

FIELD TEST DEVICE

LoRaWAN US 902-928

Guide utilisateur / User Guide
Version V1.0.1



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Préambule / Preamble / Präambel / Preambolo / Preámbulo

- Ce guide décrit les fonctionnalités du produit adeunis®. Il explique les modes de fonctionnement du produit et la manière de le configurer.
- This guide describes the functionalities of the product adeunis®. It explains its functionments and how to configure it.
- Dieser Leitfaden beschreibt die Funktionalität des Produktes adeunis®. Er erklärt die Betriebsfunktionen des Produktes und die Art und Weise, um es zu konfigurieren.
- Questa guida descrive la funzionalità del prodotto adeunis®. Questo spiega come funziona il prodotto e come configurarlo.
- Esta guía describe las funcionalidades del producto adeunis®. En él se explica los modos de funcionamiento del producto y cómo configurarlo.

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FR

INFORMATIONS

| Document Information | |
|----------------------|--------------------|
| Title | FIELD TEST DEVICE |
| Subtitle | LoRaWAN US 902-928 |
| Document type | User Guide |
| Version | V1.0.1 |

This document applies to the following products:

| Name | Reference | Firmware Version |
|---|-----------|--|
| FIELD TEST DEVICE - LoRaWAN US 902-928 | ARF8124A | Version RTU: V01.07.01 Version APP: V01.01.02 |

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TECHNICAL SUPPORT

Website

Our website contains a lot of useful information: information on modules and wireless modems, user guides, and configuration software and technical documents which can be accessed 24 hours a day.

E-mail

If you have technical problems or cannot find the required information in the provided documents, contact our Technical Support on our website, section « Technical Support ». This ensures that your request will be processed as soon as possible.

Helpful Information when Contacting Technical Support

When contacting Technical Support, please have the following information ready:

- Product type
- Firmware version (for example V1.0)
- A clear description of your question or the problem
- A short description of the application

COMPLIANCE TO FCC US/CAN

- This device complies with part 15 of the FCC rules and Industry Canada licence-exempt RSS standard(s).

Operation is subject to the following two conditions: (1) this device may not cause Harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation of the device.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction, may cause harmful interference to radiocommunication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

- CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY ADEUNIS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lower) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be chosen so that the equivalent isotropically radiated power (e.i.r.p.) is not superior than necessary for successful communication.

Identification :

- Contains FCC ID : U3Z-ARF8133
- Contains IC : 7016A-ARF8133

Product reference: USA/CANADA: ARF8124A

Authorised representative in Canada

X Telia

440 rue Ste-Hélène, J4K 3R2, Longueuil (Québec) - CANADA

EN

INTRODUCTION

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ENVIRONMENTAL RECOMMENDATIONS

All superfluous packaging materials have been eliminated. We have done everything possible to make it easy to separate the packaging into three types of materials: cardboard (box), expanded polystyrene (filler material) and polyethylene (packets, foam protective sheets). Your device is composed of materials that can be recycled and reused if it is dismantled by a specialist company. Please observe local regulations concerning the manner in which waste packaging material, used batteries and your obsolete equipment are disposed of.

WARNINGS

Valid for products indicated in the declaration of conformity



Read the instructions in the manual.



The safety of this product is only guaranteed when it is used in accordance with its purpose. Maintenance should only be carried out by qualified persons.



Risk of explosion if the battery is removed with an incorrect type. Contact Adeunis for more information if needed.

Please note: Do not install the equipment close to a heat source or in damp conditions.

Please note: When the equipment is open, do not carry out any operations other than the ones set out in this document.



Please note: Do not open the product as there is a risk of electrical shock.



Please note: For your own safety, you must ensure that the equipment is switched off before carrying out any work on it.



Please note: For your own safety, the power supply circuit must be SELV (Safety Extra Low Voltage) and must be from limited power sources.



This symbol on the device or its packaging means the use of a DC voltage.

RECOMMANDATIONS REGARDING USE

- Before using the system, check that the power supply voltage shown in the user manual corresponds to your supply. If it doesn't, please consult your supplier.
- Place the device against a flat, firm and stable surface.
- The device must be installed in a location that is sufficiently ventilated so that there is no risk of internal heating and it must not be covered with objects such as newspapers, cloths, curtains, etc.
- The device's aerial must be free and at least 10 cm away from any conducting material.
- The device must never be exposed to heat sources such as heating equipment.
- Do not place the device close to objects with naked flames such as lit candles, blowtorches, etc.
- The device must not be exposed to harsh chemical agents or solvents likely to damage the plastic or corrode the metal parts.

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DISPOSAL OF WASTE BY USERS IN PRIVATE HOUSEHOLDS WITHIN THE EUROPEAN UNION



This symbol on the product or on its packaging indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of your waste by taking it to a collection point designated for the recycling of electrical and electronic appliances. Separate collection and recycling of your waste at the time of disposal will contribute to conserving natural resources and guarantee recycling that respects the environment and human health. For further information concerning your nearest recycling centre, please contact your nearest local authority/town hall offices, your household waste collection company or the shop where you bought the product



After use, the batteries must be disposed of at an appropriate recycling centre. They must not be thrown away to degrade in the environment. When batteries are replaced, the device must be correctly implemented.



Warning for Switzerland : the annex 4.10 of SR 814.013 Standard must be applied for batteries.

