



Software Modem Discovery Evaluation Kit: User Guide

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2 Introduction

The Software Modem (referred to modem) is a software set which runs on Murata LoRa module to provide API for LoRaWAN operation.

To facilitate the evaluation of the Modem, an application layer firmware was developed to run on a separate application processor.

The purpose of this document is to provide a quick start guide for users to get started with the evaluation of the Software Modem.

3 Evaluation Kit Information

3.1 Components

The evaluation kit of the Modem consists of 2 hardware pieces: the Modem board and the Application Processor board.

- Modem board
The modem firmware (MAC stack and Modem services) developed by Semtech is embedded within the LoRa modem module¹. This module is soldered on an evaluation kit called DISCO-L072CZ-LRWAN1¹.
- Application board
A separate STM32L073RZ² microcontroller is used as the application processor. This processor resides on a NUCLEO L073RZ⁵ evaluation board.
Connections

The communication of modem APIs between the Modem and the Application Processor is through a UART link.

And from the evaluation kit to the host PC, 2 serial connections are available:

- One communication port connecting the application processor and host. This is necessary for command sending and response reading.
- One debug port connecting Modem and host. This is optional.

¹ More information at: <https://os.mbed.com/platforms/ST-Discovery-LRWAN1/>

² More information at: <https://www.st.com/en/microcontrollers-microprocessors/stm32l073rz.html>

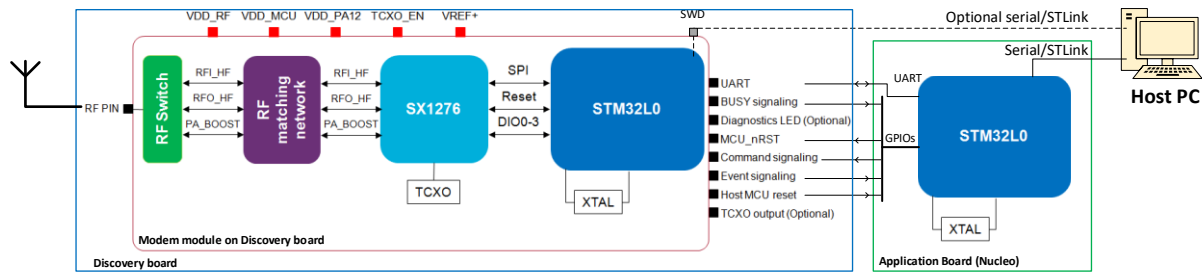


Figure 1 Block diagram illustrating the connections between the Modem evaluation kit, the Application Processor, and the Host PC

4 Quick Start Guide

4.1 Connecting the Hardware

With all of the evaluation boards powered off, complete the connections as shown below.

First, connect the UART and other communication lines between the Modem board and Application board.

Table 1 Wiring connection between Modem board and application board

Function (From Modem View)	DISCO-L072CZ-LRWAN1 (CN3 Header)	NUCLEO-L073RZ (CN10 Header)
TX	Pin 13 (PA9)	Pin 33 (PA10)
RX	Pin 21 (PA10)	Pin 21 (PA9)
"COMMAND" GPIO input	Pin 25 (PB8)	Pin 3 (PB8)
"BUSY" GPIO output	Pin 18 (PA8)	Pin 23 (PA8)
"EVENTPENDING" GPIO output	Pin 25(PB9)	Pin 5 (PB9)
"MCURESET" GPIO input	Pin 17 (PB2)	Pin 22 (PB2)
Ground	Pin 12 (GND)	Pin 9 (GND)

The connection on the pin map of both boards is shown in Figure 2.

