LoRaWAN Demonstrator

By Adeunis RF

Provider Edition

User guide version V1.2
Software version V1.1

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Information

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This document applies to the following products

Name	Reference	Firmware version
LoRaWAN Demonstrator by Adeunis RF	ARF8084BA	V1.1

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- Product type (e.g. Wireless M-Bus),
- Firmware version (e.g. V3.03)
- Clear description of your question or the problem
- A short description of the application
- Your complete contact details

Declaration of conformity

We ADEUNIS RF,
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declare under our own responsibility that the products

Name LoRaWAN Demonstrator
Reference(s) ARF8084BA

to which this declaration refers conform with the relevant standards or other standardising documents

- EN 300 220-1 (v2.4.1) (2012-05)
- EN 60950-1 (2001) + A11 (2004)
- EN 301 489-1 (v1.8.1) (2008-04)
- EN 301 489-3 (v1.4.1) (2002-08)
- EN 62311 (2008)

According to the RTTE Directive 99/5/EC

Notes:

- Conformity has been evaluated according to the procedure described in Annex III of the RTTE directive
- Receiver class (if applicable): 3

Crolles, July 24th, 2015 Hervé Vincent, CEO

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INTRODUCTION

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Warnings

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.

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

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 safety, the power supply circuit must be SELV (Safety Extra Low Voltage) and must be a limited power sources.

Recommendations 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 aggressive chemical agents or solvents likely to damage the plastic or corrode the metal parts.
- Install your device close to its DC power supply.

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 off 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.

EINLEITUNG

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Die durch dieses Produkt gewährte Sicherheit kann nur bei einer Anwendung entsprechend dem vorgesehenen Einsatzzweck gewährleistet werden.

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- Die Antenne des Gerätes muss frei liegen und von jeglichen leitenden Werkstoffen mindestens 10 cm entfernt sein.
- Das Gerät darf niemals der Einwirkung von Wärmequellen oder Heizgeräten ausgesetzt sein.
- Das Gerät darf sich niemals in der Nähe von Gegenständen mit offener Flamme befinden, wie brennenden Kerzen, Schweißbrennern usw.
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2 Device overview

The LoRaWAN demonstrator by Adeunis RF is a LoRaWAN CLASS A v1.0 compliant device. It is NOT a point to point device and cannot be operated in such a way. It is meant to be paired to an operated network.

2.1 Form factor

The device takes the shape of a remote control with embedded GPS, accelerometer and temperature sensor.

