RemOcean Optical Instruments
Interface Control Document
Document Number: SAT-DN-00579
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Contract Number:	L 16317/HCBIOARGO dated 7 March 2011 L 16634/HC-REMOCEA dated 27 April 2011 L 17446/HC-REMOCEA dated 2 October 2011
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1 Introduction

1.1 Reference Documents

The following documents may be referenced in the body of this document.

RD 1 Satlantic Proposal 2509-6599 for AOO-Sensors-CNRS(LOV), 5 January 2011

RD 2 CNRS Purchase Order L 16317/HCBIOARGO dated 7 March 2011

RD 3 CNRS Purchase Order L 16634/HC-REMOCEA dated 27 April 2011

RD 4 CNRS Purchase Order L 17446/HC-REMOCEA dated 2 October 2011

RD 5 OCR-504 Operation Manual, Satlantic, SAT-DN-00034 Rev.E1 23 June 2011

RD 6 Bio-Triplet Integrator's User's Guide, WET Labs, Rev.A 9 June 2011

RD 7 c-Rover 7 (CRV7) Beam Transmissometer User's Integration Guide, WET Labs, Rev.A 9 June 2011

RD 8 Drawing 5380901 General Dimensions of RemOcean Instrument B, WET Labs, 21 March 2011

RD 9 Drawing 5380902 General Dimensions of RemOcean Instrument A, WET Labs, 21 March 2011

RD 10 Drawing E810131A, Cable, RemOcean Float to Instrument A, Satlantic, 11 April 2011

RD 11 Drawing E810132A, Cable, RemOcean Float to Instrument B, Satlantic, 11 April 2011

RD 12 Drawing SE 300-62, SubConn® Micro Series 8 Contacts, SubConn, 11-08

RD 13 Technical Bulletin 65 70 rev 0109, LPBH/LPIL-9/12 Low Profiler Wet Pluggable Series, Teledyne Impulse, 2009

1.2 Abbreviations & Symbols

AOP Apparent Optical Property

ASCII American Standard Code for Information Interchange, is a character-encoding scheme based on the ordering of the English alphabet.

CDOM Colored Dissolved Organic Matter

ECO Environmental Characterization Optics (WET Labs)

IOP Inherent Optical Property

OCR Ocean Color Radiometer (Satlantic)

TDF Telemetry Definition File

PAR Photosynthetically Active Radiation

Symbol	Description	Units
$E_d(\lambda)$	Downwelling spectral irradiance below the sea-surface	$\mu W\ cm^{-2}\ nm^{-1}$
$E_s(\lambda)$	Downwelling spectral irradiance above the sea-surface	$\mu W\ cm^{-2}\ nm^{-1}$
$L_u(\lambda)$	Upwelling spectral radiance below the sea-surface	$\mu W\ cm^{-2}\ nm^{-1}\ sr^{-1}$
$L_s(\lambda)$	Upwelling spectral radiance measured near the sea surface	$\mu W\ cm^{-2}\ nm^{-1}\ sr^{-1}$
$\beta(\theta,\lambda)$	Volume scattering coefficient	$m^{-1}\ sr^{-1}$
λ	Wavelength	nm
SF	Scale factor, slope	Property units/count
Off	Offset (same as Dark)	counts
Dark	Dark counts (same as Off)	counts
c	Beam attenuation coefficient	m^{-1}

Table 1 Symbols

Data Type	Description
AI	ASCII integer number.
AF	ASCII floating point number.
AS	ASCII string, text.
BD	Double precision floating point number. Field length is 8 bytes. IEEE 754-2008.
BF	Single precision floating point number. Field length is 4 bytes. IEEE 754-2008.
BS	Signed binary integer (2's complement). Most significant byte first. Field length is 1-4 bytes.
BSLE	Signed binary integer (2's complement). Least significant byte first (Little-Endian). Field length is 1-4 bytes.
BU	Unsigned binary integer. Most significant byte first. Field length is 1-4 bytes.
BULE	Unsigned binary integer. Least significant byte first (Little-Endian). Field length is 1-4 bytes.

Table 2 Data Types

Fit Types	Description
OPTIC2	Special factored polynomial with one gain range. For optical sensors only.
	$y = \mathrm{Im} \cdot a_1 \cdot (x - a_0)$, if the sensor is immersed. $y = 1.0 \cdot a_1 \cdot (x - a_0)$, if the sensor is not immersed.
	The independent variable, x, may be any numeric data type. Two calibration coefficients, a_0, a_1, and the immersion coefficient, Im, are specified in the instrument file. The immersion coefficient can be overridden by the application if the sensor is calibrated for water but used in air. The default is to use the immersion coefficient found in the instrument file. The wet or dry status of the optical sensors is determined from the log file headers. The resultant fitted value, y, is a floating-point number.
POLYU	Unfactored polynomial.
	$y = \sum_{k=0}^{n} a_k x^k = a_0 x^0 + a_1 x^1 + a_2 x^2 + \cdots + a_n x^n$
	The independent variable, x, may be any numeric data type. Any number of fitting coefficients, ak, may be specified in the instrument file. The resultant fitted value, y, is a floating-point number.
POLYF	Factored polynomial.
	$y = a_0 \prod_{k=1}^{n} (x - a_k) = a_0 \cdot (x - a_1) \cdot (x - a_2) \cdots (x - a_n)$
	The independent variable, x, may be any numeric data type. Any number of fitting coefficients, a_k, may be specified in the instrument file. The resultant fitted value, y, is a floating-point number.

