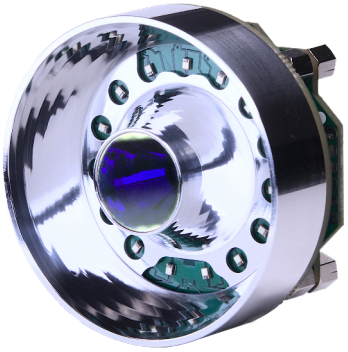
HYDROMEA

User Manual

LUMA™ 100/250/500/FLEX

Fast, Low-power, Optical Underwater Communication Systems



Ver 2.0

Contents

1 Introduction

The LUMA 100/250/500/FLEX are optical modems for fast, reliable underwater communication. Each Luma is a full transceiver and thus capable of half-duplex communication (transmission and reception). The modem features a deep-sleep mode which drastically reduces the power consumption. The deep-sleep mode is fully configurable for maximum adaptation to specific use-cases.

2 Operation

2.1 Setup

Attach both modems to their respective host systems using matching female SubConn Micro 6 connectors such as MCIL6F, MCBH6F, MCOM6F, MCPBOF6F or MCDC6F. Please make sure to match the pinout provided in *Electrical and Software Characteristics*.

- Apply a suitable supply voltage (12 V – 36 V).
- When properly aligned and within communication range, the two modems now provide a **half-duplex** serial communication link.

WARNING:

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

2.2 Operation

When in *active* mode the modem will broadcast all data received over the cable and send over the cable all data received from the optical receiver. It will therefore act as a transparent modem on a RS232 or RS485 communication line.

For information about sleep modes, refer to the Sleep Mode section.

3 Modem configuration

The LUMA modems can be configured with the *LumaConf* software, available here:

https://files.hydromea.com/luma/lumaconf/LumaConf_latest.zip

LumaConf runs on Windows 7, Windows 8, Windows 10 and Windows 11, 64 bit versions. Installation is not required; simply extract the executable file from the ZIP archive to a location of your preference (e.g. the Desktop) and run it. Windows may generate a warning about running software downloaded from the internet, which can be ignored.

