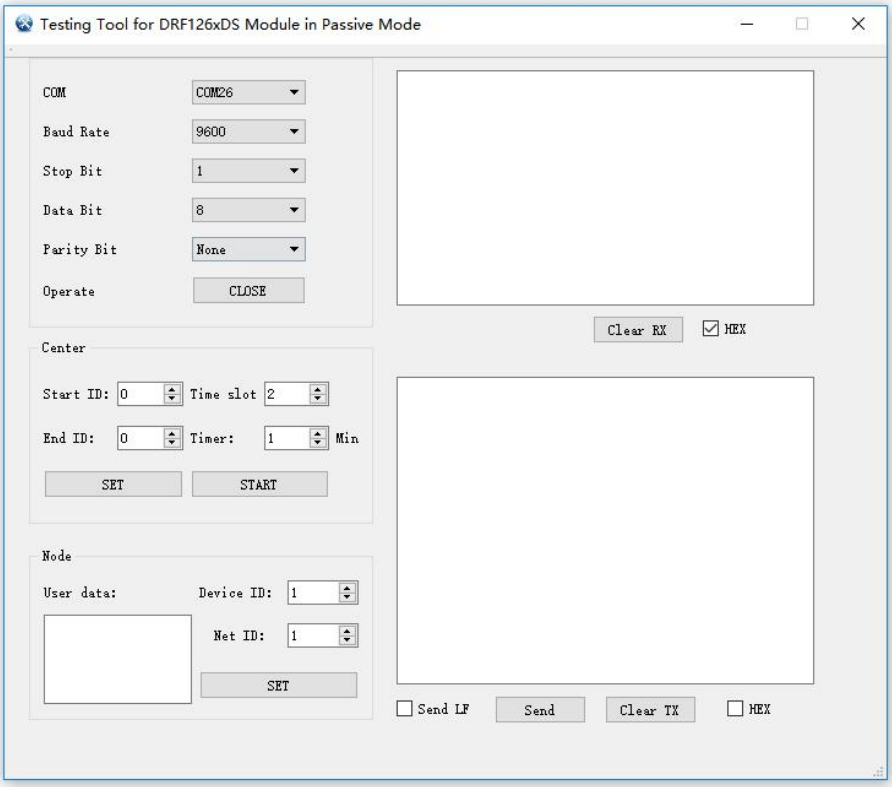


Figure 23: Testing Tool for Passive Mode in Star Network

The parameters in the second part (Center area) are used for the central module. The Start ID and End ID specify the range of device ID of the node modules. The time slot determines the max time for the central module to collect the data from one node module. The timer refers to the period which the central fulfills one round of data collection for targeted node modules.

The third part (Node area) sets the data which the node module will send to the central module. There is a text area (User data) in which the testing data (e.g. 0123456789) can be input. When the node module receives the wake-up command, it will pick up the data in this area as if the data is from its host. After the node module receives the data collection command from the central module, it will send the data to the central module at once.Users also can change the Device ID and Net ID of the node module and click SET button to make the new parameters come into effect.

By following some of the parameters from previous section, the central module is set with Net ID=1 and Device ID=1 and the node module is set with Net ID=1 and Device ID=2. The time slot for 10 bytes of data (0123456789) is 2S when Spread Factor=11 and Bandwidth=125kHz (refer to Figure 20). Since the device ID of node module is 2, the Start ID can be set to 1 and the End ID can be set to 3 for verification. The timer can be set to 1 minute for simple.

Now the central module can be connected to the testing tool by opening the corresponding COM port. When the new parameters are input in the center area, users can click SET button to make new values come into effect.

The (ff ff 07 0d 00 01 00 03 02 1a) is the Network Parameter Setting Command (table 6 in the datasheet) sent to the central module by the host (here is the testing tool) and (ff ff 02 0e 10 ) is the response of the central module to this command from the host.

