User manual

OCR-504

Multispectral Ocean Color Radiometer

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Section 1 Overview and specifications

The Ocean Color Radiometer, or OCR, measures apparent optical properties in the ocean. The 500 series uses optical wavelengths selected by the user from a standard list. The sensor operates via an RS232 or RS422 interface or an RS485 if the user operates the sensor in a SatNet network environment.

OCR model description

OCR-500 series sensors use the naming convention below, with this format:

OCR-50x-tffm, *where*

x = Number of channels	
	4 = four-channel radiometer
	7 = seven-channel radiometer
t = Type of radiometer	
	I = irradiance
	R = radiance
	1/R = both irradiance and radiance
ff = Field of view	
	10 = 10 degrees half-angle
	CS = cosine
M = Media	
	A = air
	W = water
OP = Options	
	UV = ultraviolet
For example, OCR-504-R10W has 4 radiance channels, each with a 10° half-angle field of view, for in-water use.	

Examples of 500-series sensors:

OCR-504 irradiance

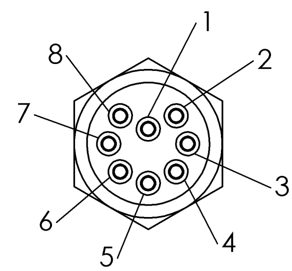
OCR-507 radiance

OCR-504-UV radiance-irradiance

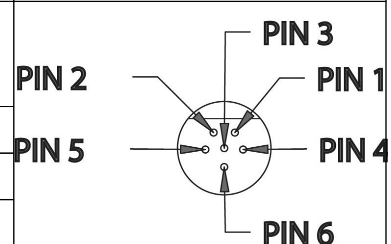
1.1 Mechanical

	Standard	2000 m	AUV	Integrated	
Length	10.92 cm	10 cm	12 cm	9.74 cm	9.27 cm
Diameter	4.57 cm		7.54 cm (optical face)	4.57 cm	
Weight in air, water	0.24 kg, 0.06 kg	0.2 kg, 0.04 kg	0.6 kg, 0.4 kg	0.3 kg, 0.15 kg	0.2 kg, 0.04 kg
Depth rating	200 m	2000 m	1000 m	2000 m	
Material	Acetron®	Titaniam	Aluminum	Aluminum	Titanium

1.1.1 Standard bulkhead connector functions

Contact	Function	Description	Pinouts (MCBH-8-MP)
1	Voltage in	Voltage Direct Current	
2	V-/SG, power supply return, Signal Ground	Power supply return/signal ground	
3	RS422 TXA	Serial communication from sensor to PC	
4	RS422 TXB	Serial communication from sensor to PC	
5	RS232 TX	Serial communication from sensor to PC	
6	RS232 RX	Serial communication from PC to sensor	
7	NA RS485 SatNet™ A	SatNet interface A	
8	NB RS485 SatNet™ B	SatNet interface B	

1.1.2 Optional titanium bulkhead connector functions

Contact	Function	Description	IE55-1206-BCR
1	V-/SG, power supply return, Signal Ground	Power supply return/signal ground	
2	RS232 RX	Serial communication from PC to sensor	
3	No connect	Not connected	
4	Voltage in	Voltage Direct Current (6–22)	
5	RS232 TX	Serial communication from sensor to PC	
6	No connect	Not connected	

1.1.3 AUV and integrated sensor connector wiring functions

The sensors made for Autonomous Underwater Vehicles and the sensors built to integrate into systems are typically hardwired, so the manufacturer usually supplies them with a potted wiring harness. In AUVs the sensor is mounted in the science bay with the optical face pointed straight up. For integrated sensors, a user-specified connector may be available on request.

Contact	Wire color	Function	Description
1	Red	Voltage in	Voltage Direct Current

2	Black	V-/SG, power supply return, Signal Ground	Power supply return/signal ground
3	Green	RS232 TX	Serial communication from sensor to PC
4	Blue	RS232 RX	Serial communication from PC to sensor

1.1.4 AUV glider wiring

When the sensor is used in an AUV, for example the Slocum Glider, a wiring harness approximately 10 in. long ships with the sensor.

Table 1 Molex 22-01

Contact	Wire color	Function	Description
1	Black	V-/SG, power supply return, Signal Ground	Power supply return/Signal ground
2	Red	Voltage in	DC power supply (6–22 V)

Table 2 Molex 35507-0500

Contact	Wire color	Function	Description
1	Black	V-/SG, power supply return, Signal Ground	Power supply return/Signal ground
2	Blue	RS232 RX	Serial data receive (to sensor)
3	Green	RS232 TX	Serial data transmit (from sensor)
4	—	—	not used
5	—	—	not used

1.2 Electrical

Input	6–22 VDC
Current draw	25 mA
Communications	RS232 (RS422 and RS485 available)
Data rate	57600 (default)
Data storage	None

1.3 Optical

1.3.1 Radiance

Field of view	10°
Detectors	custom 13 mm^2 silicon photodiodes
Bandwidth range	400–700 nm (custom available)
Number of channels	4 (504) or 7 (507)
Spectral bandwidth	10 or 20 nm
Filter type	custom low-fluorescence interference

Out-of-band rejection	10^{-6}
Out-of-field rejection	5×10^{-4}
Typical NER	300×10^{-6} µW cm^{-2} nm^{-1}

