PAR Sensor
Operation Manual

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Revision History

Document Version	***Description***	***Date***	***Editor***
A	Initial Release	2007-09-21	Sean Nutter, EIT
B	Added Digital PAR option	2011-07-06	Scott Feener, P.Eng.
C	Changed Satlantic Inc. to Satlantic LP	2012-01-24	Scott Feener, P.Eng.
D	Depth rating change	2012-12-07	K. Brown, P.Eng.

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1 Introduction

1.1 Purpose of this Manual

Photosynthetically **A**ctive **R**adiation (PAR, 400-700 nm) is an important parameter used in energy balance models, ecosystem characterization, and productivity analyses for agronomic, oceanic, and climnological studies. In addition, measurements of PAR are routinely used in laboratory studies focusing on plant physiology and photosynthesis.

Phytoplankton and higher plants use electromagnetic energy in the PAR region for photosynthesis. The radiation in this range, usually measured as Photosynthetic Photon Flux Density (PPFD), has units of quanta (photons) per unit time per unit surface area. The units most commonly used are micromoles of quanta per square meter per second (µmol photon•m^{-2}•s^{-1}).

1.2 Definitions, Acronyms and Abbreviations

PAR	Photosynthetically Active Radiation
PPFD	Photosynthetic Photon Flux Density

1.3 Referenced Documents

RD1. Satlantic Instrument File Standard, Satlantic Inc., SAT-DN-00134, Version 6.1, 2010-02-04
RD2. Satlantic Log File Standard, Satlantic Inc., SAT-DN-00135, Version 1.1, 2007-08-30
RD3. SatView User Guide, Satlantic Inc., Version 2.9, 2008-07-22

2 Description of PAR Sensor

The Satlantic PAR sensor comes in six standard configurations. Your particular configuration must be specified at the time of purchase. The PAR sensor configurations are:

1.) Deep water linear PAR sensor (PAR-LIN-2000m). This PAR sensor has a linear output and titanium housing suitable for use at depths of up to 2000 meters of seawater.

2.) Shallow water linear PAR sensor (PAR-LIN-600m). This PAR sensor has a linear output and Acetal housing suitable for use at depths of up to 600 meters of seawater.

3.) Deep water logarithmic PAR sensor (PAR-LOG-2000m). This PAR sensor has a logarithmic output and titanium housing suitable for use at depths of up to 2000 meters of seawater.

4.) Shallow water logarithmic PAR sensor (PAR-LOG-600m). This PAR sensor has a logarithmic output and Acetal housing suitable for use at depths of up to 600 meters of seawater.

5.) Deep water Digital PAR sensor (PAR-SER-2000m). This PAR sensor has RS-232 serial telemetry and titanium housing suitable for use at depths of up to 2000 meters of seawater.

6.) Shallow water Digital PAR sensor (PAR-SER-600m). This PAR sensor has RS-232 serial and Acetal housing suitable for use at depths of up to 600 meters of seawater.

Specifications for each configuration and interface connector pin descriptions are provided below in Table 1 and Table 2. Mechanical configuration information is provided in Figure 1.

2.1 Specifications

Table 1: PAR Sensor Specifications

Standard Configuration	PAR-LIN	PAR-LOG	PAR-SER
Electrical			
Input Voltage	6-30 VDC		
Input Current @ 12 V	6 mA		14 mA
Interface	Analog		RS-232
Output Voltage	0-5 VDC		-
Baud Rate	-	-	19200 bps (8N1)
Optical			
Field of view	cosine response (spectrally corrected)		
Collector area	86.0 mm^2		
Detectors	custom 17 mm^2 silicon photodiode		
Cosine response	Within 3% 0°– 60° / within 10% 60°– 85°		
Typical Measurement Range	0 - 5000 µmol photons•m^{-2}•s^{-1}		

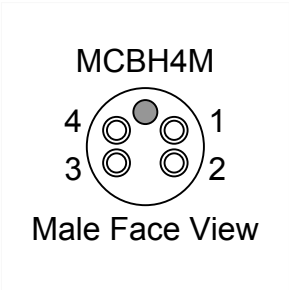
Table 2: PAR Sensor Physical Specifications