Table 3 Fit Types

1.3 Scope

This document specifies the interfaces of the RemOcean optical instruments described in RD 1. The following interface characteristics are specified:

1. Sensor
    1.1. Property
    1.2. Range
    1.3. Sensitivity
2. Mechanical
    2.1. Orientation and field of view
    2.2. Materials
    2.3. Dimensions
    2.4. Weight
    2.5. Depth rating
    2.6. Connections
3. Electrical
    3.1. Connector types
    3.2. Connector pin assignment
    3.3. Voltage input range
    3.4. Current or Power requirements
4. Telemetry
    4.1. Data communication serial protocol, byte format, flow control
    4.2. Data rates
    4.3. Sample rates/intervals
    4.4. Data Frame formats
    4.5. Sensor values
5. Control
    5.1. Commands and replies

2 System Description

2.1 Sensor

The RemOcean optical instruments comprise two integrated sensor system configurations:

Instrument A combines the OCR-504 ICSW and ECO FLBBCD (Triplet);

Instrument B combines the OCR-504 ICSW, ECO FLBBCD (Triplet) and c-Rover.

The instrument capabilities are summarized in Table 4 and Table 5.

Instrument	Measurements	λ	Range	Sensitivity
OCR-504 ICSW	Downwelling Irradiance, $E_d(\lambda)$	380 nm	300 $\mu W \cdot cm^{-2} \cdot nm^{-1}$	0.0025 $\mu W \cdot cm^{-2} \cdot nm^{-1}$
		412 nm		
		490 nm		
	PAR	400-700 nm	3500 $\mu Mole\ photons \cdot m^{-2} \cdot s^{-1}$	0.01 $\mu Mole\ photons \cdot m^{-2} \cdot s^{-1}$
ECO FLBBCD	Chlorophyll A (chl)	Ex 470 nm Em 695 nm	30 µg/l	0.15 µg/l
	Backscatter (bb)	700 nm	3 m^{-1}	0.0015 m^{-1}
	CDOM (CD)	Ex 370 nm Em 460 nm	375 ppb	0.18 ppb

Table 4 RemOcean Optical Instrument A

Instrument	Measurements	λ	Range	Sensitivity
OCR-504 ICSW	Downwelling Irradiance, $E_d(\lambda)$	380 nm	300 $\mu W \cdot cm^{-2} \cdot nm^{-1}$	0.0025 $\mu W \cdot cm^{-2} \cdot nm^{-1}$
		412 nm		
		490 nm		
	PAR	400-700 nm	3500 $\mu Mole\ photons \cdot m^{-2} \cdot s^{-1}$	0.01 $\mu Mole\ photons \cdot m^{-2} \cdot s^{-1}$
ECO FLBBCD	Chlorophyll A	Ex 470 nm Em 695 nm	30 µg/l	0.15 µg/l
	Backscatter	700 nm	3 m^{-1}	0.0015 m^{-1}
	CDOM	Ex 370 nm Em 460 nm	375 ppb	0.18 ppb
c-Rover	Beam Attenuation Coefficient, c	650 nm	90 m^{-1}	0.001 m^{-1}

Table 5 RemOcean Optical Instrument B

2.2 Mechanical

Instrument A and B are mounted high on the profiling float and oriented in such a manner that the fields of view of both the OCR-504 ICSW and the ECO Triplet are clear. The OCR-504 ICSW is oriented with sensors upward; the field of view is the hemisphere centred on the zenith. The ECO Triplet is oriented with sensors horizontally directed away from the float.

General dimensions of instruments A and B are listed in the following tables and in the general layout drawings 5380902 and 5380901 attached.

Dimension	SN001 – 005, 031 – 035	SN006 – 026
Diameter (main housing)	101.1 mm	101.1 mm
Length (excludes connector and anode)	249.6 mm	245.4 mm
Displacement	1516 ml	1509 ml
Weight	2.12 kg	2.24 g
Construction	Aluminum, PEEK®	Aluminum
Depth Rating	2000 m	2000 m
Connections	SubConn MCBH8MNM	SubConn MCBH8MNM

Table 6 Instrument A Dimensions

Dimension	SN039 – 045	SN027 – 030
Diameter (main housing)	101.4 mm	101.4 mm
Length (excludes connector and anode)	736.5 mm	732.4 mm
Displacement	3634 ml	3627 ml
Weight	5.28 kg	5.51 kg
Construction	Aluminum, PEEK®	Aluminum
Depth Rating	2000 m	2000 m
Connections	Impulse LP-BH-12MP	Impulse LP-BH-12MP

Table 7 Instrument B Dimensions

Note: Instrument displacement and weight estimates including the bulkhead connector and anode installed, and exclude cable connectors or dummy plugs.