1.3.2 Irradiance

Field of view	spectrally corrected cosine response
Collector area	86 mm^2
Detectors	custom 17 mm^2 silicon photodiodes
Bandwidth range	400–700 nm (custom also available)
Number of channels	4 (504) or 7 (507)
Spectral bandwidth	10 or 20 nm
Filter type	custom low-fluorescence interference
Cosine response	within 3%, 0–60°; within 10%, 60–85°
Typical NEI	2.5×10^{-3} µW cm^{-2} nm^{-1}

Section 2 Operation

⚠ WARNING

Sensors that use ultraviolet light sources (< 400 nm): Do not look directly at a UV light source when it is on. It can cause damage to the eyes. Keep products that have UV light sources away from children, pets, and other living organisms. Wear polycarbonate UV-resistant safety glasses to protect the eyes when a UV light is on.

2.1 Delivered items

- the sensor
- a dummy connector and lock collar
- a plastic protective cover for the optical face
- a CD with calibration files, software, and user manuals
- Optional: Bio-shutter, attached to sensor. The protective cap is not attached to the optics.

Table 3 Manufacturer-supplied software

Software	Function
SatView	Collects, saves, and shows data in real-time
SatCon	Converts binary data to ASCII data
ProSoft	Processes data from multiple sensors

Use the .sip file on the CD to use the SatView and SatCon software.

2.2 Verify sensor functionality

Make sure that the sensor operates correctly before further setup and deployment.

1. Install the software on the PC. The software is available from the CD that ships with the sensor or from the manufacturer's web site.
2. Start the software.
3. Supply power to the sensor.
4. Move ("drag") the .sip, .cal, or .tdf file to the main window of the SatView software from the supplied CD or from PC if it has been copied there.
5. In the new window that shows, enter configurations for the sensor:
   a. Enter a name for the sensor at "Instrument Package Name". (This is auto-filled if a .sip file was moved in step 4.)
   b. Put a check in the box next to "Auto Read From:" and select the applicable COM port.
   c. Select the "Baud Rate." The default is 57600.
   d. Push **OK**.
   A green border shows around the sensor icon in the software. The sensor collects data.
6. Select (highlight) the sensor with the green border, then right-click and select *Control Panel*. The "Frames Read" value increments.
7. Double-click on any or all of the views in the "View List" area. Move each window as desired to see real-time data.
8. Go to the **Log** menu, then *Options*.
   a. In the "File Naming Mode" select AUTO CAST. The software automatically names data files with AA, AB, AC, etc.
   b. Select the ... at "Log Directory" to find or make a folder for saved data.

c. Put a check in "Log Duration" and select the amount of time for the PC to save data.
d. Push **OK**.

9. Push **Start Logging** in the main window.
The "Ready" and "Active" status indicators are green and the "Log Time" counter increases. Note that the data is saved in binary format. Use the manufacturer's SatCon software to convert and process this data.
10. To save the settings from the session, select the **File** menu, then *Save As...* and find or make a file name and location.
The software saves the settings from this session so it is not necessary to go through the setup steps again. The software will start when the user double-clicks the saved *xxx*.sat file.
11. Turn off the power supply to stop the sensor.

2.3 Set up for autonomous operation

The standard mode of operation for OCR sensors is autonomous operation and continuous data collection. It is typical to use the SatView software to set up and monitor data collection.

1. If necessary, start the software.
2. Make sure that the sensor is connected to a power source and the PC.
3. Open the *xxx.sat* session file that was saved in the previous section, Verify sensor functionality on page 7.
4. Go to the **Log** menu, then *Options*:
   a. Select an option in the "File Naming Mode" dropdown.
      - USER DEFINED—the user names the data file.
      - AUTO CAST—the software names files that increment "AA," "AB," "AC," etc.
      - TIME STAMP—the software names files with YYYY-DDD-HHMMSS.raw, which is year, day of the year, hours, minutes, seconds.
      - SQM—SeaWiFS-specific name options.
   b. Determine the location to which the data file is saved on the PC in the "Log Directory" area.
   c. Put a check in the box at "Log Duration" and enter the period of time the sensor will collect data.
   d. Put a check in the box at "Log Interval" and enter the period of time the sensor will stop between data collection cycles.
   Note that the sensor will repeat the cycle of data collection and low power until the user pushes **Stop Logging**. Each data collection cycle will be in a separate file.
   e. Put a check in the box at "Write PCZDA Time Stamps..." so that the software will write a time stamp to the file every second. It has the format $PCZDA, 132430.00,03,08,1999,, which is 1:24:30 pm, 03 August 1999.
   f. Put a check in the box at "Use GPS Data..." so that the software will use GPS data if such a sensor is attached.
5. Push **OK**.
6. Optional: Go to the **Log** menu then *Station Setup*. Enter information as needed. It will show in the header of the data file.
7. Optional: Select the sensor and right-click to see the Ancillary, Optical, and Spectral views.

2.4 Verify or change sensor settings

Use a terminal program such as Tera Term to look at and, if necessary, change the settings in the sensor prior to a deployment. The manufacturer has set up the sensor with default values listed in Configuration commands on page 10.

