AT Interface Application

RM126x

Quick Start Guide *v2.3*

1 Introduction

Ezurio's RM126x modules are preloaded with proprietary AT Interface firmware, enabling Hosted Mode operation. In this mode, users can send AT commands from a host platform to control radio behavior, such as configuring the LoRa radio, joining a LoRaWAN network server, and reading or writing data over I2C or SPI.

This document demonstrates RM126x module operation in two modes:

1. **LoRaWAN Mode**: Configuring an RM126x to communicate with a network server through a LoRaWAN gateway.
2. **Point-to-Point (P2P) Mode**: Configuring two RM126x modules to communicate directly with each other without requiring a gateway or network server.

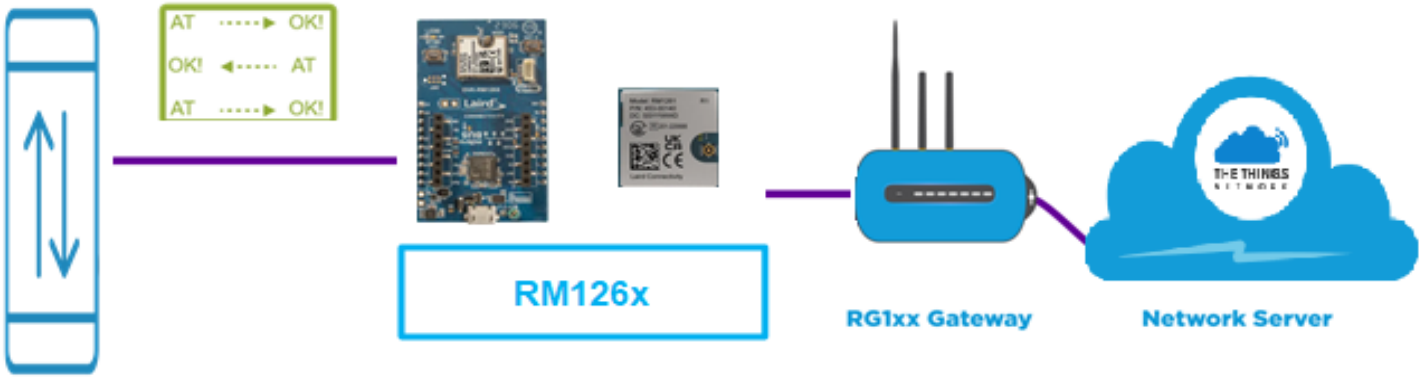


Figure 1: Standard LoRaWAN protocol

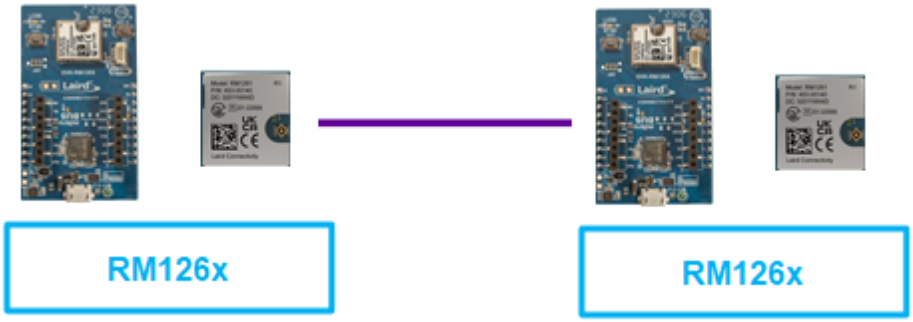


Figure 2: P2P protocol

For a complete list of AT commands, please refer to the User Guide for the RM126x AT Interface Application.

Note: Alternatively, you can develop your own custom firmware using Simplicity Studio from Silicon Labs, instead of using the preloaded AT Interface firmware. This document does not cover custom application development.

2 Requirements

This quick start guide document is applicable to the following part number(s) running Ezurio's AT Interface application.

Note: It is important that you select the hardware for your desired region.
The RM1262 supports USA, Canada, Australia, and New Zealand.
The RM1261 supports Europe, UK, Taiwan, Japan, and India.