2.3 Electrical

The OCR-504, ECO Triplet and c-Rover are powered independently by the host float by applying supply voltage to the corresponding circuits indicated in Table 9 and Table 10. Voltage requirements and typical current draw are listed in Table 8. Cables drawings for Instruments A and B are provided in drawings E810131A and E810132A attached. Table 11 shows the float's instrument port pin assignment.

Instrument	Voltage	Current
OCR-504	6-22 V	15 mA
ECO Triplet	7-15 V	90 mA
c-Rover	7-15 V	35 mA typical, 50 mA maximum

Table 8 Power Requirements

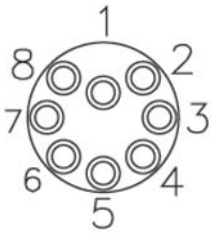
Port Identification	Instrument A Connector	SubConn MCBH8MNM
Pin	Identification	
1	Tx ECOFLBBCD	
2	Rx ECOFLBBCD	
3	Tx OCR-504	
4	Rx OCR-504	
5	V+ ECOFLBBCD	
6	V+ OCR-504	
7	N/C	
8	Ground Common	

Table 9 Instrument A Connector

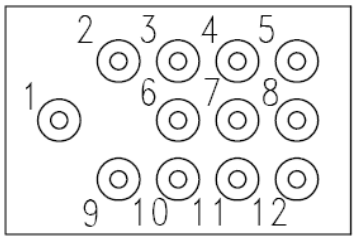
Port Identification	Instrument B Connector	Impulse LPBH-12-MP
Pin	Identification	
1	Tx ECOFLBBCD	
2	Rx ECOFLBBCD	
3	Tx OCR-504	
4	Rx OCR-504	
5	Tx c-Rover	
6	Rx c-Rover	
7	N/C	
8	N/C	
9	V+ ECOFLBBCD	
10	V+ OCR-504	
11	V+ c-Rover	
12	Ground Common	

Table 10 Instrument B Connector

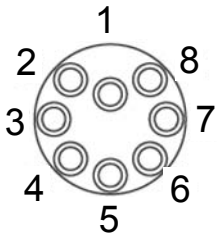
Port Identification	Float Instrument Port	MCBH8F
Pin	Identification	
1	Tx ECOFLBBCD	
2	Tx OCR-504	
3	Tx c-Rover	
4	N/C	
5	V+ ECOFLBBCD	
6	V+ OCR-504	
7	V+ c-Rover	
8	Ground Common	

Table 11 Float Instrument Port

2.4 Telemetry

The data communications interfaces for constituent instruments of Instrument A and Instrument B are summarized in this section.

2.4.1 OCR-504 ICSW Telemetry

Parameter	Default	Options
Signaling	RS-232	
Byte format	8N1	
Flow control	No	
Data rate	19200 bps	9600 – 115200 bps
Frame rate	1 Hz	0.125, 0.25, 0.5, 1, 2, 3, 4 Hz, 0 (AUTO ~7.5 Hz)

Table 12 OCR-504 ICSW Data Communication

Frame type	Length (B)	Description
short	56 (max)	ASCII, instrument identifier, raw sensor counts
long	224 (max)	ASCII, instrument identifier, raw sensor counts, calibration coefficients
binary	46	Binary, instrument identifier, raw sensor counts, ancillary data, checksum

Table 13 OCR-504 ICSW Data Frame Types

Field	Length (B)	Data Type	Description
Instrument	6	AS	String denoting the start of a frame. “SATAI4”
Serial Number	4	AI	Serial number.
Delimiter	1	AS	Tab delimiter.
Channel(λ_1)	10	AI	Sampled A/D counts from the first optical channel.
Delimiter	1	AS	Tab delimiter.
Channel(λ_2)	10	AI	Sampled A/D counts from the second optical channel.
Delimiter	1	AS	Tab delimiter.
Channel(λ_3)	10	AI	Sampled A/D counts from the third optical channel.
Delimiter	1	AS	Tab delimiter.
Channel(PAR)	10	AI	Sampled A/D counts from the fourth optical channel, PAR.
Terminator	2	AS	Carriage return/line feed ($0D_{hex}$ and $0A_{hex}$) indicates end of frame.