1. Make sure that the sensor is connected to the PC that has a terminal program installed.
2. Start the terminal program.
3. Select "Serial" then push **OK**.
4. Select **Setup**, then *Serial Port*.
5. Change the "Baud rate" to 57600. Other settings do not need to be changed:
   - Data: 8 bit
   - Parity: none
   - Stop: 1 bit
   - Flow control: none
6. Push **OK**.
7. Supply power to the sensor.
   Data shows in the terminal window.
8. To stop the data collection, enter **Ctrl C**.
   - If the sensor is in autonomous mode, the **[Auto]$** prompt shows.
   - If the sensor is in a network, the **[Remote: 050]$** prompt shows. The three characters are the network address of the remote sensor.

   The sensor is ready to accept commands.

```
[Auto]$ help

The following console commands are available for this instrument:

reset         Resets the command console.
id            Displays the instrument identification banner.
power         Turns operational power off and on.
set           Sets the instrument's configuration parameters.
show          Shows the instrument's configuration parameters.
save          Saves the instrument's configuration parameters.
sample        Samples the instrument's sensors and displays.
exit          Exits the command console.
exit!         Exits the command console and resets the instrument.

For more information in individual commands, type '-?' after the command.

[Auto]$
```

9. The settings stored in the sensor by the manufacturer should not need to be changed. Look at the value of a specific setting, for example, baud rate: At the **[Auto]$** prompt, type **show telbaud** then push **Enter** to see the baud rate that is stored in the sensor.
10. To save data on the PC:
    a. Select **File**, then *Log...*
    b. Select the directory in which to save the file, and a file name.
    c. Push **Save**.
11. To start data collection again, type **exit**.
12. To stop data collection, select **File**, then **Disconnect**.
    The terminal session ends.

2.4.1 Configuration commands

The command prompt in the terminal program is the **$** .

Notes on the use of a terminal program—

- Type -? after a command to get more details about it.
- Use the backspace key to remove characters in the command before it is sent.
- Commands are case-sensitive: **exit** is not the same as **EXIT** or **Exit.** Most commands are lower case.
- Use the <Esc> key at the **$** prompt to repeat the last command that was executed.
- Type **help** to see the available commands.

Reset	
Command line:	reset
Value:	reset
Description:	Resets the terminal console. The command prompt header shows again. Changes to settings that were not saved are lost.

ID	
Command line:	id
Value:	id
Description:	Shows the initial star-up information for the sensor.

Power	
Command line:	power
Value:	on |off | ?
Example:	power on
Description:	Power on = power to operate the sensor and collect data. Power off = decreases the power consumption of the sensor. Data collection is not possible. Power ? = Shows the status of power, either on or off.

Set	
Command line:	set
Value:	set [parameter] [value]
Example:	set telbaud 57600
Description:	Changes the settings in the sensor. To see a list, type **set -?** to see a list. Make sure to **save** to store any changes to the sensor.

Show	
Command:	show
Value:	[parameter] | all
Example:	show telbaud
Description:	Shows a specific setting, or *all* of the current settings that are stored in the sensor.

Show calibration coefficients (504 only)	
Command:	show calcoeffs

Example:	Cal coefficients: Optical Channel 1: a0: 2147582763.7 [2147582863] a1: 2.03019013945e-007 [2.03019e-07] a0: 1.365 [1.365]
Description:	Shows the ASCII calibration coefficients and the calibration values (in square brackets) that the sensor stores and uses for calculations (if enabled). Firmware versions older than 5.0.x did not store the ASCII string.

Save	
Command line:	save
Value:	save
Description:	Stores a changed setting in the sensor. See the **Set** command.

Sample	
Command line:	sample
Value:	1–4 or 1–7 (model dependent) | vreg | vana | temp | all
Example:	sample 4
Description:	Tests the operation of each optical channel, the regulated input voltage, the analog voltage, and the internal temperature of the sensor. The **all** command tests all of these values.

Exit and Exit!	
Command line:	exit or exit!
Value:	exit or exit!
Description:	Exit: the sensor starts to collect data. The terminal session stays open. Exit!: the sensor is reset to previously saved settings, and starts to collect data.

2.4.1.1 Configuration values

The **Set** and **Show** commands let the user change and look at different values that are stored in the sensor.

```
set -?

Usage: set [parameter] [value]

set telbaud [telemetry baud rate (bps)]
set maxrate [maximum frame rate (Hz)]
set initsm [initialize silent mode (on|off)]
set initpd [initialize power down (on|off)]
set initat [initialize auto telemetry (on|off)]
set netmode [network mode (on|off)]
set netadd [network address (1-255)]
set netbaud [network baud rate (bps)]
set avg [on|off]
set usecal [on|off]
set immersed [on|off]
set latency [value]
set frametype [binary|short|long]
set a0ch[1-4] [value]
set a1ch[1-4] [value]
set imch[1-4] [value]

[Auto]$ 
```

Baud rate	
Command line:	telbaud
Value:	9600 | 19200 | 38400 | **57600** (bps default) | 115200

Example:	set telbaud 57600
Description:	The rate at which data is transferred.

Maximum frame rate	
Command line:	maxrate
Value:	0.125 | 0.25 | 0.5 | 1 | 2 | 4 | 8 | 10 | 12 | 0 (auto)
Example:	set maxrate 0
Description:	Shows how often a frame of data is completed and transmitted. Frame rate is shown in Hz (frames/second). A frame rate of 0.5, for example, is one frame every 2 seconds.