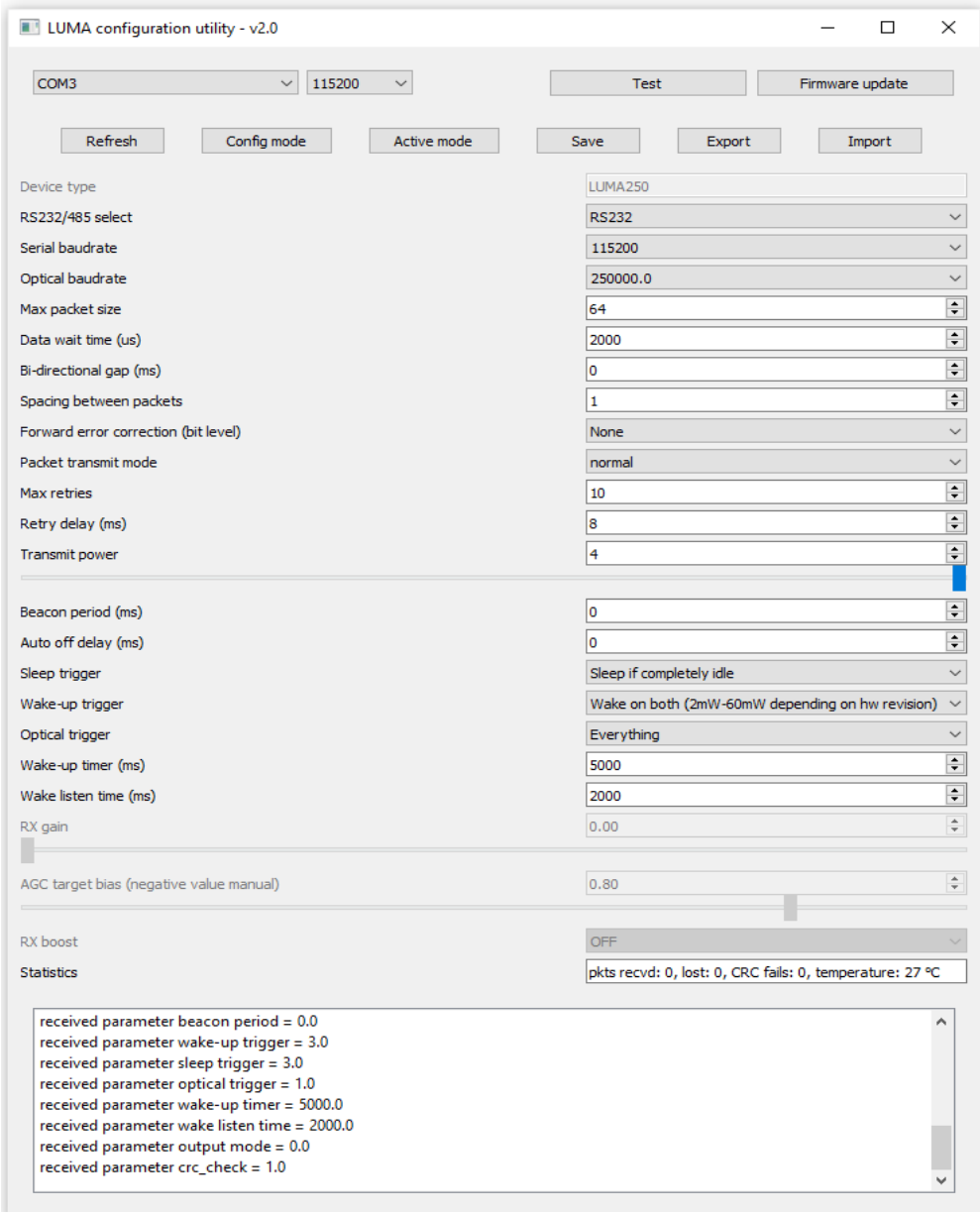


Figure 1: LumaConf modem configuration software

3.1 Connecting the modem

- Plug the LUMA modem with a serial adapter cable into a serial port, or via a USB-to-serial converter, such as the official Hydromea adapter cable. Connect a power supply to the cable (12 V – 36 V).
- In the top left corner, set the correct COM port and baud-rate. The default setting is 115200 bps, but it may be different if the modems have been configured to another baud-rate. To reset the parameters of the modem if you don't know what the configured baud-rate is, please refer to section 6.3.
- Click on "Config mode", and the parameters should become active (instead of greyed out) if all settings and connections are correct.
- The modem is now in configuration mode, which allows you to change the modem settings. Changed settings will be applied instantly (except for the RS232/485 switch) but will revert to the previous settings after a power cycle. To save the new settings to the modem's internal flash memory, click "Save". To leave configuration mode and return to regular operation, click "Active mode".

3.2 Configuration software backward compatibility

- Big firmware upgrades can break the compatibility with the LumaConf software. This has happened in between version 1.x and 2.0. Therefore, LumaConf version 2.0 will only work with firmware 2.0.
- If you want to keep using the old version of the firmware, please ensure to continue using a previous compatible version of LumaConf.
- This table contains the list of LumaConf versions that you can Download from our website:

Earlier than V2	LUMA 100/250: https://files.hydromea.com/luma/lumaconf/LumaConf_250_v1.6.zip LUMA 500: https://files.hydromea.com/luma/lumaconf/LumaConf_500_v1.3.zip
V2.0	https://files.hydromea.com/luma/lumaconf/LumaConf_v2.0.zip

Using the latest version of LumaConf will always allow you to downgrade the firmware to an old version, but you will need to use the appropriate version of LumaConf to configure an old firmware.

4 Communication settings

4.1 RS232 / RS485

The modem supports both communication using RS232 standard and RS485 standard. The default configuration is RS232. To set RS485, set the parameter *"RS232/485 select"*, then click "*Save*" to store parameters in the flash memory. This is the only parameter that is not applied instantly. At the next boot of the modem, the communication will be on RS485, therefore ensure that you are using an appropriate serial adapter.

