v2.0 Dongle specification LoRa dongle specifications

v1_05, 11th July 2025

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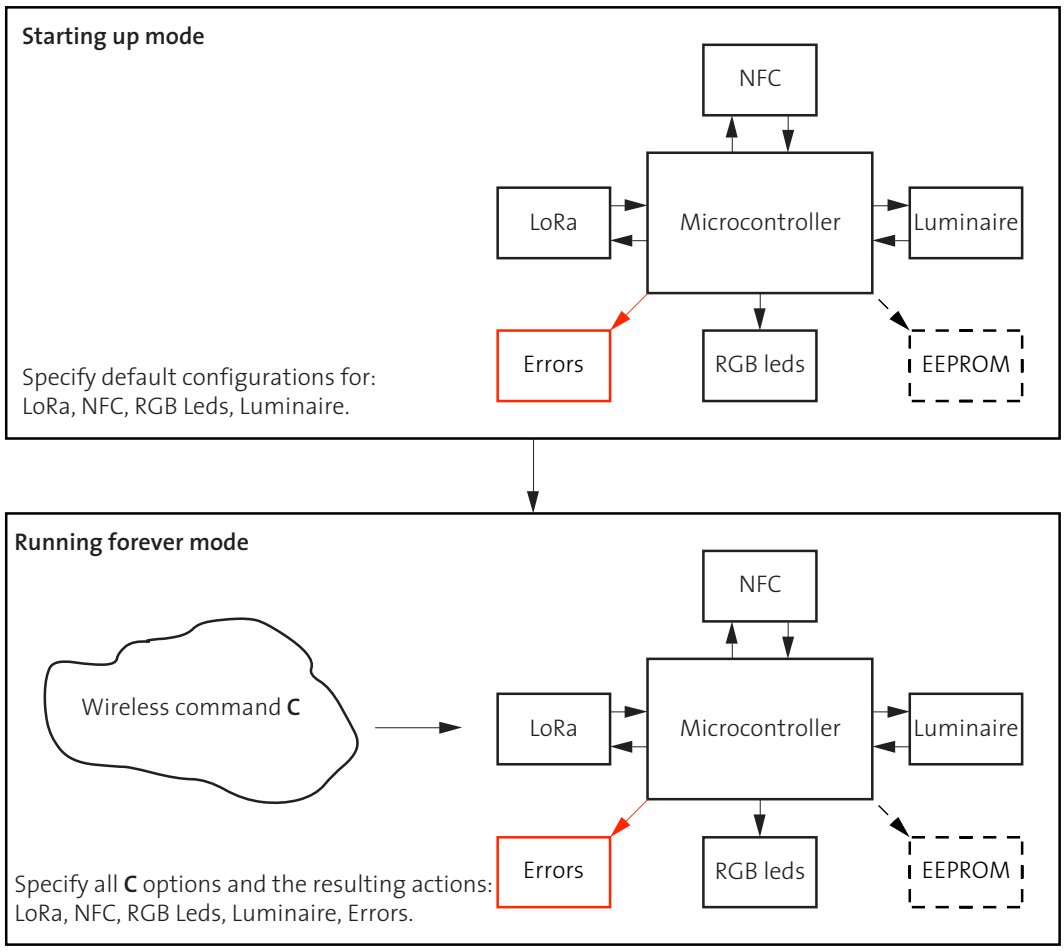


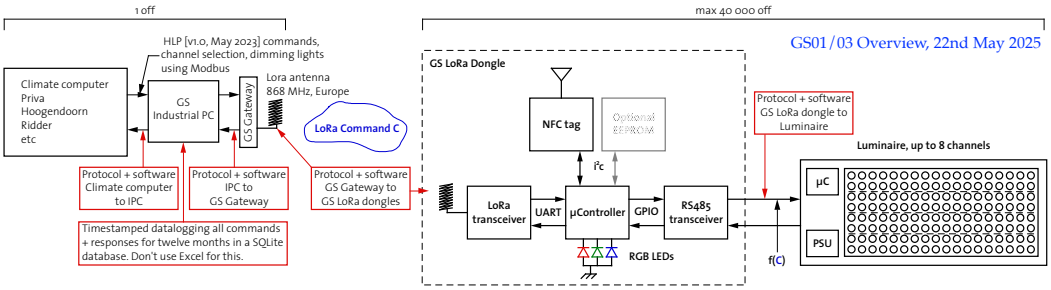
Changes
v1_05 11th July 2025
Advice for using different tools
Documents still pending to be delivered
Overview commands: which one can be used when/how?
Proposed changes for v2.1
State diagram of LEDs

Advice for using different tools

Please consider using the following tools as soon as possible.

Software & documentation
GitHub for version control for both software and documentation
Markdown for documentation
Both can be used in combination with Visual Studio Code
Start using Test Driven Development

Recommended books
Read Code complete 2 to improve the quality and structure of software
Read Test-Driven Development for Embedded C



Documents & source code still pending to be delivered
Luminaires
1. Schematic of current luminaires
2. Architecture of the software which runs on the luminaires
3. Source code of the embedded software which runs on the luminaires

Industrial PC [IPC]
4. Protocol Climate computer to IPC
5. Protocol IPC to LoRa gateway
6. Architecture of the software which runs on the Industrial PC
7. Source code running on the Industrial PC
8. Structure of SQLite database

Dongle
9. Updated version of the Lierda dongle software, expected Tue 15th July 2025
10. Lierda Handbook v4.0 in English

Overview commands: which one can be used when/how?

Options
1. Configuring the order at the factory
2. Installation greenhouse
3. Operational commands inside the greenhouse

Sending commands using
1. LoRa gateway
2. Mobile phone via IPC
3. Mobile phone NFC dongle or luminaire

General Definitions

LoRa command

Byte number	*Length bytes*	*Value*	*Description*
1	1	0x55	Frame header
2	1	0x01	Protocol version number
3	1		Number of bytes to be follow
4	1		Command
5	1	0x00	Reserved
6…6+2N	2N		Data [N times 2 bytes]
7+2N…8+2N	2		ModBus CRC-16

Why are the *Frame header, Protocol version number* and *Reserved* necessary?

Definition of some terms

Area
A dongle can 'belong' to an area. All the dongles in the same area can be configured—for example setting the dimming level—with one command.
HLP defines a maximum of 100 areas.

Region
A region indicates a geographical region for example Europe or North America.

The information obtained from the engineers of Lierda, all frequencies in MHz.
Europe
863.00—868.60
868.70—869.20
869.40—869.65
869.70—870.00
North America
923.30—927.50 [+by 0.6] **[Δf = 420 kHz], what means +by 0.6?**

ModBus CRC-16
Website to check ModBus CRC-16 can be found here.

Major changes Dongle v1.x to Dongle v2.x
LoRa
The dimming level in v1.x is sent using two bytes where the first one is always 0x00. In v2.x only one byte is transmitted.

There will be no backward compatibility.

Nominal current
Maximum current
Rated Input Power

NFC

The NFC memory is divided in blocks of four bytes. In case of the ST25DV04K in 4 kbit EEPROM which is 128 blocks of 4 bytes = 512 bytes.

For n byte variables the MSB is in the lowest location.

Example: 2483

Location	
n	24
n+1	83

Example: 80000006

Location	
n	80
n+1	00
n+2	00
n+3	06

Example: 0x0095 6900 0000 1A0D [LoRa_EUI and this we store in hex format]

n	00
n+1	95
…	
n+6	1A
n+7	0D

Dimming is actual percentage as BCD with 1% resolution

	Memory location	*Block*	*Default*	*Format*	*Variable name*	*Range*
	0	0	100	hex	dimming_ch_1	[0—100]
	4	1	100	hex	dimming_ch_2	[0—100]
	8	2	100	hex	dimming_ch_3	[0—100]
	12	3	100	hex	dimming_ch_4	[0—100]
	2…3	0	1000	BCD	nominal_output_current_mA_ch_1	[1000—9000]
	6…7	1	1000	BCD	nominal_output_current_mA_ch_2	[1000—9000]
	10…11	2	1000	BCD	nominal_output_current_mA_ch_3	[1000—9000]
	14…15	3	1000	BCD	nominal_output_current_mA_ch_4	[1000—9000]
v2.x only	32…33	8		BCD	power_increase_time_10_s	
	36	9	00	BCD	mode 00 TRANSPARANT transmission mode 01 AT_NETWORK_ACCESS configuration mode, you can update the frequency and multicast address to the wireless module; 02 AT_COMMAND mode: WAKE=1, MODE	
	37	9	30	BCD	wait_time_10s 0x30 ⇨ 300 s	[00—90]
	38…39	9	0000	BCD	area	[0001—0100]
	41…43	10	region	BCD	frequency_in_kHz	
	44…47	11	region	BCD	serial_number [high nibble: 8 Europe, 9 North America + serial number]	
	48…55	12,13	region	BCD	LoRa_EUI [=AT+DEVEUI?]	
	56…60	14	region	BCD	multicast_address [0x24868001 24: year, 868 MHz, 001 project]	
v2.x only	61…62	15		BCD	RSSI	
	63…64	15		BCD	SNR	
	82…83	20		BCD	rated_input_power_W_ch_1	
	86…87	21		BCD	rated_input_power_W_ch_2	
	90…91	22		BCD	rated_input_power_W_ch_3	
	94…95	23		BCD	rated_input_power_W_ch_4	

Depending on the region memory locations 41…60 have different default values.
What are the default settings for the different regions?
The following memory locations are not used: 1, 5, 9, 13, 16…35, 40, 60…511.
Why not use bytes 60…511 for error logging in a circular buffer?

Should we first define which important or abnormal data to store?
For how long should it be stored?
How many items should be stored?
What is the frequency of reading and writing?
60-511, approximately 452 bytes. If the information of one instruction requires 4 bytes for storage, then it can only store about 113 pieces of information. I feel the quantity is insufficient.
——2025.6.4, Du

Did you look at *GS02_03 Datalogging options.pdf*?

