RHF76-052

安信可 **LoRaWAN** 模组使用手册

V0.1

Document information

标题	内容
关键字	*LoRaWAN, IoT, Point to Point, Custom, full-duplex RHF76-052*
概括	该文档介绍如何使用 RHF76-052 模组

目录

1 前言

本文档显示用户如何使用 LoRaWAN 调制解调器进行快速测试，包括如何配置调制解调器，关键参数的详细说明，如何添加节点到服务器，如何添加设备到服务器等。

2 概括

RHF76-052 是一款 LoRAWAN 调制解调器，深圳市安信可科技有限公司产品其中一款 LoRa 模组,内置
LoRaWAN 协议栈，支持 AT 命令指令集。

此外，还需要一台主机或者 MCU 发送 AT 指令来控制模组。

考虑到固件升级，用户需要额外的开源工具 ExtraPutty。 请联系我们的技术支持。

串口配置：

波特率：9600；8 位数据；无奇偶校验，1 个停止位。

3 快速开始

由于LoRaWAN网络和点对点应用中的高性能，RHF76-052非常适合长距离长电池寿命应用。 客户可以
使用它以ABP或OTAA方式加入现有的LoRaWAN网络，也可以使用它来实现点对点通信应用。

1）要参与LoRaWAN网络，每个终端设备都必须进行个性设置和激活。 终端设备的激活可以通过两种方
式实现：通过在终端设备部署或重置时通过空中激活（OTAA），或者通过个性化激活（ABP）实现终端
设备，其中两端的终端 设备个性设置和激活是一步完成的。

2）要实现点对点应用，首先应通过AT命令将设备配置为测试（TEST）模式。 您可以使用两个调制解调
器进行通信，也可以使用RHF76-052与其他LoRa设备进行通信。

关于密钥，ID，EUI和模式的关系，请参考下表：

Mode	ID/EUI	Key
ABP	DevAddr	NwkSKey, AppSKey
OTAA	AppEUI, DevEUI	AppKey

表格 3-1 ABP and OTAA mode ID/EUI/Key

3.1 ABP 入网方式

使用 ABP 入网方式,NwkSKey 和 AppSKey 需要提前知道。 请检查服务器中这两个密钥。

首次启动设备时，请按照以下命令列表进行操作：

AT+RESET *//AT command to modem from HOST// //Reset the modem when power up//*

+RESET: OK

LoRaWAN AT Modem

+VER: 1.9.1 // Message return back to HOST follow AT command //

AT *//Sent command "AT" to double check the interface between HOST and SLAVE//*

+AT: OK

AT+ID *//Check ID of the device//*

+ID: DevAddr, 01:72:f4:d2

+ID: DevEui, 47:36:54:9f:00:2e:00:55

+ID: AppEui, 52:69:73:69:6e:67:48:46

AT+ID=DevAddr,"01 02 03 04" *//Set the new DevAddr//*

+ID: DevAddr, 01:02:03:04

AT+DR=EU868 *//Configure to LoRaWAN EU band, there are EU868, US915 and custom data rate scheme//*

+DR: EU868

AT+CH=0,868.1,DR0,DR5 *//Set Channel 0 to 868.1MHz, date rate from DR0 to DR5//*

+CH: 0,868100000,DR0:DR5

AT+CH=1,868.3,DR0,DR5 *//Set Channel 1 to 868.3MHz, date rate from DR0 to DR5//*

+CH: 0,868300000,DR0:DR5

… //16 channels could be configured totally, from 0 to 15, please check the maximum channels the gateway can support//

AT+RXWIN2=869.525,DR3 *//Set the parameters of RXWIN2. Please check the RXWIN2 with server, wrong RXWIN2 will cause downlink lost//*

// You can also use SF and Bandwidth to configure RXWIN2. For example, AT+RXWIN2=434.9,SF9,250 //

+RXWIN2: 869525000,DR3

AT+DR=DR0 *//Set the default date rate of the device//*

+DR: DR0

AT+POWER=14 *//Set default output power to 14dBm[1]//*

+POWER: 14

AT+ADR=ON *//Set ADR ON, you could also set to OFF//*

+ADR: ON

AT+KEY=NwkSKey,"2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C" *//Use the NwkSKey used in your network instead//*

+KEY: NWKSKEY 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C

AT+KEY=AppSKey,"2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C" *//Use the AppSKey used in your network instead//*

