Xeos Technologies Inc.

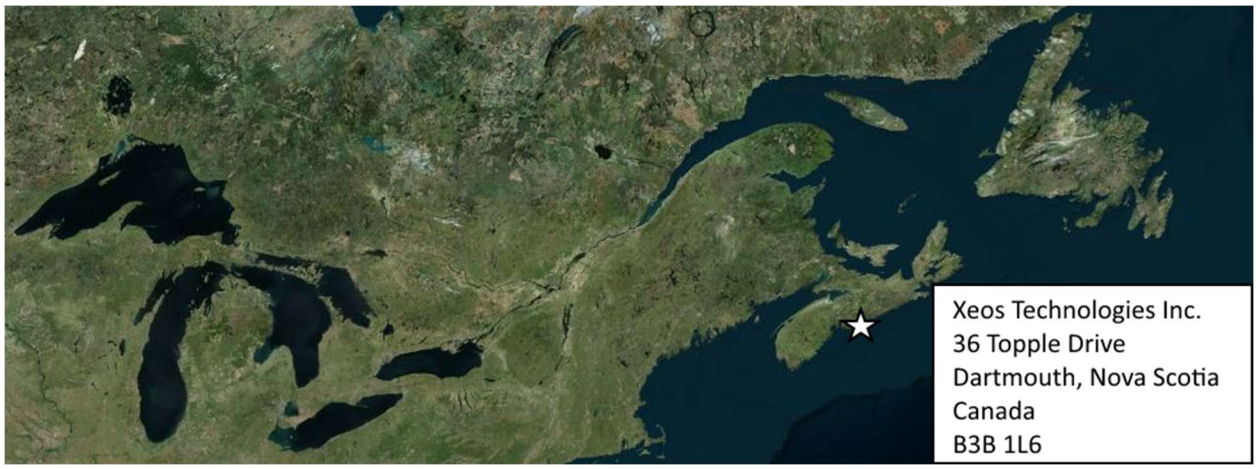
Ares User Manual

OPTICAL CHLOROPHYLL-A SENSOR

Version 1.1

September 2023

Shipped From



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Version History

Version No.	Date	Description
1.0	Jan 2023	Initial release.
1.1	Sept 2023	Added range field into frame.

Regular checks for the latest manual are suggested. Be sure to check Xeos Technologies' manuals page to compare versions and download the latest version.

Overview

The Ares Chlorophyll-a Sensor features state-of-the art technology for measuring aquatic chlorophyll-a concentrations for environmental water quality monitoring, oceanographic research, marine operations and aquaculture monitoring. The Ares is based on the optical measurement principle, using ultrabright, energy-efficient blue LEDs as an excitation source and detectors with filtering to measure the red light produced via fluorescence by chlorophyll-a contained in algal cells. These digital optical sensors are programmed with a calibrated response to a fluorescence standard.

The excitation light from the LEDs is carried to the sample volume through optical fiber and the response fluorescence is returned through an accompanying optical fiber. The fiber optics serve two key functions: to increase the efficiency of the light delivery and recovery thus reducing power requirements, and to enable a smaller optical head.

Specifications

Mechanical	
Length (excluding connector)	10.9 cm / 4.28 inch
Diameter	3.2 cm / 1.25 inch
Weight in air	138 g
Weight in water	37 g
Depth rating	500 m
Material	Acetal plastic with copper-nickel faceplate

Electrical	
Input voltage	6-18 VDC
Current draw @ 12 V (analog-only sensor)	18 mA
Current draw @ 12 V (digital+analog sensor)	20 mA
Analog voltage out (nominal)	0-5 V
Baud rate	9600-115200 (38400 default)
Serial configuration	8 bits, no parity, 1 stop bit, no flow control

Optical	
Peak excitation wavelength and bandwidth	460 nm / 18 nm
Detection wavelength range	665-1000 nm

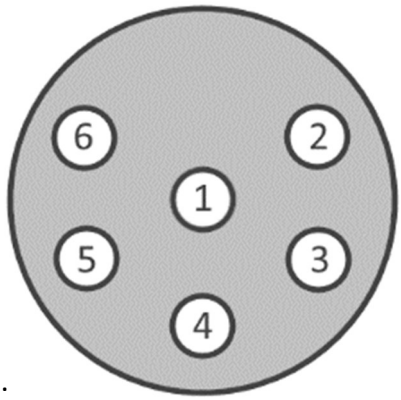
General	
Range	25 or 250 µg/L Fixed for analog sensors Configurable for digital+analog sensors
Temperature range (operating)	0 to +40 °C

The Ares uses ChibiOS Real Time Operating System (RTOS). For more information, visit www.chibios.org

Bulkhead Connector Pinout

Sensor bulkhead connector is a MCBH6M (face view below); mating connector is an MCIL6F.