1. INTRODUCING THE DEVICE

1.1. Description

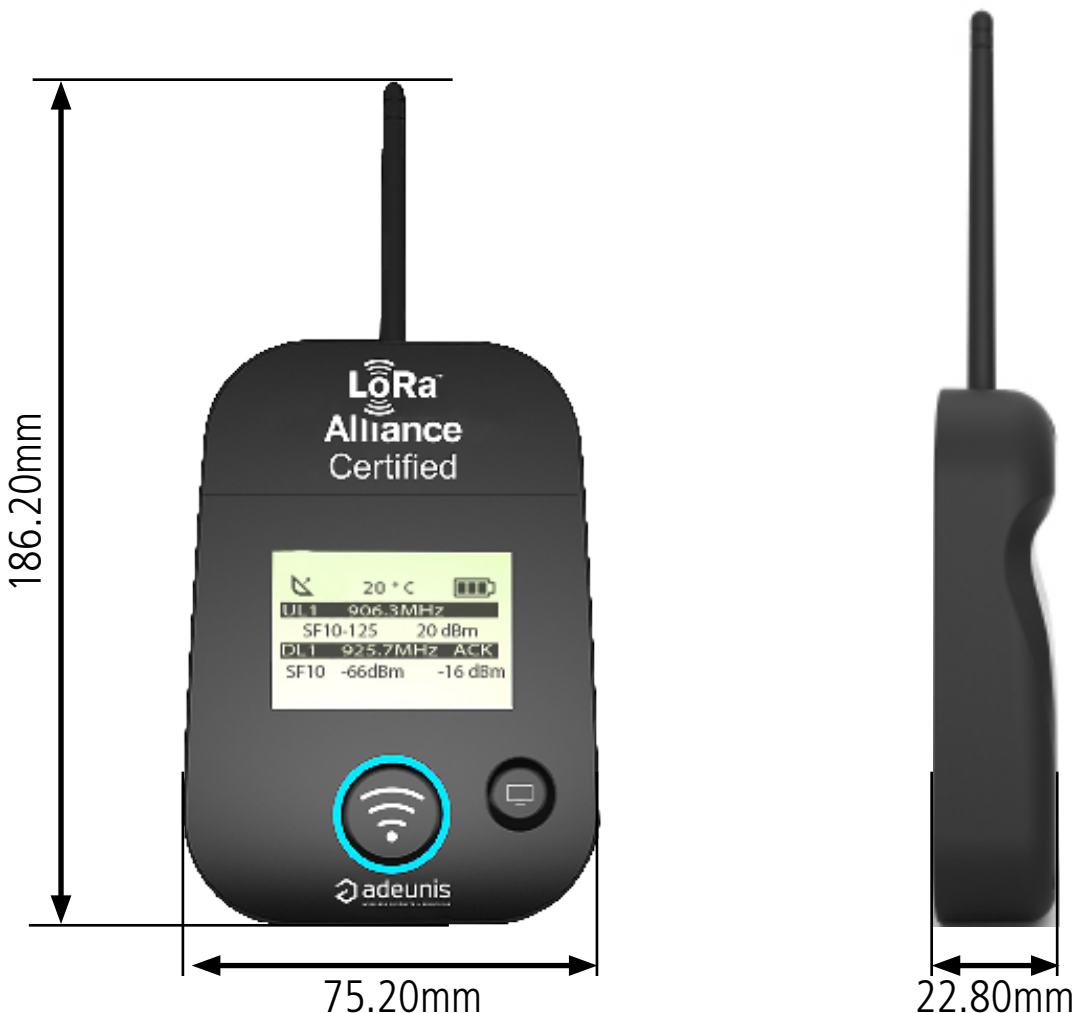
The Field Test Device (FTD) from adeunis® is a Class A LoRaWAN compatible device. This is not a point to point device and may not be used in this manner. This indicates that it must be used on a private or public operated network.

The LoRaWAN Field Test Device from adeunis® is a ready-to-use device, which makes it possible to communicate with all network operators using the LoRaWAN protocol. The system makes it possible to transmit and receive radio frames and to instantly view the results. Equipped with a large LCD screen, you can view various information relating to how the network being used is functioning (Uplink, Downlink, SF, PER, etc.) in addition to information from sensors (GPS coordinates, temperature, battery level, etc.). This device is specifically adapted for application validation, such as communicating sensors, tracking, smart building, metering, security and M2M.

Thanks to its rechargeable battery, the FTD allows several hours of functioning and can be recharged using a standard mobile phone micro-usb.

1.2. Mechanical features

| Unit specifications | |
|---------------------|---|
| Dimensions | H186.20 x L75.20 x P22.80 |
| Weight | 140g |
| Materials | Unit: ABS GP22 + Black Colouring (HB à 1.6mm) Lexan: Autotex Polycarbonate Antenna: Thermolast K TC7AA (d) (a) UL#E214855 |



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1.3. Technical specifications

| Radio | |
|-----------------------------|--|
| Communication | LoRaWAN protocol & LoRa Modulation |
| Network area | US902-928 |
| Output power | +20dBm max (all MAC commands requesting a power adjustment greater than 20dBm will be readjusted to 20dBm) |
| LoRaWAN specification | 1.0.2 revB |
| Supply | |
| Connector | Micro-USB - 5V - 500mA |
| Battery | Lithium-Ion Polymer 3.7V 2Ah 7.4Wh |
| Operational | |
| Device configuration | Via AT commands (see relevant chapter to find a full list of available AT commands) |
| Serial rate | 115.2 kbps |
| Parity | None |
| Amount of data | 8 |
| Stop bit | 1 |
| Functioning temperature | -20°C/+40°C in discharge and -20°C/ +36°C in charge |
| Network settings | |
| Applicative port (Downlink) | 1 |

1.4. Charging the FTD

The device is equipped with a rechargeable battery. Once the device has been connected to a USB charger or the USB socket of a computer, it will start to charge automatically; even if the ON/OFF communicator is set to OFF (this functions in exactly the same way as a mobile phone). The device can be used while it is charging. During charging, the charge indicator will be red. When the device is fully charged, the indicator will turn green.



Figure 1 : Device charging



Figure 2 : Device is fully charged






If the battery is completely empty, it will be necessary to recharge the device for 6 hours in order for it to be fully charged.

2. DEVICE DESCRIPTION

2.1. User interface



2.2. Button description

| Interface operation | |
|---|--|
|  | <p>Pushbutton 1</p> <p>This button allows you to carry out radio transmissions in manual mode. In the PER menu, a long press will allow you to reset the counters to zero.</p> |
|  | <p>Pushbutton 2</p> <p>This button allows you to manage the LCD screen. When the LCD backlight is switched off, pressing this button will switch on the backlight. When the LCD backlight is switched on, each press will allow you to scroll through the different screens available on this device.</p> |
|  | <p>ON/OFF Switch</p> <p>The ON/OFF switch allows you to switch the device on or off. Moving the switch to the right will turn the device on.</p> |
|  | <p>Micro-USB connector</p> <p>The micro-USB connector allows you to charge the device (see paragraph 1.4) or configure it (see paragraph 3).</p> |
|  | <p>Charge indicator</p> <p>The charge LED shows you the device's charge status (see paragraph 1.4).</p> |

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3. SCREEN DESCRIPTION

The LCD screen of the product is split on few part :

- The START screen (Showing the firmware version) - Only on the powering up
- The JOIN screen - Only on the powering up and after a command mode exit
- The UPLINK/DOWNLINK screen
- The GPS screen
- The PER screen (Packet Error Rate)
- The DOWNLINK FRAME screen

The following icon are present on each screen of the product

| Item | Icon | Description |
|------------------------------------|---------|-------------------------------|
| GPS status (First on the left) | No icon | GPS has been deactivated |
| | | GPS has not been synchronized |
| | | GPS has been synchronized |
| Temperature (Third on the left) | 20 °C | Temperature in °C |
| Battery (Last on the left) | | Battery level |
| | | Product in charge |

3.1. Start Screen

The device is switched on using the ON/OFF switch located on the underside of the device. Once it has been switched on, the device's LCD screen will light up and the start menu will be displayed. This screen show the 2 firmware versions during few seconds.

