LoRa AT Command Set for ISP4520

Application Note AN190701

Introduction

Scope

This document gives details on how to use AT commands for LoRaWAN example provided in the Insight SiP software package.

Contents

Insight SiP– Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France –**www.insightsip.com**

Revision History

Revision	Date	Ref	Change Description
R0	17/12/2019	jf pg	Preliminary release
R3	18/02/2021	jf pg	Update linked to LoraWAN 1.0.4 spec evolution

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1. Recommended Documentation

The following documents and Dev Kits (software portion) are required to understand the complete setup and programming methods:

Nordic Semiconductor Documents

- nRF52832 PS (data sheet).
- S132 nRF52832 SoftDevice Specification.
- nRF5 SDK (for software development on the nRF51 and nRF52 Series).

To access documentation, go to:

- Official Nordic Semi website *http://www.nordicsemi.com*
- The Nordic Semiconductor Documentation library *https://www.nordicsemi.com/DocLib*
- Ask any Nordic related question and get help *https://devzone.nordicsemi.com/questions*
- For any question, you can also open a case on the *http://www.nordicsemi.com*

Software Dev kits

- nRF Connect for Desktop.
- nRF5 Software Development Kit (SDK) which includes precompiled HEX files, source code as well as SES and Keil ARM project files.
- SoftDevices for nRF52832.

To access these files, go to *www.nordicsemi.com* and download the files.

Semtech Documents

- SX1261-SX1262Product Datasheet
- SX1261 Calculator Tools
- Semtech Application Notes concerning SX1261/SX1262 and LoRa

To access documentation, information, go to *https://www.semtech.com/products/wireless-rf/lora-transceivers/sx1261*

Other Insight SiP documents

To complete the above, following documents are available on Insight SIP website or/and on request:

- AN190301 App Note – Dev Kit App note
- DS4520 module data sheet.
- ISP4520-XX-GWGateway Board schematic “ISP4520C_GW_SCH”.
- ISP4520-XX-TB Test Board schematic “ISP4520C_TB_SCH”
- ISP130603 Interface Board schematic “SC130604”.

2. Firmware description

2.1. Overview

An example of AT commands is provided in the LoRa software library provided by Insight SiP at:
https://github.com/insightsip/ISP4520-examples

The project simplified architecture is:

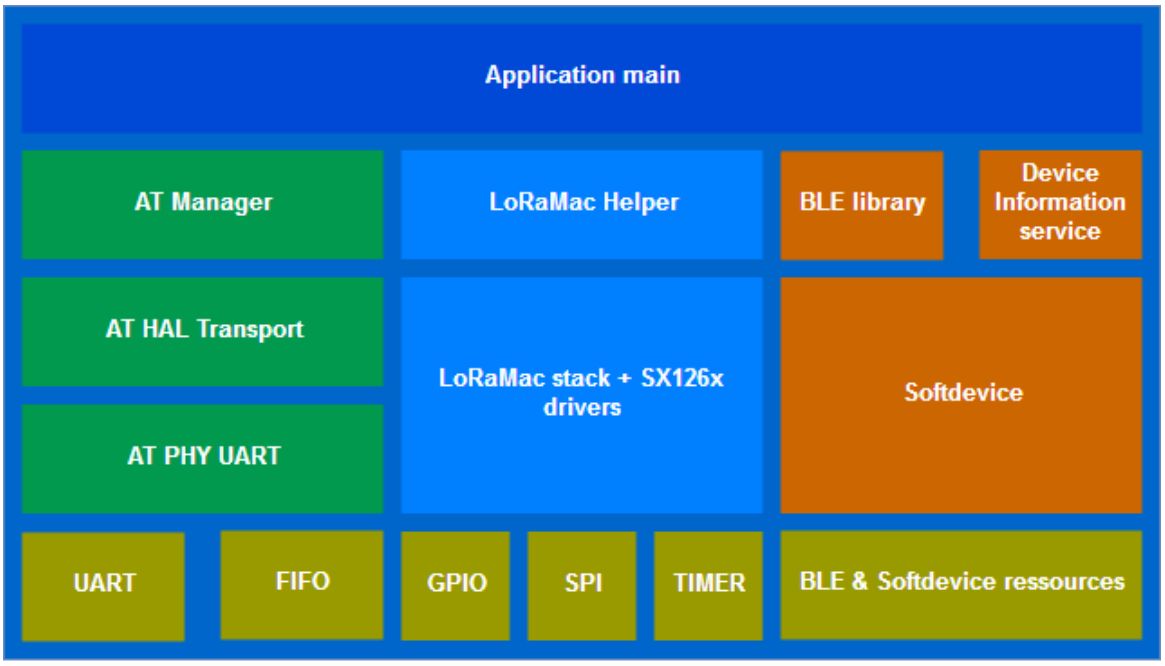

Figure 1: FW architecture

The AT commands are implemented in the at_manager.c and at_manager.h. New commands can be easily added by only modifying these files.

On the BLE side, only the Device information service is implemented.

2.2. Memory size

Using following configuration:

- Compiler Segger Embedded Studio
- Optimization: Optimize for size
- NRF_LOG disabled

The memory usage is: 85kB Flash / 26.9kB RAM.
The project needs the softdevice S132 v7.0.1 which takes 152kB Flash / 10.9kB RAM.
Therefore, the total memory usage is: 237kB Flash / 37.8kB RAM.

3. Setup

AT commands are transmitted through UART. The ISP4520 can then be controlled using a serial terminal (Putty, RealTerm etc).

This chapter we will explain how to setup AT commands between an ISP450-GW and a PC with RealTerm.

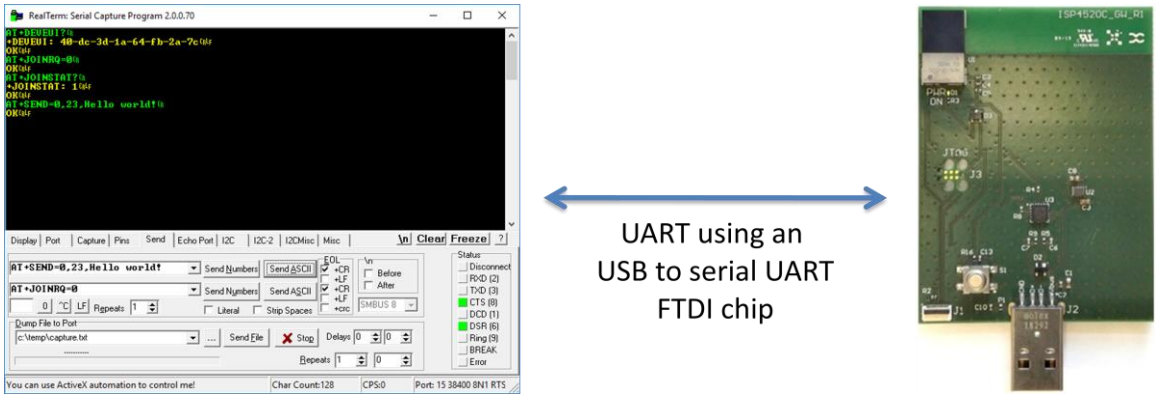

Figure 2: Setup

1. Select one of the methods:

   a. Connect the ISP4520-GW to the ISP130603 Interface Board with the 10 pin FPC jumper cable (0.5 mm pitch, provided in the Development Kit). Connect the provided USB cable from the Interface Board ISP130603 to your computer.

   b. Plug the ISP4520-GW USB to your computer. Connect an external JLINK probe with 6-pin connector (not provided in the kit) to the ISP4520-GW JTAG connector.

   Refer to picture of the hardware configuration below.