Pin	Function
1	Voltage In (DC)
2	Ground
3	RS-232 TX*
4	RS-232 RX*
5	Analog Out
6	Ground



* In an analog-only sensor, the digital interface is **disabled**.

Safety

If the sensor is suspected of being flooded, *slowly* loosen the bulkhead just enough to release the pressure.

Backing the bulkhead out of the body creates extra volume inside the housing, reducing the pressure.

Cleaning and Maintenance

Cleaning the sensing area should be done carefully and without abrasive cleaners that could scratch the epoxy windows. For example, mild detergent and a soft toothbrush are suitable.

Before each mating of the bulkhead connector, it should be greased with **MolyKote 44 Medium**.

Calibration

The Ares Chlorophyll-a Sensor is currently only calibrated at the factory. User recalibration is not recommended at this time.

It should be noted that the measurements made by all fluorescence-based sensors, including Ares, are a proxy for chl-a concentration. Agal cell packaging in particular, can significantly impact the measurements by blocking either excitation light or the fluorescent response. For some applications, it may be necessary to chemically process a water sample to determine the relationship between the sensor reading and the true chl-a concentration for a particular agal mix.

Digital Configuration Commands

This section applies only to digital sensors. The prompt is available after sending the Ares a carriage return (Enter key).

Command	Description	Argument Values
$help	Returns current settings and commands	
$set range *arg*	Sets the chl-a concentration saturation value in µg/L	25, 250
$set autogain *arg*	Turns autogain on/off	on, off
$set averaging *arg*	Turns averaging on/off	on, off
$set interval *arg*	Set the frame interval in milliseconds	1000-3600000
$set lowgain cal *arg1 arg2*	Set calibration coefficients for 0-250 range	a1 a0 (see notes)
$set highgain cal *arg1 arg2*	Set calibration coefficients for 0-25 range	a1 a0 (see notes)
$set baud *arg*	Sets the sensor baud rate	9600, 19200, 38400, 57600, 115200
$set logging *arg*	Turns logging on/off	on, off
$set frame *??????*	Set frame format. Fields are 'serial number', 'seconds', 'counts', 'ug/L', 'LED', 'Ascii/Binary'	y/n y/n y/n y/n y/n a/b
$download	Downloads data from memory	
$erase	Erases all memory	
$exit	Leave menu and continue measurements	

Range

The range of the sensor is configurable to either 25 or 250 µg/L. Autogain must be disabled to guarantee all data is collected in a given range.

Autogain

Autogain works in one of two ways, depending on the sample interval.

If the sample interval is 20 seconds or longer, then for each sample the Ares first tries a measurement at high gain. If the sample is well below saturation, then the Ares transmits a frame. If it is near saturation, the Ares immediately switches to low gain, repeats the sample, and then sends out the frame.

If the sample interval is less than 20 seconds, then a near-saturation reading causes the Ares to switch to the lower gain for the next sample. If Ares is in low gain, then three consecutive samples below a threshold will cause it to switch to high gain for the next sample.

The threshold µg/L values for gain switching include some hysteresis to limit repeated gain switching for chl-a concentrations close to the thresholds.

Averaging

If averaging is enabled, and the sample interval is 10 seconds or longer, ten individual measurements are collected. Those are then averaged and a single frame is transmitted.

If the sample interval is less than 10 seconds, Ares does not have time to perform averaging and overrides the averaging setting.

Interval

Set the output frame interval from 1000 ms (rate = 1 Hz) to 3600000 ms (rate = 1 per hour).

Calibration Coefficients

These should only be changed by advanced users. Contact Xeos for more information.

Baud

Sets the baud rate of the output frames. The change in baud rate is immediate, so the user-end will no longer be able to communicate with the sensor unless it also changes its baud rate.

Logging

Records data to internal Flash memory. The logging on the Ares is very basic and intended for continuously powered deployments. The sensor waits 30 seconds after power up before logging data, allowing time for the user to enter the menu system. After 30 seconds, the sensor begins recording data from the starting address of memory. If data is already there it will be overwritten. Because of this, the first powerup after a deployment should immediately involve downloading data and/or turning off logging.

If the memory becomes filled, the data begins overwriting earlier data at the starting address again. Thus, it is important to plan for the deployment duration and data collection interval. The memory can store 645,000 frames of data. That is sufficient for 1 frame/second for more than 1 week, or 1 frame/minute for more than 1 year. Note that while day and seconds-in-day (relative to time of power up) are recorded, they are nominal, and subject to drift. If precision timing is required, an external logging system with a real-time-clock is recommended.

Frame Configuration

The fields of a frame can be enabled or disabled, but the order of the fields is fixed. The fields are:

Serial number	Seconds since power up	Counts	Calibrated chl-a concentration in µg/L	Range	Relative LED output	Checksum

The number of **seconds since power up** is nominal - the Ares does not perform rigorous timekeeping. If timing is critical for an application, then the frame should be timestamped externally. The seconds value rolls over at 86400 (i.e. the number of seconds in 24 hours).