RM126x Development Kits

- (453-00139-K1) Development Kit, RM1262, SX1262, MHF4,
- (453-00140-K1) Development Kit, RM1261, SX1261, MHF4.

RM126x modules

- (453-00139R) Module, RM1262, SX1262, MHF4 - Tape / Reel,
- (453-00139C) Module, RM1262, SX1262, MHF4 – Cut Tape.
- (453-00140R) Module, RM1261, SX1261, MHF4 - Tape / Reel,
- (453-00140C) Module, RM1261, SX1261, MHF4 – Cut Tape.

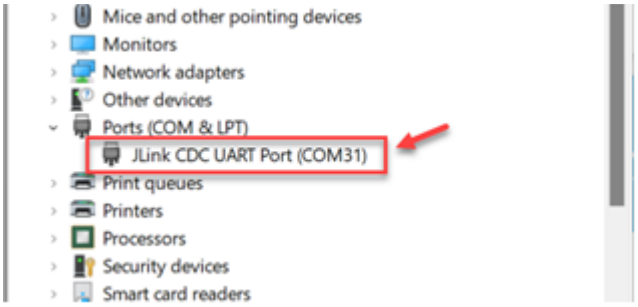
- **LoRaWAN Gateway**
- We will use the Ezurio RG1xx LoRaWAN Gateway for demonstration purposes, however any LoRaWAN gateway should work.

- **LoRaWAN Network server**
- We will use The Things Network (TTN) as the Network Server in this document, however any network server should work.

Software and Tools

1. The latest available version of the AT Interface application for RM126x can be found at: https://github.com/LairdCP/RM126x_Firmware/releases.
2. (Recommended) UwTerminalX v1.13a or later: https://github.com/LairdCP/UwTerminalX/releases.
   You can also use other terminal programs such as TeraTerm, PuTTY or RealTerm.

Note: The RM126x development boards will show up as a ***JLink CDC UART Port (SEGGER)*** device in the Windows device manager under "Ports (COM & LPT)". If the driver is not installed automatically when the DVK is plugged into your Windows PC, we recommend installing Simplicity Studio 5 or the latest version of the J-Link Software and Documentation Pack.



3 Testing with the Standard LoRaWAN Protocol

3.1 Upgrade AT Interface firmware

The RM126x modules should be updated with the latest version of the AT Interface application to fully utilize all the features of the AT command set. The firmware version loaded to the RM126x module can be verified by sending the "ATI 3" command in UwTerminalX (***Figure 5***) to confirm it matches the latest release version which can be found in https://github.com/LairdCP/RM126x_Firmware/releases.

This quick start guide document assumes that you are familiar with programming firmware for RM126x. The further information and instructions can be found in User Guide - Firmware Options and Upgrading - RM126x Series.

3.2 Configure RM126x in UwTerminalX

Before getting started, complete the following setup:

1. Attach the included external antenna to MHF4 connector.
2. Connect your RM126x development board to your PC via the included USB micro cable, and make sure that the blue "J-Link" LED is active on RM126x DVK.
3. Launch **UwTerminalX.exe** on your development PC. From the **Config** tab in the **Device** drop-down menu, select **RM1xx** under **Port Settings**. This will auto-populate the connection settings (baudrate, parity, stop bits, data bits and handshaking) with the exception of the Port.