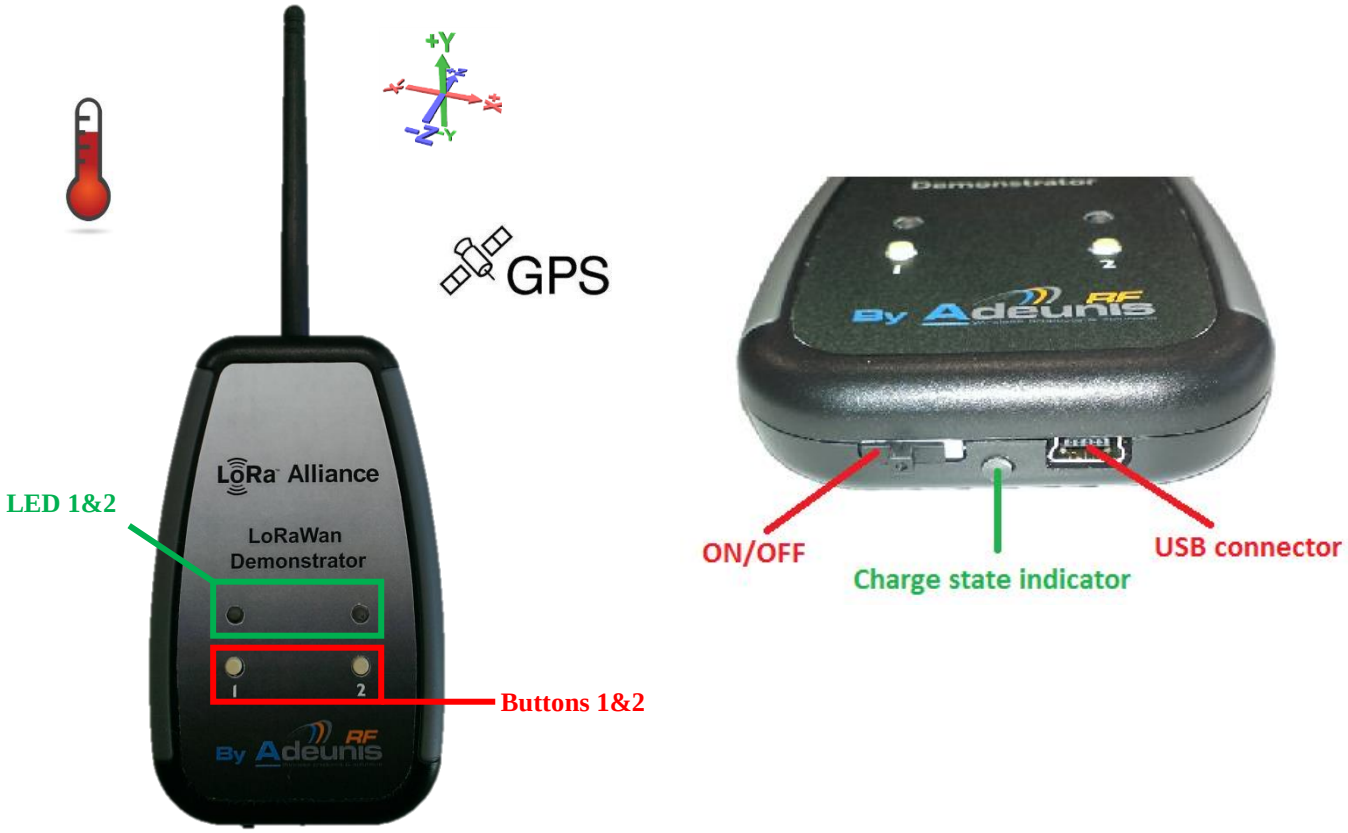

Figure 1: Demonstrator physical description

2.2 Technical specifications

Technical specifications	
Communication	LoRaWAN protocol & LoRa Modulation
Module configuration	Through AT commands
Radio data rate	Variable (SF12 - 183 bps to FSK 50 kbps)
UART configuration	115.2 kbps/N/8/1
UART port	Available through USB connector
Frequency channels	ISM band 863-870MHz
RF output power	14dBm (25mW)
Sensitivity	down to -140 dBm in SF12/CR4
Operating range (open space)	Up to 15km
Operating temperature	-40°C / +85°C
Dimensions	180 x 61 x 19 mm
Standard compliance	EN 300-220, EN 301-489, EN 60950

3 Charging the demonstrator

The product contains a rechargeable battery. Upon connecting it to a computer via a mini-USB cable, it will automatically begin charging; even if the ON/OFF switch is on the OFF position (this behavior is similar to the one of mobile phones). The product can still be used while it's charging.

During the charging process, the charge state indicator is steady **red**. When charging is completed, the charge state indicator becomes steady **green.**

Figure 2: Product during charge

Figure 3: Product when charge is completed

If the battery is completely discharged, **it will need 8 hours** of charging time to get back to full charge.

4 Using the demonstrator

The demonstrator is pre-configured at factory with the following settings and is ready to use:

Parameter	Configuration
Activation mode	(operator defined)
NWK-SKEY	(operator defined)
APP-SKEY	(operator defined)
Device Address	(operator defined)
Accelerometer / T°C sensor / BTN 1 / BTN 2	Activated / Activated / Activated / Deactivated
GPS	Activated / Permanent mode / no reset
Channel 0..2	(LoRaWAN defined)
Channel 3..6	(operator defined)
RX2 Configuration	(operator defined)
TX periodicity	20s
ACK Mode	unconfirmed

First, power-up the device by sliding the ON-OFF switch to the right:

Figure 4: using the device

4.1 LoRa testing mode

Access to the LoRa testing mode is reserved to the ROOT level of authorization. This level can be reached by using the command ATT63 ROOT. Refer to chapter 5.2 for details of the command.

The device must be place in command mode.using the \FF\FF\FF\FF+++ sequence. After setting the authorization level to ROOT, the following test mode are available:

- ATT82 : Start the LoRaWan stack onto the device. The device will perform a Personalization or an OTAA phase depending on register settings. This command is mandatory before using other test command.
- ATT83 : This command generates a LinkCheckRequest MAC command to the serveur.
- ATT84 : This command is used to schedule “unconfirmed” messages. Uplink messages are sent continuously until an <ESC> char is received from the terminal to exit this test mode
- ATT85 : This command is used to schedule “confirmed” messages. Uplink messages are sent continuously until an <ESC> char is received from the terminal to exit this test mode

4.2 User mode

At powerup the device will immediately start operating and the LEDs will start blinking. During normal operation the device will transmit LoRa frames periodically (every 20s by default), but the user can also trigger a transmission manually by pressing button 1 (BTN1) or by shaking the device and triggering its accelerometer. If a GPS coordinate is available, it is included in the payload.