Store version number:

- software running on the microcontroller
- software running on luminaire [or is that already stored in the NFC inside the luminaire?]
- which data is stored in the NFC of the luminaire?
- Don't duplicate data in the two NFCs.
- Make the wait_time_10s in the dongle and the luminaire significantly different.

Storage options

Device	Type	Cycles	kbytes	Price each per 1k/euro Mouser.com	Retention/years
STM32C092KBT6	MCU	10 k	128	0.988	30
STM32C051C8	MCU	10 k	64	0.742	30
M24512-RMN6TP	EEPROM	> 4 M	64	0.538	200
ST25DV64K	NFC	1 M	8	1.010	40
ST25DV04K	NFC	1 M	0.5	0.567	40

Cheapest option is chosing a microcontroller with more flash in case 64 kbytes extra is required.

Reading stored data from dongle

Device	Reading data
RS485	Remove dongle plug into specialised hardware connected to PC
LoRa	Over the air, data can be acquired by the Industrial PC
NFC	
512 bytes	Mobile phone, close proximity, microcontroller moving data chunks to NFC
8 kbytes	Mobile phone, close proximity, read 8 kbytes in one go

Lierda is implementing this for Phase 2.

Questions

1. What is going to be logged:
   - Errors;
   - Warnings;
   - Events?
2. LoRa configurable?
3. Storage protocol
4. How long for?
5. How much storage do we need?
6. What is the best storage option?
7. What is the best option for reading the data?

Industrial PC datalogging [every event]

SQLite structure for IPC [keep data for 12 months]
Unix timestamp
Timestamp
day
month
year
hour
minute
second
Actual command transmitted [ASCII]
All the Hortilux Lightning Protocol parameters

Dongle datalogging [only errors]

Errors

STM32C05
Reset due to
Illegal mode
Watchdog
Software
Brownout
System
Option byte loading
RAM nearly full
CRC of received LoRa data incorrect

WB25
Not responding timeout
Error response
No network found

RS485
Not responding timeout
Error response

NFC
Not found, i2c
Can't read parameters
Can't write parameters

EEPROM
Not found, i2c
Can't read parameters
Can't write parameters

Record structure for dongle

Timestamp bcd [5 bytes]
day
last digit year + month
hour
minute
second
Error code [1 byte]

Assuming 32 configuration bytes in the 512 bytes NFC then the last 80 errors can be stored locally.

Conclusions

1. If the IPC logs all the events then the dongle has to log errors only;
2. Typically the last 80 errors can be recorded in the 512 bytes NFC chip;
3. None of the dongle errors should happen, if they do it has to be fixed asap.

03: Added Errors and SQLite structure for datalogging IPC and record for dongle
02: Added ST25DV04K

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name	number
Datalogging options	GS02/03

date	size	scale
14th May 2025	A4	1:1

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v2.x only 📶 Wireless commands Gateway to LoRa Dongle

The slave address 00 is the dimming command, and it is normally issued once every 500 ms.

Upon power-up, the dongle shall transmit the command to set lights to OFF state [see command: 0x10 Dimming Ch 1…4]:

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
00 10 00 0E 00 04 08 00 00 00 00 00 00 00 00 9E AD
```

within 500 ms. After this 500 ms window, it shall transmit data according to either the actually received signals or default states.

After the instruction from the slave machine address 0xAA is issued, the issuance will stop if a correct response is received within 200 ms.

If no response is received within the time limit or the response is "error", the command will be sent again. If there is no response or all responses are "error" after sending 10 messages, stop sending this command and **save the log**. Log not implemented yet.

In the following pages every wireless command is described, including an example. It also shows the effect of the command on:
- LoRa module;
- NFC;
- RGB Leds;
- Luminaire;
- Error.

Categories of LoRa messages

Setting the Luminaire

📶 0x01 HLP command

📶 0x04 Dimming/[%], single lamp

📶 0x05 Dimming/[%] Ch 1…4 in areas

📶 0x06 Dimming/[%] single channel in areas

📶 0x07 Set nominal current/[mA], single lamp

📶 0x08 Set nominal current/[mA] Ch 1…4 in areas

📶 0x0C Set waiting time/[10 s] in areas

Configuring LoRa module

📶 0x02 Set transmission power and area, single dongle

Missing: Set transmission power and area, multiple areas

📶 0x03 AT Command, single dongle

Missing: AT Command, multiple areas

📶 0x0E Change frequency/[Hz] and multicast address in areas

Default stored in NFC

Setting the default values in the NFC. The default values are only used if the dongle has not received any commands after the *waiting time.*

📶 0x09 Set power-on default dimming level, single lamp

📶 0x0A Set power-on default dimming level in areas

📶 0x0B Change area

📶 0x0C Set waiting time/[10 s] in areas

📶 0x0E Change frequency/[Hz] and multicast address in areas

0x01 HLP command

See: HLP V1.1.0 20250526.pdf

v1.x		v2.x			
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*
1	1			0x55	Frame header
2	1			0x01	Protocol version number
3	1				Number of bytes to be follow
4	1			**0x01**	Command
5	1			0x00	Reserved
6	1			0x01	Slave address [= Channel]
7	1			0x10	Write to multiple registers
8…9	2				Address first register
10…11	2				Number of registers
12	1				Number of bytes **0xFFFF/0xFF don't modify current value**
13…13+2N	2N	13…13+N	N		Data
14+2N…15+2N	2	14+N…15+N			ModBus CRC-16

Example

Set the power of Ch 1 [=Slave address] to 100% of all dongles in areas 0x01 to 100.

Register	0x0898 = 2200 HLP: Setpoint Control Area 0x01 Ch 1
Number of registers	0x0064 = 100
Data	0x0064 = 100%

Note: The greenhouse computer conforms to the HLP regarding the dimming value. That value is given with a resolution of 0.1%. The Industrial PC properly rounds that to a whole number.

Dongle all versions

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
55 01 D3 01 00 01 10 08 98 00 64 C8 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 B7 19
```

Dongle v2.x and later [change: actual values sent as one byte instead of two]

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
55 01 6C 01 00 01 10 08 98 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 71 DD
```

All HLP Commands

Note: Add all the allowed HLP commands + examples

Register

Power on setpoint Control Area n, where 1≤ n ≤ 100

1400 + (n - 1)	Ch 1
1500 + (n - 1)	Ch 2
1600 + (n - 1)	Ch 3
1700 + (n - 1)	Ch 4

Setpoint % Control Area n, where 1≤ n ≤ 100

2200 + (n - 1)	Ch 1
2300 + (n - 1)	Ch 2
2400 + (n - 1)	Ch 3
2500 + (n - 1)	Ch 4

For example setting areas 23 to 56 to 44%, Ch 3

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
55 01 2B 01 00 03 10 08 AE 00 22 2C 2C 2C 2C 2C 2C 2C 2C 2C 2C 2C 2C 2C
22 2C 2C 2C 2C 2C 2C 2C 2C 2C 2C 2C 2C 22 2C 2C 2C 2C 2C 64 08
```

Affects
Dongle to luminaire RS485, NFC, LED

LoRa module
Nothing

Dongle to luminaire RS485

Set Ch 1 to 100%. **And the other channels to 0! This implies that the infrared channel will always be on when the visible leds are on. This is incorrect.**

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
00 10 00 0E 00 04 08 00 64 00 00 00 00 00 00 BB 6B
```

Response from luminaire RS485
None

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC

Register	*Value*	*Comment*
dimming_ch_1	100	Ch 1 100%
dimming_ch_2	**0x00**	**Ch 1 0%**
dimming_ch_3	**0x00**	**Ch 1 0%**
dimming_ch_4	**0x00**	**Ch 1 0%**

EEPROM (Not used in v1.2)

Who can issue this command?
Industrial PC

0x02 Set transmission power and area, single dongle

Byte number	*Length bytes*	*Value*	*Description*
1	1	0x55	Frame header
2	1	0x01	Protocol version number
3	1		Number of bytes to be follow
4	1	**0x02**	Command
5	1	0x00	Reserved
6…9	4		Dongle serial number
10…11	2	0x00 00	Reserved
12…13	2	0x00 00	Reserved
14…15	2	0x00 00	Reserved
16…17	2	0x00 00	Reserved
18	1	0x00	Reserved
19	1		Transmission power of dongle in dBm [2—34, 0xFF: use previous setting]
20	1		Area [1—100, 0xFF: use previous setting]
21…22	2		ModBus CRC-16

The requirements document has been revised: 0x02-0x16 ; 0x16=22dBm
——2025.6.3,Du

WB25 manual
The default maximum transmission power is 16dBm, and the maximum power is 22dBm. So why 2—34? Please provide the requirements document.

Example
Set the transmission power of the Dongle with SN 8000 0001 to 22dBm and the area to 01.

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22
55 01 13 02 00 80 00 00 01 00 00 00 00 00 00 00 00 00 16 01 FE 0C
```

Affects
LoRa module, Dongle to luminaire RS485, NFC, **LED?**

LoRa module
Configure LoRa module configuration, Tx 22 dBm and region 01

```
AT+POWER=X1,<X2>,<X3>,<X4n>
```
What should the command be?

The instruction sets the transmission power of the module description
• If the ADR function is turned on, while the module is running, the server will dynamically adjust the sending power of the module according to the ADR mechanism
• After this parameter is modified, the AT + SAVE instruction should be executed
• The default maximum transmission power is 16dBm, and the maximum power is 22dBm

X1 Current transmitting power size, factory value: 0 (the default is 16dBm)
X2 Power index range
  Bit 7…4 Maximum power index
  Bit 3…0 Minimum power index
  Power meter supported power number = minimum power index value + 1, power meter supports 16 power values
  Note: *The power index range configuration is applied in the communication, and the set power meter is still the complete power meter.*
X3 Power meter function
  Bit 0 0 does not display the power meter, but only displays the current power
  1 shows the complete power meter
  Bit 2…1 0 No power meter is set, and the default factory configuration is available
  1 Power value corresponding to the manually defined custom power index
  2 automatically decreases, with a step value of 2
  3 undefined
X4n The power value corresponding to the power index, per unit dBm, and range from 2 to 22dBm.