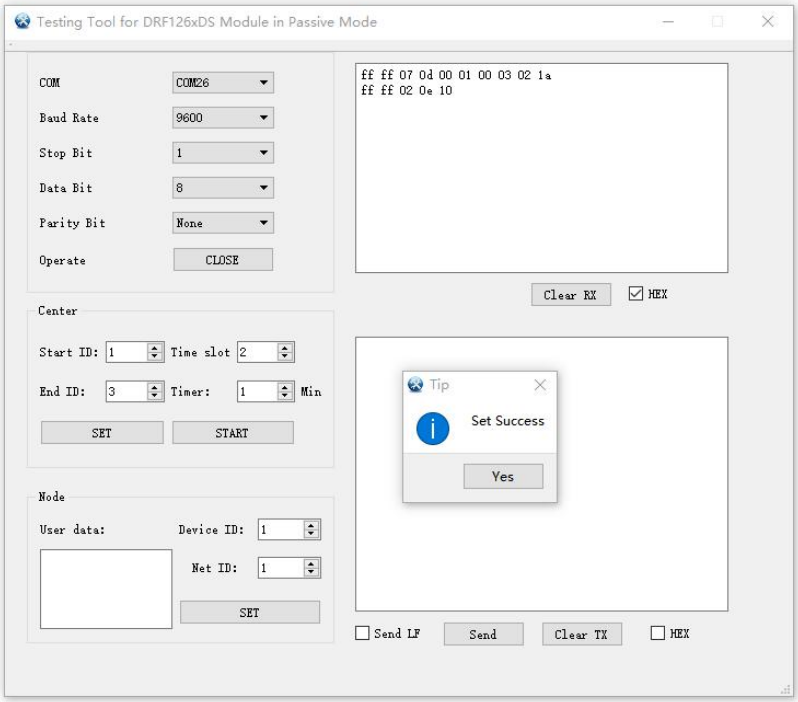


Figure 24: Setting Parameters for Central module

Users can connect the node module to another testing tool and input 0123456789 in the User data and keep device ID and Net ID unchanged since the node module is set with Net ID=1 and Device ID=2 already through configuration tool. If the Net ID of the node module is not the same as central module's and its Device ID is out of the range Start ID ~ End ID, users also can make quick changes here and click the SET button to make the new parameters come into effect. For example, we change the Device ID=2 and Net ID=1, the RX area on the right-top of the tool shows the SET ID command (ff ff 05 09 00 02 01 11) but there is no response. Since the node module is set to power mode 2 in which mode the module can not be configured with parameters, users need to switch the module to power mode 0 or mode 1 (EN=0, MO=0/1) and then click the SET button. The module will give the correct response (ff ff 02 0a 0c) for this change.

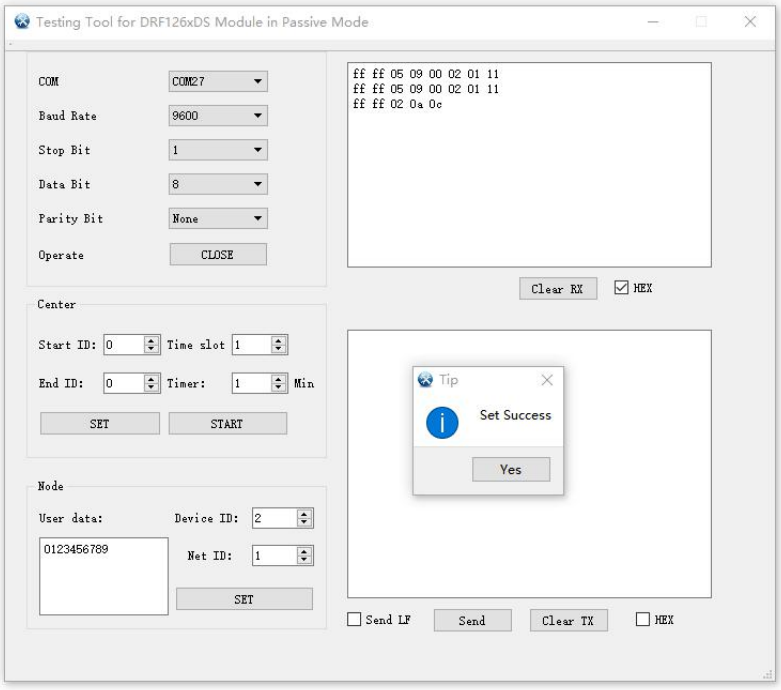


Figure 25: Changing ID of the Node Module

Assuming the testing tool connecting the central module is central tool and the testing tool connecting the node module is node tool. Users can click the START button in the central tool to start the data collection. The tool will send wake-up command (ff ff 02 21 23) to the central module. When the latter receives it, it will give the response (ff ff 02 22 24) to the host (which is showed in the tool) and meanwhile the central module broadcasts the wake-up command to the node modules to wake them up from power mode 2. After waiting for 1 time slot, the central module will send data collection command one by one (from Start ID to End ID)

