ZHAGA LR-1 LoRaWAN lighting controller - command specification

Table of contents

1 Revision history

Revision	Author	Date	Approved by	Changes
R1	Fran Penić	14.07.2023.		Command specification V1
R2	Fran Penić	17.07.2023.		Added profile conf. example
R3	Fran Penić	20.07.2023.		Added energy reporting, changed status message
R4	Fran Penić	25.07.2023.		Added commands to read profile info, expanded energy message
R5	Tihomir P.	01.08.2023		Changed the title. Removed TODO remark that was solved. Port definitions table layout corrected. Apparent power unit changed to VA.
R6	Fran Penić	21.08.2023		Added commands for DC and LBT threshold
R7	Fran Penić	15.11.2023		Changed profiles, added various new commands
R8	Fran Penić	05.12.2023.		Added DALI write disable command
R9	Fran Penić	11.01.2024.		Updated Configuration response port commands. Added BOOT message and some configuration commands. Added responses to all commands.
R10	Fran Penić	17.01.2024.		Added Multicast setup command

2 Port definitions

Port	Description	UL/DL
10	Command port	UL/DL
11	Command response port	UL
20	Configuration port	UL/DL
21	Configuration response port	UL
30	Status request port	DL
31	Status port	UL

3 Command port

The command port is used to send DALI commands directly to the lamp's power supply.

If downlink responses are enabled, an uplink is sent on this port for every command that does not already have an associated uplink. The uplinks are of the form 0xAABB, with AA being the command and BB being either 1 in case of successful execution, or 0 otherwise.

Command	Description	Parameters
0x01	Set brigh tness	0xXX XX – brightness level (0x00 – 0xFE)
0x02	Turn lamp off	-
0x03	Turn lamp on and set brightness to last active level	-
0xF0	Send DALI command	0xXX XX – DALI command
0xF1	Send DALI query	0xXX XX – DALI query
0xE0	Send DALI special command	0xXXXX XXXX – DALI special command
0xE1	Send DALI special query	0xXXXX XXXX – DALI special query

4 Command response port

The command response port is used for responses to commands sent to the command port

Command	Description	Parameters
0xF1	Response to DALI query	0xXXYY XX – DALI query that was executed YY – DALI response to the query
0xE1	Response to DALI special query	0xXXXXYY XXXX – DALI special query that was executed YY – DALI response to the special query

5 Configuration port

The configuration commands are used to configure the various parameters of the controller, as well as the lighting profiles.

If downlink responses are enabled, an uplink is sent on this port for every command that does not already have an associated uplink. The uplinks are of the form 0xAABB, with AA being the command and BB being either 1 in case of successful execution, or 0 otherwise.

5.1 Profile description

The profile list contains 8 configurable profiles, each of which consists of four parameters:

- Profile type
- Weekdays for which this profile will be active
- Index of the first step in the profile step table
- Index of the last step in the profile step table

The profile type is an 8-bit value, where bit 0 determines whether the step time is given in half-hour increments (HHM) or as a percentage of night duration (PCT). The next two bits determine the profile type, which can be either NONE, absolute (ABS) or duration (DUR).

If the profile type is NONE (0x00) the brightness of the lamp can be set by downlink and will not change over time.

If the profile type is ABS, the time of each step in the profile step table defines the time at which that step becomes active. If calendar is enabled, the lamp will always be off between sunrise and sunset.

If the profile type is DUR, the profile will start at either sunset (if calendar is enabled) or when the lamp is turned on, and each step will be active for the time specified in the time table.

The meaning of the time value of a profile step for each profile type:

1. ABS/HHM (0x05) - The time of day at which the step becomes active
2. ABS/PCT (0x04) - The first step determines the time of day at which the profile will start, while time values of the other steps are given as a percentage of night duration
3. DUR/HHM (0x03) - The time in half-hour intervals that the step will be active for
4. DUR/PCT (0x02) - The time as a percentage of night duration that the step will be active for

The “Weekdays” parameter is an 8-bit value that determines the days of the week for which the profile should be active, with bit 0 corresponding to Monday, bit 1 to Tuesday etc., and bit 7 corresponding to Holidays.

The light controller will execute the first profile matching the current day of the week, starting at the currently enabled profile index.

The profile step table contains 64 configurable steps, each of which consists the time and brightness associated with that step.