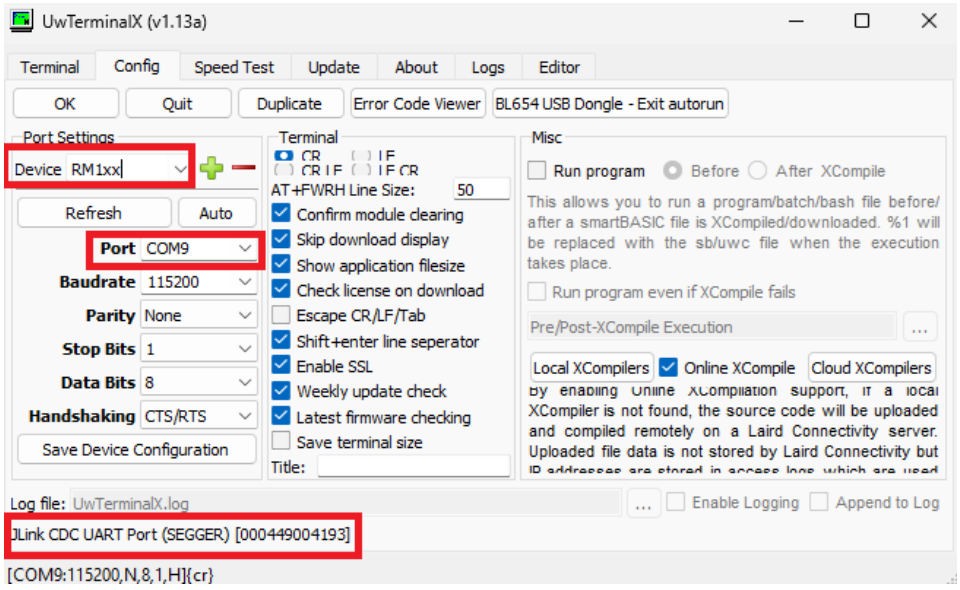


Figure 3: UwTerminalX: Settings & Config window

4. Press **Refresh** and select the COM Port which your RM126x development kit was assigned by Windows Device Manager. In the bottom-left corner of UwTerminalX you should see JLink CDC UART Port (SEGGER).
5. Please keep all other Settings and click **Save Device Configuration** followed by **OK** to advance to the Terminal tab.
6. Type AT into the terminal and press **Enter**. If you see the return value OK, then you are successfully communicating with your RM126x over UART.
7. Retrieve DevEUI using AT%S 501? The output below is an example and your DevEUI will be different.

```
AT%S 501?
0025CAfffffffff4
```

Note: This step is not required if firmware is upgraded via UART. If you upgrade firmware through SWD, the radio will DevEUI will be erased. Therefore, the value of the pre-programmed DevEUI should be stored so that it can be re- programmed in later step. Alternatively, you can scan the QR code on the module label which contains this DevEUI value.

Also, in the firmware version 127.4.1.421 and 128.4.1.421, DevEUI is erased when AT&F is called. In later firmware, this will be fixed so that DevEUI will persist over AT&F.

c 

8. Next, perform a factory reset with the **AT&F** command. This will set all writable parameters to their default values and perform a warm reset.

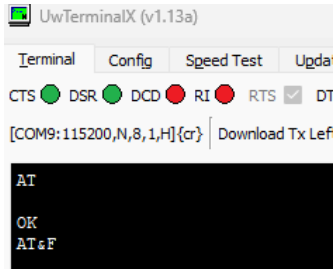


Figure 4: UwTerminalX: AT and AT&F command usage

9. In the next step, we are requesting the RM126x module name and firmware version with the **ATI** command:

```
ATI 0
RM1262

ATI 3
128.4.1.772
```