Depth Rating	600 m	7000 m
Construction	Acetal	Titanium
Dimensions		
Length	76.2 mm (3 in)	73.2 mm (2.88 in)
Diameter	30.5 mm (1.2 in)	3.797 mm (1.495 in)
Weight (in air)	108 g (0.24 lb)	351 g (0.77 lb)
Weight (in water)	47.5 g (0.105 lb)	264 g (0.58 lb)
Operating Temperature	-40 to 85 °C	

Table 3: PAR Sensor Connector Pin Configurations

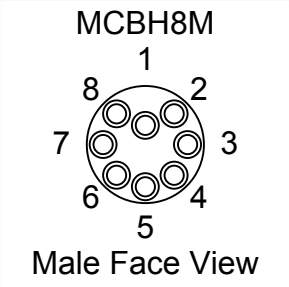
PAR-LIN and PAR-LOG

Pin	*Signal*	*Description*
1	GND	Power Supply
2	AOUT	Analog output signal (0 to 5 V)
3	AGND	Analog ground (AGND internally connected to GND)
4	Vin+	DC Power Supply (6 to 30 V)



PAR-SER

Pin	*Signal*	*Description*
1	Vin+	DC Power Supply (6 to 30 V)
2	GND	Power Supply Return
3	N.C.	Not internally connected
4	N.C.	Not internally connected
5	TXD	RS-232 Transmit (Data From Sensor)
6	RXD	RS-232 Receive (Data to Sensor)
7	N.C.	Not internally connected
8	N.C.	Not internally connected



