

LUMA X

LUMA X UV

a fast, long-range, optical underwater communication system

Manual

Version 1.11 for Firmware Version 1.4



HYDROMEAL

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Contents

1	Introduction	4
2	Initial setup	4
2.1	Windows 10 setup.....	5
2.2	LUMA X setup.....	6
2.3	Setting the IP address.....	7
2.4	Testing the communication	8
2.5	Transmitting data	9
3	Modem configuration	9
3.1	Main page.....	10
3.2	Parameters page	10
3.3	Status page.....	14
3.4	IP address change page.....	16
3.5	Communication test.....	16
4	Modem firmware upgrade using <i>LumaConf</i>	17
5	Maintenance	19
6	API	19
6.1	API parameters.....	19
1.1	API usage examples using Python	25
7	Electrical and software Characteristics.....	26
8	Mechanical Characteristics	27
9	LUMA X-UV eye safety certification.....	30
10	Errata.....	34

WARNING:

- **bright LED light source, do not look directly at emitter**
- **a few people may experience epileptic seizures when viewing flashing lights**

1 Introduction

The LUMA X is an optical modem for fast, reliable wireless underwater communication. Each LUMA X is a full transceiver and thus capable of half-duplex communication (transmission and reception).

Note: this manual applies to the LUMA X as well as the LUMA X-UV. Throughout the manual all references to LUMA X also apply to LUMA X-UV except for when there is an explicit differentiation.

Note: this manual is only valid for the v1.4 firmware version of the LUMA X modem. You can check your firmware version on the main webpage of your modem (see chapter 0 of the manual to access the LUMA X webpage). If your modem firmware is outdated, please contact Hydromea in order to get the latest version of the LUMA X firmware.

2 Initial setup

Note: while submerging the LUMA X, a small number of bubbles may come out of the pressure compensation vent at the connector end of the modem. When LUMA X is back on the surface a small amount of water may come out of the vent.

For normal operation of the LUMA X, only the Ethernet cable is used for the communication. The serial cable is only used for factory reset and firmware upgrade of the modem.

The LUMA X comes preconfigured to forward data, automatically select the transmission speed and the amount of LEDs used for transmission depending on the distance between the modems and the amount of ambient light. They do not require configuration for normal use, however this setup guide will allow you to check if the optical communication link is well established and enable you to change the configuration of the modem if necessary.

Note: As the LUMA modems form a bridge, they should not be connected to the same cabled network (i.e. do not plug both modems into the same switch). Doing so may lead to a loop in the network, where one LUMA picks up traffic from the other LUMA and feeds it back to the switch, flooding the network with packets. The modems should be connected to two separate cabled networks as shown in Figure 1.

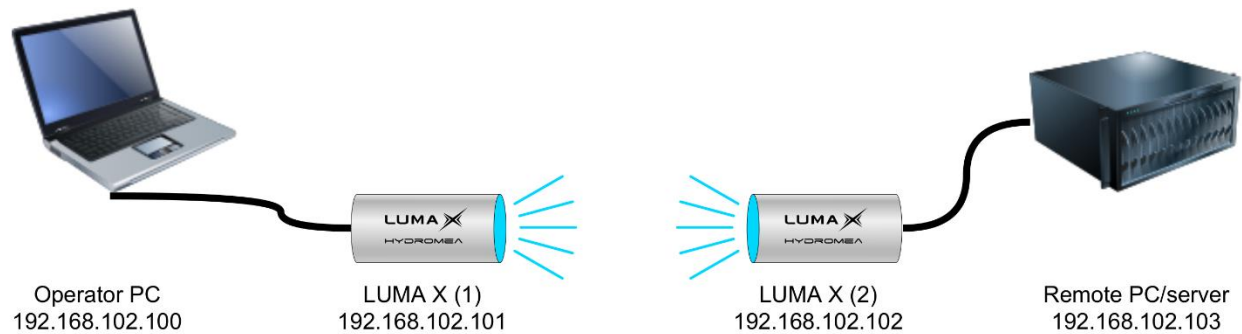


Figure 1: Typical initial test setup. The IP addresses of the modems are not critical but useful to differentiate them

2.1 Windows 10 setup

The following steps explain how to set an IP address on your Windows 10/11 PC

- go to → *Settings* → *Network & Internet* → *Ethernet* (in left column) → *Network and Sharing Center* (in right column) → *Change adapter settings* (in left column) → right click on Ethernet adapter → *Properties* → select Internet Protocol Version 4 (TCP/IPv4) → *Properties*
- set the address as shown in Figure 2

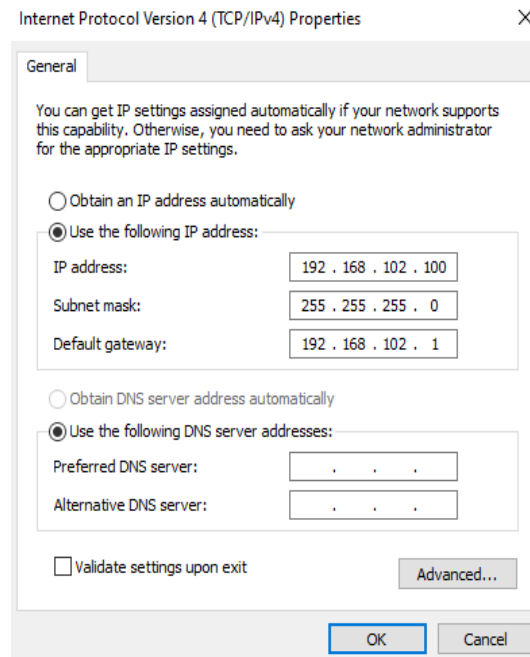


Figure 2: Windows 10 network settings

Verifying the IP address setting:

- Open a command line: → *Windows PowerShell*

- Type: `ipconfig /all`
- You should see the IPv4 address setting shown in Figure 3

```
Ethernet adapter Ethernet 2:  
  
Connection-specific DNS Suffix . :  
Description . . . . . : Intel(R) PRO/1000 MT Desktop Adapter #2  
Physical Address. . . . . : 08-00-27-91-8C-2B  
DHCP Enabled. . . . . : No  
Autoconfiguration Enabled . . . . : Yes  
IPv4 Address. . . . . : 192.168.102.100(Preferred)  
Subnet Mask . . . . . : 255.255.255.0  
Default Gateway . . . . . : 192.168.102.1  
NetBIOS over Tcpi. . . . . : Enabled
```

Figure 3: IPv4 address settings

On the remote PC, repeat the procedure, but set the IP address to 192.168.102.103.