If you wish to go back to RS232 communication, either use an RS485 serial adapter to follow the same procedure as above, or reset the modem parameters as explained in the section Parameters reset to factory defaults.

4.2 Serial baud-rate

This is the baud-rate setting for the communication to the modem over the attached cable. The baud-rate has to match the selected baud-rate of the host computer or connected device. Available baud-rates are:

9600, 19200, 38400, 57600, 115200, 204800, 227556, 256000, 512000 bits per second (default *115200* bps)

When changing the baud-rate of the modem, the baud-rate of the host PC also has to be changed to the same value. LumaConf will try to autoselect the new baud-rate.

Note that the changed baud-rate is not permanent until a "Save" command is sent, which is only possible if the new baud-rate settings work on the modem and the host PC.

4.3 Optical baud-rate

The optical baud-rate adjusts the speed at which the modems communicate between each other on the optical medium. Please ensure that this value is equal or higher than the serial baud-rate, otherwise the modem will struggle to keep up with the communication speed.

If you configure the modems to use one of our additional settings that add redundancy (e.g. ACK mode, forward error correction), please ensure that the optical baud-rate provides bandwidth for this, or do not use the full bandwidth of the serial communication.

4.4 Maximum packet size

The modem collects serial input data from the RS232/485 connection to combine it into a packet. This parameter specifies the maximum packet size. Packets can be smaller if there is no more input data after a specified time period. Large values reduce overhead, small values improve latency. The default value is 64, which is a good compromise.

4.5 Data wait time

This parameter specifies the maximum time in microseconds that the modem will wait for additional data before sending a packet before the maximum packet size is reached. Larger values reduce packet overhead but increase the maximum latency. Smaller values improve latency, but increase the packet overhead, which results in lower average throughput. The default value is 2000 microseconds.

4.6 Bi-directional gap

To ensure equal sharing of the optical medium between the 2 communicating modems, this parameter configures a wait time in milliseconds introduced between packets.

4.7 Spacing between bytes

In certain applications, where communication speed is not critical but power consumption is, you can configure a small delay between bytes that are sent on the optical medium. The default and minimum is 1, and it's possible to go up to 255.

4.8 Forward error correction

Forward error correction makes the communication link more robust and reliable, at the cost of maximum bandwidth. The following settings are available:

- None: No forward error correction is applied. This enables the highest throughput.
- 2x bit correction: A codec that uses 2x redundancy to detect and fix bit errors.
- Burst (+30) correction: A codec that can detect and fix burst errors. It adds 30 bytes to the packet size. Burst correction is supported for serial baud-rates of 9600 bps and 19200 bps. Higher baud-rates can be used only if the average speed of data transmission is below 19200 bps.

4.9 Transmit Power

250 500 Flex

This parameter specifies the number of emitting LEDs used during transmission, each power level corresponds to a bank of 3 LEDs.

Please note that this configuration does not apply to Luma 100, for which the transmit power parameter is fixed to 1.

4.10 Packet transmit mode

The packet transmit mode specifies the packet-level redundancy used to increase robustness of the link.

- **Normal:** No packet-level redundancy is used (default).
- **4.1 redundant:** adds a 5th packet for every 4 packets for redundancy and error correction.
- **Dynamic retransmission:** The modem continues to send packets to use the full available optical bandwidth for the period of time specified in *4.5 Data wait time*.
- **ACK mode:** The modem continues to send packets until they are acknowledged by the receiver modem.

4.11 ACK mode configuration

When **ACK mode** is enabled as *"Packet transmit mode"*, the modem expects an acknowledgment from the receiver after sending a packet. If no acknowledgment is received, the modem will **automatically retransmit** the packet based on the following two parameters:

- **Max retries:** this parameter determines how many times the modem will attempt to retransmit a packet if no acknowledgment is received. A higher number of retries increases the likelihood of successful delivery in environments with interference, signal fading, or packet loss. However, it also increases the latency and power consumption if many retries are needed.

- **Retry delay:** the time in milliseconds between retransmissions of a packet. A short retry delay reduces overall transmission time for lost packets, but can lead to collisions if both devices retransmit at once. A longer retry delay may help reduce collisions but increases total latency.