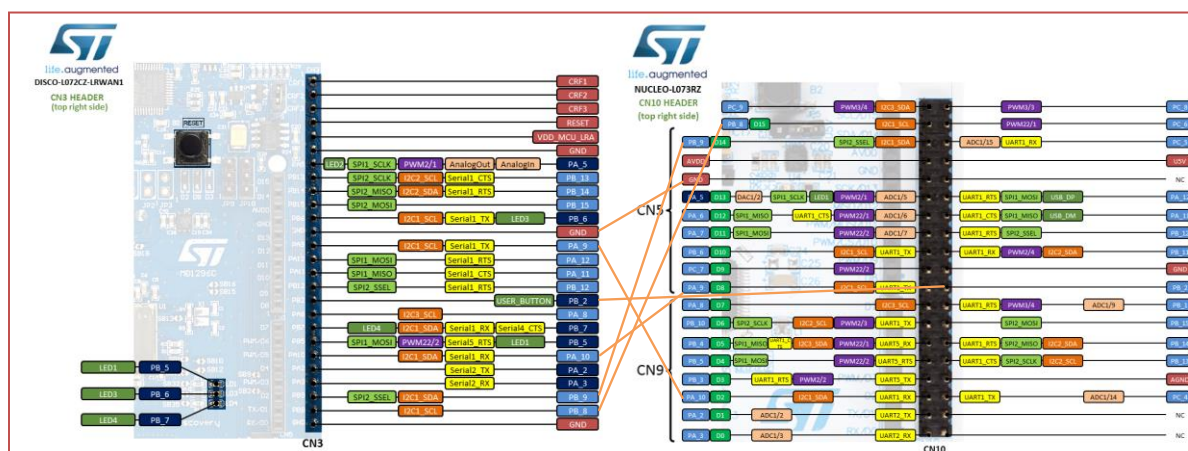


Figure 2 Connections between Modem board and Application board on the pin map

The next step is to plug in the USB cables from both boards to the host PC.

The Modem board is powered by a micro USB cable, and the Application board is powered by a mini USB cable. These two USB cables also handle the communication for 2 serial-over-USB (STLink) links to the PC host.

A fully operational set of Modem and Application evaluation kits is shown in Figure 3.

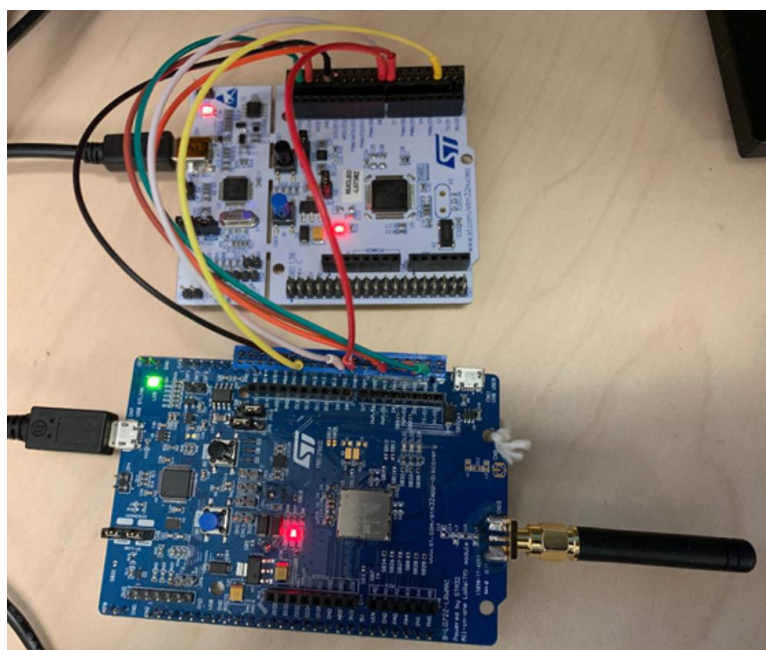


Figure 3 Fully operational Modem and Application evaluation kit

4.2 Flashing the Firmware

Use STLink programmer software to flash the hex firmware into the Modem board, or directly drag and drop bin files to the target.

The STLink Programmer can be downloaded from here <https://www.st.com/en/development-tools/stsw-link004.html>

4.3 Getting the Host PC Ready

4.3.1 Installing Driver

STLink is required as the driver for serial over USB. Follow external instructions³ to install the software.

