LMG 1101

LTER

Cruise Data Report

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Introduction

The LMG data acquisition systems continuously log data from a suite of instrumentation throughout the cruise. This document describes the format of that data and its location on the distribution CDs. It also contains important information that may affect how this data is processed such as instrument failures or other known problems with acquisition.

The data collected during this cruise is distributed on a CD-ROM written in ISO9660 level-1 format. This data format has very strict requirements on filenames and organization. However, it is readable by virtually every computing platform.

All of the data has been archived with the Unix “tar” command and/or compressed using Unix “gzip” compression. Tar files have a “.tar” extension and Gzipped files have a “.gz” extension. Tools are available on all platforms for uncompressing and de-archiving these formats. On Macintosh, Stuffit Expander with DropStuff will open a tar archive and uncompress gzipped and Unix compressed files. For Windows, WinZip, a shareware utility included on this CD (remember, it is shareware) will open these files.

In some cases to adhere to the ISO9660 format the .tar extension was removed. When we tarred the files then gzip the tar archive the name of the file became *File*.tgz. This name does not follow the 8.3 naming convention of the ISO9660 format. On Windows and Mac Platforms Winzip and Stuffit Expander handles this just fine. When they expand the *File*.gz the expanded file becomes *File*.tar, which both software packages can handle. On Unix platforms gunzip expands *File*.tgz but it does not append the .tar extension. So you may not recognize the file as a tar archive, but OS does recognize it as a tar archive. If you use the file command it will return saying it is a tar file. The below tar command will un-archive the file just fine.

IMPORTANT: Read the last section in this document, Acquisition Problems and Events, for important information that may affect the processing of this data.

Archive Data Extraction

It is often useful to know exactly how an archive was produced when expanding its contents. Tar files were created using the following commands:

```
tar cvf archive-file files-to-be-archived
```

To create a list of the files in the archive:

```
tar tvf  archive-file  > contents.list
```

To extract the files from the archive:

```
tar xvf  archive-file file(s)-to-extract
```

G-zipped files will have a ".gz" extension on the filename. These files can be decompressed after de-archiving, using:

```
gunzip filename.gz
```

CD Directory Structure

ADCP: ADCP.tar Cal: InstCoef.txt ctd/ deployed/ mocness/ underway/ CTD: Ctd.tar Imagery: Imag.tar Maps: LMG1101.track LMG1101.jpg LMG1101.ps Process: JGOF.tar PCO2.tar PROC.tar QC.tar Report: Report.doc RVDAS: nav/ uw/ Salinity: Logsheet.pdf Salts.xls Science: Science.tar Utility: Acrobat Winzip Waypoint: Waypoint.txt XBT: Xbt.tar XCTD: Xctd.tar		

Distribution Contents

ADCP

/Adcp/

This directory contains a tar file of gentoo's proc directory, which contains a database of the averaged ping data, Matlab m-files used in processing the data, and daily graphs of the currents. For more information contact Teri Chereskin at tchereskin@ucsd.edu .

Calibration

/Cal/

The tar files in the Cal directory contain images of calibration sheets for each of the following systems: Sound Velocity Probe(SVP_CALS.TAR), Meteorological System(MET_CALS.TAR), Underway System(UW_CALS.TAR), and CTD_CALS.pdf.

Refer to the InstCoef.txt file along with the specific instrument calibration sheets, both located in this directory, for information on how the RVDAS data was collected and processed.

CTD

CTD/

The ctd data was collected and processed on a computer running Windows 98, using Seasave Win32 – Version 5.31a and SBE Data Processing – Version 5.31a

For more information and software visit the web site at www.seabird.com.

CTD/Setup/

In the Setup directory there is a Config file in html, excel, and text form which contain information of which sensors where used and what freq or volt the where connected to. The file also contains a table with the vertical distance in meters from the pressure port that each sensor was mount. The distances are positive as pressure increases.

CTD/Scripts/

This directory contains the batch file and psu files that we used for post processing the data. The data was processed with the standard seabird processing method. This is just a preliminary processing which was done to verify that the sensors were functioning properly during the cruise. The raw data should be re-processed using the pre and post cruise sensor calibrations.

CTD/Data/raw

The raw.tgz file is a tar archive file that has been compressed with gzip, for more information on this see the above *Introduction* section. This archive contains the raw file collect at each CTD cast, which is represented by a set of four files containing a bottle-firing file (.bl), a configuration file (.con), a data file (.dat) and a header file (.hdr). Casts are named with the following g501CCC.ext, where g is for the LMG, 501 is the cruise 05-01, CCC is the cast number. For example; the raw files associated with the Cast 1on this cruise are: g501001.bl, g501001.con, g501001.dat, g501001 .hdr. The raw data files(*.dat) are binary files.

CTD/Data/process

The process.gz file is a tar archive file that has been compressed with gzip. For more information on this see the above *Introduction* section. This archive contains the processed data files for each CTD cast, the processing method used is briefly described in the above section *CTD/Scripts/.* Also see the above section *CTD/Data/raw* for a description of the file naming convention used. Each processed cast is represented here by a set of ten files:

GXXXCCC.con	A copy of the configuration file for the cast.
GXXXCCC.cnv	The converted file for the whole cast.
GXXXCCC.ros	The rosette file that contains the scan lines for each bottle trip.
GXXXCCC.btl	The bottle file that contains the avg, standard deviation, min, and max for a select set of variables for each bottled fired during the upcast.
DGXXXCCC.cnv	The converted file for the down cast.
DGXXXCCC.asc	An ASCII formatted file for the down cast without a header.
DGXXXCCC.hdr	The header for the down cast.
UGXXXCCC.cnv	The converted file for the up cast.
UGXXXCCC.asc	An ASCII formatted file for the up cast without a header.
UGXXXCCC.hdr	The header for the up cast.

Imagery

/Imagery/

This directory contains things such as ice imagery, isobar charts, sat imagery, wave and wind images, and weather reports.

Data and Science Report

/Report/

Copies of this report in MS Word, HTML, and text formats.

XBT

/XBT/

Expendable Bathythermographic (XBT) “Deep Blue” probes were used to obtain water column temperature profiles. The dataset includes the following files:

dat.zip	The probe drop schedule and other configuration files.
efiles.zip	The edited data files.
log.zip	The log files for drop and GPS positioning.
nav.zip	The navigation files.
sfiles.zip	The raw data files.
*.pdf	Scanned images of the paper log sheets.

XCTD

/XCTD/

Expendable Conductivity, Temperature, and Depth (XCTD) digital probes were used to obtain water column temperature and Salinity profiles. The two files were created for each drop .RDF files contain the raw data, and the .EDF contain the exported ascii data.

Logsheets

/logsheet/

This directory contains logsheets for XBT, XCTD, air samples and TCO2 data. For further information on this data (TCO2), contact Tim Newberger at ***tnewberg@ldeo.columbia.edu*****.**

Salts

/Salinity/

This directory contains the log sheet for the Salt sample take during the Drake Transect Sampling, also a spreadsheet containing the Salt sample and TSG comparison. These samples were analyzed with the onboard AutoSal by the MST.

Science

/Science/

This directory contains data and photos collected by the individual scientists. There are directories for each science group. Data like Mocness, PRR, PUV, mooring data and sediment trap data are located in here.

Maps

/Maps/

This directory contains a tar file, maps.tar, which contains various cruise maps generated with GMT. The tar file scripts.tar contains the csh scripts use to create these maps, along with data point files.

WAYPOINTS

/WAYPTS/

Contains the waypoint file used for the cruise; this is read by the DAS system and the selected waypoint is displayed on the CCTV system.

QC Plots

/QC_PLOTS/

Postscript files of data stored each day on RVDAS for quality control analysis during the cruise. There are 3 types of files, named metXXX.ps, navXXX.ps, and oceanXXX.ps, where XXX is represents the Julian day. Met files are a summary of the data from the meteorological instruments, Nav files are a summary of navigational data, and Ocean files are a summary of the underway seawater and bathymetry data.

JGOFS Data Set

/JGOF/

The JGOFS data set consists of a single file produced each day named jg<julian_day>.dat.gz where <julian_day> is the day the data was acquired. The ".gz" extension indicates that the individual files are compressed before archiving. The daily file consists of 22 separate columnar fields in text format, which are described below. The JGOFS data set is obtained primarily by applying calibrations to raw data and decimating to whole minute intervals. However, several fields are derived measurements from more than a single raw input. *Note: Null, unused, or unknown fields are filled with 9's in the JGOFS data.*

Additionally, 3 separate QC plots are generated daily by the ET using the JGOFS data set. These plots include TSG and Bathymetry data, meteorological data, and navigation data. The files are called ocean<julian_day>.ps, met<julian_day>.ps, and nav<julian_day>.ps respectively.

Field	Data	Units
01	GMT date	dd/mm/yy
02	GMT time	hh:mm:ss
03	PCOD latitude (negative is South)	Ddd.dddd
04	PCOD longitude (negative is West)	Ddd.dddd
05	Ships speed	Knots
06	GPS HDOP	-
07	Gyro Heading	Degrees (azimuth)
08	Course over ground	Degrees (azimuth)
09	Mast PAR	μEinsteins/meters^2 sec
10	Sea surface temperature	°C
11	Not used	-
12	Sea surface salinity	PSU
13	Sea depth (uncorrected, calc. sw sound vel. 1500 m/s)	meters
14	True wind speed (port windbird)	meters/sec
15	True wind direction (port windbird)	degrees (azimuth)
16	Ambient air temperature	°C
17	Relative humidity	%
18	Barometric pressure	mBars
19	Sea surface fluorometry	volts (0-5 FSO)
20	Not used	-
21	PSP	W/m^2
22	PIR	W/m^2

TSG Data files

/TSG/tsgfl

RVDAS processes the ltsg.d### file, using the Seabird calibration. It produces a daily tsgfl.d### file with the below fields.

```
04+321:00:01:23.978 -00.070 -00.089 02.8042 33.75690 0.471306 4.341880
```

Field	Data	Units
1	RVDAS Time Tag	
2	Internal water temperature	°C
3	External water temperature	°C
4	Conductivity	S/cm
5	Salinity	PSU

Field	Data	Units
6	Transmissometer signal	Volts

RVDAS

/RVDAS/

RVDAS (Research Vessel Data Acquisition System) was developed at Lamont-Doherty Earth Observatory of Columbia University and has been used on the R/V Maurice Ewing for several years. It was adapted for use on the Nathaniel B. Palmer and her sister ship, the R/V Laurence M. Gould.

Below you will find detailed information on the data included. Be sure to read the "Significant Acquisition Events" section below for important information about data acquisition during this cruise.

Meteorological and Light Data

Measurement	File ID	Collect. Status	Rate	Instrument
Air Temperature	lmwx	continuous	1 sec	R. M. young 41372VC
Relative Humidity	lmwx	continuous	1 sec	R. M. young 41372VC
Wind Speed/Direction	lmwx	continuous	1 sec	R. M. young 5106
PAR, (Photosynthetically-Available Radiation)	lmwx	continuous	1 sec	BSI QSR-240
Barometer	lmwx	continuous	1 sec	R. M. young 61201
GUV & PUV	lguv	continuous	1 sec	GUV2511 & PUV2510
PIR (LW radiation)	lmwx	continuous	1 sec	Eppley PIR
PSP (SW radiation)	lmwx	continuous	1 sec	Eppley PSP
Port Ultrasonic Wind Speed/Direction	lmwx	continuous	1 sec	Gill Wind Observer II

Navigational Data

Measurement	File ID	Collect. Status	Rate	Instrument
Attitude GPS	lash	continuous	1 sec	Ashtec ADU-2
Trimble GPS	tgps	civilian mode	1 sec	Trimble 20636-00SM
Gyro	lgyr	continuous	0.2 sec	Anschutz Gyro
Garmin GPS	lgar	continuous	1 sec	Garmin 17
Seapath GPS	Lsep	Continuous	1 sec	Seapath 330

Geophysical Data

Measurement	File ID	Collect. Status	Rate	Instrument
Bathymetry	lknu	variable	Varies	Knudsen 320B/R
Net Depth Sensor	lnds	variable	~1/3 sec	Omega PX-605
DUSH 11 Winch	lwn1	variable	varies	Markey DUSH 11
DUSH 5 Winch	lwn1	variable	varies	Markey DUSH 5
DUSH 4 Winch	lwn1	variable	varies	Markey DUSH 4

Oceanographic Data

Measurement	File ID	Collect. Status	Rate	Instrument
Salinity	utsg	continuous	1 sec	SeaBird 45
Sea Surface Temperature	Lrtm	continuous	1 sec	SeaBird 38
Fluorometry (digital)	lflr	continuous	1 sec	Turner 10-AU-005
Fluorometry (digital)	ldflr	continuous	1 sec	Wetlab ECO
ADCP, Speed Log	ladc	continuous	1 sec	RD Instruments
Oxygen	loxy	continuous	1 sec	
PCO2	lpco2	continuous	2.5 min	

Data File Names and Structures

RVDAS data is divided into two broad categories, ***Underway*** and ***Navigation***. The groups are abbreviated "uw" and "nav". Thus, these two tar files, lmguw.tar and lmgnav.tar exist under the top-level rvdas directory. The instruments are broken down as shown. Each data file is g-zipped to save space on the distribution. Not all data types are collected everyday or on every cruise.

RVDAS data files are named following the convention: LMG[FileID].dDDD.

- The FileID is a 4-character code representing the system being logged, for example: lmet (for meteorology)
- DDD is the Julian day of the data collection

Underway Data	**File ID**
Meteorological - Cambell	lmwx
Knudsen	lknu
microTSG	utsg
Digital Remote Temperature	lrtm
Fluorometer – Wetlab ECO	ldfl
ADCP	ladc
Sound Velocity Probe	lsvp
GUV & PUV	lguv
PCO2 System	lpco
Oxygen	loxy
Wet Wall Flows	lsea
Winches: Dush4,5,&11	lwn1
Net Depth Sensor	lnds

Navigation Data	**File ID**
Gyro Compass	lgyr
P-CODE GPS	tgps
Ashtech ADU2 GPS	lash
Garmin 17 GPS	lgar
Seapath 330 GPS	lsep

Data is received by the RVDAS system via RS-232 serial connections. The data files that comprise the rvdas data set are described below. A time tag is added to each line of data received and the data is written to disk.

```
YY+DDD:HH:MM:SS.SSS [data stream from instrument]
```

Where, YY: two-digit year, DDD: Julian Day, HH: 2 digit hours, MM: 2 digit minutes SS.SSS: seconds. All times are UTC.