Response from LoRa module configuration
OK

Dongle to luminaire RS485
Nothing

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC

Register	*Value*	*Comment*
area	0001	Area

EEPROM (Not used in v1.2)

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

0x03 AT Command, single dongle

Send AT Command to the wireless module.

Byte number	*Length bytes*	*Value*	*Description*
1	1	0x55	Frame header
2	1	0x01	Protocol version number
3	1		Number of bytes to be follow
4	1	**0x03**	Command
5	1	0x00	Reserved
6…9	4		Dongle serial number
10…10+N	N		AT command
11+N	12+N		ModBus CRC-16

This instruction mainly configures the wireless module. It is not used during operation and has been deleted.
——2025.6.3, Du

Baudrate can't be set. Please give another example.
Which AT commands are allowed? Give complete overview of AT commands + examples.

Example
Send the instruction "AT+BAUD=9600\r\n" to the wireless module with SN 8000 0001

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                            A  T  +  B  A  U  D  =  9  6  0  0 \r \n
55 01 16 03 00 80 00 00 01 41 54 2B 42 41 55 44 3D 39 36 30 30 0D 0A CE
74
```

Affects
LoRa module, Dongle to luminaire RS485, **LED?**

LoRa module
Configure LoRa module configuration 9600 baud.

```
AT+BAUD=X1\r\n
AT+SAVE\r\n
```

The instruction sets the serial port rate in transmission mode, and the user switches from the instruction mode to transmission mode description.
After this parameter is modified, the AT+SAVE instruction should be executed.
The serial port configuration in the command mode is fixed to 9600N81, which cannot be configured through this instruction.

X1 Baud rate supported in the transmission mode, factory value: 9600
value range: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

Response from LoRa module

1	OK	Set success
2	BAD PARM	Instruction parameter error
3	ERROR	Unknown error

Dongle to luminaire RS485
Configure Luminaire to the same baud rate

Response from luminaire RS485

LEDs

NFC

EEPROM (Not used in v1.2)

Who can issue this command? Industrial PC, Mobile app [iOS and Android]

0x04 Dimming/[%], single lamp

v1.x		v2.x			
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*
1	1			0x55	Frame header
2	1			0x01	Protocol version number
3	1				Number of bytes to be follow
4	1			0x04	Command
5	1			0x00	Reserved
6…9	4				Dongle serial number
10…11	2	10	1		Ch 1
12…13	2	11	1		Ch 2 [Don't change setting: 0xFFFF or 0xFF]
14…15	2	12	1		Ch 3
16…17	2	13	1		Ch 4
18…19	2				ModBus CRC-16

Example
Set all four channels of Dongle (SN: 80000001) to 100% output.

Dongle all versions
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19
55 01 10 04 00 80 00 00 01 00 64 00 64 00 64 00 64 90 BC
```

Dongle v2.x and later
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
55 01 0C 04 00 80 00 00 01 64 64 64 64 0C 9C
```

Affects
Dongle to luminaire RS485, LED

LoRa module
Nothing

Dongle to luminaire RS485
Dongle with this serial number set Ch 1…4 to 100%.
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
00 10 00 0E 00 04 08 00 64 00 64 00 64 00 64 8A 97
```

Response from luminaire RS485
None

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC
None

EEPROM (Not used in v1.2)

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

0x05 Dimming/[%] Ch 1…4 in areas

v1.x		v2.x				
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*	
1	1			0x55	Frame header	
2	1			0x01	Protocol version number	
3	1				Number of bytes to be follow	
4	1			**0x05**	Command	
5	1			0x00	Reserved	
6	1				First area	[1—100]
7	1				Number of areas	[1—100]
8…9	2	8	1		Dimming Ch 1	
10…11	2	9	1		Dimming Ch 2	
12…13	2	10	1		Dimming Ch 3	[Don't change setting: 0xFFFF or 0xFF]
14…15	2	11	1		Dimming Ch 4	
16…17	2				ModBus CRC-16	

Example
All four channels of the lamps in Area 1 for 2 Areas set output to 100%.

Dongle all versions
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E 05 00 01 02 00 64 00 64 00 64 00 64 93 5C
```

Dongle v2.x and later
```
01 02 03 04 05 06 07 08 09 10 11 12 13
55 01 0A 05 00 01 02 64 64 64 64 F4 A6
```

Affects
Dongle to luminaire RS485, NFC, LED

LoRa module
Nothing

Dongle to luminaire RS485
Dongles in these areas set Ch 1, 2, 3, 4 to 100%.

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
00 10 00 0E 00 04 08 00 64 00 64 00 64 00 64 8A 97
```

Response from luminaire RS485
None

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC
None

EEPROM (Not used in v1.2**)**

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

0x06 Dimming/[%] single channel in areas

v1.x		v2.x				
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*	
1	1			0x55	Frame header	
2	1			0x01	Protocol version number	
3	1				Number of bytes to be follow	
4	1			**0x06**	Command	
5	1			0x00	Reserved	
6	1				Channel	[1—4]
7	1				First area	[1—100]
8	1				Number of areas	[1—100]
9…9+2N	2N	9	N		Setting	
10+2N…11+2N	2	10+N…11+N			ModBus CRC-16	[0xFFFF/0xFF don't change setting]

Example
Set the lamp output of channel 1 to 100% of the dongles in 1—100 areas.

Why is this command necessary? Just set dimming Ch1…4 for 1…100 Areas.

Dongle all versions

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
55 01 CF 06 00 01 01 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64
00 64 00 64 00 64 00 64 00 64 00 64 00 64 00 64 D5 8A
```

Dongle v2.x and later

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
55 01 6B 06 00 01 01 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
64 64 64 64 64 64 64 64 64 64 64 64 72 68
```

Affects
Dongle to luminaire RS485, NFC, LED

LoRa module configuration
Nothing

Dongle to luminaire RS485
Dongles in these areas set Ch 1 to 0x0064 [=100 %].

```
01 02 03 04 05 06 07 08 09 10 11
00 10 00 0E 00 01 02 00 64 AB 05
```

Response from luminaire RS485
None

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC
None

EEPROM (Not used in v1.2)

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

0x07 Set nominal current/[mA], single lamp

Please explain this command.

v1.x		v2.x				
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*	
1	1			0x55	Frame header	
2	1			0x01	Protocol version number	
3	1				Number of bytes to be follow	
4	1			**0x07**	Command	
5	1			0x00	Reserved	
6…9	4				Dongle serial number	
10…11	2				Ch 1 Nominal output current	
12…13	2				Ch 2 Nominal output current	[0xFFFF don't change setting]
14…15	2				Ch 3 Nominal output current	
16…17	2				Ch 4 Nominal output current	
18	1			0x00	Reserved	
19…20	2				ModBus CRC-16	

Example
Set dongle with SN of 80000001 to
Ch 1 to 0x03E8 1000 mA
Ch 2 to 0x07D0 2000 mA
Ch 3 to 0x0BB8 3000 mA
Ch 4 to 0x0FA0 4000 mA

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20
55 01 11 07 00 80 00 00 01 03 E8 07 D0 0B B8 0F A0 00 B3 DE
```

Affects
Dongle to luminaire RS485, NFC, LED

LoRa module configuration
Nothing

Dongle to luminaire RS485
The corresponding AA 11 instruction:

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA 11 00 0E 00 04 08 10 00 20 00 30 00 40 00 8C BF
```

Response from luminaire RS485
The old version of the lamp will not respond **How do you differentiate old/new?**

The new version of the lamp will respond:

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 11 00 0E 00 04 08 10 00 20 00 30 00 40 00 33 FF
```

LEDs
Only the new version
How do you differentiate between old and new? Please make a state diagram using PlantUml.
Red and green lights flashing alternately: Received the correct response message from the lamp; if the lamp does not respond, the Dongle will repeatedly send the message every 250 ms, continuously for 10 times, then exit this state and enter the blue light flashing for 1 second. If the lamp responds, it will directly exit this mode and return to the blue light flashing state for 1 second.

NFC

Register	*Value*	*Comment*
nominal_output_current_mA_ch_1	**0x1000**	Ch 1
nominal_output_current_mA_ch_2	**0x2000**	Ch 2
nominal_output_current_mA_ch_3	**0x3000**	Ch 3
nominal_output_current_mA_ch_4	**0x4000**	Ch 4

EEPROM (Not used in v1.2**)**

Who can issue this command? Industrial PC, Mobile app [iOS and Android]

0x08 Set nominal output current/[mA] Ch 1…4 in areas

Please explain this command.

v1.x		v2.x				
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*	
1	1			0x55	Frame header	
2	1			0x01	Protocol version number	
3	1				Number of bytes to be follow	
4	1			**0x08**	Command	
5	1			0x00	Reserved	
6	1				First area	[1—100]
7	1				Number of areas	[1—100]
8…10	2				Ch 1 Nominal output current	
11…12	2				Ch 2 Nominal output current	
13…14	2				Ch 3 Nominal output current	
15…16	2				Ch 4 Nominal output current	
17	1			0x00	Reserved	
18…19	2				ModBus CRC-16	

Example
Set nominal current/[mA] for dongles Area 1 for 2 Areas to:
Ch 1 1000 [0x03E8]
Ch 2 2000 [0x07D0]
Ch 3 3000 [0x0BB8]
Ch 4 4000 [0x0FA0]

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18
55 01 0F 08 00 01 02 03 E8 07 D0 0B B8 0F A0 00 82 C2
```

Affects
Dongle to luminaire RS485, NFC, LED

LoRa module configuration
Nothing

Dongle to luminaire RS485
The corresponding AA 11 instruction:

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA 11 00 0E 00 04 08 10 00 20 00 30 00 40 00 8C BF
```

Response from luminaire RS485
The old version of the lamp will not respond **How do you differentiate old/new?**
The new version of the lamp will respond:

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 11 00 0E 00 04 08 10 00 20 00 30 00 40 00 33 FF
```

LEDs
Only the new version How do you differentiate old/new? Please make a state diagram using PlantUml.
Red and green lights flashing alternately: Received the correct response message from the lamp; if the lamp does not respond, the Dongle will repeatedly send the message every 250 ms, continuously for 10 times, then exit this state and enter the blue light flashing for 1 second. If the lamp responds, it will directly exit this mode and return to the blue light flashing state for 1 second.