Initialize silent mode	
Command line:	initsm
Value:	on | off
Example:	set initsm on
Description:	Enables or disables the banner that shows when power is supplied.

Initialize power down	
Command line:	initpd
Value:	on | off
Example:	set initpd off
Description:	"On" enables the power save mode. Data will not be collected "Off" disables this mode. The sensor operates at normal power.

Initialize automatic telemetry	
Command line:	initat
Value:	on | off
Example:	set initat on
Description:	"On" enables automatic data collection. "Off" disables automatic data collection. The sensor operates in a "polled" mode, where the user polls the sensor with an <Enter> or <Space> key command.

Network mode	
Command line:	netmode
Value:	on | off
Example:	set netmode off
Description:	"On" enables network operation. "Off" disables network operation. Refer to the section on Network operation on page 13 for other requirements to set up a network.

Network address	
Command line:	netadd
Value:	1–255 (in integers)
Example:	set netadd 3
Description:	Identifies a sensor in a network. Must be unique.

Network baud rate	
Command line:	net baud
Value:	9600 | 14400 |19200 | 28800 | 38400 | 57600 | 76800
Example:	set netbaud 76800
Description:	The rate at which data is transmitted on the network. Faster baud rates are better, but cable quality or long transmission distances may require a slower baud rate.

2.5 Network operation

The sensor can also operate as part of a SatNet™ network in which all communication occurs through a controller, or "master" sensor and terminal program. The network controller sends data to a user-supplied data acquisition system. Note that OCR-504 and -507 multispectral sensors **cannot** be a network controller. HOCR sensors **can** be a network controller.

To set up network operation:

- The Network Mode parameter must be on.
- The network interface pins NA and NB must be connected to another SatNet™ sensor that operates as the Network Master.
- The network Baud Rate parameter must be the same for the sensor and the network controller.
- The network address must be unique.

While the network is in operation the OCR sensor is controlled by the network controller. Data from each of the sensors is sent to the controller, which then sends the data to a user-supplied data acquisition system such as a PC. Communication with the network must go through the network controller.

2.6 OCR 504 data formats

The standard data from the sensor is in binary format, and is defined by the Technical Definition File (.tdf) from the manufacturer and whether the sensor measures radiance or irradiance.

Format description	
AF = ASCII floating point number	BS = Binary signed
AI = ASCII integer number	BU = Binary unsigned
AS = ASCII string, test	

Field Name	Field size, bytes	Description
Instrument	6 (1–10 permitted)	AS-formatted string that usually starts "SAT" followed by the type of sensor.
Serial number	4 (1–10 permitted)	AS- or AI-formatted string. The Instrument and Serial number are the frame header.
Timer	10	AF-formatted string that shows how many seconds have passed since the initialization sequence was completed. This field is left-padded with zeros and is accurate to two decimal places.
Sample delay	2	BS-formatted value that shows the number of milliseconds to offset the timer value.
Channel (lambda$_n$)	4	BU-formatted value from the *n* optical channel.
V in sense	2	BU-formatted value that shows the regulated input voltage.

V a sense	2	BU-formatted value that shows the analog voltage.
Int. Temp.	2	BU-formatted value that shows the internal temperature.
Frame counter	1	BU-formatted value that keeps count of each transmitted frame from 0–255, at which point it starts over at 0.
Check sum	1	BU-formatted value that puts a check sum on a frame of data.
Terminator	2	This field is the end of the frame, <CR-LF>

Note: the optical channels lambda$_1$ to $_n$ are discrete output channels. In some cases, not all optical channels are used. The manufacturer can configure sensors so that unused optical channels are not part of the output. This decreases the size of the data files.

2.6.1 Engineering units

Data in engineering units is shown as tab-delimited ASCII text. This is the "short" data frame.

Relevant configuration parameters:

- frametype short
- usecal on

Field name	Field size, bytes	Description
Instrument	6	AS-formatted string. Irradiance sensors are SATFI4. Radiance sensors are SATFR4.
Serial number	4 1–10 permitted	AS- or AI-formatted string. the Instrument and Serial number are the frame header.
Tab	1	Delimiter
Channel (lambda$_1$)	10 (typical, max)	AF-formatted value that shows output (engineering units) from channel 1. Irradiance output is uW/cm^2/nm. Radiance output is uW/cm^2/sr.
Tab	1	Delimiter
Channel (lambda$_2$)	10 (typical, max)	AF-formatted value that shows output (engineering units) from channel 2. Irradiance output is uW/cm^2/nm. Radiance output is uW/cm^2/sr.
Tab	1	Delimiter
Channel (lambda$_3$)	10 (typical, max)	AF-formatted value that shows output (engineering units) from channel 3. Irradiance output is uW/cm^2/nm. Radiance output is uW/cm^2/sr.
Tab	1	Delimiter
Channel (lambda$_4$)	10 (typical, max)	AF-formatted value that shows output (engineering units) from channel 4. Irradiance output is uW/cm^2/nm. Radiance output is uW/cm^2/sr.
Terminator	2	This field is the end of the frame, <CR-LF>

Output example:

SATF140001 *<tab>* 5.6134 *<tab>* 8.9193 *<tab>* 14.6706 *<tab>* 22.4710

2.6.2 Standard data

Raw Analog-to-Digital Conversion counts are shown as tab-delimited ASCII text. This is the "short" data frame.

