



Device Specification

Elega String Lights

April 2022 - Version 1.0

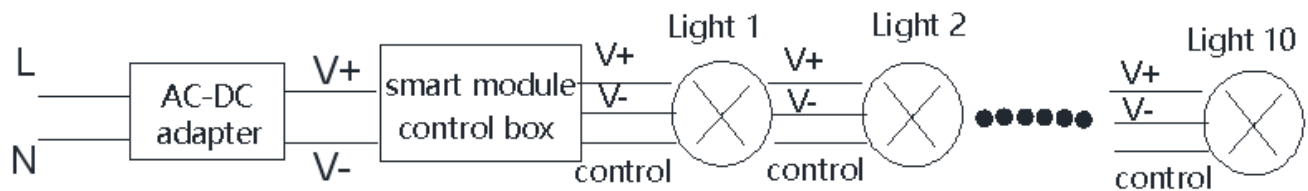
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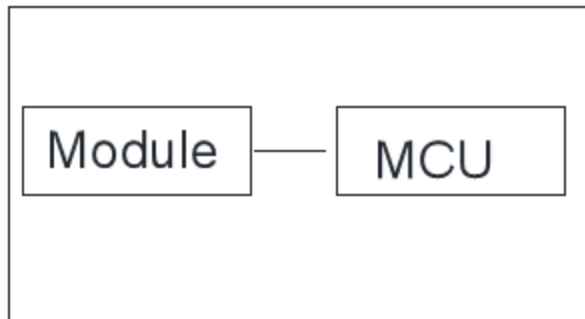
Version History

| Version | Change by | Date | Notes |
|---------|-----------|----------|---------------|
| 1.0 | Joseph | 4/2/2022 | Initial draft |

Introduction



Control box



Friendly Name, Device Type, and Model Number

- The friendly name is "String Lights".
- The device class is "LIGHT"
- The device class is "LIGHT"
- The model number is TBD.

Features

- Warm White/ Cool White, CCT tunable - 3000K to 6500K
- RGB colors
- Remote operation via the Hubspace mobile app.
- Scheduling and timer control.

Hardware

The unit is made up of:

- Hubspace module
- 10 addressable RGBW LED lights
- Button with LED
- Transformer/power supply
- smart Module Control Box to control the lights

Power Consumption Requirements

None.

Default Setting

The default light setting is white, 3000K, 100% brightness.

Power-on Behavior

The light status after a power outage is selectable in the app:

- Last Used On (Default) - switches on to the last state. If the last state was off, the light turns on to the last state, e.g., color state/brightness.
- Last Used Off - switches on to the last state. If the last state was off, the light remains off. If the user switches the power on and off twice, the light will come on at the last state, e.g., color state/brightness.
- Safety Mode - restores the light to 3000K at 100% brightness.

Module Pin Map

| Vertical Module Pin Number | Horizontal Module Pin Number | Module Pin Name | Signal Name | Signal Polarity | Function |
|----------------------------|------------------------------|-----------------|-------------|-----------------|---------------|
| 1 | 1 | VCC | 3.3V In | | 3.3V In |
| 3,18 | 3,14,21,22 | GND | Ground | | Ground |
| 5 | 5 | PWM1 | NRST | Active LOW | MCU Reset |
| 7 | 7 | PWM2 | BUTTON_N | Active LOW | Button |
| 9 | 9 | PWM3 | BUTTON-LED | | Button LED |
| 11 | 11 | PWM4 | | | |
| 13 | 13 | PWM5 | | | |
| 12 | 28 | GPIO6 | | | |
| -- | 21 | GPIO7 | | | |
| -- | 29 | GPIO8 | | | |
| 6 | 10 | RX1 | MCU-TX | | Data from MCU |
| 8 | 8 | TX1 | MCU-RX | | Data to MCU |
| 15 | 15 | FACTORY_MODE_N | | | Test point |
| 10 | 4 | BM_SEL / GPIO5 | | Active LOW | Test point |
| 4 | 16 | TX0 | | | Test point |
| 2 | 18 | RX0 | | | Test point |
| 14 | 2 | RESET_N | | | Test point |

MCU <> Module UART Protocol

The Hubspace Module and the light controller MCU will communicate over a serial UART using the following protocol.