NFC

Register	*Value*	*Comment*
nominal_output_current_mA_ch_1	0x1000	Ch 1
nominal_output_current_mA_ch_2	0x2000	Ch 2
nominal_output_current_mA_ch_3	0x3000	Ch 3
nominal_output_current_mA_ch_4	0x4000	Ch 4

EEPROM (Not used in v1.2**)**

Who can issue this command? Industrial PC, Mobile app [iOS and Android]

0x09 Set power-on default dimming level, single lamp

v1.x		*v2.x*			
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*
1	1			0x55	Frame header
2	1			0x01	Protocol version number
3	1				Number of bytes to be follow
4	1			**0x09**	Command
5	1			0x00	Reserved
6…9	4				Dongle serial number
10	1				Ch 1 Power-on default output percentage
11	1				Ch 2 Power-on default output percentage [0xFF don't change setting]
12	1				Ch 3 Power-on default output percentage
13	1				Ch 4 Power-on default output percentage
14…15	2				ModBus CRC-16

Example
Set the default dimming level/[%] of Dongle with SN 80000001 to:
Ch 1 to 100 [=0x64]
Ch 2 to 50 [=0x32]
Ch 3 to 50
Ch 4 to 100

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
55 01 0C 09 00 80 00 00 01 64 32 32 64 42 D6
```

Affects
NFC, LED

LoRa module configuration
Nothing

Dongle to luminaire RS485

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA 61 00 0E 00 04 08 01 00 00 50 00 50 10 00 C9 B2
```

Response from luminaire RS485
The old version of the lamp will not respond.
The new version of the lamp will respond:

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 61 00 0E 00 04 08 01 00 00 50 00 50 10 00 76 F2
```

LEDs
Red and green lights flashing alternately: Received the correct response message from the lamp; if the lamp does not respond, the Dongle will repeatedly send the message every 250ms, continuously for 10 times, then exit this state and enter the blue light flashing for 1 second. If the lamp responds, it will directly exit this mode and return to the blue light flashing state for 1 second.

NFC

Register	*Value/[%]*	*Comment*
dimming_ch_1	100	Ch 1
dimming_ch_2	50	Ch 2
dimming_ch_3	50	Ch 3
dimming_ch_4	100	Ch 4

EEPROM (Not used in v1.2**)**

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

0x0A Set power-on default dimming level/[%] in areas

v1.x		*v2.x*				
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*	
1	1			0x55	Frame header	
2	1			0x01	Protocol version number	
3	1				Number of bytes to be follow	
4	1			**0x0A**	Command	
5	1			0x00	Reserved	
6	1				First area	[1—100]
7	1				Number of areas	[1—100]
8	1				Ch 1 Power-on default output percentage	
9	1				Ch 2 Power-on default output percentage	
10	1				Ch 3 Power-on default output percentage	[0xFF don't change setting]
11	1				Ch 4 Power-on default output percentage	
12…13	2				ModBus CRC-16	

Example
Set the power-on default dimming level/[%] dongles in Area 1 for 2 Areas to:
Ch 1 100
Ch 2 50
Ch 3 50
Ch 4 100

```
01 02 03 04 05 06 07 08 09 10 11 12 13
55 01 0A 0A 00 01 02 64 32 32 64 6B 56
```

Affects
NFC, LED

LoRa module configuration
Nothing

Dongle to luminaire RS485
Nothing

Response from luminaire RS485
Nothing

LEDs
LED: Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC

Register	*Value/[%]*	*Comment*
dimming_ch_1	100	Ch 1
dimming_ch_2	50	Ch 2
dimming_ch_3	50	Ch 3
dimming_ch_4	100	Ch 4

EEPROM (Not used in v1.2**)**

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

0x0B Change area

v1.x		*v2.x*				
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*	
1	1			0x55	Frame header	
2	1			0x01	Protocol version number	
3	1				Number of bytes to be follow	
4	1			**0x0B**	Command	
5	1			0x00	Reserved	
6	1				Area to be changed	[1—100]
7	1				New area	[1—100]
8…9	2				ModBus CRC-16	

Example
Change the area of dongles in area 1 to 100:

```
01 02 03 04 05 06 07 08 09
55 01 06 0B 00 01 64 95 8B
```

Affects
NFC, LED

LoRa module configuration
Nothing

Dongle to luminaire RS485
Nothing

Response from luminaire RS485
None

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC

Register	*Value*	*Comment*
area	0x0100	Area 100

EEPROM (Not used in v1.2**)**

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

0x0C Set waiting time/[s] in areas

v1.x		*v2.x*				
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*	
1	1			0x55	Frame header	
2	1			0x01	Protocol version number	
3	1				Number of bytes to be follow	
4	1			**0x0C**	Command	
5	1			0x00	Reserved	
6	1				First area	[1—100]
7	1				Number of areas	[1—100]
8…9	2		**Why two bytes?**		Default waiting time/[s]	[0—990]
10…11	2				ModBus CRC-16	

Example
Set waiting time of dongles in Area 1 for 2 Areas to 600 s [=0x0258]:

```
01 02 03 04 05 06 07 08 09 10 11
55 01 08 0C 00 01 02 02 58 21 C5
```

Affects
NFC, LED

LoRa module configuration
Nothing

Dongle to luminaire RS485
Nothing

Response from luminaire RS485
None

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC

Register	*Value*	*Comment*
wait_time_10s	0x60	Waiting time for finding network. If network is not found after this time default settings are applied. It can be 0 for small networks where the output is fixed.

EEPROM (Not used in v1.2**)**

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

v2.x only 0x0D Put the Dongle into the Ranging Mode

Configure the module to Debug mode with the aim of generating RSSI and SNR data after receiving the data.

v2.x				
Byte number	*Length bytes*	*Value*	*Description*	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0x0D**	Command	
5	1	0x00	Reserved	
6	1		First area	[1—100]
7	1		Number of areas	[1—100]
8	1		Data retention (0) / clearing (1)	[0—1]
9…10	2	0x0000	Reserved	
11…12	2		ModBus CRC-16	

Example
Dongle enters the ranging mode： start Area 1 and 2 Areas will record the strength of the received signal in the NFC.

```
01 02 03 04 05 06 07 08 09 10 11 12
55 01 09 0D 00 01 02 00 00 00 4E 14
```

Why not have diagnostic equipment?

Affects
NFC

LoRa module configuration
Nothing

Dongle to luminaire RS485
Nothing

Response from luminaire RS485
None

LEDs
None

NFC
After the MCU reads the RSSI and SNR data, it stores them in NFC rows 15…17.
Should that be row 15 RSSI and row 15 SNR instead of 15…17?

Lierda also stores the standard deviation of the RSSI and the SNR.

0x0E Change frequency/[Hz] and multicast address in areas

v1.x		*v2.x*			
Byte number	*Length bytes*	*Byte number*	*Length bytes*	*Value*	*Description*
1	1			0x55	Frame header
2	1			0x01	Protocol version number
3	1				Number of bytes to be follow
4	1			**0x0E**	Command
5	1			0x00	Reserved
6	1				First area [1—100]
7	1				Number of areas [1—100]
8…13	6				Frequency [0xFFFF FFFF FFFF don't change]
14…17	4				Multicast address [0xFFFF FFFFF don't change]
18…19	2				ModBus CRC-16

Note: frequency is sent as ASCII code. **Why not as BCD?**

Example
Set the communication frequencies and multicast address for dongles in start with Area 1 and for 2 Areas:
Change the communication frequency of Area 1 and for 2 Areas to 868 125 Hz, and the multicast address to 24868001.

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19
                        8  6  8  1  2  5
55 01 10 0E 00 01 02 38 36 38 31 32 35 24 86 80 01 68 D3
```

LoRa module configuration
```
AT+FREQ=X1,X2,X3,<X4>\r\n
AT+SAVE\r\n
AT+RESET\r\n
```

For example: In the 915 MHz frequency band, the frequency 921.20 MHz is changed to 923.30 MHz, and the multicast address is changed from 24915001 to 24915002.
Set frequency
```
AT+RX2=11,923300000\r\n
```

Set Multicast address
```
AT+DEVADDR=24915002,4,0,12345678901234567890123456789012,
12345678901234567890123456789012\r\n
AT+SAVE\r\n
AT+RESET\r\n
```
Lierda engineer suggests that after configuring the wireless module, in addition to using `AT+SAVE`, also use `AT+RESET`.

This command sets the module frequency point table, and the user can set the module to use a custom frequency table.
After this command is set, the module requires AT + SAVE to run with the new description frequency table.
If the user product follows the standard EU868 / AU 915
To be compatible with the non-standard EU868 / AU 915, can use this instruction to meet the setting of the expected frequency table.

X1 The frequency setting mode
- 0 Clear the previous frequency configuration, restart the module, and run with the factory default parameters.
- 1 Set the uplink frequency table, which is automatically generated according to the starting frequency, channel bandwidth and channel number.
- 2 Set the uplink frequency table, and set the specified frequency corresponding to the logical channel separately.