The delimiters used to separate fields in the raw data files are usually spaces and commas, but other delimiters are used (::, =, @) and occasionally there is no delimiter. Care should be taken when reprocessing the data that the fields separations are clearly understood. An example data

lknu – Knudsen Sonar

```
08+024:07:36:36.245 HF,00.00, 000,0,LF,448.9,-026,1
```

Field	**Data**	**Units**
1	RVDAS Time Tag	
2	HF – high frequency header (12 kHz)	
3	HF - depth to surface	meters
4	HF - Echo Strength	
5	HF – Depth Valid Flag	
6	LF – low frequency header (3.5 kHz)	
7	LF - depth to surface	meters
8	LF - Echo Strength	
9	LF – Depth Valid Flag	

Inds – Net Depth Sensor

```
99+099:00:18:19.775 V01 00199.8
```

Field	Data	Units
1	RVDAS Time Tag	
2	V01 – Sensor 1	label
3	Depth	meters

Iwn1 - Winches

```
08+033:11:27:50.673 RD,DUSH-5,00111.63,00000000,-0000012,1938
```

Field	Data	Units
1	RVDAS Time Tag	
2	Record Identifier, RD=Remote Data	
3	Winch Indentifier, DUSH-X where X is 4, 5, or 11	
4	Tension	lbs
5	Speed	Meters/minute
6	Payout	meters
7	Checksum	

Imwx - Cambell Meterological DAS

```
08+034:13:52:14.216 PUS,A,356,002.15,M,+332.28,+000.97,60,08
```

Field	Data	Units
1	RVDAS Time Tag	
2	PUS tag – Port UltraSonic Anemometer	
3	Unit Identification, A-Z	
4	Port Wind Direction, degrees relative to Bow	deg
5	Port Wind Speed	m/s
6	Units, M=meters per second	
7	Sound Speed	m/s
8	Sonic Temperature	°C
9	Status, 0=ok, 60=Heating Enabled & ok, Other value mean a fault	
10	Check Sum	

```
08+034:13:52:14.216 SUS,A,356,002.15,M,+332.28,+000.97,60,08
```

Field	Data	Units
1	RVDAS Time Tag	
2	SUS tag – Starboard UltraSonic Anemometer	
3	Unit Identification, A-Z	
4	Port Wind Direction, degrees relative to Bow	deg
5	Port Wind Speed	m/s
6	Units, M=meters per second	
7	Sound Speed	m/s
8	Sonic Temperature	°C
9	Status, 0=ok, 60=Heating Enabled & ok, Other value mean a fault	
10	Check Sum	

```
08+034:13:52:14.454 MET,12.22322,44.25706,-75,-25,-363.6365,2.332982,-0.08215196,278.6845,
279.2192,854.6198
```

Field	Data	Units
1	RVDAS Time Tag	
2	MET tag	
3	Power Supply Voltage	Volts
4	Enclosure Relative Humidity	%
5	Air Temp	°C
6	Air Relative Humidity	%
7	PAR	mVolts
8	PSP Thermopile	mVolts
9	PIR Thermopile	mVolts
10	PIR Case Temperature	°K
11	PIR Dome Temperature	°K
12	Barometer	mBars

utsg – microTSG, Thermosalinograph

For further information on this data, check on www.seabird.com on SBE 45 MicroTSG Thermosalinograph

```
08+037:13:45:57.596   2.6470,  3.03853,  33.8129, 1459.351
```

Field	Data	Units
1	RVDAS Time Tag	
2	Internal water temperature	°C
3	Conductivity	S/m
4	Salinity	psu
5	Sound Velocity	m/s

lrtm – digital Remote Temperature

For further information on this data, check on www.seabird.com on SBE38 Digital Thermometer

08+037:13:47:17.841 2.2527

Field	Data	Units
1	RVDAS Time Tag	
2	External water temperature	°C

ldflr – Fluorometer, Wetlab ECO

```
08+037:13:55:08.434 99/99/99    99:99:99        0.00    2585    73      543
```

Field	Data	Units
1	RVDAS Time Tag	
2	Fluorometer Date	mm/dd/yy
3	Fluorometer Time	hh:mm:ss
4	Chlorophyll Signal	μg/l
5	Reference	λq
6	Counts – Chlorophyll Signal	Count
7	Thermistor	

loxy - Oxygen

For further information on this data, contact Tim Newberger at ***tnewberg@ldeo.columbia.edu***

```
04+117:23:57:23.504 MEASUREMENT        3830     380  Oxygen:           309.95      Saturation:
83.48   Temperature:        -1.35      DPhase:             33.41      BPhase:             32.22
```

```
      RPhase:            0.00      BAmp:     262.09      BPot:     163.00      RAmp:
0.00   RawTem.:         694.92
```

Field	Data	Units
1	RVDAS Time Tag	
2-4	Measurement ID, Model Number, Serial Number	alphanumeric
5	Oxygen heading	text
6	Oxygen Reading	Raw numeric
7	Saturation heading	text
8	Saturation Reading	Raw numeric
9	Temperature heading	text
10	Water Temperature	ºC
11	Dphase heading	text
12	Dphase	Raw numeric
13	Bphase heading	text
14	BPhase	Raw numeric
15	Rphase heading	text
16	Rphase	Raw numeric
17	Bamp heading	text
18	Bamp	Raw numeric
19	Bpot heading	text
20	Bpot	Raw numeric
21	Ramp heading	text
22	Ramp	Raw numeric
23	RawTem heading	text
24	RawTemp	Raw numeric

lpco – PCO2 system

For further information on this data, contact Tim Newberger at ***tnewberg@ldeo.columbia.edu***

```
02+319:23:59:13.748 2002319.99851    7154.27     26.49    1033.6     325.79      6.74     329.3
53.76    0   Equil
```

Field	Data	Units
1	RVDAS Time Tag	
2	Julian date file string	Julian
3	IR voltage reading	mV
4	Cell temperature	°C
5	Barometer	millibars
6	VCO2	mL
7	Equilibrator temperature	°C
8	PCO2	millibars
9	Gas flow	mL/min
10	Solenoid position ID	number
11	Valve Position ID	number
12	Measured gas	name

Lguv – Biospherical GUV

```
08+037:14:17:59.211 020608 141758 -.000099 1.307E0 7.24E0 1.316E1 2.609E1 3.285E1 3.505E1 8.075E-
2 38.993 17.985
```

GUV only

Field	Data	Units
1	RVDAS Time Tag	

GUV and PUV

Field	Data	Units
1	RVDAS Time Tag	

2	GUV Computer Date	mmddyy
3	GUV Computer Time	hhmmss
4	Ed0Gnd - GUV	Volts
5	Ed0305 - GUV	µW/cm²nm
6	Ed0313 - GUV	µW/cm²nm
7	Ed0320 - GUV	µW/cm²nm
8	Ed0340 - GUV	µW/cm²nm
9	Ed0380 - GUV	µW/cm²nm
10	Ed0395 - GUV	µW/cm²nm
11	Ed0PAR - GUV	µE/cm²sec
12	Ed0Temp - GUV	°C
13	Ed0VIn	Volts

2	GUV Computer Date	mmddyy
3	GUV Computer Time	hhmmss
4	EdZGnd -PUV	Volts
5	EdZ305 -PUV	µW/cm²nm
6	EdZ313 -PUV	µW/cm²nm
7	EdZ320 -PUV	µW/cm²nm
8	EdZ395 -PUV	µW/cm²nm
9	EdZ340 -PUV	µW/cm²nm
10	EdZPAR -PUV	µE/cm²sec
11	LuZChl -PUV	µE/srm²sec
12	EdZ380 -PUV	µW/cm²nm
13	WTemp -PUV	°C
14	Depth -PUV	m
15	EdZTemp -PUV	°C
16	LuZTemp -PUV	°C
17	Tilt -PUV	Degrees
18	Roll -PUV	Degrees
19	Ed0Gnd - GUV	Volts
20	Ed0305 - GUV	µW/cm²nm
21	Ed0313 - GUV	µW/cm²nm
22	Ed0320 - GUV	µW/cm²nm
23	Ed0340 - GUV	µW/cm²nm
24	Ed0380 - GUV	µW/cm²nm
25	Ed0395 - GUV	µW/cm²nm
26	Ed0PAR - GUV	µE/cm²sec
27	Ed0Temp - GUV	°C
28	Ed0VIn	Volts

lsvp - Sound Velocity Probe in ADCP Transducer Well

```
00+348:01:59:52.128  1539.40
```

Field	Data	Units
1	RVDAS Time Tag	
2	Sound velocity	m/s

ladc – ADCP Speed Log

```
00+019:23:59:59.099 $PUHAW,UVH,-1.48,-0.51,250.6
```

Field	Data	Units
1	RVDAS Time Tag	
2	$PUHAW	
3	UVH (E-W, N-S, Heading)	
4	Ship Speed relative to reference layer[1] velocity[2], East vector	knots
5	Ship Speed relative to reference layer[1] velocity[2], North vector	knots
6	Ship heading	degrees

[1]The reference layer is an average velocity measured in a number of depth "bins". On the LMG, the bins are eight meters deep and bins 3-10 define the reference layer. Hence, the reference layer is the water column from 16-80 meters beneath the ship.

[2]The speed ouput is water velocity relative to the ship's hull and is therefore opposite of the actual movement of the ship. For example, if the ship's heading is due north, the North/South reference layer

velocity is likely to be negative (southerly).

Iash – Ashtech GPS

ATTD: Attitude Data

```
01+081:00:00:00.806 $PASHR,ATT,345605.0,165.03,+001.86,-01.96,0.0018,0.0173,0*22
```

Field	Data	Units
1	RVDAS Time Tag $PASHR	
2	ATT	
3	GPS Time sec. of the week	seconds
4	heading (rel. to true North)	degrees
5	pitch	degrees
6	roll	degrees
7	Measurement RMS error	meters
8	Baseline RMS error	meters
9	attitude reset flag	

```
01+081:00:00:00.966 $GPGGA,235952.00,6051.7937,S,06030.2175,W,1,08,01.0,+00068,M,,M,,*79
```

Field	Data	Units
1	RVDAS Time Tag $GPGGA	
2	UTC time at position	hhmmss.ss
3	Latitude	ddmm.mmm
4	North (N) or South (S)	
5	Longitude	ddmm.mmm
6	East (E) or West (W)	
7	GPS quality (1=GPS 2=DGPS)	
8	Number of GPS satellites used	
9	HDOP	
10	Antenna Height	meters
11	M for Meters	
12	Geoidal height	meters
13	M for meters	
14	age of diff. GPS data	sss
15	differential reference station ID	aaaa

Igyr - Gyro

```
02+315:23:59:58.194 $PASVW,00.1,A*1D
02+315:23:59:58.414 $IIVHW,287.7,T,,M,,N,,K*71
02+315:23:59:58.616 $HEHDT,287.7,T*25
02+315:23:59:58.821 $HEROT,001.6,A*2C
02+315:23:59:58.984 $HCHDT,,T*07
```

HDT: True Heading

```
01+083:00:00:02.893 $HEHDT,246.3,T*2C
```

Field	Data	Units
1	RVDAS Time Tag $HEHDT	
2	Heading XXXXX = ddd.d	degrees
3	T flag for true heading, checksum	

ROT: Rate of Turn

```
01+083:00:00:03.093 $HEROT,-006.3,A*03
```

Field	Data	Units
1	RVDAS Time Tag $HEROT	
2	Rate of turn	degrees/min
3	Status: A = data valid, checksum	

lsep – Seapath 330 GPS

INZDA: Time and Date Data

10+351:23:59:58.142 $INZDA,235958.08,17,12,2010,,*78

Field	Data	Units
1	RVDAS Time Tag	
2	$INZDA Tag	
3	time	hhmmss.ss
3	day	dd
4	month	mm
5	year	yyyy
6	(blank)	
7	Check sum	hexadecimal

INGGA: Global Positioning Fix Data

10+351:23:59:58.142 $INGGA,235958.07,6118.168460,S,06008.089527,W,1,12,0.7,22.57,M,17.79,M,,*46

Field	Data	Units
1	RVDAS Time Tag	
2	$INGGA Tag	
3	Time (UTC)	hhmmss.ss
3	Latitude in degrees with decimal minutes	ddmm.mmm
4	{NIS} (latitude is north or south)	
5	Longitude in degrees with decimal minutes	ddmm.mmm
6	{EIW} (longitude is east of west)	
7	GPS quality indicator: 0 = invalid position, 1 = GPS SPS used, 2 = DGPS used, 3 = GPS PPS used, 4 = GPS RTK used, 5 = GPS float RTK used, 6 = dead reckoning	
8	Number of Satellites in use (00-99)	
9	HDOP	
10	Height above ellipsoid in meters	m.mm
11	M	
12	Age of DGPS corrections in seconds	ss.ss
13	M	
14	(blank)	
15	*Check sum	hexadecimal

INRMC: Recommended Minimum Specific GNSS Data

10+351:23:59:58.200 $INRMC,235958.07,A,6118.168460,S,06008.089527,W,12.8,331.22,171210,11.3,E,A*1C

Field	Data	Units
1	RVDAS Time Tag	
2	$INRMC Tag	
3	UTC of position	hhmmss.ss
4	Status A = Data Valid, V = Navigation Receiver Warning	

Field	Data	Units
5	Latitude in degrees with decimal minutes	ddmm.mmm
6	North (N) or South (S)	
7	Longitude in degrees with decimal minutes	ddmm.mmm
8	East (E) or West (W)	
9	Speed Over Ground, knots	knots
10	Course Over Ground, degrees True	degrees
11	Date	ddmmyy
12	Magnetic Variation, degrees E/W	degrees
13	Mode Indicator E= Estimated Mode	
14	*Check sum	

PSXN,20: Data Quality

10+351:23:59:58.200 $PSXN,20,1,2,0,0*38

Field	Data	Units
1	RVDAS Time Tag	
2	$PSXN Tag	
3	20 (PSXN identifier)	
3	Horizontal position and velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
4	Height and vertical velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
5	Heading quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
6	Roll and pitch quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
7	*Check sum	hexadecimal

PSXN,23: Roll, Pitch, Heading and Heave

10+351:23:59:58.213 $PSXN,23,0.02,-0.76,330.56,*0B

Field	Data	Units
1	RVDAS Time Tag	
2	$PSXN Tag	
3	23 (PSXN identifier)	
3	Roll in degrees. Positive with port side up.	d.dd
4	Pitch in degrees. Positive with bow up.	d.dd
5	Heading in degrees true	d.dd
6	Heave in meters. Positive is down	m.mm
7	*Check sum	hexadecimal

lgar - Garmin GPS

GGA: Global Positioning Fix Data

08+034:12:26:06.131 $GPGGA,122607,6446.4733,S,06403.4455,W,1,11,0.9,-193.4,M,9.7,M,,*5A

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGGA Tag	
3	UTC of position	hhmmss.ss
4	Latitude in degrees with decimal minutes	ddmm.mmm
5	North (N) or South (S)	
6	Longitude in degrees with decimal minutes	ddmm.mmm
7	East (E) or West (W)	

Field	Data	Units
8	GPS quality (1=GPS 2=DGPS)	
9	Number of GPS satellites used	
10	Horizontal dilution of precision (HDOP)	
11	Antenna height above/below mean-sea-level (geoid)	meters
12	Units for antenna height (M = Meters)	
13	Geoidal Separation[1]	
14	Units for Geoidal Separation (M = Meters)	meters
15	Age of differential GPS data, number of seconds since last SC104 Type 1 or 9	
16	Differential reference station ID	

[1]Geoidal Separation: the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid). A negative value represents mean-sea-level below ellipsoid.