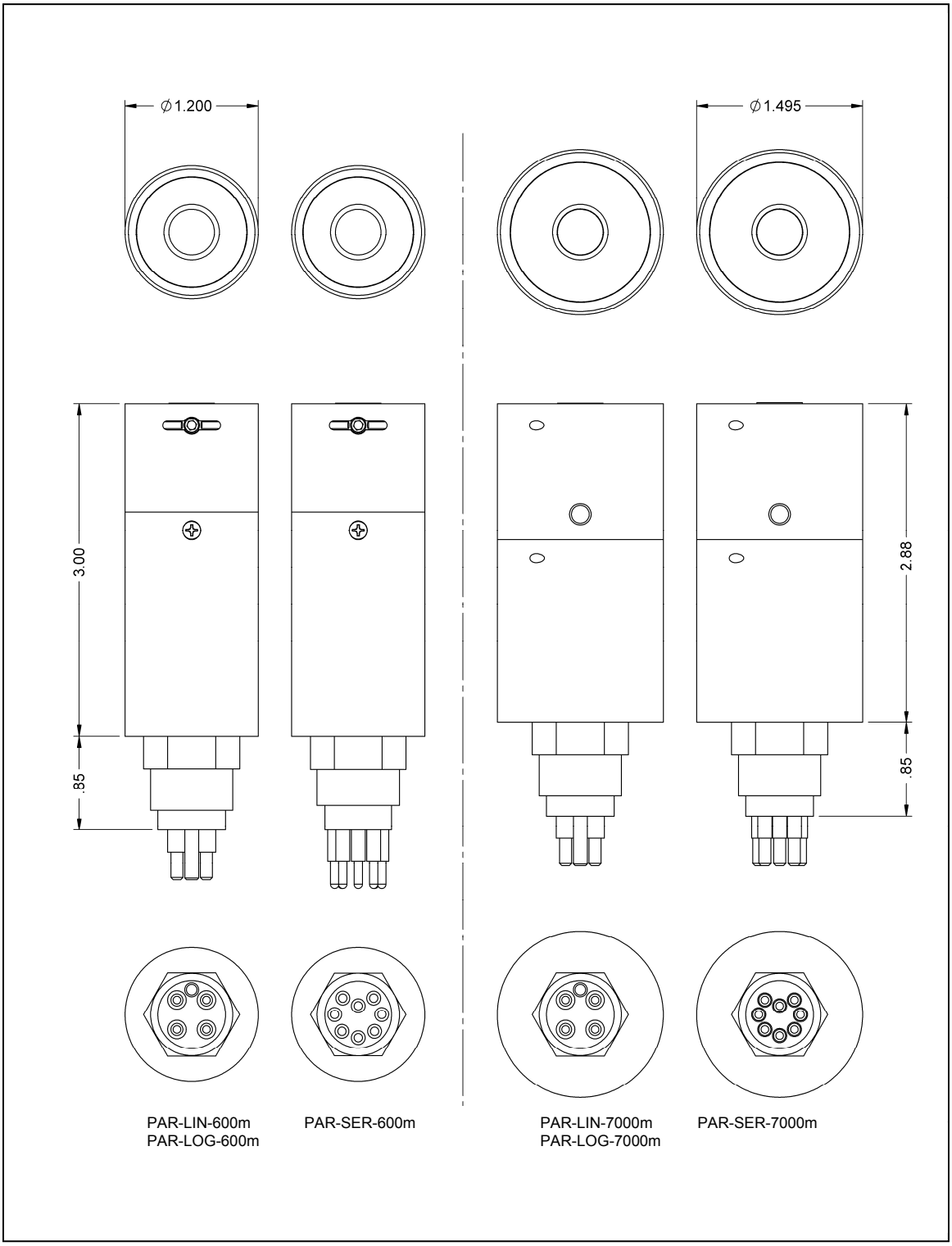


Figure 1: PAR Sensor Mechanical Configurations

3 Safety

Satlantic equipment should be operated and maintained with extreme care only by personnel trained and knowledgeable in the use of oceanographic electronic equipment.

3.1 Personal Safety

3.1.1 Flooded Instrument

Use EXTREME CAUTION handling any instrument suspected of being flooded. If the instrument leaked at depth it might be pressurized when recovered. Indications of a flooded instrument include short circuits between connectors or an extended gap between the end cap and housing. If an instrument is suspected of being flooded, disconnect its power source, place it in a safe location and contact Satlantic for further instructions.

If the instrument cannot be safety stored away, the following steps may be taken to release the pressure to render the instrument safe. PROCEED AT YOUR OWN RISK. To depressurize the PAR Sensor, slowly unscrew the instrument bulkhead just enough to break the seal with the end cap, allowing trapped water to escape around the connector threads. Attempt to drain the instrument completely. Depressurized and drained, the PAR Sensor is safe for normal storage.

3.1.2 Electricity

Use care when handling, connecting and operating power supplies and batteries. A shorted power supply or battery can output high current, harming the operator and damaging equipment.

While trouble-shooting with a multi-meter, take care not to short the probes. Shorts can damage equipment, create safety hazards, and blow internal fuses.

3.2 Equipment Safety

3.2.1 Instruments

Do not leave instruments in direct sunlight when not in use. Direct sunlight can easily increase the internal temperature of the instrument beyond its rating.

Employ measures to protect instruments and cables from being fouled or overrun by the vessel.

3.2.2 Connections

Handle electrical terminations carefully. They are not designed to withstand strain. Disconnect the cables from the components by pulling on the connector heads and not the cables or molded splices. Twisting or wiggling the connector while pulling will damage the connector pins.

3.2.3 Recovery

Do not haul instruments in by their electrical cables, unless they are reinforced with mechanical strength members for the purpose. Hauling on electrical cables can cause damage to the instrument port connectors, cables, and splices.

4 Operating the PAR Sensor

Satlantic's linear PAR sensor and Logarithmic PAR sensor are both analog output sensors with a 0-5 Vdc output range. Sections 4.1 and 4.2 below describe the calibration coefficients and how to compute PAR based on a measured analog voltage.

Satlantic's digital PAR sensor is a serial RS-232 output sensor. Section 4.3 below describes the sensor data format, the calibration coefficients, and how to compute PAR from the raw data.

4.1 Linear PAR Sensor Data Analysis

The linear output PAR Sensor uses a linear fitting function to convert between output voltage and PAR. The relationship between PAR and voltage is described by:

$$PAR = \mathrm{Im} \bullet a_1 (x - a_0)$$

where Im is the immersion coefficient, a_1 is the scaling factor, a_0 is the voltage offset, and x is the voltage. This information can be found on your calibration sheet. This equation calculates PAR in units of µmol photons•m^{-2}•s^{-1}.

For more information on this fitting function please refer to the Satlantic Instrument File Standard document (RD1).