3 Set the downlink frequency table. The frequency table is automatically generated according to the starting frequency, channel bandwidth and the number of channels. If this item is not set, the default downlink
frequency = uplink frequency.

X2 Number of channels, with an effective range of 1~16. Pay attention to cooperate with the base station side.

X3 Depending on the X1 parameter setting
If X1=1 or 3, then X3 is the starting frequency in unit Hz
If X1=2, X3 is the actual frequency point, there may be multiple parameters, the number of frequency points depends on X2, unit Hz

X4 Chbandwidth, with a default of 200 kHz, and optional parameters. X4 works only for either X1=1 or 3.

Response from LoRa module

1 OK	Set success
2 BAD PARM	parameter error
3 ERROR	Unknown error

```
Format 1   AT+DEVADDR=X1n\r\n  AT+SAVE\r\n
Format 2   AT+DEVADDR=X1,X2,X3,X4,X5\r\n  AT+SAVE\r\n
Please give AT Command
```

The instruction is set DevAddr, data format is 16,4 bytes

- After this parameter is modified, the AT+SAVE instruction should be description executed.
- This instruction is applicable to the CLASS C configuration multicast in ABP activation mode or in OTAA mode.

Format 1 (the instruction contains only the parameter X1):

X1n DevAddr, in 16 decimal numbers, in 4 bytes: X11X12X13X14
Factory value: 00 00 00 00 00 00 00 000
DevAddr Is the unique device address of the LoRaWAN whole network, taking the value range:
0x0000 0000—0xFFFF FFFF, high bytes first, data format is 16 bases, a total of 4 bytes
DevAddr According to the network access activation mode, distinguish between two situations:
1. The DevAddr must be set through locally activated nodes (ABP)
2. Through aerial activation (OTAA), there is no need to set DevAddr. Once the JOIN LoRaWAN network is successful, the parameter will be automatically rewritten (server allocation). If CLASS C multicast is required in this mode, set the corresponding parameters according to Format 2.

Format 2 (the instruction carries the parameters from X2 to X5):
The format represents setting the CLASS C multicast parameters:

X1	multicast DevAddr, expressed in 16 decimal numbers, a total of 4 bytes: X11X12X13X14
X2	reserved, fixed to 4
X3	multicast group number, X3 value range: 0-2. At present, the module supports 3 multicast groups
X4	APPSKEY: X4 used for multicast encryption$_1$ X4$_2$…X4$_{16}$, Data format is 16 hex bytes
X5	NWKSKEY: X5 used for multicast encryption$_1$ X5$_2$…X5$_{16}$, Data format is 16 hex bytes.

Response from LoRa module

1 OK	Set success
2 BAD PARM	parameter error
3 ERROR	Unknown error

Affects
LoRa module, NFC, LED

Dongle to luminaire RS485
Nothing

Response from luminaire RS485
Nothing

LEDs
Green light remains on (disconnected from wireless command within 5 seconds and will exit)

NFC

Register	*Value*	*Comment*
frequency_in_kHz	0x869525	Frequency in kHz
multicast_address	0x24868001	Multicast address [24: 2024, 868: Europe, 001: project number]

EEPROM (Not used in v1.2**)**

Who can issue this command?
Industrial PC, Mobile app [iOS and Android]

v2.x only

0x0F Transparent Command Transmission

Please explain this command.

Configure the module to Debug mode with the aim of generating RSSI and SNR data after receiving the data.

v2.x				
Byte number	*Length bytes*	*Value*	*Description*	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0x0F**	Command	
5	1	0x00	Reserved	
6	1		First area	[1—100]
7	1		Number of areas	[1—100]
8	N		Data, max 200 bytes	
8+N…9+N	2		ModBus CRC-16	**Don't change: 0xFFFF**

Example

Send instructions to Area 1 for 3 Areas:

```
01 02 03 04 05 06 07 08 09 10 11 12
55 01 NN 0F 00 01 03 AA BB 01 02 03....CC CRC16
```

Affects

Depends on the command.

LoRa module configuration

Depends on the command.

Dongle to luminaire RS485

```
01 02 03 04 05
AA BB 01 02 03 ....CC CRC16
```

Response from luminaire RS485

Depends on command

LEDs

Depends on command

NFC

Depends on command

Which command(s) do you want to send which you can't send with the current protocol?

v2.x only 0xAA 51 Set time for the power increase of the lamps/[s]

Please explain this command.

v2.x				
Byte number	*Length bytes*	*Value*	*Description*	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0xAA**	Command MSB	
5	1	**0x51**	Command LSB	
6	1		First area	[1—100]
7	1		Number of areas	[1—100]
8…9	**2?**		Power rise time **BCD in s?**	[0x00—**0x99**]
10…15	6	0x0000000000	Reserved	
16…17	2		ModBus CRC-16	

Example
Change the power increase time/[s] start Area 1 for 100 Areas to 1000 s: **Limit is 990 s!**

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E AA 51 01 64 10 00 00 00 00 00 00 00 97 E0
```

Affects
Luminaire, NFC

LoRa module configuration
Depends on command

Dongle to luminaire RS485
Issue Instruction AA 51

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA 51 01 64 10 00 00 00 00 00 00 00 30 2D [is this correct?]
```

Response from luminaire RS485
?

LEDs
?

NFC
Save the data to columns 00-01 of row 08 in the NFC.
power_increase_time_10_s Power rise time

v2.x only

0xAA A0/A1 Set the rated input power/[W] of the lamp

Please explain this command.

v2.x			
Byte number	*Length bytes*	*Value*	*Description*
1	1	0x55	Frame header
2	1	0x01	Protocol version number
3	1		Number of bytes to be follow
4	1	0xAA	Command MSB
5	1	**0xA0/ 0xA1**	Command LSB [A0= after reset, A1 = immediate]
6	1		First area [1—100]
7	1		Number of areas [1—100]
8…9	2		Ch 1 Input power BCD
10…11	2		Ch 2 Input power BCD
12…14	2		Ch 3 Input power BCD
15…16	2		Ch 4 Input power BCD
17…18	2		ModBus CRC-16

Example
Set the the rated input power/[W] start at Area 1 for 100 Areas:
Ch 1 1070
Ch 2 150
Ch 3 200
Ch 4 180

0xA0: apply value after reset
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E AA A0 01 64 10 70 01 50 02 00 01 80 21 8D
```

0xA1: apply value immediately
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E AA A1 01 64 10 70 01 50 02 00 01 80 25 71
```

Affects
Luminaire, NFC

LoRa module configuration
Depends on command

Dongle to luminaire RS485
Issue instruction AA A0 or AA A1

0xA0: apply value after reset
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA A0 01 64 10 70 01 50 02 00 01 80 86 40 [Is this correct?]
```

0xA1: apply value immediately
```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA A1 01 64 10 70 01 50 02 00 01 80 82 BC [Is this correct?]
```

Response from luminaire RS485
?

LEDs
?

NFC
Save the data to NFC rows 20-23, columns 02-03

rated_input_power_W_ch_1	Ch 1 Input power
rated_input_power_W_ch_2	Ch 2 Input power
rated_input_power_W_ch_3	Ch 3 Input power
rated_input_power_W_ch_4	Ch 4 Input power

v2.x only 0xAA C1 Set starting voltage of the lamp/[V] instantly

Please explain this command.

v2.x				
Byte number	*Length bytes*	*Value*	*Description*	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0xAA**	Command MSB	
5	1	**0xC1**	Command LSB	
6	1		First area	[1—100]
7	1		Number of areas	[1—100]
8…9	2		Minimum starting voltage BCD	
10…11	2		Under-voltage Extinguishing Value BCD	
12…14	2		Under-voltage Extinguishing Value BCD	
15…16	2		Reserved	
16…17	2		ModBus CRC-16	

Example
Set starting voltage of the lamp/[V] start with Area 1 for 100 Areas:

Minimum starting voltage 400
Under voltage extinction 450
Under voltage recovery 480

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E AA C1 01 64 04 00 04 50 04 80 00 00 AB 4D
```

Affects
Luminaire

LoRa module configuration
None

Dongle to luminaire RS485
Issue Instruction AA C1

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA C1 01 64 04 00 04 50 04 80 00 00 0C 80 [Is this correct?]
```

Response from luminaire RS485
?

LEDs
?

NFC
?

v2.x only 0xAA B1 Set under voltage protection for lamps/[V]

Please explain this command.

v2.x				
Byte number	*Length bytes*	*Value*	*Description*	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0xAA**	Command MSB	
5	1	**0xB1**	Command LSB	
6	1		First area	[1—100]
7	1		Number of areas	[1—100]
8…9	2		Ch 1 Under voltage protection BCD	
10…11	2		Ch 2 Under voltage protection BCD	
12…13	2		Ch 3 Under voltage protection BCD	
14…15	2		Ch 4 Under voltage protection BCD	
16…17	2		ModBus CRC-16	

Example
Set under voltage protection for lamps/[V] start with Area 1 for 100 Areas

Ch 1 200
Ch 2 50
Ch 3 80
Ch 4 60

Why example under voltage == over voltage?

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E AA B1 01 64 02 00 00 50 00 80 00 60 81 3A
```

Affects
Luminaire

LoRa module configuration
None

Dongle to luminaire RS485
Issue Instruction AA B1

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA B1 01 64 02 00 00 50 00 80 00 60 26 F7 [Is this correct?]
```

Response from luminaire RS485
?

LEDs
?

NFC
?

v2.x only 0xAA D1 Set over voltage protection for lamps/[V]

Please explain this command.

v2.x				
Byte number	*Length bytes*	*Value*	*Description*	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0xAA**	Command MSB	
5	1	**0xD1**	Command LSB	
6	1		First area	[1—100]
7	1		Number of areas	[1—100]
8…9	2		Ch 1 Over voltage protection BCD	
10…11	2		Ch 2 Over voltage protection BCD	
12…13	2		Ch 3 Over voltage protection BCD	
14…15	2		Ch 4 Over voltage protection BCD	
16…17	2		ModBus CRC-16	

Example
Set over voltage protection for lamps/[V] start with Area 1 for 100 Areas

Ch 1 200 V
Ch 2 50 V
Ch 3 80 V
Ch 4 60 V

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E AA D1 01 64 02 00 00 50 00 80 00 60 7F 3B
```