Message Format

Message format is as follows:

Function Code: 1 byte

Flags: 1 byte

Payload Length: 1 byte

Payload: [payload length bytes]

CRC: 1 byte (and is an XOR of all the data starting at Function Code up until end of payload)

The resend timeout is 300ms. The command will be retried 3 times before the MCU is reset using the reset line.

Flags:

0x1 - Request from App

0x2 - Response from MCU

0x4 - Error Flag (only ever in MCU response) in case request couldn't be honored. If set, the payload (which should be one byte long) is the error code.

Current error codes are:

```
#define ERROR_CODE_CRC_FAIL 1

typedef struct {
    uint8_t index; // Bulb ID, 0 to 11
    uint8_t red;
    uint8_t green;
    uint8_t blue;
    uint8_t ww; // Warm white LED
    uint8_t cw; // Cool white
} __attribute__((__packed__)) bulb_data_t;
```

Command Request From App:

Function Code: 0xAF

Flags: 0x1

Payload Length: 6*N (where N is the number of bulb values we're trying to change)

Payload: The actual data length bytes

CRC: <calculated>

Command Response from your MCU (success):

Function Code: 0xAF

Flags: 0x2

Payload Length: 0

CRC: 0xAD

Command Response from your MCU (CRC failure):

Function Code: 0xAF

Flags: 0x6

Payload Length: 1

Payload: 1

CRC: 0xA9

Examples of what the request could look like:

1. Turn off all lights

0xAF, 0x01, 0x48,
0x00, 0x00, 0x00, 0x00, 0x00, 0x00,
0x01, 0x00, 0x00, 0x00, 0x00, 0x00,
0x02, 0x00, 0x00, 0x00, 0x00, 0x00,
0x03, 0x00, 0x00, 0x00, 0x00, 0x00,
0x04, 0x00, 0x00, 0x00, 0x00, 0x00,
0x05, 0x00, 0x00, 0x00, 0x00, 0x00,
0x06, 0x00, 0x00, 0x00, 0x00, 0x00,
0x07, 0x00, 0x00, 0x00, 0x00, 0x00,
0x08, 0x00, 0x00, 0x00, 0x00, 0x00,
0x09, 0x00, 0x00, 0x00, 0x00, 0x00,
0x0A, 0x00, 0x00, 0x00, 0x00, 0x00,

0x0B, 0x00, 0x00, 0x00, 0x00, 0x00,
0xE6

2. Turn on first bulb to 100% Red, second to 100% Green, third to 100% Blue and leave the rest in the current state (which is why we're only sending 3 entries)

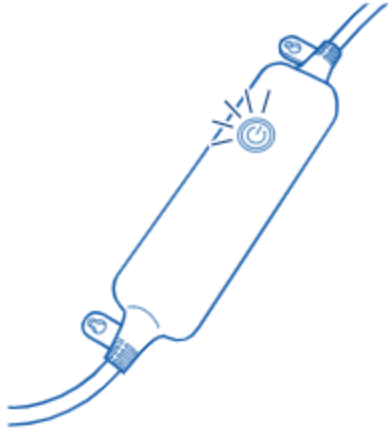
0xAF, 0x01, 0x12
0x00, 0xFF, 0x00, 0x00, 0x00, 0x00,
0x01, 0x00, 0xFF, 0x00, 0x00, 0x00,
0x02, 0x00, 0x00, 0xFF, 0x00, 0x00,
0x40

3. Turn on first bulb to 100% 3000K (warm white), second to 100% 6000K (Cool white), third to 100% 4500K white, forth to 50% 4500K white, and leave the rest in the current state