Table 14 OCR-504 ICSW Data Frame Format: *short*

Example: SATAI40001 2684550016 2684315904 2684407360 2684127360

Field	Length (B)	Data Type	Description
Instrument	6	AS	String denoting the start of a frame. “SATBI4”
Serial Number	4	AI	Serial number.
Delimiter	1	AS	Tab delimiter.
Channel(λ_1)	10	AI	Sampled A/D counts from the first optical channel
Delimiter	1	AS	Tab delimiter.
Channel(λ_1)	14	AF	The OPTIC2 fit type a_0 coefficient for channel 1.
Delimiter	1	AS	Tab delimiter.
$A_1(\lambda_1)$	19	AF	The OPTIC2 fit type a_1 coefficient for channel 1.
Delimiter	1	AS	Tab delimiter.
Im(λ_1)	6	AF	The OPTIC2 fit type Im (immersion) coefficient for channel 1.
Delimiter	1	AS	Tab delimiter.
Channel(λ_2)	10	AI	Sampled A/D counts from the second optical channel
Delimiter	1	AS	Tab delimiter.
$a_0(\lambda_2)$	14	AF	The OPTIC2 fit type a_0 coefficient for channel 2.
Delimiter	1	AS	Tab delimiter.
$a_1(\lambda_2)$	19	AF	The OPTIC2 fit type a_1 coefficient for channel 2.
Delimiter	1	AS	Tab delimiter.
Im(λ_2)	6	AF	The OPTIC2 fit type Im (immersion) coefficient for channel 2.
Delimiter	1	AS	Tab delimiter.
Channel(λ_3)	10	AI	Sampled A/D counts from the third optical channel.
Delimiter	1	AS	Tab delimiter.
$a_0(\lambda_3)$	14	AF	The OPTIC2 fit type a_0 coefficient for channel 3.
Delimiter	1	AS	Tab delimiter.
$a_1(\lambda_3)$	19	AF	The OPTIC2 fit type a_1 coefficient for channel 3.
Delimiter	1	AS	Tab delimiter.
Im(λ_3)	6	AF	The OPTIC2 fit type Im (immersion) coefficient for channel 3.
Delimiter	1	AS	Tab delimiter.
Channel(PAR)	10	AI	Sampled A/D counts from the fourth optical channel, PAR.
Delimiter	1	AS	Tab delimiter.
a_0(PAR)	14	AF	The OPTIC2 fit type a_0 coefficient for channel 4, PAR.
Delimiter	1	AS	Tab delimiter.
a_1(PAR)	19	AF	The OPTIC2 fit type a_1 coefficient for channel 4, PAR.
Delimiter	1	AS	Tab delimiter.
Im(PAR)	6	AF	The OPTIC2 fit type Im (immersion) coefficient for channel 4, PAR.
Terminator	2	AS	Carriage return/line pair ($0D_{hex}$ and $0A_{hex}$) indicates end of frame.

Table 15 OCR-504 ICSW Data Frame Format: *long*

Example: SATBI40001 2684550016 2147267103.1 2.03203332555e-007 1.368 2684315904 2147492578.4 1.95923384221e-007 1.410 2684407360 2147582763.7 2.03019013945e-007 1.365 2684127360 2147871011.6 1.97172313736e-007 1.354

Field	Length (B)	Data Type	Description
Instrument	6	AS	String denoting the start of a frame. “SATDI4”
Serial Number	4	AI	Serial number.
Timer	10	AF	Number of seconds since the end of the initialization sequence. The field is left padded with zeros and has two digits after the decimal.
Sample Delay	2	BS	Number of milliseconds to offset the Timer value to accurately indicate when the sensor was sampled.
Channel(λ_1)	4	BU	Sampled A/D counts from the first optical channel.
Channel(λ_2)	4	BU	Sampled A/D counts from the second optical channel.
Channel(λ_3)	4	BU	Sampled A/D counts from the third optical channel.
Channel(PAR)	4	BU	Sampled A/D counts from the fourth optical channel, PAR.
Vin Sense	2	BU	Input voltage.
Int. Temp.	2	BU	Internal temperature.
Frame Counter	1	BU	A data integrity field that maintains a count of frames transmitted. The count increments from 0 to 255, at which point it rolls back to zero.
Check Sum	1	BU	Data integrity field implements check sum on the telemetry frame.
Terminator	2	AS	Carriage return/line feed ($0D_{hex}$ and $0A_{hex}$) indicates end of frame.

Table 16 OCR-504 ICSW Data Frame Format: *binary*

The radiometric measurements are calculated by applying the OPTIC2 fit type to the raw data contained in the Channel(λ) fields with the calibration coefficients that are stored in the instrument.

$$y = \mathrm{Im} \cdot a_1 \cdot (x - a_0)$$

$$E_d(\lambda_n) = \mathrm{Im}(\lambda_n) \cdot a_1(\lambda_n) \cdot (Channel(\lambda_n) - a_0(\lambda_n))$$

Calibration coefficients are recorded in the instrument files stored on the documentation CD that accompanies the instrument. The conversion can be applied internally by the instrument by setting the configuration parameter *usecal*. Resulting data formats are described in RD 5.