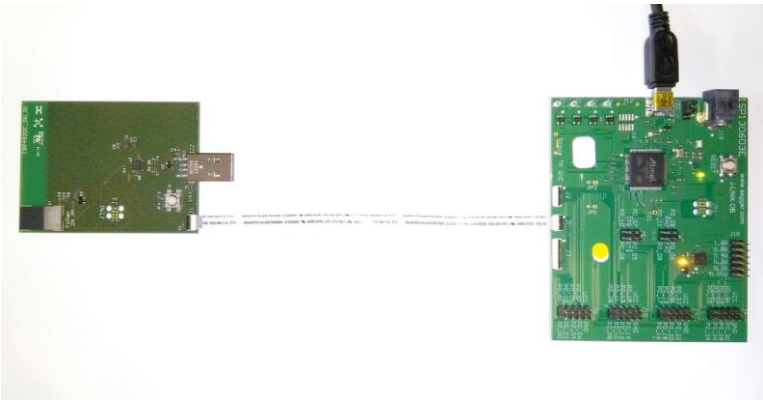

Figure 3: ISP4520-GW firmware loading via embedded JTAG in Interface Board

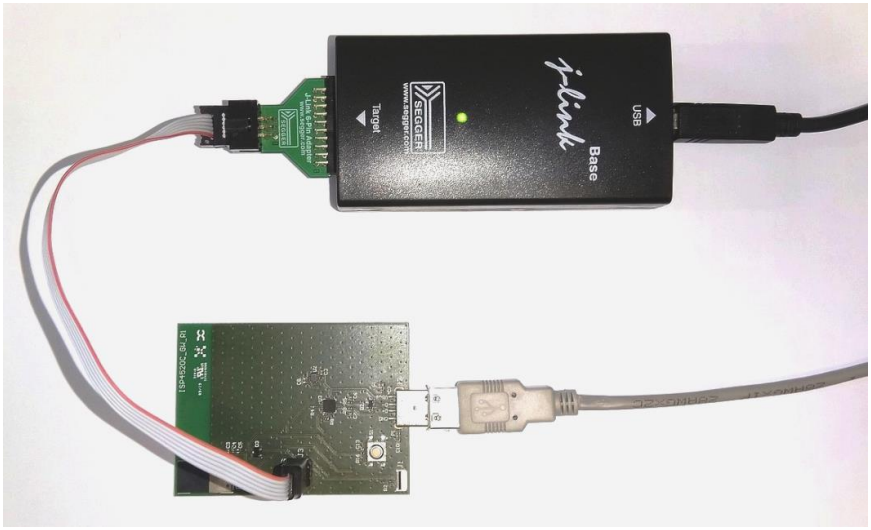

Figure 4: ISP4520-GW firmware loading via JTAG using Segger JLink with 6 pin adapter

2. Using Segger Embedded Studio, open the project named “at-commands.emProject” in <Your directory>ISP4520-Examples\src\apps\lorawan\at_commands\ses\.
3. Build the project corresponding to your module version and load it to the module.
4. If not done already, plug the ISP4520-GW USB to your computer. Download and install a serial terminal software (RealTerm for example)
5. On RealTerm select the port number associated with the ISP4520-GW. Configure the Port with Baudrate:38400, Parity: None, Data bits:8, Stop bits: 1, Hardware Flow control: RTS/CTS.
6. Try sending AT commands using RealTerm and check for responses. Make sure to tick the +CR case. Send with “Send ASCII” button.

4. AT commands list

4.1. Format and syntax

The format is based on the “Hayes” standard which is used to control modems.

The AT command set described in document consists in custom commands (except ATZ, ATE and ATI). Every AT command can be declined in 3 categories:

Type	Description	Syntax
Set	Set values or perform actions	<CMD>=... or <CMD>
Read	check values	<CMD>?
Test	Test existence and provide info	<CMD>=?