Command	Description	Parameters
0x01	Set status reporting period	0xAAXXXX AA – 1 to send status on brightness change, 0 otherwise XXXX – status reporting period in minutes If period is 0, no status messages are sent **Default:** Status on brightness change disabled 15 minute status reporting period
0x02	Set energy reporting period	0xXXXX XXXX – energy reporting period in minutes If period is 0, no energy messages are sent **Default:** 20 minute energy reporting period
0x03	Set reported energy parameters	0xXXXX XXXX – reported parameters (see table in chapter 8.2) **Default:** 0x100c

0x04	Set confirmed uplink sending period	0xXX XX – Every XX-th status message will be a confirmed uplink If XX = 0, no confirmed messages will be sent **Default:** Every 5th status message is confirmed
0x11	Get status reporting period	-
0x12	Get energy reporting period	-
0x20	Set time	0xXXXXXXXX – UNIX timestamp of UTC time
0x21	Set time zone	0xXX – Time zone **Default:** UTC+1
0x22	Set offset from sunset for profile start	0xXX – Time offset in minutes (positive – profile starts after sunset) **Default:** 0 – No offset
0x23	Set DST rules	0xAABBCCDDEEFFGG AA – Month when DST starts (1 is January) BB – Week of the month when DST starts (-1 is last week, 1 is first week, ...) CC – Day of the week when DST starts (1 is Monday, 7 is Sunday) DD – Month when DST ends EE – Week of the month when DST ends FF – Day of the week when DST ends GG – Time in UTC+0 when change occurs (24-hour) **Default:** Starts last Sunday in March at 01:00 UTC+0 Ends last Sunday in October at 01:00 UTC+0
0x24	Enable or disable calendar	0xXX 0x00 – Disable calendar 0x01 – Enable calendar

		Default: Calendar enabled
0x25	Add Holidays	0xAABBAABB...00 AA – Day of the month BB – Month of the year 00 – End of command
0x26	Remove Holidays	0xAABBAABB..00 AA – Day of the month [1 – 31] BB – Month of the year [1 – 12] 00 – End of command **Default holidays:** 25.12., 26.12., 01.01., 06.12., and 01.05.
0x30	Set coordinates	0xXXXXXXXXYYYYYYYY 0xXXXXXXXX – latitude in 12.20 fixed point format [-94371840 - 94371840] 0xYYYYYYYY – longitude in 12.20 fixed point format [-188743680 - 188743680] NE positive, SW negative **Default:** 45,815 N, 15,982 E
0x40	Set default brightness at power up	0xXX – Brightness [0 – 254] **Default:** 254
0x50	Set duty cycle on/off	0xXX 0x00 – OFF 0x01 – ON **Default:** ON

0x51	Set Listen-before-talk threshold	0xXX XX – Threshold in negative dBm (ex. 0x7F = -127 dBm) [1 – 140] **Default:** 100
0x52	Set Data rate	0xXX XX - Data rate [0 - 7] **Default:** 2
0x53	Set ADR on/off	0xXX 0x00 – OFF 0x01 – ON **Default:** ON
0x54	Set minimum and maximum join delay time	0xXXYY XX – minimum join delay time in seconds YY – maximum join delay time in seconds The device waits for a random number of seconds between the given values before attempting to join a network **Default:** 0 – 30 second join delay
0x55	Enable or disable downlink responses	0xXX 0x00 – Disable downlink responses 0x01 – Enable downlink responses **Default:** Downlink responses disabled
0x56	Set multicast parameters	0xXYZ X – 4-byte McAddr Y – 16-byte McNwkSKey Z – 16-byte McAppSKey

0x60	Set dimming curve	0xXX XX – 1: linear, 0: logarithmic **Default:** Linear
0x61	Disable setting brightness over DALI	0xXX 0x00 – Enable DALI brightness setting 0x01 – Disable DALI brightness setting **Default:** Brightness setting enabled
0x62	Set LED mode	0xXX 0x00 – LED always off 0x01 – LED briefly flashes on power-on 0x02 – LED flashes until network is joined **Default:** LED flashes until network is joined
0x70	Set temporary brightness level	0xXXYYYY XX – Brightness level YYYY – Time in minutes
0xD0	Configure profile at index XX of the profile list	0xXXAABBCCDD XX – profile list index AA – profile type BB – weekdays CC – Index of first step in the profile step table DD – Index of last step in the profile step table For profiles with type 0 (NONE), parameter DD is ignored
0xE0	Configure a single step in the profile step table	0xXXYYZZ XX – Index of the step in the profile step table YY – Step level ZZ – Step time
0xF0	Configure multiple steps in the profile step table	0xXXYYZZYYZZ...FF

		XX – Index of the first step in the profile step table YY – Step level ZZ – Step time FF – End of the command
0xC1	Enable profile	0xXX XX – Index of the profile to enable in the profile list
0xD1	Get profile list info	-
0xD2	Get profile XX steps	0xXX – profile index
0xFE	Reset to factory default configuration	0xXX The bits of XX determine which part of the configuration to reset 0x01 – Reset configured parameters 0x02 – Reset profile list and step table 0x04 – Reset holiday list