Relevant configuration parameters:

- frametype short
- usecal off

Field name	Field size, bytes	Description
Instrument	6	AS-formatted string. Irradiance sensors are SATAI4. Radiance sensors are SATAR4.
Serial number	4 1–10 permitted	AS- or AI-formatted string. the Instrument and Serial number are the frame header.
Tab	1	Delimiter
Channel ($lambda_1$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 1.
Tab	1	Delimiter
Channel ($lambda_2$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 2.
Tab	1	Delimiter
Channel ($lambda_3$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 3.
Tab	1	Delimiter
Channel ($lambda_4$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 4.
Terminator	2	This field is the end of the frame, <CR-LF>

Output example:

SATA1400012684315904 *<tab>* 2684407360 *<tab>* 2684127360

2.6.3 Calibration coefficients

Raw Analog-to-Digital Conversion counts are shown as tab-delimited ASCII text. Both data and calibration coefficients are shown. This is the "long" data frame.

Relevant configuration parameters:

- frametype long
- usecal off

Field name	Field size, bytes	Description
Instrument	6	AS-formatted string. Irradiance sensors are SATBI4. Radiance sensors are SATBR4.
Serial number	4 1–10 permitted	AS- or AI-formatted string. the Instrument and Serial number are the frame header.
Tab	1	Delimiter
Channel ($lambda_1$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 1.
Tab	1	Delimiter
A0 ($lambda_1$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 1.
Tab	1	Delimiter
A1 ($lambda_1$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 1.
Tab	1	Delimiter
Im ($lambda_1$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 1.
Tab	1	Delimiter
Channel ($lambda_2$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 2.
Tab	1	Delimiter
A0 ($lambda_2$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 2.
Tab	1	Delimiter
A1 ($lambda_2$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 2.

Tab	1	Delimiter
Im (lambda$_2$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 2.
Tab	1	Delimiter
Channel (lambda$_3$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 3.
Tab	1	Delimiter
A0 (lambda$_3$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 3.
Tab	1	Delimiter
A1 (lambda$_3$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 3.
Tab	1	Delimiter
Im (lambda$_3$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 3.
Tab	1	Delimiter
Channel (lambda$_4$)	10 (typical, max)	AU-formatted value that shows the A/D counts from channel 4.
Tab	1	Delimiter
A0 (lambda$_4$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 4.
Tab	1	Delimiter
A1 (lambda$_4$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 4.
Tab	1	Delimiter
Im (lambda$_4$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 4.
Terminator	2	This field is the end of the frame, <CR-LF>

Output example:

SATB140001 2684550016 2147267103.1 2.03203332555e-007 1.368 2684315904 2147 492578.4 1.95923384221e-007 1.410 2684407360 2147582763.7 2.03019013945e-007 1.365 2684127360 2147871011.6 1.97172313736e-007 1.354

2.6.4 Engineering units with calibration coefficients

Data is shown in engineering units with calibration coefficients as tab-delimited ASCII text. This is a "long" data frame.

Relevant configuration parameters:

- frametype long
- usecal on

Field name	Field size, bytes	Description
Instrument	6	AS-formatted string. Irradiance sensors are SATGI4. Radiance sensors are SATGR4.
Serial number	4 1–10 permitted	AS- or AI-formatted string. the Instrument and Serial number are the frame header.
Tab	1	Delimiter
Channel (lambda$_1$)	10 (typical, max)	AF-formatted value that shows output from channel 1. Irradiance output is uW/cm^2/nm. Radiance output is uW/cm^2/sr.
Tab	1	Delimiter
A0 (lambda$_1$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 1.
Tab	1	Delimiter
A1 (lambda$_1$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 1.

Tab	1	Delimiter
Im ($lambda_1$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 1.
Tab	1	Delimiter
Channel ($lambda_2$)	10 (typical, max)	AF-formatted value that shows output from channel 2. Irradiance output is $uW/cm^2/nm$. Radiance output is $uW/cm^2/sr$.
Tab	1	Delimiter
A0 ($lambda_2$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 2.
Tab	1	Delimiter
A1 ($lambda_2$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 2.
Tab	1	Delimiter
Im ($lambda_2$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 2.
Tab	1	Delimiter
Channel ($lambda_3$)	10 (typical, max)	AF-formatted value that shows output from channel 3. Irradiance output is $uW/cm^2/nm$. Radiance output is $uW/cm^2/sr$.
Tab	1	Delimiter
A0 ($lambda_3$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 3.
Tab	1	Delimiter
A1 ($lambda_3$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 3.
Tab	1	Delimiter
Im ($lambda_3$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 3.
Tab	1	Delimiter
Channel ($lambda_4$)	10 (typical, max)	AF-formatted value that shows output from channel 4. Irradiance output is $uW/cm^2/nm$. Radiance output is $uW/cm^2/sr$.
Tab	1	Delimiter
A0 ($lambda_4$)	14 (max)	Manufacturer OPTIC2 fit type at A0 coefficient for channel 4.
Tab	1	Delimiter
A1 ($lambda_4$)	19 (max)	Manufacturer OPTIC2 fit type at A1 coefficient for channel 4.
Tab	1	Delimiter
Im ($lambda_4$)	6 (max)	Manufacturer OPTIC2 fit type Im (immersion) coefficient for channel 4.
Terminator	2	This field is the end of the frame, <CR-LF>

Output example:

SATG140001 5.6134 2147267103.1 2.03203332555e-007 1.368 8.9193 214749257.4 1. 95923384221e-007 1.41014.6706 2147582763.7 2.03019013945e-007 1.365 22.4710 21 47871011.6 1.97172313736e-007 1.354

Section 3 General maintenance

NOTICE

Do not use abrasive cleaner on the optical face of the sensor. It will cause scratches on the optical epoxy and glass.