0xAF, 0x01, 0x18
0x00, 0x00, 0x00, 0x00, 0xFF, 0x00,
0x01, 0x00, 0x00, 0x00, 0x00, 0xFF,
0x02, 0x00, 0x00, 0x00, 0x7F, 0x7F,
0x03, 0x00, 0x00, 0x00, 0x3F, 0x3F,
0xB6

Manual Operation

The lights can be used without attaching to a Hubspace account by using a button on the power supply. For example:



The button operation will be:

1. Short presses will cycle through the following states:
 - a. White mode, 3000K, 100%
 - b. Preset/sequence 1 through to X
 - c. Off
 - d. Return to (a)
2. Long push of the button (5 seconds) will put the lights into the setup mode.

Button LED Operation

| State | LED State | Description |
|------------|-----------|--|
| Off | Off | Lights are off |
| On | On | Lights are on |
| Setup Mode | Blinking | Device is in setup mode. Stays in this mode for 5 minutes or until connected. Return to the previous state after exit. |

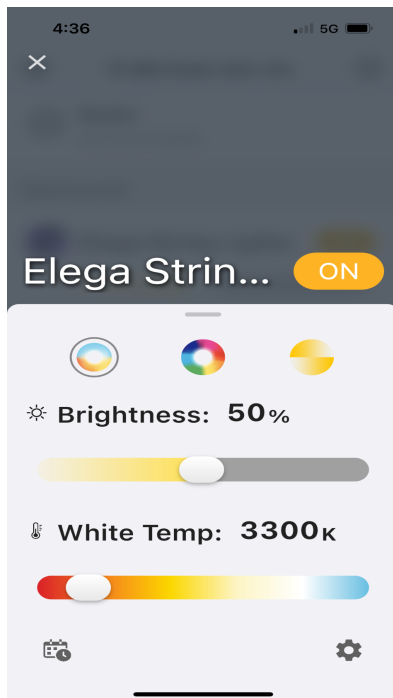
App Operation

The UI for the light will contain the following sub tabs:

- White selection
- Color selection
- Sequences/presets selection
- Light pattern setting

White Selection Tab

The UI will enable the selection of brightness and white color temperature, like this:



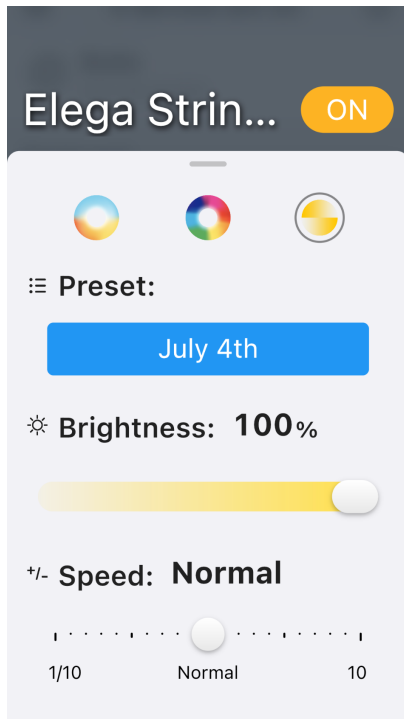
White Light Tab with Brightness and CCT Selection

Color Selection Tab



Color Light Tab with Brightness and Color Pickers

Sequences/Presets Selection Tab



Preset Tab with Brightness and Speed Control (if preset is a sequence) and Preset Popup

Sequences

The device must support the following sequences. These sequence animations may approximate what is listed here but with an emphasis on meeting the color requirements.

| # | Sequence Name |
|---|---|
| 1 | Christmas - red, green, blank, animated. Motion Effect: Bounce Motion Speed: 50 Trail: on Brightness Effect: Outer Phase Brightness Speed: 32 Brightness Depth: 100 Remix: Off |
| 2 | Fade 3 - fading red, green and blue, animated. |