2.2 LUMA X setup

Once the host computer's IP address is set correctly the connection to the LUMA X can be tested.

- Connect **only one** LUMA X to a computer via an Ethernet connection using Hydromea's power/data cable.
- Connect the LUMA X to a suitable supply voltage (12 V – 36 V) using Hydromea's power/data cable.
- Optional step: to test that the IP address has been set correctly, the computer should now be able to ping the LUMA X on its default IP address 192.168.102.101 and the modem should respond to it.
 - Windows 10: Open a command line: → *Windows PowerShell*
 - enter `ping 192.168.102.101`
- Open a browser, and enter 192.168.102.101 into the address field. The LUMA X web interface main page should appear (see Figure 5)



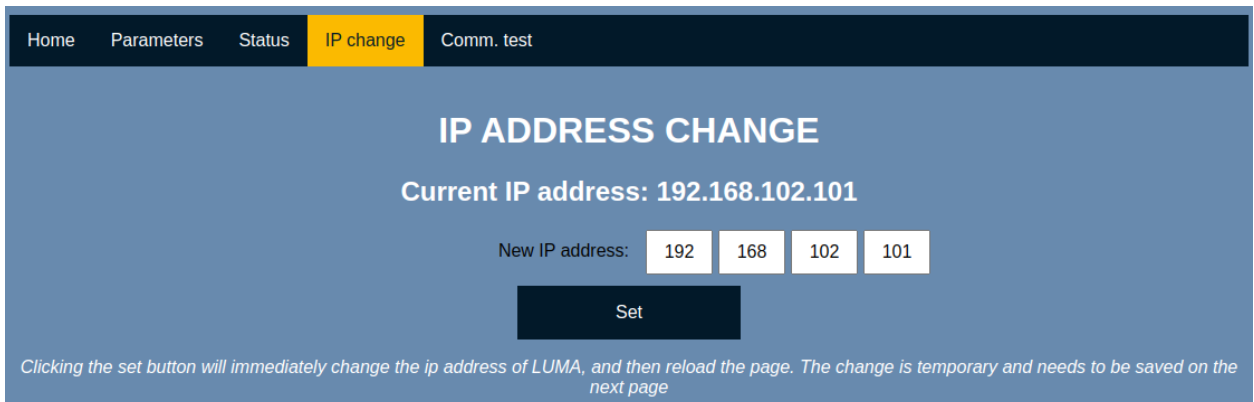
All LUMA X have their IP address factory-set to 192.168.102.101.

You can change the IP address of the modem through the web interface.

2.3 Setting the IP address

For the initial test, modem (1) can remain at the default IP address. The other modem (2) must be set to a new IP address that is unique within the subnet. For the initial example, we use 192.168.102.102.

- Plug in **only** modem number (2) and navigate your browser to 192.168.102.101
- Click on the menu item “IP change”



- Enter the new IP address 192.168.102.102 (for the second modem)

- Click “Set”. The new IP address is now temporarily applied, and the page will reload showing the new IP address:



- To store the new setting to flash memory, click “Save”. The modem is now set to the new IP address.

2.4 Testing the communication

To test communication by exchanging messages between modems, the modem’s firmware provides a simple interface as shown in Figure 4. Connect the first modem to the operator PC, and connect the second modem to a remote PC (e.g., a second laptop, or an ethernet-capable remote device). The operator PC should be set to IP address 192.168.102.100. The remote PC should be set to IP address 192.168.102.103 (this IP address is given as an example for the initial setup – it can be chosen freely within the same subnet).

Power up the modems on both sides. The boot-up takes up to 10 seconds.

Access the “Comm. Test” page from the operator PC,

http://192.168.102.101/test_comm.html

and from the remote PC,

http://192.168.102.102/test_comm.html

Messages can be exchanged from one modem to another and should be displayed on the page.

Note that ambient light, artificial light sources (fluorescent office lighting, LED lamps, screens, sunlight) may interfere with the optical channel and disrupt communication. If a link cannot be established, try to turn off lights, or cover the modems with an opaque sheet of cardboard or cloth while ensuring line of sight between the modems. Ideally the modems should be separated by at least 1 meter, as the receivers may saturate at very close range.



Figure 4: messaging interface for modem-to-modem communication

2.5 Transmitting data

On the operator PC, open a Shell, and type:

```
ping 192.168.102.103
```

If everything is configured correctly, the modems will visibly flash with blue light, and the ping will show the response from the remote PC.

The optical link is now ready and will forward any ethernet traffic from one side to the other side.

3 Modem configuration

This chapter will describe the modem configuration in detail.

LUMA X modems come preconfigured allowing for easy optical communication and do not need additional configuration.

However, for more specific use cases, where limiting the number of LEDs used for transmission or limiting the modem to a specific optical speed, these can be changed in the “Parameters” section of the LUMA X web interface.

The web interface is also useful to get some statistics about the modem itself, such as the throughput, number of packets received and lost as well as the supply voltage of the modem.

3.1 Main page



Figure 5: main page of the web-based configuration-UI

This page provides information about the current revision of the hardware, firmware and API. It also provides the firmware’s SHA and the unique processor ID.