GLL: Geographic Position – Latitiude/Logitude

`08+034:12:26:06.211 $GPGLL,6446.4733,S,06403.4455,W,122607,A`

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGLL Tag	
3	Latitude	ddmm.mmm
4	North (N) or South (S)	
5	Logitude	ddmm.mmm
6	East (E) or West (W)	
7	UTC of position	hhmmss.ss
8	Status: A = Data Valid, V =Data Not Valid	

VTG: Track Made Good and Speed over Ground

`08+034:12:26:06.211 $GPVTG,167,T,151,M,000.0,N,0000.0,K`

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG Tag	
3	Track, degrees true	degrees
3	T flag for True	
4	Track, degrees magnetic	degrees
5	M flag for Magnetic	
6	Speed over Ground	knots
7	N flag for Knots	
8	Speed over Ground	kmhr
9	K flag for km/hr	

tgps – Trimble Centurion GPS

GGA: Global Positioning Fix Data

08+034:12:26:06.131 $GPGGA,122607,6446.4733,S,06403.4455,W,1,11,0.9,-193.4,M,9.7,M,,*5A

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGGA Tag	
3	UTC of position	hhmmss.ss
4	Latitude in degrees with decimal minutes	ddmm.mmm

Field	Data	Units
5	North (N) or South (S)	
6	Longitude in degrees with decimal minutes	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality (1=GPS 2=DGPS)	
9	Number of GPS satellites used	
10	Horizontal dilution of precision (HDOP)	
11	Antenna height above/below mean-sea-level (geoid)	meters
12	Units for antenna height (M = Meters)	
13	Geoidal Separation[1]	
14	Units for Geoidal Separation (M = Meters)	meters
15	Age of differential GPS data, number of seconds since last SC104 Type 1 or 9	
16	Differential reference station ID	

[1]Geoidal Separation: the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid). A negative value represents mean-sea-level below ellipsoid.

GLL: Geographic Position – Latitiude/Logitude

```
08+034:12:26:06.211 $GPGLL,6446.4733,S,06403.4455,W,122607,A
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGLL Tag	
3	Latitude	ddmm.mmm
4	North (N) or South (S)	
5	Logitude	ddmm.mmm
6	East (E) or West (W)	
7	UTC of position	hhmmss.ss
8	Status: A = Data Valid, V =Data Not Valid	

VTG: Track Made Good and Speed over Ground

```
08+034:12:26:06.211 $GPVTG,167,T,151,M,000.0,N,0000.0,K
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG Tag	
3	Track, degrees true	degrees
3	T flag for True	
4	Track, degrees magnetic	degrees
5	M flag for Magnetic	
6	Speed over Ground	knots
7	N flag for Knots	
8	Speed over Ground	kmhr
9	K flag for km/hr	

RMC: Recommended Minimum Specific GNSS Data

08+034:13:17:26.627 $GPRMC,131726.605,A,6446.4820,S,06403.3075,W,000.0,094.4,030208,16.3,E

Field	Data	Units
1	RVDAS Time Tag	
2	$GPRMC Tag	

Field	Data	Units
3	UTC of position	hhmmss.ss
4	Status A = Data Valid, V = Navigation Receiver Warning	
5	Latitude in degrees with decimal minutes	ddmm.mmm
6	North (N) or South (S)	
7	Longitude in degrees with decimal minutes	ddmm.mmm
8	East (E) or West (W)	
9	Speed Over Ground, knots	knots
10	Course Over Ground, degrees True	degrees
11	Date	ddmmyy
12	Magnetic Variation, degrees E/W	degrees
13	Mode Indicator E= Estimated Mode	

LMG Sensors

Shipboard Sensors

Sensor	Description	Serial #	Cal. Date	Status
Port Anemometer	Gill Ultrasonic Wind Observer II	840019		Collected
Starboard Anemometer	Gill Ultrasonic Wind Observer II	71738		Collected
Barometer	R.M. Young 61201	BP01150	08-May-2009	Collected
Humidity/Wet Temp	RM Young 41372LC	06720	11-Feb-2010	Collected
PAR for Mast	Biosph. Inst. QSR-240P	6393	31-Aug-2010	Collected
PIR	Eppley PIR	32031F3	15-Jan-2010	Collected
PSP	Eppley PSP	31701F3	15-Jan-2010	Collected
GUV (Mast)	Biosph. Inst. GUV-2511	25110805126	19-May-2009	Collected
Transmissometer	WET Labs C-Star 25 cm deep	CST-407DR	13-Oct-2009	Collected
MicroTSG	Sea-Bird 45	200	12-Aug-2010	Collected
Digital Remote Temp	Sea-Bird 38	351	16-Sep-2008	Collected
Fluorometer	WET Labs ECO-FL	FLRTD-399	15-Sep-09	Collected

CTD Sensors

Sensor	Description	Serial #	Cal. Date	Status
CTD Fish	Seabird SBE9Plus	0328	19-Aug-2009	Collected
Primary Temperature (up to cast # 006)	Seabird SBE3	2637	11-Feb-2010	Collected
Primary Temperature (after cast # 006)	Seabird SBE3	4573	05-May-2010	
Secondary Temperature	Seabird SBE3	2205	16-Apr-2010	Collected
Primary Conductivity	Seabird SBE4	1223	11-Feb-2010	Collected
Secondary Conductivity	Seabird SBE4	2048	21-Apr-2010	Collected
Primary Dissolved Oxygen (up to cast # 004)	Seabird SBE43	190	11-Feb-2010	Collected
Primary Dissolved Oxygen (after cast # 004)	Seabird SBE43	182	29-Sep-2010	
Secondary Dissolved Oxygen	Seabird SBE43	200	11-Feb-2010	Collected
Fluorometer	Wet Labs ECO	FLRTD-380	11-Feb-2010	Collected
PAR	Biosph. Inst. QSP-2300	4561	05-Feb-2010	Collected
Transmissometer	Wet Labs C-Star	CST-830DR	14-Oct-2009	Collected

Deployed Sensors

Sensor	Description	Serial #	Cal. Date	Status
PRR (underwater unit)	Biospherical PRR-800	3115	02-Jul-2009	Collected
PRR (surface unit)	Biospherical PRR-810	3115	02-Jul-2009	Collected
PUV	Biospherical PUV-2500	3113	29-Sep-2005	Collected

Mocness Sensors

Sensor	Description	Serial #	Cal. Date	Status
Temperature	Seabird SBE3	2470	11-Feb-2010	Collected
Conductivity	Seabird SBE4	2047	08-Aug-2009	Collected
Fluorometer	Wet Labs ECO	AFLT-001	19-Apr-2010	Collected
Transmissometer	Wet Labs C-Star	CST-891DR	30-Sep-09	Collected

Underway Calibration Sheets

Note: Embedded pdf files can be opened with a right-click, Acrobat Document Object, Open

Remote Temperature (SBE-38)

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0351
CALIBRATION DATE: 16-Sep-08

SBE 38 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

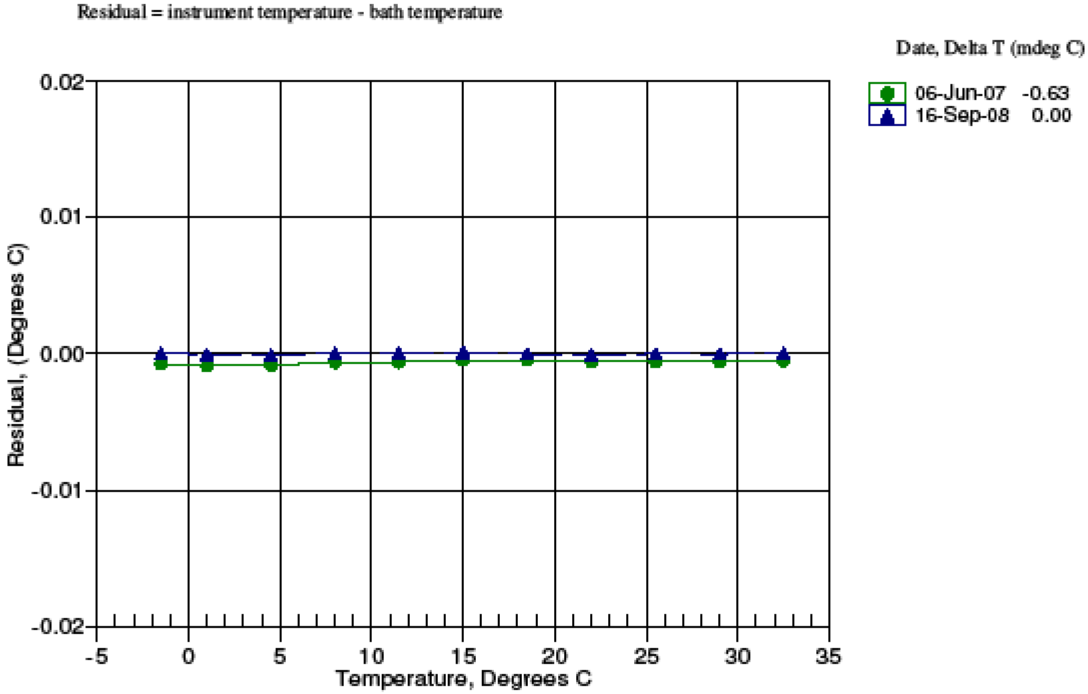
ITS-90 COEFFICIENTS

a0 = -1.726168e-005
a1 = 2.760151e-004
a2 = -2.333162e-006
a3 = 1.553861e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50010	767504.4	-1.50005	0.00005
0.99990	685724.0	0.99985	-0.00005
4.50000	587333.1	4.49993	-0.00007
8.00000	504698.0	8.00002	0.00002
11.50000	435062.4	11.50004	0.00004
14.99990	376188.2	14.99997	0.00007
18.50000	326250.7	18.49999	-0.00001
22.00000	283763.4	21.99993	-0.00007
25.49990	247504.5	25.49990	-0.00000
28.99990	216469.9	28.99988	-0.00002
32.49990	189830.6	32.49993	0.00003

Temperature ITS-90 = $1/\{a0 + a1[\ln(n)] + a2[\ln^2(n)] + a3[\ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



Transmissometer (Wetlabs C-Star)

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

C-Star Calibration

Date October 13, 2009 S/N# CST-407DR Pathlength 25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.794 V
V_{ref}	4.687 V

Temperature of calibration water	22.6 °C
Ambient temperature during calibration	22.0 °C

Relationship of transmittance (Tr) to beam attenuation coefficient (c), and pathlength (x, in meters): $Tr = e^{-cx}$

To determine beam transmittance: $Tr = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})$

To determine beam attenuation coefficient: $c = -1/x * \ln(Tr)$

V_d Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.

Revision L 6/9/09

Fluorometer (Wetlabs ECO-FL)

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 9/15/2009 S/N: FLRTD-399

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark Counts)

	Analog Range 1	Analog Range 2	Analog Range 4 (default)		Digital
Dark Counts	0.097	0.054	0.033	V	68 counts
Scale Factor (SF)	6	12	24	µg/l/V	0.0074 µg/l/count
Maximum Output	4.96	4.96	4.96	V	16330 counts
Resolution	0.7	0.7	0.7	mV	1.0 counts

Ambient temperature during characterization 22.3 °C

Analog Range: 1 (most sensitive, 0–4,000 counts), 2 (midrange, 0–8,000 counts), 4 (entire range, 0–16,000 counts).

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations *in-situ* is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

FLRTD-399_workbookj1.xls Revision J 3/17/08

PSP (Eppley model PSP)

THE EPPLEY LABORATORY, INC.
12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 31701F3

Resistance: 674 Ω at 23°C
Temperature Compensation Range: -20° to + 40°C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one half a solar constant).