The following table describes the LEDs operation:

Phase description	LED1	LED2
Startup: In personalization mode, the device checks if a device address is present In OTAA mode, the devices waits for the network to provide the necessary keys	Steady Red & Green	Dedicated to GPS Operation Blink Red = GPS not synchronized Blink Green = GPS synchronized OFF = GPS OFF or in sleep mode
The Device address was found / The keys were received	Green for 3s then turn off	
Execution of a LoRa cycle	Steady Red	
At the end of a LoRa cycle, an answer was received	Blinks green 5 times, then turns off	
At the end of a LoRa cycle, no answer was received	Turns off	
Between two LoRa cycles	Off	

The LoRa frames transmitted to the network will be available to the user through the operator's back-end.

5 Device configuration

The device's configuration can be changed from a PC. In order to do so, the device should be turned ON and connected to a PC via its USB port and a mini-USB cable. The device will be recognized as a serial peripheral (creation of a virtual serial COM port).

5.1 Serial link parameters

Parameter	Value
Speed	115200 bps
Parity	None
Bits	8
Stop bit	1

When plugged to a PC, the device should be recognized as a serial peripheral:

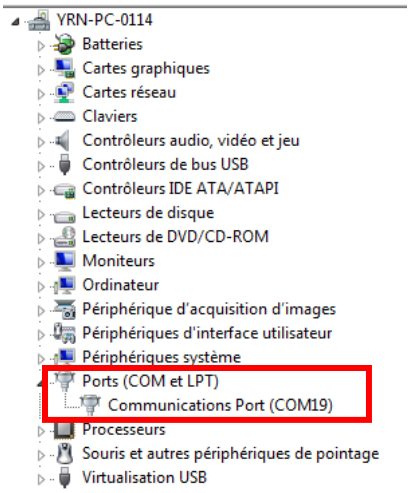

Figure 5: Device as a serial peripheral

The serial driver is available on ADEUNIS RF Website as "USB_DONGLE_DRIVER_WMBUS"

The product can then be configured via a Terminal such as Hercules:

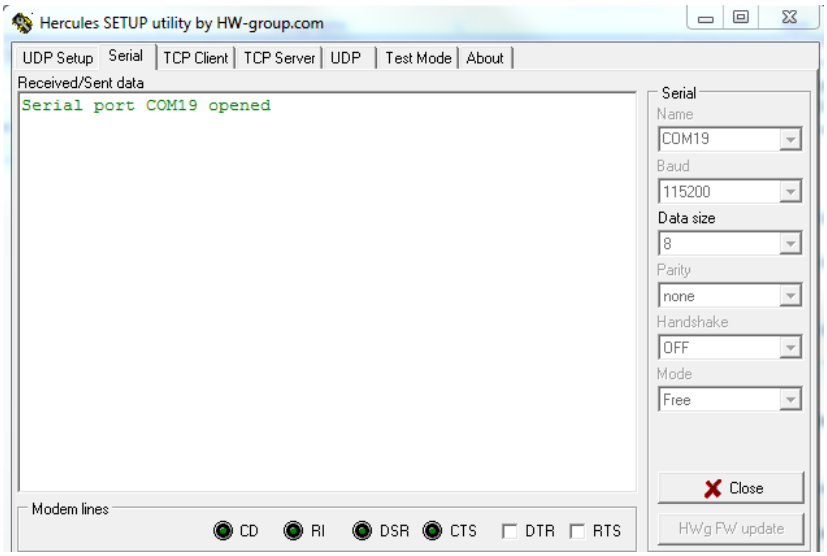

Figure 6: Hercules Terminal

5.2 Command Interface

All commands are written in ASCII

Commands can be used once the device has been placed in command mode. The commands are based on AT commands format and are structures as follows:

- Starts with 2 ASCII characters “AT”
- Followed by 1 or more ASCII characters depending on the command
- Ends by <CR> or <CR><LF>