The rules are the following:

- Every command starts with “AT”.
- Commands are case sensitive.
- Parameters are not case sensitive.
- Commands can be terminated by <CR> or <LF>.
- Every command (except the reset command) is followed by a final response. The final response ends with <CR><LF>.
- Read and Test commands gives an additional response before the final response. The additional response ends with <CR><LF>.

The final response format is:

<Status><CR><LF>

Where <Status> can be:

- OK: Command run successfully.
- UNKNOWN_CMD: The command is unknown.
- ERROR_NOT_SUPPORTED: The command exists but the type (set, read or test) is not supported.
- ERROR_PARAM: There is an error in one of the parameters.
- ERROR_BUSY: SX126x is busy.
- ERROR_NOT_JOINED: The command requires the device to have joined the network and it is not the case.
- ERROR_DUTY_CYCLE: The device is allowed to transmit yet (ETSI regulation).
- ERROR: All other errors.

The additional response format is:

<CMD(*)>: <Returned value><CR><LF>

(*) The “AT” word is removed here.

4.2. Commands list

4.2.1. ATZ

The ATZ command resets the CPU.

Examples:

ATZ

4.2.2. ATE

The ATE enable / disable echo.

Type	Input parameter	Additional response	Final response
Set	0 = Disable 1 = Enable	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	-	-

4.2.3. ATI

The ATI command gives the information of the device.

Type	Input parameter	Additional response	Final response
Set	-	-	-
Read	-	Module name Device ID Firmware version	AT_SUCCESS
Test	-	-	-

Examples:

ATI?
ISP4520
368EB3F9DBF6FA43
3.1.1
OK

4.2.4. AT+DEVEUI

The AT+DEVEUI command gives access the device identifier.

Type	Input parameter	Additional response	Final response
Set	64-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	64-bit value in hexadecimal separated by -	AT_SUCCESS
Test	-	hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+DEVEUI=FE-DC-BA-98-76-54-32-10
OK

AT+DEVEUI?
+DEVEUI: FE-DC-BA-98-76-54-32-10
OK

AT+DEVEUI=?
+DEVEUI: hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.5. AT+APPEUI

The AT+APPEUI command gives access to application identifier.

Type	Input parameter	Additional response	Final response
Set	64-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	64-bit value in hexadecimal separated by -	AT_SUCCESS
Test	-	hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+APPEUI=FE-DC-BA-98-76-54-32-10
OK

AT+APPEUI?
+ APPEUI: FE-DC-BA-98-76-54-32-10
OK

AT+APPEUI=?
+ APPEUI: hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.6. AT+JOINEUI

The AT+JOINEUI command gives access to join identifier.

Type	Input parameter	Additional response	Final response
Set	64-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	64-bit value in hexadecimal separated by -	AT_SUCCESS
Test	-	hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+JOINEUI=FE-DC-BA-98-76-54-32-10
OK

AT+JOINEUI?
+JOINEUI: FE-DC-BA-98-76-54-32-10
OK

AT+JOINEUI=?
+JOINEUI: hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.7. AT+APPKEY

The AT+APPKEY command gives access to application key.

Type	Input parameter	Additional response	Final response
Set	128-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+APPKEY=FE-DC-BA-98-76-54-32-10-FE-DC-BA-98-76-54-32-10
OK

AT+APPKEY=?
+APPKEY: hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.8. AT+NWKKEY

The AT+NWKKEY command gives Network root key.

Type	Input parameter	Additional response	Final response
Set	128-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+ NWKKEY=FE-DC-BA-98-76-54-32-10-FE-DC-BA-98-76-54-32-10
OK

AT+ NWKKEY=?
+APPKEY: hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.9. AT+FNWKSINTKEY

The AT+FNWKSINTKEY command gives Forwarding Network session integrity key.

Type	Input parameter	Additional response	Final response
Set	128-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+FNWKSINTKEY=FE-DC-BA-98-76-54-32-10-FE-DC-BA-98-76-54-32-10
OK

AT+FNWKSINTKEY=?
+FNWKSINTKEY: hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.10. AT+SNWKSINTKEY

The AT+SNWKSINTKEY command gives Serving Network session integrity key.