2.4.2 ECO Triplet Telemetry

Parameter	Default	Options
Signaling	RS-232	
Byte format	8N1	
Flow control	No	
Data rate	19200 bps	2400 – 230400 bps
Frame rate	1 Hz	to 8 Hz

Table 17 ECO Triplet Data Communication

Frame type	Length (B)	Description
Standard	49 (max)	ASCII, date, type, emission wavelengths, raw sensor counts, ancillary data
Short	20 (max)	ASCII, instrument serial number, raw sensor counts
Long	56 (max)	ASCII, instrument serial number, raw sensor counts, calibration coefficients
BOSS	58 (max)	ASCII, instrument identifier, emission wavelengths, calculated sensor data

Table 18 ECO Triplet Data Frame Types

Field	Length (B)	Data Type	Description
Date	8	AS	Dummy date 99/99/99
Delimiter	1	AS	Tab delimiter.
Time	8	AS	Dummy time 99:99:99
Delimiter	1	AS	Tab delimiter.
FL EM	3	AI	Chlorophyll fluorometer emission wavelength in nm.
Delimiter	1	AS	Tab delimiter.
ChlRawData	4	AI	Sampled A/D counts from the chlorophyll fluorometer.
Delimiter	1	AS	Tab delimiter.
bb EM	3	AI	Scattering emission wavelength in nm.
Delimiter	1	AS	Tab delimiter.
bbRawData	4	AI	Sampled A/D counts from the scattering meter.
Delimiter	1	AS	Tab delimiter.
CD EM	3	AI	CDOM fluorometer emission wavelength in nm.
Delimiter	1	AS	Tab delimiter.
CDRawData	4	AI	Sampled A/D counts from the CDOM fluorometer.
Delimiter	1	AS	Tab delimiter.
Therm	3	AI	Sampled A/D counts from the internal thermistor.
Terminator	1	AS	Line feed pair ($0A_{hex}$) indicates end of frame.

Table 19 ECO Triplet Data Frame Format: *Standard*

Example: 99/99/99 99:99:99 695 2010 700 1766 460 2128 527

Field	Length (B)	Data Type	Description
$RawData_{Chl}$	4	AI	Sampled A/D counts from the chlorophyll fluorometer.
Delimiter	1	AS	Tab delimiter.
$RawData_{bb}$	4	AI	Sampled A/D counts from the scattering meter.
Delimiter	1	AS	Tab delimiter.
$RawData_{CDOM}$	4	AI	Sampled A/D counts from the CDOM fluorometer.
Delimiter	1	AS	Tab delimiter.
SN	4	AI	String denoting the serial number of the instrument.
Terminator	1	AS	Line feed ($0A_{hex}$) indicates end of frame.

Table 20 ECO Triplet Data Frame Format: *Short*

Example: 2223 2010 1766 2128

Field	Length (B)	Data Type	Description
$RawData_{Chl}$	4	AI	Sampled A/D counts from the Chlorophyll fluorometer.
Delimiter	1	AS	Tab delimiter.
$RawData_{bb}$	4	AI	Sampled A/D counts from the Scattering meter.
Delimiter	1	AS	Tab delimiter.
$RawData_{CDOM}$	4	AI	Sampled A/D counts from the CDOM fluorometer.
Delimiter	1	AS	Tab delimiter.
SN	4	AI	String denoting the serial number of the instrument.
Delimiter	1	AS	Tab delimiter.
SF_{Chl}	8	AF	Chlorophyll Scale Factor, the POLYF fit type a_0 coefficient.
Delimiter	1	AS	Tab delimiter.
$Dark_{Chl}$	2	AI	Chlorophyll Dark offset, the POLYF fit type a_1 coefficient.
Delimiter	1	AS	Tab delimiter.
SF_{bb}	8	AF	Scattering Scale Factor, the POLYF fit type a_0 coefficient.
Delimiter	1	AS	Tab delimiter.
$Dark_{bb}$	2	AI	Scattering Dark offset, the POLYF fit type a_1 coefficient.
Delimiter	1	AS	Tab delimiter.
SF_{CDOM}	8	AF	CDOM Scale Factor, the POLYF fit type a_0 coefficient.
Delimiter	1	AS	Tab delimiter.
$Dark_{CDOM}$	2	AI	CDOM Dark offset, the POLYF fit type a_1 coefficient.
Terminator	1	AS	Line feed ($0A_{hex}$) indicates end of frame.

Table 21 ECO Triplet Data Frame Format: *Long*

Example: 2223 2010 1766 2128 7.300E-03 48 1.892E-06 50 8.802E-02 52

The ECO Triplet measurements are calculated by applying the POLYF fit type to the raw data contained in the sensor fields with the calibration coefficients that are stored in the instrument.

$$y = a_0 \cdot (x - a_1)$$

$$Chl = SF_{Chl} \cdot (RawData_{Chl} - Dark_{Chl})$$

$$bb = SF_{bb} \cdot (RawData_{bb} - Dark_{bb})$$

$$CDOM = SF_{CDOM} \cdot (RawData_{CDOM} - Dark_{CDOM})$$

Calibration coefficients, SF and Dark, are listed in records that accompany the instrument.