As a result of a series of comparisons, it has been found to have a sensitivity of:

8.36×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 1400 watts meter^{-2}. This radiometer is linear to within ± 0.5% up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Tenth International Pyrheliometric Comparisons (IPC X) at Davos, Switzerland in September-October 2005.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Useful conversion facts: 1 cal cm^{-2} min^{-1} = 697.3 watts meter^{-2}
1 BTU/ft^{2}-hr^{-1} = 3.153 watts meter^{-2}

Shipped to: Raytheon Technical Services (NSF)
Port Hueneme, CA

Date of Test: January 15, 2010

In Charge of Test: Debra L. Beaty

S.O. Number: 62361
Date: January 20, 2010

Reviewed by: Thomas D. Kirk

Remarks:

PIR (Eppley model PIR)

THE EPPLEY LABORATORY, INC.
12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

**STANDARDIZATION OF
EPPLEY PRECISION INFRARED RADIOMETER
Model PIR**

Serial Number: 32031F3

Resistance: 709 Ω at 23°C
Temperature Compensation Range: -20° to + 40°C

This pyrgeometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 23°C as measured by Standard Omega Temperature Probe, RTD#1.

As a result of a series of comparisons, it has been found to have a sensitivity of:

3.86×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter^{-2}. This radiometer is linear to within ±1.0% up to this intensity.

The calibration of this instrument is traceable to the International Practical Temperature Scale (IPTS) through a precision low-temperature blackbody.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Shipped to: Raytheon Technical Services (NSF)
Port Hueneme, CA

S.O. Number: 62360
Date: January 20, 2010

Date of Test: January 15, 2010

In Charge of Test: Debra L. Beatty

Reviewed by: Thomas D Kirk

Remarks:

PAR (QSR-240P)

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	8/31/2010
Model Number	QSR240
Serial Number	6393
Operator	TPC
Standard Lamp	GS-1024(8/26/08)

Probe Excitation Voltage Range: 6 to 10 VDC(+)

Output Polarity: Positive

Probe Conditions at Calibration(in air):

Calibration Voltage:	6	VDC(+)
Probe Current:	1.3	mA

Probe Output Voltage:

Probe Illuminated	95.9	mV
Probe Dark	0.3	mV
Probe Net Response	95.6	mV
RG780	0.4	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

9.271E+15 quanta/cm²sec
0.01540 uE/cm²sec

Calibration Scale Factor:
(To calculate irradiance, divide the net voltage reading in Volts by this value.)

Dry: 1.0310E-17 V/(quanta/cm²sec)
6.2087E+00 V/(uE/cm²sec)

Notes:
1. Annual calibration is recommended.
2. Calibration is performed using a Standard of Spectral Irradiance traceable to the National Institute of Standards and Technology (NIST).
3. The collector should be cleaned frequently with alcohol.
4. Calibration was performed with customer cable, when available.

QSR240R 09/24/95

Temperature/Relative Humidity (RMYoung model 41372LC)

Meteorological Instruments

YOUNG

COPY

Temperature Sensor Calibration Report

Customer: *Raytheon Technical Services Co*

Test Number: 44159 Customer PO: RM10889-50
Test Date: 15 April 2004 Sales Order: 7108

Test Sensor:
Model: 41372LC Serial Number: *6720*
Description: Temperature/Relative Humidity Sensor

Report of calibration comparison of test temperature sensor with National Institute of Standards and Technology traceable standard thermometers at three temperatures in the R.M. Young Company controlled temperature calibration bath facilities. Calibration accuracy ± 0.1° Celsius.

Bath Temperature (degrees C)	Current Output (milliamps)	Indicated (1) Temperature (degrees C)
-49.98	4.011	-49.93
0.03	12.006	0.04
49.97	19.994	49.96

(1) Calculated from current output

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial #	NIST Test Reference
Brooklyn Thermometer Model 43-FC	8006-118	204365
Brooklyn Thermometer Model 22332-D5-FC	25071	249763
Brooklyn Thermometer Model 2X400-D7-FC	77532	228060
Keithley Multimeter Model 191	15232	234027

Tested By: E. Chenney

R.M. YOUNG COMPANY 2801 Aero Park Drive, Traverse City, Michigan 49686 USA
Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com

Barometer (RMYoung model 61201)

YOUNG

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

CALIBRATION REPORT
Barometric Pressure Sensor

Customer: *Raytheon Polar Services*

Test Number: 95081 Customer PO: R44967-01
Test Date: 8 May 2009 Sales Order: 080

Test Sensor:
Model: 61201 Serial Number: *P01150*
Description: Barometric Pressure Sensor

Report of calibration comparison of test barometric pressure sensor with National Institute of Standards and Technology traceable standard pressure calibrator at five pressures in the RM Young Company controlled pressure facility. Calibration accuracy ± 1.0 hPa.

Reference Pressure (hPa)	Voltage Output (millivolts)	Indicated (1) Pressure (hPa)
800.0	-2	799.9
875.0	1250	875.0
950.0	2501	950.1
1025.0	3751	1025.1
1100.0	4999	1099.9

(1) Calculated from voltage output

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial #	NIST Test Reference
Druck Pressure Controller Model DPI515	51500497	UKAS Lab 0221
Fluke Multimeter Model 8060A	4855407	234027

Tested By: E. Clemmmy

METEOROLOGICAL INSTRUMENTS
Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: www.youngusa.com

GUV (Biospherical Instruments 2511)

Biospherical Instruments Inc.

GUV-2511 Calibration Certificate

System Serial Number	25110805126	Date of Calibration	5/19/2009
Calibration database	25110805126v4.mdb	Date of Certificate	5/19/2009
DASSN	0109	Standard of Spectral Irradiance	GS-1019(8/28/08)
Microprocessor Tag Number	2	Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per μW/(cm²·nm)]	ScaleSmall [Volts per μW/(cm²·nm)]	ScaleMedium [Volts per μW/(cm²·nm)]	ScaleLarge [Volts per μW/(cm²·nm)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0305	2	305	4.6900E-11	5.0294E-06	1.4697E-03	4.4747E-01	-9.4000E-05	-6.9000E-05	1.1000E-03	μW/(cm²nm)
Ed0313	6	313	2.4800E-10	2.5241E-05	7.3730E-03	2.5969E+00	-1.2900E-04	-1.3000E-04	1.0530E-03	μW/(cm²nm)
Ed0320	8	320	2.6300E-10	2.7298E-05	8.0230E-03	2.7771E+00	-3.2100E-04	-3.1400E-04	3.6500E-04	μW/(cm²nm)
Ed0340	10	340	2.0100E-10	2.0445E-05	5.9931E-03	2.1181E+00	-1.1400E-04	-1.1600E-04	1.1020E-03	μW/(cm²nm)
Ed0380	12	380	7.5400E-11	7.6859E-06	2.2427E-03	7.8731E-01	-4.0500E-04	-4.0400E-04	3.2900E-04	μW/(cm²nm)
Ed0395	13	395	3.2800E-10	3.3334E-05	9.7862E-03	3.4048E+00	1.2000E-05	1.2000E-05	1.2970E-03	μW/(cm²nm)

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per μE/(cm²·s)]	ScaleSmall [Volts per μE/(cm²·s)]	ScaleMedium [Volts per μE/(cm²·s)]	ScaleLarge [Volts per μE/(cm²·s)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0PAR	16	400-700	1.7100E-05	1.7421E+00	5.1049E+02	1.7869E+05	-2.3000E-05	-2.3000E-05	1.3450E-03	μE/(cm²sec)

Auxilliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
Ed0Temp	22	0	1	0.01	0.01	0.01	0	0	0	°C
Ed0Vin	27	0	1	-0.25	-0.25	-0.25	0	0	0	V

Calibration Data – Do Not Destroy

page 2 of 2

CTD Calibration Sheets

CTD Fish

SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0328
CALIBRATION DATE: 19-Aug-09

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 53980

DIGIQUARTZ COEFFICIENTS:

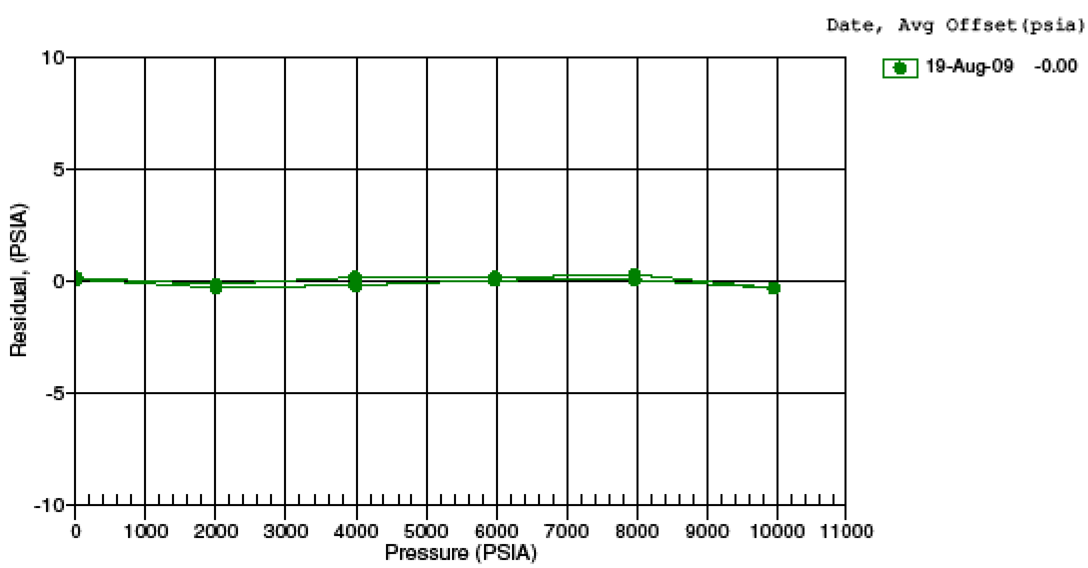
C1 = -5.847002e+004
C2 = 6.910390e-001
C3 = 1.753360e-002
D1 = 4.241600e-002
D2 = 0.000000e+000
T1 = 3.026040e+001
T2 = -1.938830e-004
T3 = 4.330190e-006
T4 = 2.020250e-009
T5 = 0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M = 1.13300e-002
AD590B = -8.47592e+000
Slope = 0.99997
Offset = -0.8399 (dbars)

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.520	33053.30	23.1	15.810	14.592	0.072
2001.763	33609.50	23.3	2002.737	2001.462	-0.301
3988.549	34155.10	23.3	3989.690	3988.358	-0.191
5975.575	34690.70	23.4	5976.997	5975.609	0.034
7962.513	35216.60	23.5	7964.018	7962.573	0.060
9949.782	35733.30	23.6	9950.981	9949.479	-0.303
7967.565	35218.00	23.8	7969.306	7967.861	0.296
5975.765	34690.80	24.0	5977.316	5975.928	0.163
3988.162	34155.10	24.1	3989.657	3988.325	0.163
2000.167	33609.10	24.2	2001.302	2000.027	-0.140
14.515	33053.30	24.4	15.882	14.663	0.148

Residual = corrected instrument pressure - reference pressure



CTD Temperature (Primary) (casts 001 through 005)

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2637
CALIBRATION DATE: 27-Jan-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.33539282e-003
h = 6.40111202e-004
i = 2.34398126e-005
j = 2.38405238e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121582e-003
b = 5.98644623e-004
c = 1.58957632e-005
d = 2.38559840e-006
f0 = 2882.330

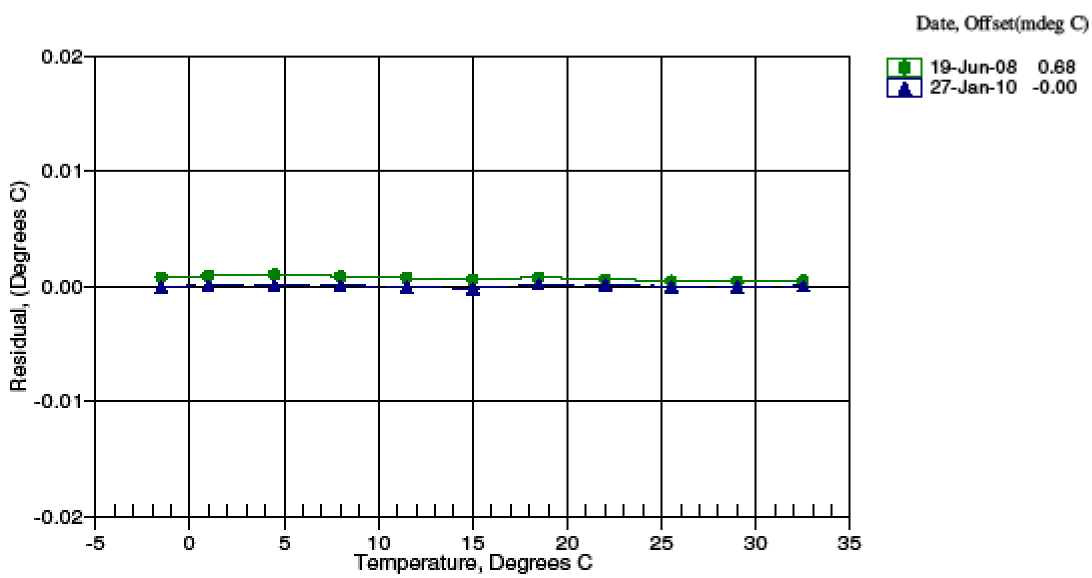
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5002	2882.330	-1.5003	-0.00006
0.9998	3048.879	0.9999	0.00007
4.4999	3293.604	4.4999	0.00003
7.9998	3552.157	7.9999	0.00006
11.4998	3824.914	11.4997	-0.00008
14.9999	4112.250	14.9997	-0.00021
18.4998	4414.534	18.5000	0.00016
21.9998	4732.049	21.9999	0.00010
25.4998	5065.143	25.4998	-0.00001
28.9998	5414.137	28.9997	-0.00008
32.4998	5779.341	32.4998	0.00002

Temperature ITS-90 = $1/\{g + h[\ln(f_0/f)] + i[\ln^2(f_0/f)] + j[\ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be $1.00024 * T_{90}$ (-2 to 35 °C)

Residual = instrument temperature - bath temperature



CTD Temperature (Primary) (casts 006 and on)

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4573
CALIBRATION DATE: 05-May-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.39226443e-003
h = 6.42157444e-004
i = 2.14463615e-005
j = 1.76989950e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121143e-003
b = 6.00088109e-004
c = 1.53829545e-005
d = 1.77132876e-006
f0 = 3148.982