Affects
Luminaire

LoRa module configuration
None

Dongle to luminaire RS485
Issue Instruction AA D1

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA D1 01 64 02 00 00 50 00 80 00 60 D8 F6 [Is this correct?]
```

Response from luminaire RS485
?

LEDs
?

NFC
?

v2.x only 0xAA F1 Set temperature protection for lamps/[0.1 °C]

Please explain this command.

v2.x Byte number	Length bytes	Value	Description	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0xAA**	Command MSB	
5	1	**0xF1**	Command LSB	
6	1		First area	[1—100]
7	1		Number of areas	[1—100]
8…9	2		Temperature protection recovery BCD	
10…11	2		Temperature protection power reduction BCD	
12…13	2		Temperature protection light-off BCD	
14…15	2	0x0000	Reserved	
16…17	2		ModBus CRC-16	

Example
Set temperature protection for lamps/[0.1 °C] start with Area 1 for 100 Areas

Temperature protection recovery	50.0
Temperature protection power reduction	55.0
Temperature protection light-off	65.0

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 01 0E AA F1 01 64 05 00 05 50 06 50 00 00 94 11
```

Affects
Luminaire

LoRa module configuration
None

Dongle to luminaire RS485
Issue Instruction AA F1

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA F1 01 64 05 00 05 50 06 50 00 00 33 DC [Is this correct?]
```

Response from luminaire RS485
?

LEDs
?

NFC
?

v2.x only

0xAA 91 Set the power calibration of the lamps

Please explain this command.

v2.x Byte number	*Length bytes*	*Value*	*Description*	
1	1	0x55	Frame header	
2	1	0x01	Protocol version number	
3	1		Number of bytes to be follow	
4	1	**0xAA**	Command MSB	
5	1	**0x91**	Command LSB	
6	1		First area [1—100]	
7	1		Number of areas	[1—100]
8	1		After ch 1…4 reach full brightness, increase Ch 1 power	
9	1		After ch 1…4 reach full brightness, decrease ch 1 power	
10	1		Ch 1 Increase power	
11	1		Ch 1 Decrease power	
12	1		Ch 2 Increase power	
13	1		Ch 2 Decrease power	
14	1		Ch 3 Increase power	
15	1		Ch 3 Decrease power	
16	1		Ch 4 Increase power	
17	1		Ch 4 Decrease power	
18…19	2		ModBus CRC-16	

Example
Set for Area 1 for 100 Areas
After Ch 1…4 are fully lit, the power value of Ch 1 increases by 5
Ch 2 no change
Ch 3 no change
Ch 4 no change

This is a curious command: it is possible to increase and decrease the power at the same time.

1. **What is the unit of the values, %?**
2. **It might be better to use a signed char so that the increase and decrease can be set with one byte**
3. **If full brightness has been reached, how is it possible to increase the power even further?**
4. **Use unsigned char: -128 <= x <= 127**

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19
55 01 10 AA 91 01 64 05 00 00 00 00 00 00 00 00 00 E1 34
```

Affects
Luminaire

LoRa module configuration
None

Dongle to luminaire RS485
Issue Instruction AA 91

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14
AA 91 01 64 05 00 00 00 00 00 00 00 00 00 C4 99 [Is this correct?]
```

Response from luminaire RS485
?

LEDs
?

NFC
?

AT Commands to LoRa module

86:EU868;
90:US915;
91:AU915;
Refer to the Lierda Handbook:
3.4.3.1

See: WB25 Series LoRaWAN module_Overseas_Product Manual_V3.0.pdf
This manual describes EU and AU but not US. Please provide the Lierda Handbook v4.0 in English.

All AT commands start with AT+ and are terminated with \r\n

Parameters independent of region and fixed for all dongles
Define f as *12345678901234567890123456789012*

APPKEY=	f,0	
NET=	86,13	[Lierda: for first parameter only 2 or 20 not 86]
OTAA=	0,0	[0 The ABP is for activation, 0 Hot Start is turned off]
APPSKEY=	f	
NWKSKEY=	f	
CLASS=	2	[2 Class C, always on]
SAVE	no parameters required	
RESET	no parameters required	

Parameters dependent of region and fixed for all dongles

	EU	*US*	*Remark*
BAND=	86	90	Fixed [86: EU868, 90: US915, 91: AU915]
CHMASK=	FF	00FF	Fixed
DEVADDR=	80000001	90000001	Serial number
DEVADDR=	24868001,4,0,f,f	24915001,4,0,f,f	Multicast Address
RX2=	5,868000000	11,915000000	Frequency

AT+CHMASK=X1

X1=FF	Randomly scan the specified 8 frequency points: CH 0 to CH 7
X1=00FF	The module scan the specified 8 frequency points: CH 8 to CH 15

AT+RX2=X1,X2

X1	Spreading factor and bandwidth [5: SF7, BW 125 kHz, 11: SF9, BW 500 kHz]
X2	RX 2 communication frequency, unit Hz, factory value: 869525000

The LoRa module and transmitter should operate at the same spreading factor (SF) and bandwidth for optimal communication.
Assuming
1. Maximum allowed duty cycle of the LoRa transmitter is 1%;
2. The last message is retransmitted every 500 ms.

Then the maximum transmission time of a message should be ≤ 5 ms.
EU: DR5 [SF7, 125 kHz] impossible to transmit data within 5 ms
US: DR11 [SF9, 500 kHz] impossible to transmit data within 5 ms
Possible solutions:
1. Retransmit time 100x duration of last message;
2. Use Frequency Shift Keying, but this reduces the LoRa range.

https://www.semtech.com/design-support/faq/faq-lorawan/P20#:~:text=LoRaWAN

LoRaWAN data rates range for LoRa between 0.3 kbps to 11 kbps, and FSK data rate at 50 kbps for Europe. In North America, the minimum data rate is 0.9 kbps due to FCC rules.

0.3 kbps =	300 bits/s =	30 bytes/s → 1 byte requires	33.0 ms
11 kbps =	11 000 bits/s =	1 100 bytes/s → 1 byte requires	0.9 ms
50 kbps =	50 000 bits/s =	5 000 bytes/s → 1 byte requires	0.2 ms [Reduced LoRa range!]

HLP command set dimming for 100 areas is about 215 bytes → about 0.2 to 7.2 s. Therefor repeat time 20—720 s. Conclusion: make the interval duration between two transmissions dependent on the size/duration of the message.

AT commands not allowed as part of wireless command but can/cannot be used by the μC

μC		Do nothing instruction
μC	FACTORY	Reset to factory settings
	GPIO	Set/Clear GPIO pin(s)
	PERIPH	Set peripheral function
μC	VER	Read product version
μC	RESET	Reset module
μC	DEBUG	Configure output log
	BAUD	Set baudrate
	TIMEOUT	Set serial port timeout
μC	RTC	Set the real time clock [Industrial PC can send this command! Finally we have a timestamp]
	SYSTEM	Configure module
	CONFIRM	Set the transmission type of the uplink
	DEVEUI	Set the DevEui of the module
	APPEUI	Set the application service identifier
	PORT	Set the port number
μC	ADR	Enable/Disable adaptive data rate ADR mechanism
μC	POWER	Set the transmission power of the module
	DATARATE	Set the communication rate of the module
μC	FREQ	Set the module frequency point table
μC	JOIN	Configure the relevant parameters of network registration
	STATUS_OUTPUT_REG	Interpretation of Data Frames Content
	LINK CHECK	Detect the quality of the network wireless links
	NET	Set up the NET function of the module
	TIMESYNC	Takes the server real-time time and updates the local RTC time

Dongle to luminaire RS485

Dongle to luminaire RS485 protocol
RS485 ModBus RTU - 9600 baud, 8 data bits, 1 stop bit, no parity

0x0010 Dimming/[%] Ch 1…4

Byte number	*Length bytes*	*Value*	*Description*		
1…2	1	**0x0010**	Control the ON/OFF and Power of the Lamps		
3…4	2	0x000E	Bytes to follow [fixed]		
5…6	2	0x0004	Write register quantity [fixed]		
7	1	0x08	Byte quantity [fixed]		
8…9	2		Ch 1 dimming	[0—100]	
10…11	2		Ch 2 dimming	[0—100]	[0xFF don't change setting] ?
12…13	2		Ch 3 dimming	[0—100]	
14…15	2		Ch 4 dimming	[0—100]	
16…17	2		Modbus-16 CRC [LSB MSB]		

Example
Set the output of Ch 1…4 to 100% [=0x0064].

Ch 1	0x0064
Ch 2	0x0064
Ch 3	0x0064
Ch 4	0x0064

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
00 10 00 0E 00 04 08 00 64 00 64 00 64 00 64 8A 97
```

Response from luminaire
None

Dongle to luminaire RS485

Please explain this command.