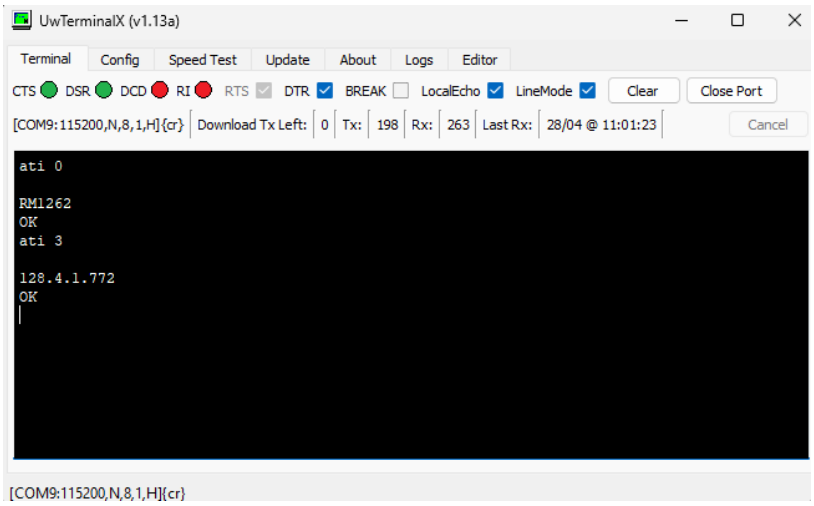


Figure 5: UwTerminalX: ATI command usage

10. Configure the RM126x to enable the radio to connect to LoRaWAN Network Server via a LoRaWAN Gateway.
11. First, set the S register to configure the region for the desired country using the ATS 611=x, where x is the number of the selected region as per the below selections:

- RM1261 only:
  - 1: EU_EU868
  - 2: UK_EU863_870
  - 8: TAIWAN_AS923_1
  - 9: JAPAN_AS923_1
  - 11: INDIA_IN865_867
- RM1262 only:
  - 3: USA_CANADA_US902_928
  - 4: AUSTRALIA_AU915_928
  - 5: AUSTRALIA_AS923_1
  - 6: NEW_ZEALAND_AS923_1
  - 7: NEW_ZEALAND_AU915_92

```
ATS 611=3
```

12. For US, set sub-band that match network server. In this example, sub-band2 is used that is used for TTI.

```
ATS 617=2
```

13. Check if the pre-programmed DevEUI is set with"AT%S 501?"

```
AT%S 501?
```

14. If "0000000000000000" is returned, the DevEUI has been erased. Set 64 bit (16 hexadecimal characters) of the LoRaWAN Dev EUI that you retrieved in step 7.

```
AT%S 501="0025CAfffffffff4"
```

15. Set the 64 bit (16 hexadecimal characters) LoRaWAN Join EUI. Replace the string value, between the quotes, with your own user defined value.

```
AT%S 502="0025CA0000000001"
```

16. Set the 128 bit (32 hexadecimal characters) LoRaWAN AppKey EUI. Replace the string value, between the quotes, with your own user defined value.

```
AT%S 500="0025CA00000000010025CA0000000001"
```

17. Save parameters to non-volatile memory and reset the module by performing a warm reset.

```
AT&W
OK

ATZ
OK
```

Note: The RM126x modules operate in Class A by default, so no configuration is required for standard use. If testing with Class B or Class C is needed, use S Register 603 to configure the device class with the following syntax:

`ATS 603=<value>`

where <value> is 0 for Class A, 1 for Class B and 2 for Class C.

The Ezurio RG1xx Gateway does not support Class B, therefore, if you are testing with this Gateway only Class A or Class C should be configured.

3.3 Register RM126x and Gateway to Network Server

This section assumes you are familiar with configuring your gateway and registering both the RM126x module and the gateway with your network server. For demonstration purposes, this application note uses the **Ezurio RG1xx** as the LoRaWAN gateway and **The Things Network (TTN)** as the network server. For additional information on configuring the RG1xx and TTN, refer to Application Note - Setting up Basic station on the Things Stack v3.

3.4 Connect and Send Uplink Message to TTN

1. Use the following command to initiate a join request:

```
AT+JOIN
```

An example of a successful join response:

```
JOIN: [OK], [TX]: C:11, F:904500000Hz, DR:0, [RX]: W:1, C:3, F:925100000Hz, DR:10
```

- **OK**:
  Indicates the RM126x successfully received a Join Accept from the server.
- **[TX]** (Transmit parameters for the Join Request):
- **C**: Channel used to send the Join Request.
- **F**: Frequency used to send the Join Request.
- **DR**: Data rate used to send the Join Request.
- **[RX]** (Receive parameters for the Join Accept):
- **W**: Receive window used (1 = RX1, 2 = RX2).
- **C**: Channel used to receive the Join Accept.
- **F**: Frequency used to receive the Join Accept.
- **DR**: Data rate used to receive the Join Accept.