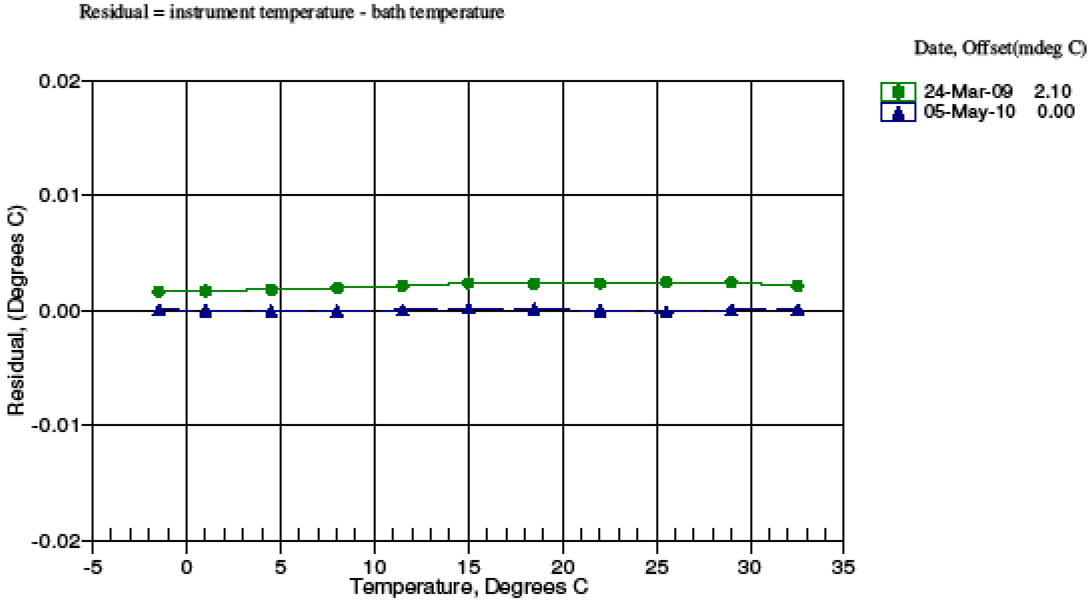
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	3148.982	-1.4999	0.00006
1.0000	3330.461	1.0000	-0.00005
4.5000	3597.070	4.4999	-0.00006
8.0000	3878.674	7.9999	-0.00007
11.4999	4175.680	11.4999	0.00003
14.9999	4488.496	15.0000	0.00015
18.4999	4817.481	18.5000	0.00007
21.9999	5163.021	21.9998	-0.00005
25.5000	5525.495	25.4998	-0.00018
29.0000	5905.268	29.0000	0.00002
32.5000	6302.636	32.5001	0.00006

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



CTD Temperature (Secondary)

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2205
CALIBRATION DATE: 16-Apr-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.34915814e-003
h = 6.48594954e-004
i = 2.38255316e-005
j = 2.27090246e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121095e-003
b = 6.05639729e-004
c = 1.65813033e-005
d = 2.27250218e-006
f0 = 2907.932

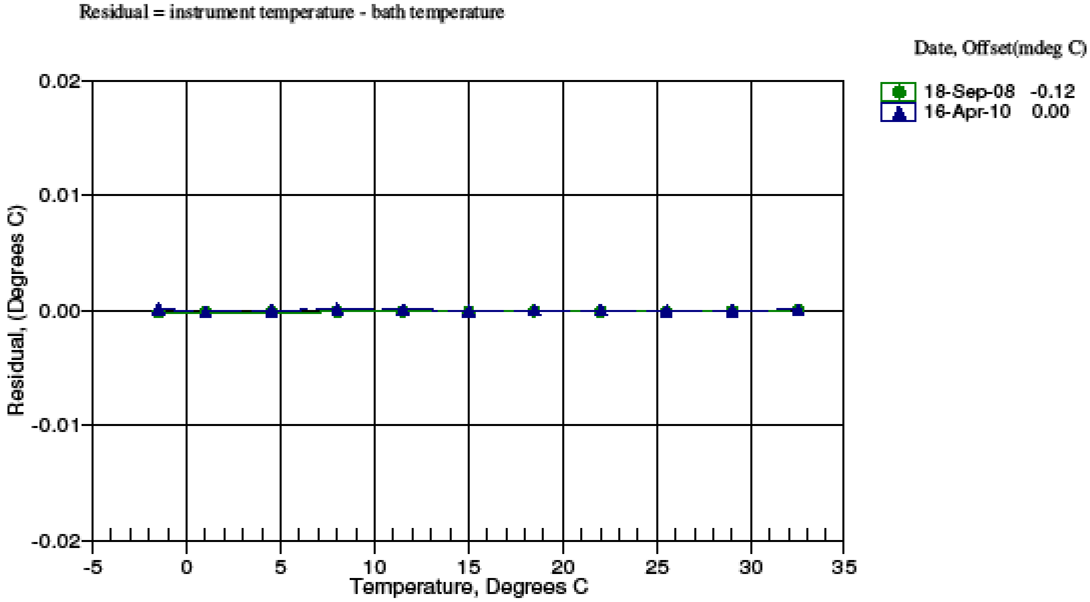
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2907.932	-1.4999	0.00010
1.0000	3073.945	0.9999	-0.00014
4.4999	3317.742	4.4998	-0.00008
7.9999	3575.143	8.0000	0.00012
11.4999	3846.471	11.5000	0.00006
15.0000	4132.097	14.9999	-0.00006
18.5000	4432.363	18.5000	0.00001
22.0000	4747.582	22.0000	0.00000
25.5000	5078.072	25.5000	-0.00002
29.0000	5424.138	29.0000	-0.00004
32.5000	5786.078	32.5000	0.00004

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



CTD Conductivity (Primary)

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1223
CALIBRATION DATE: 28-Jan-10