4.2 Logarithmic PAR Sensor Data Analysis

The PAR Sensor with a logarithmic output uses a logarithmic fitting function to convert between output voltage and PAR. The relationship between PAR and voltage is described by:

$$PAR = \mathrm{Im} * 10^{\frac{x - a_0}{a_1}}$$

where a_1 is the scaling factor, a_0 is the voltage offset, and x is the voltage. This information can be found on your calibration sheet. This equation calculates PAR in units of µmol photons•m-^{2}•s^{-1}.

The calibration sheet also shows the calibration coefficients for integrating the Logarithmic PAR sensor into a Sea-Bird Electronics data logger. See Appendix A - Derivation of the calibration coefficients for a Sea-Bird Electronics data logger.

4.3 Digital PAR Sensor Operation

To begin operation of the digital PAR sensor, connect the power/telemetry cable to the PAR sensor, a suitable power supply, and a spare RS-232 port on your computer. Using your favourite terminal emulator (Windows HyperTerminal, Tera Term, etc), configure the port for 19200 bps, with 8 data bits, no parity, 1 stop bit, and no flow control. Telemetry will begin automatically when power is applied.

4.3.1 Initialization Sequence

Once power is applied to the digital PAR sensor, the instrument begins a brief window of operation called the *initialization sequence*, during which time the onboard electronics are readied for operation. A start-up banner will be output on the telemetry interface, similar to the one shown below:

```
Satlantic Digital PAR Sensor
```

```
Copyright (C) 2003, Satlantic Inc. All rights reserved.
Instrument: SATPAR
S/N: 0229
Firmware: 1.0.0

Press <Ctrl+C> for command console.
Initializing system. Please wait...
```

The first section of the banner identifies the instrument as a Satlantic Digital PAR sensor, provides the serial number and firmware version, and indicates the instrument type identifier (SATPAR) used at the beginning of a telemetry frame. See the Telemetry Format section for more information on the telemetry data frame.

Pressing the Ctrl and C keys together (<Ctrl+C>) during operation will allow the user to access the **Command Console** in order to change certain configuration parameters affecting instrument operation.

4.3.2 Autonomous Operation

Autonomous, or stand-alone, operation for the PAR sensor is defined as the continuous operation of the instrument outside the scope of a network. This is the only supported mode of operation for the instrument.

During autonomous operation, the default behavior of the instrument is to continually sample its optical sensor and output telemetry on the RS-232 telemetry interface. When the instrument is used in the field, this telemetry would be collected and saved to a storage medium. Generally, a data acquisition application like Satlantic's SatView software would be used, or the sensor may be integrated with a data logger. However, telemetry output can also be controlled with simple commands sent to the instrument through the telemetry interface. These commands are simple one-byte transmissions. In an embedded or larger scale system, the data acquisition software could use this feature to finely control telemetry output and instrument operation. These commands can also be sent directly by the user with a terminal emulation program.

The following table defines these command bytes and their effect on the instrument. All commands are ASCII control characters. They are not echoed back so if you are using a terminal emulator to send these commands, you will not see any command values on the screen. For example, in a terminal emulation program, you would use the <Ctrl+C> command to access the command console. To do this, press and hold the Ctrl key followed by the C key. This is the same as sending the hexadecimal equivalent byte "03" to the instrument over the telemetry interface. This number is also indicated in the table.

Table 4: Command Bytes

Command	Hex	Description
<Ctrl+C>	03	This command interrupts normal operation of the instrument and invokes the *Error! Reference source not found.*.
<Ctrl+S>	13	This command stops free-running telemetry output, enabling polled telemetry output.
<Enter> or <Space>	0D or 20	If the instrument is running with polled telemetry output, either of these commands will force the instrument to sample its sensors and return a telemetry frame.
<Ctrl+A>	01	This command stops polled telemetry output, enabling free-running telemetry output.
<Ctrl+R>	12	This command forces the instrument to reset itself. The instrument will reboot and the initialization sequence will begin again.

With the exception of the <ENTER> and <SPACE> commands, as well as the <Ctrl+R> reset command, repeatedly sending a command will have no effect.

The free-running and polled telemetry output modes described above are sub-modes of normal operation. When the instrument is free-running, telemetry frames are output from the instrument according to the *maximum frame rate* configuration parameter.