Counts will generally be positive values, but for low chl-a concentrations they may be negative. On the other hand, **calibrated chl-a concentration** is clamped to a minimum value of 0 µg/L.

Range is a single ASCII character, either 'H' or 'L' indicating a High (250 µg/L) or Low (25 µg/L) measurement range.

Relative LED output is a measure of the LED intensity, relative to the output at 20°C when the sensor was calibrated. LED output is inversely proportional to temperature. Though the temperature sensitivity of the Ares is small, advanced users may wish to apply an additional correction using this field. Contact Xeos for more information.

The **checksum** is a two-letter code. The algorithm starts by summing all of the byes in the frame before the checksum into a 32-bit value. It then takes the least significant byte of that sum and converts each nibble into a printable ascii character by adding 65.

Note: At the time of writing, binary frames have not yet been implemented.

Download

Reads the Flash memory and sends frames out of the serial port at the current baud rate. The download can be stopped by pressing the ESC-key while the serial connection is active. The output frames are formatted as:

Days since power up	Seconds since power up	Range	Counts	Relative LED output	Checksum

The number of **days since power up** and **seconds since power up** is nominal - the Ares does not perform rigorous timekeeping. If timing is critical for an application, then the frame should be timestamped externally. The seconds value rolls over at 86400 (i.e. the number of seconds in 24 hours). At rollover, the days counter increments. The days since power up starts at zero.

Range is a single ASCII character, either 'H' or 'L' indicating a High (250 µg/L) or Low (25 µg/L) measurement range.

Counts will generally be positive values, but for low chl-a concentrations they may be negative. Raw counts are provided, rather than calibrated chl-a concentration units, by design. Using the calibration coefficients stored on the sensor, the calibrated values can easily be calculated after download. However, some users way wish to apply different coefficients (ex. a post-deployment calibration after a long deployment).

Relative LED output is a measure of the LED intensity, relative to the output at 20°C when the sensor was calibrated. LED output is inversely proportional to temperature.

The **checksum** is a two-letter code. The algorithm starts by summing all of the byes in the frame before the checksum into a 32-bit value. It then takes the least significant byte of that sum and converts each nibble into a printable ascii character by adding 65.

Erase

Clears the entire memory.

Exit

Data collection resumes with the exit command. If, while in the menu, no input is received for one minute, then data collection automatically resumes.

Mounting and Field-use Considerations

The Ares is designed to be easy to use. Simply power it up and collect the output digital or analog signal. However, some considerations will ensure that the data is of the highest quality. These include sample volume, ambient light, bubbles, sediment, and biofouling.

The primary sample volume, defined as the volume of overlapping fields-of-view of the source and detection fibers, is small and close to the end of the sensor. However, scattering increases this volume. For the most accurate measurements, an unobstructed volume of about 10 cm around the end of the sensor is recommended. The impact of objects in that volume will increase as they get closer to the Ares' optical input and output.

The Ares uses modulated light to make its measurement. This technique is the same as that used by infrared remote controls for household electronics. The technique allows the signal of interest to be separated from the unmodulated ambient light. However, very strong light levels will reduce the margin available from the photodetector to make its measurements. Thus, mounting the Ares pointing upward near the water surface would not be recommended. Mounting the sensor either horizontally and facing downward is sufficient to reduce ambient light levels.

If the Ares is mounted in a place with many bubbles, they may become trapped in the copper-nickel endplate if the Ares is mounted facing downward. In those environments, mounting horizontally would be preferrable. However, generally below a few meters in depth, bubbles should not be an issue. Similarly, mounting the Ares facing upward in a high sediment environment could allow sediment to collect on the sensing face. In that case mounting horizontal or downward is preferred.

Biofouling is a problem common to most aquatic sensors. The Ares uses a copper-nickel endplate to deter biofouling. The time between required cleaning of the sensor will vary greatly from site to site and between applications.

Engineering Drawing

Warranty, Support and Limited Liability

Xeos Technologies Inc. warranties the Ares Chlorophyll-a Sensor to be free of defects in material or manufacturing for a period of one year following delivery. Liability is limited to repair or replacement of the defective part and will be done free of charge.

LIMITED WARRANTY: Xeos Technologies Inc. warrants that the product will perform substantially in accordance with the accompanying written materials for a period of one year from the date of receipt.

CUSTOMER REMEDIES: Xeos Technologies Inc. entire liability and your exclusive remedy shall be at Xeos Technologies Inc. option, either (a) return of the price paid or (b) repair or replacement of the product that does not meet Xeos Technologies Inc. Limited Warranty and that is returned to Xeos Technologies Inc. with a copy of your receipt. This Limited Warranty is void if failure of the product has resulted from accident, abuse, or misapplication. Any replacement product will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer.

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