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -4.15446488e+000
h =  5.22247214e-001
i = -1.93705608e-004
j =  3.80769144e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  1.21913091e-005
b =  5.21650534e-001
c = -4.15259822e+000
d = -8.09335860e-005
m =  4.3
CPcor = -9.5700e-008 (nominal)
```

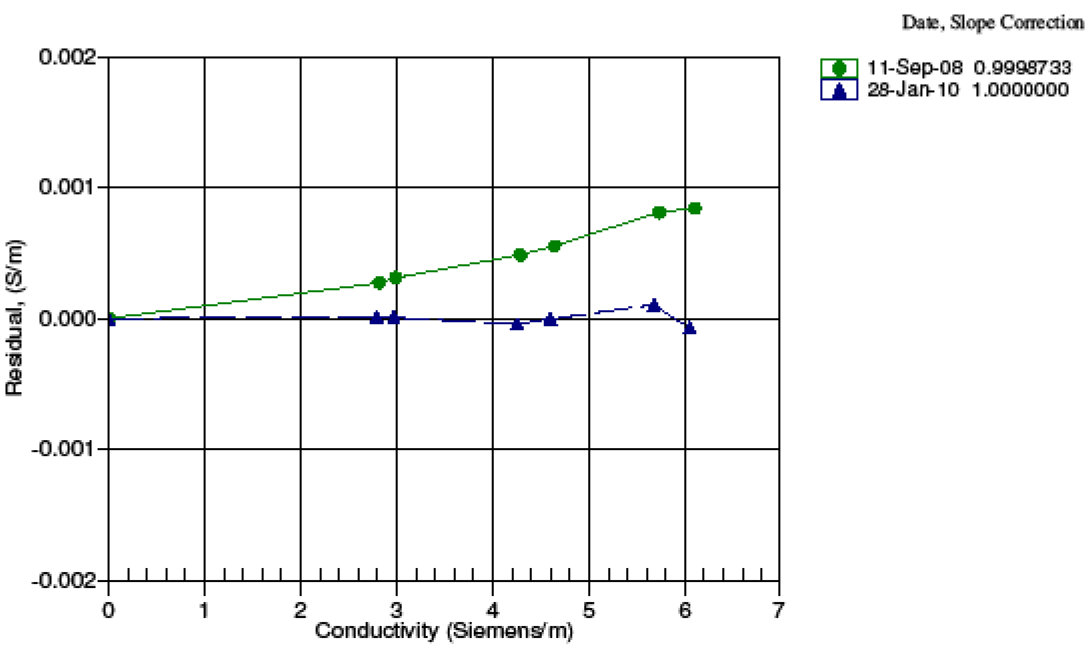
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.82111	0.00000	0.00000
-0.9499	34.6321	2.79534	7.83479	2.79536	0.00001
1.0815	34.6320	2.96874	8.04293	2.96874	0.00001
14.9999	34.6318	4.25136	9.43909	4.25131	-0.00004
18.4999	34.6310	4.59642	9.78021	4.59642	-0.00001
29.0000	34.6281	5.67495	10.77555	5.67506	0.00010
32.4999	34.6222	6.04595	11.09663	6.04588	-0.00007

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



CTD Conductivity (Secondary)

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2048
CALIBRATION DATE: 21-Apr-10

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS
g = -1.03133379e+001
h = 1.43412702e+000
i = -5.62945873e-003
j = 6.09810841e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 1.82579531e-006
b = 1.41846003e+000
c = -1.02774333e+001
d = -6.55266496e-005
m = 6.1
CPcor = -9.5700e-008 (nominal)

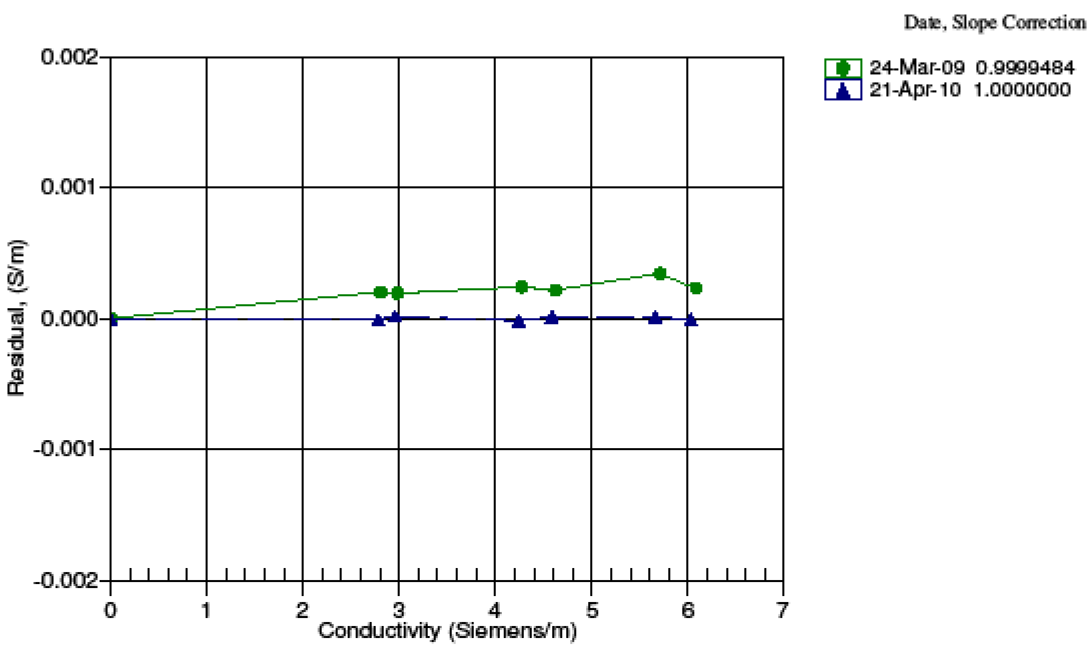
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.69177	0.00000	0.00000
-1.0000	34.5068	2.78196	5.17966	2.78195	-0.00001
1.0000	34.5070	2.95203	5.29378	2.95205	0.00002
14.9999	34.5081	4.23778	6.08636	4.23776	-0.00002
18.5000	34.5076	4.58181	6.28114	4.58182	0.00001
29.0000	34.5067	5.65729	6.85334	5.65730	0.00001
32.5000	34.5007	6.02715	7.03900	6.02714	-0.00001

Conductivity = $(g + hf^2 + if^3 + jf^4)/10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



CTD Dissolved Oxygen (Primary) (casts 001 through 003)

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0190
CALIBRATION DATE: 10-Feb-10p

SBE 43 OXYGEN CALIBRATION DATA

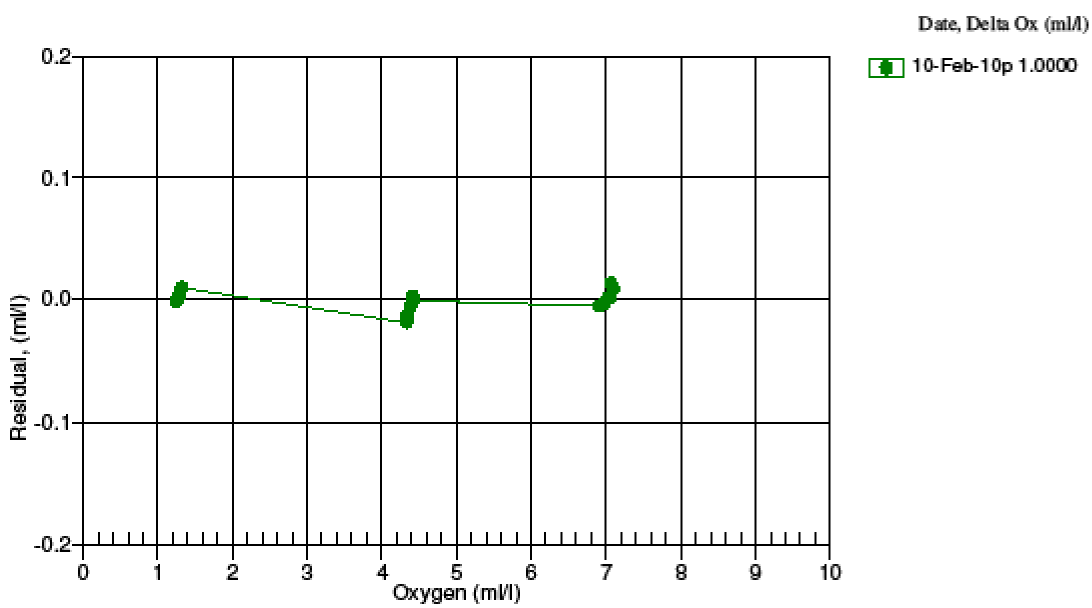
COEFFICIENTS
Soc = 0.5655
Voffset = -0.4980
Tau20 = 1.12

A = -7.2021e-003
B = 3.4448e-004
C = -3.9733e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.30000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.24	2.00	0.00	0.728	1.24	-0.00
1.26	6.00	0.01	0.763	1.26	0.00
1.28	12.00	0.01	0.814	1.29	0.00
1.29	20.00	0.01	0.874	1.30	0.01
1.31	26.00	0.02	0.920	1.32	0.01
1.32	30.00	0.02	0.950	1.33	0.01
4.33	2.00	0.00	1.297	4.31	-0.02
4.34	6.00	0.01	1.405	4.33	-0.01
4.38	20.00	0.01	1.763	4.38	-0.01
4.39	12.00	0.01	1.572	4.38	-0.01
4.42	30.00	0.02	1.995	4.42	0.00
4.42	26.00	0.02	1.910	4.42	-0.00
6.90	30.00	0.02	2.834	6.89	-0.00
6.97	20.00	0.01	2.511	6.97	-0.00
7.02	26.00	0.02	2.741	7.02	0.00
7.04	6.00	0.01	1.976	7.05	0.00
7.06	2.00	0.00	1.809	7.08	0.01
7.09	12.00	0.01	2.240	7.10	0.01

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU] K = temperature [deg K]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



CTD Dissolved Oxygen (Primary) (casts 004 and on)

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0182
CALIBRATION DATE: 29-Sep-10p

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.5118
Voffset = -0.5044
Tau20 = 1.00

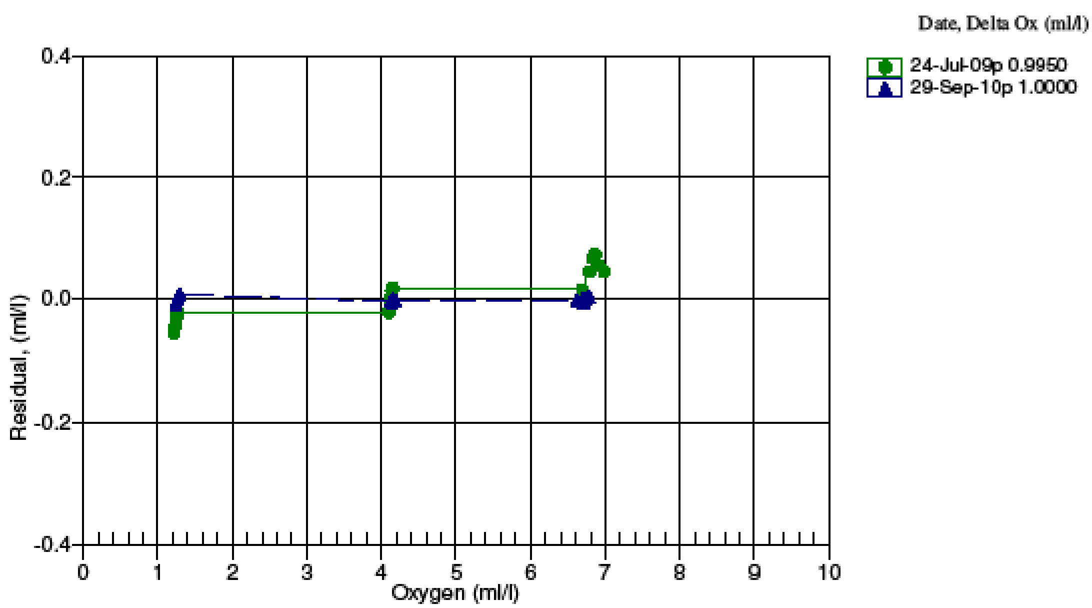
A = -6.3560e-003
B = 3.9961e-004
C = -5.1482e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.30000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.24	2.00	0.02	0.757	1.24	-0.01
1.25	6.00	0.02	0.790	1.24	-0.00
1.26	12.00	0.02	0.841	1.26	0.00
1.28	20.00	0.02	0.902	1.28	0.01
1.28	26.00	0.02	0.943	1.29	0.01
1.29	30.00	0.02	0.971	1.30	0.01
4.12	6.00	0.02	1.453	4.12	-0.00
4.14	2.00	0.02	1.349	4.14	-0.01
4.14	12.00	0.02	1.608	4.14	-0.00
4.17	20.00	0.02	1.796	4.17	0.00
4.17	26.00	0.02	1.921	4.18	0.00
4.18	30.00	0.02	2.005	4.18	0.00
6.62	30.00	0.02	2.878	6.62	-0.00
6.68	12.00	0.02	2.285	6.68	0.00
6.70	20.00	0.02	2.578	6.70	0.00
6.70	26.00	0.02	2.775	6.69	-0.00
6.72	6.00	0.02	2.051	6.72	0.00
6.78	2.00	0.02	1.889	6.78	0.01

Oxygen (ml/l) = Soc * (V + Voffset) * $(1.0 + A * T + B * T^2 + C * T^3)$ * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU] K = temperature [deg K]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



CTD Dissolved Oxygen (Secondary)

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0200
CALIBRATION DATE: 15-Apr-10p

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.3842
Voffset = -0.5084
Tau20 = 1.06

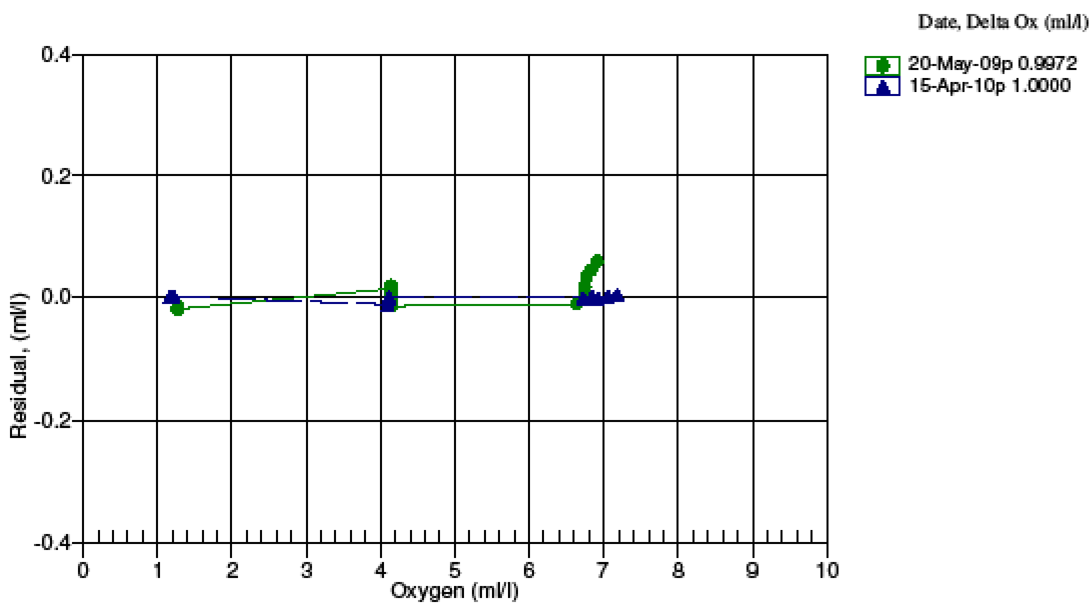
A = -1.7144e-003
B = 1.7161e-004
C = -3.1824e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.30000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.16	2.00	0.00	0.822	1.16	0.00
1.17	6.00	0.00	0.860	1.17	0.00
1.19	12.00	0.00	0.919	1.19	0.00
1.20	20.00	0.00	0.997	1.20	0.00
1.21	26.00	0.00	1.056	1.21	0.00
1.22	30.00	0.00	1.098	1.22	0.00
4.10	2.00	0.00	1.611	4.09	-0.01
4.10	6.00	0.00	1.738	4.10	-0.00
4.10	12.00	0.00	1.926	4.10	-0.00
4.11	20.00	0.00	2.175	4.11	0.00
4.12	26.00	0.00	2.365	4.11	-0.00
4.12	30.00	0.00	2.502	4.12	0.00
6.72	30.00	0.00	3.758	6.72	-0.00
6.82	26.00	0.00	3.585	6.81	-0.00
6.84	20.00	0.00	3.283	6.84	0.00
6.92	12.00	0.00	2.901	6.92	-0.00
7.05	6.00	0.00	2.625	7.05	0.00
7.18	2.00	0.00	2.446	7.18	0.01

Oxygen (ml/l) = Soc * (V + Voffset) * $(1.0 + A * T + B * T^2 + C * T^3)$ * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU] K = temperature [deg K]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



CTD Primary Fluorometer

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 2/11/2010 S/N: FLRTD-380

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark Counts)

	Analog Range 1	Analog Range 2	Analog Range 4 (default)	Digital
Dark Counts	0.102	0.059	0.037 V	73 counts
Scale Factor (SF)	6	13	26 µg/l/V	0.0077 µg/l/count
Maximum Output	4.93	4.93	4.93 V	16326 counts
Resolution	0.8	0.8	0.8 mV	1.0 counts

Ambient temperature during characterization 22.3 °C

Analog Range: 1 (most sensitive, 0–4,000 counts), 2 (midrange, 0–8,000 counts), 4 (entire range, 0–16,000 counts).

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations *in-situ* is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

FLRTD-380_workbook.xls Revision J 3/17/08

CTD PAR

Biospherical Instruments Inc

CALIBRATION CERTIFICATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 02/05/10 **Job No.:** R-10502
Model Number: QSP-200L
Serial Number: 4403
Operator: TPC
Standard Lamp: GS1024(8/28/08)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP-200 uses a log amplifier to measure the detector signal current with V = log I (Amps) / IRef
To calculate irradiance, use this formula:

Irradiance = Calibration factor * (10^Light Signal Voltage - 10^Dark Voltage)

With the appropriate (solar corrected) Irradiance Calibration Factor:

Dry Calibration Factor:	**2.08E+13**	**quanta/cm²·sec/"amps"**	**3.45E-05**	**µEinsteins/cm²·sec/"amps"**
Wet Calibration Factor:	**3.50E+13**	**quanta/cm²·sec/"amps"**	**5.81E-05**	**µEinsteins/cm²·sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	86.4	mA		
Supply Voltage:	6	Volts		
Lamp Integrated PAR Irradiance:	9.27E+15	quanta/cm^2·sec	0.01540	µEinsteins/cm²sec
SC3 Immersion Coefficient:	0.594	Scalar Correction: 1		PAR Solar Correction: 1.0000

Nominal Filter OD	Calibrated Trans.	Sensor Voltage	Measured Trans.	Measured Signal (Amps)	Estimated Signal (Amps)	Calc. Output (Volts)	Error (Volts)	Error (%)	Test Irrad. (quanta/ cm^2·sec)
No Filter	100.00%	2.651	100.00%	4.48E-08	4.48E-08	2.652	0.001	0.0	9.27E+15
0.3	36.10%	2.218	36.70%	1.64E-08	1.62E-08	2.212	-0.006	-1.6	3.40E+15
0.5	27.60%	2.105	28.22%	1.26E-08	1.24E-08	2.097	-0.008	-2.2	2.62E+15
1	9.27%	1.661	9.95%	4.46E-09	4.15E-09	1.632	-0.029	-6.9	9.23E+14
2	1.11%	0.854	1.29%	5.76E-10	4.97E-10	0.804	-0.050	-13.8	1.19E+14
3	0.05%	0.260	0.09%	4.23E-11	2.39E-11	0.214	-0.046	-43.5	8.77E+12

Dark Before: 0.145 Volts
Light - No Filter Hldr.: 2.650 Volts I_{Ref} = 1.00E-10 Amps
Dark After - NFH: 0.146 Volts I_{Dark} = 1.40E-10 Amps RG780 0.205
Average Dark 0.145 Volts 10^{VDark} = 1.397655 Amps

Notes:
1. Annual calibration is recommended.
2. There is increasing error associated with readings below zero.
3. The collector should be cleaned frequently with alcohol.
4) This section is for internal use and for more advanced analysis.

QSP-200L,QSP2300(2006-) .xls

CTD Transmissometer

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

C-Star Calibration

Date October 14, 2009 S/N# CST-830DR Pathlength 25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.793 V
V_{ref}	4.651 V

Temperature of calibration water	23.1 °C
Ambient temperature during calibration	23.0 °C

Relationship of transmittance (Tr) to beam attenuation coefficient (c), and pathlength (x, in meters): **$Tr = e^{-cx}$**

To determine beam transmittance: **$Tr = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})$**

To determine beam attenuation coefficient: **$c = -1/x * \ln(Tr)$**

V_d Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.

Revision L 6/9/09

Deployed Calibration Sheets

PRR-800 Irradiance

Biospherical Instruments Inc.

System Serial Number	8000803115		
Calibration database	8000803115v6.mdb	Date of Calibration	7/2/2009
DASSN	0070	Date of Certificate	7/2/2009
Microprocessor Tag Number	1	Standard of Spectral Irradiance	GS-1019(8/28/08)
		Operator	TPC

PRR-800 Irradiance

Note:
Calibration factors are immersion corrected for use under water

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per µW/(cm² nm)]	ScaleSmall [Volts per µW/(cm^nm)]	ScaleMedium [Volts per µW/(cm^nm)]	ScaleLarge [Volts per µW/(cm² nm)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
EdZ313	1	313	1.3897E-10	1.4175E-05	4.1414E-03	1.3556E+00	1.0000E-06	3.0000E-06	1.5700E-04	µW/(cm²nm)
EdZ320	2	320	1.6854E-10	1.7191E-05	5.0224E-03	1.7899E+00	1.7800E-04	1.8100E-04	4.1600E-04	µW/(cm²nm)
EdZ340	3	340	1.3122E-10	1.3384E-05	3.9103E-03	1.4285E+00	1.2400E-04	1.1900E-04	3.6700E-04	µW/(cm²nm)
EdZ380	4	380	5.6068E-11	5.7189E-06	1.6708E-03	5.8741E-01	-2.0400E-04	-2.1000E-04	-1.1700E-04	µW/(cm²nm)
EdZ395	5	395	2.5920E-10	2.6438E-05	7.7240E-03	2.6801E+00	-4.8200E-04	-4.8300E-04	-4.8500E-04	µW/(cm²nm)
EdZ412	6	412	3.3144E-10	3.3807E-05	9.8769E-03	3.4854E+00	-6.0000E-06	-1.1000E-05	1.5700E-04	µW/(cm²nm)
EdZ443	7	443	3.0204E-10	3.0808E-05	9.0008E-03	3.2336E+00	-2.1300E-04	-2.1600E-04	-1.8500E-04	µW/(cm²nm)
EdZ490	8	490	6.0963E-10	6.2182E-05	1.8167E-02	5.6874E+00	-1.9300E-04	-1.9200E-04	-1.2000E-04	µW/(cm²nm)
EdZ510	9	510	7.9719E-10	8.1313E-05	2.3756E-02	8.4034E+00	-2.6300E-04	-2.6700E-04	-1.5600E-04	µW/(cm²nm)
EdZ520	10	520	9.0387E-10	9.2194E-05	2.6935E-02	9.6560E+00	-2.4000E-04	-2.4200E-04	-1.8600E-04	µW/(cm²nm)
EdZ532	11	532	6.5970E-10	6.7290E-05	1.9659E-02	6.9615E+00	1.2400E-04	1.2100E-04	2.8700E-04	µW/(cm²nm)
EdZ555	13	555	8.0373E-10	8.1980E-05	2.3951E-02	7.4497E+00	3.6000E-05	2.9000E-05	1.7200E-04	µW/(cm²nm)
EdZ565	14	565	8.0245E-10	8.1850E-05	2.3913E-02	7.9788E+00	1.2300E-04	1.2400E-04	1.0900E-04	µW/(cm²nm)
EdZ625	15	625	1.3694E-09	1.3967E-04	4.0807E-02	1.3749E+01	-6.9300E-04	-6.9500E-04	-6.1200E-04	µW/(cm²nm)
EdZ665	16	665	8.9783E-10	9.1579E-05	2.6755E-02	9.3278E+00	1.2100E-04	1.1900E-04	2.7800E-04	µW/(cm²nm)
EdZ670	17	670	2.0248E-09	2.0653E-04	6.0339E-02	1.9454E+01	3.9300E-04	3.9300E-04	6.8700E-04	µW/(cm²nm)

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per µE/(cm² s)]	ScaleSmall [Volts per µE/(cm^s)]	ScaleMedium [Volts per µE/(cm^s)]	ScaleLarge [Volts per µE/(cm² s)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
EdZPAR1	18	400-700	1.7784E-05	1.8139E+00	5.2995E+02	1.8787E+05	4.3000E-05	4.2000E-05	1.2580E-03	µE/(cm²sec)
EdZPAR2	19	400-700	1.7031E-05	1.7371E+00	5.0752E+02	1.8318E+05	4.8500E-04	4.8400E-04	1.7200E-03	µE/(cm²sec)

Auxiliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	
EdZGnd	0	0	1	1	1	1	0	0	0	V
WTemp	20	0	1	0.1912	0.1912	0.1912	-0.0512	-0.0512	-0.0512	C
Depth	21	0	1	0.0265	0.0265	0.0265	0.2801	0.2801	0.2801	m
EdZTemp	22	0	1	0.01	0.01	0.01	0	0	0	C
Tilt	24	0	1	0.0343	0.0343	0.0343	3.5000	3.5000	3.5000	°
Roll	25	0	1	0.0344	0.0344	0.0344	3.5056	3.5056	3.5056	°
EdZVin	27	0	1	-0.25	-0.25	-0.25	0	0	0	V

Calibration Data – Do Not Destroy page 2 of 4

PRR-800 Radiance

Biospherical Instruments Inc.

System Serial Number	8000803115		
Calibration database	80000803115v6.mdb	Date of Calibration	7/2/2009
DASSN	0071	Date of Certificate	7/2/2009
Microprocessor Tag Number	2	Standard of Spectral Irradiance	GS-1019(8/28/08)
		Operator	TPC

PRR-800 Radiance

Note:
Calibration factors are immersion corrected for use under water

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per μW/(cm^2nm sr)]	ScaleSmall [Volts per μW/(cm^2nm sr)]	ScaleMedium [Volts per μW/(cm^2nm sr)]	ScaleLarge [Volts per μW/(cm^2nm sr)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
LuZ313	1	313	7.2755E-09	7.4210E-04	2.1681E-01	7.4645E+01	2.9300E-04	2.9500E-04	5.0700E-04	μW/(srcm^2nm)
LuZ320	2	320	9.5230E-09	9.7134E-04	2.8379E-01	9.5527E+01	-2.5700E-04	-2.5500E-04	-2.6900E-04	μW/(srcm^2nm)
LuZ340	3	340	6.7255E-09	6.8600E-04	2.0042E-01	7.1935E+01	4.1900E-04	4.1400E-04	-1.2210E-03	μW/(srcm^2nm)
LuZ380	4	380	2.4453E-09	2.4942E-04	7.2870E-02	2.5462E+01	4.8600E-04	4.8600E-04	2.8400E-04	μW/(srcm^2nm)
LuZ395	5	395	9.3990E-09	9.5870E-04	2.8009E-01	9.9862E+01	1.0000E-04	1.0100E-04	-6.9900E-04	μW/(srcm^2nm)
LuZ412	6	412	9.8576E-09	1.0055E-03	2.9376E-01	9.3769E+01	8.6000E-05	9.0000E-05	1.3800E-04	μW/(srcm^2nm)
LuZ443	7	443	8.9492E-09	9.1281E-04	2.6668E-01	9.2344E+01	-2.1800E-04	-2.1800E-04	-2.6500E-04	μW/(srcm^2nm)
LuZ490	8	490	1.7072E-08	1.7413E-03	5.0874E-01	1.6369E+02	5.5600E-04	5.5800E-04	3.5500E-04	μW/(srcm^2nm)
LuZ510	9	510	1.9247E-08	1.9632E-03	5.7357E-01	2.0608E+02	4.4900E-04	4.4500E-04	-3.6000E-05	μW/(srcm^2nm)
LuZ520	10	520	1.9931E-08	2.0330E-03	5.9395E-01	2.1147E+02	1.1700E-04	1.1400E-04	-2.2500E-04	μW/(srcm^2nm)
LuZ532	11	532	1.5625E-08	1.5937E-03	4.6562E-01	1.5909E+02	5.9400E-04	5.9000E-04	-1.0490E-03	μW/(srcm^2nm)
LuZ555	14	555	1.8935E-08	1.9313E-03	5.6425E-01	1.8029E+02	-3.9700E-04	-3.9800E-04	-1.1270E-03	μW/(srcm^2nm)
LuZ565	15	565	1.8466E-08	1.8835E-03	5.5028E-01	2.0078E+02	1.1700E-04	1.0900E-04	-2.0260E-03	μW/(srcm^2nm)
LuZ625	16	625	2.8294E-08	2.8860E-03	8.4316E-01	2.8076E+02	2.7200E-04	2.7100E-04	1.2100E-04	μW/(srcm^2nm)
LuZ665	17	665	1.7589E-08	1.7941E-03	5.2415E-01	1.6173E+02	-7.5000E-05	-7.2000E-05	-1.1000E-04	μW/(srcm^2nm)
LuZ670	18	670	3.8477E-08	3.9246E-03	1.1466E+00	3.6016E+02	-3.6000E-05	-3.7000E-05	6.0000E-05	μW/(srcm^2nm)

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per nE/(m^2*s)]	ScaleSmall [Volts per nE/(m^2*s)]	ScaleMedium [Volts per nE/(cm^2*s)]	ScaleLarge [Volts per nE/(cm^2*s)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
LuZChl	19	Chl Emiss Spec	3.9063E-11	3.9844E-06	1.1641E-03	3.6959E-01	-1.3200E-04	-1.3100E-04	-7.4000E-05	nE/(srm^2sec)

Auxiliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	
LuZGnd	0	0	1	1	1	1	0	0	0	V
LuZTemp	22	0	1	0.01	0.01	0.01	0	0	0	C
LuZVin	27	0	1	-0.25	-0.25	-0.25	0	0	0	V

Calibration Data – Do Not Destroy page 3 of 4

PRR-810 (Surface Reference Unit)

Biospherical Instruments Inc.

System Serial Number	8000803115		
Calibration database	8000803115v6.mdb	Date of Calibration	7/2/2009
DASSN	0072	Date of Certificate	7/2/2009
Microprocessor Tag Number	3	Standard of Spectral Irradiance	GS-1019(8/28/08)
		Operator	TPC

Note:

PRR-810 Calibration

Monochromatic Channels	Address	Wavelength (nm)	Responsivity (Amps per μW/(cm² nm))	ScaleSmall (Volts per μW/(cm² nm))	ScaleMedium (Volts per μW/(cm² nm))	ScaleLarge (Volts per μW/(cm² nm))	OffsetSmall (volts)	OffsetMedium (volts)	OffsetLarge (volts)	Measurement Units
Ed0313	1	313	2.1139E-10	2.1562E-05	6.2994E-03	2.2326E+00	1.3100E-04	1.3000E-04	2.5300E-04	μW/(cm² nm)
Ed0320	2	320	2.5898E-10	2.6414E-05	7.7171E-03	2.7503E+00	-3.2000E-05	-3.1000E-05	-2.1000E-05	μW/(cm² nm)
Ed0340	3	340	1.8874E-10	1.9252E-05	5.6245E-03	1.9787E+00	1.9300E-04	1.9000E-04	-9.4000E-05	μW/(cm² nm)
Ed0380	4	380	8.9484E-11	9.1274E-06	2.6666E-03	9.3554E-01	8.1000E-04	8.0700E-04	-6.7000E-05	μW/(cm² nm)
Ed0395	5	395	3.8729E-10	3.9503E-05	1.1541E-02	4.1563E+00	-3.3000E-04	-3.3000E-04	-4.2100E-04	μW/(cm² nm)
Ed0412	6	412	4.4146E-10	4.5029E-05	1.3156E-02	4.6592E+00	1.0200E-04	1.0300E-04	-2.8500E-04	μW/(cm² nm)
Ed0443	7	443	4.2087E-10	4.2929E-05	1.2542E-02	4.3361E+00	1.3900E-04	1.4300E-04	1.0500E-04	μW/(cm² nm)
Ed0490	8	490	8.2041E-10	8.3682E-05	2.4448E-02	8.6783E+00	-6.7000E-05	-7.0000E-05	-1.3400E-04	μW/(cm² nm)
Ed0510	9	510	1.0737E-09	1.0952E-04	3.1996E-02	1.1399E+01	6.2200E-04	6.1900E-04	3.7800E-04	μW/(cm² nm)
Ed0520	10	520	1.2311E-09	1.2558E-04	3.6688E-02	1.3373E+01	-2.4200E-04	-2.4100E-04	-7.7100E-04	μW/(cm² nm)
Ed0532	11	532	8.9115E-10	9.0897E-05	2.6556E-02	9.3598E+00	6.6000E-05	6.7000E-05	6.5000E-05	μW/(cm² nm)
Ed0555	13	555	1.0538E-09	1.0749E-04	3.1404E-02	1.1196E+01	-2.0700E-04	-2.1000E-04	-2.4200E-04	μW/(cm² nm)
Ed0565	14	565	1.0789E-09	1.1005E-04	3.2151E-02	1.0328E+01	-7.0000E-05	-7.3000E-05	-7.4000E-05	μW/(cm² nm)
Ed0625	15	625	1.8181E-09	1.8544E-04	5.4178E-02	1.7901E+01	5.7700E-04	5.8200E-04	6.9900E-04	μW/(cm² nm)
Ed0665	16	665	1.1801E-09	1.2037E-04	3.5166E-02	1.2634E+01	-1.1800E-04	-1.2800E-04	-1.5730E-03	μW/(cm² nm)
Ed0670	17	670	2.7190E-09	2.7734E-04	8.1026E-02	2.8610E+01	-9.0000E-06	-1.2000E-05	-7.2000E-05	μW/(cm² nm)

Broadband Channels	Address	Wavelength (nm)	Responsivity (Amps per μE/(cm² s))	ScaleSmall (Volts per μE/(cm² s))	ScaleMedium (Volts per μE/(cm² s))	ScaleLarge (Volts per μE/(cm² s))	OffsetSmall (volts)	OffsetMedium (volts)	OffsetLarge (volts)	Measurement Units
Ed0PAR1	18	400-700	2.3308E-05	2.3774E+00	6.9458E+02	2.2254E+05	-3.7600E-04	-3.7700E-04	-4.0500E-04	μE/(cm²sec)
Ed0PAR2	19	400-700	2.2748E-05	2.3203E+00	6.7789E+02	2.4208E+05	-1.2800E-04	-1.2800E-04	-5.2400E-04	μE/(cm²sec)

Auxiliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	
Ed0Gnd	0	0	1	1.00	1.00	1.00	0.00	0.00	0.00	V
Ed0Temp	22	0	1	0.01	0.01	0.01	0.00	0.00	0.00	C
Ed0Vin	27	0	1	-0.25	-0.25	-0.25	0.00	0.00	0.00	V

Calibration Data – Do Not Destroy page 4 of 4

PUV

Biospherical Instruments Inc.

PUV-2500 Calibration Certificate

Calibration factors are immersion corrected for use under water

System Serial Number	25000203113		
Calibration database	25000203113v3.mdb	Date of Calibration	9-29-05
DASSN	0064	Date of Certificate	10/4/2005
Microprocessor Tag Number	1	Standard of Spectral Irradiance	99188(4/12/05)
		Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per µW/(cm^2·nm)]	ScaleSmall [Volts per µW/(cm^2·nm)]	ScaleMedium [Volts per µW/(cm^2·nm)]	ScaleLarge [Volts per µW/(cm^2·nm)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
EdZ305	2	305	1.4462E-11	1.4751E-06	4.3096E-04	1.3738E-01	-4.1720E-04	-4.2216E-04	-2.6465E-04	µW/(cm^{2}nm)
EdZ313	5	313	1.3180E-10	1.3443E-05	3.9276E-03	1.2240E+00	-1.5039E-04	-1.5444E-04	-1.5242E-04	µW/(cm^{2}nm)
EdZ320	6	320	9.1103E-11	9.2925E-06	2.7149E-03	8.8670E-01	1.9994E-04	1.9488E-04	4.0567E-04	µW/(cm^{2}nm)
EdZ340	11	340	1.1567E-10	1.1798E-05	3.4469E-03	1.0790E+00	1.2609E-04	1.2475E-04	2.3951E-04	µW/(cm^{2}nm)
EdZ380	18	380	5.3398E-11	5.4466E-06	1.5913E-03	5.1716E-01	1.7755E-04	1.7524E-04	3.0760E-04	µW/(cm^{2}nm)
EdZ395	10	395	2.1295E-10	2.1721E-05	6.3460E-03	2.2549E+00	-9.7043E-06	-1.1754E-05	1.8627E-04	µW/(cm^{2}nm)

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per µE/(cm^2·s)]	ScaleSmall [Volts per µE/(cm^2·s)]	ScaleMedium [Volts per µE/(cm^2·s)]	ScaleLarge [Volts per µE/(cm^2·s)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
EdZPAR	14	0	1.7610E-05	1.7963E+00	5.2479E+02	1.6696E+05	1.0244E-04	9.0243E-05	2.1383E-04	µE/(cm^{2}sec)
LuZChl	15	0	5.2889E-11	5.3947E-06	1.5761E-03	5.4263E-01	-1.5166E-05	-2.2920E-05	7.1193E-05	nE/(sr·m^{2}sec)

Auxiliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
EdZGnd	0	0	1	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	V
WTemp	20	0	1.0000E+00	1.9017E-01	1.9017E-01	1.9017E-01	-2.4542E-01	-2.4542E-01	-2.4542E-01	C
Depth	21	0	1.0000E+00	2.5534E-02	2.5534E-02	2.5534E-02	2.8672E-01	2.8672E-01	2.8672E-01	m
EdZTemp	22	0	1.0000E+00	1.0000E-02	1.0000E-02	1.0000E-02	0.0000E+00	0.0000E+00	0.0000E+00	C
LuZTemp	23	0	1.0000E+00	1.0000E-02	1.0000E-02	1.0000E-02	0.0000E+00	0.0000E+00	0.0000E+00	C
Tilt	24	0	1.0000E+00	3.5635E-02	3.5635E-02	3.5635E-02	3.4980E+00	3.4980E+00	3.4980E+00	°
Roll	25	0	1.0000E+00	3.6663E-02	3.6663E-02	3.6663E-02	3.5291E+00	3.5291E+00	3.5291E+00	°
EdZVin	27	0	1.0000E+00	-2.5000E-01	-2.5000E-01	-2.5000E-01	0.0000E+00	0.0000E+00	0.0000E+00	V

Calibration Data – Do Not Destroy page 2 of 3

Mocness Calibration Sheets

Pressure

DEPTH SENSOR CALIBRATION
SERIAL #178 XI-18-2010

The pressure sensor used in MOCNESS is a titarum strain gauge with an internal temperature sensor. The temperature f the sensor is measured and used to correct for thermal effects. The MCNESS measures the voltage across the temperature and pressure bridges f the sensor and reports these values in its output data stream. The MCNESS pressure sensor is calibrated at several pressure points and ro temperatures. There are no adjustments in the MOCNESS hardware andll the calibration is done with software in the surface control computer. Te values sent up the wire in the MOCNESS data straam (the bridge voltage) are scaled to be sent as integers in the range of 0–99999 for temperatu. The calibration data is fit in the following equation:

Z=(C1*VT+C0)*VP^2+(B1*VT+B0)*VP+(A1*VT+A0)

Where
- Z = pressure in decibars (1 decibar is aprox. 1m of water)
- VP = voltage reading from pressure sensr
- VT = voltage reading from strain gauge teperature sensor

Serial number = 178

C1= -4.905836339649276e-12

C0= 3.913477086547072e-08

B1= 1.144591303033090e-07

B0= 0.10333754008354

A1= -0.00410050111951

A0= -1.521207434502750e+02

A

Temperature

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2470
CALIBRATION DATE: 27-Jan-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.31691782e-003
h = 6.54931954e-004
i = 2.45468568e-005
j = 2.33644788e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121479e-003
b = 6.12825460e-004
c = 1.75320965e-005
d = 2.33814547e-006
f0 = 2731.562

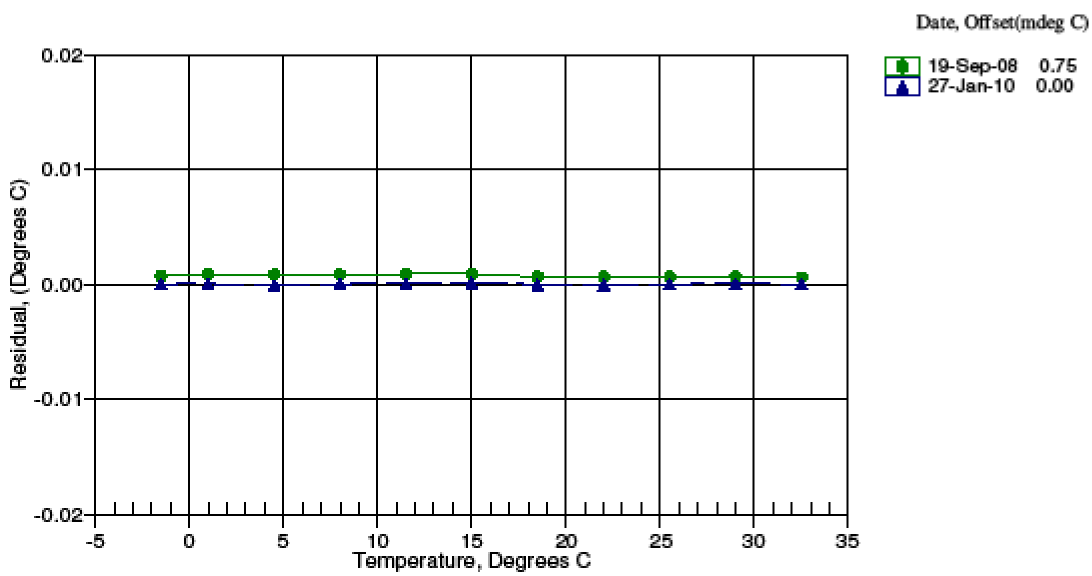
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5002	2731.562	-1.5002	0.00002
0.9998	2885.651	0.9998	0.00003
4.4999	3111.768	4.4998	-0.00011
7.9998	3350.316	7.9998	-0.00000
11.4998	3601.616	11.4998	0.00005
14.9999	3865.986	15.0000	0.00011
18.4998	4143.689	18.4998	-0.00002
21.9998	4435.059	21.9997	-0.00009
25.4998	4740.377	25.4998	-0.00000
28.9998	5059.894	28.9998	0.00002
32.4998	5393.869	32.4998	0.00001

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



Conductivity

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2047
CALIBRATION DATE: 28-Aug-09

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -1.06216482e+001
h =  1.45506045e+000
i = -5.67339561e-003
j =  6.18791169e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  1.88214514e-006
b =  1.43936849e+000
c = -1.05859556e+001
d = -6.87782781e-005
m =  6.1
CPcor = -9.5700e-008 (nominal)
```