NOTICE

Do not use acetone or other solvents to clean any part of the sensor.

1. After each cast or exposure to natural water, flush the sensor with clean fresh water.
2. Use soapy water to clean any grease or oil on the optical face of the sensor. It is made of plastic and can be damaged if an abrasive cleaner is used.
3. Dry the sensor with a clean soft cloth.
4. Install the dummy plug and lock collar to protect the bulkhead connector.
5. Install the protective cap on the optical face.

3.1 Clean bulkhead connectors

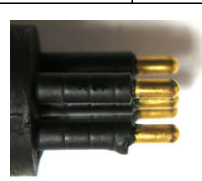
NOTICE

Do not use WD-40® or petroleum-based lubricants on bulkhead connectors. It will cause damage to the rubber.
Damaged connectors can cause a loss of data and additional costs for service.

Damaged connectors can cause damage to the sensor and make it unserviceable.

Examine, clean, and lubricate bulkhead connectors at regular intervals. Connectors that are not lubricated increase the damage to the rubber that seals the connector contacts. The incorrect lubricant will cause the bulkhead connector to fail.

1. Apply isopropyl alcohol (IPA) as a spray or with a nylon brush or lint-free swab or wipes to clean the contacts.
2. Flush with additional IPA.
3. Shake the socket ends and wipe the pins of the connectors to remove the IPA.
4. Blow air into the sockets and on the pins to make sure they are dry.
5. Use a flashlight and a magnifying glass to look for:

Any corrosion.		
Cracks, scratches, or other damage on the rubber pins or in the sockets.		

Separation of the rubber from the pins.	
Swelled or bulging rubber pins.	

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.

   - 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
   - Dow Corning Molykote® III Compound (DC III)
   - Dow Corning High Vacuum Grease® (DC 976 V)
   - Dow Corning 4 Electrical Insulating Compound® (DC 4)
   - Dow Corning Molykote 44 High Temperature Grease® (DC 44)

   Use a finger to put a small quantity (approximately 1 cm in diameter) of silicone grease on the socket end of the connector and push as much of the lubricant as possible into each socket.

7. Connect the connectors.
8. Use a lint-free wipe to clean any unwanted lubricant from the sides of the connectors.

Section 4 Optional equipment: Bioshutter

The bioshutter works to decrease biofouling on the optical faces of the multispectral (504, 507, and 504 UV) and hyperspectral sensors, which can help to increase deployment time. The bioshutter uses a separate power supply to operate and is typically connected to the optical sensor with a Y-cable (supplied by the manufacturer. The basic operation sequence:

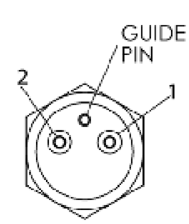
- The shutter opens when power is supplied to the bioshutter, and the device enters a low power mode.
- During the low power mode, the internal backup is charged.
- When power is removed from the bioshutter, the internal power supply closes the shutter.

This mode of operation works well for moored deployments. The bioshutter operates independently of the optical sensor and the controller, as long as there is enough time to charge the internal power supply (approximately 30 seconds).

4.1 Mechanical specifications

	850 m	**850 m RA**	**500 m**	**300 m**
Length	20.3 cm	21.9 cm	19.6 cm	
Diameter	5.1 cm		6.3 cm	5.7 cm
Weight in air	0.9 kg		0.87 kg	0.7 kg
Depth rating	850 m		500 m	300 m
Shutter rotation	180 or 90° clockwise (counterclockwise optional)			

4.1.1 Bulkhead connector

Contact	**Function**	**Description**	**MCBH-2-MP**
1	Voltage in	8–20 VDC input	
2	Ground	Power return	