3.2 Parameters page

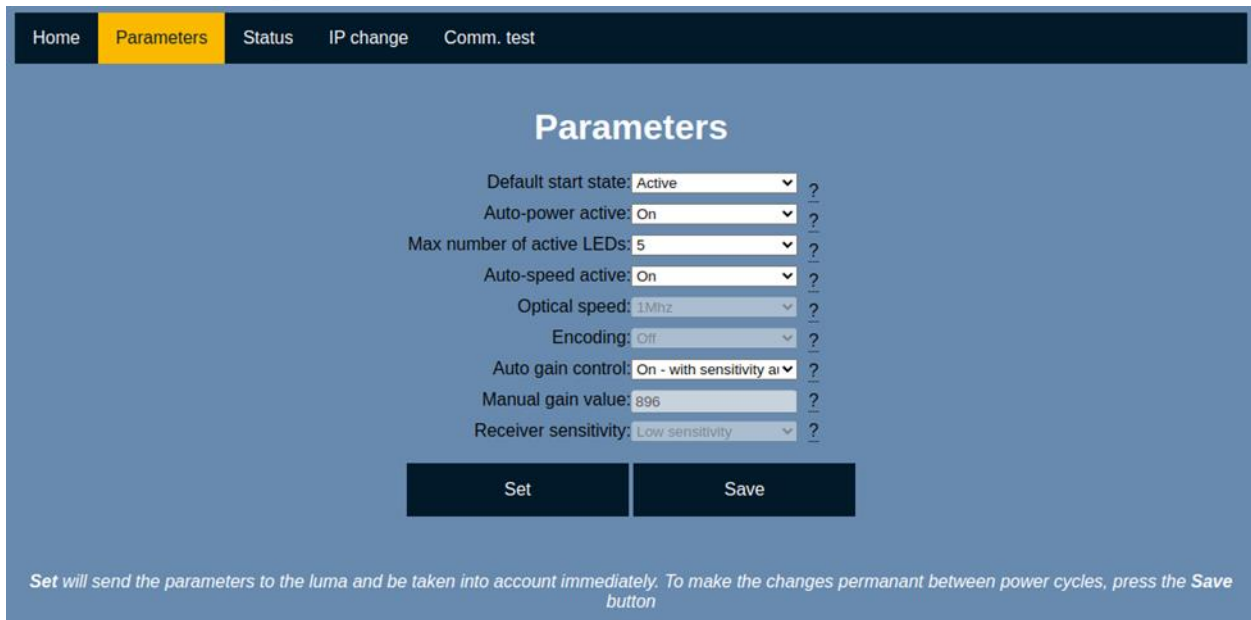


Figure 6: parameter page of the web-based configuration-UI

This is the main configuration page for the LUMA X. Hovering over the “?” next to each parameter provides a short description.

Note: No change will become effective until the “Set” button has been pressed. After power-cycling the modem, the parameters will revert to the previous setting. Pressing the “Save” button will store the new set of parameters into the modem’s flash memory and make it the new permanent set of parameters.

The factory set parameters are in **bold**

Default Start State	Active Config	<p>The state which LUMA X will boot into after power-cycling. The <i>Config</i> state should only be used for debugging or configuration as the modems will not forward any data.</p> <p>It allows the user to connect multiple modems on the same switch without creating switching loops.</p>
Auto-power active	On Off	<p><i>On</i>: the modems will adjust the number of LED banks used based on the strength of the received signal and the ambient light level.</p> <p><i>Off</i>: the modem will use the maximum number of LEDs specified in <i>Max number of active LEDs</i> (below) except when it is in overheat mode.</p>
Max number of active LEDs	1 2 3 4 5	<p>The maximum number of LED banks the modem can use. If <i>Auto-power active</i> is <i>On</i>, it will automatically select the optimal number of banks while not going above the number of LED banks specified her.</p> <p>If <i>Auto-power active</i> is <i>Off</i>, the modem will always use the number of LED banks specified her.</p> <p>Limiting the maximum number of active LED banks will impact the maximum range, but will reduce the power consumption as well as the amount of light generated by the modem.</p> <p>If the modem is used outside the water and starts to overheat, it will automatically decrease the number of active LED banks in order maintain a safe temperature (< 60°C)</p>

Auto-speed active	On Off	<p><i>On</i>: the modems automatically negotiate the optical speed at which they should communicate.</p> <p>If the modems are close to each other or there is a lot of ambient light variation, the modems may switch their speed often and it can vary between 1Mbits/s and 10Mbits/s, which can be undesirable. In this case set the auto speed to <i>Off</i>.</p> <p>This parameter should be set to the same value on both modems.</p>
Optical speed	1 MHz 2 MHz 4 MHz 6 MHz 8 MHz 10 MHz	<p>In case <i>Auto-speed active</i> is set to <i>Off</i>, the optical speed used for data transmission can be set manually.</p> <p>A higher optical speed means less range and less resilience to optical noise and ambient light.</p> <p>This parameter should be set to the same value on both modems.</p>
Encoding	On Off	<p><i>On</i>: increases the link quality, decreases throughput</p> <p><i>Off</i>: decreases link quality, increases throughput.</p> <p>Note: the improvements of the link quality from through encoding are minimal for now, but this is an area of the LUMA X modem under heavy development and may be improved in the future.</p>
Auto gain control	On - with sensitivity autoselect On - fixed sensitivity Off	<p><i>On - with sensitivity autoselect</i>: The LUMA X will adapt to the ambient light level by changing the receiver gain and sensitivity.</p> <p><i>On - fixed sensitivity</i>: should be done in case of troubleshoot and debugging</p> <p><i>Off</i>: should be done in case of troubleshoot and debugging</p>
Manual gain value	0-2800 (500)	This sets the receiver gain

		<p>if <i>Auto gain control</i> is <i>On</i>, the current gain value is displayed, but cannot be changed.</p> <p>if <i>Auto gain control</i> is <i>Off</i>, it is a mutable parameter</p>
Receiver sensitivity	<p>On</p> <p>Off</p>	<p>In case the <i>Auto gain control</i> is <i>Off</i> or <i>On - with fixed sensitivity</i>, this is a mutable parameter.</p> <p>Setting the <i>Receiver sensitivity</i> to <i>On</i> will increase the modem's light sensitivity. This will increase the communication range, but make it more susceptible to ambient light or optical noise.</p> <p>If <i>Auto gain control</i> is <i>On - with sensitivity autoselect</i>, the modem will decide itself when it needs to go to high or low sensitivity.</p> <p>Manually changing this value should be left for troubleshooting.</p>