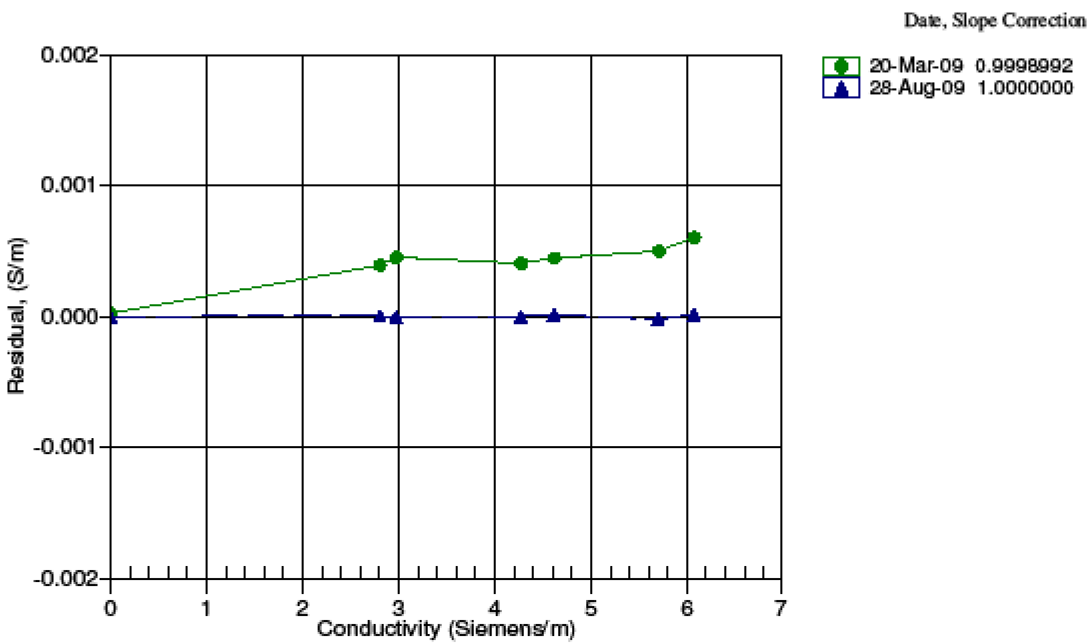
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.71193	0.00000	0.00000
-0.9999	34.7785	2.80182	5.17599	2.80183	0.00000
1.0001	34.7794	2.97312	5.28932	2.97311	-0.00001
15.0001	34.7801	4.26765	6.07668	4.26765	0.00000
18.5001	34.7800	4.61408	6.27027	4.61409	0.00001
29.0001	34.7799	5.69704	6.83911	5.69702	-0.00002
32.5001	34.7758	6.06974	7.02389	6.06975	0.00001

