LoRaWAN RANGE USER GUIDE

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1. ABOUT THIS DOCUMENT

This document describes how to configure and use downlink commands in ELA Innovation's line of LoRaWAN certified products.

2. APPLICABLE PRODUCT(S)

LR ID

IDF320002 : version EUROPE 868MHz

IDF320006 : version US 915MHz

LR TEMP

IDF320003 : version EUROPE 868MHz

IDF320007 : version US 915MHz

LR HOME

IDF320004 : version EUROPE 868MHz

IDF320008 : version US 915MHz

LR N'TRACK

IDF320005 : version EUROPE 868MHz

IDF320009 : version US 915MHz

3. GENERAL

When using LoRaWAN technology, three aspects are indispensable for communication: “DEVEUI” for identifying the device, and two keys – NwkSkey for authentication, and AppsKey for encryption. There are two methods for providing this information to both the device and the server.

- Activation By Personalization: APB
- Over the Air Activation: OTAA

The LR tag’s firmware uses the OTAA method, as it is more secure. This method requires the device to have the following three identifiers available:

- **DEVEUI:** globally unique device identifier
- **APPEUI**: globally unique identifier for pairing server
- **APPKEY**: 128-bit encryption key for pairing the device with the application server

Specific to the LoRaWAN protocol standard, these three identifiers can be configured via NFC. The APPKEY parameter is only accessible via the NFS interface (write only parameter).

Using this approach, the device executes a pairing procedure with the network (JOIN REQUEST). During the procedure, the LR device and the network generate the essential DevAddr, NwkSKey, and AppSKey information automatically. The procedure of the JOIN REQUEST can be viewed on the tag via a high brightness LED. When the flashing Led stops, it indicates the successful pairing on the network (JOIN ACCEPT).

4. PARAMETER LIST

Parameter	Min / Max	Description
Name	V1.0.3 & V1.0.4 : Up to 20 characters max V1.0.5 : 8 characters max	Tag name
Enable	True/False	Application activation False = application deactivated True = Application activated
Power	{14,12,10,8,6,4}	LoRaWAN transmission power in dBm
LoRa class	{“A”, “C”}	Define the LoRaWAN device class
LoRa DR Mode	{0, 1, 2, 3, 4, 5, 6, 0xFF}	LoRaWAN interface data rate 0 = DR0 .. 6 = DR6 0xFF = ADR (adaptative data rate)
Lora Ack	True/False	Configuration of frame acknowledgment False = Acknowledgment and retransmission deactivated True = Acknowledgment and retransmission activated
DEVEUI	64 bits	DevEUI address of LoRa module in the following format: “XXXXXXXXXXXXXXXX”
AppEUI	64 bits	AppEUI (JoinEUI) for LoRa server in the following format: “XXXXXXXXXXXXXXXX”
AppKEY	128 bits	AppKEY for LoRa server in the following format: “XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX”

Num. Sensors	{0, 1, 2, 3, 4, 5, 6, 7}	Number of sensors used by the tag.
Sensor1	T, RHT, MAG, MOV, ANG, LUX, GPS	Format of first sensor used on the card. (optional field depending on Num. Sensors)
…	…	…
SensorN	T, RHT, MAG, MOV, ANG, LUX, GPS	Format of Nth sensor used on the card. (optional field depending on Num. Sensors)
Standard period	60 / 86400	Emission period in seconds in “Standard” mode (no movement detected)
Motion period	60 / 86400	Emission period in seconds in “Motion” mode (movement detected)
Acceleration limit	NA	Motion detection limit in hexadecimal

Table 1: Parameter list

5. TAG CONFIGURATION

NFC configuration is performed by using both the Device Manager application and ACR122U NFC reader, which is used to write data to the tag’s NFC 2K chip.

In order to have all tag configuration parameters at your disposal, you must use an up-to-date version of Device Manager (version ≥ 2.3.0).