Table 1: parameters within the web-based configuration UI

3.3 Status page

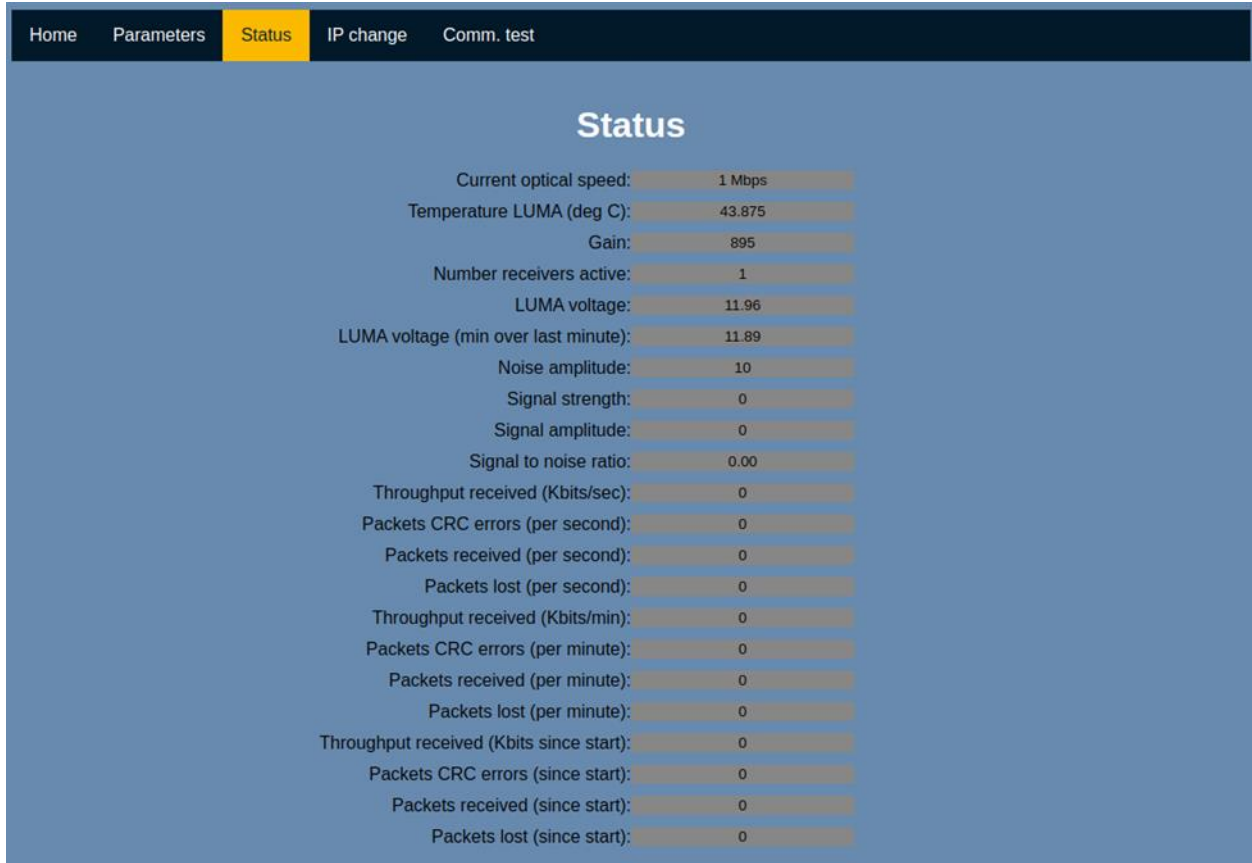


Figure 7: status page of the web-based configuration-UI

This page provides information about the current status of the LUMA modem and is updated once every second. For all data rates (throughput, packet CRC errors, received and loss), three values are displayed: per second, per minute and total since the start of the modem.

Current optical speed	Optical speed used by the modem, in case <i>Auto-speed active</i> is <i>On</i> , this value may change.
Temperature LUMA	Temperature (in degrees Celsius) of the optical transceiver. When the modem gets too hot, it will reduce the number of LED banks it uses to avoid overheating.
Gain	Gain value of the receiver. A high gain value indicates that the modems are far apart and in darkness, a low gain value indicates that the modems are close to each other or that there is a high amount of ambient light.

Number receivers active (1 .. 4)	the number of receivers the modem is using (the sensitivity) to detect light pulses
LUMA voltage	supply voltage of the modem
LUMA voltage (min over last minute)	minimum value of the supply voltage observed over the last minute. This is useful to detect an input voltage drop
Noise amplitude (0 .. 255)	Amplitude of the noise the modem observes.
Signal strength (0 .. 255)	a metric indicating the strength of the signal received
Signal amplitude (0 .. 1024)	Metric indicating the amplitude of the pulses received
Signal to noise ratio (0 .. 255)	Signal to noise ratio Metric, using the noise amplitude and the signal amplitude.
Throughput received [kbps]	Average data rate for data received
Packets CRC errors	Number of packets discarded in last second due to CRC error (indicator for the stability of the link)
Packets received	Number of error-free packets received within the last second
Packets lost	Number of packets lost within the last second between successfully received packets. Note: if no packet is successfully received, lost packets cannot be tracked.

Table 2: modem and link information provided by the web-based configuration UI

3.4 IP address change page

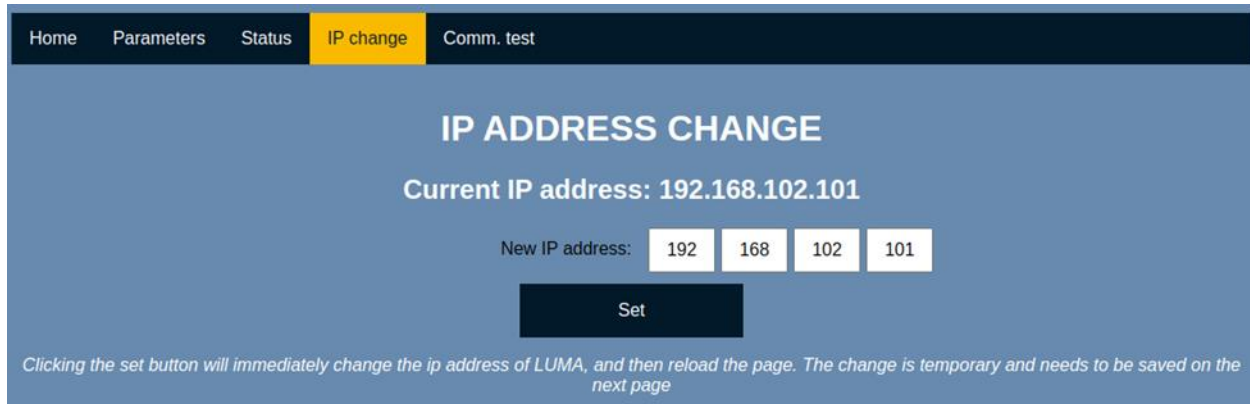


Figure 8: IP-setting page of the based configuration-UI

This page lets you modify the IP address of the web-based configuration interface (which you are using right now). The current IP address of the of the web-based configuration interface is displayed and can be changed. Changing the IP address and pressing *Set* button will immediately change the IP address, however this change is not permanent and the change would be reverted during a power-cycling. After pressing *Set* button, the webpage will try to reconnect to the web-based configuration interface using the new IP address. After reloading the page, the new IP address will be shown and a *Save* button is available. Pressing the *Save* will store the new IP address in the modem’s flash memory, thus making the change permanent.



Figure 9: saving the IP address to flash in the web-based configuration-UI

3.5 Communication test

In order to test the modems’ communication capability without using any additional tools apart from a web browser, we added a communication test page, which allows the user to send text messages to the other modem, which will display the message on its respective communication test page.

This tool can be used to ensure that the modems can communicate in case parameters are changed or when testing in a difficult environment, such as in a high ambient light.



4 Modem firmware upgrade using *LumaConf*

The *LumaConf* software allows you to communicate with the modem using the serial cable which can be used for resetting the settings, or do a firmware upgrade of the modem.