4.1.2 Dimensions

Figure 1 Standard bioshutter dimensions

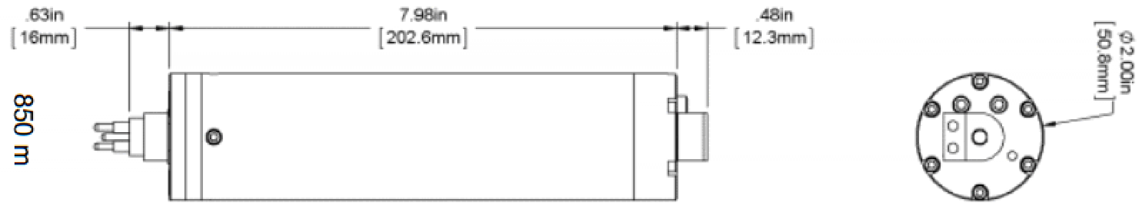
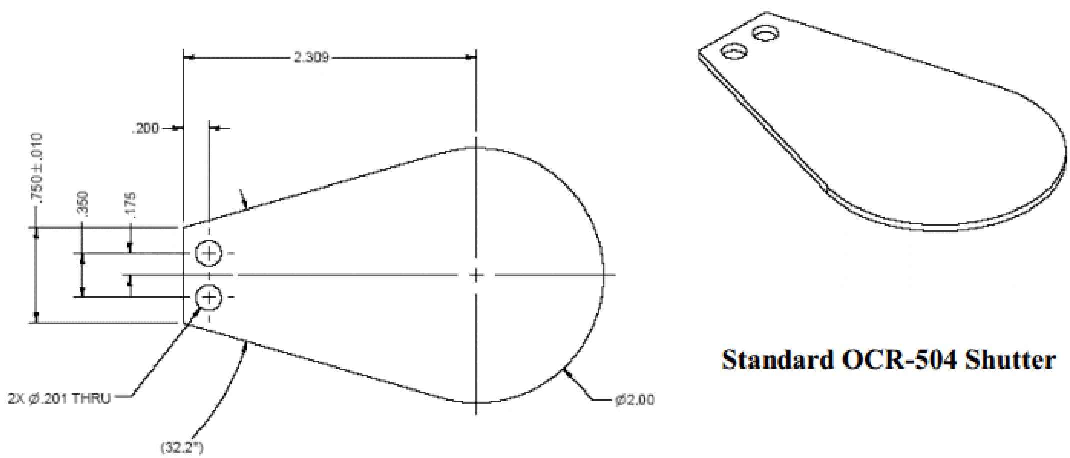
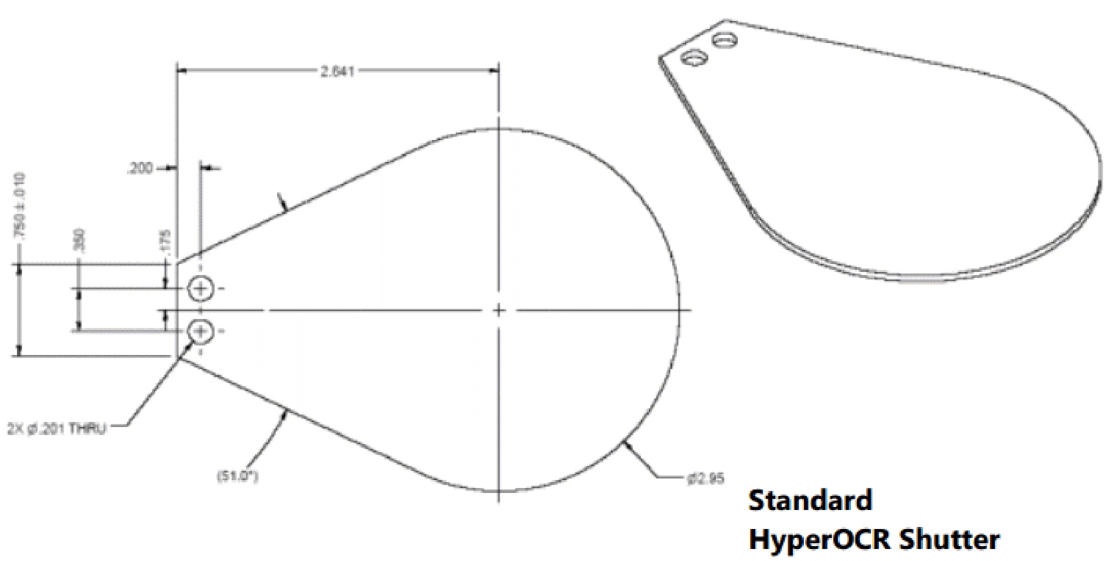


Figure 2 OCR 504 shutter



Shutter weight: 31 g.

Figure 3 HyperOCR shutter



Shutter weight: 100 g.

4.2 Electrical specifications

Input	8–20 VDC
Current draw, typical	250–300 mA
Current draw, low power	13 mA or less
Shutter speed, open	5–10 rpm
Shutter speed, close	4–5 rpm

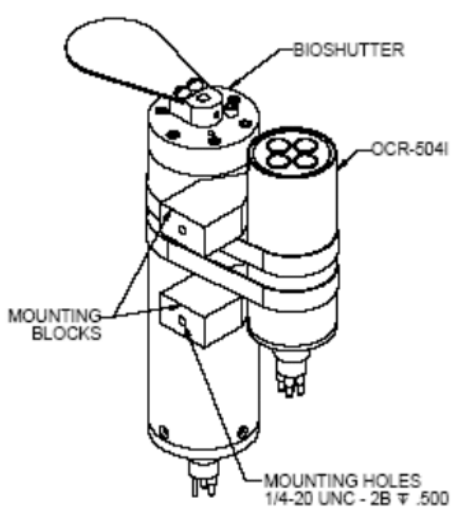
4.3 Operation and maintenance

The manufacturer ships the bioshutter attached to the sensor that was purchased by the user if it was so ordered. The items delivered:

Sensor only	Sensor with bioshutter	Bioshutter only
8-contact dummy plug and lock collar		
Test cable		
Characterization page		
	Y-cable with 2- and 8-contact (socket) connectors and one 8-contact (pin) connector	
	2 mounting blocks	
	2 #80 316 stainless steel hose clamps	
	2-contact dummy plug and lock collar	