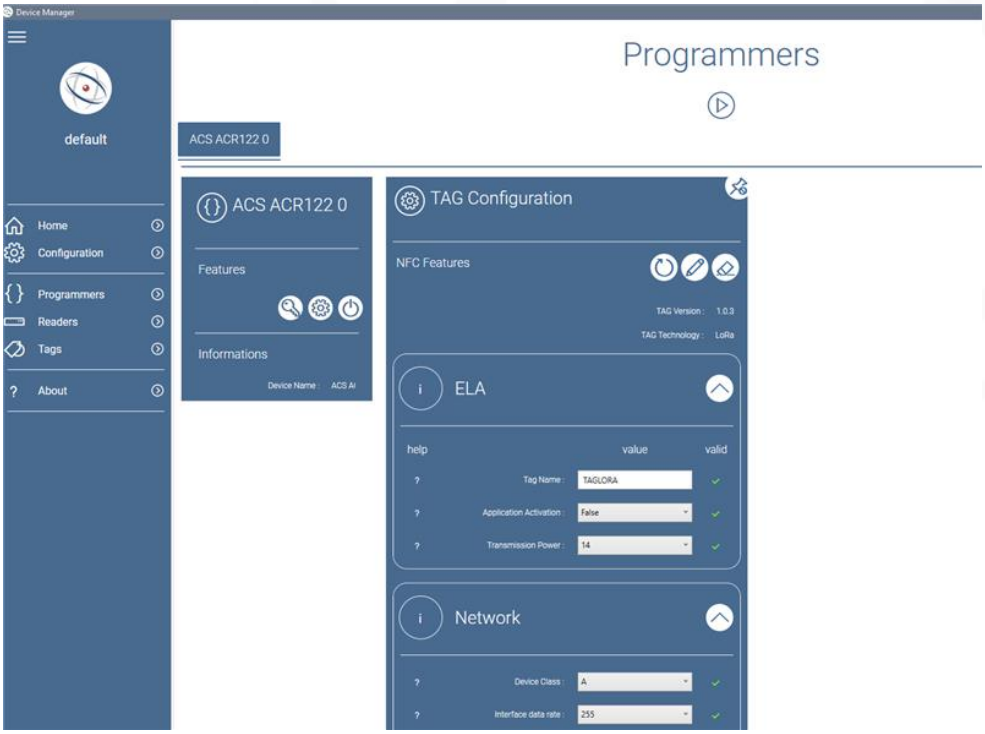

Figure1: Programmer panel

Figure2: NFC ACR122U reader

The Device Manager application and User Guide are available in the ELA Innovation download space:

- https://elainnovation.com/downloads.html
- https://elainnovation.com/Local/ela/files/1305/User_guide_Device_Manager_EN.pdf

The green LED lights up when the LoRa tag is placed on the NFC reader:

Figure3: Indicator light on NFC ACR122U reader

LoRa tag configuration window:

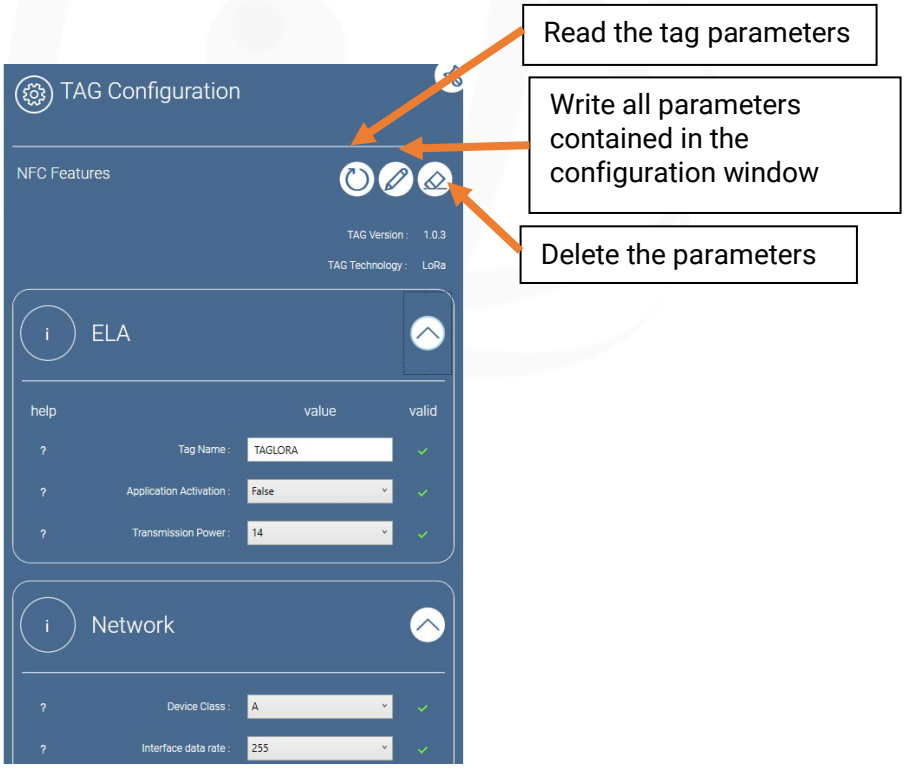

Figure4: NFC configuration window

6. IMPLEMENTATION OF THE LORAWAN TAG

6.1 TAG ACTIVATION

After opening the case, please insert the two AA batteries supplied with the tag:

Figure 5: opened casing with batteries

After initialization, the tag starts the JOIN REQUEST procedure automatically. It is not necessary to wait for the LED to stop before closing the box. Screw the housing completely in, making sure that the seal is fully inserted into the groove.

If the LED stops flashing, this indicates that the pairing has been successful. If the LED continues to flash after a few minutes, it is possible that the LoRaWAN network does not recognize the identifiers. In this case, please check the DEVEUI, APPEUI and APPKEY parameters of the network and of the tag via NFC (if necessary, reinsert the APPKEY supplied with the tag).

7. "LORA RECEPTION" MODE & REMOTE

The LoRaWAN protocol offers two-way communication, which means that you can transfer data to the LoRa device.

In reception mode, the tag interprets downlink messages received by the LoRaWAN module and executes the associated actions. In Class A, reception mode is activated right after transmission. Class C allows reception at any time, but it consumes significantly more power than Class A.

Downlink message format:

LR tag (TAGLR) downlink frame format				
Fixed length				*Variable length*
ELA header 2 bytes	FW_rev 1 byte	Protocol_rev 1 byte	CmdInfo 1 byte	CmdData 0-16 bytes

Table 2: Downlink frame format

Field description:

Field	Length	Default Value	Description
ELA header	2 bytes	0x0001	Field reserved for information to be defined
FW_rev	1 byte	v1.0.3 : 0x03 v1.0.4 : 0x04 v1.0.5 : 0x05	TAGLR firmware version
Protocol_rev	1 byte	0x03	TAGLR protocol version (frame format)
CmdInfo	1 byte	0xXX	Information about the command type Bits 7-4: command type • 0: LED • 1: Buzzer • 2: Reserved • 3: LoRa class • 4-15: Reserved Bits 3-0: Number of bytes in CmdData field • 0-15: Number of bytes in CmdData field
CmdData	0-16 bytes	0xXXXX	Command parameters

Table 3: Field description

For better visibility, color codes are used to represent :

- The type of control (LED, standard period...)
- The parameter of the data command (value to be transmitted)

List of usable commands :

Commands	Firmware	Actions	Value	Activation
NAME	v1.0.5	NAME modification	0001050328XXXXXXXXXXXXXXX	Upon receipt
LED_OFF	v1.0.3 v1.0.4 v1.0.5	Switching off the LED	000105030200000	Upon receipt
LED_ON XXXX	v1.0.3 v1.0.4 v1.0.5	Activates the LED (XXXX in seconds)	0001050302XXXX	Upon reception with LED flashing (1 Hz)
Classe A	v1.0.3 v1.0.4 v1.0.5	Equipment in class A	000105033100	As soon as the tag is received, it modifies the class and switches to the "JOIN" procedure.
Classe C	v1.0.3 v1.0.4	Equipment in class C	000105033102	As soon as the tag is received, it modifies the