It is available here:

https://files.hydromea.com/luma/LumaConf_lumaX.zip

In order to upgrade the firmware of LUMA X or carry out a factory-reset, LUMA X must be put into *Bootloader* mode. The following steps will upgrade LUMA X firmware and/or carry out a factory reset:

- Start *LumaConf*
- Ensure that the LUMA X is connected to a computer through the serial connection. This is most easily achieved by using Hydromea's power/data cable-box which provides a serial connection through a USB-to-serial conversion within the power/data cable and can be accessed via a micro-USB port.
- Ensure that the LUMA X is connected to a power supply
- In *LumaConf* set *Interface* to the correct serial port
- Click on *Firmware update* within *LumaConf*. This will open the *Bootloader* dialog box (see Figure 10).
- Cycle the power for LUMA X
- The user now has a few seconds after start-up to discover the LUMA X by clicking the *Discover* button. Once it appears in the *Devices* window, the LUMA X will stay in bootloader mode and more options will be available to the user.
 - **Firmware update+factory reset:** select the proper firmware file by clicking on *Select ...* and then start the update by clicking on *Write Flash*. Wait for the progress bar to reach 100%. After a firmware update a factory reset will also be carried out automatically.

Note: please make sure that you select the proper firmware image, the last digits of the filename LX##### need to match the serial number engraved on the modem.

- **Factory reset only:** clicking on *Clear Settings* will factory reset all LUMA X settings.
- Clicking on *start Application* will cause the attached LUMA X to exit the bootloader and restart. The LUMA X will restart in *config* mode as a firmware update will also cause a factory reset which sets the *Default state* after reboot to *config*.
- Closing the bootloader window and selecting Ethernet in *Interface* will then lead to the LUMA X showing up in *LumaConf*.

Note: a limited set of options is available in the *Bootloader* menu when one or multiple LUMA X is/are connected via Ethernet and in *config* mode. In this case the *Bootloader* window will list all LUMA X connected to the network with their last IP byte as an index. The only available actions in this mode are reading the unique serial number of a LUMA X by clicking on *Get Info* which then shows the serial number in *Processor ID* or to soft reset the attached modem(s) by clicking on *Reset*.

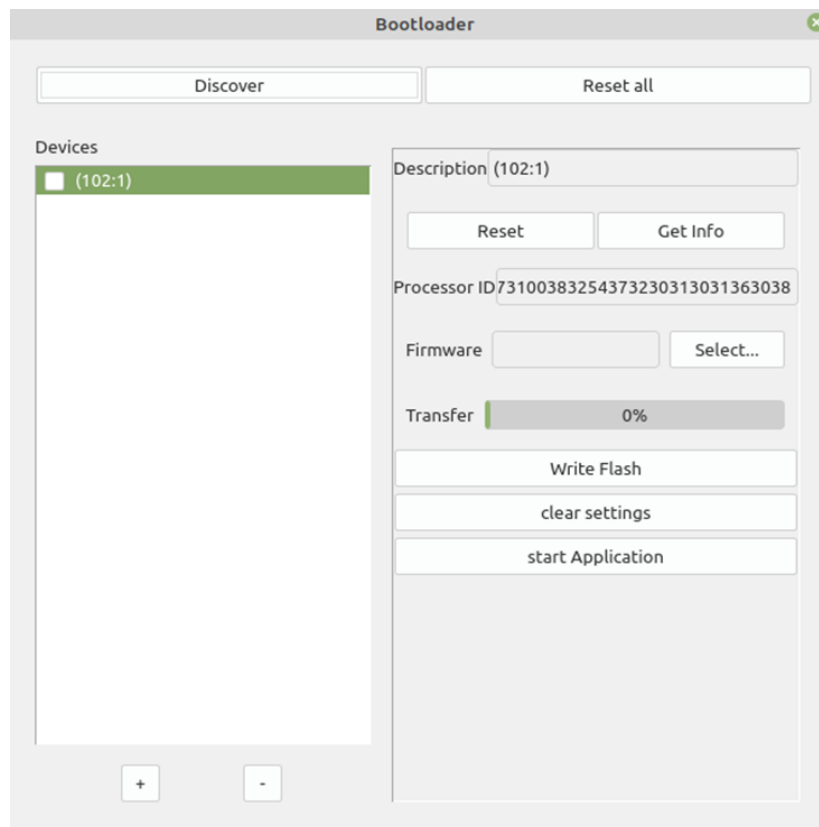


Figure 10: Bootloader section of LumaConf for upgrading the firmware or factory reset of LUMA X

Discover	Query and display all connected LUMA X.
Reset all	Reset all connected LUMA X
Get info	Retrieve the processor ID of the selected LUMA X
Firmware	(only in serial) selects the firmware cfi file for upgrade
Write Flash	(only in serial): Programs the firmware to the LUMA X. It is completed once the transfer progress bar reaches 100%. In case of transfer error, the bar will regress to 0%
Clear settings	(only in serial): Will factory-reset the parameters on the LUMA X, such as its IP address and the <i>config/active</i> mode into <i>config</i> .
Start application	(only in serial): Will start the LUMA X. Note: power cycling the LUMA X and closing the Firmware upgrade window will not put LUMA X into bootloader mode and it will start normally as well.

5 Maintenance

Please wash the modem with warm water (only) to remove any built-up which could negatively affect its operation. Apply a thin film of silicone grease to the rubber part of the connector pins to protect the connector and to facilitate mating. For maintenance details regarding the connector follow SubConn's instructions.

6 API

Hydromea provides an API, based on REST, with which key operating parameters of the LUMA X can be changed or status parameters retrieved while the modem is running. The following tables provide a complete list of these parameters, followed by examples showing how to retrieve and change them (in case they are writable). The examples are written in Python.