Type	Input parameter	Additional response	Final response
Set	128-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+SNWKSINTKEY=FE-DC-BA-98-76-54-32-10-FE-DC-BA-98-76-54-32-10
OK

AT+SNWKSINTKEY=?
+SNWKSINTKEY: hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.11. AT+NWKSENCKEY

The AT+NWKSENCKEY command gives Network session encryption key.

Type	Input parameter	Additional response	Final response
Set	128-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+NWKSENCKEY =FE-DC-BA-98-76-54-32-10-FE-DC-BA-98-76-54-32-10
OK

AT+NWKSENCKEY=?
+NWKSENCKEY: hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.12. AT+APPSKEY

The AT+APPSKEY command gives access to application session key.

Type	Input parameter	Additional response	Final response
Set	128-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test		hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+APPSKEY=FE-DC-BA-98-76-54-32-10-FE-DC-BA-98-76-54-32-10
OK

AT+APPSKEY=?
+APPSKEY: hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh-hh
OK

4.2.13. AT+DEVADDR

The AT+DEVADDR command gives access to the device address.

Type	Input parameter	Additional response	Final response
Set	32-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	32-bit value in hexadecimal separated by -	AT_SUCCESS
Test	-	hh-hh-hh-hh	AT_SUCCESS

Examples:

AT+DEVADDR=FE-DC-BA-98
OK

AT+DEVADDR?
+DEVEUI: FE-DC-BA-98
OK

AT+DEVADDR=?
+DEVEUI: hh-hh-hh-hh
OK

4.2.14. AT+NETID

The AT+NETID command gives access to network id.

Type	Input parameter	Additional response	Final response
Set	24-bit value in hexadecimal separated by -	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	24-bit value in hexadecimal separated by -	AT_SUCCESS
Test	-	hh-hh-hh	AT_SUCCESS

Examples:

AT+NETID=FE-DC-BA
OK

AT+NETID?
+ NETID: FE-DC-BA
OK

AT+NETID=?
+ NETID: hh-hh-hh
OK

4.2.15. AT+JOINRQ

The AT+JOINRQ command performs join request (ABP/OTAA).

Type	Input parameter	Additional response	Final response
Set	0 = ABP 1 = OTAA	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	-	-

Examples:

AT+JOINRQ=1
OK

4.2.16. AT+JOINSTAT

The AT+JOINSTAT command gives the join status of the LoRa link.

Type	Input parameter	Additional response	Final response
Set	-	-	-
Read		0 = Not joined 1 = joined	AT_SUCCESS
Test	-	-	-

Examples:

AT+JOINSTAT?
+JOINSTAT: 1
OK

4.2.17. AT+RCV

The AT+RCV command gives the last received data in ASCII.

Type	Input parameter	Additional response	Final response
Set	-	-	-
Read		string format: <confirm>, <port>, <payload> Where confirm indicates the status of an uplink confirmed message	AT_SUCCESS
Test	-	-	-

Examples:

AT+RCV?
+RCV: 1,23,Hello world!
OK

4.2.18. AT+SEND

The AT+SEND command allows the user to send data in ASCII.

Type	Input parameter	Additional response	Final response
Set	string format: <confirm>, <port>, <payload> confirm=1 for confirmed message confirm=0 for unconfirmed message	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	-	-

Examples:

AT+SEND=1,23,Hello world!
OK

4.2.19. AT+ADR

The AT+ADR command enables or disables to adaptative data rate.

Type	Input parameter	Additional response	Final response
Set	0 = Disabled 1 = Enabled	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	0 = Disabled 1 = Enabled	AT_SUCCESS
Test	-	-	-

Examples:

AT+ADR=1
OK

AT+ADR?
+ADR: 1
OK

4.2.20. AT+CLASS

The AT+CLASS command gives access to the device class.