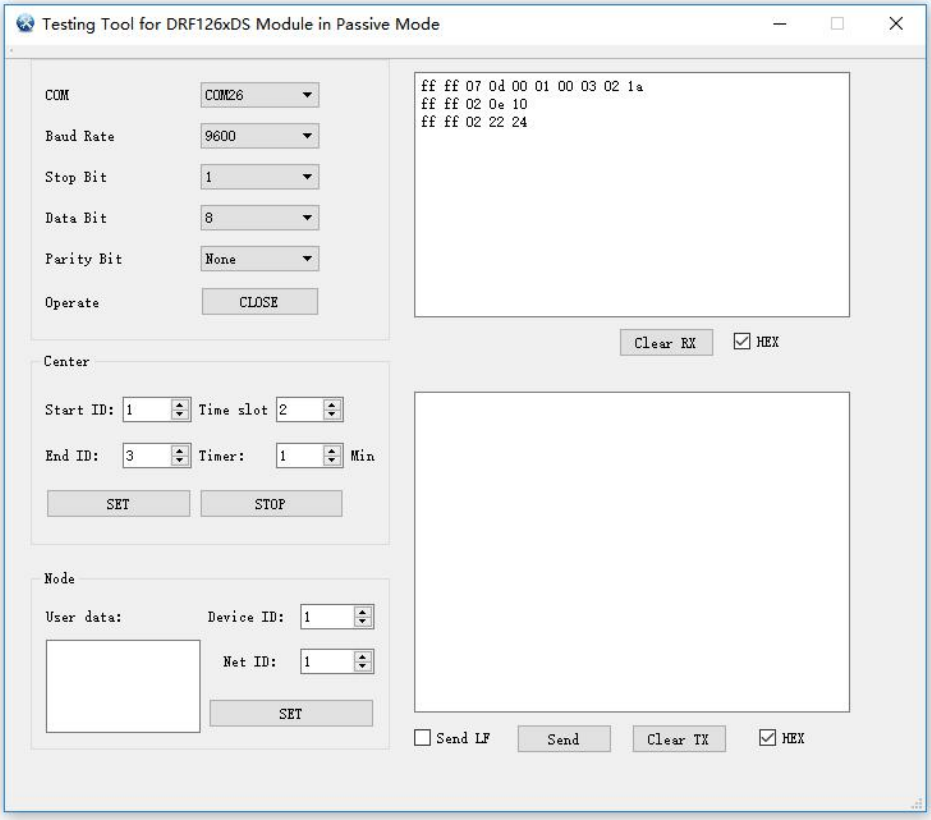


Figure 26: The Central Module Gives Response and Broadcasts the Wake-up Command

When the node module receives the wake-up command and finds its device ID is included, it will switch to the power mode 0 (no matter its former mode is mode 0 or mode 2) and send Data Request Command (ff ff 02 1f 21) to its host (here refers to the testing tool connecting to it). The node tool then responds to the node module with the data at the fixed data format (ff ff 0c 20 30 31 32 33 34 35 36 37 38 39 39) among which the ff ff is the header, 0c is the length of the command, 20 is the command type, 30 31 32 33 34 35 36 37 38 39 is the data (from the User data area in HEX format) and the last 39 is the CRC byte. The node module keeps the data inside and wait for the data collection command containing its ID from the central module. As soon as the node module gets the command, it will send the data to the central module and switch from power mode 0 to its former power mode (determined by the logic levels on EN and MO pins). The Figure 27 shows the process on the node module side.