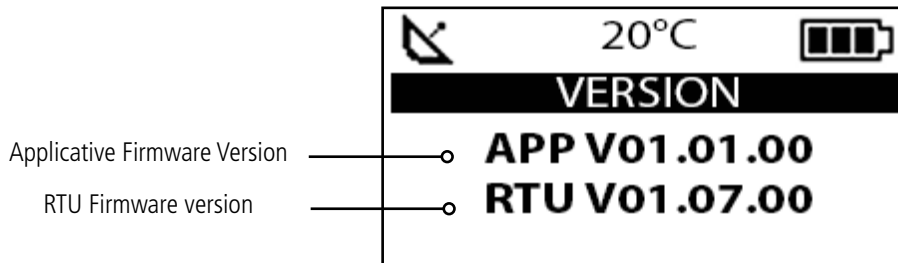


Figure 5 : Firmware version

NOTE : If the device does not switch on, this could mean that there is insufficient battery charge. You would then need to connect the device to a USB charger. When the battery is completely empty, it is possible that the device will not switch on, even when connected. Please wait a few minutes before the device can be used.

3.2. Join Screen

When the device is configure in OTAA mode (Over the Air Activation) default mode, the product start a join request session (JRx) and show the frequency, SF and power used during this session. When the product receive a Join Accept (JA) from the network, the information is displayed on the screen and the product switch to the main screen (Uplink/Downlink).

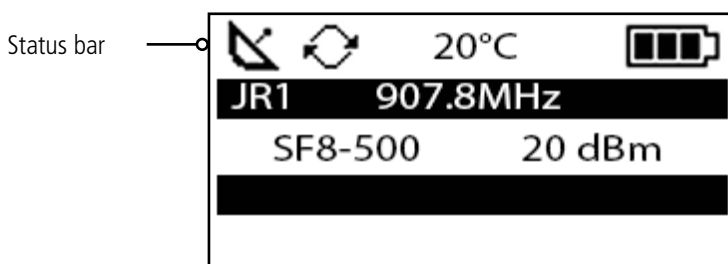


Figure 6 : Join Request

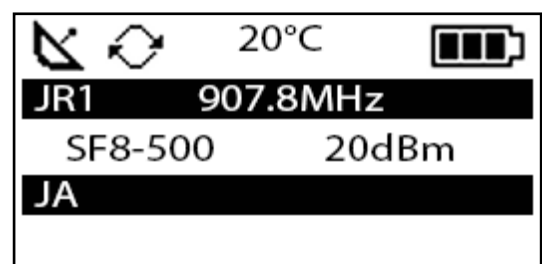


Figure 7 : Join Accept

The request are identify «JR» following with a number showing the number of request done. The frequency used for the request is showing after this information.

Note : If there is no network available, the «Join Request» will be send indefinitely, and the product will stay in this screen.

| Item | Icon | Description |
|-----------------------------------|---------|--|
| RF status (Second on the left) | No icon | The JOIN phase is completed and the device is operational on the network |
| | | The device is in JOIN phase, and is trying to connect to the network |

IMPORTANT: the operating principle of the LoRaWAN protocol in this geographical area can lead to a long delay (several minutes) to complete the JOIN procedure.

3.3. Uplink/Downlink screen

In periodic mode, this screen is displayed when the device is operational on a network but also when the device has been configured in ABP (Activation By Personalization) mode.

Uplink and Downlink transmission information will be displayed on the LCD screen.

The first line show the Uplink information «ULx» with x for the number and frequency of repetition.

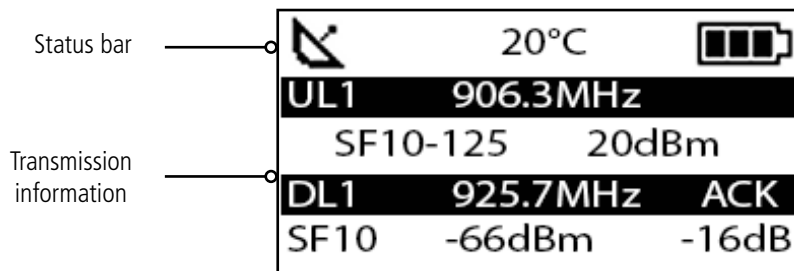


Figure 8 : Principal screen

The second line show the SF and the power used

The third line show the Downlink information «DLx» with x for the number and frequency of the reception window

The last line show the SF, RSSI and SNR of the frame received

| Item | Icon | Description |
|---|---------|--|
| Transmission Status (Second on the left) | No icon | There is currently no radio transmission |
| | | Manual transmission has been triggered (transmission cycle in progress) |
| | | Periodic transmission has been triggered (transmission cycle in progress) |
| Uplink information (Black Line) | | Display showing the number of Uplink (UL1 to UL8) frame repetitions as well as the transmission frequency of the frame, accurate to one decimal place. |
| Uplink Information (White Line) | | Display showing the SF used as well as the transmission power of the frame. |
| Downlink Information (Black Line) | | Display showing the listening window of the device (DL1 or DL2) as well as the reception frequency of the frame, accurate to one decimal place. |
| Downlink Information (White Line) | | Display showing the SF, the RSSI and the SNR of the most recent frame received. |

The Downlink information displayed on the device relates to a Downlink frame sent from a LoRaWAN network. If no information can be found in this section, this does not indicate that the device will not function on the network but only that it has not received any information from the network. To validate the upload link (sending a frame from the device to the network) it is necessary to use an interface that will allow you to read frames from the network (example: back-end or application).

The device can either be configured in CONFIRMED mode or UNCONFIRMED MODE (see paragraph 5.4) In CONFIRMED mode, the confirmation frame allows you to obtain Downlink information. In UNCONFIRMED mode, this information will not automatically be displayed.

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3.4. GPS screen

This screen can be accessed by briefly pressing on pushbutton 2 after the home screen. It will allow you to view the functioning information of the GPS module, as well as the device's GPS positioning.