0xAA 10/11 Set nominal output current/[mA] Ch 1…4

Byte number	*Length bytes*	*Value*	*Description*	
1	1	**0xAA**	GS Private command	
2	1	**0x10/0x11**	Set the nominal current of each channel [0:reset, 1: immediate]	
3…4	2	0x000E	Bytes to follow [fixed]	
5…6	2	0x0004	Write register quantity [fixed]	
7	1	0x08	Byte quantity [fixed]	
8…9	2		Ch 1 Nominal output current BCD	
10…11	2		Ch 2 Nominal output current BCD	
12…13	2		Ch 3 Nominal output current BCD	[0xFF don't change setting] ?
14…15	2		Ch 4 Nominal output current BCD	
16…17	2		Modbus-16 CRC [LSB MSB]	

Example

Set nominal output current/[mA] of Ch 1…4

Ch 1	3000
Ch 2	800
Ch 3	1000
Ch 4	600

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA 11 00 0E 00 04 08 30 00 08 00 10 00 06 00 B1 2F
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 11 00 0E 00 04 08 30 00 08 00 10 00 06 00 0E 6F
```

Instruction 0xAA Introduction

Is this a Dongle to luminaire command or a LoRa command?

If the rated current for each channel is set as per the following requirements, please note that after applying this function, the NFC value will be overridden. The NFC needs to be updated synchronously to the original settings.

NFC luminaire or NFC dongle?

Dongle to luminaire RS485

Please explain this command.

0xAA 50/51 Set the time for increasing power/[10 s?]

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0x50/0x51**	Set the time for increasing power [0:reset, 1: immediate]
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8…9	2		Time for increasing power BCD **[10 s?]**
10…12	3	0x000000	Reserved
13…15	3	0x000000	Reserved
16…17	2		Modbus-16 CRC [LSB MSB]

Example
Set the time for increasing power to 900 s.

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA 51 00 0E 00 04 08 00 90 00 00 00 00 00 00 65 9A
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 51 00 0E 00 04 08 00 90 00 00 00 00 00 00 DA DA
```

Dongle to luminaire RS485

0xAA 60/61 Set power-on default dimming level/[%]

Ch 1…4

	Byte number	*Length bytes*	*Value*	*Description*
	1	1	**0xAA**	GS Private command
	2	1	**0x60/0x61**	Set the default startup state for each channel [0:reset, 1: immediate]
	3…4	2	0x000E	Bytes to follow [fixed]
	5…6	2	0x0004	Write register quantity [fixed]
	7	1	0x08	Byte quantity [fixed]
Why 4 bytes?	8…9	2		Ch 1 Power-on default output BCD
	10…11	2		Ch 2 Power-on default output BCD
	12…13	2		Ch 3 Power-on default output BCD
	14…15	2		Ch 4 Power-on default output BCD
	16…17	2		Modbus-16 CRC [LSB MSB]

Example

Set power-on default dimming level/[%] for Ch 1…4

Ch 1	80
Ch 2	0
Ch 3	100
Ch 4	75

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA 61 00 0E 00 04 08 00 80 00 00 01 00 00 75 84 70
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 61 00 0E 00 04 08 00 80 00 00 01 00 00 75 38 30
```

Dongle to luminaire RS485

Please explain this command.

0xAA 91 Calibration of the entire lamp power Ch 1…4

Please explain this command.

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0x91**	Set the default startup state for each channel [0:reset, 1: immediate]
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8	1		After Ch 1…4 reach full brightness, increase Ch 1 power
9	1		After Ch 1…4 reach full brightness, decrease Ch 1 power
10	1		Ch 1 Increase Power/[**W?**]
11	1		Ch 1 Decrease Power/[**W?**]
12	1		Ch 2 Increase Power/[**W?**]
13	1		Ch 2 Decrease Power/[**W?**]
14	1		Ch 3 Increase Power/[**W?**]
15	1		Ch 3 Decrease Power/[**W?**]
16	1		Ch 4 Increase Power/[**W?**]
17	1		Ch 4 Decrease Power/[**W?**]
18…19	2		Modbus-16 CRC [LSB MSB]

Example

Set calibration of the entire lamp power Ch 1…4/[%?]

Ch 1 ↑ after full brightness	+0
Ch 1 ↓ after full brightness	-5
Ch 1 ↑	+0
Ch 1 ↓	-5
Ch 2 ↑	0
Ch 2 ↓	-10
Ch 3 ↑	+0
Ch 3 ↓	-15
Ch 4 ↑	+0
Ch 4 ↓	-50

I thought that the requirement for all the "Dongle to luminaire commands" is that always the same number of bytes is sent to the luminaire: 17 bytes. In this case 19. Use signed chars: -128 ≤ x ≤ 127 instead of increase and decrease.

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19
AA 91 00 0E 00 04 0A 00 05 00 05 00 10 00 15 00 50 E6 BE
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19
55 91 00 0E 00 04 0A 00 05 00 05 00 10 00 15 00 50 97 7E
```

After the instruction from the slave machine address AA is issued, the issuance will stop if a correct response is received within 200ms, If no response is received within the time limit or the response is "error", the command will be sent again. If there is no response or all responses are "error" after sending 10 messages, stop sending this command and save the log.

Please specify the error message from the luminaire.

Dongle to luminaire RS485

v2.x only 0xAA xx Set transparant transmission or downlink commands

Byte number	*Length bytes*	*Value*	*Description*
1	1	0xAA	Slave address, broadcast
2	1	xx	No fixed value
3…3+N	2		Bytes to follow, max 200
4+N…5+N	2		Modbus-16 CRC [LSB MSB]

Example

```
01 02 03 04 05
AA BB 01 02 03 ....CC CRC16
```

Response from luminaire

None

Dongle to luminaire RS485

Please explain this command.

v2.x only 0xAA A0/A1 Set rated current/[A] for Ch 1…4

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0xA0/0xA1**	Set the time for increasing power [0:reset, 1: immediate]
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8…9	2		**Ch 1 Input power** BCD
10…11	2		**Ch 2 Input power** BCD
12…13	2		**Ch 3 Input power** BCD
14…15	2		**Ch 4 Input power** BCD
16…17	2		Modbus-16 CRC [LSB MSB]

Example

Set input power/[W]

Ch 1	1170
Ch 2	120
Ch 3	230
Ch 4	100

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA A0 00 0E 00 04 08 11 70 01 20 02 30 01 00 34 94
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 A0 00 0E 00 04 08 11 70 01 20 02 30 01 00 8B D4
```

Why not: OK or ERROR?

Tab: **Wireless Communication Instruct**
Command: Set rated current
Channels: Input power

Tab: Instruction 0xAA Introduction
Set the default power for each channel，constant 100% or all gears remain constant，Constantly maintaining 100% power might occur when the voltage is low, and the power cannot be adjusted downward.

Difference input power and default power?
Gears?
the power cannot be adjusted ??

Dongle to luminaire RS485

Please explain this command.

v2.x only 0xAA B1 Set output under voltage protection value/[V]

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0xB1**	Set under voltage protection
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8…9	2		Ch 1 Under voltage protection output BCD
10…11	2		Ch 2 Under voltage protection output BCD
12…13	2		Ch 3 Under voltage protection output BCD
14…15	2		Ch 4 Under voltage protection output BCD
16…17	2		Modbus-16 CRC [LSB MSB]

Example

Set output under voltage protection/[V]

Ch 1	200
Ch 2	50
Ch 3	80
Ch 4	60

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA B1 00 0E 00 04 08 02 00 00 50 00 80 00 60 54 A6
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 B1 00 0E 00 04 08 02 00 00 50 00 80 00 60 EB E6
```

Dongle to luminaire RS485

Please explain this command.

v2.x only 0xAA C1 Set input under voltage protection value/[V]

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0xC1**	Set input under voltage protection value/[V]
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8…9	2		Ch 1 Input under voltage protection BCD
10…11	2		Ch 2 Input under voltage protection BCD
12…13	2		Ch 3 Input under voltage protection BCD
14…15	2		Ch 4 Input under voltage protection BCD
16…17	2		Modbus-16 CRC [LSB MSB]

Example

Set input under voltage protection/[V]

Ch 1	400
Ch 2	450
Ch 3	480
Ch 4	0

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA C1 00 0E 00 04 08 04 00 04 50 04 80 00 00 A5 A0
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 C1 00 0E 00 04 08 04 00 04 50 04 80 00 00 1A E0
```

Dongle to luminaire RS485

Please explain this command.

v2.x only 0xAA D1 Set output over voltage protection value/[V]

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0x51**	Set output **over** voltage protection value
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8…9	2		Ch 1 Output over voltage protection BCD
10…11	2		Ch 2 Output over voltage protection BCD
12…13	2		Ch 3 Output over voltage protection BCD
14…15	2		Ch 4 Output over voltage protection BCD
16…17	2		Modbus-16 CRC [LSB MSB]

Example

Set output under voltage protection/[V]

Ch 1	200
Ch 2	250
Ch 3	280
Ch 4	260

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA D1 00 0E 00 04 08 06 00 02 50 02 80 02 60 34 0F
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 1D 00 0E 00 04 08 06 00 02 50 02 80 02 60 47 83
```

Dongle to luminaire RS485

Please explain this command.

v2.x only 0xAA F1 Set temperature protection value/[0.1°C?]

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0xF1**	Set temperature protection value
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8…9	2		Temperature Protection Recovery Value
10…11	2		Temperature Protection Power Reduction Value
12…13	2		Temperature Protection Light-off Value
14…15	2	0x0000	Reserved
16…17	2		Modbus-16 CRC [LSB MSB]

Example

Set temperature protection value/[°C]

T Recovery	50.0
T Power reduction	60.0
T Light off	70.0

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA F1 00 0E 00 04 08 05 00 06 00 07 00 00 00 94 1E
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 F1 00 0E 00 04 08 05 00 06 00 07 00 00 00 2B 5E
```

Dongle to luminaire RS485

Please explain this command.

v2.x only 0xAA 91 Calibration of entire lamp power

Please explain this command.

Byte number	*Length bytes*	*Value*	*Description*
1	1	**0xAA**	GS Private command
2	1	**0x91**	Set temperature protection value
3…4	2	0x000E	Bytes to follow [fixed]
5…6	2	0x0004	Write register quantity [fixed]
7	1	0x08	Byte quantity [fixed]
8	1		After Ch 1…4 reach full brightness, Ch 1 power increase
9	1		After Ch 1…4 reach full brightness, Ch 1 power decrease
10	1		Ch 1 power increase
11	1		Ch 1 power decrease
12	1		Ch 2 power increase
13	1		Ch 2 power decrease
14	1		Ch 3 power increase
15	1		Ch 3 power decrease
16	1		Ch 4 power increase
17	1		Ch 4 power decrease
18…19	2		Modbus-16 CRC [LSB MSB]

Example

Ch 1	0 - 5 = -5
Ch 2	0 - 10 = -10
Ch 3	0 - 15 = -15
Ch 4	0 - 50 = -50

I thought that the requirement for all the "Dongle to luminaire commands" is that always the same number of bytes is sent to the luminaire: 17 bytes. In this case 19. Use signed chars: -128 ≤ x ≤ 127 instead of increase and decrease.

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
AA 91 00 0E 00 04 0A 00 05 00 05 00 10 00 15 00 50 E6 BE
```

Response from luminaire

```
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
55 91 00 0E 00 04 0A 00 05 00 05 00 10 00 15 00 50 97 7E
```

After the instruction from the slave machine address AA is issued, the issuance will stop if a correct response is received within 200ms, If no response is received within the time limit or the response is "error", the command will be sent again. If there is no response or all responses are "error" after sending 10 messages, stop sending this command and save the log.