Field	Length (B)	Data Type	Description
Instrument	10	AS	String denoting the start of a frame. “FLBBCDREM”
Delimiter	1	AS	Hyphen delimiter
SN	4	AI	Serial Number.
Delimiter	1	AS	Tab delimiter.
FL EM	3	AI	Chlorophyll fluorometer emission wavelength in nm.
Delimiter	1	AS	Tab delimiter.
FL Data	9	AF	Chlorophyll-a measurement in µg/l.
Delimiter	1	AS	Tab delimiter.
bb EM	3	AI	Scattering emission wavelength in nm.
Delimiter	1	AS	Tab delimiter.
bb Data	9	AF	Scattering measurement in m^{-1}.
Delimiter	1	AS	Tab delimiter.
CD EM	3	AI	CDOM fluorometer emission wavelength in nm.
Delimiter	1	AS	Tab delimiter.
CD Data	9	AF	CDOM measurement in ppb.
Terminator	1	AS	Line feed pair ($0A_{hex}$) indicates end of frame.

Table 22 ECO Triplet Data Frame Format: *BOSS (Physical Units)*

Example: FLBBCDREM-2285 695 1.460E-02 700 6.311E-05 460 7.120E-01

2.4.3 c-Rover Telemetry

Parameter	Default	Options
Signaling	RS-232	
Byte format	8N1	
Flow control	No	
Data rate	19200 bps	2400 – 230400 bps
Frame rate	1 Hz	to 8 Hz

Table 23 c-Rover Data Communication

Frame type	Length (B)	Description
Default	39	ASCII, instrument identifier, raw sensor counts for reference measurement and signal, calculated sensor measurements in physical units, ancillary data.

Table 24 c-Rover Data Frame Types

Field	Length (B)	Data Type	Description
Instrument	4	AS	String denoting the start of a frame. “CRV7”
Delimiter	1	AS	Hyphen delimiter
SN	3-4	AI	Serial number.
Delimiter	1	AS	Tab delimiter.
Ref Raw	5	AI	Reference raw count value, sampled A/D counts.
Delimiter	1	AS	Tab delimiter.
Sig Raw	5	AI	Signal raw count value, sampled A/D counts.
Delimiter	1	AS	Tab delimiter.
Corr Sig Raw	5	AI	Corrected signal raw count value, CSC_{sig}.
Delimiter	1	AS	Tab delimiter.
c	6	AF	Calculated Beam Attenuation Coefficient, c, in m^{-1}.
Delimiter	1	AS	Tab delimiter.
Therm	3	AI	Internal thermistor raw count value, sampled A/D counts.
Terminator	1	AS	Line feed pair ($0A_{hex}$) indicates end of frame.

Table 25 c-Rover Data Frame Format

Example: CRV7-035 13565 15377 15389 00.032 536

The c-Rover calculations are described in RD 7. Briefly, beam transmittance, Tr, is calculated:

$$Tr = \frac{CSC_{sig} - CSC_{dark}}{CSC_{cal} - CSC_{dark}}$$

Where,

CSC_{sig} , corrected signal count for the measured output signal;

CSC_{dark} , corrected signal count for the dark offset, measurement of a blocked path;

CSC_{cal} , corrected signal counts for clean water.

Transmittance is related to beam attenuation coefficient, c, by the relationship:

$$Tr = e^{-cx}$$

Where,

x, path length, 25 cm. Therefore,

$$c = -\frac{1}{x} \cdot \ln\left(\frac{CSC_{sig} - CSC_{dark}}{CSC_{cal} - CSC_{dark}}\right)$$

The values, CSC_{cal} and CSD_{dark} are listed in the calibration record that accompanies the instrument.

2.5 Control

2.5.1 OCR-504 ICSW Control

This section describes the minimal commands required to configure the OCR-504 for RemOcean operation. Table 26 lists relevant commands and settings; factory settings are indicated by bold type. The full OCR-504 command set is described in RD 5.

Use a terminal emulation program to connect to the serial interface of the instrument. Once power is applied, the OCR-504 initializes and starts transmitting data frames to the host. To access the command console, press `<Ctrl+C>` , i.e. press and hold the Ctrl key and type C. The data transmission stops and the console command prompt is displayed.

```
OCR-504 Command Console
Type 'help' for a list of available commands.


[Auto]$
```

The dollar sign prompt, `$`, is preceded by `[Auto]` indicating the current operating mode.

At the prompt, type a command followed by the `<Enter>` key to execute the command and display the results, if any. Commands and arguments are case sensitive. To recall the last executed command, press the `<Esc>` key on a clear command prompt.

After using the `set` command to change settings, execute the `save` command before leaving the command console. Changes can be abandoned by exiting the console without saving.

Command Syntax	Description
<Ctrl+C>	Interrupt operation and invoke the command console.
<Ctrl+R>	Reset, reboot the instrument.
`<Esc>`	Recall the last executed command.
`exit`	Exit the command console and resume operation.
`help`	Display a list of available console commands.
`command` `-?`	Display help for the specified command.
`reset`	Reset the command console.
`id`	Display the instrument identification banner.
`save`	Save all configuration parameter values modified using the `set` command in persistent storage. If the save command is not invoked, changes to parameter values made during the current console session are lost when the console is exited or power is removed.
`show` *`parameter`* | `calcoeffs` | `all`	Show the value of the specified parameter, the calibration coefficients, or all parameters. Show displays the current value of parameters modified during the current console session even if they have not yet been saved.
`set` *`parameter value`*	Set a configuration parameter value. The command requires two arguments, the “parameter” and the “value” which must be a valid option for

<table>
<tr><th>Command Syntax</th><th>Description</th></tr>
<tr><td></td><td>the parameter. Options are separated by the “|” symbol in the command syntax description. Only one option may be specified. Integration of the instrument with a host system such as the RemOcean profiling float requires a particular configuration. Modifying settings affects instrument operation and may affect the integration of the instrument with the host.