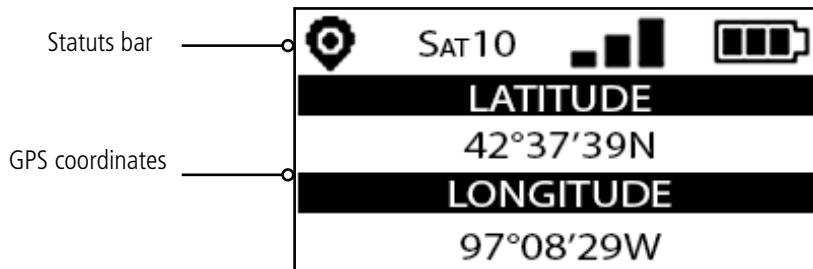


Figure 9 : GPS screen

| Item | Icon | Description |
|---|--------|---|
| Number of Satellites (Second on the left) | SAT xx | Indicates the number of satellites received by the device |
| GPS signal (Third on the left) | | Indicator showing the quality of the GPS signal 1 bar: weak reception 2 bars: average reception 3 bars: good reception |
| LATITUDE | | Display showing latitude coordinates in degrees, minutes and seconds |
| LONGITUDE | | Display showing longitude coordinates in degrees, minutes and seconds |

When GPS has not yet been "fixed", no information on latitude or longitude will be displayed on the screen and the information icon will indicate that GPS has not been synchronized.

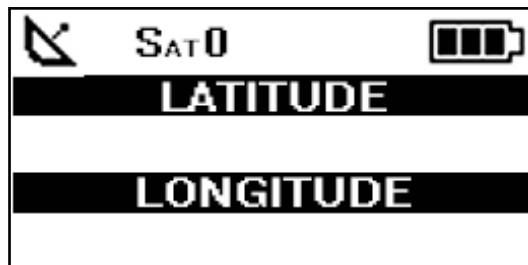


Figure 10 : GPS screen (No synchronisation)

If the device falls out of synchronization with GPS, the information on this screen will no longer be available. There will be no memory of the last received position.

3.5. PER (Packet Error Rate) screen

This menu can be accessed by briefly pressing on pushbutton 2 after the GPS menu. It will allow you to evaluate the quality of the radio connection between the device and the network.

The screen will display:

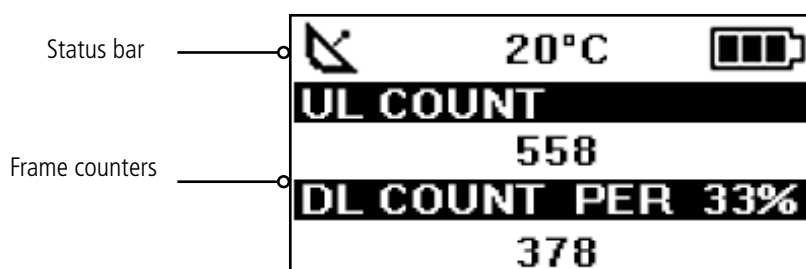


Figure 11 : PER screen

- The number of frames sent (UL COUNT), including repetitions
- The number of frames received (DL COUNT)
- The Packet Error Rate (PER) as a percentage

The PER measurement is calculated by comparing the number of frames transmitted to the number of frames received:

- $PER (\%) = 100 - ((DL_COUNT/UL_COUNT) * 100)$

IMPORTANT : in this menu, a long press in the button 1 will allow you to reset the counters to zero.

3.6. Downlink screen

This menu can be accessed by briefly pressing on pushbutton 2 after the PER menu. It will allow you to view a downlink frame sending by the network. This frame is displayed in ASCII characters. The non printable characters are replace by a point.

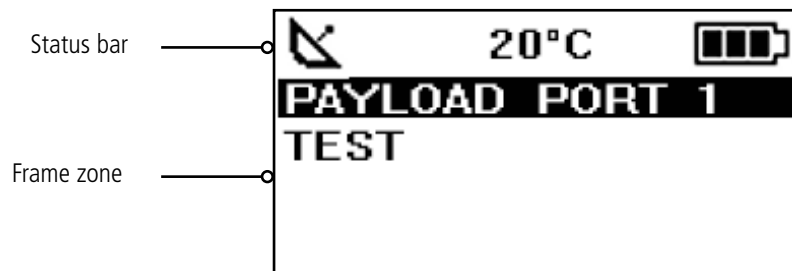


Figure 12 : Downlink screen

The screen allow a viewing of 51 characters (17 characters per lines). If the size of the payload is upper than 51 bytes, the product will not display the extra bytes.

4. DECODING THE PAYLOAD

The payload is divided into 2 frames to be compliant with regulation. The first byte (status byte) will enable you to identify the presence of information contained in the payload.

These 2 frames are systematically transmitted in periodic mode or in event mode (button pressed or triggering of the accelerometer). Specifically, during accelerometer triggering (following a vibration detected by the FTD), the MAC LinkCheckRequest command is issued and the LinkCheckAnswer command is received back (symbolized by the ANS on the DL line of the display).

4.1. Frame 1 description

Information will always be shown in the order indicated in the following table.

| Byte N° | 1 | 2 to 5 | | | | 6 to 9 | | | | 10 |
|-------------|-----------|--------------|-----------|-----------|-----------|---------------|-----------|-----------|-----------|-------------|
| Description | Status | GPS Latitude | | | | GPS Longitude | | | | GPS Quality |
| Example | 30 | 45 | 15 | 96 | 90 | 00 | 55 | 34 | 50 | 27 |

Example of a payload received: 30451596900055345027

This example will be used in order to explain how the payload is decoded.

if no GPS coordinate is available, only the Status byte (byte n°1) is sent.

if no GPS coordinate is available and transmission was generated from periodic transmission mode (no bouton pressed, no accelerometer), only the first byte (status byte) is sent and its value will be 0x00.

4.1.1 Status

For frame 1, using the previous example, the value of status byte is 0x30 i.e. 0011 0000 in binary so in the table:

| Hex | Binary | Comments |
|-----|--------|---|
| 30 | 0 | Not used |
| | 0 | Transmission triggered by the accelerometer |
| | 1 | Transmission triggered by pressing pushbutton 1 |
| | 1 | Presence of GPS information |
| | 0 | Not used |
| | 0 | Not used |
| | 0 | Not used |
| | 0 | Not used |

0: Data missing from the payload

1: Data present in the payload

4.1.2 Latitude

| Hex | Frame N° | Byte N° | Bit N° | Comments | Value |
|-----|----------|---------|--------------------|---|------------|
| 45 | 1 | 2 | 7..4 | BCD coding of the entire degree section (tenth of a degree) | 45°15,9690 |
| | | | 3..0 | BCD coding of the entire degree section (whole degrees) | 45°15,9690 |
| 15 | | 3 | 7..4 | BCD coding of the entire minute section (tenth of a minute) | 45°15,9690 |
| | | | 3..0 | BCD coding of the entire minute section (whole minutes) | 45°15,9690 |
| 96 | | 4 | 7..4 | BCD coding of the decimal section (tenth) | 45°15,9690 |
| | | | 3..0 | BCD coding of the decimal section (one hundredth) | 45°15,9690 |
| 90 | | 5 | 7..4 | BCD coding of the decimal section (one thousandth) | 45°15,9690 |
| | | | 3...1 | Not used | |
| | 0 | | Hemispheric coding | 0 : North 1 : South | |

Note: the value expressed in the payload will be in degrees, minutes and fractions of a second. A conversion to degrees, minutes and seconds must be carried out in order to make a comparison with the coordinates displayed on the device's LCD screen.