After receiving a command, the device will emit the following response:

- ASCII character “O” if the command is accepted
- ASCII character “E” if the command is rejected
- Ends by <CR><LF>

The following commands are available:

Command	Description	Reply example
\FF\FF\FF\FF+++	Entry in command mode	«CM»<cr><lf>
AT/V	Displays the firmware version	«LORA-DEMO _v1.0»<cr><lf>
ATS<n>?	Returns content of register <n>	S<n>=<y><cr><lf> with <y> as the register content
ATS<n>=<m>	Assign value <m> to register <n>	«O»<cr><lf> if Ok, «E»<cr><lf> if error
ATR	Reset device configuration to factory settings	«O»<cr><lf>
AT&W	Save the new configuration	«O»<cr><lf>
AT&RST	Reset	«O»<cr><lf>
ATO	Exit command mode	«O»<cr><lf>
ATT63 PROVIDER	PROVIDER password, unlocks some registers	«O»<cr><lf>
ATT63 ROOT	PROVIDER password, unlocks LoRa test mode	«O»<cr><lf>

After modifying a parameter, make sure to save the new configuration by issuing the AT&W command.

5.3 Available registers

5.3.1 Network Keys

In order to access a LoRa Network, 6 different types of keys exist:

KEY	Who asks for it?	Who provides it?	What is it used for?
APP-EUI	OTAA: User PERSO: unused	Operator	Needed for joint request
APP-KEY	OTAA: User PERSO: unused	Operator	Needed for joint request
DEV-EUI	ADEUNIS	IEEE	Needed for Joint request Unique device ID (MAC address)
NWK-SKEY	OTAA: Device PERSO: User	OTAA: Network PERSO: Operator	Network Session key used for encryption of MAC commands in FRMPayload (if Fport=0)
APP-SKEY	OTAA: Device PERSO: User	OTAA: Network PERSO: User (arbitrarily chosen)	Application Session key used for encryption of Applicative payload in FRMPayload (if Fport≠0)
Device Address	OTAA: Device PERSO: User	OTAA: Network PERSO: Operator	Network address of device

There two different ways to enter a LoRa network: personalization (**PERSO**) and Over-the-air activation (**OTAA**). In either case the DEV-EUI, which is essentially a MAC address, is provided by the end-point manufacturer (in this case ADEUNIS).

5.3.1.1 Personalization mode

In personalization mode, the user has to **manually** enter the following keys in the device:

- NWK-SKEY
- APP-SKEY
- Device Address

APP-EUI and APP-Key are unnecessary.

After turning ON the product, LED1 will be turned steady Red and Green and will stay that way unless the device address is different from 0. If the address is different from 0, the demonstrator begins normal operation (provided that the other keys are correct).

5.3.1.2 OTAA mode

In OTAA mode, the user has to **manually** enter the following keys in the device:

- APP-EUI
- APP-KEY

After turning ON the product, LED1 will be turned steady Red and Green and will stay that way until the device recovers the NWK-SKEY and APP-SKEY wirelessly. These keys are **automatically provided/calculated by the network**. Once the keys are acquired, the device begins normal operation.

The newly acquired keys (NWK-SKEY and APP-SKEY) can be read from the corresponding registers if the product is placed in command mode.

5.3.1.3 Registers List

These registers are locked. In order to be unlocked, the following command must be sent:
ATT63 PROVIDER<CR>

The network keys are available through the following registers:

Register Number	Description	Default Value	Range / Values	Comment
214	LORA APP-EUI MSB	0		
215	LORA APP-EUI LSB	0		
216	LORA APP-KEY MSB	0		
217	LORA APP-KEY MID MSB	0		
218	LORA APP-KEY MID LSB	0		
219	LORA APP-KEY LSB	0		
221	Activation Mode	0	0 = Personalization 1 = OTAA	
222	LORA NWK_SKEY MSB	0		
223	LORA NWK_SKEY MID MSB	0		
224	LORA NWK_SKEY MID LSB	0		
225	LORA NWK_SKEY LSB	0		
226	LORA APP_SKEY MSB	0		
227	LORA APP_SKEY MID MSB	0		
228	LORA APP_SKEY MID LSB	0		
229	LORA APP_SKEY LSB	0		
281	Device Address	0		

5.3.2 Serial link - Not implemented yet

Serial link parameters can be changed through the following registers:

Register Number	Description	Default Value	Range (Min-Max)	Comment
210	UART datarate	7	TBD	115.2kbps
211	UART byte size	1	TBD	8 bits
212	UART parity	0	TBD	No parity

5.3.3 Synchronization Word

These registers are locked. In order to be unlocked, the following command must be sent:
ATT63 PROVIDER<CR>

The SYNC word can be changed through the following register:

Register Number	Description	Default Value	Range / Values	Comment
204	Sync Word	0x34C194C1		

5.3.4 Channels configuration

These registers are locked. In order to be unlocked, the following command must be sent:
ATT63 PROVIDER<CR>

Seven different communication channels are available and configurable through the following registers:

Register Number	Description	Default Value	Range / Values	Comment
250	Channel 0	1		Imposed by LoRaWAN
251	Channel 1	1		Imposed by LoRaWAN
252	Channel 2	1		Imposed by LoRaWAN
253	Channel 3	0		User defined
254	Channel 4	0		User defined
255	Channel 5	0		User defined
256	Channel 6	0		User defined

Those registers can contain 3 types of values:

Register value	Description
0	Channel deactivated
1	LoRaWAN default configuration
Other	User defined, will be taken into account **ONLY IF THERE IS NO CF LIST**. If the device is configured in OTAA and a CF list is transmitted by the network during OTAA, the CF list values will prevail

By default, channels 0-2 use the LoRaWAN parameters and channels 3-6 are deactivated.

If a register contains other values than 0 or 1, those are custom values provided by the user. The information contained in the custom value is the channel frequency and authorized spreading factor range for ADR.
If ADR (Adaptive Datarate) is activated, the Spreading Factor actual value is automatically managed by the network; the user cannot enforce a specific value of SF. If ADR is deactivated, the SF value is the one contained in register S201.

For custom configuration, a channel register contains 8 **ASCII** characters, coded as such:

C7	C6	C5	C4	C3	C2	C1	C0
Channel frequency in MHz x100 (Example: 868100 for 868.1MHz)						SF min	SF max

With the SF (C1 and C0) coded in the following way:

SF value	Description
0	SF12
1	SF11
2	SF10
3	SF9
4	SF8
5	SF7
6	SF7 – BW 250kHz
7	FSK 50 kbps

For example, to set frequency at 868.1MHz and authorize SF 7 to 9 in channel 0, the user should type in a terminal:
ATS250=86810053<CR>

5.3.5 RX2 window configuration

These registers are locked. In order to be unlocked, the following command must be sent:
ATT63 PROVIDER<CR>

The second RX window, RX2 can be configured in a similar way as the channels, with a minor difference: a specific value of SF is enforced.

It can be accessed through the following register:

Register Number	Description	Default Value	Range / Values	Comment
257	RX2 configuration	1		

This register can contain 3 types of values:

Register value	Description
0	Channel deactivated
1	LoRaWAN default configuration
Other	User defined, will be taken into account **ONLY IF THERE IS NO CF LIST**. If the device is configured in OTAA and a CF list is transmitted by the network during OTAA, the CF list values will prevail

By default, RX2 contains the LoRaWAN parameters. If the register value is different from 0 or 1, RX2 has a custom configuration.

For custom configuration, the register contains 8 **ASCII** characters, coded as such:

C7	C6	C5	C4	C3	C2	C1	C0
unused	Channel frequency in MHz x100 (Example: 869525 for 869.525MHz)						SF

With the SF (C1 and C0) coded in the following way:

SF value	Description
0	SF12
1	SF11
2	SF10
3	SF9
4	SF8
5	SF7
6	SF7 – BW 250kHz
7	FSK 50 kbps

For example, to set RX2 frequency at 869.525 MHz and enforce SF12, the user should type in a terminal:
ATS257=8695250<CR>

5.3.6 ADR Configuration

These registers are locked. In order to be unlocked, the following command must be sent:
ATT63 PROVIDER<CR>

The Adaptive Datarate (ADR) can be configured through register S220. This register contained 4 bytes, coded as such:

Byte 1 (reserved, write 0)	Byte 2 (reserved, write 0)	Byte 3 (reserved, write 0)	Byte 4							
			7	6	5	4	3	2	1	0

Byte 4		
Bit N°	Default value	Description
0	1	0 =ADR bit disabled 1 = ADR bit enabled
1	1	0 = ADRACKReq disabled 1 = ADRACKReq enabled
7..2	0	Reserved

Note on ADR: If ADR is activated, the device will have no control over the SF as this parameter may be changed by the network (see 5.3.4). If ADR is deactivated, the SF value is the one contained in register S201 (see 5.3.7).