500 Flex 4.12 RX Gain

Note: the RX Gain configuration only applies to Luma 500 and Luma Flex. It does not apply to Luma 100 and Luma 250.

This setting will adjust the gain of the receiver. The range is from 0 to 0.5 for Luma 500 and

from 0 to 1 for Luma Flex.

A lower gain is used for high ambient lighting environments and short distance, while it is raised when the distance is higher or the ambient is dark.

Please note that you will be able to set the parameter only if the Auto Gain Control (AGC) setting is disabled, please refer to the paragraph below.

500 Flex 4.13 AGC target bias

Note: the AGC target bias configuration only applies to Luma 500 and Luma Flex. It does not apply to Luma 100 and Luma 250.

The modem has an **Auto Gain Control (AGC)** feature, that automatically adjusts the receiver gain depending on the ambient light.

If this parameter is set to a negative value, the AGC is disabled and you can set manually the RX gain using the appropriate parameter. If you set a positive value, the modem will adjust the gain to obtain the set ambient bias target.

Flex 4.14 RX Boost

Note: the RX boost configuration only applies to Luma Flex. It does not apply to Luma 100, Luma 250 and Luma 500.

Luma Flex features a boost configuration of the receiver, useful when the device is used at long distance or in very dirty water. Enable this parameter to set the boost on the receiver.

Please do not use the boost feature when the lighting is not dark, as it will make the receiver overheat.

5 Sleep Mode

The sleep mode helps reduce the power drawn by the device in power constrained applications. In this mode the device enters a "deep sleep" configuration in which the operations are reduced and the power drawn is very low. We provide different configurations of the sleep mode, depending on the way the modem has to wake up:

- **Wake on cable:** the modem is woken up by any data that is sent on the cable serial interface.
- **Wake on optical:** the modem is woken up by any other modem communicating to it on the optical medium.

- **Wake on timer:** the modem automatically wakes up periodically at configurable defined times, checks if any data is coming, and if idle goes back to sleep.

5.1 Sleep Mode configuration

5.1.1 Going to sleep

- **Auto-off delay:** if the modem is idle for the time specified by this parameter, it enters sleep mode. If set to 0, the sleep mode is disabled.

- **Sleep trigger:** this defines that is the condition to be met to enter the sleep mode after the "auto-off delay". The options are:

  - *"Sleep if idle on optical"*: the modem will go to sleep only if it does not receive data or beacon messages on the optical medium, please check the "Optical trigger" parameter below.

  - *"Sleep if idle on cable"*: the modem will go to sleep if no data is received on the serial cable communication.

  - *"Sleep if completely idle"*: the modem will go to sleep if both previous conditions are met.

- **Optical trigger:** This parameter defines what it means to be *"idle on optical"*. Options are:

  - *"Only beacon messages"*: normal optical communication will not prevent the modem from going to sleep, only beacon messages will.

  - *"Everything"*: every packet that is received by the modem will prevent it from going to sleep.

- **Beacon period:** It is the time in milliseconds between beacon messages, that has to be set on the sending modem to both keep the receiver awake and to wake it up when it's in sleep mode. When set to 0 it will disable the beacon message sending.

5.1.2 Waking up from sleep

The parameter that defines how the modem will be woken-up is "wake-up trigger". This setting will impact how much power will be drawn during the sleep. The options are:

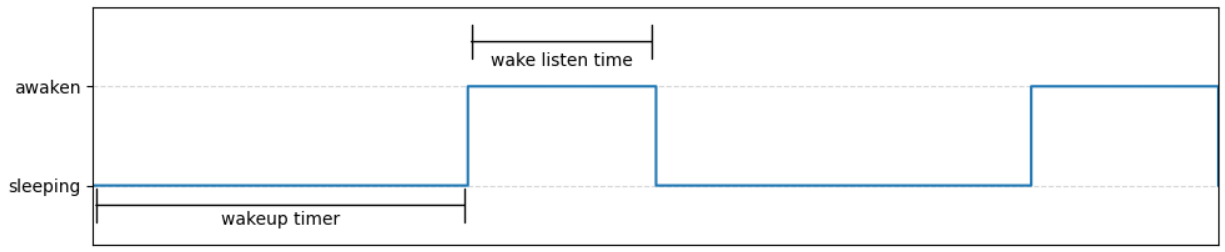
- *"Wake on optical":* the modem will wake up when it receives messages from the optical medium. Please note that this mode is only available for Luma100 and Luma250 modems. The power draw is around 5mW.
- *"Wake on wire":* the modem will wake up when it receives messages from the serial cable. The power draw is between 2mW and 60mW depending on the hardware revision.
- *"Wake on both":* a combination of the previous modes.
- *"Wake on timer":* the modem will wake up at software defined intervals to check if there is any communication going on. Please refer to the next paragraph for its configuration. The power draw is around 2mW.

5.1.3 Wake on timer

The wake on timer functionality is only present on newer revisions of the hardware. LumaConf will not allow setting it on older boards.

The parameters needed to set it up are the following:

- **Wake-up timer:** the time the modem will stay in sleep mode.
- **Wake listen time:** the time the modem will stay awake to check if any communication is going on.



Figure

Figure 2: Sleep on timer graph

Known issue: when the wake on timer mode is set, during the first cycle, the time for which the modem is in sleep mode will be around 10 times longer. Next cycles are as configured.

5.2 Sleep Mode configuration example:

Using *LumaConf*, configure two modems as follows:

- on the modem A that should enter sleep (e.g. a modem installed on a sensor), change auto off delay to 30 seconds, sleep trigger to *"Sleep if completely idle"*, optical trigger to *"everything"* and wakeup trigger to *"Wake on optical"*.
- on the modem B that wakes up the other modem (e.g. on an ROV), change *"beacon period"* to 2 seconds.

After changing settings, click *"Refresh"* to verify that the modem received the correct value. Click *"Save"* to store the new value permanently in the modem's internal flash. Then click *"Active mode"* to leave config mode and put the modem into normal operation. Do these operations for both modems. Modem B will start blinking a beacon message every 2 seconds.

If modem A doesn't receive any beacon messages for 30 seconds, it will go to sleep. When it receives the beacon messages from modem B, it will wake up. As long as it keeps receiving beacon messages, it will stay awake.

Note that if using the wake on optical option, strobing lights, or other sources of pulsed light interference, may also temporarily wake the modem up. In rare circumstances, this could be an issue, e.g. if the modem is located under a flickering light for extended periods, as it will be woken up continuously as soon as it goes to sleep.

6 Firmware updater tool

The firmware updater tool is used to perform firmware updates, and to reset the parameters to factory defaults. For both those operations, it is needed to be in bootloader mode.

6.1 Entering bootloader mode

The bootloader mode always communicates using RS232 serial at 115200 bps, so ensure that you use an appropriate serial adapter and the correct baud-rate setting in LumaConf. This allows for modem recovery if the stored settings are lost (e.g. serial baudrate).

- Select the correct COM serial port and set 115200 as baud-rate (at the very top of *LumaConf*, the speed for your COM port, not the settings of the modem).

- Open the firmware updater tool (button on the top-right section of LumaConf).
- Turn off the power supply to the modem (or unplug the SubConn connector, but leave the serial dongle in the USB port).
- Turn back on the modem (or plug it back in).
- A device entry should appear.

Please note that if you have your firmware updater tool open, this will prevent the modem from booting normally as it will stop in bootloader mode. Therefore, if you wish to just reboot the modem, ensure that the tool is closed.

6.2 Firmware update

Note: Firmware updates **MUST** be applied to **both** modems, as updates may introduce protocol changes that render communication between mismatched firmware versions incompatible.

Once you are in bootloader mode, you can perform the firmware upgrade:

- Click on the *"Check available firmware"* button, this will retrieve the list of available firmware from our firmware server. Then select the version that you want to flash. Otherwise you can use a local file (e.g. a special firmware provided by us) by clicking on the select button.
- Click on *"Write flash"*. This will start the flashing procedure. Wait until the progress bar reaches 100%.
- Click *"Start application"*. You should now be able to connect to the modem and configure it, if you flash a version that is compatible with your LumaConf version. If not, please download the appropriate LumaConf version or flash the latest firmware.
- Verify that the modem settings are still correct - they carry across firmware updates in general, but bigger updates or downgrades (e.g. v1.x to v2.x) invalidate the settings and revert to factory defaults.