The save command must be invoked to store new settings in persistant storage before exiting the command console.

A list of parameters and valid values follows. Factory settings are indicated by bold type.</td></tr>
<tr><td>set telbaud 9600 | 19200 | 38600 | 57600 | 115200</td><td>Telemetry baud rate in bps.</td></tr>
<tr><td>set maxrate 0 | 0.125 | 0.25 | 0.5 | 1 | 2 | 4</td><td>Maximum frame rate in Hz. The value 0 specifies an automatic frame rate where frames are output as fast as possible. The fastest rate possible is approximately 7.5 Hz but may be affected by other settings such as averaging, telemetry baud rate and frame type.</td></tr>
<tr><td>set initsm on | off</td><td>Initialize Silent Mode. If silent mode is off the instrument displays a verbose banner at initialization.</td></tr>
<tr><td>set initpd on | off</td><td>Initialize Power Down. In power down mode, the instrument boots into a power saving mode and does not sample or transmit telemetry.</td></tr>
<tr><td>set initat on | off</td><td>Initialize Automatic Telemetry to enable free running telemetry in accordance with the frame rate setting. If Automatic Telemetry is off, the instrument is in polled mode in which single telemetry frames are sent in response to <Enter> or <Space> commands.</td></tr>
<tr><td>set netmode on | off</td><td>Network Mode makes the instrument a node on a SatNet network. Although this mode option is available in firmware, it is not compatible with the RemOcean configuration.</td></tr>
<tr><td>set avg on | off</td><td>Optical Data Averaging calculates the mean of a number of sensor ADC samples. The number of samples, n, used for each data frame depends on the frame rate, Hz, according to the following table:
<table>
<tr><td>Hz</td><td>0.125</td><td>0.25</td><td>0.5</td><td>1</td><td>2</td><td>4</td><td>7.5</td></tr>
</table></td></tr>
<tr><td>set usecal on | off</td><td>Apply Calibration Coefficients enables measurements to be calculated by applying the calibration coefficients and appropriate fit formulas to the raw sensor data. When enabled, the data frame contains measurements formatted in physical units. When not enabled, the data frame contains raw sensor ADC counts.</td></tr>
<tr><td>set immersed on | off</td><td>Apply immersion coefficients to the optical data in telemetry frames that use engineering units.</td></tr>
<tr><td>set latency 0 .. 4294967296</td><td>Add a startup delay before sampling begins after power-up. The unit of the latency parameter is millisecond.</td></tr>
<tr><td>set frametype binary | short | long</td><td>Frame Type specifies the format and content of the data frame.</td></tr>
<tr><td>set a0ch1|2|3|4 value</td><td>Set the calibration coefficients, a0, a1 and Im for each channel.</td></tr>
</table>

Command Syntax	Description

`set a1ch1|2|3|4 value`
`set imch1|2|3|4 value`
	a0, dark offset, is entered in decimal format using up to 14 characters, e.g.,
	`set a0ch2 2147267103.1`
	a1, scale, is entered in scientific notation using up to 19 characters, e.g.,
	`set a1ch2 2.03203332555e-007`
	Im, immersion coefficient, is entered in decimal format using up to 5 characters, e.g.,
	`set imch4 1.354`

Table 26 OCR-504 ICSW Commands and Settings

2.5.2 ECO Triplet Control

This section describes minimal commands to configure the ECO Triplet for RemOcean operation.

Use a terminal emulation program to connect to the serial interface of the instrument. Once power is applied, the ECO Triplet initializes and starts transmitting data frames to the host. To access the command console, type !!!!!! , do not press the <Enter> key. Data transmission stops and instrument identification, settings and calibration coefficients are displayed.

```
Ser FLBBCD-0001
Ver TripletDv5.14
Ave 18
Pkt 0
m1d 48
m2d 47
m3d 42
m1s 7.300E-03
m2s 1.862E-06
m3s 8.900E-02
Seq 2
```

Type a command followed by the `<Enter>` key to execute the command and display the results, if any. Commands and arguments are not case sensitive.

After changing settings, execute the `$sto` command to store to flash memory. Before using the `$sto` command changes can be abandoned by the $rls command or removing power from the instrument.