4.3.3 Telemetry Format

The telemetry format for the Digital PAR instrument, as with all Satlantic instrumentation, follows the Satlantic Data Format Standard. This standard defines how Satlantic telemetry can be generated and interpreted. For every sample taken of the instruments sensors, the instrument will compose and transmit one frame of telemetry containing all the relevant sensor information for that sample. The instruments calibration file defines the specific format of this frame, and is described in the table below. Data fields are comma-delimited.

Table 5: Serial Data Format

Field Name	Field Size (bytes)	Description
Instrument	6	A unique 6 character AS formatted string denoting the start of a frame of telemetry. For the Digital PAR sensor, the instrument string is “SATPAR”.
Serial Number	4	An AS/AI formatted string denoting the serial number of the instrument. This field combined with the INSTRUMENT field uniquely identifies the instrument. This combination is known as the frame header or synchronization string.
Comma	1	Comma delimiter
Timer	4 - 10	The field is an AF formatted string indicating the number of seconds that have passed since the end of the initialization sequence. This field is precise to two digits after the decimal.
Comma	1	Comma delimiter
PAR counts	10	An AU formatted value representing the sampled Analog-to-Digital converter counts.
Comma	1	Comma delimiter
Checksum	1-3	The checksum is the two's complement of the least significant byte of the sum of the ASCII codes of all characters in a given frame, up to and including the comma right before the checksum. This includes commas and periods.
Terminator	2	This field indicates the end of the frame. The frame is terminated by a carriage return/line feed pair ($0D_{hex}$ and $0A_{hex}$).

Example telemetry:

```
SATPAR0229,10.01,2206748544,234
```

4.3.4 Configuration

The Digital PAR sensor has been configured at Satlantic with standard configuration parameters. These parameters control aspects of the instruments operation to account for the wide variety of applications in which the PAR sensors are used. In addition to the autonomous mode described in section 4.3.2, a configuration mode is also available to modify configuration parameters and test various systems of the instrument. This configuration mode is implemented by the instruments **Command Console**.

In most cases, the command console is accessed using a terminal emulation program. For communication with the PAR instrument, you will need to make a direct connection to the serial port hosting the instrument. Connect the instrument using the RS-232 telemetry interface. For communications software, use your favorite terminal emulator (Windows® XP and earlier versions came with one called HyperTerminal®). Ensure that the serial connection to the instrument is at the telemetry baud rate. Use any ANSI or ANSI-compliant (i.e. VT-xxx) emulation. While operating in this mode, the PAR instrument uses simple character I/O with no control character interpretation. Therefore, most terminal emulators will do.

The command console can be accessed at any point during the instruments operation by pressing <Ctrl+C>.

4.3.4.1 Command Console

When the console is first invoked, you will see a prompt on your terminal emulator screen similar to the one shown below:

```
Satlantic PAR Sensor
Command Console
Type 'help' for a list of available commands.
S/N: 0229
Firmware: 1.0.0

$
```

The command prompt is the "$" character. Using the command prompt is quite simple. Type a command at the prompt followed by the <Enter> key. This will execute the command, displaying the results to the screen, if any. You can easily edit commands if you make a mistake. Use the <Backspace> key to delete characters in your command before you execute them.

The command console interprets all commands as case sensitive. This means that the command "`exit`" is different from "`EXIT`". Most commands require small case letters.

If this is your first time using the command console, a good starting point is the "`help`" command. As you probably noticed, the command prompt header suggests this command for novice users. Executing this command will display the following text:

```
Available commands:

set     Sets the instrument's configuration parameters.
        Usage: set [parameter] [value]

        set telbaud [telemetry baud rate (bps)]
        set maxrate [maximum frame rate (Hz)]
show    Shows the instrument's configuration parameters.
        Usage: show [parameter|all]

        set telbaud
        set maxrate
save    Saves the instrument's configuration parameters.
exit    Exits the command console.
exit!   Exits the command console and resets the instrument.
```

All commands available to the instrument are listed on the left, with descriptions on the right. The available parameters are also indicated.