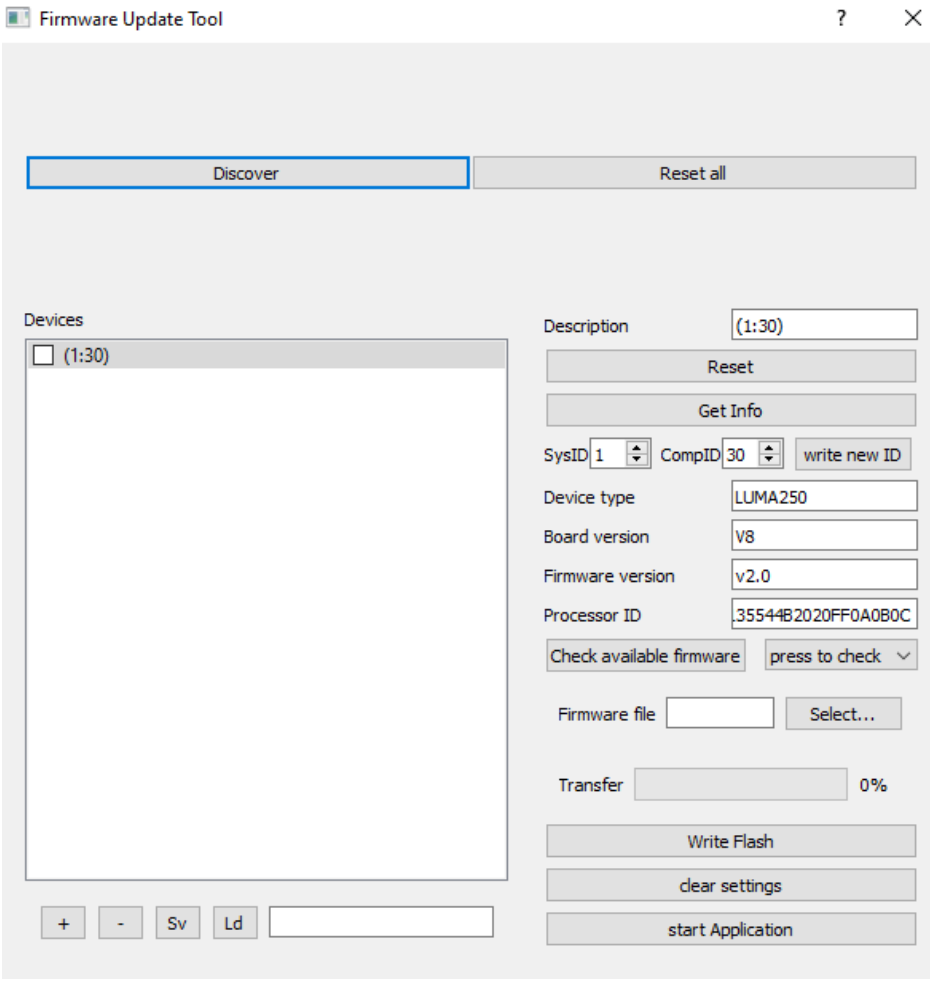


Figure 3: Firmware updater tool

6.3 Parameters reset to factory defaults

Once you are in bootloader mode, use the *"clear settings"* button in the firmware updater tool to reset the parameters, and then you can click on *"start application"* to return to normal operation.

7 Communication test

Another tool that is included in the LumaConf software is the communication test.

After having ensured the connection with a modem, you can open the Luma communication test window by clicking on the *"Test"* button on the top right of LumaConf.

By opening it, the modem will automatically switch to active mode, and you will see on the screen all the data that the modem is receiving. On the bottom of the window, you have a textbox to manually enter text to be sent through the modem. You also have 2 modes to automatically send data, one with low and the other one with high throughput.