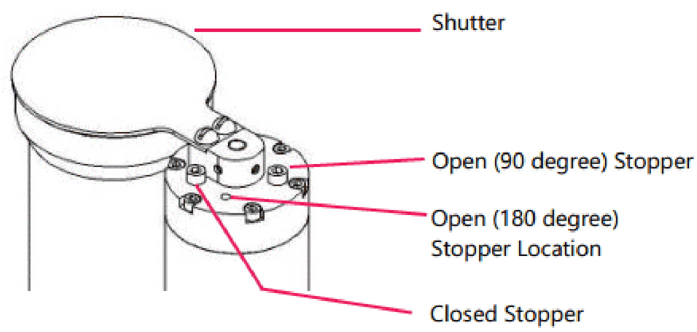
If the bioshutter is purchased by itself, do the steps below to attach it to an optical sensor.

1. Apply a layer of neoprene between the pressure housings and the hose clamps and V-blocks to prevent scratches.
2. Put the bioshutter and the sensor side by side on a flat surface so that the copper shutter is on top of the optical face of the sensor.
3. Note the location of the ¼-20 holes in the V-blocks. These are used for screws to mount to a deployment structure. Make sure that there will be no interference with the rotation of shutter if such a deployment structure is used.
4. Slide the hose clamps onto the pressure housings.
5. Set the V-blocks between the pressure housings. Make sure that the blocks are as close to the top and the bottom of the shorter sensor as practical.



6. Use a flat blade screwdriver to loosely tighten the hose clamps onto the pressure housings.
7. Adjust the distance between shutter and the optical face to 0.5–1 mm.
8. Tighten the hose clamps onto the OCR and bioshutter.
9. The ends of the hose clamps are sharp. Wrap the ends with electrical tape.
10. Use an abrasive pad if necessary to clean the copper shutter before each deployment.
11. Optional: the shutter is set up by the manufacturer to rotate 180 degrees clockwise. The user can set up the shutter to rotate 90 degrees if necessary.

    - Move the 10-32 stainless steel screw to the other open hole. The shutter will rotate 90 degrees to the new hard stop position.



4.3.1 Calculate power use

The bioshutter is typically used in battery-powered moored deployments and can use the same power supply as the OCR to which it is attached. The equation below lets the user estimate the power use of the bioshutter.

$$DBCR \approx (N/3600) \times \left(\int^{t_{SS}} 0.2427e^{-0.0971t}dt + I_{MTR} \times t_{OPEN} + I_{SS} \times t_{ON} \right)$$

Where:

- DBCR = Daily Battery Capacity Requirement
- N = number of events/day
- I_{MTR} = motor current (assume 100 mA)
- t_{OPEN} = time to open the shutter (assume 10 seconds)
- I_{SS} = current necessary in steady state (assume 13 mA)
- t_{SS} = amount of time, in seconds, per event, that the bioshutter has power supplied.

The integral part of the equation is derived from the charge current of the internal backup supply that exponentially decreases.

If the bioshutter operates for 60 seconds every hour for 24 hours, for example, the DBCR is approximately 0.025 Ah per day.

4.3.2 Maintenance

The only maintenance necessary for the bioshutter is to clean the copper shutter at regular intervals and flush the pressure housing after each deployment.

1. Use a ScotchBrite® pad or steel wool to clean the copper shutter. Clean the shutter in place—do not remove from the pressure housing.
2. Flush the sensor and bioshutter with clean fresh water after each deployment.
3. Use a clean soft cloth to dry the sensor and bioshutter.
4. Refer to Clean bulkhead connectors on page 19 for details on the maintenance of bulkhead connectors.
5. Attach the dummy plug and lock collar

Section 5 General information

Revised editions of this user manual are on the manufacturer's website.

5.1 Service and support

The manufacturer recommends that sensors be sent back to the manufacturer annually to be cleaned, calibrated, and for standard maintenance.
Refer to the website for FAQs and technical notes, or contact the manufacturer for support at support@seabird.com.

Do the steps below to send a sensor back to the manufacturer.

1. Complete the online Return Merchandise Authorization (RMA) form or contact the manufacturer.
   Note: *The manufacturer is not responsible for damage to the sensor during return shipment.*
2. Remove all batteries from the sensor, if so equipped.
3. Remove all anti-fouling treatments and devices.
   Note: *The manufacturer will not accept sensors that have been treated with anti-fouling compounds for service or repair. This includes AF 24173 devices, tri-butyl tin, marine anti-fouling paint, ablative coatings, etc.*
4. Use the sensor's original ruggedized shipping case to send the sensor back to the manufacturer.
5. Write the RMA number on the outside of the shipping case and on the packing list.
6. Use 3rd-day air to ship the sensor back to the manufacturer. Do not use ground shipping.
7. The manufacturer will supply all replacement parts and labor and pay to send the sensor back to the user via 3rd-day air shipping.

5.2 Warranty

This sensor is warranted against defects in materials and workmanship for one year from the date of purchase. The warranty is void if the manufacturer finds the sensor was abused or neglected beyond the normal wear and tear of deployment. The manufacturer will replace or repair, as deemed necessary, any defective components. This warranty does not include shipping charges to and from the manufacturer's facility.

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