+KEY: APPSKEY 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C

AT+CLASS=A *//set to Class A mode//*

+CLASS: A

AT+CMSGHEX="00 ff 22 33 5f 88 01 98 ad ac 46 12 be 43 54 43 35 45 33 45 44 35 33 54 5 43" *//Now you can send message to Gateway. 4 kinds of command could be used to transmit: AT+MSG, AT+CMSG, AT+MSGHEX, AT+CMSGHEX//*

+CMSGHEX: Start LoRaWAN transaction

+CMSGHEX: TX "00 FF 22 33 5F 88 01 98 AD AC 46 12 BE 43 54 43 35 45 33 45 44 35 33 54 05 43"

+CMSGHEX: Wait ACK

+CMSGHEX: ACK Received

+CMSGHEX: PORT: 12; RX: "11 22 33 44 55 66 77 88 99 00"

+CMSGHEX: RXWIN1, RSSI -82, SNR 10.25

+CMSGHEX: Done

Note:

(1) *RHF76-052 模组在 434MHz/470MHz 频率下输出功率最大为 20dBm，在 868MHz/915MHz 频率下最大值为 14dBm。 如果您有不同的要求，请联系 support@aithinker.com*

3.2 OTAA 入网方式

使用 OTAA 入网方式，需要 AppKey 和 AppEui。 您应该首先使用服务器检查 AppKey 和 AppEui。

首次启动设备时，请按照以下步骤操作：

AT+RESET *//AT command to modem from HOST// //Reset the modem when power up//*

+RESET: OK

LoRaWAN AT Modem

+VER: 1.9.1 // Message return back to HOST follow AT command //

AT *//Sent command "AT" to double check the interface between HOST and SLAVE//*

+AT: OK

AT+ID *//Check ID of the device//*

+ID: DevAddr, 01:72:f4:d2

+ID: DevEui, 47:36:54:9f:00:2e:00:55
+ID: AppEui, 52:69:73:69:6e:67:48:46
AT+ID=DevEui,"47 36 54 9f 00 2e 00 55" //Set the new DevEui//
+ID: DevEui, 47:36:54:9f:00:2e:00:55
AT+ID=AppEui,"52 69 73 69 6e 67 48 46" //Set the new AppEui//
+ID: AppEui, 52:69:73:69:6e:67:48:46
AT+DR=EU868 //Configure to LoRaWAN EU band, there are EU868, US915 and custom data rate scheme//
+DR: EU868
AT+CH=0,868.1,DR0,DR5 //Set Channel 0 to 868.1MHz, date rate from DR0 to DR5//
+CH: 0,868100000,DR0:DR5
AT+CH=1,868.3,DR0,DR5 //Set Channel 1 to 868.3MHz, date rate from DR0 to DR5//
+CH: 0,868300000,DR0:DR5
… //16 channels could be configured totally, from 0 to 15, please check the maximum channels the gateway can support//
AT+RXWIN2=869.525,DR3//Set the parameters of RXWIN2. Please check the RXWIN2 with server, wrong RXWIN2 will cause downlink lost//
// You can also use SF and Bandwidth to configure RXWIN2. For example, AT+RXWIN2=434.9,SF9,250 //
+RXWIN2: 869525000,DR3
AT+DR=DR0 //Set the default date rate of the device//
+DR: DR0
AT+POWER=14 //Set default output power to 14dBm//
+POWER: 14
AT+ADR=ON //Set ADR ON, you could also set to OFF//
+ADR: ON
AT+KEY=AppKey,"2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C" //Use the AppKey used in your network instead//
+KEY: APPKEY 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
AT+CLASS=A //set to Class A mode//
+CLASS: A
AT+Join //Join command//
+JOIN: Starting
+JOIN: NORMAL, count 1, 0s, 0s
+JOIN: Network joined
+JOIN: NetID 000024 DevAddr 48:00:00:01
+JOIN: Done
AT+CMSGHEX="00 ff 22 33 5f 88 01 98 ad ac 46 12 be 43 54 43 35 45 33 45 44 35 33 54 5 43" //Now you can send message to Gateway. 4 kinds of command could be used to transmit: AT+MSG, AT+CMSG, AT+MSGHEX, AT+CMSGHEX//
+CMSGHEX: Start LoRaWAN transaction
+CMSGHEX: TX "00 FF 22 33 5F 88 01 98 AD AC 46 12 BE 43 54 43 35 45 33 45 44 35 33 54 05 43"
+CMSGHEX: Wait ACK
+CMSGHEX: ACK Received
+CMSGHEX: PORT: 12; RX: "11 22 33 44 55 66 77 88 99 00"
+CMSGHEX: RXWIN1, RSSI -82, SNR 10.25
+CMSGHEX: Done