Figure 4: Luma communication test

8 Installation

100 250 500

The Luma 100 / 250 / 500 modems offer four M5-threaded holes to attach it to a surface. Please ensure that there are washers between the modem and the attachment surface. **Please avoid over-tightening the attachment screws by limiting the torque as specified in section Mechanical Characteristics.**

9 Maintenance

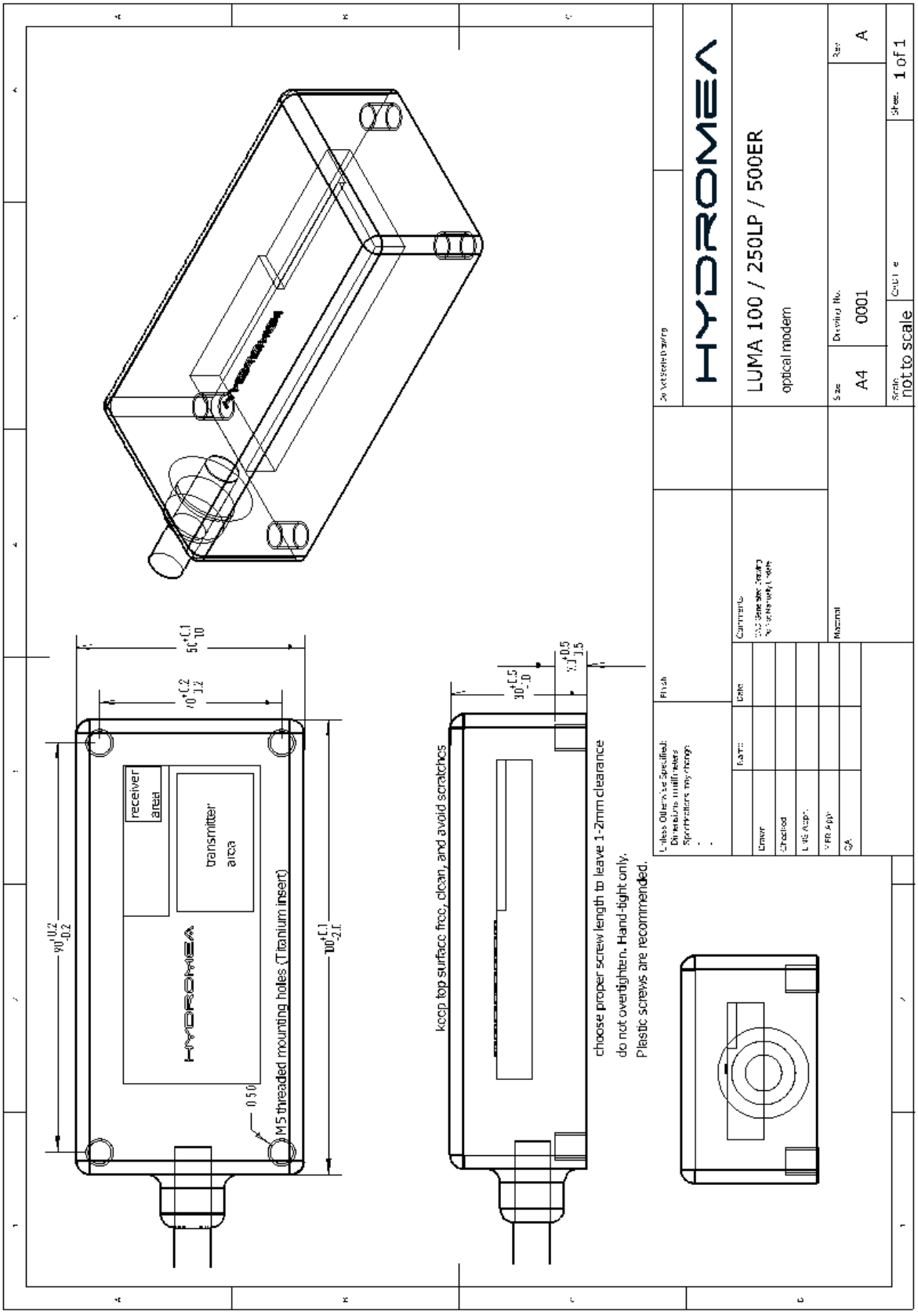
Please wash the modem with warm water (only) to remove any built-up which could negatively affect its operation. Apply a thin film of silicone grease to the rubber part of the connector pins to protect the connector and to facilitate mating. For maintenance details regarding the connector follow SeaConn's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

