



**Xeos**  
*Technologies Inc.*

# Ares Duo User Manual

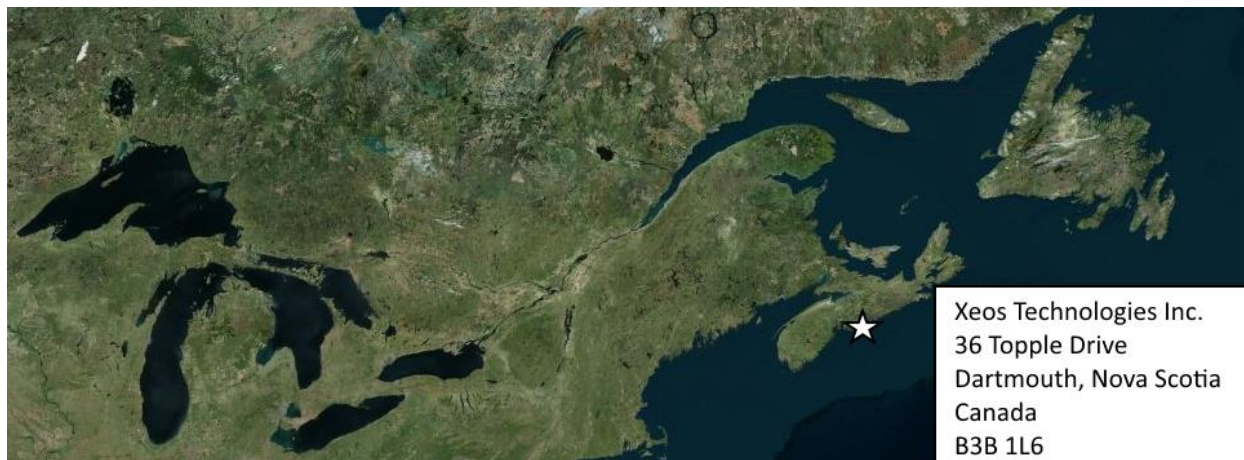
OPTICAL TURBIDITY + CHLOROPHYLL SENSOR



Version 1.2

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## Shipped From



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## Version History

Version No.	Date	Description
1.0	June 2023	Manual launch
1.1	Apr 2024	Moved Drawings to drawings.xeostech.com
1.2	May 2024	Remove autogain, change max frame rate

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 Duo Turbidity + Chlorophyll Sensor features state-of-the art technology for measuring both water clarity and chlorophyll-a concentration for environmental water quality monitoring, oceanographic research, marine operations and aquaculture monitoring. The Ares Duo is based on optical measurement principles, using ultrabright, energy-efficient LEDs as a light sources and detectors with filtering. These optics measure the light scattered by suspended particulate material in a water volume (turbidity) and fluorescent emission (chlorophyll-a). These digital optical sensors are programmed with a calibrated response to the scattered light providing quantitative measurements of turbidity measured in **Nephelometric Turbidity Units or NTUs** and chlorophyll-a concentration in **micrograms per liter of water ( $\mu\text{g/L}$ )**.

To measure turbidity the light from an infrared LED is carried to the sample volume through an optical fiber and scattered light is returned through an accompanying optical fiber angled at 90 degrees. 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. To measure chlorophyll-a concentration, the light from a blue LED is carried to the sample volume through an optical fiber and fluorescent emission is returned through an accompanying optical fiber. A filter at the LED blocks any unwanted red light produced by the LED and a filter at the detector isolates the red fluorescence from scattered blue light.

## Specifications

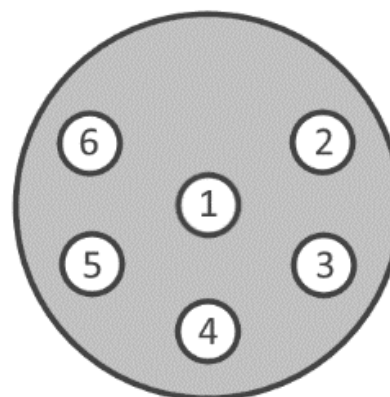
Mechanical	
Length (excluding connector)	10.8 cm / 4.24 inch
Diameter	4.45 cm / 1.75 inch
Weight in air	246 g
Weight in water	69 g
Depth Rating	500 m
Material	Acetal plastic with copper-nickel faceplate
Electrical	
Input voltage	6-18 VDC
Current draw @ 12 V	21.5 mA (peak)
Baud rate	9600-115200 (38400 default)
Serial configuration	8 bits, no parity, 1 stop bit, no flow control
Optical	
Turbidity peak wavelength	850 nm
Turbidity optical bandwidth	30 nm
Chlorophyll-a peak wavelength	465 nm (blue)
Chlorophyll-a detection wavelength	> 665 nm (red)
General	
Turbidity range	150 or 1500 NTU (configurable)
Chlorophyll-a range	25 or 250 µg/L (configurable)
Temperature range (operating)	0 to +40 °C

The Ares uses ChibiOS Real Time Operating System (RTOS). For more information, visit [www.chibios.org](http://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	Reserved
6	Ground



## 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 Xeos Ares Duo Turbidity + Chlorophyll Sensor is currently only calibrated at the factory. User recalibration is not recommended at this time.