2. Or if the join fails, it will return a response in the following format:

```
AT+JOIN
```

3. JOIN: [FAIL], [TX]: C:15, F:905300000Hz, DR:0
4. The **ADRJ** asynchronous response is issued upon successful joining and provides details of the LoRaWAN parameters adopted during the join procedure.

```
ADRJ: DR:[x] 0, PO:[x] 22, NB:[x] 1, CP:[x] 00:ff:00:00:00:00:00:00:02, PL:[^] 11
```

- **Parameters in ADRJ:**
- **DR:** Transmit data rate in use. – 0 = DR0
- **PO:** Transmit power level in use (in dBm). -22 = 22 dBm
- **NB:** Number of transmissions in use. - 1 = uplink messages are sent once without retries
- **CP:** Channel plan in use, represented as a bitmap. - 00:ff:00:00:00:00:00:00:02 = enables channels 8–15 (Sub-Band 2) and channel 65
- **PL:** Maximum payload length supported by the current data rate. – 11 = 11 bytes

- **State Indicators:**
  - **^:** Parameter was increased during the join procedure.
  - **v:** Parameter was decreased during the join procedure.
  - **!:** (Channel Plan only) Plan was changed during the join procedure.
  - **x:** Parameter was unchanged during the join procedure.

5. To send uplink data from the RM126x to a LoRa network server (such as TTN), use the following command:

```
AT+SEND "<UPLINK DATA IN HEX FORMAT>
```

6. Example:

```
AT+SEND "01"


TX: [ACK], C:13, F:904900000Hz, DR:3
```

- **Parameters in response:**
  - [ACK]: Uplink was acknowledged by the network server (confirmed uplink).
  - C: Channel used for transmission.
  - F: Frequency used for transmission.
  - DR: Data rate used for transmission.

7. Before the message above, you may notice that both the data rate and maximum payload length increased as a result of ADR (Adaptive Data Rate) adjustments:

```
ADRX: DR:[^] 2, PO:[x] 22, NB:[x] 1, CP:[x] 00:ff:00:00:00:00:00:00:02, PL:[^] 125


ADRX: DR:[^] 3, PO:[v] 20, NB:[x] 1, CP:[x] 00:ff:00:00:00:00:00:00:02, PL:[^] 242
```

Note: By default, the RM126x sends messages as confirmed packets. To change this behavior to unconfirmed packets, use the following command:

ATS 604=<value>

where 0 = unconfirmed packet and 1 = confirmed packet.

---

8. Confirm the LoRa Network Server received the data under the Application/End Device/Live Data as shown in the example below from TTN.

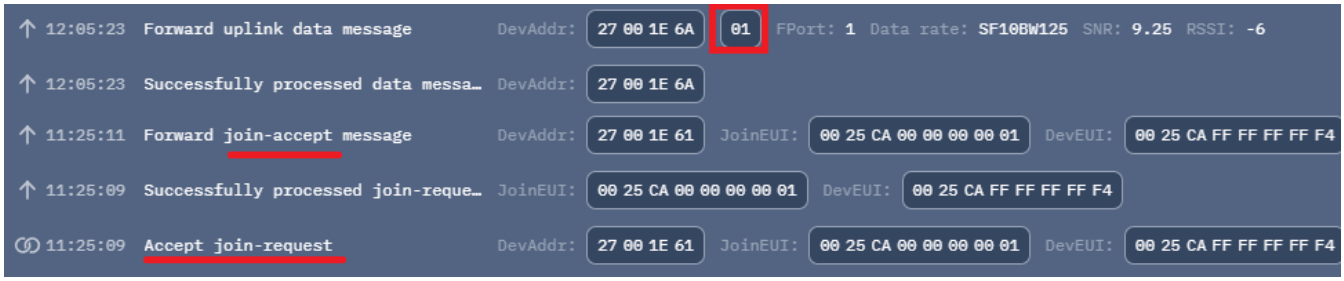


Figure 6: End device's live data page on TTN

3.5 Receive Downlink Message from TTN

1. On TTN, enter the string you want to send down to the RM126x module (0909 in the example below). On TTN Network Server this can be scheduled under: Application > End Devices > Messaging > Downlink, and click **Schedule Downlink**.