Please note there are typographical errors in the help for the `show` command - the examples should indicate "`show telbaud`" and "`show maxrate`", not "`set`". This does not affect operation however.

Some commands require additional command line parameters. Entering a command with an invalid or missing parameter will result in an "`Invalid command`" message.

4.3.4.1.1 SET COMMAND

The "set" command modifies configuration parameters for the instrument. These parameters affect various aspects of the instruments operation and can be modified by the user to customize the instrument.

This command requires two command line parameters. The first parameter specifies the configuration parameter to modify. The second specifies the new value to assign to the parameter. A list of all available configuration parameters is shown by typing "`help`".

IMPORTANT! Be careful using this feature. Changes made to the PAR sensor configuration parameters affect the way the instrument operates. Before you modify any of configuration parameters, make sure you understand the consequences of the change.

For more information on these parameters and their affect on your instruments operation, see section 4.3.4.2 Digital PAR Sensor Configuration Parameters below.

4.3.4.1.2 SHOW COMMAND

The "show" command displays configuration parameters for the instrument. These parameters are modified by the "set" command explained above. This command requires only one command line parameter, which is the same as the first parameter of the "`set`" command. Using the "`show`" command in this way displays the current value of the configuration parameter, even if it has not yet been saved. You may also use "`all`" as the command line parameter to show a complete list of all configuration parameters and their current values. For example, using the "`show all`" command on your PAR sensor would display something like this:

```
Maximum Frame Rate: 2 Hz
Telemetry Baud Rate: 19200 bps
```

For more information on these parameters and their affect on your instruments operation, see section 4.3.4.2 Digital PAR Sensor Configuration Parameters below.

4.3.4.1.3 SAVE COMMAND

Modifying configuration parameters with the "`set`" command does not necessarily mean that those parameters will be retained for use in the next session with the instrument. When the "`save`" command is issued, all configuration parameters are placed in persistent storage inside the instrument. If these parameters are not saved once they are modified, all changes will be lost when power is removed from the instrument.

The "`save`" command requires no additional command line parameters. Once the command is issued, it cannot be undone.

4.3.4.1.4 EXIT AND EXIT! COMMANDS

The "`exit`" and "`exit!`" commands end the current command console session. Once the console exits, normal operation will resume in most cases. Otherwise, the instrument will reset itself before normal operation can begin. The only difference between the two versions of this command is that the "exit!" command forces a reset of the instrument, even if it isn't necessary.

If you attempt to exit the console with modified configuration parameters that have not been saved, the following dialog will be presented:

```
The configuration parameters have been modified.
Save changes [y/n]?
```

Choose "y" for yes or "n" for no to answer this question. If you choose yes, the configuration parameters will be saved and the instrument will reset itself. Otherwise, any modifications to the configuration parameters will be lost on the next power cycle. See the SAVE COMMAND section above for more information on saving configuration parameters.

4.3.4.2 Digital PAR Sensor Configuration Parameters

This section describes, in detail, the function of each configuration parameter used by Digital PAR sensor. The title of each section identifies the name of the parameter, as displayed by the "`show`" command. Also clearly identified in each section is the command line parameter keyword used in both the "`set`" and "`show`" commands.

See the descriptions of the "`set`" and "`show`" commands described in the Command Console section above for more information.

4.3.4.2.1 TELEMETRY BAUD RATE

Command Line Parameter: `telbaud`

The telemetry baud rate defines the speed at which data is transferred on the telemetry interface. This should not be confused with the frame rate. Baud rates are specified in units of bits per second (bps). Any data acquisition or terminal emulation software must be configured to communicate with the instrument at this baud rate. Only certain standard parameter values are accepted: *9600, 19200, 38400,* and *57600*.

IMPORTANT! The default baud rate is 19200 bps and should not be changed unless absolutely necessary. The bit rate timing may not be accurate enough to allow communication with some computers, preventing further communication. If this occurs, the sensor will need to be returned to Satlantic for reprogramming and recalibration, as the housing must be opened to reprogram the microcontroller.