3.3 自定义数据速率的应用

除了 EU868 和 US915 数据速率方案外，RHF76-052 还支持自定义数据速率方案。 在定义数据速率方案之前，客户需要深入了解 LoRa 和 LoRaWAN。
例如,
AT+DR=custom
+DR: CUSTOM

AT+DR=Scheme
+DR: CUSTOM
+DR: CUSTOM DR0 RFU
+DR: CUSTOM DR1 RFU
+DR: CUSTOM DR2 RFU
+DR: CUSTOM DR3 RFU
+DR: CUSTOM DR4 RFU
+DR: CUSTOM DR5 RFU
+DR: CUSTOM DR6 RFU
+DR: CUSTOM DR7 RFU
+DR: CUSTOM DR8 RFU
+DR: CUSTOM DR9 RFU
+DR: CUSTOM DR10 RFU
+DR: CUSTOM DR11 RFU
+DR: CUSTOM DR12 RFU
+DR: CUSTOM DR13 RFU
+DR: CUSTOM DR14 RFU
+DR: CUSTOM DR15 RFU
AT+DR=Custom,DR0,SF10,125
+DR: CUSTOM DR0 SF10 BW125K
AT+DR=Custom,DR1,SF9,125
+DR: CUSTOM DR1 SF9 BW125K
AT+DR=Custom,DR2,SF8,125
+DR: CUSTOM DR2 SF8 BW125K
AT+DR=Custom,DR3,SF7,125
+DR: CUSTOM DR3 SF7 BW125K
AT+DR=Custom,DR4,SF7,500
+DR: CUSTOM DR4 SF7 BW500K
//Here we define DR0 to DR4 totally 5 kinds of data rate different from LoRaWAN definition. Note that both GW and Node should follow this rule when in custom data rate definition//
AT+DR=Scheme *//Check the data rate scheme again//*
+DR: CUSTOM
+DR: CUSTOM DR0 SF10 BW125K
+DR: CUSTOM DR1 SF9 BW125K
+DR: CUSTOM DR2 SF8 BW125K
+DR: CUSTOM DR3 SF7 BW125K
+DR: CUSTOM DR4 SF7 BW500K
+DR: CUSTOM DR5 RFU
+DR: CUSTOM DR6 RFU
+DR: CUSTOM DR7 RFU
+DR: CUSTOM DR8 RFU
+DR: CUSTOM DR9 RFU
+DR: CUSTOM DR10 RFU
+DR: CUSTOM DR11 RFU
+DR: CUSTOM DR12 RFU
+DR: CUSTOM DR13 RFU
+DR: CUSTOM DR14 RFU
+DR: CUSTOM DR15 RFU

3.4 全双工网关的应用

网关支持全双工，这意味着网关的下行链路和上行链路存在频率偏移。 使用 AT + RXWIN1 和 AT + RXWIN2 命令，RHF76-052 可以轻松地支持全双工网关。 默认情况下，RXWIN1 中的频移关闭，下行

链路在 RXWIN1 中使用与上行链路相同的频率。 如果要移动频率偏移，则使用"AT + RXWIN1 = ON"将其设置为 ON。

例如，上行使用 8 个信道：471.5MHz，471.7MHz，471.9MHz，472.1MHz，472.3MHz，472.5MHz，472.7MHz 和 472.9MHz; 下行链路使用固定移位频率的另外 8 个信道，例如为 10MHz，即 481.5MHz，481.7MHz，481.9MHz，482.1MHz，482.3MHz，482.5MHz，482.7MHz 和 482.9MHz。 您可以配置下面的调制解调器：

AT+CH=0,471.5,DR0,DR5 *//Set the uplink channel and data rate//*
+CH: 0,471500000,DR0:DR5
AT+CH=1,471.7,DR0,DR5
+CH: 1,471700000,DR0:DR5
AT+CH=2,471.9,DR0,DR5
+CH: 2,471900000,DR0:DR5
AT+CH=3,472.1,DR0,DR5
+CH: 3,472100000,DR0:DR5
AT+CH=4,472.3,DR0,DR5
+CH: 4,472300000,DR0:DR5
AT+CH=5,472.5,DR0,DR5
+CH: 5,472500000,DR0:DR5
AT+CH=6,472.7,DR0,DR5
+CH: 6,472700000,DR0:DR5
AT+CH=7,472.9,DR0,DR5
+CH: 7,472900000,DR0:DR5