6.1 API parameters

status.json (read only)

Parameter	Description
amplitude	Current amplitude value of the Luma, selected by the auto gain
ambient	Ambient value read by the Luma sensor
temperature	Current temperature of the Luma
throughput_received_sec	Data received successfully by the modem in bits per seconds

crc_errors_sec	Number of CRC errors that happened in the last second in the Luma. A high number could indicate some noise or that the Luma is at the edge of the maximal range
pkt_rcv_sec	Number of packet received in the last second
pkt_loss_sec	Number of packet lost in the last second. Note that the Luma can only detect packet loss after it has received a packet out of sequence
throughput_received_min	Data received successfully by the modem in bits per seconds over the last minute
crc_errors_min	Number of CRC errors that happened in the last second in the Luma. A high number could indicate some noise or that the Luma is at the edge of the maximal range
pkt_rcv_min	Number of packet received in the last second
pkt_loss_min	Number of packet lost in the last second. Note that the Luma can only detect packet loss after it has received a packet out of sequence
throughput_received_total	Data received successfully by the modem in bits per seconds over the runtime of the modem
crc_errors_total	Number of CRC errors that happened in the last second in the Luma. A high number could indicate some noise or that the Luma is at the edge of the maximal range
pkt_rcv_total	Number of packet received in the last second
pkt_loss_total	Number of packet lost in the last second. Note that the Luma can only detect packet loss after it has received a packet out of sequence
gain	Current gain value of the receiver

nb_additional_rcv	Number of extra receivers active
status_electronics	Status of the electronics, 0 indicates an internal problem
volt_board	The voltage the LUMA sees at its VCC input port.
volt_board_min	The voltage the LUMA sees at its VCC input port, sampled at a higher rate and displaying the minimum value observed over the last minute. Useful to detect if the input voltage experiences some drop due to high current draw during transmission.
noise_amplitude	Amplitude of the noise the modem observes.
SNR	Signal to noise ratio Metric, using the noise amplitude and the signal amplitude.
signal_strength	Metric indicating the strength of the signal received
signal_amplitude	Metric indicating the amplitude of the pulses received
optical_speed	Optical speed used by the modem, in case it is set with auto-speed on, this value may change.

general_info.json (read only)

Parameter	Description
hw_version	Hardware version of the Luma (16 bit value 8'MAJ, 8'MIN) concatenated in one parameter for compatibility
hw_version_maj	Hardware version of the Luma, major version
hw_version_min	Hardware version of the Luma, minor version
hw_version_rev	Hardware version of the Luma, revision
fw_version	firmware version of the Luma (16 bit value 8'MAJ, 8'MIN) concatenated in one parameter for compatibility
fw_version_maj	firmware version of the Luma, major version
fw_version_min	firmware version of the Luma, minor version

fw_version_rev	firmware version of the Luma, revision
sha_version	Specific firmware variant of the Luma
api_version	Version of the API. (16 bit value 8'MAJ, 8'MIN) concatenated in one parameter for compatibility
api_version_maj	Version of the API, major version
api_version_min	Version of the API, minor version
api_version_rev	Version of the API, revision
bootloader_version_maj	Bootloader version, major
bootloader_version_min	Bootloader version, minor
bootloader_version_rev	Bootloader version, revision
proc_id_0	Unique identifier of the Luma (MSB 32bit)
proc_id_1	Unique identifier of the Luma (32bit)
proc_id_2	Unique identifier of the Luma (32bit)
proc_id_3	Unique identifier of the Luma (LSB 32bit)

parameters.json (read/write)

Parameter	Valid input	Description
start_state	0:config, 1: active	The state which the LUMA X will boot into. This is factory set to <i>config</i> , but for normal operation this should be set to <i>active</i>
optical_speed	{1, 4, 6, 8, 10}	Speed (in Mbits/s) of the optical Link. Note that higher transmit speeds mean less range.
nb_led	[1-5]	Number of active LED banks. This is the max number of LEDs if auto power is on, the modem will decide on the number of

		LEDs, but will never go higher than this parameter
encoding	0: no encoding, 1: encoding	Enabling Encoding, improves the link quality at the cost of throughput
led_tx_pwr_normal	[0-100]	Note this parameter does nothing, but is kept for compatibility's sake
led_tx_pwr_cooldown	[0-100]	Note this parameter does nothing, but is kept for compatibility's sake
auto_gain_control	0:off, 1:on	The LUMA X will adapt to the parasitic light level by changing the receiver gain.
manual_gain	[0-4000]	Manual gain value for the receiver when auto gain is off
nb_receivers	[1-4]	If auto gain is on, this will be selected automatically by the LUMA X during active operation, otherwise it is a settable parameter
agc_amplitude_adjust	[0-4000]	Advanced parameter, in case of troubles with the autogain control, allows the system to aim for lower or higher target gain value.
keep_alive_pkt	0:off, 1:on	Luma will send small packets periodically, 10 times per second in case of a successful link. Can improve the autogain
autogain_speed	0: slow 1: normal (default) 2: fast	Makes the auto gain faster or slower. A fast autogain will react quicker to ambient light, but may be unusable in some cases. A slow autogain will be more stable, but may be too slow to react to a fast changing environment

signal_filtering_type	0: low filtering 1: normal filtering (default) 2: high filtering 3: very high filtering	Filtering the data (smoothing it with a low pass filter) will remove the noise, but will also alter the light pulses thus reducing the range.
auto_power	0: off, 1: on	Activates or not the auto power
auto_speed	0: off, 1: on	Activates or not the auto speed

Ip_address.json (read/write)

Parameter	Valid input	Description
Ip_addr1	[0-255]	First byte of the ip address (0-255)
Ip_addr2	[0-255]	Second byte of the ip address (0-255)
Ip_addr3	[0-255]	Third byte of the ip address (0-255)
Ip_addr4	[0-255]	Fourth byte of the ip address (0-255)

control.json (write)

Parameter	Description
save_parameters	Saves all current parameters into ROM to be persistent between restart
save_ip_address	Saves the IP address that was entered in ip_address.json

read_parameters_from_rom	Gets all parameters from ROM and replace the recent changes
reset_parameters	Resets all parameters back to default
reboot	Restart the Luma, makes it go into bootloader

comm_eval.json (read/write)

This API page will control the sending and receiving of messages, it is used in the “comm. test” page of the web interface

Parameter	Valid input	Description
message_write	Text, max 128characters	The message to send to the other modem, which will be contained in the “message_read” parameter
message_read	read only	Last message sent by the other modem.

1.1 API usage examples using Python

Example of using the API using python `requests` library

```
import requests
requests.post('http://192.168.102.101/api/parameters.json', json =
{'optical_speed':6, 'nb_led':3, 'auto_gain_control':1})
```

The above example is putting the luma **101** to **6Mhz**, **3 banks of LEDs** and with **autogain** active.