	v1.0.5			class and switches to the "JOIN" procedure.
LoRaPower	v1.0.5	Transmission power Lora (dBm)	0001050341XX	Upon receipt: XX=04 (4dBm) XX=06 (6dBm) XX=08 (8dBm) XX=0A (10dBm) XX=0C (12dBm) XX=0D (14dBm)
LoRaDRMode	v1.0.5	Datarate mode of the Lora interface	0001050351XX	Upon receipt: 0x00=DR0 [..], 0x06=DR6, 0xFF=ADR (adaptative data rate)
LoraAck	v1.0.5	Acknowledgement and retransmission disabled	0001050361XX	Upon receipt: 0x00= Acknowledgement and retransmission disabled 0x01 = Acknowledgement and retransmission activated
Standard period	v1.0.5	Transmission period in seconds	0001050373XXXXXX	Dès réception, exemple : XXXXXX=0x004650 = 18000 secondes.
Motion period	v1.0.5	Wake-up period if motion is detected	0001050383XXXXXX	Upon receipt example : XXXXXX=0x000258 = 600 secondes.
AccThresh	v1.0.5	Acceleration threshold	0001050392XXXX	Upon receipt example : XXXX=0x0064 = 100.
RAZ CNT	v1.0.5	MOV counter reset	00010503A100	Upon receipt
		MAG counter reset	00010503A101	Upon receipt

7.1 LED ACTIVATION

The parameters for the LED activation command are as follows:

CmdInfo	CmdData
0x02 Bits 7-4 = 0, bits 3-0 =2	Duration of LED activation in seconds, on a 16-bit unsigned integer

Table 4: LED command

Example of a LED activation command:

- 000102030200 20: LED blink (1 Hz) for 32 seconds.

As soon as this command is received, the tag activates the LED for the period specified in the *CmdData* field.

7.2 CHANGING LORAWAN CLASS

The parameters for the Class change command are as follows:

CmdInfo	CmdData
0x31 Bits 7-4 = 2, bits 3-0 = 2	LoRa Class on an 8-bit unsigned integer • 0x00 = Class A • 0x01 = Class B (not currently supported) • 0x02 = Class C • 0x03 to 0xFF = not supported

Table 5: LoRaWAN Class command

Example of a command to change LoRaWAN Class:

- 00010203102: Switch to Class C.

As soon as this command is received, the tag modifies its operating Class based on the value provide specified in the *CmdData* field. This change implies a new OTAA procedure with the server.

8. "LORAWAN TRANSMISSION" MODE

Based on the sensor information obtained during the configuration NFC, the tag will create the frame to be transmitted. The radio frame emission can be viewed on the tag via a short activation of a LED intended for this purpose.

Field	Field value	Field information
Header Ela	0x0103	Field reserved, not editable
FW_rev	0x01	TAGLR firmware version, not editable
Protocol_rev	0x01	TAGLR protocol version, not editable
Frame_cnt	0xXXXXXX	Counter of the number of frame transmission attempts by the tag since the last JOIN sequence (application start or stop)
Frame_type	0xXX	Frame information Bits 7-4: frame type • 0: Standard mode periodic frame • 1: Motion mode periodic frame • 2: Non periodic detection frame for magnetic state change • 3: Non periodic motion detection frame • 4-15: RFU Bits 3-0: Number of sensors • 0: no sensors (advertising frame) 1-15: number of sensors in the frame
SensorInfo	0xXX	Information about the sensor Bits 7-4: Sensor type • 0: Temperature (T) • 1: Humidity/temperature (RTH) • 2: magnetic Hall effect (MAG) • 3: Movement (MOV) • 4: 3D Accelerometer (ANG) • 5: Luminosity (LUX) • 6: Geolocation (GPS) • 7-15: RFU Bits 3-0: Number of information bytes for the sensor (length of SensorData field) 0-15: Number of information bytes for the sensor
SensorData	0xXXXX	Sensor values

- Example with "LR TEMP" format:

Raw data :

0x01030101 00009C 01 02 0AAB

Details:

LEN.	TYPE	VALUE
4	0x01030101	Field reserved
3	0x00009C	156 frames transmit of the TAG
1	0x01	Standard mode periodic frame, number of sensors= 1
1	0x02	Sensor Temperature
2	0x0AAB	Data sensor 0x0AAB=2731 * 0,01°C = **27,31°C**

Note: for a negative temperature, 2's complement is made: -27.31°C will be 55F5

- Example with “LR HOME” format:

Raw data :

0x1030101000000303130B3829220003540000F760

Details:

LEN.	TYPE	VALUE
4	0x01030101	Field reserved
3	0x00009c	156 frames transmit of the TAG
1	0x03	Standard mode periodic frame, number of sensors= 3
1	0x13	Sensor RHT
3	0x0B3829	Temperature: 0x0B38=2872 * 0,01°C = **28,72°C**
		Humidity: 0x29= 41% RH
1	0x22	Sensor MAG
2	0x0003	Event counter (15MSB) = 1 magnetic field detection
		Current status (LSB)= 1 magnet detected
1	0x54	Sensor LUX
4	0x0000F760	Luminosity: 0xF760= 63328 * 0.01 lux = 633.28 lux

- Example with “LR ID » format:

Raw data :

0x1030101000041222200183200 0B

Details:

LEN.	TYPE	VALUE
4	0x01030101	Field reserved
3	0x000041	65 frames transmit of the TAG
1	0x22	Non periodic detection frame for magnetic state change, number of sensors= 2
1	0x22	Sensor MAG
2	0x0018	Event counter (15MSB): 24 magnetic field detection
		Event status (LSB)= 0 no magnet detected
1	0x32	Sensor MOV
2	0x000B	Overflow counter stored in 15 MSB: 5 motion detections
		Event status (LSB)= 1 detected motion

- Example with “LR n’TRACK”:

Raw data :

0x1030101000001332200003200576D4074A455422E78F5003C000F46

Details:

LEN.		TYPE	VALUE	
4		0x01030101	Field reserved	
3		0x000020	32 frames transmit of the TAG	
1		0x33	Non periodic motion detection frame, number of sensors = 3	
1		0x22	Sensor MAG	
2		0x0000	Event counter (15MSB): no magnetic field detection	
			Event status (LSB)= 0 no magnet detected	
1		0x32	Sensor MOV	
2		0x000B	Overflow counter stored in 15 MSB: 5 motion detections	
			Event status (LSB)= 1 detected motion	
1		0x6D	Sensor GPS	
13		0x4074A455422E78F5003C000F46	Longitude	0x4074A455 = 3.82253
			Latitude	0x422E78f5=43.6181
			Altitude	003C= 60 mètres
			Velocity	000F=15*0.1km/h=1.5km/h
			Info	0b01= FIX valid
				0x6= 6 satellites

Note:

Longitude and latitude are coded in hexadecimal. To convert the data into GPS coordinates, use the hexadecimal conversion to a float (sign, exponents, mantisse). These coordinates are in decimal degrees (DD). A brief flashing of the LED is provided to indicate the geolocation search.

9. EVENT SPECIFIC OPERATING MODE

9.1 EVENT ON MOVEMENT

The ID and N'TRACK formats have inertial event frame functionality.

- This frame sends data at a faster recurrence set by the "motion period" parameter. The data contained in this frame is the same as that contained in the "standard period" frame, only the recurrence changes.

- The motion event frame is output when the motion exceeds the "Acceleration threshold".