4.1.3 Longitude

| Hex | Frame N° | Byte N° | Bit N° | Comments | Value |
|-----|----------|---------|--------------------|---|------------|
| 00 | 1 | 6 | 7.4 | BCD coding of the entire degree section (one hundredth of a degree) | 005°53,450 |
| | | | 3..0 | BCD coding of the entire degree section (one tenth of a degree) | 005°53,450 |
| 55 | | 7 | 7.4 | BCD coding of the entire degree section (whole degrees) | 005°53,450 |
| | | | 3..0 | BCD coding of the entire minute section (one tenth of a minute) | 005°53,450 |
| 34 | | 8 | 7.4 | BCD coding of the entire minute section (whole minutes) | 005°53,450 |
| | | | 3..0 | BCD coding of the decimal section (tenth) | 005°53,450 |
| 50 | | 9 | 7.4 | BCD coding of the decimal section (one hundredth) | 005°53,450 |
| | | | 3..1 | Not used | |
| | 0 | | Hemispheric coding | 0 : East 1 : West | |

Note: the value expressed in the payload will be in degrees, minutes and fractions of a second. A conversion to degrees, minutes and seconds must be carried out in order to make a comparison with the coordinates displayed on the device's LCD screen.

4.1.4 GPS quality (Not available in Legacy mode)

| Hex | Value | Frame N° | Byte N° | Bit N° | Comments | Value |
|-----|-------|----------|---------|--------|----------------------|----------------------------------|
| 27 | 2 | 1 | 10 | 7..4 | Reception scale | 1: Good 2: Average 3: Poor |
| | 7 | | | 3..0 | Number of satellites | 1 ... 16 |

The byte's MSB allows you to find out the quality of the GPS signal

The byte's LSB allows you to find out the number of satellites viewed by the device

4.2. Frame 2 description

Information will always be shown in the order indicated in the following table.

| Byte N° | 1 | 2 | 3 | 4 | 5 to 6 | 7 | 8 |
|-------------|--------|-------------|------------|------------|---------------|------|-----|
| Description | Status | Temperature | UL counter | DL counter | Battery level | RSSI | SNR |
| Example | 8F | 1B | 20 | 20 | 0F C9 | 52 | 07 |

Example of a payload received: 8F1B20200FC95207

This example will be used in order to explain how the payload is decoded.

For frame 2, using the previous example, the value of status byte is 0x8F i.e.1000 1111 in binary so in the table:

| Hex | Binary | Comments |
|-----|--------|---------------------------------------|
| 8F | 1 | Presence of temperature information |
| | 0 | Not used |
| | 0 | Not used |
| | 0 | Not used |
| | 1 | Presence of Uplink frame counter |
| | 1 | Presence of Downlink frame counter |
| | 1 | Presence of battery level information |
| | 1 | Presence of RSSI and SNR information |

0: Data missing from the payload

1: Data present in the payload

4.2.1 Temperature

| Hex | Binary | Frame N° | Byte N° | Comments | Value |
|-----|--------------|----------|---------|--------------------------------------|---------------|
| 1B | 0001 1011 | 2 | 2 | Temperature in °C (two's complement) | -128 ... +127 |

Aid for decoding temperature

| Hex | Sign Bit | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Value T°C |
|-------|----------|-------|-------|-------|-------|-------|-------|-------|-----------|
| Value | | 64 | 32 | 16 | 8 | 4 | 2 | 1 | |
| 1B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | +27°C |
| F4 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | -12°C |

- For a positive temperature (sign bit = 0) : Value T°C = 16 + 8 + 2 + 1 = +27°C
- For a negative temperature (sign bit = 1) : Value T°C = (64+32+16+4)-128 = -12°C

4.2.2 UL counter

| Hex | Decimal | Frame N° | Byte N° | Comments | Value |
|-----|---------|----------|---------|----------------------|-----------|
| 20 | 32 | 2 | 3 | Uplink frame counter | 0 ... 255 |

Please note: This counter is not the LoRaWAN stack frame counter, but an internal frame counter. Therefore, there is no correlation between this counter and the one that you can view on the network.

4.2.3 DL counter

| Hex | Decimal | Frame N° | Byte N° | Comments | Value |
|-----|---------|----------|---------|------------------------|-----------|
| 20 | 32 | 2 | 4 | Downlink frame counter | 0 ... 255 |

Please note: This counter is not the LoRaWAN stack frame counter, but an internal frame counter. Therefore, there is no correlation between this counter and the one that you can view on the network.

4.2.4 Battery level

| Hex | Decimal | Frame N° | Byte N° | Comments | Value |
|----------|---------|----------|---------|--------------------------------|-----------|
| 0F C9 | 4041 | 2 | 5 to 6 | Voltage of the battery (in mV) | 0...65535 |

4.2.5 RSSI

| Hex | Decimal | Frame N° | Byte N° | Comments | Value |
|-----|---------|----------|---------|------------------------------------|-----------|
| 52 | 82 | 2 | 7 | RSSI Value in dBm (Absolute value) | 0 ... 255 |

In the example the RSSI value is -82dBm

4.2.6 SNR

| Hex | Decimal | Frame N° | Byte N° | Comments | Value |
|-----|---------|----------|---------|------------------------------------|---------------|
| 07 | 07 | 2 | 8 | SNR Value in dB (Two's complement) | -128 ... +127 |

In the example the SNR value is 7 dB

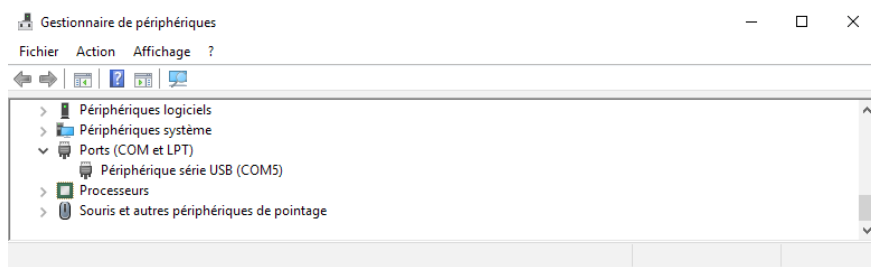
5. DEVICE CONFIGURATION

The device can be configured using the USB connector. This connection allows you to communicate with the device via the IoT Configurator or a virtual com port and to transmit AT commands in order to modify the parameters of the device.