Conductivity = $(g + hf^2 + if^3 + jf^4)/10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



Fluorometer (only used on first cast)

PO Box 518
620 Applegate St.
Philomath OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
http://www.wetlabs.com

Chlorophyll Fluometer Characterization

Date:	**04/1/10**
Serial #:	AFD-001
Tech:	DCI

Dark Counts	**0.1841 volts**
CEV	**2.431 volts**
SF	**9.835**
FSV	**4.70 volts**
Linearity:	**0.999 R^2 (0–1.5 volts)**
	0.995 R^2 (0– 5.45 volts)

Notes:

Dark Counts: Sigal output of the meter in clean water with black tape over detector.

CEV is the chlorohyll equivalent voltage. This value is the signal output of the fluorometer when uing a fluorescent proxy that has been determined to be approximately equivalent to **22.1** g/l of a *Thalassiosira weissflogii* phytoplanktum culture.

SF is the scale fact used to derive chlorophyll concentration from the signal voltage output of the fluormeter. The scale factor is determine by using the following equation: SF = (22.1) / (CEV- dark).

FSV is the maximun signal voltage output that the fluorometer is capable of.

Chlorophyll concentran expressed in µg/l (mg/m^3) can be derived by using the following equation: (µg/l) = (Vmeasured -dark) *SF

The relationship betwen fluorescence and chlorophyll-*a* concentrations in-situ is high variable. The scale factor listed on this doment was determined by using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The popution was assumed to be reasonably healthy and the concentration was determined by using the absorptiomethod. To accurately determine chlorophyll concentration using a fluorometer you must perform secdary measurements on the populations of interest. This is typically done using extraction based measument techniques on discrete samples. For additional information on determination of chlorophyll concention see [Standard Methods For The Examination Of Water And Wastewater] part 10200 H published joity by: American Public Health Association, American Water Works Association and Water Environme Federation.

Transmissometer (only used on first cast)

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

C-Star Calibration

Date September 30, 2009 S/N# CST-891DR Pathlength 25 cm

	Analog meter
V_d	0.058 V
V_{air}	4.828 V
V_{ref}	4.725 V

Temperature of calibration water	21.1 °C
Ambient temperature during calibration	22.9 °C

Relationship of transmittance (Tr) to beam attenuation coefficient (c), and pathlength (x, in meters): $Tr = e^{-cx}$

To determine beam transmittance: $Tr = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})$

To determine beam attenuation coefficient: $c = -1/x * \ln(Tr)$

V_d Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.

Revision L 6/9/09

Acquisition and Processing Information

Processing Specifics

Refer to the InstCoef.txt file along with the specific instrument calibration sheets, both located in the Cal/ directory of the data distribution, for information on how the RVDAS data was collected and processed.

Errors and Events

This section lists all significant events and known problems with acquisition during this cruise including instrument failures, data acquisition system failures, and other factors affecting this data set.

Date (Julian)	Time (GMT)	Event	Location
002	14:05	Started data logging	@68W
005	16:52	Stopped data logging	@ Palmer Station
007	11:14	Started data logging	Leaving Palmer Station
008	07:45	On CTD cast 003 pumps stopped working. Replaced both pumps and cable. Primary Oxygen sensor was also reading much lower than the secondary. Also swapped out primary Oxygen sensor.	63 57.91 S 066 51.27 W
009	01:00	On CTD cast 005 primary temperature sensor flooded. Replaced primary temp sensor.	64 36.63 S 068 17.81 W
022	17:21	Stopped data logging	@ Rothera Station
022	22:00	US defeats the Brits in soccer for the first time in Antarctic history.	Rothera Station
023	10:43	Started data logging	Leaving Rothera Station
035	10:22	Stopped data logging	@ Palmer Station
036	13:14	Started data logging	Leaving Palmer Station
039	15:37	Stopped data logging	@68W