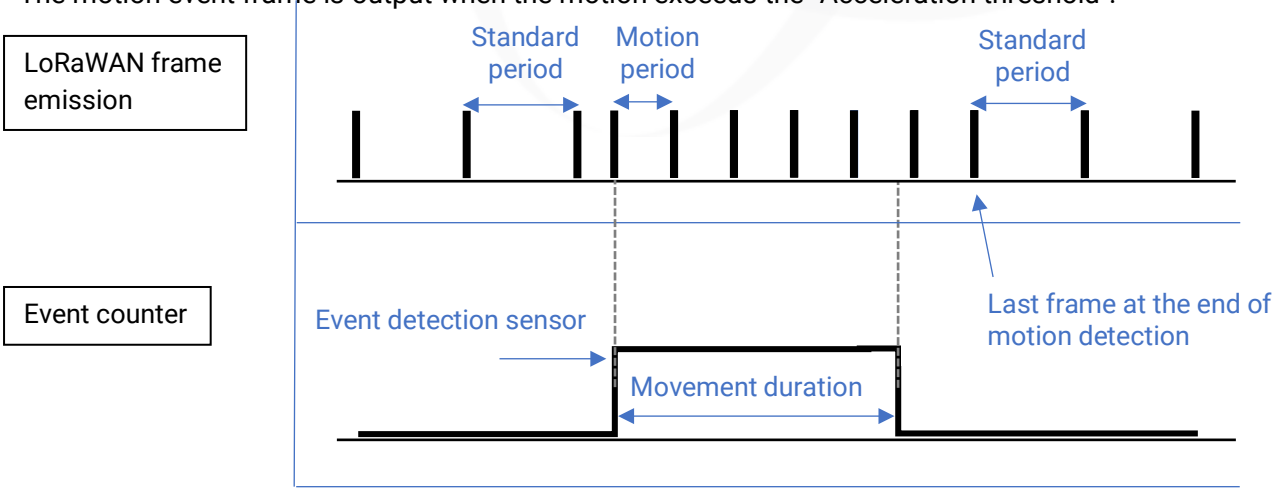

Figure 6: Demonstration diagram of an event frame with changeover to "motion period".

Note: For ID format, this feature is available from version v1.0.5 onwards.

9.2. EVENT ON MAGNETIC DETECTION

ID, N'TRACK and HOME formats have magnetic event frame functionality.

The event is triggered when the magnetic field is close to the arrow on the label.

Example with Magnet 04:

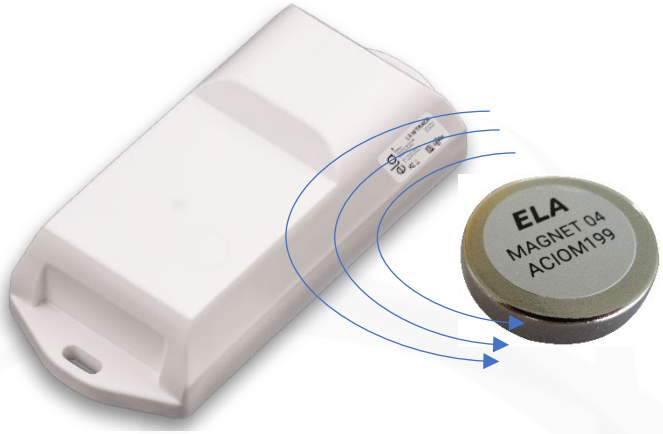

Figure 7: LR N'TRACK

- The data contained in this frame are the same as those contained in the "standard period" frame. For the N'TRACK format, the GPS acquisition is not updated to guarantee an event-driven frame.
- The frame on magnetic detection is emitted at each new state of magnetic detection (present and absent).

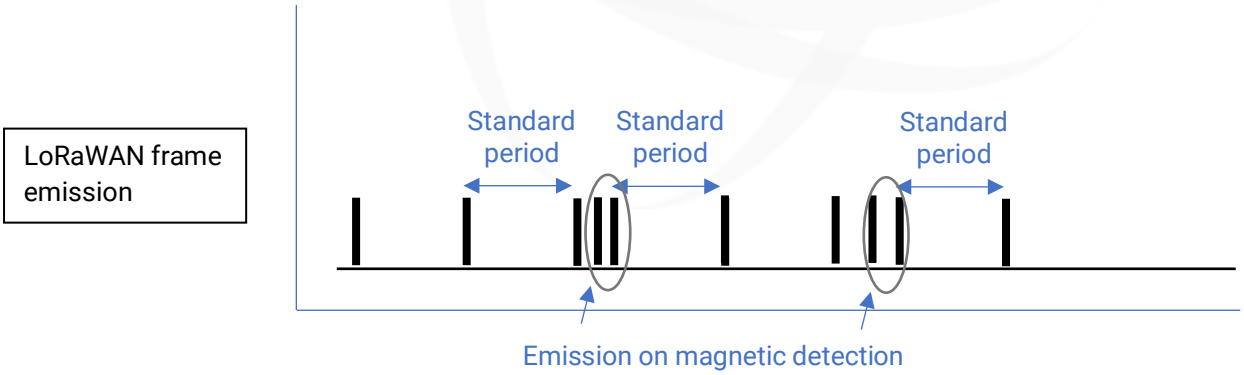

Figure 8: Demonstration diagram of an event frame at a sensor event

Note: The LoRaWAN protocole specification specifies a maximum time for occupying the radio channel. The maximum channel occupancy is 1% in Europe in the 868 MHz band. It is therefore possible that events too close together may prevent transmission on the band.