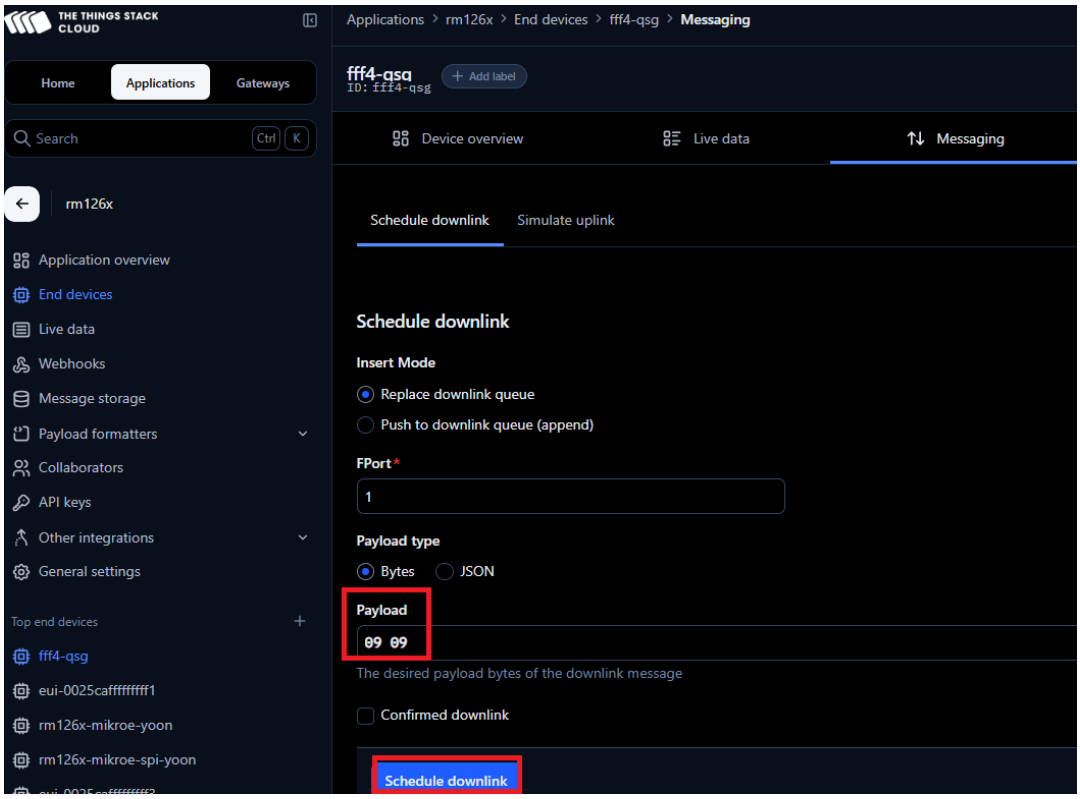


Figure 7: Schedule downlink from TTN

2. The LoRaWAN end device can receive data only after it sends uplink data in Class A, therefore to RX the downlink packet, send another uplink message from the RM126x node.

```
AT+SEND "01"
```

3. TX: [ACK], C:13, F:904900000Hz, DR:3
4. The RM126x will show the received downlink message.

```
RX: W:1, P:1, C:7, F:927500000Hz, DR:13, R:16dBm, S:52dB, 0909
```

- W: window to receive downlink message (1 = RX1, 2 = RX2)
- P: port at which downlink messsage arrived
- C: channels used to receive downlink
- F: frequency used to receive downlink
- DR: data rate used to receive downlink
- R: RSSI measured for the received message
- S: SNR measured for the received message

4 Testing with the P2P protocol

It is possible to use up to 63 devices in a P2P network, depending on the region. For the number of devices supported in a specific region please reference Table 1: Max Network Size per Region, of the P2P User Guide. For this example, we will configure three devices to demonstrate P2P functionality.

Each P2P peer is assigned a unique device address in ascending order beginning with 0. We will call the first device node0, the second device node1 and the third device node2. The node0 will send out beacons, based on which other peers (e.g. node1, node2) will synchronize timing in order to schedule transmit and receive slots.