5.1. Connecting the device to a computer

Connect the Field Test Device (FTD) to the USB input of a computer. The FTD device has a Type B micro USB connector. During connection, the device must be recognised by the computer as a Virtual Com Port (VCP) device.

Using Windows: Verification that the device has been recognized to be functioning properly can be obtained by consulting the device manager. You should see the USB series device with a corresponding COM port number appear during connection.



If you are not able to see a device of this type, you must install the USB driver for this device, available to download from our website: <https://www.adeunis.com/en/downloads/>

Select the file: DRIVER-stsw-stm32102_vcpdriver.zip.

5.2. Command mode

Use a COM port terminal in order to communicate with the device. We use the HERCULES COM port soft terminal available to download for free by clicking on the following link: http://www.hw-group.com/devices/hercules/index_en.html

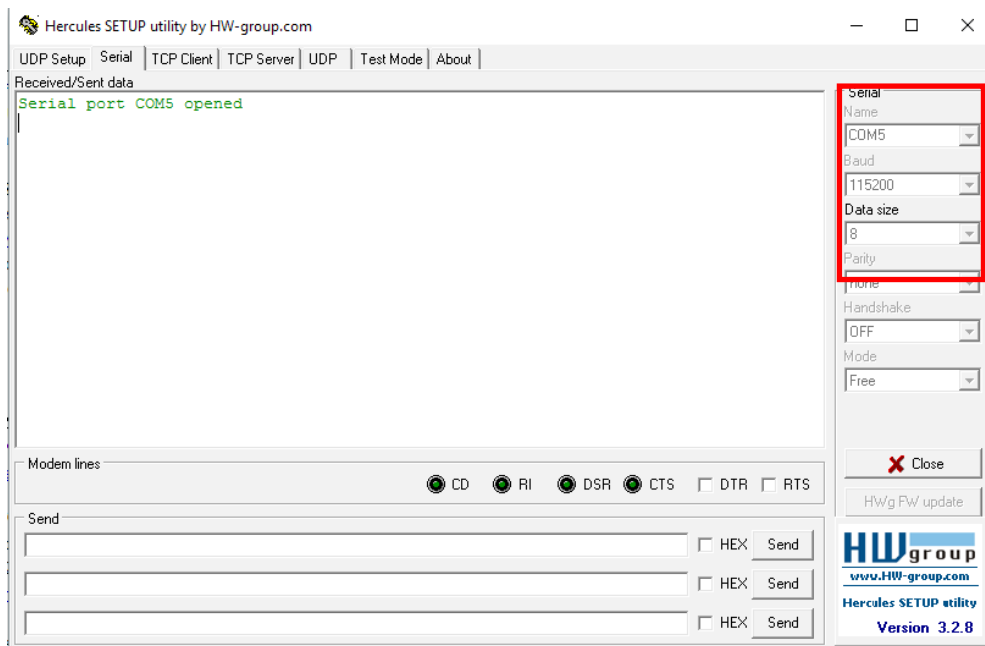
- With Hercules, select the "Serial" tab, then configure the serial port with the following serial parameters:

| Parameters | Value |
|------------|-------------|
| Rate | 115 200 bps |
| Parity | None |
| Data | 8 |
| Stop Bit | 1 |

EN

- Select the serial port on which the device has been created with Windows (Name).
- Click on the "Open" button to open the serial port.

PLEASE NOTE: If the com port has been opened correctly, Hercules will display the message "Serial COM3 port opened". Alternatively, "Serial port com opening error" will be displayed, meaning either that the com port is already open for another application, or it does not exist.



Switch ON/OFF



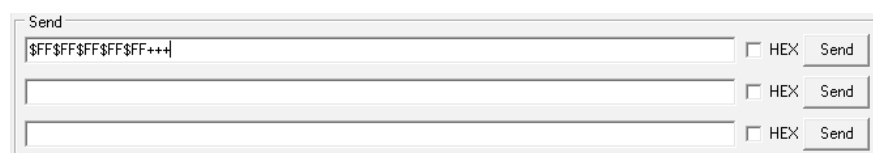
Bottom view

- To supply power to the device, move the switch to the right.

You must send a specific frame in order to move the device to configuration mode.

Frame expressed in hexadecimals: 0xFF 0xFF 0xFF 0xFF 0xFF 0x2B 0x2B 0x2B

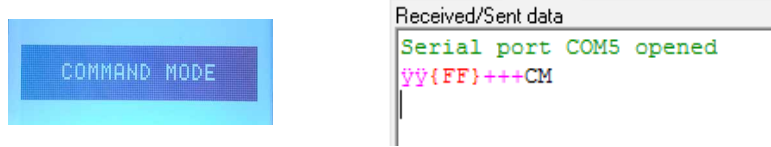
For Hercules, this frame must be entered in one of the 3 lines available at the bottom. The hexadecimal format must be expressed using a "\$" in this program, which gives us the following frame: \$FF\$FF\$FF\$FF\$FF\$2B\$2B\$2B



- Send the transition frame in command mode in order to switch the device to configuration mode by clicking on the SEND button. After a few seconds, you should see the COMMAND MODE screen appear on the device's LCD. This may take some time due to the fact that transition to command mode can only happen during a transmission cycle.



On the com port terminal, you should also have "CM" feedback for Command Mode. Sending a character on Hercules is displayed in magenta and receiving a character is displayed in black. If you do not see sending characters, this is probably because ECHO is not active on this program. To activate the option in the accessible menu, right click in the viewing window.