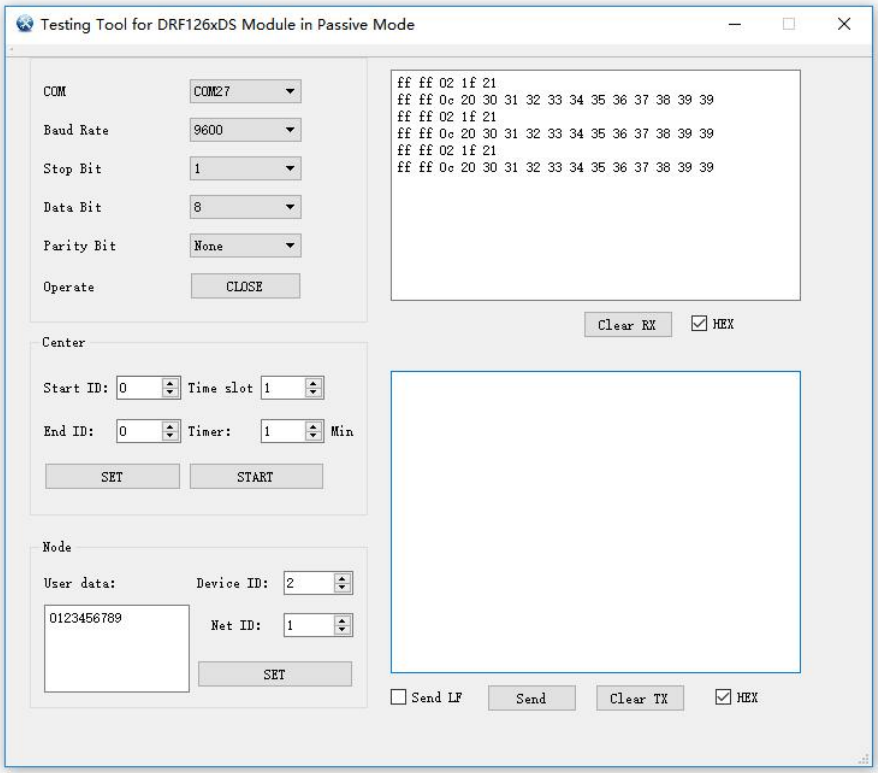


Figure 27: The Node Module Gets the Data

When the central module receives the data from the node module, it transfers it (00 02 30 31 32 33 34 35 36 37 38 39) to its host (here refers to the testing tool). The first two bytes (00 02) in the data package is the device ID of the node module and 30 31 32 33 34 35 36 37 38 39 is the data in Hex format from the node.

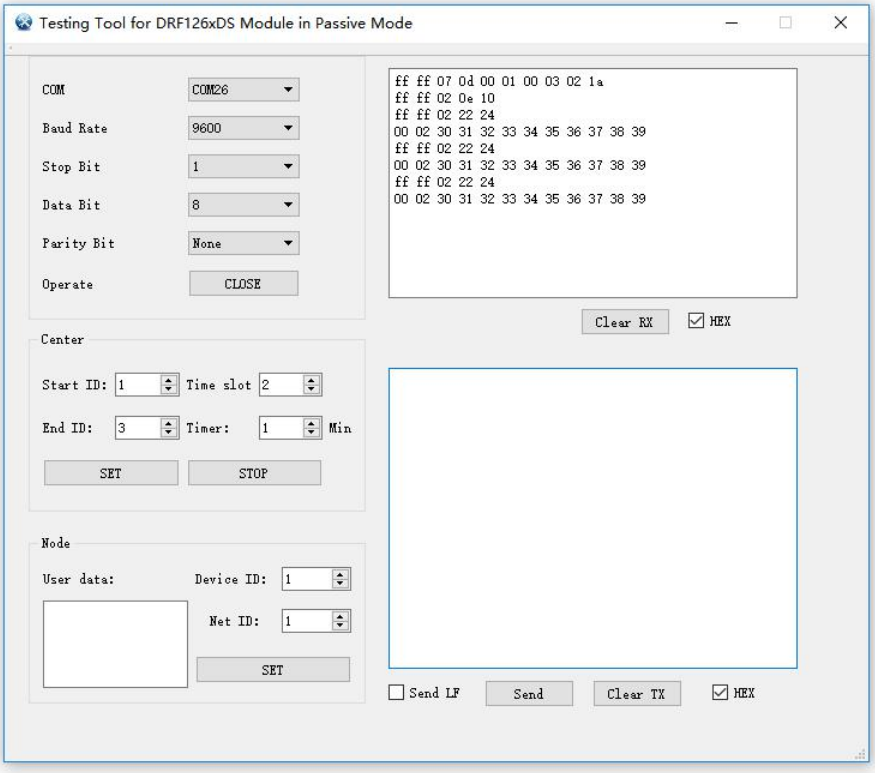


Figure 28: Broadcasting the Wake-up Command

In the testing the central module sends totally three data collection commands with device ID from 1 to 3. Since there is only one node module with device ID=2, the central module only gets one data package in one round of collection (Timer=1 minute). When the counting of 1 minute is finished, the central tool will send wake-up command again to start the next round of data collection and repeat this process till users click the STOP button to finish the testing. The central tool sends a STOP command (FF FF 02 23 25) to the central module which will inform the node modules go back to former power mode. The central module gives response (ff ff 02 24 26) to this command.