IMPORTANT: When testing P2P functionality with two or more RM126x modules which are in close proximity (within 4-5 feet) of each other, Tx power should be set to its lowest setting of 1 dBm. Testing with a higher TX power could result in damaging the radios due to RF energy saturation on the receiver, from which the radio may not be recoverable. Setting TX power to 1dBm is covered in the parameter settings below.

1. Plug in each of the three RM126x DVK to USB ports in your computer and access them through a serial terminal with proper configuration, as explained in 0 Configure RM126x in UwTerminalX above.

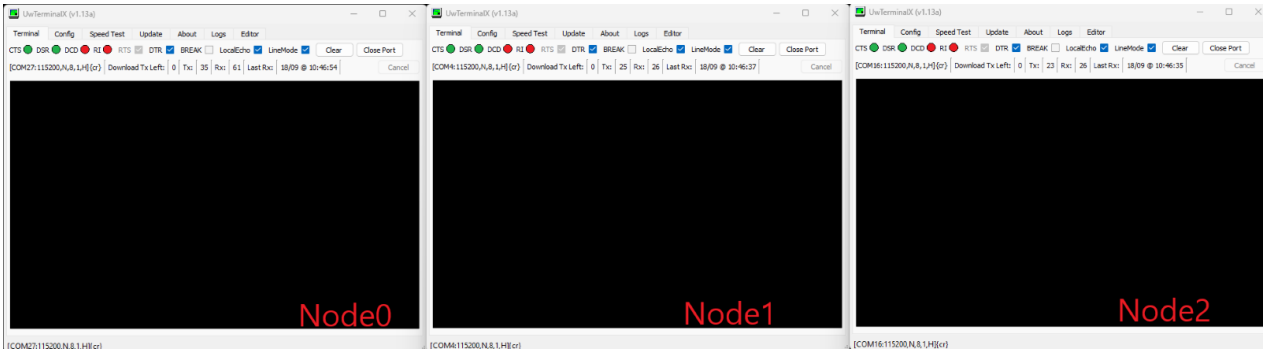


Figure 8: Three RM126x prepared for P2P test

2. On node1, enter the following commands.

Commands	Description
AT&F	Factory reset the RM126x (Optional – this will restore module to default settings)
ATZ	Soft reset
ATS 603=3	Set node1 for P2P mode
ATS 611=3	Set region to US (See AT Interface User Guide for correct Region setting if not US)
AT&W	Save parameters to non-volatile memory
ATZ	Soft reset
ATS 700=1	Set P2P Device address to 1 for node1
ATS 701=3	Set P2P network size to 3 (Should be equal to the number of nodes in the network including 0)
ATS 703=2	Set P2P data rate to DR2 (See AT Interface User Guide for Alternative data rate options)
ATS 704=0	Set P2P Listen duration to 0 which enables Class C listening.
ATS 705=0	Set P2P listen frequency to 0 which enables Class C listening behavior
ATS 706=2	Set P2P Beacon data rate to DR2 (See AT Interface User Guide for Alternative data rate options)
ATS 708=1	Set P2P Tx power to 1dBm (The reduced Tx power is used here in assumption that your two RM126x are in close proximity.)
ATS 707=20	Set allowed P2P Packet size. **Note that this value may differ for each country. It should be lower than value returned by "ATI 4003"**
ATS 702=26	Set P2P Windows length. **Note that this value may differ for each country. It should be higher than value returned by "ATI 4005"**
AT&W	Save parameters to non-volatile memory
ATZ	Soft reset
AT+P2PS	Start P2P session. The node1 will start listening for synchronization events.