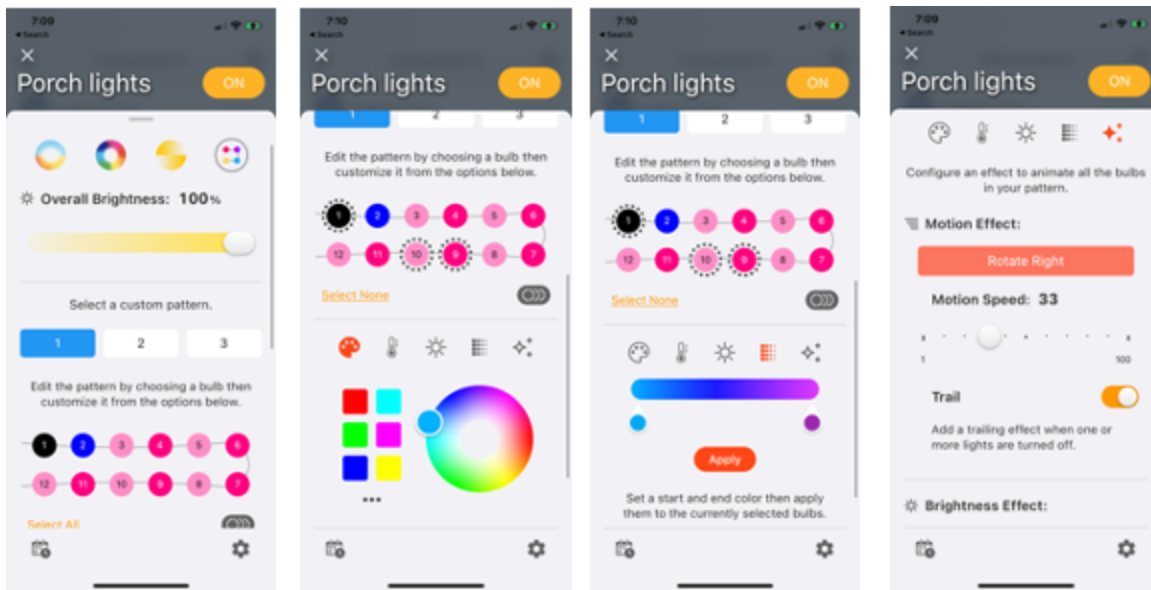
| | |
|----|--|
| 3 | Fade 7- fading between red, green, yellow, blue, yellow, cyan, magenta, white in sequence. |
| 4 | Flash - white flash on/off. |
| 5 | <p>July 4th - fade between red, white (5600), blue.</p> <p>Motion Effect: Steady</p> <p>Motion Speed: N/A</p> <p>Trail: Off</p> <p>Brightness Effect: Twinkle</p> <p>Brightness Speed: 61</p> <p>Brightness Depth: 200</p> <p>Remix: On</p> |
| 6 | Jump 3 - switching between red, green and blue in sequence. |
| 7 | Jump 7 - switching between red, green, yellow, blue, yellow, cyan, magenta, white in sequence. |
| 8 | <p>Rainbow - red, orange, yellow, green, blue,, violet with off bulbs in between spread out across 12 bulbs, with an animation.</p> <p>Motion Effect: Rotate Right</p> <p>Motion Speed: 63</p> <p>Brightness Effect: Steady</p> <p>Trail: On</p> <p>Brightness Speed: N/A</p> <p>Brightness Depth: N/A</p> <p>Remix: N/A</p> |
| 9 | Sleep - white, fade to off after 30 minutes. |
| 10 | <p>Valentine's Day - pulsing red, white and pink.</p> <p>Motion Effect: Steady</p> <p>Motion Speed: N/A</p> <p>Brightness Effect: Impulse</p> <p>Brightness Speed: 23</p> <p>Brightness Depth: 74</p> |