4.3.4.2.2 MAXIMUM FRAME RATE

Command Line Parameter: `maxrate`

This parameter allows you to define the maximum frame rate that the instrument will use during normal operation with free-running telemetry output. The frame rate defines how often a frame of telemetry is composed and transmitted. Frame rates are specified in units of frames per second or Hertz (Hz). There are several factors involved in determining how quickly the instrument can transmit frames. On-board electronics, such as the Analog-to-Digital converters used to sample each sensor, may limit how fast a telemetry frame can be composed. Generally, a Digital PAR sensor cannot exceed a frame rate faster than 7.5 Hz, even under the best of conditions.
\

Only certain standard frame rates are accepted by this parameter: *0, 0.125, 0.5, 1, 2, 4, 8, 10,* and *12*. These values are in Hz.

When modifying this parameter with the "`set`" command, you must enter one of these numbers as the value parameter. Any non-integer values are truncated. To specify an automatic (AUTO) frame rate, input "`0`" as the value parameter. This will cause the instrument to output frames as fast as possible.

Specifying a frame rate faster than is practically possible will not force the actual frame rate to that level. The instrument will only transmit as fast as possible for the given operating parameters. This is essentially the same as specifying an AUTO frame rate. In addition, frames are always transmitted as a whole. Once a frame starts transmitting, it is transmitted continuously until the frame is completely output. Specifying a frame rate of, for example, 0.5 Hz does not mean that half a frame is transmitted every second. It means that every two seconds, a frame will begin transmitting.

4.3.5 Digital PAR Sensor Data Analysis

The Digital PAR Sensor uses a linear fitting function to convert between raw ADC counts and PAR. The relationship between PAR and raw ADC counts is described by:

$$PAR = \mathrm{Im} \bullet a_1 (x - a_0)$$

where Im is the immersion coefficient, a_1 is the scaling factor, a_0 is the offset, and x is the ADC raw counts reported by the Digital PAR sensor. This information can be found on your calibration sheet. This equation calculates PAR in units of µmol photons•m^{-2}•s^{-1}.

For more information on this fitting function please refer to the Satlantic Instrument File Standard document (RD1).

5 Maintenance

5.1 Preventive Maintenance

The PAR Sensor requires virtually no maintenance. Protecting it from impacts, rinsing it with fresh water after each use, and properly storing it with the dummy connector in place will prolong the life of the PAR Sensor. External power sources should always be removed during storage.

The electrical connector and cable are the most vulnerable components of the PAR-Sensor. Subconn provides the following guidance for handling connectors:

- Lubricate connector sparingly with silicone grease, such as Dow Corning Molykote 44. (Satlantic recommends Dow Corning DC-4 electrical insulating compound, a lubricant designed for electrical connectors, and DC-111 valve lubricant and sealant.)
- Do not use petroleum based lubricants.
- Any accumulation of sand or mud in the female contact should be removed with fresh water to prevent splaying of the contact and damage to the o-ring seals.
- Do not over tighten bulkhead nuts.
- When disconnecting, pull straight, not at an angle or by moving side to side.
- Do not disconnect by pulling on the cable.
- Avoid sharp bends at cable entry.
- Ensure there are no angular loads on connectors.

6 Warranty

Warranty Period

All Satlantic equipment is covered under a one-year parts and labor warranty from date of purchase.

Restrictions

Warranty does not apply to products that are deemed by Satlantic to be damaged by misuse, abuse, accident or modifications by the customer. The warranty is considered void if any optical or mechanical housing is opened. In addition, the warranty is void if the warranty seal is removed, broken or otherwise damaged.

Provisions

During the one year from date of purchase warranty period, Satlantic will replace or repair, as deemed necessary, components that are defective, except as noted above, without charge to the customer. This warranty does not include shipping charges to and from Satlantic.

Returns

To return products to Satlantic, whether under warranty or not, contact the Satlantic Customer Support Department and request a Returned Material Authorization (RMA) number and provide shipping details. All claims under warranty must be made promptly after occurrence of circumstances giving rise thereto and must be received by Satlantic within the applicable warranty period. Such claims should state clearly the product serial number, date of purchase (and proof thereof) and a full description of the circumstances giving rise to the claim. All replacement parts and/or products covered under the warranty period become the property of Satlantic LP.

