LoRaWAN Demonstrator

By Adeunis RF

User Edition

User guide version V1.1

ADEUNIS RF

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Information

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This document applies to the following products

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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

1 Table of contents

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

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.

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.

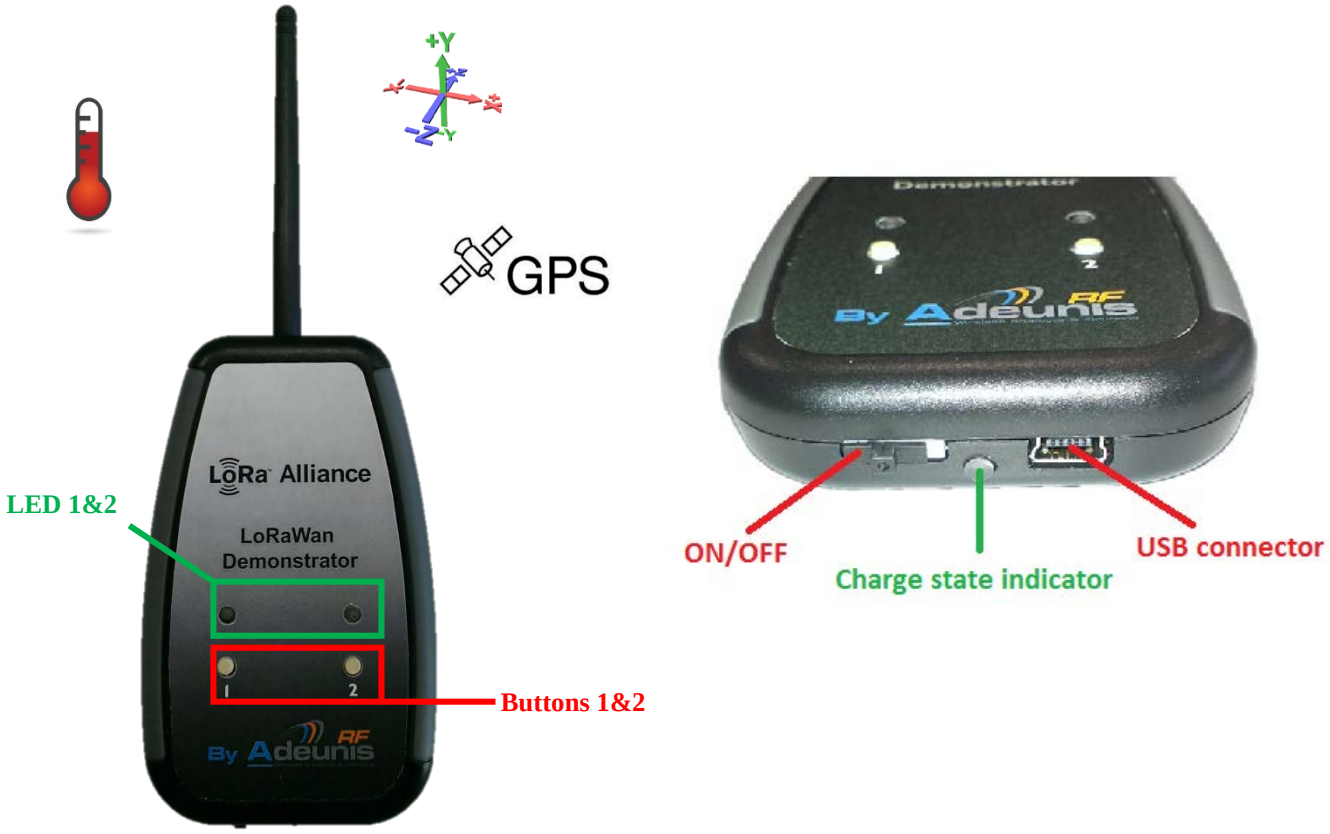

Figure 1: Demonstrator physical description

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

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 device 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:

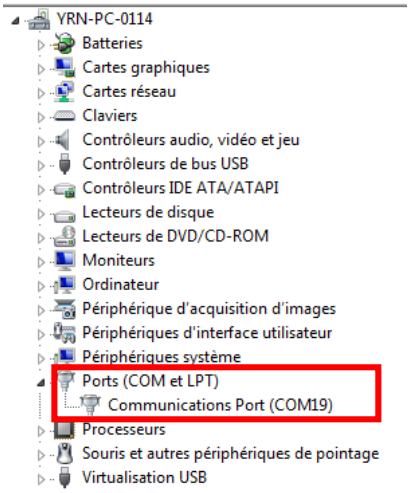

Figure 5: Device as a serial peripheral

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:

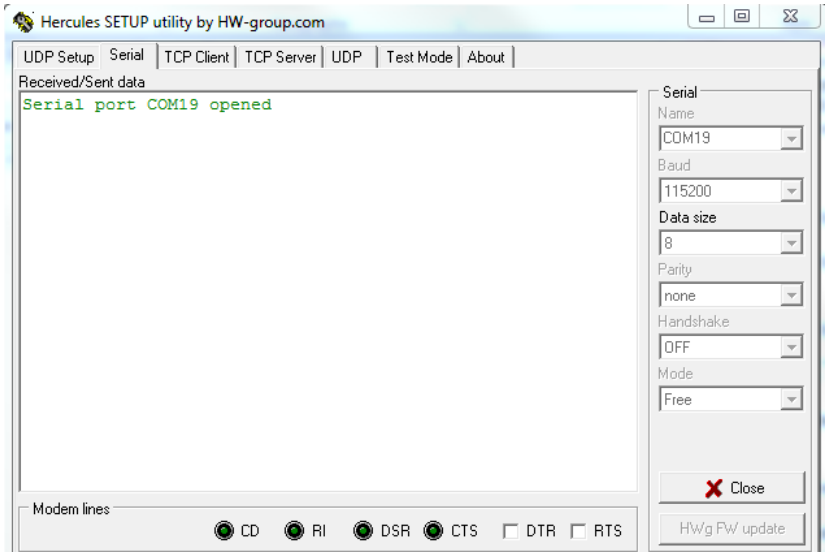

Figure 6: Hercules Terminal

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>

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

5.3 Available registers

5.3.1 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).

5.3.2 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	

5.3.3 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	Unit in mg

5.3.4 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. 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.
  For example: if the value is