| | |
|----|---|
| | Remix: On |
| 11 | Wake - 30 minutes minimum white brightness to maximum brightness. |
| 12 | <p>Halloween - orange, green, warm white, magenta , animated.</p> <p>Motion Effect: Steady</p> <p>Motion Speed: N/A</p> <p>Brightness Effect: Breathing</p> <p>Brightness Speed: 27</p> <p>Brightness Depth: 90</p> <p>Remix: On</p> |
| 13 | <p>Easter Eggs (was Easter) - yellow, green, magenta, cyan, animated.</p> <p>Motion Effect: Shuffle</p> <p>Motion Speed: 39</p> <p>Trail: No</p> <p>Brightness Effect: Alter Phase</p> <p>Brightness Speed: 33</p> <p>Brightness Depth: 83</p> <p>Remix: On</p> |
| 14 | <p>St. Patrick - Green and blank alternating</p> <p>Motion Effect: Shuffle</p> <p>Motion Speed: 65</p> <p>Trail: On</p> <p>Brightness Effect: Breathing</p> <p>Brightness Speed: 33</p> <p>Brightness Depth: 83</p> <p>Remix: No</p> |
| 15 | <p>Hanukkah , blue, white repeated animated.</p> <p>Motion Effect: Steady</p> <p>Motion Speed: N/A</p> <p>Brightness Effect: Lightning</p> |

| | |
|----|--|
| | <p>Brightness Speed: 24</p> <p>Brightness Depth: 83</p> <p>Remix: On</p> |
| 16 | <p>Cinco De Mayo - Green, White, Red, animated.</p> <p>Motion Effect: Steady</p> <p>Motion Speed: N/A</p> <p>Brightness Effect: Inner Phase</p> <p>Brightness Speed: 19</p> <p>Brightness Depth: 81</p> <p>Remix: Off</p> |
| 17 | <p>Double Rainbow - red, orange, yellow, green, blue,, violet, violet, blue, green, yellow, orange, red</p> <p>Motion Effect: Middle In</p> <p>Motion Speed: 29</p> <p>Trail: No</p> <p>Brightness Effect: Lightning</p> <p>Brightness Speed: 21</p> <p>Brightness Depth: 90</p> <p>Remix: Off</p> |
| 18 | <p>Under the Sea - Blue and Cyan</p> <p>Motion Effect: Bounce</p> <p>Motion Speed: 21</p> <p>Trail: N/A</p> <p>Brightness Effect: Breathing</p> <p>Brightness Speed: 23</p> <p>Brightness Depth: 69</p> <p>Remix: Off</p> |
| 19 | <p>Effervescent: Various white and blank lights</p> <p>Motion Effect: Shuffle</p> <p>Motion Speed: 91</p> |

| | |
|--|--|
| | <p>Trail: On</p> <p>Brightness Effect: Twinkle</p> <p>Brightness Speed: 89</p> <p>Brightness Depth: 100</p> <p>Remix: On</p> |
|--|--|

Light Pattern Selection Tab



NOTE: UI needs to be confirmed and developed

The string lights have 10 individually addressable lights. This UI has the following requirements. They are listed as “Must”, “Should”, and “May”:

1. **Color Setting:** This UI must allow the user to set **the color** of each light individually.
 - a. This includes the ability to set lights as white or RGB or a mixture of both. e.g., red, white 3000K, blue, red, white 3000K, blue on the same string.
 - b. Note: It is **not required** to set the brightness of each light independently.
2. **Preview:** The UI should show a visualization of the 10-light string so the user can see what the colors are for each bulb.
 - a. A stretch goal is to enable a preview of the animations available.
3. **Global Brightness:** This UI must allow the user to set the master brightness of the pattern with a brightness control - this affects all the lights concurrently.
4. **Animations:** The UI should enable the lights to be animated through a selection of motion effects and brightness effects.
 - a. **Motion Effects** the following are available:

| | |
|---|--|
| 0 | Steady - The lights do not animate and stay steady lit. |
| 1 | Rotate Right - Light colors marquee to the right |
| 2 | Rotate Left - Light colors marquee to the left |
| 3 | Shuffle - Light colors shuffle around |
| 4 | Middle Out - Bulbs fire and fade in a pattern radiating out from the middle of the chain. If multiple chains are connected, each sub-chain will do this same animation. It looks like the lights are “chasing” from the middle out. Colors are stationary. |
| 5 | Middle In - Like Middle Out, but the opposite direction. Bulbs fire and fade from the ends towards the middle. Colors are stationary. |
| 6 | Bounce - like the cylon from BattleStar Galactica |