5.2 Profile configuration example

In this example, a profile with the following steps will be configured:

Weekdays	Time	Formatted time	Brightness	Formatted brightness
Monday Tuesday Wednesday Thursday Friday	20:00	0xC8	30%	0x4C
	21:30	0xD5	80%	0xCB
	01:30	0x0D	100%	0xFE
	04:30	0x2B	70%	0xB2
	07:00	0x46	0%	0x00
Saturday Suday Holiday	20:00	0xC8	80%	0xCB
	01:30	0x0D	60%	0x98
	04:30	0x2B	50%	0x7F
	07:00	0x46	0%	0x00

First, the steps defined for weekdays in the table above can be written to the profile step table, starting at index 10:

0xF00A4CC8CBD5FE0DB22B0046CBC8980D7F2B0046FF

Next, the two ABS/HHM profiles that use these steps will be defined at indexes 6 and 7:

0xD006051F0A0E

0xD00705E00F12

Finally, the newly defined profile can be started:

0xC106

6 Configuration response port

The configuration response port is used for responses to commands sent to the configuration port

Command	Description	Parameters
0x11	Status reporting period	0xAAXXXX AA – 1 if sending status on brightness change, 0 otherwise XXXX – status reporting period in minutes
0x12	Energy reporting period	0xXXXX XXXX– energy reporting period in minutes
0xD1	Profile list info	0xAABBCCDDAABBCCDD... AA – Profile index BB – Profile type CC – First step index DD – Last step index Repeats for every profile of type other than 0
0xD2	Profile XX step info	0xXXAABBAABBAA... XX – Profile index AA – Step level BB – Step type

7 Status request port

The status response port is used to request immediate transmission of a status message.

Command	Description	Parameters
0x01	Request status message	-
0x02	Request energy message	-

8 Status port

The status port is used for periodic status and energy consumption messages, as well as alarms.

8.1 Status message

The format of a status message is described in the table below:

Byte	**0**	**1-4**	**5**	**6**
Description	0x01 – Command Identifier	UNIX timestamp in seconds	DALI Status	Current brightness level
Byte	**7**	**8**	**9**	**10**
Description	Current profile index	Current control gear temperature with an offset of 60 °C Ex. 114 = 54 °C	RSSI of last received downlink [negative dBm] Ex. 84 = -84 dBm	SNR of last received downlink [signed dB] Ex. 251 = -5 dB

The bits of the DALI Status byte have the following meaning:

Bit	**Description**	**Value**
0	Ballast status	0 = OK
1	Lamp failure	0 = OK
2	Lamp on	0 = OFF
3	Limit error	0 = OK
4	Fade ready	0 = READY
5	Reset state	0 = NO
6	Missing short address	0 = NO
7	Power failure	0 = OK

8.2 Alarm message

The alarm message is sent in case an error is detected. The format is as follows:

Byte	**0**	**1**
Description	0x03 – Command identifier	Active alarms

The bits of the “Active alarms” field correspond to the following events:

Bit	**Description**
1	DALI error
2	Internal error
3	RTC not set, but required for ABS profile
4	RTC not set, fallback for DUR profile available

8.3 Boot message

The boot message is sent every time the device is turned on. The format is as follows:

Byte	**0**	**1**	**2**	**3-6**
Description	0x04 – Command identifier	Firmware major version number	Firmware minor version number	UNIX timestamp of the device’s waketime
Byte	**7-10**	**11**	**12**	**13**
Description	Mean night duration in seconds	DALI status	Current profile index	Current brightness level

8.4 Energy consumption message

The format of the energy consumption message is dependent on which parameters were chosen for reporting.

Byte	**0**	**1-4**	**5-6**	**...**
Description	0x02 – Command identifier	UNIX timestamp in seconds	Reported parameters	Parameters indicated by bytes 5-6, in order

The parameters and their formats are shown in the table below:

Bit	Description	Format
0	Apparent power [VA]	3b + 1b scale factor
1	Apparent energy [VAh]	3b + 1b scale factor
2	Active power [W]	3b + 1b scale factor
3	Active energy [Wh]	3b + 1b scale factor
4	Loadside power [W]	3b + 1b scale factor
5	Loadside energy [Wh]	3b + 1b scale factor
6	Power factor [%]	1b
7	Supply voltage [0,1 Vrms]	2b
8	Light source voltage [0,1 V]	2b
9	Light source current [mA]	2b
10	Light source total on-time [s]	4b
11	Light source on-time since last power-on [s]	4b
12	Control gear total operating time [s]	4b

For power and energy measurements, a scale factor is used to widen the measurement range. The value of these parameters can be computed by the formula:

$$X = Value \cdot 10^{scale\ factor}$$