Reading the API is similar:

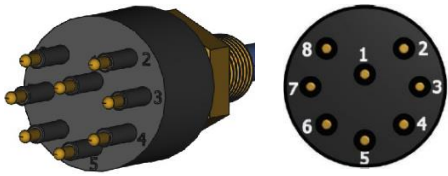
```
response = requests.get("http://192.168.102.101/api/status.json")
print(response.json())
```

and gives the following result:

```
{'amplitude': 3864, 'ambient': 3742, 'temperature': 40.3125,
'throughput_received': 0, 'crc_errors': 0, 'pkt_rcv': 0, 'pkt_loss': 0,
'gain': 990, 'nb_additional_rcv': 0, 'status_electronics': 1}
```

7 Electrical and software Characteristics

(*)

Supply voltage (Vs)	12 – 36 V	
Power consumption	2 W (active mode, receiving) 2 – 17 W (active mode, transmitting)	
Range	LUMA X: > 50m (164 ft) in clear dark water LUMA X-UV: 50m (164 ft) in clear dark water	
Data rate (optical)	1 Mbit/s – 10 Mbit/s	
Data rate (Ethernet)	10/100 Mbit/s	
Data rate (serial)	Software selectable: 9600, 19200, 38400, 57600, 115200, 204800, 227556, 256000, 512000	
Transmission power	Software selectable: 1, 2, 3, 4 or 5 banks with 3 LEDs each	
Interface	Software selectable: Ethernet RS232 RS485	
Emission wavelength	480 nm (LUMA X) 395 nm (LUMA X-UV)	
Beam pattern	120-degree cone (LUMA X) 60-degree cone (LUMA X-UV)	
Connector pinout		1: Vcc 2: GND 3: RS232 RX / RS485 D+ 4: RS232 TX / RS485 D- 5: Ethernet RX- 6: Ethernet RX+ 7: Ethernet TX- 8: Ethernet TX+

(*) subject to change without notice

8 Mechanical Characteristics

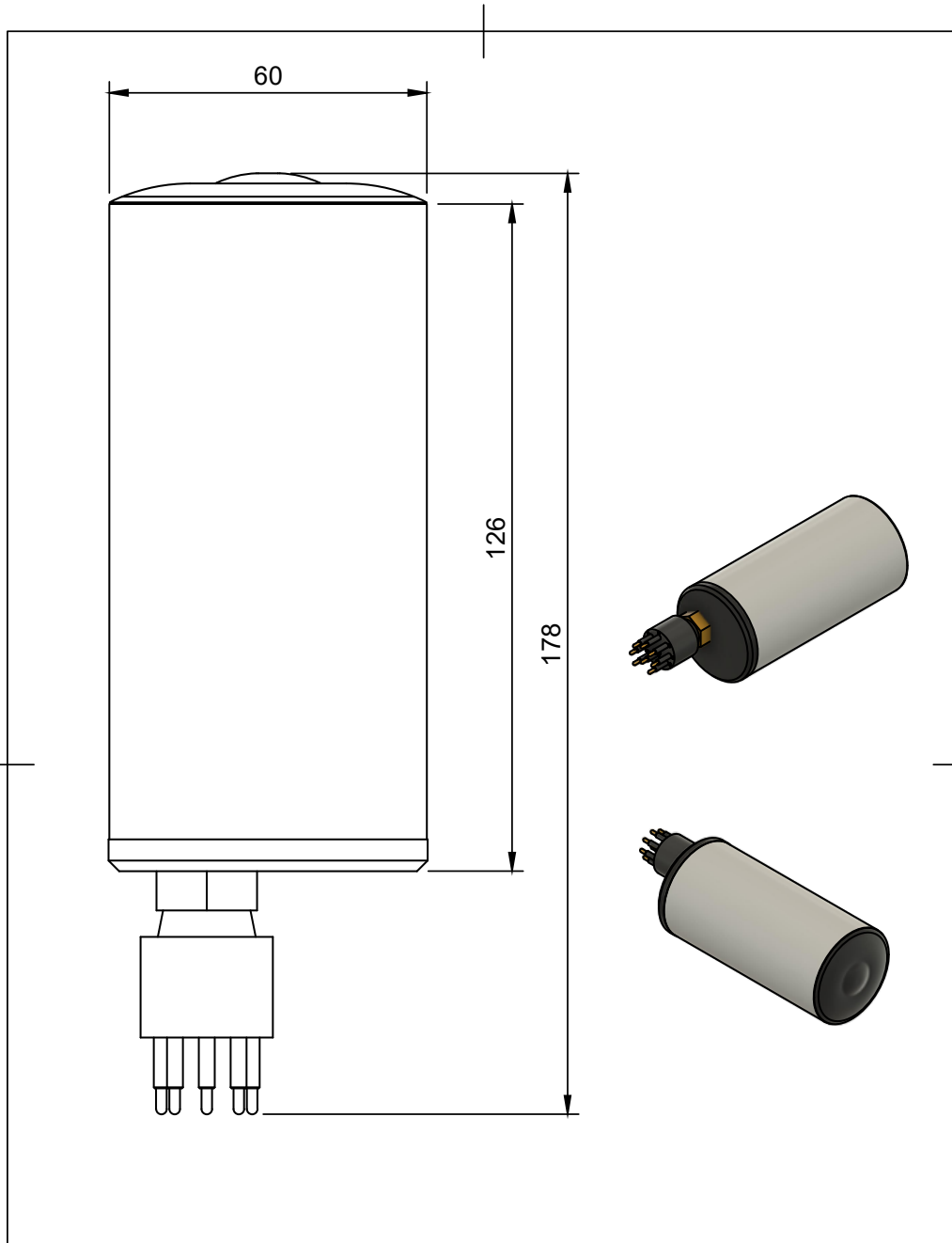
(*)

Length x Diameter (Housing)	126 x 60 mm (5" x 2.4") total length with connector: 178 mm (7")
Weight in air	475 g (1 lb 7 oz)
Weight in water	125 g (10.5 oz)
Connector	SubConn Ethernet Circular 8 – DBH8M
Depth rating	6000 m (19000 ft) 12000 m (on request)
Operating temperature	-5°C to +40°C (23°F to +104°F)
Storage temperature	-21°C to +50°C (-6°F to +122°F)

(*) subject to change without notice

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Dept.	Technical reference	Created by Hydromea (FS) 31/12/2021	Approved by		
		Document type	Document status		
		Title LUMA X v2 (12/2021)	DWG No.		
		Rev. 2	Date of issue 31. 12. 2021	Sheet 1/1	