Note on ADRACKReq: When the device has transmitted multiple frames but hasn't received any downlink (whether it's a generic downlink or an ACQ) from the server, enabling ADRACKReq will allow the device to try and "force" a downlink from the server when a certain amount of transmitted frames is reached. That way it can ensure that it is still connected to the network.
If an ADRACKReq is sent but the device still receives no answer, it will increase its SF value in order to increase the radio link budget. The goal is to re-establish a potentially lost connection between device and server.

5.3.7 Spreading Factor

These registers are locked. In order to be unlocked, the following command must be sent:
ATT63 PROVIDER<CR>

When ADR is deactivated, the Spreading Factor can be set through register S201:

Register Number	Description	Default Value	Range (Min-Max)	Comment
201	SF	12	5-12	5 = FSK 50kbps 6 = SF7 250kHz 7-12 = SF7-SF12

5.3.8 Transmission periodicity

Frames can be transmitted automatically by the device. The transmission periodicity in seconds can be set through the following register:

Register Number	Description	Default Value	Range / Values	Comment
280	Frame Tx periodicity	20	0-86400	In seconds

If the register is set to 0, periodic transmission is disabled. Frames can only be sent by pressing button 1 or by triggering the accelerometer (i.e. by shaking the product).

5.3.9 ACK request

When sending a frame to the network, the demonstrator can ask for an acknowledge (ACK) frame in return. When asking for an acknowledge frame, the device is configured in **CONFIRMED** mode. Otherwise, it is configured in **UNCONFIRMED** mode. This can be done through the following register:

Register Number	Description	Default Value	Range / Values	Comment
282	ACK request	0	0 = unconfirmed 1 = confirmed	

5.3.10 Accelerometer

The device's accelerometer is configured by default to trigger whenever the device is shaken by hand. However, its configuration can be modified to suit the user's application. Two parameters can be changed:

- The full scale, i.e. the maximum acceleration that the accelerometer will be able to detect
- The detection threshold, i.e. the acceleration level above which the accelerometer will trigger

This can be done through the following registers:

Register Number	Description	Default Value	Range / Values	Comment
240	Full scale	8	2 to 16	Unit in g
241	Detection Threshold	2000	0 – (Full scale x 1000)	Unit in mg

5.3.11 GPS configuration

The demonstrator contains a GPS which can be configured through the following register:

Register Number	Description	Default Value	Range (Min-Max)	Comment
271	GPS configuration	0x0011		

Essentially, the GPS can be:

- Activated/deactivated
- Cold start at startup / Not Cold start at startup
- Configured in permanent ON (car mode) or pulsed mode.

This register contains 2 bytes separated in groups of 4 bits and **the total value must be written in hexadecimal format**:

Byte 1		Byte 2	
UNUSED, write 0	Reset	Startup Time	Mode

value	Reset	Startup Time (minutes)	Mode
0	Do not reset GPS at startup	10	GPS OFF
1	Reset GPS at startup	1	GPS permanently ON
2	/	2	Periodic 05s ON / 60s OFF
3	/	3	Periodic 10s ON / 60s OFF
4	/	4	Periodic 15s ON / 60s OFF
5	/	5	/
6	/	6	/
7	/	7	/
8	/	8	/
9	/	9	/

For example, to set the GPS permanent ON with no reset, the user should send (startup time is irrelevant in permanent ON, so in this example we choose 1min):

0000 0000 0001 0001 = 0011_{hexa} so ATS271=0011<CR>

To set the GPS periodic 10s/60s with no reset and 5min startup time, the user should send:

0000 0000 0005 0003 = 0053_{hexa} so ATS271=0053<CR>

GPS operation

If activated, the GPS is completely autonomous and independent from the main software. Essentially two modes exist: permanent and periodic mode.

1. Permanent mode

If configured in permanent mode, the GPS is always on and at full power, like the GPS used in cars. This is the performance mode and we highly recommend to use it if the device is moving fast (e.g. If placed in a car), or if satellite visibility is bad.

2. Periodic mode

In periodic mode, the GPS will start with a full on power phase ranging from 1 to 10 minutes (Startup Time), then will enter its periodic mode. During periodic mode, the GPS will wake up for 5 to 15s (depending on the chosen mode) every 60s. The rest of the time it is placed in stand-by mode, which allows for low consumption. This mode should be used in rather static conditions (stationary or walking pace), with good satellite visibility.