AT+RXWIN1=ON *//Enable the RXWIN1 configuration command//*
+RXWIN1: ON
AT+RXWIN1=0,481.5 *//set downlink frequency channel in RXWIN1 to achieve full-duplex ol the gateway//*
+RXWIN1 0,481500000
AT+RXWIN1=1,481.7
+RXWIN1 1,481700000
AT+RXWIN1=2,481.9
+RXWIN1 2,481900000
AT+RXWIN1=3,482.1
+RXWIN1 3,482100000
AT+RXWIN1=4,482.3
+RXWIN1 4,482300000
AT+RXWIN1=5,482.5
+RXWIN1 5,482500000
AT+RXWIN1=6,482.7
+RXWIN1 6,482700000
AT+RXWIN1=7,482.9
+RXWIN1 7,482900000
//Now the modem could support the full-duplex gateway with the RXWIN1 with shift frequency channel//

3.5 下行链接

LoRaWAN 调制解调器是双向设备，因此如果服务器发送，则可以接收下行链路。 在 LoRaWAN A 类模式中，两个接收窗口将被打开以从服务器接收下行链路，但是 LoRaWAN C 类设备几乎可以在任何时候从服务器接收下行链路。 以下示例显示调制解调器报告如何接收下行链路消息。

示例: *(CMSG)*

```
+CMSG: Start LoRaWAN transaction
+CMSG: TX "Ai-Thinker"
+CMSG: Wait ACK
+CMSG: ACK Received
+CMSG: PORT: 5; RX: "14 54 54"
+CMSG: RXWIN2, RSSI -88, SNR 13.5
+CMSG: Done
```

示例: *(Class C)*

```
+CMSG: ACK Received
+CMSG: PORT: 5; RX: "14 54 54"
+CMSG: RXWIN2, RSSI -88, SNR 13.5
```

C 类下行链路将使用最后的消息命令（MSG / CMSG / MSGHEX / CMSGHEX）作为其提示符号。 可能是以下任何一种情况。

```
+MSG: PORT: 5; RX: "14 54 54"
+CMSG: PORT: 5; RX: "14 54 54"
+MSGHEX: PORT: 5; RX: "14 54 54"
+CMSGHEX: PORT: 5; RX: "14 54 54"
```

3.6 LoRa 点对点通信

RHF76-052 不仅支持 LoRaWAN 协议栈，还可以像通过 AT 指令集控制的正常 LoRa 收发器一样。

a) 发送模式

AT+RESET *//AT command to modem from HOST// //Reset the modem when power up//*
+RESET: OK

LoRaWAN AT Modem
+VER: 1.9.1 // Message return back to HOST follow AT command //
AT *//Send command "AT" to double check the interface between HOST and SLAVE//*
+AT: OK
AT+Mode=Test*//Set to test mode first//*
+MODE: TEST
AT+TEST=RFCFG,472.3,8,250,8,8,20 *//Configure the modem,like Freq, SF, BW, Preamble length, TX output power//*
+TEST=RFCFG,472.3,8,250,8,8,20
AT+TEST=TXLRPKT[2],"00 00 01 00 00 AF 80 07 02 00 00 39"*//You could now transmit packet now//*
+TEST: TXLRPKT "00 00 01 00 00 AF 80 07 02 00 00 39 "
+TEST: TX DONE

注意:

b) *分组传输有两种命令：AT + TEST = TXLRPKT 用于以 HEX 格式传输数据包; AT + TEST = TXLRSTR 用于在字符串中传输数据包*

c) 接收模式

AT+RESET *//AT command to modem from HOST// //Reset the modem when power up//*
+RESET: OK

LoRaWAN AT Modem
+VER: 1.9.1 *// Message return back to HOST follow AT command //*
AT *//Send command "AT" to double check the interface between HOST and SLAVE//*
+AT: OK
AT+Mode=Test*//Set to test mode first//*
+MODE: TEST
AT+TEST=RFCFG,472.3,8,250,8,8,20*(3)(4)* *//Configure the modem,like Freq, SF, BW, Preamble length//*
+TEST=RFCFG,472.3,8,250,8,8,20
AT+TEST=RXLRPKT *//Set to LoRa Rx continues mode//*
+TEST: RXLRPKT
+TEST: LEN:12, RSSI:-101, SNR:6
+TEST: RX "00 00 01 00 00 AF 80 07 02 00 00 39"//Return the message in HEX if receive a packet//
Note:

(2) *RX 的前导码长度应等于或大于 TX*

(3) *当扩频因子设置为 11 或者 12 时，接收和发送两者的小数据优化都将设置为 ON；其他情况下将设置关闭.*

3.7 其他重要指令

3.7.1 选择 LoRaWAN 的类

AT+CLASS=A   *// Enable Class A mode, this is the default configuration when power on in the first time*

+CLASS: A
AT+CLASS=C   *// Enable Class C mode//*
+CLASS: C
注意：启用 C 类模式后，需要传送至少一个消息，使 LoRaWAN 协议栈打开额外的接收窗体（RXWIN2）！！！

3.7.2 设置为睡眠模式

AT+LOWPOWER *//Set to Sleep mode//*
+LOWPOWER: SLEEP

AT *//Wake up when in Sleep mode//(5)*
+LOWPOWER: WAKEUP
注意:

(4) *任何 AT 命令都可以唤醒设备。所以当你想要操作设备时，使用"AT"命令作为第一个命令来唤醒。然后跟着真正的操作命令。*

3.7.3 从模块中获取帮助

a) 从正常模式中获取帮助 (ABP or OTAA 模式)
AT+HELP *//Get Help list//*
+HELP: OK
     AT -- AT Ping

```
      HELP -- Print command list
  FDEFAULT -- Factory data reset
     RESET -- Software reset
       DFU -- Bootloader mode
  LOWPOWER -- Enter sleep mode
       VER -- Version
       MSG -- Unconfirmed
    MSGHEX -- Unconfirmed (HEX)
      CMSG -- Confirmed
   CMSGHEX -- Confirmed (HEX)
        CH -- Set channel
       ADR -- ADR ON/OFF
        DR -- Set datarate
      REPT -- MSG/MSGHEX repetition
     POWER -- TX power
    RXWIN1 -- RX window1
    RXWIN2 -- RX window2
      PORT -- TX port
      MODE -- LWABP/LWOTAA/TEST
        ID -- DevAddr/DevEui/AppEui
       KEY -- NWKSKEY/APPSKEY/APPKEY
     CLASS -- Class(A/B/C)
      JOIN -- OTAA Join request
      TEST -- Test commands
      UART -- UART configure
     DELAY -- RX window delay
```

　　b) 从测试模式中获取帮助

AT+MODE=TEST *//Set to TEST mode first//*

+MODE: TEST

AT+TEST=HELP *//Get HELP list in TEST mode//*

```
+TEST: HELP
        STOP -- AT+TEST=STOP
        HELP -- AT+TSET=HELP
        TXCW -- AT+TEST=TXCW
     TXCLORA -- AT+TEST=TXCLORA
       RFCFG -- AT+TEST=RFCFG,[F],[SF],[BW],[TXPR],[RXPR],[POW]
     RXLRPKT -- AT+TEST=RXLRPKT
     TXLRPKT -- AT+TEST=TXLRPKT,"HEX"
     TXLRSTR -- AT+TEST=TXLRSTR,"TEXT"
        RSSI -- AT+TEST=RSSI,F,[CNT]
        LWDL -- AT+TEST=LWDL,TYPE,DevAddr,"HEX",[FCNT],[FPORT],[FCTRL]
```

3.7.4 恢复出厂设置

AT+FDefault=RisingHF*//Reset LoRaWAN AT modem to factory default configuration.//*

+FDEFAULT: OK

注意：该命令将所有配置重置为出厂默认设置，如通道，数据速率，输出功率等。

3.7.5 固件升级

RHF76-052 模块使用一种称为 ExtraPuTTY 的工具来升级固件，波特率为 115200bps。有两种访问固件升级模式的方法。

一，硬件触发方式

在设备上电时，将 RHF76-052 模块的引脚 14（GPIO_PA15）保持为低电平。 两个 LED（连接到 pin16 GPIO_PB4 和模块的 GP21_PB5）将闪烁，表示启动加载程序已准备好升级固件。

二，软件触发方式

AT + DFU = on //设置为 DFU 模式//

两个 LED（连接到 pin16 GPIO_PB4 和模块的 GP21_PB5）将闪烁，表示启动加载程序已准备好升级固件。

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