Liability

IF SATLANTIC EQUIPMENT SHOULD BE DEFECTIVE OR FAIL TO BE IN GOOD WORKING ORDER THE CUSTOMER'S SOLE REMEDY SHALL BE REPAIR OR REPLACEMENT AS STATED ABOVE. IN NO EVENT WILL SATLANTIC LP BE LIABLE FOR ANY DAMAGES, INCLUDING LOSS OF PROFITS, LOSS OF SAVINGS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM THE USE OR INABILITY TO USE THE EQUIPMENT OR COMPONENTS THEREOF.

7 Contact Information

If you have any problems, questions, suggestions or comments about the equipment or manuals, please contact us.

Location

Satlantic LP
Richmond Terminal, Pier 9
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Halifax, Nova Scotia
B3K 5X8 Canada

Tel: (902) 492-4780
Fax: (902) 492-4781

Email: support@satlantic.com
Web: http://www.satlantic.com

Business Hours

Satlantic is normally open for business between the hours of 9 AM and 5 PM Atlantic Time. Atlantic Time is one hour ahead of Eastern Time. Daylight saving time is in effect from 2:00 a.m. on the second Sunday in March through 2:00 a.m. on the first Sunday in November. Atlantic Standard Time (AST) is UTC-4. Atlantic Daylight Saving Time (ADT) is UTC-3.

Satlantic is not open for business during the following holidays:

New Year's Day	1 January
Good Friday	Friday before Easter Sunday (Easter Sunday is the first Sunday after the full moon on or following March 21st, or one week later if the full moon falls on Sunday)
Victoria Day	First Monday before 25 May
Canada Day	1 July
Halifax Natal Day	First Monday in August
Labour Day	First Monday in September
Thanksgiving Day	Second Monday in October
Remembrance Day	11 November
Christmas Day	25 December
Boxing Day	26 December

8 Declaration of Conformity

DECLARATION OF CONFORMITY

Company contact details:
Satlantic LP
Richmond Terminal, Pier 9, 3481 North Marginal Road, Halifax, Nova Scotia, B3K 5X8, Canada
Tel: +1 902-492-4780 Fax: +1 902-492-4781 Email: info@satlantic.com

Satlantic LP declares that their:
1) PAR Sensor - Photosynthetically Active Radiation Sensor
2) OCR-500 - Ocean Color Radiometer
3) HyperOCR - Hyperspectral Ocean Color Radiometer
4) SAT-THS - Tilt Heading Sensor.
5) Bioshutter
6) Profiler II
7) ISUS - In Situ Ultraviolet Spectrophotometer
8) STOR-X
9) Alkaline Battery Pack

are classified within the following EU Directive:
Electromagnetic Compatibility Directive 2004/108/EC

and further conform with the following EU Harmonized Standard:
EN 61326-1:2006

Dated: 12 October 2012
Position of signatory: President
Name of Signatory: Marlon Lewis
Signed below:
on behalf of Satlantic LP

Appendix A - Derivation of the calibration coefficients for a Sea-Bird Electronics data logger.

The following is a derivation for taking Satlantic's Logarithmic calibration coefficients and using them in a Sea-Bird Electronics data logger. Please see Sea-Bird Electronics application note: APPLICATION NOTE NO. 11 QSP-L for more information.

Satlantic's equation for calculating PAR is:

$$PAR = \mathrm{Im} * 10^{\frac{x - a_o}{a_1}} \quad .1$$

where a_1 is the scaling factor, a_0 is the voltage offset (typically '0'), and x is the voltage. Sea-Bird Electronics Sea Soft program uses the following equation to calculate PAR:

$$PAR = \frac{multiplier * 10^9 * 10^{\frac{V - B}{M}}}{Calibration\_const.} + offset \quad .2$$

where *multiplier* = 1 (from their technical note), *B* = 0 (From their technical note). For the Satlantic Logarithmic sensor the offset is also set to zero. This makes equation 2 equivalent to:

$$PAR = \frac{10^9 * 10^{\frac{V}{M}}}{Calibration\_const.} \quad .3$$

To make equation 3 equivalent to equation 1 (Satlantic's equation) then:

$M = a_1$

$$Calibration\_const = \frac{10^9 * 10^{\frac{a_0}{a_1}}}{\mathrm{Im}}$$

and from equation 2:

multiplier = 1
B = 0
offset = 0