5.3. AT command

A command starts with 2 ASCII characters: "AT", followed by one or more characters and data (see the list below for the syntax of AT commands available on the modem).
 Each command must finish with a "CR" or "CR" "LF" – both are acceptable.
 (CR indicates: Carriage Return, LF indicates: Line Feed)

Once the command has been received, the modem will feedback:
 <cr><lf> "Data" for ATS type playback control <n> ?, AT/S or AT/V
 "O" <cr><lf>, for any other command when this has been accepted.
 "E" <cr><lf>, if it refuses the command due to a syntax error, unknown command, unknown range, invalid parameter, etc.
 "CM" <cr><lf>, if it accepts the input in command mode

Table of AT commands:

| Command | Description | Response |
|----------------|--|--|
| AT<n> ? | Feeds back the content of the n range | Sn=y where y represents the content of the n range |
| AT<n>=<m> | Transfers the m value to the n range | "O" if the operation has been accepted "E" if the operation has been refused "W" if the operation has encountered a problem during configuration |
| AT/S | Edits the content of all of the user ranges in the form of a list. | Sxxx=y for each range |
| AT/V | Feeds back the version of the software | Example: 8123AAA_PRG_1601_V01.00.00:8134AAA_PRG_1601_V01.00.00 (chapter 6) |
| AT&W | Saves the current configuration to non-volatile memory. | "O" if the operation has been accepted. "E" if the operation has been refused. |
| AT0 | Exit command mode | "O" if the operation has been accepted. "E" if the operation has been refused. |
| ATT63 PROVIDER | Unblock the operating range | "O" if the operation has been accepted. "E" if the operation has been refused. |

Example of a set of commands and corresponding responses that can be seen on the terminal:

| Command | Description | Answer |
|-----------------|--|---|
| \FFF\FFF\FFF+++ | Input request in command mode | CM |
| ATS221=1 | Transition request in OTAA activation mode | 0 |
| ATS214=0018B200 | APP_EUI MSB modification change | E -> This command is not validated (register no unlocked) |
| ATT63 PROVIDER | Unblock the operating range | 0 |
| ATS214=0018B200 | APP_EUI MSB modification change | 0 |
| ATS215? | Feeds back the value of the S215 range | S215=44512451 |
| AT&W | Memory request for the state range | 0 |
| ATO | Output request in command mode | 0 |

Interpreting the previous example: the user wanted to modify the start of the APP_EUI after having made an unauthorized command (answer **E**), and the ranges were unblocked in order to modify the range. The second section of the APP_EUI was verified and the parameters were saved before exiting. When exiting command mode, the device will make a JOIN request.

5.4. Register description

Once supplied with power, the Field Test Device will function according to the last saved configuration (factory settings if this is the first time the device has been switched on, or if this configuration has not been changed).

ATS<n>=<m> or ATR type modification commands allow you to modify the content of these ranges.

It is essential to save the parameters using the AT&W command before exiting the command mode, otherwise all of your changes will be lost.

IMPORTANT: The registers that are not documented (that can appear in the list following the AT/S command) in the paragraphs that follow are reserved and must not be changed.

5.4.1 Function registers

The below list of registers allows to change the behavior of the product.
Details on how each register works can be found after the table.

| Range | Content | Default value | Comments |
|-------|---------------------------|---------------|---|
| S341 | Accelerometer | 2000 | 0 : deactivated 1-2000 : Sensibility range |
| S370 | Payload format | 1 | 0 : Format Legacy (Demonstrator) 1 : Format Field Test Device |
| S371 | GPS configuration | 11 | 0: GPS deactivated 1: GPS activated/Continuous Mode 11 : GPS activated/Continuous Mode + GPS Reset (Cold Start) |
| S380 | Frame transmission period | 600 | 0: No periodic transmission 1 to 86400 (expressed in seconds) : Periodic transmission |
| S382 | Acknowledge mode | 1 | 0: deactivated 1: activated All other values are RESERVED. |
| S383 | Uplink Port | 1 | 1-223 |
| S385 | Personalized Payload Size | 0 | 0 : Deactivated 1 to 11 : Size of the payload |

| Range | Content | Default value | Comments |
|-------|-----------------------------------|---------------|--|
| S386 | Personalize Payload Text - Bloc 1 | 0 | Each bloc allow to define 4 bytes of the payload |
| S387 | Personalize Payload Text- Bloc 2 | 0 | |
| S388 | Personalize Payload Text- Bloc 3 | 0 | |
| S389 | Personalize Payload Text- Bloc 4 | 0 | |

S370 : Payload format

The Field Test Device (FTD) is compatible with the previous version of the device (the LoRaWAN Demonstrator). In order to modify the format of the payload and to make it compatible with the previous device, it will be necessary to modify this range.

S371 : GPS configuration

The way in which the GPS module is configured is completely independent from the main firmware. Two functioning modes are available:

- Permanent Mode
- Periodic Mode

In **permanent mode**, the GPS is always active and will operate at maximum power (like the GPS in a car). This is the most efficient mode and we would recommend using it when it is necessary to move the Field Test Device (example: if the device will be in a car), or if satellite visibility is poor.

In **periodic mode**, the GPS will start for a period of 5 mins at maximum power before switching to periodic power. In this mode, the GPS will become active for 30-40 seconds every 10 minutes. The rest of the time, it will be in rest mode, which will aid the device's independence. This mode should be used for static use (fixed position, or very slow movement), or where satellite visibility is very good.

The user can also choose to reset the GPS once it is switched on. This operation will allow you to delete the GPS memory as well as all previously acquired information. This can be useful when the GPS is not able to synchronize itself while it is starting up. Essentially, the GPS will use its internal memory to set a position and to locate satellites, but when the GPS has not been used for a long period of time or has traveled a great distance (for example, if it has traveled on-board an aircraft to another country), the information will be inaccurate and must be deleted.

If the GPS coordinates are available during transmission of a LoRa frame, these coordinates will be included in the payload. Otherwise the corresponding bytes will be deleted, rendering the payload shorter.

S380 : Frame transmission period

The device is capable of automatically making periodic transmissions. The transmission period is defined in seconds and can be anywhere between 0 and 86400 (24 hours).

If the value for the period is equal to 0, the function will then be deactivated.

S382 : Acknowledge Mode

The range will allow you to select the method of functioning for the device:

- Unconfirmed Mode (acknowledge deactivated)
- Confirmed Mode (acknowledge activated)

S383 : Uplink Port

The communication port for the Uplink frame can be configured in this frame. You can select a value between 1 and 223

S385 : Personalize Payload Size

This option allow to send a define payload instead of the standard define inside the product

The user can set the size of the payload and the text to send

When the value of the register is set to , the function is deactivated and the product use the standard payload.

When the value get a number, the product send the characters of the registers S386 to S389.

S386 to S389 : Personalize Payload Text

The 4 registers allow to set a specific payload :

- The register S386 allow to define the bytes 1 to 4 of the frame
- The register S387 allow to define the bytes 5 to 8 of the frame
- The register S388 allow to define the bytes 9 to 11 of the frame
- The register S389 allow to define the bytes 12 to 15 of the frame

The value must be set in hexadecimal code : example for the «TEST» word --> 54455654

WARNING : The register need to be completed with zero to send a byte, or the product will completed by himself the register and you will not have the result you would like to have. Example with : AT\$S385=1.