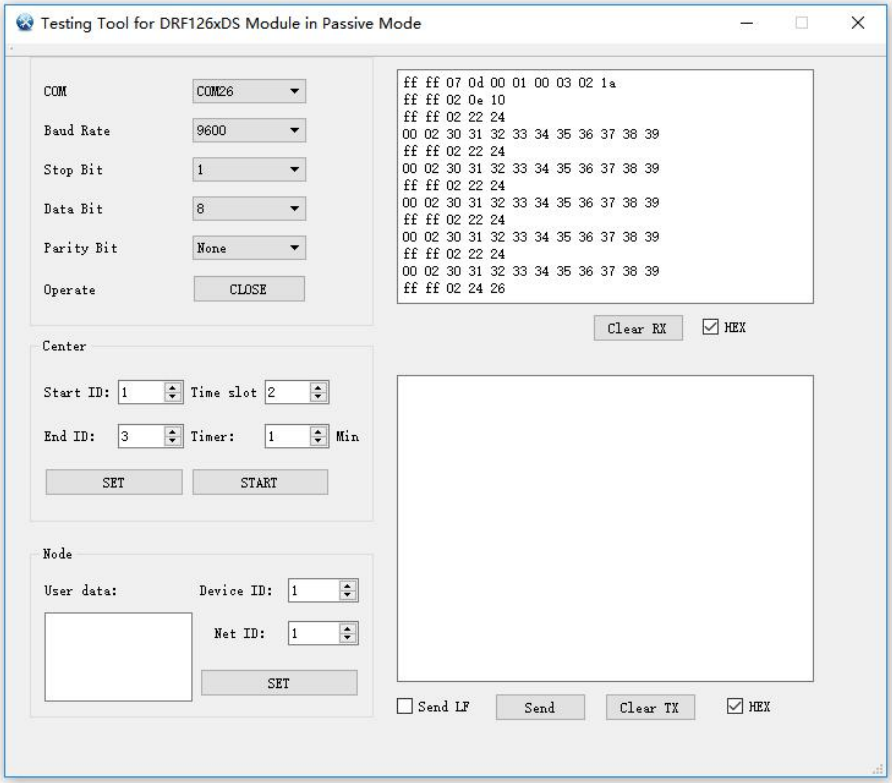


Figure 29: Finish Testing with STOP Command

Notes:

1. To start the first round of data collection, the host needs to send two commands to the central module. One is Parameter Setting Command which sets the Start ID, End ID and Time slot and another is Wake-up command which will let the central module wake up related node modules and start the counting for one round of data collection. If users want to start the second round (or more) of data collection, users only need to send the wake-up command if the network parameters are not changed.

2. The function of wake-up command is to let the central module wake up all of related node modules if the latter are in power mode 2 (half sleep mode) and force them to work in power mode 0 so the central module doesn't need to send long preamble to wake up the node module one by one. It will let the central module collect the data more quickly. The disadvantage of it is that the targeted node modules are all woken up and keep in the receive status till the data are collected. Therefore the power consumption will be increased if there are a lot of node modules needing to be collected in one round. For example, if the Start ID=1 and End ID=100, there are 100 node modules will be woken up when the central module receives the wake-up command from its host. When the node module with Device ID=1 receives the first data collection command, it will be back to former power mode (mode 0 or mode 2 depending on the EN/MO pins) after it sends out the data to the central module. For the node module with Device ID=100, it will keep in the receive status (power mode 0) till it receives the 100$^{th}$ data collection command from the central module. Therefore the 100$^{th}$ node module consumes the highest energy. If users use higher RF data rate, the air transmission time can be reduced and the waiting time of the last node modules also be reduced correspondingly but the communication distance will be affected.

Therefore users need to make the trade-off between the number of node modules and the RF data rate according to the application.

3. If users don't need to consider power consumption, the node modules can work in power mode 0 (EN=0, MO=0) and the central module can work in power mode 0 or power mode 1. If the node module is used in lower power applications, it must be set to power mode 2 (EN=1, MO=0) and the central module must be set to power mode 1 (EN=0, MO=1) in order to send longer preamble to wake up the node modules effectively.

4. The testing tool connecting the node module can show the formatted data in the RX area so users can input the data into the User data area and get the formatted data when the node module sends the data to the central module. It is useful when the users want to send data to the node module through microcontroller and don't know how to format the data at the start.

Dorji Applied Technologies
A division of ***Dorji Industrial Group Co., Ltd***

Add.: Rm 210-212, Yuanxiong Bldg, Tongxin Rd. 26, Longgang district, Shenzhen, China 518129
Tel: 0086-755-28156122
Email: dorji@dorji.com
Web: http://www.dorji.com

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