## Mechanical Specifications

All Xeos Drawings are hosted in STEP and PDF format on [drawings.xeostech.com](http://drawings.xeostech.com)

## Digital Configuration Commands

The command-line prompt is available after sending the Ares Duo a carriage return (Enter key).

Command	Description	Argument Values
\$help	Returns current settings and commands	
\$set turb range <i>arg</i>	Sets the turbidity saturation value in NTU	150, 1500
\$set chl range <i>arg</i>	Sets the chlorophyll-a saturation value in $\mu\text{g/L}$	25, 250
\$set averaging <i>arg</i>	Turns averaging on/off	on, off
\$set interval <i>arg</i>	Set the frame interval in milliseconds	2000-3600000
\$set turb-1500 cal <i>arg1 arg2</i>	Set calibration coefficients for turbidity 0-1500 range	a1 a0 ( <b>see notes</b> )
\$set turb-150 cal <i>arg1 arg2</i>	Set calibration coefficients for turbidity 0-150 range	a1 a0 ( <b>see note</b> )
\$set chl-250 cal <i>arg1 arg2</i>	Set calibration coefficients for turbidity 0-250 range	a1 a0 ( <b>see notes</b> )
\$set chl-25 cal <i>arg1 arg2</i>	Set calibration coefficients for turbidity 0-25 range	a1 a0 ( <b>see note</b> )
\$set baud <i>arg</i>	Sets the sensor baud rate	9600, 19200, 38400, 57600, 115200
\$set logging <i>arg</i>	Turns logging on/off	on, off
\$set frame ?????????? (where each ? represents a one letter argument)	Set frame format. Fields are 'serial number', 'seconds', 'counts', 'NTU', 'LED1', 'counts', 'ug/L', 'LED2', 'Ascii/Binary'	y/n y/n y/n 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	

### Turbidity Range

The range of the turbidity channel is configurable to either 150 or 1500 NTU.

### Chlorophyll Range

The range of the chlorophyll channel is configurable to either 25 or 250  $\mu\text{g/L}$ .

### Averaging

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

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

## Interval

Sets the output frame interval from 2000 ms 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 Duo 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. If there is no interaction in the first 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 419,000 frames of data. That is sufficient for 1 frame every three seconds for more than 2 weeks, or 1 frame/minute for more than 9 months. 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:

<b>Serial number</b>	<b>Seconds since power up</b>	<b>Counts (Turbidity)</b>	<b>Calibrated (Turbidity)</b>	<b>Range (Turbidity)</b>	<b>Relative LED output (Turbidity)</b>	...
...	<b>Counts (Chl-a)</b>	<b>Calibrated (Chl-a)</b>	<b>Range (Chl-a)</b>	<b>Relative LED output (Chl-a)</b>	<b>Checksum</b>	

The number of **seconds since power up** is nominal - the Ares Duo 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 turbidities they may be negative. On the other hand, **calibrated** turbidity is clamped to a minimum value of 0 NTU. Similarly, chlorophyll concentration counts will often be negative but calibrated values will be clamped to 0 µg/L.

**Range** is either 0 or 1, with 0 representing the smaller range of each parameter (150 NTU for turbidity and 25 µg/L for chlorophyll) and 1 representing the larger 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 Duo is small.

The **checksum** is a two-letter code. The algorithm starts by summing all of the bytes 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:

<b>Days since power up</b>	<b>Seconds since power up</b>	<b>Range (Turbidity)</b>	<b>Counts (Turbidity)</b>	<b>Relative LED output (Turb)</b>	...
					...
		<b>Range (Chl-a)</b>	<b>Counts (Chl-a)</b>	<b>Relative LED output (Chl-a)</b>	<b>Checksum</b>

The number of **days since power up** and **seconds since power up** is nominal - the Ares Duo 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 either 0 or 1, with 0 representing the smaller range of each parameter (150 NTU for turbidity and 25 µg/L for chlorophyll) and 1 representing the larger range.

**Counts** will generally be positive values but they may be negative. Raw counts are provided, rather than calibrated units, by design. Using the calibration coefficients stored on the sensor, the calibrated values can easily be calculated after download. However, some users may 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 bytes 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 Duo is designed to be easy to use. Simply power it up and collect the serial output. 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, turbidity, by its nature causes scattering in all directions. Some light scatters multiple times over a much larger volume, before being detected by the Ares Duo. For the most accurate measurements, an unobstructed volume of greater than 5 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 Duo's optical inputs and outputs. The chlorophyll-a measurement will also depend on a clear sampling volume in front of the sensor.

The Ares Duo 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 Duo pointing upward near the water surface would not be recommended.

If the Ares Duo is mounted in a place with many bubbles, they may become trapped in the copper endplate if the Ares Duo is mounted facing downward. In those environments, mounting horizontally would be preferable. However, generally below a few meters in depth, bubbles should not be an issue. Similarly, mounting the Ares Duo 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 Duo 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.

## Warranty, Support and Limited Liability

Xeos Technologies Inc. warrants the Ares Duo 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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