- AT\$S386=AB000000 --> The system understand the frame **AB**000000 and send the first byte --> You will receive **AB**
- AT\$S386=AB --> The system understand the frame **00**0000AB and send the first byte --> You will receive **00**

5.4.2 Network register

| Range | Content | Default value | Comments |
|-------|-------------------------------|---------------|---|
| S201 | Spreading Factor value | 10 | Read-only |
| S204 | Sync Word | -- | Read-only |
| S214 | LORA APP_EUI (First section) | 0018B244 | Parameter coded with 16 characters. Each range contains a section of the key. |
| S215 | LORA APP_EUI (Second section) | 41524632 | |
| S216 | LORA APP_KEY (First section) | (see note) | Parameter coded with 16 bytes. Each of the 4 ranges will contain 4 bytes. |
| S217 | LORA APP_KEY (Second section) | (see note) | |
| S218 | LORA APP_KEY (Third section) | (see note) | |
| S219 | LORA APP_KEY (Fourth section) | (see note) | |
| S220 | LoRaWAN Options | 1 | Default: 1 Bit 0: Activation of the ADR ON(1)/OFF(0) Bit 1: Reserved Bit 2: Reserved Bit 3 to 7: Reserved |
| S221 | Activation mode | 1 | 0 : ABP 1 : OTAA |

| Range | Content | Default value | Comments |
|-------|--------------------------------|---------------|---|
| S222 | LORA NWK_sKEY (First section) | 0 | Parameter coded with 16 bytes. Each of the 4 ranges contains 4 bytes. |
| S223 | LORA NWK_sKEY (Second section) | 0 | |
| S224 | LORA NWK_sKEY (Third section) | 0 | |
| S225 | LORA NWK_sKEY (Fourth section) | 0 | |
| S226 | LORA APP_sKEY (First section) | 0 | Parameter with 16 bytes. Each of the 4 ranges contains 4 bytes. |
| S227 | LORA APP_sKEY (Second section) | 0 | |
| S228 | LORA APP_sKEY (Third section) | 0 | |
| S229 | LORA APP_sKEY (Fourth section) | 0 | |
| S258 | Band type | 2 | Read-only 1 : AS923 2 : US915 3 : reserved 4 : reserved |
| S259 | Band Number | 0 | 0: the device uses all the channels [0-63] in 125 kHz and [64-71] in 500 kHz 1: the device will use only Band n°1. Use the channels [0-7] in 125 kHz and a channel [65] in 500 kHz. ... 8: the device will use only Band n°8. Use the channels [56-63] in 125 kHz and 71 in 500 kHz. |
| S280 | NETWORK ID | 0 | |
| S281 | DEVICE ADDRESS | 0 | |

S214 and S215: LORA APP_EUI

The S214 and S215 ranges determine the APP_EUI key used during the JOIN phase in OTAA mode. The key is made up of 16 characters spread across these 2 ranges, which can each contain 8 characters. The S214 range contains the start of the key, while the S215 range contains the end of the key.

Example : 0018B244 41524632

S214 = 0018B244

S215 = 41524632

S216 to S219: LORA APP_KEY

The ranges from S216 to S219 determine the APP_KEY used during the JOIN phase in OTAA mode. The key is made up of 32 characters spread across these 4 ranges, which can each contain 8 characters. The S216 range contains the first 8, the S217 range contains the next 8, the S218 range contains the next 8 and the S219 range contains the last 8.

Example : 0018B244 41524632 0018B200 00000912

S216 = 0018B244
 S217= 41524632
 S218 = 0018B200
 S219 = 00000912

S221: Activation mode

This range will allow you to configure the device's activation mode:

- The "Over The Air Activation" (OTAA) mode uses a JOIN phase before it can transmit on the network. This mode uses the code APP_EUI (S214 and S215) and the code APP_KEY (S216 to S219) during this phase in order to create the network communication keys. Once this phase has finished, the APP_sKEY, NWK_sKEY and DEVICE ADDRESS codes will be present in the corresponding ranges. A new JOIN phase will start each time the device exits command mode, is reset or is supplied with power.

| Code | Description |
|---------|-------------------------------|
| APP_EUI | Global application identifier |
| APP_KEY | Device application key |

- The "Activation By Personalization" (ABP) mode does not have a JOIN phase, but transmits directly on the network by directly using the codes NWK_sKEY (S222 to S225), APP_sKEY (S226 to S229) and DEVICE ADDRESS (S281) in order to communicate.

| Data Rate (DR) value | Description |
|----------------------|-------------------------|
| NWK_sKEY | Network session key |
| APP_sKEY | Application session key |
| DEVICE ADDRESS | Network device address |

S222 à S225: LORA NWK_sKEY

The ranges from S222 to S225 determine the NWK_sKEY used during network exchanges. The key is made up of 32 characters spread across these 4 ranges, which can each contain 8 characters. The range S222 contains the first 8, the S223 range contains the next 8, the S224 register contains the next 8 and the S225 range contains the last 8.

Example: 0018B244 41524632 0018B200 00000912

S216 = 0018B244
 S217= 41524632
 S218 = 0018B200
 S219 = 00000912

S226 to S229: LORA APP_sKEY

The ranges from S226 to S229 determine the APP_sKEY used during network exchanges. The key is made up of 32 characters spread across these 4 ranges, which can each contain 8 characters. The S226 range contains the first 8, the S227 range contains the next 8, the S228 range contains the next 8 and the S229 range contains the next 8.

Example : 0018B244 41524632 0018B200 00000912

S216 = 0018B244
 S217= 41524632
 S218 = 0018B200
 S219 = 00000912

S281: DEVICE ADDRESS

This range will allow you to determine the address of the device on the network when using the ABP mode. In the OTAA mode, this parameter is automatically input during the JOIN phase.

6. DEVICE UPDATES

The device has 2 firmwares:

- RTU firmware
- APPLICATIVE firmware

It is possible to find out the references for versions loaded onto the device using the command AT/V

Example :

8124AAC_PRG_1802_ **V01.01.02**:8133CAF_PRG_1803_ **V01.07.01**

The APPLICATIVE firmware version is: V01.01.02

The RTU firmware version is: V01.07.01

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7. DOCUMENT HISTORY

| Version | Content |
|---------|-----------------|
| V1.0.0 | Creation |
| V1.0.1 | Various updates |