4.3.2 Preparing Terminal software

A COM terminal software can be used to send a command to the evaluation kit, and read the output from either application MCU or Modem MCU. Tera Term⁴, Putty⁵ or MobaXterm⁶ can be used as the terminal.

Configuration for the COM port connection:

- Baud rate: 115200
- Data bits: 8
- Stop bits: 1
- Parity: None
- Flow control: None

Configuration for the terminal:

- Implicit CR in every LF
- Local echo force on

³ Information and installation guide available at: <https://os.mbed.com/teams/ST/wiki/ST-Link-Driver>

⁴ Open source, more information available at: <https://ttssh2.osdn.jp/index.html.en>

⁵ Open source, more information available at: <https://www.putty.org/>

⁶ Free for personal use, more information available at: <https://mobaxterm.mobatek.net/>

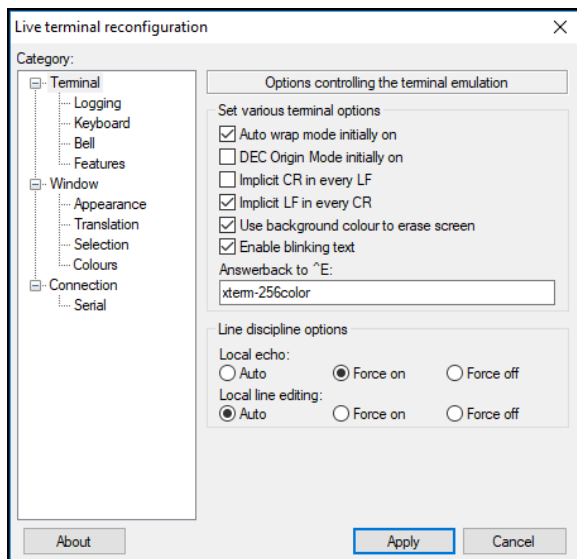


Figure 4 Terminal configuration example for MobaXterm

Open the serial terminal and connect to both ports. A reset is suggested for both boards.

After the reset, the start-up information should be displayed on the terminal.



Figure 5 Modem board start-up information

The above figure shows the start-up information printed by the Modem board. Please note that this terminal is read-only. All command should be sent to the application board, which is handled by the other port, with start-up information shown below.



Figure 6 Application board start-up information

4.4 Using Commands to Operate Modem

On the application board terminal, using command “h” can list the supported commands.

4.4.1 Sending Commands

We can type commands to generate corresponding opcode and parameters to the Modem board through UART.

The general command format is:

“command” “parameters”

- The “command” is the name of operations, for example, “join” or “tx”
- The “parameters” is a list of the parameters sent to the Modem. If it is a hex string, it is converted to an integer, with space in between.
For example, we can use the command “tx 100 0 1 2 3 4” to send an uplink frame of 5 bytes using FPort 100.

Two types of commands are supported

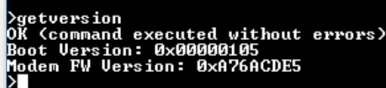
- Synchronous command: commands sent to the Modem with an instant response expected, the response time should be within 50 us.
- Asynchronous command: commands sent to the Modem with an additional non-instant response expected.

Proper network coverage is required so that the Modem can join the network, send uplink frames and receive downlink frames.

4.4.2 Reading Responses

On the console, if a response message is available, the application MCU will pull the data, validates the checksum, and display the response data and status.

A screenshot of a successful synchronous command sending and response pull is shown below.



```
>getversion
OK (command executed without errors)
Boot Version: 0x00000105
Modem FW Version: 0xA76ACDE5
>
```

Figure 7 Screenshot of the message exchange for info command

Sometimes the terminal displays “NO RESPONSE FROM MODEM”, which indicates the response is not ready by the predefined timeout (50 ms) after finished sending the commands.

5 Command Reference

List of commands supported is listed below.

More information:

- A multi-byte parameter should be converted to a list of bytes, which is input by decimal number 0-255.
- The input parameter is LSB first. For example: “alarm 10 0 0 0” is the command to set the alarm to 10 seconds.