Type	Input parameter	Additional response	Final response
Set	A, B, C a, b, c	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	A, B, C a, b, c	AT_SUCCESS
Test	-	A, C	AT_SUCCESS

Examples:

AT+CLASS=A
OK

AT+CLASS?
+CLASS: A
OK

AT+CLASS=?
+CLASS: A, C
OK

4.2.21. AT+DR

The AT+DR command gives access to the data rate.

Type	Input parameter	Additional response	Final response
Set	Integer corresponding to the DR	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	Integer corresponding to the DR	AT_SUCCESS
Test	-	0, 1, 2, 3, 4 ,5 ,6, 7	AT_SUCCESS

Examples:

AT+DR=0
OK

AT+DR?
+DR: 0
OK

AT+DR=?
+DR: 0, 1, 2, 3, 4, 5, 6, 7
OK

4.2.22. AT+JOINDLY1

The AT+JOINDLY1 command gives access to the device class.

Type	Input parameter	Additional response	Final response
Set	Delay in ms	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	Delay in ms	AT_SUCCESS
Test	-	-	-

Examples:

AT+JOINDLY1=5000
OK

AT+JOINDLY1?
+JOINDLY1: 5000
OK

4.2.23. AT+JOINDLY2

The AT+JOINDLY2 command gives access to the device class.

Type	Input parameter	Additional response	Final response
Set	Delay in ms		AT_SUCCESS AT_ERROR_PARAM
Read		Delay in ms	AT_SUCCESS
Test	-	-	-

Examples:

AT+JOINDLY2=6000
OK

AT+JOINDLY2?
+JOINDLY2: 6000
OK

4.2.24. AT+PNET

The AT+PNET command gives access to the public network mode.

Type	Input parameter	Additional response	Final response
Set	0 = Private 1 = Public		AT_SUCCESS AT_ERROR_PARAM
Read		0 = Private 1 = Public	AT_SUCCESS
Test	-	-	-

Examples:

AT+PNET=1
OK

AT+PNET?
+PNET: 1
OK

4.2.25. AT+RXDLY1

The AT+RXDLY1 command gives access to the device class.

Type	Input parameter	Additional response	Final response
Set	Delay in ms		AT_SUCCESS AT_ERROR_PARAM
Read		Delay in ms	AT_SUCCESS
Test	-	-	-

Examples:

AT+RXDLY1=1000
OK

AT+RXDLY1?
+RXDLY1: 1000
OK

4.2.26. AT+RXDLY2

The AT+RXDLY2 command gives access to the device class.

Type	Input parameter	Additional response	Final response
Set	Delay in ms		AT_SUCCESS AT_ERROR_PARAM
Read		Delay in ms	AT_SUCCESS
Test	-	-	-

Examples:

AT+RXDLY2=2000
OK

AT+RXDLY2?
+RXDLY1: 2000
OK

4.2.27. AT+RXDR2

The AT+RXDR2 command gives access to the data rate of the 2nd receive window.

Type	Input parameter	Additional response	Final response
Set	Integer corresponding to the DR		AT_SUCCESS AT_ERROR_PARAM
Read		Integer corresponding to the DR	AT_SUCCESS
Test		0, 1, 2, 3, 4 ,5 ,6, 7	AT_SUCCESS

Examples:

AT+RXDR2=0
OK

AT+RXDR2?
+RXDR2: 0
OK

AT+RXDR2=?
+DR: 0, 1, 2, 3, 4, 5, 6, 7
OK

4.2.28. AT+RXFQ2

The AT+RXDR2 command gives access to the frequency of the 2nd receive window.

Type	Input parameter	Additional response	Final response
Set	Frequency in Hz		AT_SUCCESS AT_ERROR_PARAM
Read		Frequency in Hz	AT_SUCCESS
Test	-	-	-

Examples:

AT+RXFQ2=869525000
OK

AT+RXFQ2?
+RXFQ2: 869525000
OK

4.2.29. AT+TXP

The AT+TXP command gives access to the device transmit power.