Note 1. As periodic mode is less powerful, we highly recommend a startup time >5min so that the GPS can synchronize and acquire the ephemeris and other information it needs for proper navigation. Indeed, until the GPS has acquired this information, its sensitivity is reduced by 15dB and it can prove to be very difficult for the GPS to acquire the information while in periodic mode.

Note 2. The GPS embeds intelligent functionalities that will constantly reassess the quality of the signal. If the GPS deems that the signal/information it possesses is not reliable enough it will wake up randomly and force acquisition for a variable time until it gets back to a comfortable state of operation. Thus the GPS could wake up more frequently that 5-15s every 60s.

The user can also choose to reset the GPS at startup. This reset operation clears the memory of the GPS and deletes all the information it had previously acquired. This can prove to be useful if the GPS cannot seem to be able to synchronize during the Startup Time. Indeed the GPS will try to use its internal information to predict its position and find satellites, but when the GPS hasn't been used for a long time (days) or it has been moved over a great distance while being off (for example travelling by plane to another country/city) this information is consequently outdated and it is best to discard it.

If GPS coordinates are available at the time of transmission of a LoRa frame, these coordinates will be included in the payload. Otherwise the corresponding payload bytes (bytes 3-10) are deleted, the frame is shortened.

6 Payload description

The applicative payload of LoRa frames is built as follows:

Note: Bit 7 is the MSB and Bit 0 is the LSB.

Byte N°		Description
1		Bit 7 = 1 : T°C info is present Bit 6 = 1 : accelerometer was triggered Bit 5 = 1 : BTN1 was triggered Bit 4 = 1 : GPS info is present Bit 3 : Up Counter is present Bit 2 : Down Counter is present Bit 1 = 1 : Battery voltage information is present Bit 0 : RSSI + SNR information is present
2		Temperature in °C, signed in two's complement
3	b[7..4]	BCD coding of the integer part of Latitude's degrees (tens of degrees)
	b[3..0]	BCD coding of the integer part of Latitude's degrees (units of degrees)
4	b[7..4]	BCD coding of the integer part of Latitude's minutes (tens of minutes)
	b[3..0]	BCD coding of the integer part of Latitude's minutes (units of minutes)
5	b[7..4]	BCD coding of the decimal part of Latitude's minutes (tenths of minutes)
	b[3..0]	BCD coding of the decimal part of Latitude's minutes (hundredths of minutes)
6	b[7..4]	BCD coding of the decimal part of Latitude's minutes (thousandths of minutes)
	b[3..0]	B[3..1] = unused B0 = coding of hemisphere : 0 = North, 1 = south
7	b[7..4]	BCD coding of the integer part of Longitude's degrees (hundreds of degrees)
	b[3..0]	BCD coding of the integer part of Longitude's degrees (tens of degrees)
8	b[7..4]	BCD coding of the integer part of Longitude's degrees (units of degrees)
	b[3..0]	BCD coding of the integer part of Longitude's minutes (tens of minutes)
9	b[7..4]	BCD coding of the integer part of Longitude's minutes (units of minutes)
	b[3..0]	BCD coding of the decimal part of Longitude's minutes (tenths of minutes)
10	b[7..4]	BCD coding of the decimal part of Longitude's minutes (hundredths of minutes)
	b[3..0]	B[3..1] = unused B0 = coding of hemisphere : 0 = East, 1 = West
11		Uplink frame counter
12		Downlink frame counter
13		MSB Battery voltage (in mV)
14		LSB Battery voltage (in mV)
15		RSSI (dB, absolute value)
16		SNR (dB, signed in two's complement)

ANNEX 1: RSSI and SNR

The uplink frame contains information about the RSSI and the SNR.

- The RSSI value is the actual absolute value in dB. It is in fact a negative number, as the RSSI will saturate above -20dBm.
  For example: if the value is 100, this means that the RSSI is -100 dBm

- The SNR value is a signed value in two's complement, ranging from -128 to +127

  Values from 0 to 127 are positive values: 0=0; 1=1; 2=2…
  For example: if the value is 10, the SNR is +10dB

  Values from 255 to 128 are negative values: 255=-1; 254=-2; 253=-3…
  For example: if the value is 251, the SNR is -5dB