3. On node2, enter the following commands.

Commands	Description
AT&F	Factory reset the RM126x (Optional – this will restore module to default settings)
ATZ	Soft reset
ATS 603=3	Set node2 for P2P mode
ATS 611=3	Set region to US (See AT Interface User Guide for correct Region setting if not US)
AT&W	Save parameters to non-volatile memory
ATZ	Soft reset
ATS 700=2	Set P2P Device address to 2 for node2
ATS 701=3	Set P2P network size to 3 (Should be equal to the number of nodes in the network including 0)
ATS 703=2	Set P2P data rate to DR2 (See AT Interface User Guide for Alternative data rate options)
ATS 704=0	Set P2P Listen duration to 0 which enables Class C listening.
ATS 705=0	Set P2P listen frequency to 0 which enables Class C listening behavior
ATS 706=2	Set P2P Beacon data rate to DR2 (See AT Interface User Guide for Alternative data rate options)
ATS 708=1	Set P2P Tx power to 1dBm (The reduce Tx power is used here in assumption that your two RM126x are in proximity.)
ATS 707=20	Set allowed P2P Packet size. **Note that this value may differ for each country. It should be lower than value returned by "ATI 4003"**
ATS 702=26	Set P2P Windows length. **Note that this value may differ for each country. It should be higher than value returned by "ATI 4005"**
AT&W	Save parameters to non-volatile memory
ATZ	Soft reset
AT+P2PS	Start P2P session. The node1 will start listening for synchronization events.

4. On node0, enter the following commands.

Commands	Description
AT&F	Factory reset the RM126x (Optional – this will restore module to default settings)
ATZ	Soft reset
ATS 603=3	Set node0 for P2P mode
ATS 611=3	Set region to US (See AT Interface User Guide for correct Region setting if not US)
AT&W	Save parameters to non-volatile memory
ATZ	Soft reset
ATS 700=0	Set P2P Device address to 0 for node0
ATS 701=3	Set P2P network size to 3 (Should be equal to the number of nodes in the network including 0)
ATS 703=2	Set P2P data rate to DR2 (See AT Interface User Guide for Alternative data rate options)
ATS 704=0	Set P2P Listen duration to 0 which enables Class C listening.
ATS 705=0	Set P2P listen frequency to 0 which enables Class C listening behavior
ATS 706=2	Set P2P Beacon data rate to DR2 (See AT Interface User Guide for Alternative data rate options)
ATS 708=1	Set P2P Tx power to 1dBm (The reduce Tx power is used here in assumption that your two RM126x are in proximity.)
ATS 707=20	Set allowed P2P Packet size. **Note that this value may differ for each country. It should be lower than value returned by "ATI 4003"**

ATS 702=26	Set P2P Windows length. **Note that this value may differ for each country. It should be higher than value returned by "ATI 4005"**
AT&W	Save parameters to non-volatile memory
ATZ	Soft reset
AT+P2PS	Start P2P session. The node0 will broadcast beacons for synchronization events.

5. On node0, transmit data to node1 over P2P connection with unicast.

```
AT+P2PT 1,"00AA"
```

On the node1, the transmitted message will appear.

```
RX: [P2P] S:0, R:-113dBm, S:3dB, 00AA
```

- S: Source address of the sending peer. – 0 = node0
- R: RSSI measured for the received message.
- S: SNR measured for the received message

6. This time, we broadcast a message from node1.

```
AT+P2PT 64,"00BB"
```

Node0 and node2 will receive the message with some time delay.

```
RX: [P2P] S:1, 00BB
```

Where **S:1** indicates the P2P packet was received from Node 1, followed by the data, **00BB**

7. End P2P connection when P2P test is done. Issue this command on all nodes - node0, node1 and node2.

```
AT+P2PE
```

5 Revision History

Version	Date	Notes	Contributor(s)	Approver
1.0	10 Oct 2023	Initial Release	Seokwoo Yoon Rikki Horrigan	Senthooran Ragavan
2.0	1 April 2024	Ezurio rebranding	Sue White	Senthooran Ragavan
2.1	20 May 2024	Updated details of P2P broadcast address and network size following P2P optimization (GA1.4)	Greg Leach	Senthooran Ragavan
2.2	01 May 2025	Updated new commands per GA1.5	Seokwoo Yoon	Jonathan Kaye
2.3	06 June 2025	Inserted AT&W and ATZ after region configuration for P2P	Seokwoo Yoon	Jonathan Kaye