Type	Input parameter	Additional response	Final response
Set	Integer corresponding to the TX_POWER		AT_SUCCESS AT_ERROR_PARAM
Read		Integer corresponding to the TX_POWER	AT_SUCCESS
Test		0, 1, 2, 3, 4 ,5	

Examples:

AT+TXP=0
OK

AT+TXP?
+TXP: 0
OK

AT+TXP=?
+TXP: 0, 1, 2, 3, 4, 5
OK

4.2.30. AT+BATT

The AT+BATT command gives battery level.

Type	Input parameter	Additional response	Final response
Set	-	-	-
Read		Battery level 0..254 0 = 0%, 254 = 100% 255 = No value	AT_SUCCESS
Test	-	-	-

Examples:

AT+BATT?
+BATT: 254
OK

4.2.31. AT+RSSI

The AT+RSSI command gives the RSSI of the last received LoRa frame.

Type	Input parameter	Additional response	Final response
Set	-	-	-
Read		RSSI in dBm	AT_SUCCESS
Test	-	-	-

Examples:

AT+RSSI?
+RSSI: -70
OK

4.2.32. AT+SNR

The AT+SNR command gives the SNR of the last received LoRa frame.

Type	Input parameter	Additional response	Final response
Set	-	-	-
Read		SNR	AT_SUCCESS
Test	-	-	-

Examples:

AT+SNR?
+SNR: 12
OK

4.2.33. AT+DUTYC

The AT+DUTYC command enables/disables the ETSII duty cycle.

Type	Input parameter	Additional response	Final response
Set	0 = Disabled 1 = Enabled		AT_SUCCESS AT_ERROR_PARAM
Read		0 = Disabled 1 = Enabled	AT_SUCCESS
Test	-	-	-

Examples:

AT+HW?
+HW: EU-C
OK

4.2.34. AT+CHANNEL

The AT+CHANNEL command allows configuration of new channels.

Type	Input parameter	Additional response	Final response
Set	Id,frequency,drmin,drmax	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	For each channel: Id,frequency,drmin,drmax	AT_SUCCESS
Test	-	-	-

Examples:

AT+CHANNEL=3,867100000,0,5
OK

AT+CHANNEL?
+CHANNEL: 0, 868100000, 0, 5
+CHANNEL: 1, 868300000, 0, 5
+CHANNEL: 2, 868500000, 0, 5
+CHANNEL: 3, 867100000, 0, 5
+CHANNEL: 4, 0, 0, 0
+CHANNEL: 5, 0, 0, 0
+CHANNEL: 6, 0, 0, 0
+CHANNEL: 7, 0, 0, 0
+CHANNEL: 8, 0, 0, 0
+CHANNEL: 9, 0, 0, 0
+CHANNEL: 10, 0, 0, 0
+CHANNEL: 11, 0, 0, 0
+CHANNEL: 12, 0, 0, 0
+CHANNEL: 13, 0, 0, 0
+CHANNEL: 14, 0, 0, 0
+CHANNEL: 15, 0, 0, 0
OK

4.2.35. AT+CERTIF

Enable /disable certification mode

Type	Input parameter	Additional response	Final response
Set	0 = Disabled 1 = Enabled	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	-	-

Examples:

AT+CERTIF=1
OK

4.2.36. AT+CTXRST

The AT+CTXRST command deletes the MAC context from the non-volatile memory and then resets the CPU.

Type	Input parameter	Additional response	Final response
Set	1 = Enabled	-	AT_SUCCESS AT_ERROR_PARAM
Read	-	-	-
Test	-	-	-

4.3. Events list

Events are messages sent from the device to the user at any given time.

Event	Parameter	Description	Example
+RXDATA	string format: <port>, <payload>	Event received when the device receives a new message from the network.	+RXDATA: 23, Hello world!
+JOINED		Event received the device has joined the network.	+JOINED