Please specify the error message from the luminaire.

Instruction 0xAA Introduction

Please explain all the numbers and names.

Example 1: Vertex 1050W 100R+10FR+5G5B

Control Channel	NFC	Physical Layer
CH1 – 100R	00 01 31 00	Max output 1010W
CH2 – 10FR	00 03 08 00	Max output 300W
CH3 – 5G5B	00 02 08 00	Max output 150W
CH4 - None	00 00 00 00	Not in use

Example 2: Vertex 795W 100R+10G+10B

Control Channel	NFC	Physical Layer
CH1 – 100R	00 01 26 50	Max output 1010W
CH2 – None	00 03 08 00	Max output 300W
CH3 – 10G	00 04 04 00	Max output 150W
CH4 – 10B	00 00 00 00	Not in use

Example 3: Vertex 1050W 95R5B+10G+10FR

Control Channel	NFC	Physical Layer
CH1 – 95R5B	00 01 31 00	Max output 1010W
CH2 – 10FR	00 03 08 00	Max output 300W
CH3 – 10G	00 02 08 00	Max output 150W
CH4 – None	00 00 00 00	Not in use

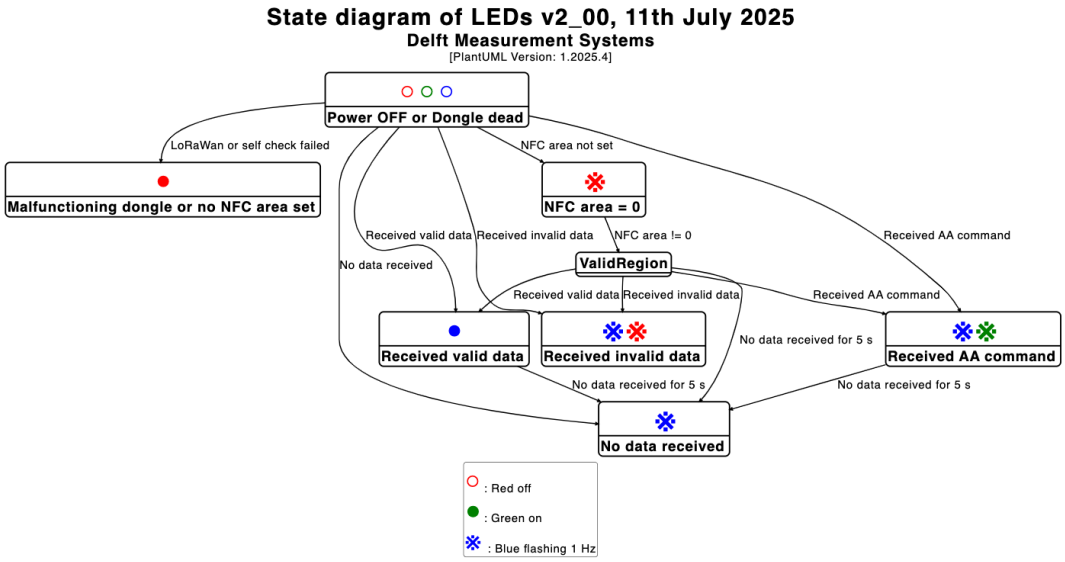
Example 4: Vertex 795W 100R+10FR+10B

Control Channel	NFC	Physical Layer
CH1 – 100R	00 01 26 50	Max output 1010W
CH2 – 10FR	00 02 08 00	Max output 300W
CH3 – None	00 04 04 00	Max output 150W
CH4 – 10B	00 00 00 00	Not in use

11. Red light constantly on: the equipment malfunctioned, the self-check failed, and the LoraWAN configuration failed;
12. The blue light flashes once every second: No data was received wirelessly;
13. The red light flashes once every second: The NFC area number is 00;
14. Blue light constantly on: The Dongle has received valid data, if no valid data is received after 5 seconds, the blue light will flash;
15. The red and blue lights flash alternately: The Dongle receives wireless data, but the data content is incorrect, it exits when receiving correct data or there is no new data for 5 seconds;
16. The red and green lights flash alternately: Upon receiving the correct AA command message sent by the gateway, if the lamp does not respond, the Dongle will repeat the sending every 250ms for 10 consecutive times, then exit this state and enter the blue light flashing for 1 second. If the lamp responds, it will directly exit this mode and return to the blue light flashing for 1 second;

Please indicate all the possible states of the LEDs + the corresponding states of the system. The state of the LEDs not shown is unclear.

Below is an attempt to deduce a state diagram from the information above, points 1…6.



Data logging

Storage options

Device	Type	Cycles	kbytes	Price each per 1k/euro Mouser.com	Retention/years
STM32C092KBT6	MCU	10 k	128	0.988	30
STM32C051C8	MCU	10 k	64	0.742	30
M24512-RMN6TP	EEPROM	> 4 M	64	0.538	200
ST25DV64K	NFC	1 M	8	1.010	40
ST25DV04K	NFC	1 M	0.5	0.567	40

Cheapest option is chosing a microcontroller with more flash in case 64 kbytes extra is required.

Reading stored data from dongle

Device	Reading data
RS485	Remove dongle plug into specialised hardware connected to PC
LoRa	Over the air, data can be acquired by the Industrial PC
NFC 512 bytes 8 kbytes	 Mobile phone, close proximity, microcontroller moving data chunks to NFC Mobile phone, close proximity, read 8 kbytes in one go

Lierda is implementing this for Phase 2.

Questions

1. What is going to be logged:
   - Errors;
   - Warnings;
   - Events?
2. LoRa configurable?
3. Storage protocol
4. How long for?
5. How much storage do we need?
6. What is the best storage option?
7. What is the best option for reading the data?

Industrial PC datalogging [every event]

SQLite structure for IPC [keep data for 12 months]
Unix timestamp
Timestamp
day
month
year
hour
minute
second
Actual command transmitted [ASCII]
All the Hortilux Lightning Protocol parameters

Dongle datalogging [only errors]

Errors

STM32C05
Reset due to
Illegal mode
Watchdog
Software
Brownout
System
Option byte loading
RAM nearly full
CRC of received LoRa data incorrect

WB25
Not responding timeout
Error response
No network found

RS485
Not responding timeout
Error response

NFC
Not found, i2c
Can't read parameters
Can't write parameters

EEPROM
Not found, i2c
Can't read parameters
Can't write parameters

Record structure for dongle
Timestamp bcd [5 bytes]
day
last digit year + month
hour
minute
second
Error code [1 byte]

Assuming 32 configuration bytes in the 512 bytes NFC then the last 80 errors can be stored locally.

Conclusions

1. If the IPC logs all the events then the dongle has to log errors only;
2. Typically the last 80 errors can be recorded in the 512 bytes NFC chip;
3. None of the dongle errors should happen, if they do it has to be fixed asap.

03: Added Errors and SQLite structure for datalogging IPC and record for dongle
02: Added ST25DV04K

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name: Datalogging options
number: GS02/03
date: 14th May 2025
size: A4
scale: 1:1

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Microcontroller starting up

The following has to happen at the start up of the microcontroller inside the dongle:
[The sequence of the action is as yet random. Eventually has to be put in the correct order.]

Configure UART Tx as output, Rx as input
Set RS485 UART to 9600 baud, no 8 data bits, 1 stop bit, no parity;
Check luminaire responds to commands [how?];
Configure an interrupt based 10 ms timer;
Configure i^2c;
    Check NFC read and write
    Check EEPROM read and write
Read flags
    Low level on NRST (external reset)
    Window watchdog event (WWDG reset)
    Independent watchdog event (IWDG reset)
    Software reset (SW reset) (see Software reset)
    Low-power mode security reset (see Low-power mode security reset)
    Option byte loader reset (see Option byte loader reset)
    Power-on reset
Enable/configure
    SRAM parity check
    Independent watchdog
    System window watchdog
    BOR threshold at falling V_{DD} supply
    BOR threshold at rising V_{DD} supply
    Brown out reset enable
Check LoRa module by sending 'Do nothing instruction' command;
Configure RGB led GPIO ports as outputs;
Configure all unused GPIO pins as …
Configure LoRa module
    Read default setting from NFC [to be specified]
    Connect to LoRaWan network
    If connection to network fails: turn luminaire on with default dimming level
Check free RAM [how?]

Proposed changes for v2.1

No backward compatibility
All values are sent/stored as hex, never as BCD
Response from dongle will either be OK<CR> or #x<CR> the latter is error x.
All errors are stored in a circular buffer in the NFC starting with the Unix timestamp
No *reserved* bytes are sent
0xFF/0xFFFF means don't modify current setting or *don't care*
0x0000 0000 for serial number means broadcast to all dongles