Command Syntax	Description
!!!!!	Interrupt operation and invoke the command console.
$run	Run, resume operation, execute the current settings.
`$ave 1..65535`	Average of the number of measurements specified is calculated and used for the reported value. Factory setting is **18**. The frame rate is proportional to 1/n. A change in this setting changes the frame rate.
`$mnu`	Menu displays the instrument identification and current settings.
`$pkt 0..65535`	Packet size is the number of data frames to be reported. Specifying "0" causes the instrument to continue reporting indefinitely. Factory setting is **0**.
`$rat 2400..230400`	Baud rate for instrument communications must be a valid rate. If the rate specified is not valid, the default rate 19200 bps is set. Factory setting is **19200**.
`$rfd`	Reload factory default settings.
`$rls`	Reload settings from flash memory.
`$seq 0..3`	Select a predefined output sequence, or frame format, from options: 0 Standard 1 Short **2** Long (factory setting) 3 BOSS (Physical Units)

Command Syntax	Description
`$m1d 0..65535`	Set Dark offset for measurement 1, Chlorophyll. The value is an integer in the range 0..65535.
`$m1s` *SF*	Set Scale Factor for measurement 1, Chlorophyll. The value is a floating point number and may be entered in decimal or exponential form, e.g. 0.0073 or 7.3E-3.
`$m2d 0..65535`	Set Dark offset for measurement 2, Scattering.
`$m2s` *SF*	Set Scale Factor for measurement 1, Scattering.
`$m3d 0..65535`	Set Dark offset for measurement 3, CDOM.
`$m3s` *SF*	Set Scale Factor for measurement 3, CDOM.
`$sto`	Stores all settings modified during the current session in flash memory. If the $sto command is not invoked, changes to made during the current console session are lost when power is removed.

Table 27 ECO Triplet Commands and Settings

Ser FLBBCDBOSS-2285

Ver TripletDv5.14

Ave 18

Pkt 0

m1d 48

m2d 47

m3d 42

m1s 7.300E-03

m2s 1.862E-06

m3s 8.900E-02

Seq 1

$mnu

Ser FLBBCDBOSS-2285

Ver TripletDv5.14

Ave 18

Pkt 0

m1d 48

m2d 47

m3d 42

m1s 7.300E-03

m2s 1.862E-06

m3s 8.900E-02

Seq 1

$par

ratr 19200

m1n 9

m1f 23

m2n 9

m2f 23

m3n 11

m3f 24

so1 50

so2 50

so3 50

rv1 695

rv2 700

rv3 460

sv1 160

sv2 135

sv3 95

sat 4080

eit 0

eet 0

prs 0

bat 1

snd 1

ihm 0

iom 0

nma 10

div 16

2.5.3 c-Rover Control

This section describes minimal commands to configure the c-Rover for RemOcean operation.

Use a terminal emulation program to connect to the serial interface of the instrument. Once power is applied, the c-Rover initializes and starts transmitting data frames to the host. To access the command console, type !!!!!! , do not press the <Enter> key. Data transmission stops and instrument identification, settings and calibration coefficients are displayed.

```
Ser CRV7-035
Ver BAM CSTAR 4.14
Ave 30
Pkt 0
```

Type a command followed by the `<Enter>` key to execute the command and display the results, if any. Commands and arguments are not case sensitive.

After changing settings, execute the `$sto` command to store to flash memory. Before using the `$sto` command changes can be abandoned by the $rls command or removing power from the instrument.

Command Syntax	Description
`!!!!!`	Interrupt operation and invoke the command console.
`$rat 2400..230400`	Baud rate for instrument communications must be a valid rate. If the rate specified is not valid, the default rate 19200 bps is set. Factory setting is **19200**.
`$ave 1..65535`	Average of the number of measurements specified is calculated and used for the reported value. Factory setting is **18**. The frame rate is proportional to 1/n. A change in this setting changes the frame rate.
`$pkt 0..65535`	Packet size is the number of data frames to be reported. Specifying "0" causes the instrument to continue reporting indefinitely. Factory setting is **0**.
`$run`	Run, resume operation, execute the current settings.
`$mnu`	Menu displays the instrument identification and current settings.
`$mld 0..65535`	Set Dark count value for calculating physical unit output. The value is an integer in the range 0.65535.
`$mls slope`	Set Scale Factor value for calculating physical unit output. The value is a floating point number and may be entered in decimal or exponential form, e.g. 0.0073 or 7.3E-3.
`$rfd`	Reload factory default settings.
`$rls`	Reload settings from flash memory.
`$sto`	Stores all settings modified during the current session in flash memory. If the $sto command is not invoked, changes to made during the current console session are lost when power is removed.

Table 28 c-Rover Commands and Settings

$par

01n 9

01f 20

02n 9

02f 20

so2 0

rv2 0

sv2 52

sat 17000

ref 13595

ihm 0

iom 0

nma 30

scs 0.9443

sco 0.0544

pth 25.00

cln 15513

$mnu

Ser CRV7-035

Ver BAM CSTAR 4.14

Ave 30

Pkt 0

Revision History

Date	Author	Rev	Comments
2011-07-20	KMB	A	Initial Release
2011-12-09	KMB	B	Add OCR commands for setting cal coefficients Revise mass and volume figures