- b. The speed of the motion can be independently set.
- c. **Trail:** This option is active only when Motion Effects are set to a value other than Steady and at least one light bulb in the string is set to Off.
- d. **Brightness Effects** - these apply an effect to the brightness of the string:

| | |
|---|--|
| 0 | Steady - The lights do not change brightness and stay steady lit. This is also the default. |
| 1 | Lightning - Bulbs fire quickly and fade slowly in a chain, like a flash of lighting or a string of firecrackers (that could also be the name). |
| 2 | Outer Phase - Bulbs fire from the outer ends of the string to the center of the string |
| 3 | Inner Phase - Bulbs fire from the center of the string to the ends. Bulb 6 fires towards bulb 1. Bulb 7 up towards bulb 12. |
| 4 | Alter Phase - Even-numbered bulbs fire at a different frequency from odd number bulbs. |
| 5 | Breathing - the bulbs brighten and dim in a breathing-type way. |
| 6 | Impulse - all bulbs quickly brighten and then quickly dim. |
| 7 | Twinkle - The string is divided into 3 groups of 4. The bulbs in each group fire on and off at different intervals. |
| | |

The speed of the brightness effect can be independently set.

- e. **Brightness Depth:** The UI should present a depth of how much the brightness will dim. 0 = full depth.

- f. **Remix** - if this option is set, there is a chance that the brightness effect for each bulb will not run. It adds a snazzy effect to the brightness.
- 5. **Pattern Storage:** The UI should enable storage of 3 color and animation patterns. The user will be able to select from one of the patterns and adjust it. These patterns will be available when scheduling.
 - a. The pattern speed must be configurable and savable.
 - b. Custom 1
 - c. Custom 2
 - d. Custom 3

Default Pattern 1 Pairs of Red, Green, and Blue with blanks in between

Motion Effect: Bounce

Motion Speed: 50

Trail: On

Brightness Effect: Steady

Brightness Speed: N/A

Brightness Depth: N/A

Remix: N/A

Default Pattern 2 Green to Red Spectrum with brown in the middle, animated

Motion Effect: Steady

Motion Speed: N/A

Trail: N/A

Brightness Effect: Impulse

Brightness Speed: 15

Brightness Depth: 100

Remix: Off

Default Pattern 3 One White bulb (3000k) the rest blank, animated

Motion Effect: bounce

Motion Speed: 84

Trail: On

Brightness Effect: Alter Phase

Brightness Speed: 15

Brightness Depth: 100

Remix: Off

Scheduling

The user can schedule the lights to come on and off at different times or based on sunrise or sunset. The user will be able to schedule the following:

1. Set all the lights to all white at a brightness and CCT setting
2. Set all the lights to the same color at a set brightness.
3. Set the lights to a preset or one of the 3 custom settings.

Onboarding And Removal

Onboarding is done via QR code scanning, setup mode, or manual code entry. The QR code shall be placed on the device. Scanning the QR code of a device already on another account will transfer it to the scanner's account.

QR code or manual entry onboarding

The user scans the QR code or enters the code manually into the app.

QR codeless setup mode onboarding

This is a backup way to add a device if the QR code is not available. Pressing the button for 5 seconds will trigger setup mode. The lights will pulse to indicate this mode.

Device Removal

When the device is removed from an account, or reset by the service, it will return all settings to default.

Voice Integrations

The product will integrate with Alexa and Google Home.

Factory Test Mode

For factory test mode (FTM) operation, see the Elego String Light Factory Test Specification.