10 Electrical and Software Characteristics

Supply voltage (Vs)	12 V – 36 V	
Data rate (wire)	Software selectable: 9600, 19200, 38400, 57600, 115200, 204800, 227556, 256000, 512000	
Transmission power	Luma 100: 1 bank with 3 LEDs Luma 250/500: 4 banks with 3 LEDs Luma Flex: 1 bank with 3 LEDs, 1 bank with 12 LEDs	
Interface	Software selectable: RS232 / RS485	
Emission wavelength	475 nm	
Beam pattern	Luma 100/250/500: 120 degree cone Luma Flex: 20 degree cone	
Connector pinout	Only applies to Luma 100/250/500: 	1: Supply voltage (Vs) 2: GND 3: RS232 RX/RS485 D+ 4: RS232 TX/RS485 D- 5: n/c 6: n/c
Error correction	Software selectable: Forward error correction, overhead 2:1 Burst error correction ACK Mode	
Sleep modes	Software selectable wake up trigger: on optical, on cable, on both, on timer.	
Beacon signal interval	Software selectable: 0 (= off), 1 – 120 seconds	

11 Mechanical Characteristics

Length x Width x Height	100 x 50 x 30 mm (3.9" x 2" x 1.2") – Luma Flex: OEM
Weight in air	Luma 100/250/500: 250 g (8.8 oz) – Luma Flex: 49 g (1.73 oz)
Weight in water	Luma 100/250/500: 50 g (1.76 oz) – Luma Flex: OEM
Connector	Luma 100/250/500: SubConn MCIL6M – Luma Flex: On demand
Depth rating	Luma 100/250/500: 6000 m (19000 ft) – Luma Flex: OEM
Operating temperature	All devices: -5°C to +40°C (23°F to +104°F)
Storage temperature	All devices: -21°C to +50°C (-6°F to +122°F)
Max torque applied to M5 attachment threads	Luma 100/250/500: 0.8 N·m


HYDROMEA
LUMA 100 / 250LP / 500ER
optical modem
A4
0001
A
not to scale
1 of 1
receiver area
transmitter area
M5 threaded mounting holes (Titanium insert)
keep top surface free, clean, and avoid scratches
choose proper screw length to leave 1-2mm clearance
do not overtighten. Hand-tight only.
Plastic screws are recommended.

12 Firmware Changelog

Version	Release date	Changelog
2.0	7.2025	• RS232/RS485 selection as a parameter – no need to flash a different firmware image anymore. • ACK mode – a new mode for reliable communication, where packets are retransmitted until acknowledged by the receiver. • Sleep modes: ◦ Improved configuration parameters: easier setup and more flexible options. ◦ Significantly reduced power consumption in sleep modes (up to 95% less power when cable wakeup is used) (*). ◦ New timer-based sleep mode: the device sleeps and wakes up according to software-defined timings (*). ◦ SWiG L1 standard compliance – when none of our extended features (e.g., ACK mode or error correction) are used. • Improved usability in LumaConf configuration software. (*) Only available on the new hardware revision of the modem.

13 Errata

Version	Release date	Errata
1.0	01.04.2021	Original version
1.1	22.12.2021	• Updated logo • Added Errata • Updated links to LumaConf
1.2	07.04.2022	• Updated link to LumaConf
1.3	27.04.2023	• Updated drawing in 11, it now contains tolerances
1.4	23.01.2024	• Added operating and storage temperature ratings
1.5	27.08.2024	• Added maximum torque that can be applied to M5 threads • Updated photo on front page
2.0	18.07.2025	• Updated to firmware version v2.0
2.1	31.07.2025	• Minor graphical corrections • Fixed LumaConf links and datasheet