Table 2 List of commands and responses

Name	Code	Description	Input	Output
GetEvent	0x00	Retrieve pending events		type[1], count[1], eventdata[n]
GetVersion	0x01	Get bootloader + firmware version		bootversion[4], firmwareversion
Reset	0x02	Reset modem		
FactoryReset	0x03	Perform modem factory reset		
Firmware	0x04	Write firmware update	part[4+128]	
GetTime	0x05	Get GPS wall time		timestamp[4]
SetAlarm	0x06	Set alarm / wakeup timer	seconds[4]	
GetTrace	0x07	Get diagnostic crash log		backtrace log[n]
GetPin	0x08	Get device registration PIN		PIN[4]
GetChipEui	0x09	Get device chip EUI		ChipEUI[8]
GetJoinEui	0x0A	Get join EUI		JoinEUI[8]
SetJoinEui	0x0B	Set join EUI and derive keys	JoinEUI[8]	
GetDevEui	0x0C	Get device EUI		DeviceEUI[8]
SetDevEui	0x0D	Set device EUI and derive keys	DeviceEUI[8]	
SetAppKey	0x0E	Set application key	Appkey[16]	
SetNwkKey	0x0F	Set network key	NwkKey[16]	
GetInterval	0x12	Get DM reporting interval		interval[1]
SetInterval	0x13	Set DM reporting interval	interval[1]	
GetRegion	0x14	Get regulatory region		region[1]
SetRegion	0x15	Set regulatory region	region[1]	
GetProfile	0x16	Get ADR profile		type[1]
SetProfile	0x17	Set ADR profile and optional parameters	type[1]+list[16]*	
Join	0x18	Start (re-)joining the network		
RequestTx	0x19	Transmit frame unconfirmed	port[1], data[n]	
UploadInit	0x1A	Set file upload port, encryption mode, size	p[1],en[1],sz[2]	
UploadData	0x1B	Write data for file upload transmission	data[n]	
StreamInit	0x1C	Set data stream parameters	param[2-5]	

EmergencyTx	0x1D	Transmit frame immediately (smoke alarm)	port[1], data[n]	
GetCharge	0x1E	Get accumulated charge counter		charge[4]
GetMaxPayload	0x1F	Get max payload size		size[1]
SetClass	0x20	Set LoRaWAN class A/C	class[1]	
SetMulticast	0x21	Set multicast session parameters	param[40]	
SetTxPowOff	0x22	Set TX power correction offset	offset[1]	
GetDmPort	0x23	Get DM port		port[1]
SetDmPort	0x24	Set DM port	port[1]	
DmStatus	0x25	Send DM status now	inflight[n]	
GetStatus	0x26	Get modem status		status[1]
Suspend	0x27	Suspend/Resume radio operations	suspend[1]	
SetDmInfo	0x28	Set default info for DM status	inflight[n]	
StreamData	0x29	Send data stream record	port[1]+record[n]	
GetClass	0x2A	Get the LoRaWAN device class		class[1]
ListRegions	0x2B	List the supported regulatory regions		regions[1:5]
GetTxPowOff	0x2C	Get power correction offset		offset[1]
GetDmInfo	0x2D	Get default info fields for DM status		inflight[n]
SetAppStatus	0x2E	Set application-specific status for DM	appstatus[8]	
StreamStatus	0x2F	Retrieve stream status	port[1]	pending[2]+free[2]
Test	0x32	Radio test functions (Not Implement Yet)		

The Modem could send an asynchronous event to the application MCU, which is also displayed on the terminal.

Table 3 List of the events

Event	Code	Description	Output
Reset	0x00	Modem has been reset	reset count[2]
Alarm	0x01	Alarm timer expired	
Joined	0x02	Network successfully joined	
TxDone	0x03	Frame transmitted	Status[1]
DownData	0x04	Downlink data received	port[1], downdata[n]
UploadDone	0x05	File upload completed	Status[1]

SetConf	0x06	Config has been changed by DM	Info tag[1]
Mute	0x07	Modem has been muted or unmuted by DM	Mute[1]
StreamDone	0x08	Data Stream Fragments Sent	



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