9 LUMA X-UV eye safety certification



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R-LAB-974-1 V2



Test Report - Photobiological Safety Assessment R-LAB-974-1 V2

CUSTOMER INFORMATION	
Customer	HYDROMEAS SA Avenue de Lonquemalle 11 Switzerland - 1020 - Renems
Order followed by	M. Georges Georgatos
Customer reference	GFA on quotation from the 27/09/2022
PISEO LABORATORY INFORMATION	
Test Laboratory	PISEO SAS, Parc Lyon Sud, 4 Rue de l'Arсенal, F-69200 VENISSIEUX
TEST EQUIPMENT	
Laboratory Equipment	Everfine OST-300 bench - Asset N°065 Yokogawa WT3000 Asset N°011 AC Power Supply Chroma 6408 Asset N°119 Pt100, SF50-10-4-PB-1-6-50 - Asset N°146 Relative humidity probe EE061-F61 - Asset N°136 NI 9219 datalogger - Asset N°140
Quote Reference / Service	PIS-974 - Photobiological Risk Assessment
Report version and date	V2 on 10/13/2022 cancel and replace V1
Date of tests	October 4 th , 2022
Applicable standards	EN 62471: December 2008 Photobiological safety of lamps and systems using lamps
Ambient laboratory temperature	25.0°C +/- 1.0°C and relative humidity < 65.0 %
Stabilization time	0 minutes (cold Start)
PRODUCT INFORMATION	
Product	LUMA X-UV (malfunction mode)
Manufacturer	Hydromeas SA
Type	Wireless optical modem
Identification / Serial number	/
Light source designation	UV LED CUN96A1G/Seoulviosys
Light source technology	<input checked="" type="checkbox"/> LED <input type="checkbox"/> Fluo <input type="checkbox"/> Halogène <input checked="" type="checkbox"/> Autres: <input type="text"/>
Ballast / Driver	Integrated
Date and sampling method	Supplied by customer
Power supply	230.0 VAC 50.0 Hz
PISEO sample ID	E-LAB-974-1
REMARKS	
<ul style="list-style-type: none"> - Traceability and standard(s) photometrical and colorimetric calibration certificates references can be provided upon request. - The current test report is based on tests performed on one specimen, or sample. It does not prejudice conformity of the whole manufactured products. It is not permitted to transfer the results on other systems or configurations. - Reproduction in any form, in whole or in part, without the express written consent of PISEO is strictly prohibited. - Temperature and relative humidity records during measurement and stabilization phases are available on request. - The test results do not take uncertainties into account. They are available upon request. - The test results are rounded off. The rule is available upon request. - Measurement characteristics with "*" sign are not performed under COFRAC accreditation. - All data below are provided by the customer. PISEO disclaims any responsibility for wrong data. - The data preceded by « x » are not given by the customer, but recorded by PISEO. - V2 : modification of picture 	




RISK GROUP CLASSIFICATION
Risk Group 0 (No Risk)

TEST CONDITIONS	
Ageing	N/A (LED)
GLS / non GLS consideration	<input type="checkbox"/> GLS*** (500 lx) <input checked="" type="checkbox"/> Non-GLS (200 mm distance)
System electrical power consumption	32.4 W
≠ Power factor	≠ 0.517
Measurement distance	200 mm

***GLS : General Lighting Service (according to standard definition)

RISK GROUP LIMIT VALUES TABLE FOR LUMINAIRES IN STEADY CYCLE									
Hazard	Spectrum	Symbol	Group risk limit values						Uncertainty values (k=2) %
			GR0		GR1		GR2		
			No Risk	Result	Low Risk	Result	Moderate Risk	Result	
UV actinic UV	Suv(λ)	$E_s (W.m^{-2})$	0.001	1.7e-04	0.003	-	0.03	-	18,7
Near UVA		$E_{UVA} (W.m^{-2})$	10	5.1	33	-	100	-	18,7
Blue Light	B(λ)	$L_b (W.m^{-2}.sr^{-1})$	100	77	10000	-	4000000	-	20,8
Blue Light for small source	B(λ)	$E_b (W.m^{-2})$	0.01*	-	1.0	-	400	-	12,2
Thermal Retinal	R(λ)	$L_r (W.m^{-2}.sr^{-1})$	28000/a	3.5e04	28000/a	-	71000/a	-	16,5
Thermal Retinal, weak visual stimulus **	R(λ)	$L_{r'} (W.m^{-2}.sr^{-1})$	6000/a	3.3e01	6000/a	-	6000/a	-	17,4
Infrared for eye		$E_{IR} (W.m^{-2})$	100	1.0e-02	570	-	3200	-	15,6

* Small source defined by $\alpha < 0.011$ radian. The averaged FOV (Field Of View) at 10000s is 0.1 radian
 ** Implies non-GLS source assessment

Report page number	4 report pages
Test and Measurement Operator	Mr Thibault LOISON
Approved by	Mme Anaïs PONS
Signature	13/10/2022  _____ Signé par : Anaïs PONS
Vénissieux, October 7, 2022	

End of the accredited COFRAC report

10 Errata

Version	Release date	Errata
1.0	6.5.2021	Original version
1.1	25.5.2021	<ul style="list-style-type: none"> • swapped Vcc and GND in connector pinout in table in chapter 5 • added chapters 4.4 (since removed) and 4.5 (since removed) • updated table in chapter 4.1 (since removed) • added version number to front page
1.2	7.6.2021	<ul style="list-style-type: none"> • added Windows 10 IP address configuration • added firewall exception configuration
1.3	22.12.2021	<ul style="list-style-type: none"> • update to web interface configuration • updated dimensional drawing to reflect v2 dimensions (units sold from Dec. 2021 are 20mm longer)
1.3.1	11.1.2022	<ul style="list-style-type: none"> • updated mechanical dimension in table 8
1.3.2	16.2.2022	<ul style="list-style-type: none"> • added note about <i>LumaConf</i> not being certified • added note about firmware file selection • deleted a broken reference • minor typo edits
1.4	31.3.2022	<ul style="list-style-type: none"> • Added chapter 6
1.5	4.7.2022	<ul style="list-style-type: none"> • Added extra info for range and wavelength
1.6	7.11.2022	<ul style="list-style-type: none"> • Modified front page to reflect that the manual is for LUMA X and LUMA X-UV
1.7	16.1.2023	<ul style="list-style-type: none"> • Added differentiation between beam patterns of LUMA X and LUMA X-UV • Renamed document to reflect that it is for LUMA X as well as LUMA X-UV
1.8	28.9.2023	<ul style="list-style-type: none"> • Reflects features added/changed with firmware rev 1.4 <ul style="list-style-type: none"> ○ added auto-speed and auto power ○ added communication test interface ○ added API-accessible parameters
1.9	16.11.2023	<ul style="list-style-type: none"> • Updated improved range for LUMA X-UV
1.10	23.1.2024	<ul style="list-style-type: none"> • Added operating and storage temperature ratings
1.11	6.2.2024	<ul style="list-style-type: none"> • Added eye safety certification